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Geographical Society of
Central Himalaya

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Associate Editor: Dr. Rajesh Bhatt

Supervision: Prof. Kamlesh Kumar

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Edited by Vishwambhar Prasad Sati

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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.

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Research Article**Changing Farming Patterns in the West Kameng District, Eastern Himalaya**Norbu Jamchu Thongdok^{1*}; Vishwambhar Prasad Sati² and Vikrant Kumar²¹Department of Geography, Binni Yanga Government Women's College, Poma, Itanagar-791111²Department of Geography, Mizoram University (central), Tanhril, Aizawl-796004Corresponding author: E-mail: jamchuthongdok26@gmail.com**Abstract**

Farming practices form a cornerstone of rural livelihoods but remain highly dynamic. These practices exhibit considerable geographical variation across regions, shaped by a wide range of socio-economic factors. West Kameng District, located in the westernmost part of Arunachal Pradesh, has recently emerged as the state's "agricultural bowl" owing to its substantial and diverse agricultural output. The district benefits from a favourable agro-climatic zone that supports a wide array of field and horticultural crops. This study surveyed 423 farming households across 15 purposively selected villages identified as agricultural hotspots. Only active farmers were included, with a sample size fixed at 35% of the total households in each village. Data were analysed using the F-test and Compound Annual Growth Rate (CAGR) to assess the statistical significance of crop production differences and long-term growth trends. Results revealed a statistically significant difference in the production of kharif and rabi crops across years ($P = 0.0047$). However, CAGR values indicated only a marginal increase over time (0.038 for kharif and 0.004 for rabi), and the associated significance value of zero suggests no meaningful change in overall production levels in recent years. The study also identifies the primary drivers of shifts in farming patterns and recommends the adoption of climate-resilient and sustainable agricultural practices in the region.

Keywords: Farming, change, patterns, Kharif, Rabi**Introduction**

Agricultural practices and crops are highly dependent upon a particular geographical area. A cropping pattern refers to the distribution and arrangement of different crops cultivated in a specific area. In simple words, it is the sequential arrangement of the crops grown in different seasons over an allotted agricultural land. The cropping types and patterns are influenced by various physical and socioeconomic factors, including rainfall, temperature, humidity, and soil quality, as well as socio-economic factors like demand, supply, value, and minimum support price (MSP). The cropping pattern, defined as the proportion of land allocated to different crops at a specific time, is a crucial indicator of agricultural practices and reflects the complex interactions between ecological, economic, and social factors (Kaur, 2025). Existing literature highlights the complex nature of cropping pattern changes and their diverse impacts. Numerous studies have explored that the shift from traditional crops to cash crops is mostly driven by market demand and profitability; moreover, others have explained the role of technological advancements, such as high-yielding varieties and irrigation infrastructure, in enabling diversification and increased productivity (Chand & Gulati, 2012; BIRTHAL et al., 2015). Farming systems are dynamic, complex socio-ecological systems that provide food, feed, and cash and result from past farmers' livelihood strategies and land use decisions. Consequently, farming system changes and their drivers are heterogeneous and complex, varying between households, locations, and time (Carswell, 2000; Tittonell et al., 2011; Kebede et al., 2019).

Additionally, the growing impact of climate change on cropping patterns has led farmers to adapt their practices to cope with changing temperature and rainfall patterns (Aggarwal et al., 2004). Such variations in temperature, humidity, and rainfall drive the nature of the soil, agricultural practices, and patterns. Additionally, an understanding of how certain crops respond to specific soil types and underlying climatic conditions that support their growth

and yield (Thongdok & Sati, 2024). Cropping patterns are significantly influenced by various socio-economic factors, while underlying climatic conditions play a critical role in shaping changes in crop patterns and production. Notably, under rain-fed conditions, the production potential of a crop depends on the climatic conditions of an area. Therefore, each crop will flourish within a specific climatic setting that can be improved by management, yet climate change will alter the output of these requirements and subsequently, the geography of crop suitability and patterns (Travis, 2016; Chemura et al., 2020).

Nowadays, farming patterns have shifted from the cultivation of traditional crops to the cultivation of modern or cash crops, and with such a shift, farmers have adopted the practice of cultivating crops with higher demand and economic value. Traditional crops, which had high traditional value but no demand or economic value. The crops grown were fully subsistence, self-consumed, and lacked commercial value. Consequently, determinants such as population and climate change immensely influence the agricultural scenario of a region. As rising food crop demand led farmers to adopt those crops that have higher demand and price in the market, for the economic incentives and viability of the marginal farmers, on the other hand, due to socio-economic and climate variability; fluctuation of temperature, humidity, and rainfall and varying demand, and value of the crops have significantly modified the cropping patterns and farming systems (Thongdok & Sati, 2024). A study conducted by Thongdok et al. (2025) deliberates that due to a shift in farming patterns, like the introduction of fresh commercial crops replacing the traditional crops, has also enhanced the livelihood of the farmers, as commercial crops have higher demand and value in the market, hence, improving the revenue and livelihood sustainability of the farmers.

Study Area

West Kameng district is among the largest districts in the state of Arunachal Pradesh. The district is the westernmost region, sharing its international boundary with Bhutan to the west, the Pakke-Kesang district to the east, and Assam to the south. The district lies between 91° 30' and 92° 40' East longitudes and 26° 54' to 28° 01' North latitudes (Figure 1.1). The district's topography is undulating, and it ranges from 229 m up to 7090 m above mean sea level. The agroclimatic conditions also vary as the region is characterised by mainly five major climatic zones: sub-tropical, temperate, sub-temperate, alpine, and tundra, respectively. There are five major ethnic groups, which are the Shertukpen, Monpa, Sartang, Bugun (Khowa), and Aka (Hrusso). They have an agrarian-based occupation or economy; approximately 69.49 % of the total population is engaged in agriculture and allied activities in the district.

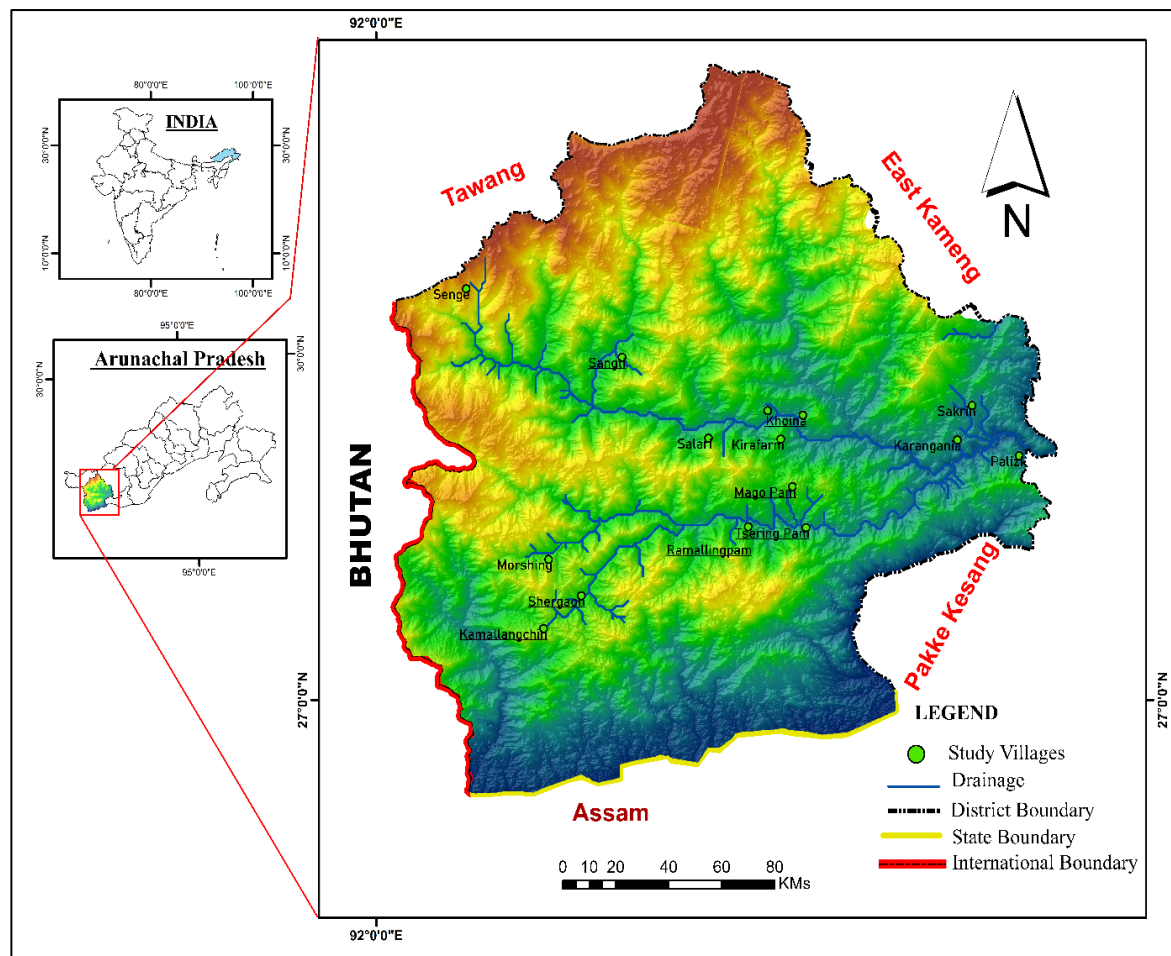


Figure 1.1. Map of the West Kameng District, Arunachal Pradesh

Methods

Data Collection

The study encompasses a wide range of data sources. Both primary and secondary sources have been broadly applied. Primary sources on demographic characteristics were acquired through a field survey. Moreover, primary data on agriculture production and productivity for the year 2022 were also obtained from respective fields. In this study, the purposive sampling technique was employed, where only farmers and contractors were surveyed and questions were asked on farming systems, production, productivity, demand and supply, and average prices of the different crops. The interviews were conducted using schedules and both open- and closed-ended questionnaires. Fifteen villages were surveyed from five CD blocks (three villages from a block). Altogether, 423 households were surveyed, with a sample size of 35% of the total HHs present in the village (Table 1.1).

Secondary sources of data, including agricultural production records from 2015 to 2021, were obtained from the records of the Office of the District Agriculture Office, Bomdila, West Kameng District, and partial demographic records from the data of Accredited Social Health Activists (ASHA).

Table 1.1. Salient information of the study villages

Village	CD Block	Number of the HHs surveyed	Total number of HH	% of HH surveyed	Elevation (in m)	Location
Morshing	Kalaktang-Rupa Block	13	35	35	2063	27°10'26''N;92°12'23''E
Kamallangchin		19	54	35	1725	27°09'58''N;92°15'76''E
Shergaon		38	106	35	1957	27°14'71''N;92°27'95''E
Ramallingam	Sinchung Block	7	20	35	1935	27°18'38''N;92°46'51''E
Tsering Pam		11	30	35	1377	27°20'24''N;92°49'47''E
Mago Pam		14	40	35	2252	27°24'96''N;92°52'34''E
Salari	Dirang Block	53	149	35	1253	27°32'58''N;92°43'76''E
Sangti		74	210	35	1611	27°24'10''N;92°16'40''E
Senge		56	160	35	2805	27°44'75''N;92°17'95''E
Jerigaon	Nafra Block	41	117	35	1777	27°33'94''N;92°47'95''E
Kirafarm		12	35	35	1950	27°35'50''N;92°47'69''E
Khoina		13	36	35	1734	27°35'75''N;92°48'61''E
Karangania	Thrizino Block	11	29	35	1284	27°17'56''N;92°42'26''E
Sakrin		21	59	35	1144	27°21'03''N;92°43'35''E
Palizi		40	112	35	752	27°17'30''N;92°46'46''E
	Σx=	423	1192	35.48		

Source: Thongdok et al., 2025

Data Analysis

To understand the changing pattern between the kharif and rabi productions, a parametric trend approach was adopted. The F-test is a statistical test used to compare the variances of two or more groups to determine if there is a significant difference between them. It calculates an F-statistic, which is the ratio of two variances, and uses the F-distribution to test the null hypothesis that the variances are equal. It is a fundamental factor of [Analysis of Variance \(ANOVA\)](#) and is also used in [linear regression](#) to assess a model's goodness of fit. Moreover, the compound annual growth rate (CAGR) was used. It is mainly employed for analysing trends and assessing agricultural productivity, and it also provides a steady, average yearly growth rate for crops.

F-test,

$$\sigma^2 = \frac{\sum(x - \bar{x})^2}{n - 1}$$

Where,

σ^2 = Variance

x = Values given in a set of data

$\bar{x}$ = Mean of the data

n = Total number of values

Compound Annual Growth Rate (CAGR),

$$CAGR = \left(\left(\frac{EV}{BV} \right)^{\frac{1}{n}} - 1 \right) \times 100$$

where:

EV = Ending value

BV = Beginning value

n = Number of years

Results

Production and Productivity of Crops

The area's favourable climate enables the cultivation of a wide range of cruciferous and non-cruciferous crops, with farming practices featuring both Kharif and Rabi seasons. Kharif crops include paddy, maize, millet, cabbage, tomatoes, chillies, ginger, garlic, and various other vegetables. Rabi crops comprise potato, green peas, wheat, barley, and mustard.

The comprehensive study findings reveal that the production and productivity rate of crops are significant. However, the intensity and rate of production of Rabi crops have seen a decreasing trend over the years. On the other hand, the production and productivity rate of Kharif crops have been witnessing an increasing trend. Farming practices have shifted, particularly in crop selection and cultivation methods. There is a transition from traditional to modern farming practices. Traditional crops have lower demand and economic value than modern or commercial crops, which have higher demand and economic value in the market. Due to such factors, the region is witnessing a drastic shift in farming patterns, such as crop choice and cultivation methods.

The study encompasses the crop production data of eight consecutive years, starting from 2015-2022, including both Kharif and Rabi crops. Table 1.2 figures from the years 2015 and 2016 show fluctuations in certain crops and productions; maize, garlic, wheat, and millets have shown a decreasing trend, whereas crops like tomato, cabbage, green peas, and potato have seen an increasing trend.

Table 1.2. Production and productivity of Kharif and Rabi crops (2015-2016)

Season	Crops	Area (in Ha)		Production (in MT)		Productivity (MT/ha)	
		2015	2016	2015	2016	2015	2016
Kharif	Paddy	882	882	1199.52	1199.52	1.36	1.36
	Maize	2815	2900	4785.5	4885.5	1.7	1.68
	Millet	1081	820	1016.14	946	0.94	1.15
	Cabbage	190	200	2584	2800	13.6	14
	Tomato	220	223	2901.8	3100	13.19	13.9
	Other vegetables	107	107	1886.48	1395.28	17.63	13.4
	Ginger	52	52	189.28	189.28	3.64	3.64
	Chillies	59	62	230.1	245	3.9	3.10
	Garlic	16.5	16	41.25	40	2.5	2.5
Rabi		5422.5	5438	14834.1	14770.7	58.46	54.54
	Wheat	227	226	211.11	210.18	0.93	0.93
	Barley	93	92	69.75	69	0.75	0.75
	Mustard	34	34	31.62	31.62	0.93	0.93
	Potato	392	390	3316.32	3299.4	8.46	8.46
	Green peas	60	63	144	152	2.4	2.42
		806	805	3772.8	3762.2	13.47	13.49

Source: Office of the ADO, Bomdila, and Primary field survey, 2023

Similarly, the data from the 2017-2018 shows a declining trend of wheat, paddy, maize, other vegetables, and an increasing trend of tomato, cabbage, chillies, potato, and green peas.

Moreover, the period also depicts the abandonment of various crops like millet, ginger, garlic, and barley (Table 1.3).

Table 1.3. Production and productivity of Kharif and Rabi crops (2017-2018)

Season	Crops	Area (in Ha)		Production (in MT)		Productivity (MT/ha)	
		2017	2018	2017	2018	2017	2018
Kharif	Paddy	883	820	1200	975	1.35	1.18
	Maize	2814	2245	4789	3020	1.72	1.34
	Cabbage	225	210	2995	3500	13.32	16.67
	Tomato	231	300	3000	4100	12.98	13.66
	Other vegetables	108	--	1408.32	--	13.4	--
	Chilies	65	100	251	1134.65	3.87	11.34
Rabi		4326	3675	13643.32	12729.65	46.64	44.19
	Wheat	227	200	211.11	187.89	0.93	0.94
	Mustard	35	--	32	--	0.91	--
	Potato	395	398	3416	3879	8.65	15.29
	Green peas	67	70	160	178	2.39	2.55
		724	668	3819.11	4244.89	12.88	18.78

Source: Office of the ADO, Bomdila, and Primary field survey, 2023

Table 1.4 shows an increasing production trend of crops like tomato, cabbage, chilies, potato, and green peas. The period also shows the introduction of fresh cash crops like cauliflower, capsicum, and green beans in the year 2019, and the abandonment of crops like paddy, maize, other vegetables, wheat and mustard. In addition, the figures from the year 2020 show extremely low production owing to the COVID-19 outbreak.

Table 1.4. Production and productivity of Kharif and Rabi crops (2019-2020)

Season	Crops	Area (in Ha)		Production (in MT)		Productivity (MT/ha)	
		2019	2020	2019	2020	2019	2020
Kharif	Tomato	390	280	7254.5	2700	18.61	25.90
	Cabbage	230	98	3890	1500	16.91	15.3
	Cauliflower	--	66	--	515	--	7.8
	Capsicum	--	35	--	216	--	6.17
	Chilies	78	25	376	75	4.8	3
Rabi		698	504	11520.5	5006	40.32	58.17
	Potato	404	130	4000	2700	9.10	20.6
	Green Pea	58	14	135.8	31	2.34	2.21
	Green beans	39	33	309	41	7.92	1.24
		462	177	4135.8	2772	11.44	24.05

Source: Office of the ADO, Bomdila, and Primary field survey, 2023

Lastly, the figures from Table 1.5 display a high production rate of both Kharif and Rabi crops. There is an increase in cash crop cultivation and production. Of all the crops, tomato,

cabbage, and potato have the highest production and productivity. Viewing the flourishing of the cultivation of various cash crops in the region.

Table 1.5. Production and productivity of Kharif and Rabi crops (2021-2022)

Season	Crops	Area (in Ha)		Production (in MT)		Productivity (MT/ha)	
		2021	2022	2021	2022	2021	2022
Kharif	Tomato	420	428	7800	8200	18.57	19.15
	Cabbage	245	247	3900	4100	15.91	16.59
	Cauliflower	116	131	1500	1605	12.93	12.25
	Capsicum	80	94	1200	1320	15	14.04
	Chillies	89	98	1050	1280	11.79	13.06
Rabi		950	998	15450	16505	74.2	75.09
	Potato	415	423	5300	5890	12.77	13.92
	Green Pea	69	76	157	178	2.27	2.34
	Green beans	41	35	360	375	8.78	10.71
		525	534	5817	6443	23.82	26.97

Source: Office of the ADO, Bomdila, and Primary field survey, 2023

Figures 1.2 and 1.3 show the production and trend of both the kharif and Rabi crops. Although it is apparent that the trend of both Kharif and Rabi crop production is increasing, a positive trend has been observed over the last eight years.

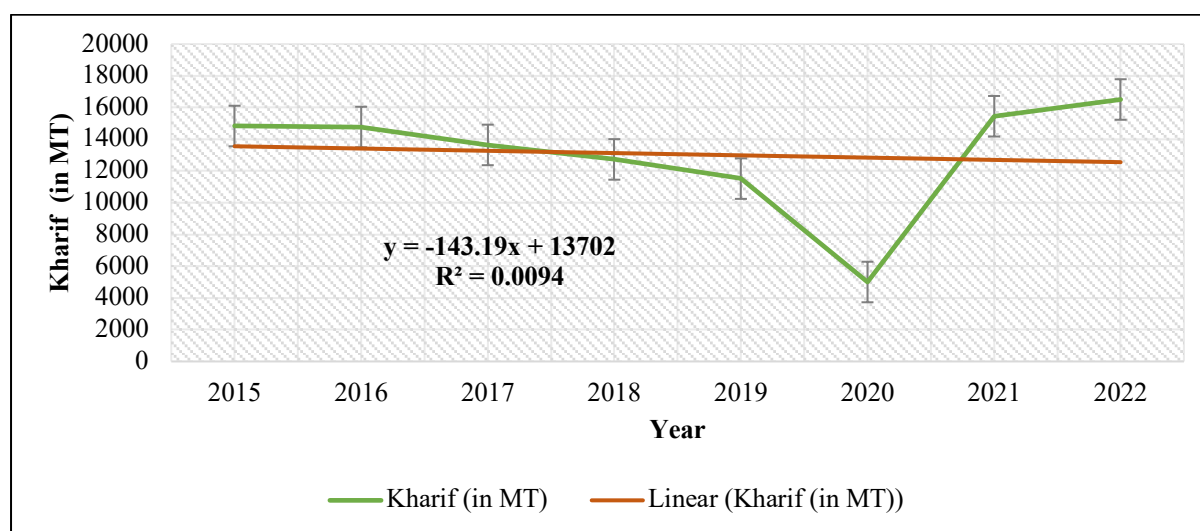


Figure 1.2. Production and trend of Kharif crops (2015-2022)

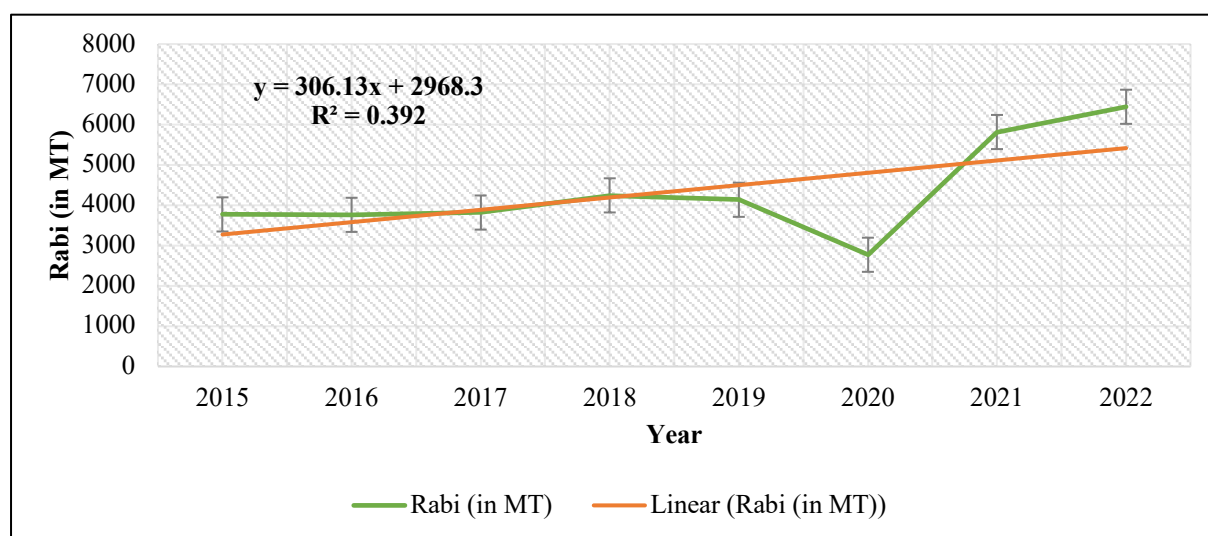


Figure 1.3. Production and trend of Rabi crops (2015-2022)

The results of the F-statistics reveal a significant production trend of the principal crops over the last eight years. The P-value of the statistics shows strong significance of 0.0047, which is under the standard P-value of the F-statistics (Table 1.6).

Table 1.6. F-Test Two-Sample for Variances of Kharif and Rabi production (2015-2022)

	Kharif (in MT)	Rabi (in MT)
Mean	13057.40875	4345.85
Variance	13048623.74	1434303.835
Observations	8	8
df	7	7
F	9.097531097	
P(F<=f) one-tail	0.004662591	
F Critical one-tailed	3.78704354	

*Alpha=<0.05

To understand the growth rate of the principal crops over the last eight years, a Compound Annual Growth Rate (CAGR) was calculated, and the statistics also reveal significant growth over the years (Table 1.7).

Table 1.7. Compound annual growth rate (CAGR) analysis of Kharif and Rabi crops

Kharif (in MT)		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	Case Sequence	.975	.062	.850	15.845	.000
	(Constant)	14263.244	5363.346		2.659	.038
Rabi (in MT)	Case Sequence	1.061	.040	1.719	26.845	.000
	(Constant)	3047.715	676.421		4.506	.004

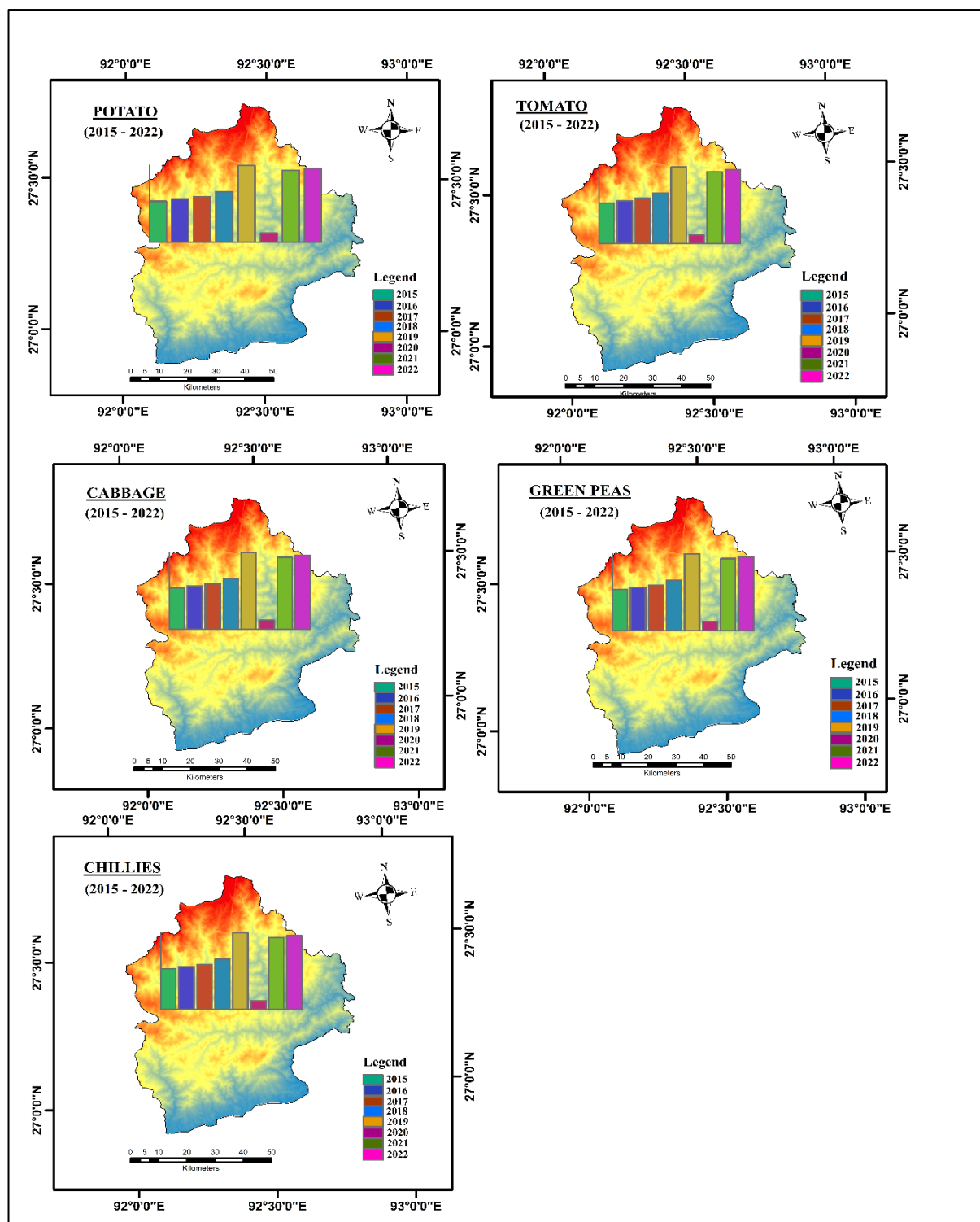


Fig. 1.4. Thematic map showing the temporal variation of crop production (2015-2022)

Factors Affecting the Change in Farming Patterns

The study identified various principal socio-economic factors affecting the changing patterns of crops and their practices in the study area.

Declining Demand and Economic Value of the Traditional Crops

In the past, the farming systems were fully subsistence; the crops produced were used for their consumption rather than for commercial purposes. However, over the years, various commercial crops were introduced, having huge demand, economic value, and most importantly, market accessibility. The farmers replaced the traditional crops (mostly cereals) due to declining demand, economic value, lower yield capacity, and being fragile to climate variability. Therefore, such crops were substituted with newly introduced commercial crops like tomato, cabbage, potato, chilies, capsicums, and green beans. The practice of commercial crops, which are genetically modified crops (GMs), has high potential for productivity and yield, and they are also climate resilient, which can endure climate variability. Above all, the introduction of commercial crops has significantly improved the farmers' socio-economic status in the region.

Short-term Impact of Climate Change

Climate change is a serious issue in the present context. Climate variability has a grave impact, particularly on farming practices. It has both positive and negative impacts on the farming systems, such as crop choice, production, and yield. It negatively affects when there is a sudden change in temperature, humidity, and rainfall patterns, particularly for traditional crops, which are not climate resilient. They are highly susceptible to abrupt changes in the underlying climate patterns over a region.

However, climate change also has a positive impact on the farming patterns, like crop choice, production, and yield. Crops that are highly resistant to harsh climatic conditions and variability are being introduced and adopted by the farmers on a large scale in the region. Such crops are genetically modified crops, also known as GM seeds. They have the potential for high productivity, yield, and, most importantly, are highly resistant and adaptable to climate change, unlike traditional crops. Therefore, climate change is having a short-term positive impact on the agricultural production in the region.

Introduction of Fresh Crops

Traditional crops have low production and yield potential. On the other hand, genetically modified crops (GMs) have the capacity for high production and yield. Due to this, various GM crops like cabbage, potato, tomato, chilies, and green beans are being freshly introduced in the region. And farmers are adopting these crops on a large scale, as these crops are also having high demand in the market, revenue generation, and good market feasibility, making these crops the first-choice crops over traditional crops, resulting in the abandonment of the practice of traditional crops in the region.

High Demand and Economic Value of Commercial Crops

There is an inverse relationship between the traditional crops and the commercial crops. The demand and economic value of the traditional crops are decreasing, whereas commercial crops are increasing. There is a high demand for commercial crops, increasing their economic value in the market also. On the other hand, the demand and economic value of the traditional crops are decreasing in the market in the region. Due to these factors, the region experienced a change in crop choice, resulting in a shift in the farming patterns in the region from traditional to modern farming practices over the years.

Changing People's Perspective

Farmers once valued traditional crops for self-reliance, low inputs, and cultural continuity, viewing innovations (including GM) with scepticism over risks, dependency, and long-term unknowns. Erratic weather exposed traditional crops' vulnerability, reframing

GM/resilient varieties as essential tools for survival and yield stability amid changing conditions. Rising demand, better prices, and visible revenue gains from commercial crops have shifted views toward agriculture as a business for prosperity, education, and household improvement, making traditional practices seem outdated and unprofitable. Many now see modern/GM adoption as a rational, short-term positive adaptation for better livelihoods.

Discussion

Farming systems and patterns are highly dynamic. Various geographical factors, including both physical and socio-economic elements, greatly influence the spatio-temporal variation. Physical factors like temperature, rainfall, humidity, and soil significantly determine the growth, production, and yield of its crops; on the other hand, socio-economic aspects like market demand, supply, and economic value of crops critically drive the crop choice and intensity of farming, as well as production. With the rising demand for commercial crops, the gap between commercial and traditional crops is lengthening over time. Therefore, the study encompasses the changing patterns of farming systems and their implications on the livelihood of the marginal farmers. The present study is associated with a study conducted by Mondal (2008); Valbuena et al. (2015); Kangalawe et al. (2017); Bhandari & Paudel (2021). Numerous studies have been conducted covering the aspects of changing farming patterns due to various external and internal factors, such as climate, population change, demand and supply and market availability. Over the years, the region has also experienced a shift in climate patterns, which has significantly contributed to changes in farming practices and crop choices. Therefore, local communities and mainly farmers have adjusted their cropping calendar and changed crops and varieties to adapt to the changing climate and climatic variability (Paudel, 2014). A steady increase in mean maximum temperature affects the natural systems, influencing the phenological processes in vegetation and increasing evapotranspiration rates, and increasing risks of crop pests and disease outbreaks of traditional crops. Therefore, among the local adaptation options have been the shift to more drought-tolerant and disease-resistant crop varieties and occasional migration to areas with better agricultural potential (Kangalawe et al., 2017). Moreover, the land is used for different productive purposes in a single year. These changes in land use affect employment and income, thereby altering the livelihoods of small farmers (Mondal, 2008). The characteristics of a particular farming system are largely determined by the past dynamics and interactions between drivers like vital factors, such as climate, local institutions, population dynamics and markets. Agroecosystems are social-ecological systems managed by humans to provide goods and services, particularly food, feed, and fibre for human needs (Conway 1987; Becker and Jahn 2001; Zimmerer 2007, 2013; Raut et al. 2011).

Conventionally, agriculture and allied sectors have been the primary sources of livelihood for people living in rural India. Additionally, over the years, the agriculture sector in India has been experiencing remarkable shifts with respect to area under cultivation, cropping pattern, productivity, use of fertilisers and pesticides, use of high-yielding varieties of seeds, market demand and accessibility (Majhi & Kumar 2018). Concerning the adoption of improved agricultural practices for doubling the income of farm families, the farmers are sensitive to the financial benefits of certain practices of the selected crops. The higher the benefit obtained from the introduced enterprise combinations of different commercial crops, the easier it is to persuade the farmers to adopt them on their farms (Ponnusamy & Devi, 2017). The potential impacts of genetically modified (GM) crops on income. On average, farmers benefit from GM, having higher effective yields and sizeable income gains. Furthermore, GM crops could contribute to rural income increases, which is particularly relevant for poverty reduction in developing countries (Qaim, 2010). Farming practice is particularly prevalent in developing countries, where almost all crops are grown for revenue. Also, food crop production has been

marketed, depending on the extent (small-scale farmers produce a surplus for which they find demand and revenue (Achterbosch et al., 2014).

The production and yields of newly introduced or commercial crops are increasing. In addition, the statistical results, like the F-test, reveal a significant change and variations in the crop production of different years. However, the CAGR statistics show slight changes and variations in crop production over the years. The shifts have been strongly witnessed in both kharif and rabi crops; the production data from 2014 to 2022 reveal that after 2016 and during the year 2017-2018, crops consisted mainly of cereals, and aromatics have disappeared. Kharif crops like ginger, garlic, and millet, and rabi crops, particularly barley, have been abandoned. During the period 2019-2020, the cultivation of kharif crops consisting of other vegetables, maize, and paddy, and rabi crops, particularly mustard have been stopped. In addition, during the year, fresh commercial crops like cauliflower were introduced, replacing the paddy and maize. On the other hand, the cropping patterns and crop choice concerning both kharif and rabi crops were seen as unchanged in the year 2021-2022, with a noticeable increase in production over the years. Therefore, the findings of the study validate that cropping patterns, mainly crop choice, have been drastically changed over the years due to socio-economic factors like declining economic conditions and demand for traditional crops, increasing demand and economic value of commercial crops in the market, climate variability, and changes in cropping patterns and the changing perspective of the farmers in the region.

Conclusions

The present study can be concluded that over the last eight years, the cropping patterns in the region have been strongly shifted from traditional to commercial due to various socio-economic and environmental factors. Adaptation and practice of commercial crops over traditional crops have largely influenced the farmers, concerning their standard of living, through the generation of higher revenues and economic viability of the commercial crops. However, most of the commercial crops are GM seeds, which require intense supplements like chemical fertilisers and other substances for growth and yield enhancement. This disintegrates the organic compounds of the soil by turning it acidic and polluting the environment as a whole. Therefore, the study also envisages balanced economic and environmental sustainability through coherent and sustainable farming practices.

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Research Article**Income Growth and Social Development among Industrial Workers: An Empirical Study of SIDCUL Industrial Estate, Uttarakhand**

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Abstract

This paper investigates the relationship between income growth and multidimensional social development among industrial workers employed in the State Infrastructure and Industrial Development Corporation of Uttarakhand (SIDCUL). Drawing theoretical inspiration from Karl Marx (Marx, 1976) and Amartya Sen (Sen, 1999), the study evaluates whether wage expansion proportionally enhances workers' capabilities, long-term security, and social status. Primary data were collected from 237 industrial workers with more than ten years of continuous service in SIDCUL units. A composite Social Development Index (SDI) (ILO, 2021) was constructed using indicators of housing quality, sanitation, health coverage, food security, education access, and subjective well-being. Descriptive statistics, comparative distribution analysis, and multiple regression techniques were applied to examine the influence of income growth, asset formation, and expenditure change on social outcomes. Regression results suggest that while income growth positively influences social development, asset accumulation exerts a stronger and more sustained effect on multidimensional welfare outcomes. Expenditure growth shows comparatively weaker explanatory power. The study concludes that industrial wage growth alone is insufficient to ensure durable socio-economic transformation. Policies that promote asset building, financial inclusion, labour security, and social infrastructure are essential for translating industrial employment into long-term capability expansion and inclusive development.

Keywords: Industrial Labour; Capability expansion; Income growth; Labour segmentation; Organized sector; Regional development; Wage Growth; Asset Formation

Introduction

Industrialization has long been regarded as a primary engine of economic growth, employment generation, and regional transformation. In states such as Uttarakhand, industrial policy has played a decisive role in restructuring the economic landscape from agrarian predominance to manufacturing-led diversification. The establishment of the State Infrastructure and Industrial Development Corporation of Uttarakhand (SIDCUL) (Govt. of India, 1948) marked a significant milestone in this transition. The industrial estates developed under SIDCUL attracted investment in pharmaceuticals, automobiles, consumer goods, and food processing, generating thousands of employment opportunities for local and migrant workers. Large-scale manufacturing units created new employment avenues and contributed to steady increases in worker incomes over the past decade. While the rise in earnings reflects positive economic momentum, development cannot be equated solely with income growth. True development involves improvements in housing conditions, access to healthcare, educational opportunities for children, financial security, and overall life satisfaction. This study therefore critically evaluates whether wage enhancement among industrial workers has translated into multidimensional social advancement. The research seeks to examine the depth and sustainability of welfare gains and to determine whether income growth alone is sufficient to generate long-term structural shifts. This study seeks to critically evaluate the Growth Realization Hypothesis (GRH), which submits that sustained income growth proportionally enhances social development outcomes. By constructing a composite Social Development Index (SDI) (Govt. of India, 1948), the research measures whether income gains among SIDCUL workers have translated into measurable improvements in multidimensional welfare.

Industrial labour studies have historically emphasized the relationship between economic structures and workers' living conditions. Classical economy, particularly the analysis of labour under capitalism, highlights the role of industrial production in shaping class relations and socio-economic inequalities. Later development economists and social scientists extended these ideas to examine labour welfare, income mobility, and regional industrial development in emerging economies such as India.

In the context of Himalayan and northern Indian industrial regions, scholars have observed that the establishment of organized industrial estates significantly alters the occupational structure of nearby rural communities. Employment opportunities created within industrial clusters often attract migrant workers and contribute to the emergence of semi-urban labour settlements. While these developments stimulate economic activity, they also produce new challenges related to housing, healthcare access, and labour security of workers. Therefore, empirical investigations of workers' socio-economic conditions are essential for understanding whether industrial growth translates into inclusive development. Studies focusing on income levels, job stability, and social welfare benefits provide important evidence for policymakers attempting to balance economic growth with labour protection and social equity.

According to Marxian Perspective as discussed in Capital (Govt. of India, 1948), Marx (1976) argues that wage increases may improve living standards without altering structural relations of production. Workers remain dependent on capital despite rising consumption. Rising earnings do not necessarily shift class position or ownership structures. Improvements in consumption can coexist with persistent structural vulnerability. This study investigates whether wage growth in SIDCUL has altered workers' economic foundations or merely improved subsistence conditions.

The Nobel laureate Amartya Sen (1999) conceptualizes development as expansion of substantive freedoms rather than income accumulation alone (Sen, 1999). Monetary resources serve as instruments; the crucial issue is how effectively they are converted into capabilities such as Health, security, Education, Housing stability, Economic resilience, Social mobility etc.

Doeringer and Piore (1971) proposed Labour segmentation theory⁵, it highlights that formal industrial sectors are rarely homogeneous. Internal labour markets create segmentation within formal sectors. Permanent and contractual workers may experience distinct levels of security, benefits, and bargaining power. Survey data show differentiation within SIDCUL employment categories, indicating that income effects may not be uniform across workers.

The objectives of this research are to examine the pattern of income growth among industrial workers over a ten-year period; to analyse changes in asset accumulation and expenditure behavior; to construct a composite index capturing social development outcomes; to estimate the relative contribution of income growth, asset formation, and expenditure change to overall social development; and to interpret the findings within broader theoretical frameworks of socio-political economy and capability expansion.

The study contributes to labour economics and regional development literature by empirically assessing whether industrial wage expansion produces structural socio-economic mobility or merely improves subsistence-level living standards.

Study Area

The study area comprises the SIDCUL Industrial Estate located primarily in Udham Singh Nagar district (Figure 1) of Uttarakhand formed after the creation of the state in 2000, was established to promote industrialization through infrastructure development, fiscal incentives, and investment facilitation (Govt. of UK 2022, Industrial development report). The corporation developed planned industrial estates equipped with roads, power supply, water

facilities, and logistical connectivity to attract private sector manufacturing units. Over the past two decades, the district has experienced rapid industrial expansion, population growth, rural-to-urban migration, and occupational shifts from agriculture to wage employment in manufacturing units. In the context of Himalayan and northern Indian industrial regions, scholars have observed that the establishment of organized industrial estates significantly alters the occupational structure of nearby rural communities. Employment opportunities created within industrial clusters often attract migrant workers and contribute to the emergence of semi urban labour settlements.

The workforce in SIDCUL engaged in production, packaging, assembly, maintenance, and administrative tasks. The organized nature of employment has improved access to statutory benefits such as provident fund contributions, Employees' State Insurance (ESI)(Employees' State Insurance Act 1948), and regulated working hours (Factories act 1948). However, segmentation within the industrial workforce persists, with varying degrees of job security, wage stability (Minimum wage act 1948.), and promotion prospects. The socio-economic background of workers is diverse. Many originate from agrarian households in nearby districts, while others migrate from neighboring states seeking stable employment. Housing arrangements vary from rented accommodations to self-owned houses constructed over time. Access to sanitation, clean drinking water, health services, and education has improved relative to pre-industrial conditions, yet disparities remain across income groups.

The industrial estate thus provides a relevant empirical context to examine whether wage growth within an organized manufacturing cluster generates durable improvements in social development indicators.

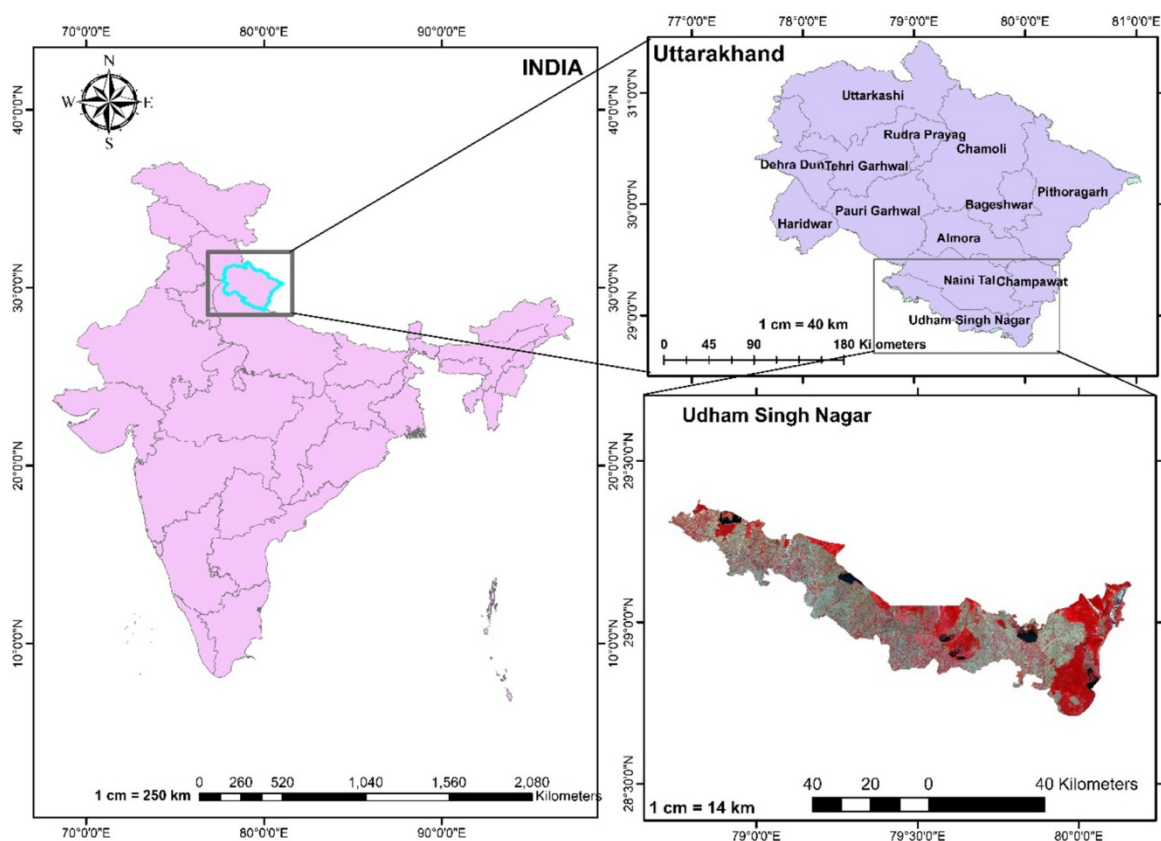


Figure 1. Udhm Singh Nagar District Geographical Map

Classical political economy perspectives emphasize the structural constraints embedded within wage labour systems, arguing that income increases may not alter underlying

class relations. Contemporary labour economics literature highlights wage differentials, skill formation, and employment stability as determinants of worker mobility. Development scholars further stress multidimensional measures of welfare, emphasizing education, health access, and asset ownership alongside income indicators. Indian labour studies demonstrate that organized sector employment reduces income volatility but does not automatically ensure wealth accumulation or intergenerational mobility. Empirical research across industrial clusters suggests that asset formation, housing security, and financial inclusion significantly mediate the relationship between income growth and long-term development outcomes. This study contributes region-specific evidence from Uttarakhand, an emerging industrial state with limited micro-level labour data.

Methodology

The study is based on primary survey data collected from industrial workers employed continuously in SIDCUL units. A composite Social Development Index (SDI) was constructed to quantify multidimensional welfare outcomes. Multiple regression analysis was employed to estimate the relative contribution of income growth, asset formation, and expenditure changes to overall social development.

Sample Selection

A total of 250 industrial workers were selected using purposive sampling criteria. A structured questionnaire was used to collect information on income levels, asset ownership, expenditure patterns, housing conditions, health coverage, and subjective well-being indicators. The inclusion condition required continuous employment of at least ten years within SIDCUL units to enable meaningful comparison of past and present income levels. Income growth over a ten-year period was treated as a central explanatory variable. This ensured that respondents experienced the trajectory of wage growth associated with industrial expansion.

Respondents were drawn from multiple industrial units across sectors such as pharmaceuticals, automotive components, food processing, and consumer goods manufacturing. Both permanent and long-term contractual workers were included to capture diversity in employment conditions.

Data Collection

Primary data were collected through direct interviews using a structured questionnaire. The instrument included sections on:

- Demographic characteristics (age, education, family size)
- Employment history and tenure
- Annual income (ten years ago and present)
- Asset ownership (land, house, vehicle, savings instruments)
- Expenditure patterns (education, health, housing, consumption)
- Access to social amenities (sanitation, electricity, health insurance)
- Subjective well-being and perceived economic security

Respondents were asked to provide approximate income categories for the past decade and current year to reduce recall bias.

Variable Specification

(a) Independent Variables

Income growth over a ten-year period was treated as a central explanatory variable. Asset accumulation and expenditure growth were included to capture broader economic behavior.

Asset Growth: Measured through an index capturing acquisition of physical and financial assets including housing, land, vehicles, savings accounts, and insurance coverage.

Expenditure Growth: Measured by changes in annual household expenditure across major categories such as education, health, and housing improvement.

(b) Dependent Variable: Social Development Index (SDI): A composite index constructed on a scale of 0–10 using standardized scores of the following indicators:

Housing quality (kachha to pucca house transition, ownership status)

Access to sanitation facilities

Availability of clean drinking water

Health insurance coverage

Children's education status

Food security stability

Savings adequacy

Subjective economic security

Each component was normalized and aggregated with equal weights to construct the composite SDI.

(c) Analytical Framework: The analysis proceeded in three stages:

Descriptive statistics and income distribution comparison.

Classification of SDI into categories (deprived, average, developed).

Multiple regression analysis to estimate the influence of economic variables on social development.

The regression model employed was:

$$SDI = \beta_0 + \beta_1 (\text{Income Growth}) + \beta_2 (\text{Asset Growth}) + \beta_3 (\text{Expenditure Growth}) + \varepsilon$$

Where:

β_0 represents the intercept,

$\beta_1, \beta_2, \beta_3$ represent coefficients of explanatory variables,

ε represents the error term capturing unobserved influences.

The model tested the statistical significance and explanatory power of each variable while estimating overall model fit using R^2 .

(d) Empirical Observations

Income Mobility: Comparison of present and past income categories reveals a shift away from lower-income brackets toward middle-income ranges. Nevertheless, concentration remains strongest in moderate earnings categories rather than high-income groups.

Results

Results reveal a statistically significant positive association between income growth and SDI. However, asset formation demonstrates the strongest standardized coefficient, indicating that wealth accumulation plays a decisive role in long-term welfare enhancement. Expenditure growth shows moderate influence. The model explains approximately one-third of variation in SDI outcomes.

Comparative Income Distribution

The comparative income distribution demonstrates a visible upward shift in wage categories over the ten-year period (Table 1 & 2 and Figure 2). The proportion of workers earning below one lakh annually declined substantially. Meanwhile, representation in middle-income categories (1–3 lakhs and 3–5 lakhs) increased significantly. A modest rise is also observed in higher income brackets (5–8 lakhs and above 8 lakhs). The data indicate measurable nominal wage mobility attributable to industrial employment stability and periodic wage revisions. However, concentration remains strongest within moderate income groups rather than high-income categories, suggesting limited vertical mobility beyond middle-income status. The proportion of workers in lower-income brackets has declined, while middle-income representation has expanded considerably.

Table 1: Income Distribution (10 Years Ago)

Income Category	Workers
Up to 1 Lakh	82
1-3 Lakhs	95
3-5 Lakhs	45
5-8 Lakhs	10
Above 8 Lakhs	5

Table 2: Income Distribution (Present)

Income Category	Workers
Up to 1 Lakh	36
1-3 Lakhs	111
3-5 Lakhs	56
5-8 Lakhs	28
Above 8 Lakhs	6

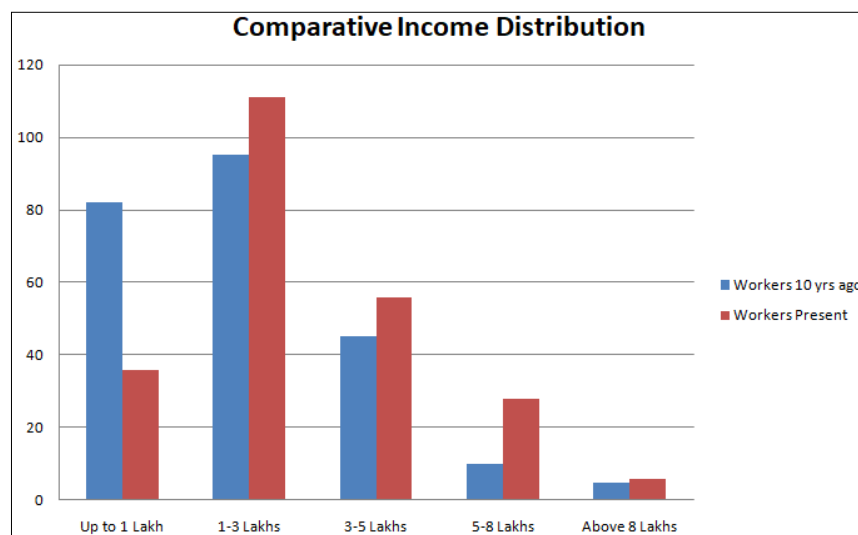


Figure 2: Comparative Income Distribution During a Decade

Regression Analysis

The regression results indicate that income growth positively influences the Social Development Index. However, asset accumulation demonstrates stronger explanatory power, suggesting that long-term wealth formation contributes more substantially to sustained social mobility. Expenditure growth shows comparatively weaker predictive strength, indicating that

higher consumption does not automatically translate into enhanced capability formation (Table 3). The model explains a meaningful proportion of variance in social development outcomes, while also implying the influence of institutional and structural variables beyond income.

Income growth exhibits a positive and statistically meaningful relationship with SDI. However, asset formation exerts a stronger influence than wage flow alone. Expenditure growth shows comparatively limited predictive strength. The model explains approximately one-third of variation in social development outcomes, indicating that non-economic factors play substantial roles.

Table 3: Standardized Regression Coefficients

Variable	Standardized Beta
Income Growth	0.32
Asset Growth	0.48
Expenditure Growth	0.19

Social Development Outcomes

While extreme deprivation has declined, the majority of respondents cluster within the “average” development range. Only a small fraction attain high-level social development status (Table 4).

Table 4: Income and Social Security Status of Industrial Workers

Worker Category	Average Monthly Income (INR)	Access to Social Security (%)
Permanent Workers	22000	78
Contract Workers	15000	42
Casual Workers	11000	18

Income Variation with Education Level

Comparative analysis of income with education level shows a positive wage growth as education level increases, at lower level it has a moderate shift as higher education level achieved like graduation and post-graduation degrees income shows a positive shift (Table 5).

Table 5: Income variation with education

Education Level	Average Monthly Income (₹)
Primary	9000
Secondary	12000
Higher Secondary	15000
Graduate+	22000

This shows a clear upward trend, income increases with higher education level Education significantly enhances earning potential.

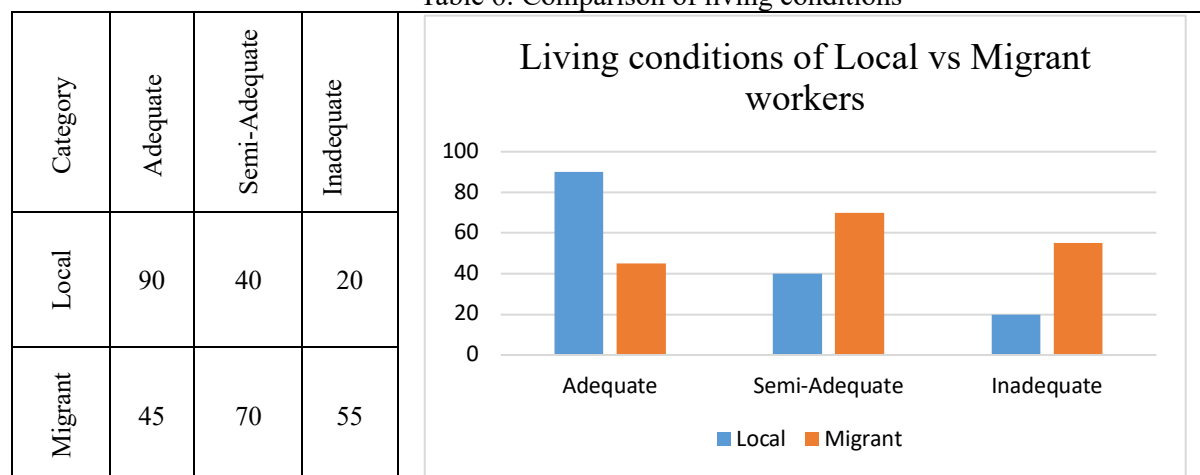
Asset Accumulation Patterns

Asset ownership improved across the sample. A notable proportion of respondents reported construction or purchase of houses during the ten-year period. Ownership of two-wheelers and small four-wheelers increased. Bank account penetration and participation in formal savings instruments expanded significantly. However, land ownership remained relatively stable, reflecting structural constraints in asset diversification. Financial assets such as mutual funds or diversified portfolios were rare, indicating limited financial inclusion beyond basic savings mechanisms.

Living Conditions of Migrant and Local Workers

SIDCUL industrial workers are composed of local as well as migrant workers, because being a hilly state livelihood means are not easily available, people migrate to the industrial areas so that they can find employment (Table 6). Living conditions of these workers are sometimes adequate but sometimes inadequate also.

Table 6: Comparison of living conditions



Local population shows higher adequate living conditions. Migrants show comparatively lower adequacy levels. Migration status significantly affects living conditions, with locals generally better off.

Expenditure Behaviour

Household expenditure increased in tandem with income growth. Significant increases were observed in education spending for children, health-related expenses, and housing improvement. Consumption of durable goods such as refrigerators, televisions, and mobile devices expanded. Despite higher expenditure, savings adequacy remained moderate. Many respondents reported vulnerability to medical emergencies and income disruptions, indicating that higher consumption did not always translate into financial resilience.

Social Development Index Distribution

(a) **Socio-Economic Status (SES):** SES is a composite measure of an individual's or family's social and economic standing based on income, housing, education, welfare and occupation. It is used to analyze, predict and correlate with variables like health, quality of life and social class.

The constructed SDI revealed the following distribution:

Deprived (SDI 0–3): Approximately 13–15 percent

Average (SDI 4–7): Approximately 78–80 percent

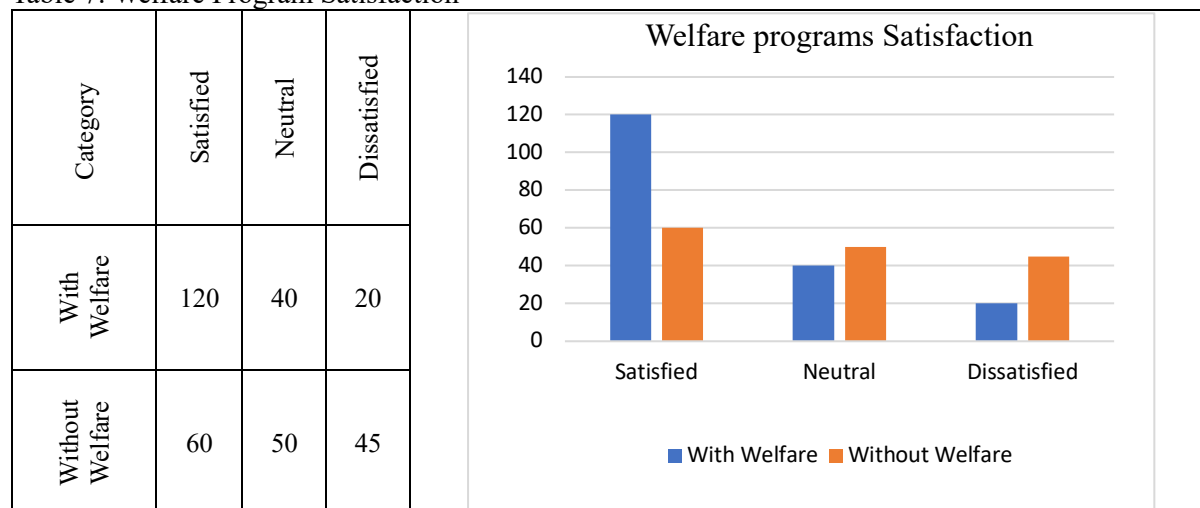
Developed (SDI 8–10): Approximately 6–8 percent

While extreme deprivation declined compared to the past, the majority of workers remain clustered within the average development category. Only a small segment achieved high multidimensional welfare status. All variables exhibited positive relationships with SDI, but asset growth demonstrated the strongest explanatory power. Income growth was statistically significant at conventional levels, confirming its positive association with social development. Expenditure growth showed comparatively weaker influence. The model explained approximately 31 percent of the variation in SDI ($R^2 \approx 0.31$), indicating

that nearly two-thirds of social development outcomes are influenced by non-economic or structural factors such as employment stability, social capital, institutional support, and cost-of-living dynamics.

(b) Welfare Programs Satisfaction Level Among Workers: Welfare programs are key to human as well as social satisfaction level, whether it is related to work related satisfaction level or living condition level satisfaction level. If welfare programs are so designed that it provides the workers a sense of security it gives them higher satisfaction (Table 7).

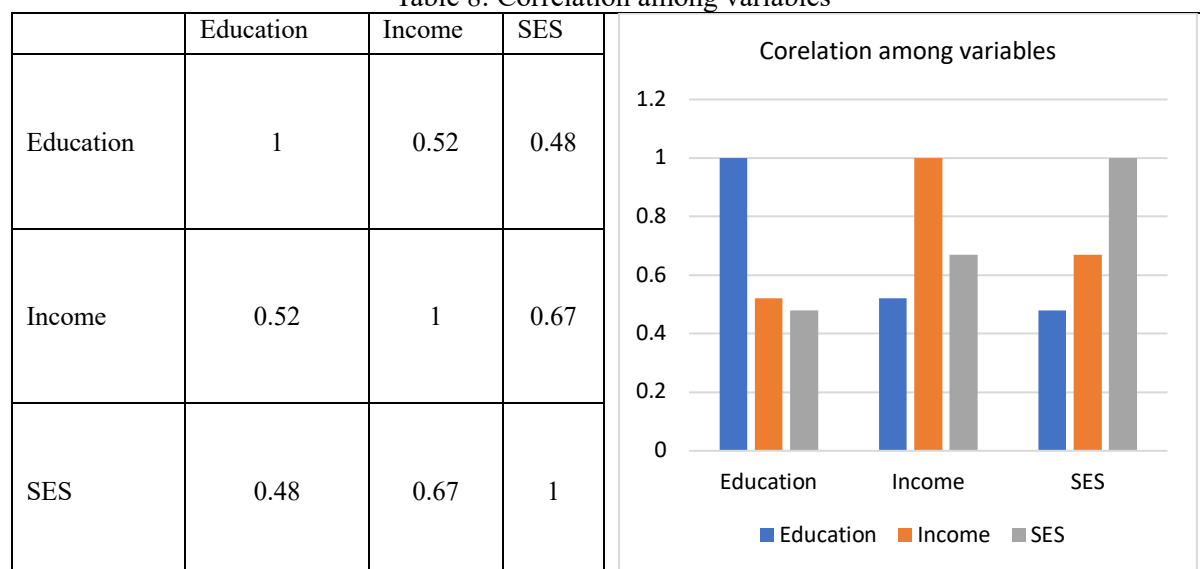
Table 7: Welfare Program Satisfaction



Those with welfare support show much higher satisfaction. Without welfare, dissatisfaction increases. Welfare programs strongly improve satisfaction levels.

(c) Correlation among Education, Income level, and SES: A correlation matrix is developed among variables education, income level and SES (Table 8).

Table 8: Correlation among variables



Key Correlations

Education & Income ≈ 0.73

Education & SES ≈ 0.72

Income & SES $\approx 0.67-1.00$

The lines represent correlation strengths, strong positive correlations across all variables. Education strongly influences both Income and SES. All three variables are positively and significantly correlated, indicating strong interdependence.

Discussion

The findings provide nuanced insights into the relationship between wage growth and multidimensional development. First, industrial employment has undeniably improved material living standards. Access to electricity, sanitation, health insurance schemes, and consumer goods has expanded. Food security has strengthened relative to pre-industrial agrarian uncertainty. These improvements represent tangible welfare gains. Second, asset accumulation plays a more decisive role in sustaining long-term development. Workers who invested in housing, savings instruments, and productive assets exhibited higher SDI scores. This finding underscores the importance of transforming income flow into asset stock. Third, the moderate explanatory power of income growth indicates structural limitations. Wage expansion alone cannot overcome constraints such as contractual insecurity, limited promotion opportunities, inflationary pressures, and rising housing costs.

From a capability perspective, income functions as a means rather than an end. The critical question lies in conversion efficiency. Factors such as education, health access, financial literacy, and institutional stability determine whether income translates into substantive freedoms. Labour segmentation further influences outcomes. Permanent workers with stable contracts display stronger asset growth and higher SDI scores compared to contractual workers facing job uncertainty. Thus, heterogeneity within the organized sector shapes capability expansion. The findings align with broader labour market analyses reported by the International Labour Organization, which emphasize that employment quality, not merely employment quantity, determines sustainable development outcomes.

The findings suggest that industrialization in Uttarakhand has generated measurable improvements in material living standards. Workers report better access to essential services, improved housing conditions, and enhanced consumption levels. Nevertheless, structural transformation remains incomplete. Long-term financial security, diversified asset portfolios, and upward class mobility are limited. The evidence supports the argument that while wage growth is necessary for welfare improvement, it is not sufficient for comprehensive development. Capability expansion requires complementary institutional support, financial literacy, and asset-building mechanisms.

The empirical findings of this study highlight that the socio-economic transformation occurring in industrial regions is not merely an outcome of employment generation but also a result of structural economic change. Industrialization in SIDCUL has contributed significantly to improving household income levels, access to urban amenities, and diversification of occupational opportunities for industrial workers. However, these benefits are unevenly distributed among workers depending on their skill level, job security, and access to institutional welfare mechanisms. Workers employed in permanent positions tend to experience relatively higher income stability, improved living standards, and better access to health and educational facilities. In contrast, contract and casual workers remain vulnerable to income fluctuations, lack of social security benefits, and occupational risks. This duality in the labour market reflects the broader structural inequalities that characterize industrial labour systems in developing economies.

Another significant observation emerging from the analysis is the role of education and skill development in enhancing workers' socio-economic mobility. Workers with technical training or higher educational attainment were found to occupy better-paid positions and

exhibit greater upward mobility compared to workers with minimal educational qualifications. This indicates that human capital formation plays a crucial role in determining the long-term socio-economic outcomes of industrial labour.

Conclusion

This study concludes that income expansion among industrial workers contributes positively to social development but does not guarantee structural mobility. Asset accumulation plays a more decisive role in long-term capability enhancement. Policy strategies must therefore move beyond income-centric approaches and integrate broader social protection, housing support, and institutional strengthening measures. Future research should incorporate longitudinal data to further examine the sustainability of income-driven development outcomes. Income mobility over the past decade reflects the positive impact of organized-sector industrialization. However, the relationship between income growth and social development is neither automatic nor comprehensive. Asset formation emerges as the most significant predictor of sustained multidimensional welfare. Expenditure growth enhances consumption but does not necessarily ensure financial resilience or structural mobility.

The findings demonstrate that economic development strategies focusing exclusively on wage enhancement may yield limited long-term transformation. Complementary institutional mechanisms are essential, including:

Housing and asset-building schemes

Financial literacy programs

Strengthened labour protection and job security

Accessible health and education infrastructure

Support for long-term savings and pension mechanisms

Industrial growth must be integrated with capability-enhancing frameworks to achieve durable socio-economic transformation. The study thus highlights the limits of income-centric development models and advocates a multidimensional approach linking wages, assets, and institutional support structures.

The results of the study have several important policy implications. First, there is a need to strengthen labour welfare policies to ensure that industrial development translates into inclusive socio-economic progress. Government agencies and industrial authorities should implement stronger labour protection mechanisms, particularly for contract workers who constitute a significant proportion of the workforce. Second, skill development programs should be expanded to enable workers to upgrade their technical competencies. Training initiatives coordinated between industry, government institutions, and educational organizations can significantly enhance the employability and productivity of workers. Third, improved access to healthcare, housing, and educational facilities for workers and their families can contribute to long-term social development. Industrial clusters such as SIDCUL should incorporate social infrastructure planning as an integral component of regional industrial policy.

Although the present study provides valuable insights into the socio-economic conditions of industrial workers, it is subject to certain limitations. The analysis is based on a cross-sectional survey, which restricts the ability to observe long-term changes in workers' socio-economic status over time. Future research could adopt longitudinal approaches to better understand how industrial employment influences intergenerational mobility. Furthermore, the study focuses on a specific industrial region, and therefore the findings may not be fully generalized to other industrial clusters with different institutional and economic contexts. Comparative studies across multiple industrial regions would provide a more comprehensive understanding of labour dynamics in India's industrial sector. Despite these limitations, the study contributes to the existing body of literature by providing empirical evidence on the

relationship between industrial employment and socio-economic development among workers. The findings reinforce the importance of inclusive industrialization strategies that prioritize both economic growth and social welfare.

Future research may incorporate longitudinal panel data, qualitative interviews, and comparative analysis across industrial clusters to deepen understanding of labour mobility and structural change.

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Research Article**Analysis of Traditional Agricultural Practices and Their Impact on Livelihood Sustainability in the Garhwal Himalaya**

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Abstract

The Garhwal Himalaya region features rugged terrain, fragile ecosystems, and an economy that depends on subsistence practices, yet has maintained traditional farming methods for hundreds of years, sustaining its mountain communities. This research investigates how indigenous farming systems interact with local sustainable livelihoods, demonstrating that traditional agricultural practices from the past protect economic stability, food security, and environmental sustainability in modern times. The traditional agricultural practices of Garhwal, including terrace farming, mixed cropping, crop rotation, and indigenous seed preservation, have evolved over multiple generations to adapt to the region's difficult topography and changing climatic conditions. The community's local knowledge systems and cultural traditions use these practices to demonstrate their deep understanding of mountain agroecology. The traditional agricultural system has undergone substantial changes due to rapid societal and economic development, including population movement, land abandonment, shifting climate patterns, and market expansion. The study examines how traditional agriculture affects household income by influencing agricultural output, household income, food security, and environmental preservation. The research investigates traditional methods because they help preserve soil, conserve water, and protect biodiversity. However, they pose challenges due to their high labour requirements, limited market opportunities, and declining financial returns. The research highlights how women sustain agricultural practices through their labour and teach farming methods to their descendants. The Garhwal Himalayan region needs sustainable development solutions, which require understanding how traditional farming affects people's ability to sustain their livelihoods.

Keywords: Garhwal Himalaya, traditional agriculture, livelihood sustainability, mountain farming, indigenous knowledge.

Introduction

The Himalayan Mountain system, which contains one of the planet's most biodiverse and topographically intricate areas, is a distinct region where humans have developed agricultural techniques to survive extreme weather conditions throughout history. The Garhwal Himalaya, which extends across the northwestern region of Uttarakhand state in India, reaches its highest peak at 7,000 meters, rising from 300 meters in the foothills to its mountain summit. The area exhibits diverse microclimates, soil types, and vegetation communities, owing to its steep elevation range, resulting in multiple agricultural systems that demonstrate both creative solutions and sustainable environmental practices (Maikhuri et al., 2001).

The Garhwal region's mountain farming systems depend on subsistence farming because households need to secure their food supply in areas with limited resources (Sati, 2024). The mountain farmers in Garhwal developed advanced agricultural methods to overcome challenges posed by steep terrain, shallow soils, unpredictable rainfall, and restricted access to machinery. The local farming method of terrace cultivation, known as 'Seedi' farming, demonstrates adaptive ingenuity by enabling farmers to convert unproductive hillsides into agricultural fields while protecting soil from erosion (Tiwari, 2000).

The socio-economic context of Garhwal agriculture is shaped by three factors: human settlement patterns, cultural identity, and seasonal migration. Villages are typically dispersed across valley floors and mountain slopes because households need to maintain multiple land parcels at different altitudes for their agricultural operations. The agricultural calendar, which

follows monsoon rhythms and altitudinal temperature gradients, governs all farming activities, as well as the full social and cultural activities of rural communities (Maikhuri et al., 2004). The agricultural system, which operates with precise adjustments, faces its most severe challenges in the twenty-first century. The combination of increasing urban migration from mountain villages and limited job opportunities has created a shortage of agricultural workers, leading to extensive land abandonment. Climate change currently disrupts established seasonal weather patterns through unpredictable monsoon patterns, altered snowmelt periods, and an increasing number of severe weather events, endangering traditional agricultural practices. The entry of market economies into isolated mountain areas has created new consumer desires, making it difficult for people to maintain their traditional farming methods (Negi & Joshi, 2004).

The research paper examines how traditional agricultural methods affect the sustainability of local livelihoods in the Garhwal Himalayas. The research study uses a multidimensional analytical framework encompassing economic, ecological, nutritional, and socio-cultural aspects to evaluate indigenous farming knowledge as a sustainable development resource in mountain regions. The research investigates essential aspects of preserving traditional practices by adapting and recognizing them as vital resources, thereby improving rural livelihoods during rapid social and environmental change.

Study Area

The study focuses on the Garhwal division of Uttarakhand, comprising seven districts: Dehradun, Haridwar, Pauri Garhwal, Tehri Garhwal, Rudrapur, Chamoli, and Uttarkashi. The total geographical area of Garhwal is approximately 35,000 square kilometers, with approximately 65 percent of it covered by forests, glaciers, and alpine meadows. In contrast, only 14 percent of the land remains suitable for agricultural development (Census of India, 2011). The agricultural development process faces fundamental constraints because the cultivable land is limited to steep, challenging-to-access hilly areas.

The Garhwal Himalaya comprises three agroclimatic zones, which educators have used as a basis for agricultural mapping. The lower hills zone (below 1,000 meters) supports subtropical crops, including rice, maize, sugarcane, and a variety of vegetables. The mid-hill zone (1,000-2,200 meters) serves as the primary farming area, which produces wheat and barley, finger millet (mandua), buckwheat (phaphar), and multiple traditional legume crops. The upper hill zone (above 2,200 meters) allows only small-scale production of frost-resistant crops during its brief growing season, resulting in pastoralism as the main source of income (Ramakrishnan, 1992). Recent demographic data shows that 3.5 million people currently reside in the Garhwal hills. The region's agricultural workforce has undergone major changes as working-age men continue to leave their villages in search of employment elsewhere. The process of women taking over agricultural work affects both traditional farming methods and households' economic survival strategies, according to Joshi and his colleagues in 2004.

Methodology

The research uses multiple methods, combining qualitative and quantitative approaches to study livelihood sustainability across its economic, ecological, nutritional, and sociocultural components. Researchers collected primary data through structured household surveys and key informant interviews with experienced farmers, women seed custodians, and extension workers, as well as through focus group discussions, including women-only groups, to document indigenous and gender-specific knowledge that structured instruments could not capture. Researchers used field observation, along with Participatory Rural Appraisal (PRA) tools, including seasonal calendars and resource mapping, to examine how land use, crop diversity, and livelihood strategies evolved across different periods.

The primary findings of this study were contextualized using secondary data, including the 2011 Census of India, district agricultural statistics, and peer-reviewed research on Himalayan agroecology. The research team analyzed quantitative data using descriptive and inferential statistical methods to identify patterns in crop diversity indices, food security scores, and income shares across different zones. The research team used thematic analysis to analyze qualitative data collected from interviews and focus group discussions. The researchers confirmed the research findings through community workshops, which validated all data sources and allowed women farmers to present their agricultural expertise and work, which sustains traditional farming practices in the Garhwal Himalaya region.

Results and Discussion

Traditional Agricultural Practices

Terrace Farming

Terrace farming is the primary agricultural method that enables Garhwal mountain farmers to cultivate crops on steep land that would otherwise remain unproductive. The construction of Garhwali terraces requires people to use their extensive knowledge of local hydrology, soil properties, and slope stability, gained through years of practical research and testing. The construction and maintenance of Garhwali terraces depend on manual labor and family members for their operation. At the same time, the fields are protected by native grasses and shrubs, which also provide animal feed (Tiwari, 2000).

The hydraulic engineering embedded in traditional terrace systems is especially important. Terrace walls are designed through graded construction to allow controlled water infiltration while preventing waterlogged conditions, and drainage channels direct excess water between terrace levels. In areas dependent on spring water, intricate gul (channel) irrigation systems distribute water across multiple terrace levels through a gravity-fed network that requires continuous community maintenance and governance. These irrigation commons represent sophisticated institutional arrangements for managing shared water resources under conditions of scarcity and spatial heterogeneity (Agrawal, 2001).

Terrace systems provide ecological services that exceed their agricultural benefits, creating stable slopes, replenishing groundwater, and fostering microhabitats. Terrace bunds support diverse communities of useful plants, including medicinal herbs, edible greens, and fodder species, helping households achieve better nutrition and increased income. The need for continuous labour to maintain terrace integrity leaves it vulnerable during periods of labor shortages caused by out-migration.

Mixed Cropping and Agrobiodiversity

The agricultural practices of traditional Garhwal communities use mixed cropping systems, allowing farmers to grow multiple crop species in a single field. The 'baranaja' system, which represents the most common mixed cropping method, permits farmers to cultivate twelve or more different crop species, which include cereals (finger millet, barnyard millet, foxtail millet), legumes (black gram, horse gram, pigeon pea, cowpea), oilseeds (sesame, flaxseed), and minor crops. The baranaja system demonstrates advanced ecological understanding, including knowledge of how different plants interact, how nitrogen moves through the ecosystem, how farmers protect their crops from pests, and how agricultural risks spread across different farming methods (Maikhuri et al., 2004).

The ecological rationale for mixed cropping in mountain environments includes several interconnected benefits. The practice of mixed cropping offers multiple advantages for mountain regions, as supported by its ecological rationale. The leguminous components of the

system fix atmospheric nitrogen through their natural processes, preventing soil fertility loss in agricultural systems that depend solely on internal resources. The different growth patterns of crops throughout their growing season create barriers that stop insect pest reproduction, while also creating spaces where beneficial insects can thrive. The different harvest times of crops in a mixed field create varying agricultural labor needs, reducing the likelihood of total crop failure across all food sources. The physical design of mixed stands uses different plant heights and growth patterns to maximize light capture, thereby reducing soil moisture loss through evaporation (Ramakrishnan, 1992).

Crop Rotation Practices

The traditional crop rotation systems used in Garhwal demonstrate their ability to understand how soil nutrients behave, how pests interact with their environment, and how different resources become available throughout the year. The main rotation system of the farm alternates between cereal and legume crops, occurring every year or every two years, while leguminous plants help sustain soil fertility through their nitrogen-fixing abilities, thereby eliminating the need for chemical fertilizers. The mid-hill zone uses a standard three-year rotation system, which begins with wheat or barley cultivation during the rabi (winter) season and continues with mixed millets and legumes during the kharif (monsoon) season, while the system requires a fallow period every three years to let the soil recover its natural state (Tiwari, 2000).

Different altitudes lead to different production possibilities, creating production limitations for various rotation methods used at different altitudes. In the lower hills, paddy farmers use terraced fields to grow kharif crops, which they follow with wheat or mustard cultivation during the rabi season to maximize their agricultural production. Farmers at higher elevations need to adopt single-cropping systems, which require them to choose frost-resistant crop varieties, as their growing season lasts only until the first frost. The traditional knowledge system used in these agricultural rotations contains extensive information on crop varietal traits, ideal planting times, and soil management requirements, developed over multiple generations by farmers.

Indigenous Seed Systems and Biodiversity Conservation

The preservation and control of traditional agricultural plant varieties exist as the most undervalued aspect of Garhwal agricultural heritage. The farming communities in this area keep vast quantities of landrace seeds, including native plant varieties developed through local agricultural practices to thrive in the specific environmental conditions of their region. The landrace collections serve as an essential genetic resource that supports research into adaptive strategies for addressing climate change and other environmental transformations (Rao et al., 2017).

The indigenous seed systems of Garhwal maintain their diverse seed varieties through social seed exchange networks that govern seed selection and storage. The storage system for valuable traditional seeds uses specialized containers that include natural preservatives that protect stored seeds from insect and fungal damage through the use of ash, neem leaves, and dried chili powder. Traditional seed custodians use multiple traits, including yield, taste, storability, pest and disease resistance, and cultural value, to evaluate their seeds, as these traits often carry genetic information that plant breeding programs cannot detect (Rao et al., 2017).

Agropastoral Integration

Traditional Garhwali farming systems depend on integrating livestock with agricultural fields because this practice creates systems that optimize resource use in mountain areas with limited nutrients. Farmers keep cattle, buffalo, sheep, and goats because these animals provide

milk, meat, and fibre, while their manure maintains soil health in fields that lack synthetic fertilizers. The 'Bugyal' grazing practice allows transhumant users to move their livestock between valley farms and high alpine pastures, which enables them to use multiple altitudinal zones for their household farming operations (Maikhuri et al., 2001).

Impacts on Livelihood Sustainability

Food Security and Nutritional Outcomes

The relationship between traditional agricultural practices and household food security in Garhwal operates through multiple pathways that extend beyond simple caloric adequacy to encompass nutritional diversity, seasonal availability, and dietary quality. Mixed cropping systems and the cultivation of multiple traditional varieties provide households with access to a diverse range of nutrients, including proteins from legumes, complex carbohydrates and fiber from millets, and micronutrients from traditional vegetables and minor crops (Maikhuri et al., 2004).

The study shows that traditional diets that use local crop diversity achieve better micronutrient outcomes than diets that use store-bought basic foods. Traditional millet varieties, including finger millet (*Eleusine coracana*) and barnyard millet (*Echinochloa frumentacea*), provide their highest nutritional value through their calcium, iron, and dietary fiber content, which exceeds that of polished white rice and refined wheat flour, which currently dominate commercial diets. The nutritional value of traditional crop diversity is affected by land abandonment and market integration, as both processes create direct nutritional effects that mainly impact vulnerable household members, including women and young children.

Income Generation and Economic Dimensions

The economic contribution of traditional agriculture to rural livelihoods in Garhwal needs assessment, focusing on its direct income generation and its indirect benefits through subsistence production, which reduces household food expenses. Traditional farming systems produce low direct cash income because farmers can only sell small amounts of their crops. They have difficulty accessing markets, yet these systems deliver substantial value to households through their agricultural production, which serves as a financial backup during income disruptions across multiple livelihood pathways (Negi & Joshi, 2004).

Emerging market opportunities for organic and traditional food products represent a potentially significant pathway for enhancing the income-generating capacity of traditional Garhwal agriculture (Table 1). The Indian urban market is seeing increasing demand for authentic mountain foods, heritage grain products, and organic produce, creating premium pricing opportunities for farmers who maintain quality standards and establish market connections. Products such as *mandua* (finger millet) flour, *jhangora* (barnyard millet), traditional rajma (kidney bean) varieties, and mountain honey have demonstrated market viability in specialty and health food segments, though translating farm-level production potential into realized market income requires significant supply chain development (Rao et al., 2017).

Table 1: Key Traditional Crops and Their Livelihood Significance in Garhwal Himalaya

Crop (Local Name)	Scientific Name	Primary Use	Altitude Range	Market Potential
Mandua	<i>Eleusine coracana</i>	Staple food, nutrition	800–2200 m	High
Jhangora	<i>Echinochloa frumentacea</i>	Cereal, kheer	600–1800 m	Moderate

Phaphar	Fagopyrum esculentum	Flour, rotis	1500–3000 m	Growing
Gahat	Dolichos biflorus	Protein source, dal	800–2000 m	High
Rajma (local)	Phaseolus vulgaris	Food, cash crop	1200–2800 m	Very High
Til	Sesamum indicum	Oilseed, ritual	500–1500 m	Moderate
Ogal / Toria	Fagopyrum tataricum	Flour, livestock feed	1800–3200 m	Low–Moderate

Environmental Sustainability

The agricultural methods used in Garhwal have developed into sustainable systems that maintain their farming output for extended periods while protecting the area's natural resources. Terrace farming systems protect steep slopes from soil erosion by keeping topsoil from being washed away by runoff and from sliding into landslides. The practice of adding organic matter through crop residue incorporation, together with green manuring and livestock manure application, helps to sustain soil biological activity and fertility in an area that faces difficulties in accessing synthetic fertilizers due to their high costs and limited availability (Ramakrishnan, 1992).

The conservation value of traditional agricultural landscapes extends beyond their preserved agricultural species to include their natural habitats, which sustain wild species with ecological and economic value. Traditional terrace fields, with their bunds, hedgerows, and water channels, create environments that support various pollinator species, soil organisms, predatory insects, and small vertebrates, helping sustain ecosystem health. The trees and shrubs maintained in traditional agroforestry systems provide habitat connectivity across agricultural landscapes, supporting the persistence of biodiversity in heavily modified mountain environments (Rao et al., 2017).

Traditional agricultural systems deliver essential ecological advantages through their water management practices. Terrace farming is a sustainable agricultural method that prevents water runoff while allowing water to infiltrate the ground, thereby sustaining groundwater resources that serve as drinking water sources for mountain communities. Terrace farming abandonment reduces water-absorption capacity, leading to reduced spring water flow across multiple regions of the Garhwal Himalayas. This demonstrates how agricultural land abandonment affects ecosystems. (Tiwari, 2000).

Women's Role in Traditional Agriculture

Women constitute the largest agricultural workforce in Garhwal, where they perform essential tasks that sustain traditional farming practices. Studies consistently indicate that women perform 60-80 percent of agricultural labor in Garhwali villages, including all activities from seed selection and storage to field preparation and planting, as well as weeding, harvesting, and post-harvest processing (Joshi et al., 2004). The traditional economic system does not recognize this work, leading to a systematic undervaluation of women's agricultural work and expertise.

Women in Garhwal have the primary responsibility for protecting traditional agricultural crop varieties, along with the related agricultural knowledge systems that help safeguard agricultural biodiversity. Through their activities as seed selectors, exchangers, and seed storers, they serve as central figures who preserve landrace diversity and pass it down to future generations. The expert knowledge base of this community serves as a vital resource that supports both household food security needs and the protection of regional biodiversity.

However, their expertise remains mostly unknown to official agricultural development plans and policy systems (Maikhuri et al., 2004).

The growing agricultural responsibilities that women must handle because of male out-migration create conflicting effects that impact both their ability to sustain livelihoods and their access to equal rights. The agricultural work performed by women provides immediate benefits by sustaining agricultural output and maintaining traditional knowledge; however, the increase in their work duties without corresponding enhancements to their access to productive assets, technological resources, market opportunities, and decision-making authority creates an equity issue that sustainable development frameworks require addressing.

Challenges Confronting Traditional Agriculture

Out-Migration and Labor Scarcity

The Garhwal Himalaya faces its most serious challenge to traditional agriculture due to out-migration, which is the main problem for agricultural operations. Census data, together with field surveys, show that mountain village residents migrate to plains cities at high rates during both seasonal periods and permanent moves because they find better economic opportunities through non-farm jobs in the national economy, which has become more interconnected. The rural population of Garhwal has experienced demographic and social transformation, as out-migration mainly involves educated young men with advanced skills, leading to villages with aging residents, female-led households, and a critical shortage of agricultural workers (Negi & Joshi, 2004).

Traditional agricultural systems face multiple interconnected effects stemming from their current worker shortage. The agricultural sector particularly suffers from labour shortages because all of its labour-intensive tasks, which include terrace construction and maintenance, complex mixed cropping management, and traditional post-harvest processing, become harder to perform without sufficient workforce resources. The practices require excessive time and effort, which household members must devote to their essential work, as most of these households consist of women, older adults, and children. The region witnesses widespread adoption of labour-saving techniques that simplify traditional farming methods by enabling farmers to reduce their mixed crop variety, make terrace maintenance easier, and use commercial products instead of manual organic farming practices.

Climate Change Impacts

Researchers have demonstrated that climate change now poses a substantial and escalating threat to conventional farming methods in the Garhwal Himalaya region, as it disrupts the delicate connections between agricultural calendars, crop selection, and environmental factors that underpin traditional farming practices. Mountain agricultural systems face direct consequences from documented trends, including changing monsoon onset and duration patterns, increasing extreme rainfall events, declining snowpack levels, altered snowmelt timing, and rising temperature fluctuations across seasons (Rao et al., 2017).

Traditional crop varieties display greater adaptability across environments and improved stress resistance compared with modern high-yielding varieties, yet their ability to cope with environmental changes remains limited. Varieties selected under historical climatic conditions may perform poorly under altered temperature and precipitation regimes, particularly with respect to vernalization requirements, photoperiod sensitivity, and heat and drought tolerance. Climate change creates dual effects on adaptive capacity: it increases the need for adaptation, yet decreases genetic diversity, which underpins such adaptation.

Pathways Toward Sustainable Livelihoods

Integration of Traditional and Modern Knowledge

The most effective way to improve people's lives through agricultural development in the Garhwal Himalaya begins with establishing proper methods for combining indigenous knowledge with current scientific knowledge and available technological solutions. The integration method establishes the authentic ecological knowledge present in traditional agricultural practices while granting mountain farming communities their right to seek greater productivity, economic growth, and improved living standards (Ramakrishnan, 1992).

The operational implementation methods combine soil science expertise with traditional composting and organic manure management techniques. Participatory plant breeding methods enable the creation of new plant varieties that combine the traditional landraces' advantages with the modern varieties' higher yields and marketable qualities. The development of labor-saving tools enables agricultural work in mountain terrace environments to become less physically demanding while maintaining ecological management standards.

Geographic Indications and Value Chain Development

The creation of geographic indication (GI) certification, together with distinct market positioning for traditional Garhwal agricultural products, serves as an essential strategy to boost economic returns from traditional farming operations. The product identity protection that GI certification provides through its geographic origin safeguarding creates obstacles to imitation, allowing higher product prices while establishing official recognition of mountain food products' cultural and ecological characteristics. The traditional Garhwali products known as rajma varieties, mountain honey, and traditional spices contain attributes that would enable successful GI application development.

Policy Frameworks for Mountain Agriculture

The traditional agricultural system and the sustainability of mountain livelihoods need support through better policies, which require a complete overhaul of agricultural development systems. Current agricultural policies in India, including support price systems, input subsidies, and extension services, show an obvious bias towards irrigated plains farming, creating disadvantages for mountain farmers who cannot access these resources.

The Garhwal region requires targeted policy measures to establish mountain-specific seed systems that will keep traditional seed varieties available while supporting their adaptive enhancement needs. The existing social protection systems must be expanded to include the recognition and financial compensation of traditional mountain agricultural practices that deliver environmental benefits. The establishment of dedicated market facilities and institutional frameworks needs to support the complete value chains of mountain food products. The economic sustainability of traditional farming will improve substantially through investments in rural road networks, cold storage systems, and digital market entry points.

Conclusion

The research investigates how traditional agricultural methods interact with livelihood sustainability in the Garhwal Himalaya, demonstrating how indigenous farming systems contribute to household food security and income generation, environmental sustainability, and cultural identity, as established in the literature. The evidence shows that traditional practices such as terrace farming, mixed cropping, crop rotation, and indigenous seed management deliver essential benefits that sustain livelihoods, and these practices require active support through policy development and investment funding.

At the same time, the analysis shows that traditional agriculture faces major challenges from multiple factors, including out-migration, climate change, market integration, and declining knowledge transfer between generations. The required responses must extend beyond preserving traditional practices, as they must create pathways for actual economic and social development that will improve the viability of mountain farming as a sustainable income option for present and future generations.

The research study shows that identified pathways, including knowledge integration and value chain development, policy reform, and dedicated assistance for women farmers, create a unified approach to sustainable mountain agricultural development. The implementation of these pathways needs different organizations, which include government bodies, research institutions, civil society groups, and farming communities, to work together. At the same time, they must prioritize the needs and viewpoints of mountain farmers, especially women, in their development planning and decision-making.

The Garhwal Himalaya mountain range serves as a miniature version of the difficulties and opportunities that mountain farming communities encounter throughout the Hindu Kush Himalayan region and in other mountain ranges worldwide. The results from this region's traditional agricultural practice maintenance and development work demonstrate how indigenous knowledge systems function as dynamic systems that create economic opportunities and environmental benefits in a world that is constantly changing.

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Research Article**Landslide Susceptibility Zonation of the Upper Satluj River Basin, Himachal Pradesh, India, Using a Random Forest Approach**

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Corresponding Author: Email: vermag433@gmail.com; ramhpshimla@gmail.com**Abstract**

Landslides are one of the major natural disasters in the Himalayan region that results in a great loss of infrastructure, environment, and human lives. The rugged topography, active tectonics and compound geo-environmental conditions make the Upper Satluj River Basin in the Kinnaur district susceptible to such incidences. The objective of this study is to delineate landslide susceptibility zones using Random Forest model. For this, 13 conditioning factors were taken into consideration, such as slope, aspect, relative relief, lithology, density of lineaments, distance to thrust line, rainfall, soil texture and land use/land cover, NDVI, SPI and TWI. The landslide inventory was divided into training (70%) and testing (30%) datasets for model development and validation. The Receiver Operating Characteristic curve was used to model performance and calculated a high Area Under the Curve of 0.841, which demonstrates good predictive power. The resulting landslide susceptibility zonation map categorized the basin into five classes, namely, very low, low, moderate, high, and very high. The study area has a high to very high susceptibility of about 30.5 %, which is mostly linked with steep slopes, high relative relief, weak lithology, and structurally disturbed regions. The results demonstrate the effectiveness of the RF model in handling complex, non-linear relationships in mountainous terrains. The susceptibility map offers a credible foundation to land-use planning, infrastructure development, and reduction of disaster risks.

Keywords: Landslide susceptibility; Random forest; Himalaya; Upper Satluj Basin.

Introduction

Among the most frequent and destructive natural disasters in the mountainous landscapes, landslides are especially likely to occur in highly vulnerable areas such as the Himalayas. This involves the downward movement of rock, debris, or soil under the influence of gravity. According to Varnes (1984), landslide can be defined as the movement of a mass of rock, debris or earth down a slope, whereas Cruden (1996) pointed out that these movements were governed by a combination of geological, geomorphological and hydrological factors. In fact, landslides are not caused by one factor, rather it is a complex interplay of natural causes, such as heavy rainfall, earth tremors, and slope instability, and anthropogenic factors, such as road construction, deforestation, and unplanned development. Landslides cause significant socioeconomic losses in the world. They cause an estimated US\$20 billion in damages to annual economies (Klose et al., 2016) and have taken over 110,000 lives since the turn of the 20th century (Niyokwiringirwa et al., 2026). The number of non-seismically induced landslides alone has caused about 32,322 deaths between 2004 and 2010 (Petley, 2012), a rate of over 4,500 deaths per annum. The developing countries, especially the mountainous areas of Asia, the Central and South American countries play the major part in the burden, especially because of the rapid urbanization process, deforestation, and the extreme weather caused by the climate, which in turn increases vulnerability. In India, there are around 0.42 million km² of land that is vulnerable to landslides (12.6% of the total area of the country) (National Remote Sensing Centre, 2023). It has the worst impact on the Himalayan region, where the Northwest and Northeast Himalayas occupy 0.14 million and 0.18 million km², respectively (National Remote Sensing Centre, 2023). The Indian Himalayas are characterised by young weak geology, rugged topography, heavy monsoon rainfall, seismic activity, and rising anthropogenic interventions, which frequently lead to landslides that affect transportation networks, devastate settlements,

and take hundreds of lives every year. Major events include the 2013 Uttarakhand disaster (more than 580 confirmed deaths and total losses of over 5,700 including missing persons; National Institute of Disaster Management, 2013) and the 2023 Himachal Pradesh monsoon-related disasters (428 deaths; Himachal Pradesh State Disaster Management Authority, 2023; Chandel et al., 2025).

The current research is based on Upper Satluj River basin in the Kinnaur district of Himachal Pradesh in the Northwest Himalayan zone. Kinnaur is extremely susceptible owing to steep slopes of Satluj River valley, poor rock formations and seismic forces. The Urni landslide is a recurring event that has posed a threat to infrastructure on multiple occasions and demonstrated the necessity of thorough evaluation (Kumar et al., 2019). Landslide susceptibility zonation (LSZ) is an important tool used to locate and map landslide prone areas. It combines various conditioning factors. Over the years, a number of methods have been devised, including qualitative/heuristic (knowledge-based) methods, which utilize expert judgment, as well as quantitative ones, including statistical models (e.g., logistic regression, frequency ratio), probabilistic methods, and sophisticated machine learning algorithms (Das et al., 2023). Machine learning methods have become popular due to their capability to describe complex non-linear relationships within heterogeneous terrains. One of them is the Random Forest (RF) algorithm introduced by Breiman (2001), which is a potent ensemble machine learning algorithm. It builds several decision trees with bootstrapped samples and combines the predictions with majority voting. RF has some strengths such as high predictive capability, insensitivity to overfitting, multicollinearity, and the ranking of variable significance, which makes it very appropriate in mapping landslide susceptibility in complex Himalayan settings. The overall aim of the research is to create landslide susceptibility zonation map as of Upper Satluj River basin in Kinnaur District using a random forest model by incorporating multi-source geospatial data obtained through remote sensing and GIS platforms. Sustainable land-use planning, infrastructure development, early warning systems, and community resilience efforts can be based on accurate susceptibility maps. Although Kinnaur district is highly vulnerable, only a limited number of studies have applied machine learning techniques for landslide susceptibility zonation in this region. Such studies are critical in the environment of accelerating climate change and rising extreme weather conditions in the Himalayas to preserve lives, ecosystems, and ensure economic well-being in susceptible districts such as Kinnaur in the long term.

Study Area

The present study focuses on the Upper Satluj River Basin in Kinnaur district, Himachal Pradesh. This basin covers the majority of the Kinnaur district, excepting the northeast of Sangla tehsil which flows into Yamuna River system (Figure1). The total area of the study region is approximately 6,245 km². Geologically, the region is a part of the Himalayan orogenic belt and is dominated by intricate tectonic environments and weak rock structures. The primary lithological formations in the basin include the Kanwar Group (comprised of mainly quartzite and black shale), Vaikrita Group (mainly schist and gneiss), and Haimanta formations (mainly shale and slate). Together with the strong tectonic activity and the geomorphological processes, these rocks have an important impact on slope stability and landscape development in the basin. Ongoing movement of the tectonic plates along the prominent structures of the Main Central Thrust (MCT) and the South Tibetan Detachment System (STDS) has generated closely compressed and faulted bedrock, whereas a current tectonic movement has been observed to fracture slope materials (Kumar et al., 2021). This tectonic system is the source of the natural

instability of the slopes within the basin.

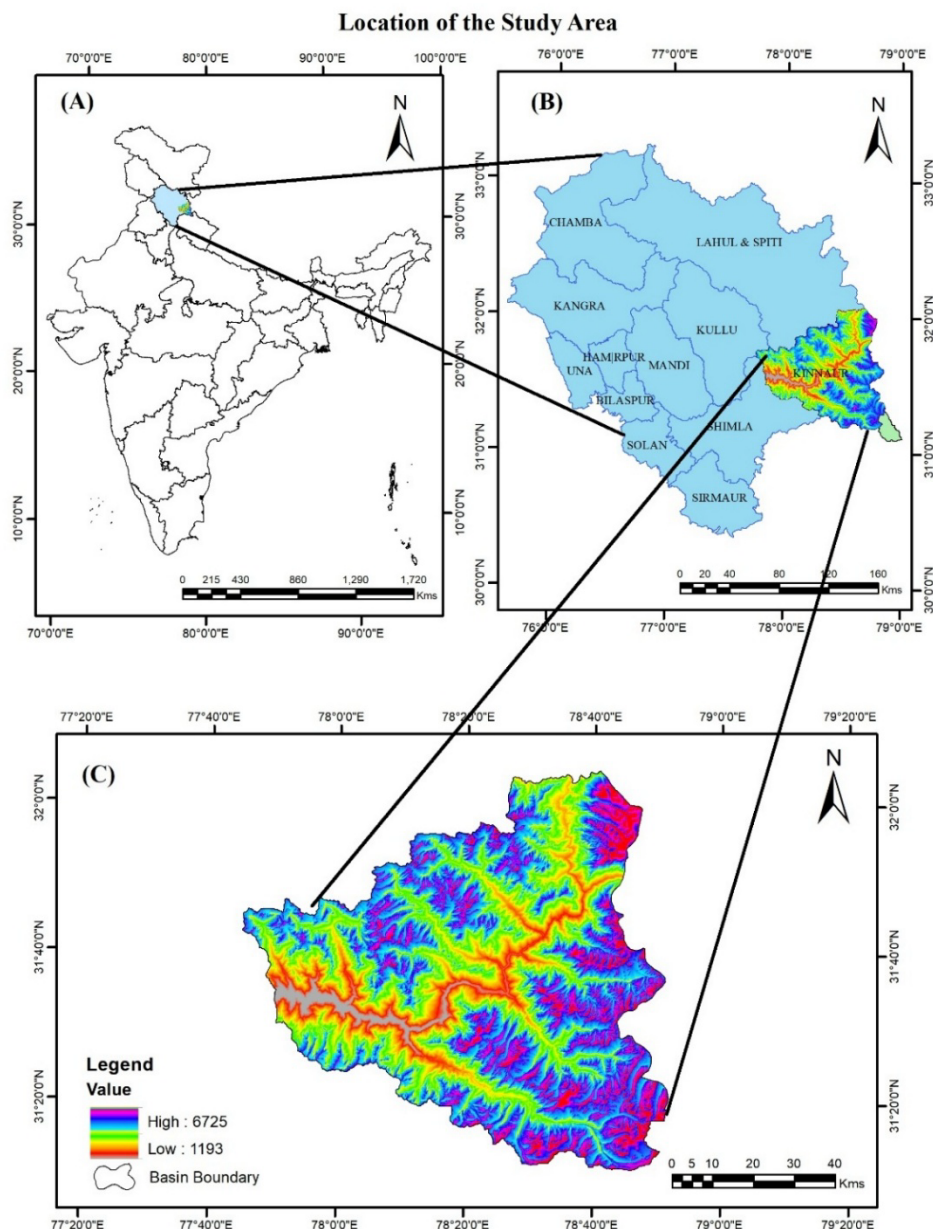


Figure 1. (A) Location of Himachal Pradesh and the Upper Satluj Basin within India; (B) Location of the Upper Satluj Basin in Himachal Pradesh; (C) Upper Satluj River Basin with elevation distribution in Kinnaur District.

The surface is very rugged and mountainous, the heights ascending between 1,193 m in the bottom valleys, and 6,725 m in the high peaks, making the relative relief, 5,532 m, very remarkable. The Satluj River, originating from the Tibetan Plateau, forms the primary drainage system of the basin. Its larger tributaries within the basin are the Spiti, Baspa, Tidong and Ropa rivers. The hydrological networks are significant in determining the geomorphology and water resources of the area (Kuniyal et al., 2019). The Upper Satluj Basin is characterised by a significant climatic variation because of the changes in altitude. The lower elevations experience a temperate climate, while the upper reaches are characterized by cold desert conditions. (Jamwal et al., 2020). The average yearly rainfall is 500 to 1,200 mm with a huge percentage of it being snowfall at the greater heights, particularly throughout the winter season. The southwest monsoon winds become weaker as it moves westward to eastward forming clear

climatic zones in the basin. The vegetation and land cover patterns are the best reflection of this climatic gradient. The lower and middle altitudes are characterized by coniferous forests with an abundance of pine, deodar and fir. Conversely, elevations that are higher have alpine grasslands, barren rocky slopes and huge glacial terrains. The valley floors, especially in and around Kalpa and Sangla, are home to apple orchards and other horticultural products which form the main agrarian economy of the region. The Upper Satluj Basin is very prone to earthquakes and frequent landslides due to the fact that it is located in the seismically active Himalayan belt. The terrain is naturally unstable due to steep slopes, poor geological formations and heavy seasonal rainfall.

Methodology

In the current research, landslide susceptibility zonation (LSZ) was created employing the machine learning algorithm of Random Forest (RF). The methodology was based on a systematic multi-step approach that involved: (i) preparation of landslide inventory, (ii) selection of geo-environmental causative variables, (iii) evaluation of multicollinearity (iv) optimization of the hyperparameters of the model and (v) validation of the final susceptibility map. The elaborate methodology which was applied in this study is as detailed in the subsequent sections.

Landslide Inventory

Landslide inventory is one of the most crucial inputs to any susceptibility mapping. It is a systematic recording of the place, nature and scale of previous landslide events in the study area thus exposing significant spatial patterns and their correlation with the underlying geo-environmental conditions. An inventory of high quality enhances both the predictability and reliability of statistical and machine learning-based models (Guzzetti et al., 2012; Fell et al., 2008). In this paper, inventory was made by integrating both the secondary data of the Bhukosh portal of Geological Survey of India and a field survey in the area. A total of 1,543 landslides were identified and mapped. The inventory was randomly divided into 70: 30 proportions to use in modelling (fig. 3). Training the Random Forest model used 70% of the landslide locations and the other 30% was reserved to validate the model. In order to maintain a balance in class representation and minimize bias, the same number of non-landslide points was randomly generated in the study area. The Receiver Operating Characteristic-Area Under the Curve (ROC-AUC) method was used to analyze the final model performance.

Causative Factors

Thirteen geo-environmental causative factors were chosen in this study and were incorporated in the Random Forest machine learning to generate the landslide susceptibility zonation map. These parameters were selected based on the literature available and are a combination of topographic, hydrological, geological, structural, and vegetation-related factors that are known to have a significant effect on slope instability in high-relief, tectonically active areas such as Kinnaur.

Slope

Slope angle is universally recognised as one of the most important factors controlling landslide occurrence because steeper gradients directly increase gravitational shear stress while simultaneously reducing the frictional resistance of the slope material (Ayalew & Yamagishi, 2005; Lee, 2005; Pradhan & Lee, 2010) (Table 1). The slope layer in the present study was derived from the ALOS PALSAR Digital Elevation Model (12.5 m resolution) (table 1) and reclassified into five classes: $<15^\circ$, $15\text{--}25^\circ$, $25\text{--}35^\circ$, $35\text{--}45^\circ$, and $>45^\circ$ (Figure 2).

Table 1 Data sources of landslide causative factors

Parameter	Source	Scale / Resolution
Slope gradient, aspect, relative relief, TWI, SPI, drainage density	ALOS PALSAR DEM https://search.asf.alaska.edu	12.5 m
Lithology, lineament, thrust	Geological Survey of India https://bhukosh.gsi.gov.in/Bhukosh/Public	1:50,000
Soil	National Bureau of Soil Survey and Land Use Planning (NBSS&LUP)	1:50,000
Rainfall	IMD Gridded Data https://imdpune.gov.in/	0.25° x 0.25°
LULC, NDVI	Sentinel-2 https://dataspace.copernicus.eu/data-collections	10 m

Slope Aspect

Slope aspect affects local microclimate, soil moisture retention, vegetation cover, and weathering intensity, all of which indirectly influence slope stability (Wieczorek et al., 1997). North- and northeast-facing slopes in the region often retain more moisture and are therefore more prone to failure in monsoon-dominated areas. The aspect map was extracted from the same ALOS PALSAR DEM and classified into nine directional classes (fig. 4b) following the common practice (Bisht et al., 2024).

Relative Relief

Relative relief is an effective proxy of terrain ruggedness and erosion capability of mountain terrain. Greater relative relief values are more slope instability because of increased undercutting and gravitational forces (Anbalagan, 1992; Saha et al., 2002). This parameter has often been employed in susceptibility mapping. The DEM of the study area was used to derive the relative relief which was then placed into five classes using the Natural Breaks technique.

Drainage Density

Drainage density is an indicator of channel dissection and is strongly related to the surface runoff, erosion of toes, and slope saturation (Gorsevski et al., 2006; Lee and Pradhan, 2007). Highly drained areas are more prone to landslides due to increased erosion and seepage of ground water. This aspect is regularly added to the studies of the Himalayas. The ALOS PALSAR DEM was used to calculate the density of drainage using hydrological tools in the ArcGIS (fig. 4d). First, the DEM was cleaned up by filling in surface depressions (sinks) so that the flow continuity is achieved. Later, layers of flow direction and flow accumulation were created to facilitate additional hydrological analysis.

Stream Power Index (SPI)

SPI measures the erosive power of concentrated surface runoff and is especially used to detect areas in which channel incision can cause adjacent slopes to become unstable. It can be expressed mathematically as:

$$SPI = A_s \times \tan \beta \quad (1)$$

where β is the local slope gradient in radians and A_s is the catchment area (Moore et al. 1991). Having applied the above equation to the DEM the obtained map was further categorized into five classes based on the Natural Breaks (Jenks) classification method (fig. 4e).

Topographic Wetness Index (TWI)

TWI identifies areas prone to water accumulation and soil saturation, which significantly reduce slope shear strength. It is one of the most commonly used hydrological factors in landslide studies (Gokceoglu & Aksoy, 1996; Lee & Evangelista, 2006). The Topographic Wetness Index (TWI) was calculated according to the method suggested by Moore et al. (1991), expressed as:

$$TWI = \ln \left(\frac{A_s}{\tan \beta} \right) \quad (2)$$

where A_s represents the specific catchment area (flow accumulation), $\tan \beta$ denotes the slope gradient, and $\ln$ refers to the natural logarithm. The resulting TWI map was then divided into five classes using the Natural Breaks (Jenks) method of classification (fig. 4f).

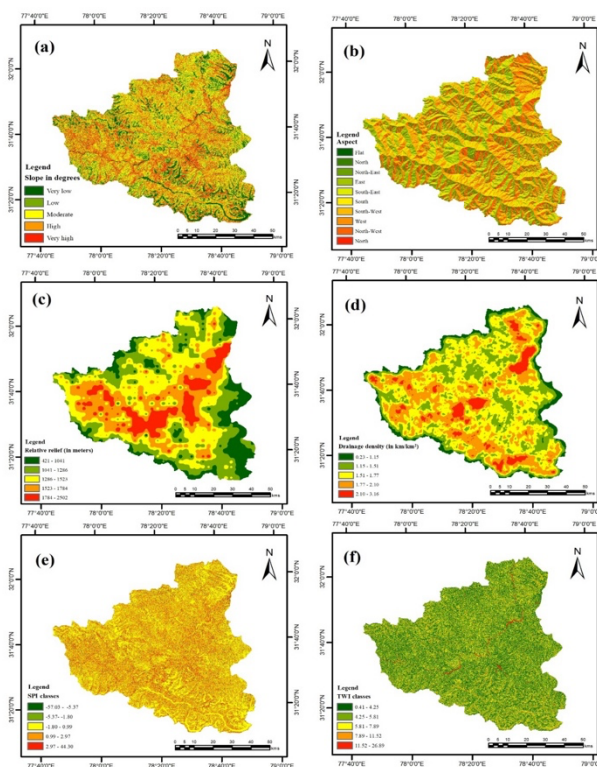


Figure 2 Causative factors considered for landslide hazard mapping: (a) Slope, (b) Aspect, (c) Relative Relief, (d) Drainage Density, (e) SPI, and (f) TWI.

Rainfall

Intensive or long-term rainfall commonly causes landslides since it causes the saturation of the soil, the pressure of pore-water, and the eventual decline in shear strength of the slope materials. The increase in pore-water pressure as rainfall increases reduces the effective stress in the slope, and thus, predisposes the slope to failure. Investigations carried out by Guzzetti et al. (2006) and Dahal and Hasegawa (2008) have shown that occurrence of landslides is closely related to areas with great rainfall (annual or seasonally). In this research, the rain distribution map of the region was drawn based on gridded information of the India Meteorological Department. The annual rainfall data during the years 2014-2024 were used and the resulting data were categorized into five groups to represent different levels of rainfall (fig. 5a).

Lithology

Lithology is the composition and the physical properties of rocks and soils in a particular locality. It is an important factor in the strength, permeability and weathering behavior of slope materials. Some rock types, especially weaker rocks like schist and shale are more susceptible to landslides since they have low cohesion and are more vulnerable to water infiltration (Gupta and Joshi, 1990). In this study, lithological data was obtained in the Geological Survey of India at 1:50,000 scale (fig. 5b). It was further divided into 12 lithological units that were analysed as a dataset (table 2).

Table 2: Different Rock Types in Various Lithological Groups.

Group Name	Lithologic
Kanawar	Quartzite, Black Shale with Nodules
Lilang	Dolomite, Limestone, Oolitic Limestone
Vaikrita	Schist, Gneiss, Migmatite, Quartzite, Marble
Rampur (Naraul)	White-Green Quartzite, Phyllite, Basic Flows
Jeori-Wangtu Banded Gneissic Complex	Granitoids, Gneisses and Migmatites
Kulu	Streaky And Banded Gneiss.
Sanugba	Shale, Slate, Calcarene, Limestone, Dolomite
Kuling	Calcareous Sandstone, Shale, Quartzite, Conglomerate
Haimanta	Shale, Slate, Siltstone, Quartzite
Jutogh (Undiff.)	Psammatic Gneiss, Garneti Mica Schist, Amphibolite
Rakcham Granite	Medium To Coarse Biotite Granite
Nako Granite	Granite

Source: Geological Survey of India

Soil

The type of soil directly influences cohesion, permeability and shear strength. The different soil textures react differently to saturation and thus are essential to proper modelling. The soil layer was obtained from the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) at a scale of 1:50,000 and reclassified based on soil texture (Figure 3).

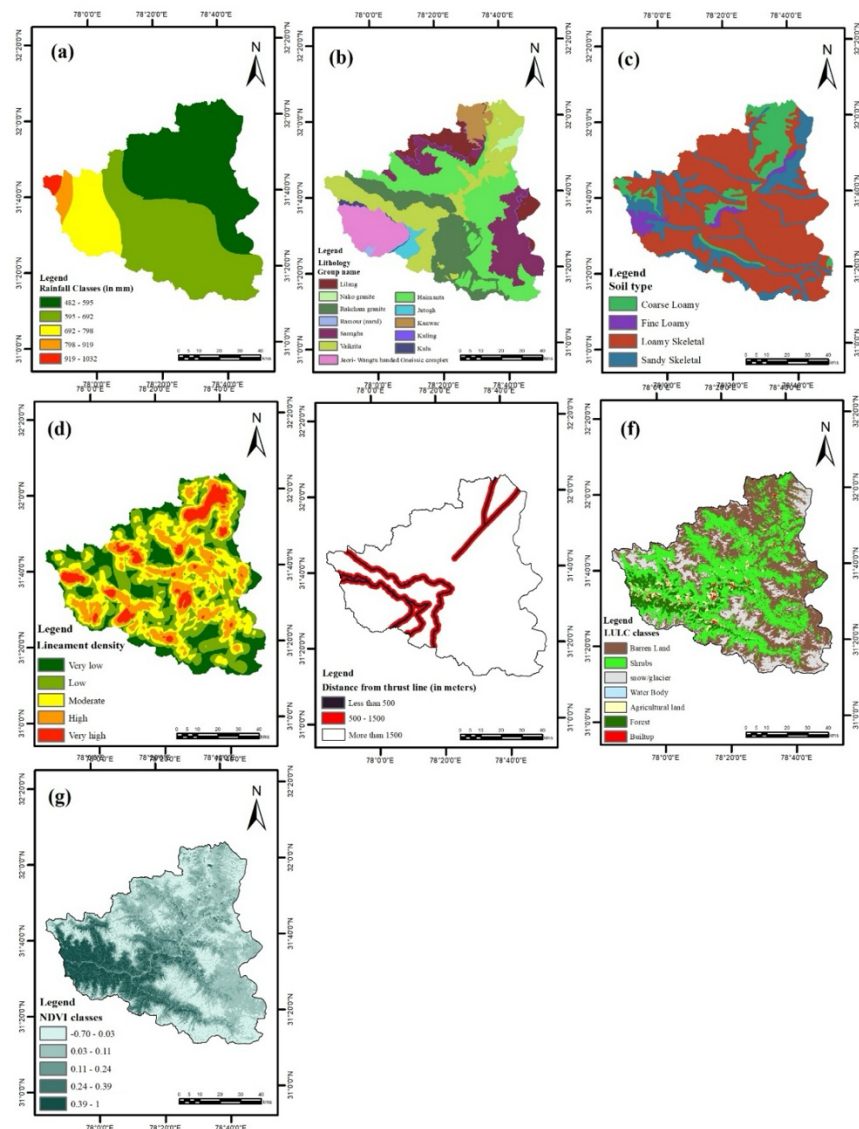


Figure 3 Causative factors considered for landslide hazard mapping: (a) Rainfall, (b) Lithology, (c) Soil, (d) Lineament Density, (e) Distance from thrust line, (f) LULC, and (g) NDVI.

Distance to Thrust Line

Regions that are found to be in close proximity to the large thrust faults are regions of high deformation, that is, the rock masses are highly sheared, fractured and weakened. These conditions cause slopes to be much more unstable and hence these areas are more prone to landslides (Anbalagan, 1992). The effects of the thrust proximity were included in the current study by adding the factor of distance to thrust, which was divided into three buffer areas: 0–500 m, 500–1500 m, and more than 1500 m.

Land Use/Land Cover

It is important to note that LULC is influential in determining the stability of the slope and the process of surface erosion, root reinforcement, and the degree of human-induced disturbances. Barren soils and urbanized areas tend to be more susceptible to landslides than a forest area, mostly because roots are bound with less strength and because there is more surface runoff (Saha et al. 2005; Pradhan and Lee, 2010). In this work, supervised classification of Sentinel-2 images (October 2023) was used to prepare the LULC map.

Normalized Difference Vegetation Index

NDVI measures the density and health of vegetation, which offers mechanical root strength and decreases surface erosion. Lower NDVI values typically correspond to higher susceptibility (Gupta & Joshi, 1990; Lee & Pradhan, 2007). The NDVI band was calculated with Sentinel-2 images (fig 5f) based on the following formula:

$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red}) \quad (3)$$

Multicollinearity Analysis

A multicollinearity analysis has been conducted prior to including the thirteen causative factors into the Random Forest model based on Variance Inflation Factor (VIF) and Tolerance statistics. It is a necessary step in landslide susceptibility study, especially when a combination of geo-environmental variables in complicated topographies such as the Himalayas is considered (Chauhan et al., 2025; Joshi & Bhandary, 2025). High multicollinearity occurs when factors are strongly inter-correlated, which can distort the model's ability to accurately assess the individual contribution of each variable, inflate variance in predictions, and reduce the overall reliability and interpretability of the results (Dormann et al., 2013). Variance Inflation Factor (VIF) measures how much the variance of a regression coefficient is inflated due to multicollinearity, while Tolerance is its reciprocal (1/VIF) and indicates the proportion of variance in a factor not explained by the other variables (O'Brien, 2007).

Landslide Susceptibility Zonation Model

LSZ has traditionally been carried out using a variety of modelling approaches that can be broadly grouped into three main categories: qualitative, semi quantitative and quantitative (Das et al., 2023). Qualitative and semi quantitative rely on expert judgment and multi-criteria decision-making techniques such as the Analytic Hierarchy Process (AHP) to assign weights to causative factors; they are simple and useful when data are limited but remain subjective (Merghadi et al., 2020; Shano et al., 2020). Statistical models, including Frequency Ratio (FR) and Logistic Regression (LR), quantify the spatial relationship between past landslides and conditioning factors through bivariate or multivariate analysis and have been widely applied in the Himalaya because of their transparency and ease of interpretation (Wang et al., 2020). Deterministic models use physically based equations (e.g., the infinite slope stability model) to calculate factor of safety; they are highly accurate at local scales but require detailed geotechnical data and are rarely feasible for large basins (Merghadi et al., 2020).

Machine-learning models have been especially popular in recent years due to their ability to reproduce complex non-linear relationships without making strong assumptions about the distribution of data; one example of such an ensemble method is the Random Forest (RF) technique, which has repeatedly demonstrated better performance in the Himalayan terrain (Merghadi et al., 2020; Taalab et al., 2018). The Random Forest (RF) algorithm was used to create the LSZ map of the Upper Satluj River Basin in the current study due to its strength, high predictive accuracy, and the ability to deal with complicated and non-linear associations between various conditioning factors (Akinci et al., 2020; Park and Kim, 2019). RF algorithm is an ensemble learning algorithm, originally proposed by Breiman (2001), which builds large decision trees based on bootstrapped samples of the input data and randomly chosen subsets of variables on each node split. The data on landslide inventory was taken as the dependent variable in this study whereas various geo-environmental and anthropogenic conditioning factors were taken as the independent variables. The data was randomly separated into training (70%), and validation (30%) to guarantee the assessment of the model is objective. Bootstrap sampling (with replacement) was used to train each decision tree of the RF model to increase the variety of the model and decrease the variance. The implementation of the model was carried out in R environment. To achieve a better model optimization and validation, the caret

package was utilized, and it simplified the systematic cross-validation and hyperparameter tuning. The most important hyperparameters that were looked at in the creation of the models were the number of trees (ntree) and the random selection of number of variables at each split (mtry). The ntree parameter was varied between 100 and 500 to identify the optimal number of trees required for stable model performance. It was noted that the out-of-bag (OOB) error flattened off around 500 trees; hence, the final model was built with 500 trees to achieve a balance between computational efficiency and predictive accuracy. The mtry hyperparameter was optimally determined by a systematic grid search between 2 and 15. The best mtry value was set to 3 since it gave the highest Area Under the Curve (AUC) in the cross-validation indicating better performance of the model. The default method of sampling was a bootstrap sampling with replacement, which created different training subsets per tree and thus increased the robustness of models. The out-of-bag (OOB) error estimate and independent validation data were used to assess model performance. The resulting susceptibility map was better interpreted and represented spatially by categorizing it into five groups: very low, low, moderate, high, and very high using the Natural Breaks (Jenks) classification system.

Model Performance

Validation of the model was performed to assess predictive performance and reliability of the model by using the Receiver Operating Characteristic (ROC) curve and the Area Under the Curve (AUC) measure. ROC curve shows the correlation between the true positive rate (sensitivity) and false positive rate (1-specificity) at various threshold values and gives a complete measure of the classification performance (Chung and Fabbri, 2003). The AUC of 0.5 to 1.0 shows that the model is able to differentiate correctly between landslide and non-landslide sites with the values nearer to 1 being more predictive. To validate the model, 30% of the landslide inventory was used for testing.

Results and Discussion

In order to determine whether multicollinearity is present in the 13 chosen landslide conditioning factors, the Variance Inflation Factor (VIF) and Tolerance values were calculated. A value that is below 0.1 is usually deemed as a high level of redundancy, and a VIF above 10 is an indication of severe problems of multicollinearity (Yi et al., 2020). The findings showed no significant multicollinearity between the variables and all VIF values were below 2 and Tolerance values were always above 0.8. Aspect had the lowest value of collinearity (VIF = 1.03), and Stream Power Index (SPI) and Topographic Wetness Index (TWI) had slightly higher but nevertheless acceptable values (VIF = 1.21 each), which is a medium value of correlation (Table 3). No variable was dropped since none of the VIF values was greater than the generally accepted level of 5.

Table 3 Multicollinearity Analysis of Causative Factors

Collinearity Statistics		
Variables	VIF	Tolerance
Aspect	1.03	0.972
Drainage Density	1.13	0.884
Lineament Density	1.08	0.926
Lithology	1.16	0.863
NDVI	1.22	0.819
Rainfall	1.27	0.785
Relative Relief	1.1	0.911
SPI	1.21	0.83
Distance from Thrust	1.17	0.853
TWI	1.21	0.828
LULC	1.12	0.897
Slope	1.13	0.887
Soil	1.19	0.842

The landslide hazard spatial distribution reveals that the very low (23.8) and low (22.3) hazard areas are confined mainly to the southern area of the study area whereas the high (20.3) and very high (10.2) hazard areas are found in the northern, northeastern and central regions (Table 4; fig. 6). This trend is indicative of active Himalayan geomorphology. The controlling factors are slope with almost 60% of very steep slopes ($>45^\circ$) located in high hazard regions and more than 95 percent gentle slopes ($<15^\circ$) being stable. This trend has been observed in other basins nearby, though the correlation is greater in the Upper Satluj Basin because there is greater local relief (Singh et al., 2024). The landslide susceptibility is also highly dependent on lithology. Mostly the Kulu Group is linked with high hazard areas (approximately 65%) because of the fractured and weathered metamorphic rocks (Gupta and Joshi, 1990). Likewise, Jutogh Group and Jeori-Wangtu Banded Gneissic Complex are highly susceptible in nature because of the low metasedimentary and gneissic formations (Saha et al., 2002; Pradhan and Lee, 2010). Conversely, more stable units like Lilang Group, Nako Granite, Kuling formation are majorly restricted to low hazard areas because they are stronger and less permeable. These trends are also supported by relief and soil features. Most high and very high hazard areas are highly related to high relative relief areas and over 94 percent of low-relief areas belong to very low and low hazard areas, in line with Das et al. (2023). Fine loamy soils are more susceptible (approximately 61% in the high hazard areas), but sandy skeletal and loamy skeletal soils are comparatively more resilient.

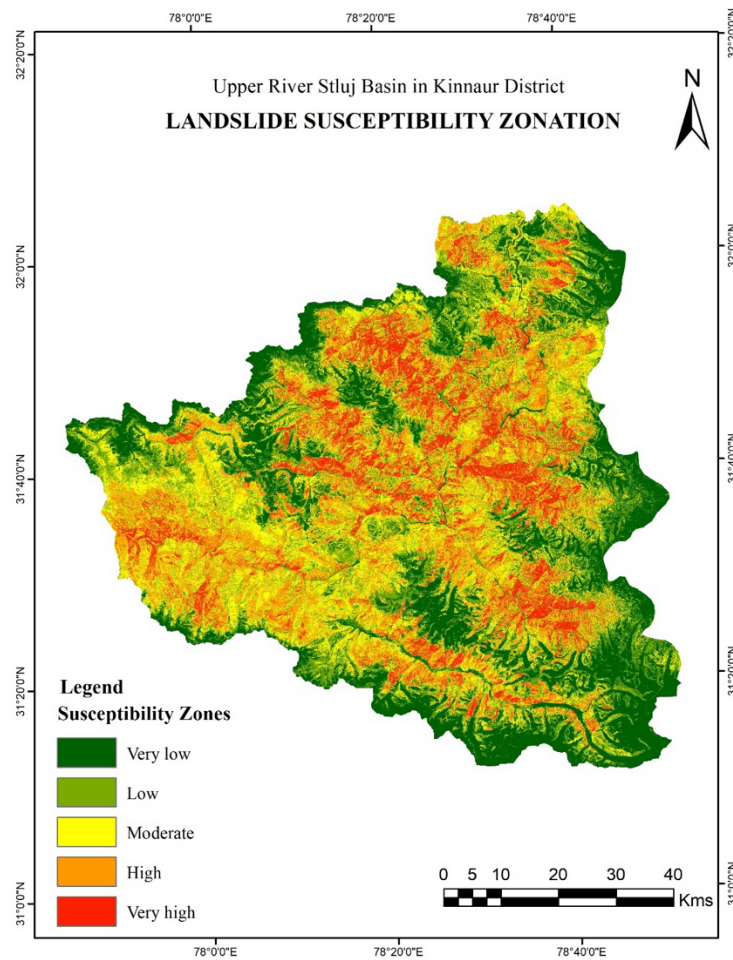


Figure 4. Landslide Susceptibility Zonation map

Table 4 Landslide Susceptibility Zones

Susceptibility Zone	Description	Area (in km)	Area (%)
I	Very Low Susceptibility	1488	23.82
II	Low Susceptibility	1390	22.26
III	Moderate Susceptibility	1460	23.38
IV	High Susceptibility	1269	20.32
V	Very High Susceptibility	639	10.23

Random Forest model showed a high predictive power with ROC–AUC of 0.841 (Figure 5), which means that this model has a high accuracy in the process of identifying areas at risk of landslides. The resulting value of the AUC is comparable to the outcomes of other studies of the same nature, such as Liu et al. (2023) (AUC $\approx$ 0.87), Badapalli et al. (2025) (AUC $\approx$ 0.89) and Abu El-Magd et al. (2021) (AUC $\approx$ 0.86), demonstrating.

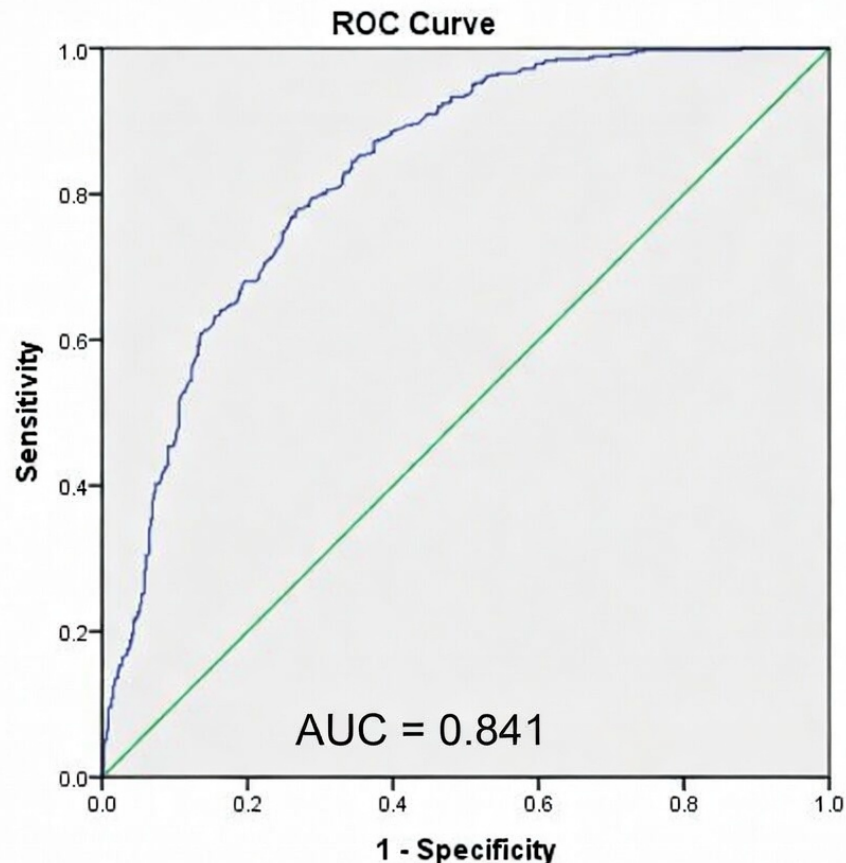


Figure 5 Validation through ROC – AUC

Conclusion

The current research enhances the knowledge of the landslide susceptibility in the Upper Satluj River Basin using a GIS-based Random Forest (RF) model. The model describes the intricate relationships between geo-environmental and human-made factors governing slope instability in this delicate Himalayan landscape. The resultant landslide susceptibility zonation (LSZ) map shows that a significant part of the basin has moderate to very high hazard zones and almost one-third of the basin has been classified as highly vulnerable. These areas are mainly related to steep slopes, high relative relief, structurally weak lithological units, and tectonically active and drainage concentrated areas. The implications of the results on practical implications on risk mitigation and planning are significant. The LSZ map will be a valuable decision-support information in terms of land-use planning as it allows to identify high-risk zones and influence the development of infrastructure, such as roads and hydropower projects, in the areas that are not threatened. It also underpins specific mitigation measures like slope stabilization practices and introduction of localized early warning mechanisms, thus making communities resilient. The RF model showed good predictive capabilities ($AUC = 0.841$) which proved that the model is appropriate when assessing landslide susceptibility in complex mountainous areas. The fact that it can deal with non-linear relationships and heterogeneous data allows it to be especially useful in Himalayan settings. But the model relies on the quality of input data and presupposes a steady conditioning factor over time. All in all, the paper provides a credible geospatial model of landslide danger evaluation in the Upper Satluj Basin and leads to the advancement of scientific knowledge and effective mitigation of risks. This study can be expanded by future studies through hybrid models that combine machine learning with physically based models, and high-resolution, multi-temporal data to more effectively represent dynamic triggering processes like rainfall and seismic activity. This would enhance

the accuracy and usefulness of landslide susceptibility models in mountainous areas that are complicated.

To sum up, the research offers a scalable method of determining landslide-prone regions and aids in sound decision-making towards sustainable development and reduction of disaster risks in the Himalayan region.

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Research Article**Sustainable Livelihood and Natural Resource Management in the North Western Himalaya: A Case of Salooni Block of Chamba District, Himachal Pradesh**Twinkle Vaid¹ and Sanjay Singh Pathania²¹Khalsa College of Education, Ranjit Avenue, Amritsar²Principal, Government Degree College, Chowari, Chamba (H.P.)Corresponding author: Email: twinklevaid23@gmail.com**Abstract**

The North Western Himalayan region, known for its ecological richness and cultural heritage, faces mounting challenges in ensuring both environmental sustainability and economic well-being of its rural communities. This study focuses on the Salooni Block of Chamba District in Himachal Pradesh, examining the potential of sustainable livelihoods through the optimal use of locally available natural resources. The research explores forest-based products, medicinal plants, traditional crops, beekeeping, horticulture, and eco-tourism as key areas to enhance income generation for local communities. The paper combines field surveys, stakeholder interviews, SWOT analysis and secondary data to identify viable green livelihood options that are environmentally sound and economically viable. In the present study, primary data was collected from hundred households in the villages of Kuntedi, Langeri and Kandhwara through structured interviews. To ensure the reliability and depth of the findings, participants were selected to represent diverse groups, including elderly villagers, local officials, NGO representatives, community leaders and other relevant stakeholders. The findings highlight that integrating small-scale enterprises, value-added processing, and traditional knowledge with modern techniques can significantly improve rural incomes while preserving ecological balance. It includes policy recommendations to promote inclusive, context-specific strategies for livelihood development offering a replicable model for sustainable mountain development. The study advocates for context-specific strategies that align livelihood generation with conservation goals, contributing to a replicable model of sustainable mountain development.

Keywords: Chamba District, Eco-tourism, Green Economy, Natural Resource Management, North Western Himalayas. Sustainable Livelihoods

Introduction

Sustainability has been a core value in Indian civilization since ancient times, deeply embedded in traditional lifestyles that emphasized balance with nature, conservation of resources, and community-centric development (Gadgil & Guha, 1992). As development paradigms have evolved over the centuries, the underlying principle of living in harmony with the environment continues to be crucial especially in the present era, where ecological degradation and socio-economic inequalities are intensifying due to climate change, and unbalanced development (UNEP, 2019; ICIMOD, 2021). The concept of sustainable livelihoods in India gained prominence during the 1990s through government programs and civil society initiatives that emphasized poverty alleviation, natural resource management, and participatory development (Chambers & Conway, 1992; Scoones, 1998). It focuses on enabling communities to utilize their assets natural, physical, human, social, and financial in ways that are productive, sustainable, and adaptable to change. In mountain regions, this involves tapping into local resources such as non-timber forest products (NTFPs), traditional agriculture, and eco-tourism potential, and converting them into viable livelihood options through value addition, small-scale processing, and sustainable enterprise development (Singh & Pandey, 2020; Thakur & Sharma, 2019).

Himachal Pradesh, nestled in the North Western Himalayan region, is ecologically diverse yet highly vulnerable to both environmental and socio-economic stresses. The state is

frequently exposed to natural hazards such as landslides, flash floods, glacial lake outbursts, forest fires, and erratic precipitation all of which are becoming more pronounced due to climate change and unsustainable development practices (Negi & Palni, 2010; ICIMOD, 2021). While the state has made notable progress in literacy and infrastructure, much of its rural population remains dependent on climate-sensitive sectors such as agriculture, horticulture, and forest-based livelihoods. These sectors are under increasing threat from land degradation, biodiversity loss, and declining water availability, putting the livelihood security of mountain communities at significant risk (Nautiyal et al., 2015). Within Himachal Pradesh, Chamba District is among the most socio-economically backward regions, as identified in various government and academic assessments (Government of India, 2018; Thakur & Sharma, 2019). A large segment of the population depends on subsistence farming, pastoralism, and forest resources, with few alternatives for income diversification. Narrowing down further, the Salooni Block, located in the northwestern part of Chamba District, presents a microcosm of the region's broader challenges. Though endowed with rich natural resources such as forests, medicinal herbs, alpine pastures, and freshwater streams Salooni remains underdeveloped and largely excluded from mainstream economic activity (Figure 1). Its villages are scattered across steep terrains, with limited road connectivity and inadequate support for rural enterprises. Despite this, the region holds significant potential for promoting sustainable and green livelihoods by utilizing local resources such as non-timber forest produce (NTFPs), traditional crops, and eco-tourism possibilities.

Therefore, the present study focuses on identifying and evaluating resource-based livelihood opportunities in Salooni Block, with an emphasis on sustainability, value addition, and community empowerment. By aligning the research with the principles of Sustainable Mountain Development and the UN Sustainable Development Goals the study contributes to the evolving discourse on localized, nature-based solutions for development in mountain regions. By integrating traditional knowledge with modern sustainability approaches, the study aims to contribute to replicable models for balanced development where livelihood generation and environmental conservation go hand in hand.

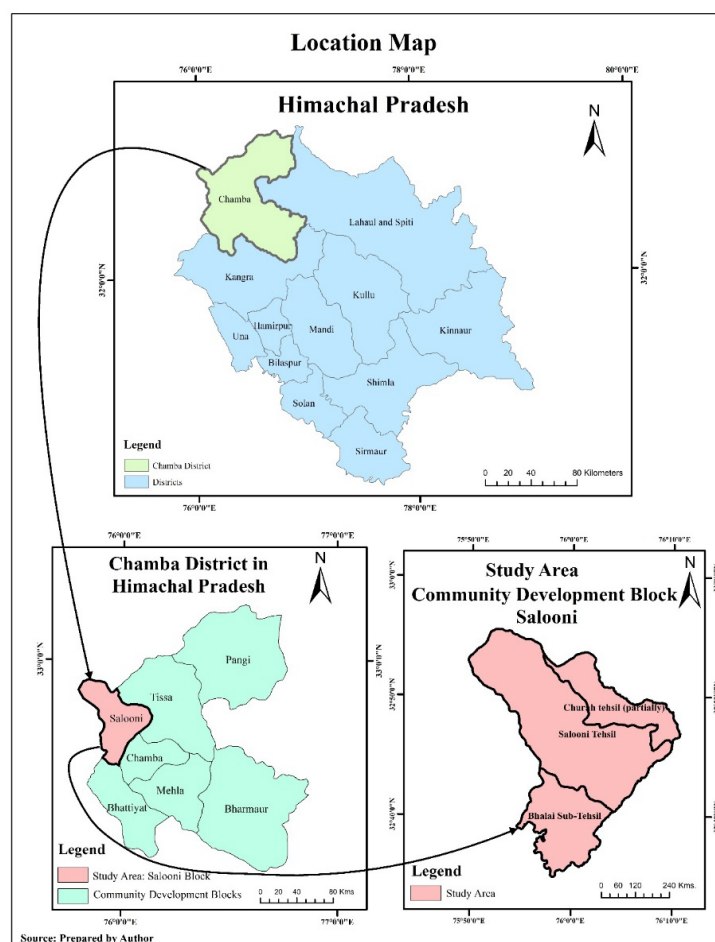


Figure 1: Location Map of Study Area

Study Area

The present study area, Salooni, is one of the seven Community Development (C.D.) blocks of Chamba district in Himachal Pradesh. The area is known for its rich ecological diversity and striking natural beauty. The region spans an area of 576.5 square kilometers and lies between latitudes $32^{\circ}30'0''$ N to $33^{\circ}00'0''$ N and longitudes $75^{\circ}45'0''$ E to $76^{\circ}15'0''$ E (figure 1). Its topography is remarkably varied, with altitudes ranging from 550 meters to 3,900 meters above mean sea level. This variation gives rise to a mosaic of landscapes including dense deodar forests, alpine meadows, snow-covered peaks, glacial streams, and serene lakes. Geographically, the block is bounded by the Pir Panjal range to the north and the Dhauladhar range to the south, making it a part of the north-western Himalayan ecosystem. The region is characterized by a close interdependence between natural resources and traditional livelihood systems. However, it also faces several socio-economic challenges typical of remote mountainous areas, such as limited infrastructure and fragile ecosystems. This unique combination of ecological wealth and developmental constraints makes Salooni a significant area for studying sustainable livelihoods and natural resource management.

Methodology

This study adopted a qualitative and exploratory research design to investigate the potential for sustainable, resource-based livelihoods in the study area. The research aimed to gain an in-depth understanding of local livelihood patterns, available natural resources, and the feasibility of sustainable livelihood interventions. Primary data were collected through a combination of field surveys, semi-structured interviews, and focus group discussions (FGDs). In the present study, primary data was collected from hundred households of villages named

Kuntedi, Langer and Kandhwara through structured interviews. To ensure the reliability and depth of the findings, participants were carefully selected to represent diverse groups, including elderly community members, local administrative staff, NGO representatives, and other relevant stakeholders. Semi-structured interviews were held with a diverse range of stakeholders, including local farmers, forest produce collectors, women's self-help groups, traditional knowledge holders, and panchayat representatives. These interviews provided detailed insights into community dependence on natural resources, existing livelihood practices, and challenges faced by residents in sustaining their incomes. In addition to primary data, secondary data were obtained from government reports, forest working plans, census documents, academic literature, and records from local institutions such as panchayats, NGOs, and cooperative societies. These sources supported contextual understanding and validation of field data.

The analysis of data was carried out using qualitative content analysis to identify key themes and patterns related to resource use, and sustainability practices. A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was used to evaluate the viability of proposed green livelihood options. A purposive sampling technique was employed, wherein villages were selected based on variations in elevation, ecological characteristics, and livelihood patterns. Within each selected village, respondents were chosen to represent diverse age groups, genders, and occupational categories, thereby ensuring a comprehensive and representative range of perspectives.

Results

The assessment of locally available natural resources in the study area highlights significant potential for sustainable livelihood enhancement through various nature-based and traditional economic activities. The data derived from official reports, academic literature, and interviews with government officials, NGO representatives, and local residents reveals a multifaceted livelihood structure rooted in the region's ecological and cultural wealth. This comprehensive approach ensures triangulation of data and strengthens the reliability and validity of the findings. The findings are discussed below under thematic categories.

Forest Resources

Forests in the Salooni block serve as a crucial source of livelihood, particularly through the collection of medicinal herbs, wild mushrooms, and other edible forest products (Figure 2). Key species like *Valeriana jatamansi* (Mushakbala) and *Trillium govanianum* (Nag Chhatri) are highly valued, with some fetching prices up to ₹20,000 per kilogram. Locally available species like morel mushrooms (Gucchi) and herbal plants such as *Matteuccia struthiopteris* (Kasrod), Nettle Leaves are highly valued for both consumption and commercial sale. As noted by a respondent during a field interview on 16th October 2023, despite the effort involved in collecting and processing, the returns justify the labour. Non-Timber Forest Products (NTFPs) provide seasonal income, especially to women, who are responsible for collection in nearly 70% of households. These forest-based resources, though often undervalued, have strong economic potential. To ensure their sustainable use, there is a need for proper valuation, regulation, and promotion of community-based conservation and marketing strategies.

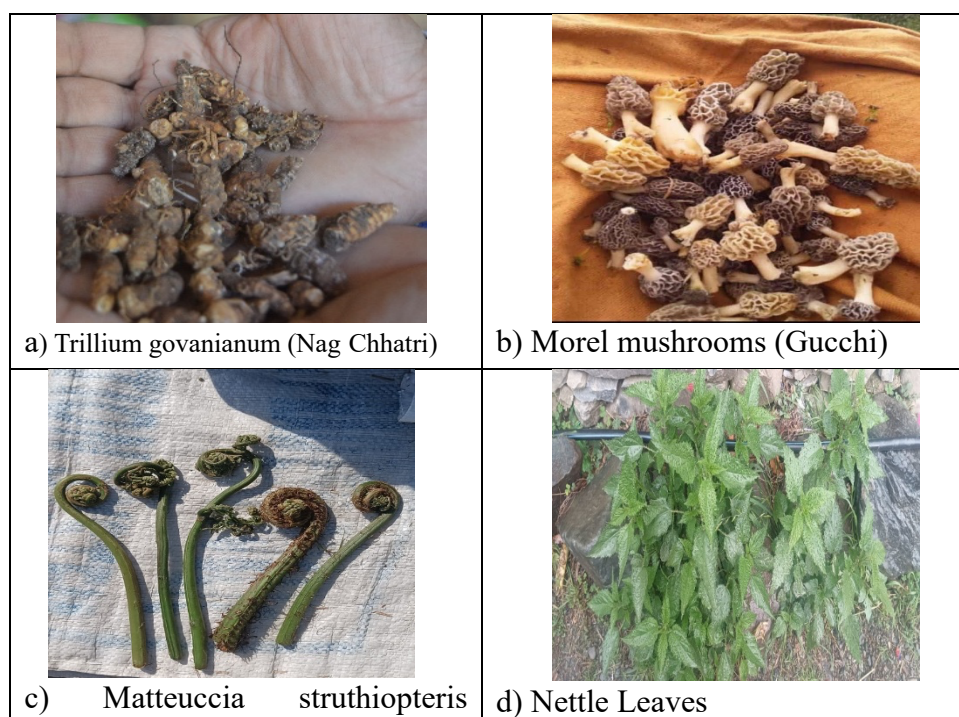


Figure 2: Pictures showing Forest Resources
 Source: Clicked by Researcher during field survey, 2024

Agriculture and Allied Activities

Agriculture is the primary livelihood in Salooni, supported by the cultivation of traditional crops well-suited to terrain and climate of the region. Among these, White Maize (*Hachchi Kukdi*), Red Maize (*Ratti*), and Popcorn Maize (*Chidku*) are locally grown and valued for their rich nutritional content, including essential vitamins, minerals, and antioxidants. The commercial promotion of these traditional maize varieties, along with awareness of their health benefits, holds strong potential for improving household incomes. By tapping into niche markets for organic and heritage grains, and pursuing initiatives such as Geographical Indication (GI) tagging, these crops can gain broader recognition and fetch premium prices (Figure 3). This would not only enhance the economic value of local agriculture but also encourage the conservation of indigenous crop diversity, contributing to both livelihood security and cultural heritage preservation.

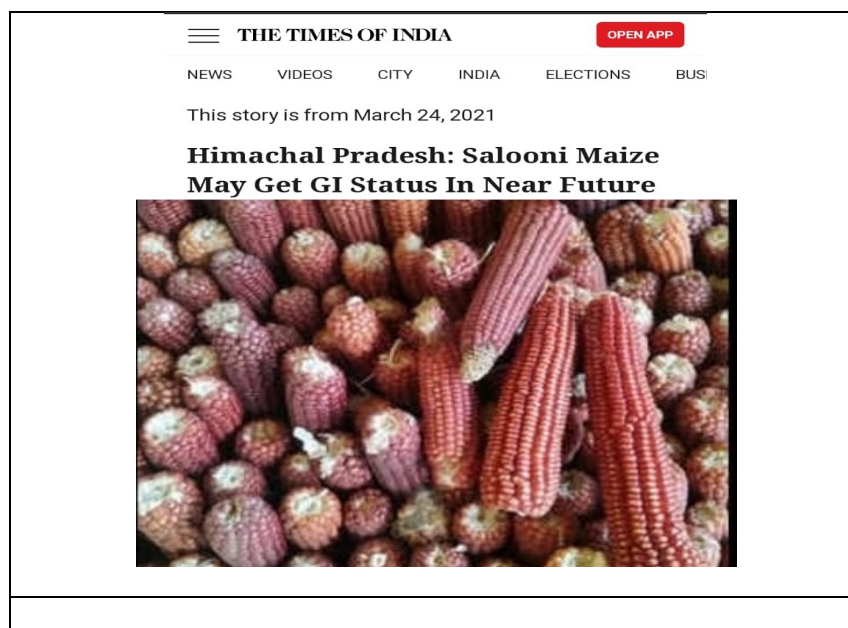


Figure 3: Newspaper Archive, Geographical Indication Status for Salooni Maize
Source: Times of India, March 24, 2021

Horticulture

Horticulture is emerging as a lucrative and sustainable livelihood option in the Salooni block, particularly due to its favourable agro-climatic conditions and mountainous terrain. The region is unsuitable for large-scale traditional agriculture; however, its geography makes it ideal for cultivating high-value crops such as potatoes, peas, cabbage, carrots, and temperate fruits like apples, plums, cherries, apricots, and pears. Additionally, dry fruits and nuts including hazelnuts, walnuts, and almonds are also grown, adding further diversity to local production systems. The implementation of the Green Gold Project by the Department of Rural Development in 2002 played a pivotal role in transforming Salooni into the vegetable hub of Chamba District. This initiative encouraged farmers to adopt vegetable cultivation as a mainstream livelihood activity. According to the local Horticulture Development Officer, farmers in the region are now earning up to ten times more compared to returns from traditional farming practices. Despite these advancements, the horticulture sector still faces challenges such as inadequate cold storage infrastructure, limited market access, and poor post-harvest handling (Sharma & Rana, 2019). Nevertheless, the Government of Himachal Pradesh continues to promote horticulture through schemes like the Mission for Integrated Development of Horticulture (MIDH), along with targeted training programs and subsidies. The gradual introduction of floriculture among local farmers further adds to agricultural diversification, reflecting a shift toward more profitable, climate-resilient, and market-oriented farming systems in the region.

Apiculture

Beekeeping is emerging as a popular and sustainable livelihood option in the Salooni region, driven by its ecological benefits, low investment requirements, and growing market demand. Apiculture not only enhances agricultural productivity through pollination but also provides income from honey, beeswax, royal jelly, and other valuable by-products. The Himalayan terrain of Salooni, though unsuitable for large-scale agriculture due to its climate and topography, offers immense potential for beekeeping. The temperate climate of region, diverse wild flora, fruit orchards, and abundance of medicinal plants create an ideal environment for premium honey production. As observed during field surveys, local

beekeepers refrain from using pesticides and chemicals, which enhances the nutritional value of the honey and increases its market appeal. Apiculture is being actively promoted by NGOs such as SPARK and local Krishi Vigyan Kendras through training programs and distribution of apiary kits, encouraging rural entrepreneurship (Figure 4). Furthermore, the Himalayan region's optimal agro-climatic conditions and rich bee flora make beekeeping a promising avenue for sustainable livelihoods in Salooni.



Source: Photographs provided by Programme Manager, Spark NGO

Figure 4: Spark NGO training locals for Apiculture

Source: Photographs provided by Programme Manager, Spark NGO

Handicrafts

Traditional handicrafts, created using locally available and eco-friendly materials like corn husk, bamboo, and kusha grass, have long been part of cultural and economic landscape of Salooni (Photo Plate 1.4). Crafts such as weaving, embroidery, wood carving, and pottery not only preserve heritage but also offer sustainable livelihood opportunities. Their promotion through tourism especially during festivals and fairs has helped create niche markets and increased demand for handmade products. Handicrafts are increasingly becoming a source of supplementary income for rural households. During the field survey, it was observed that families, particularly women, produce items like sitting mats, ropes, baskets, and woollen goods using local materials. Women's participation is especially notable through Self Help Groups (SHGs) under the National Rural Livelihood Mission, which facilitate product sales in weekly markets and build entrepreneurial capacity. These activities promote both environmental sustainability and social inclusion. For women, in particular, handicrafts provide a pathway to financial independence, skill development, and community engagement. With greater market access and institutional support, this sector holds strong potential for advancing women-led green livelihoods in Salooni.

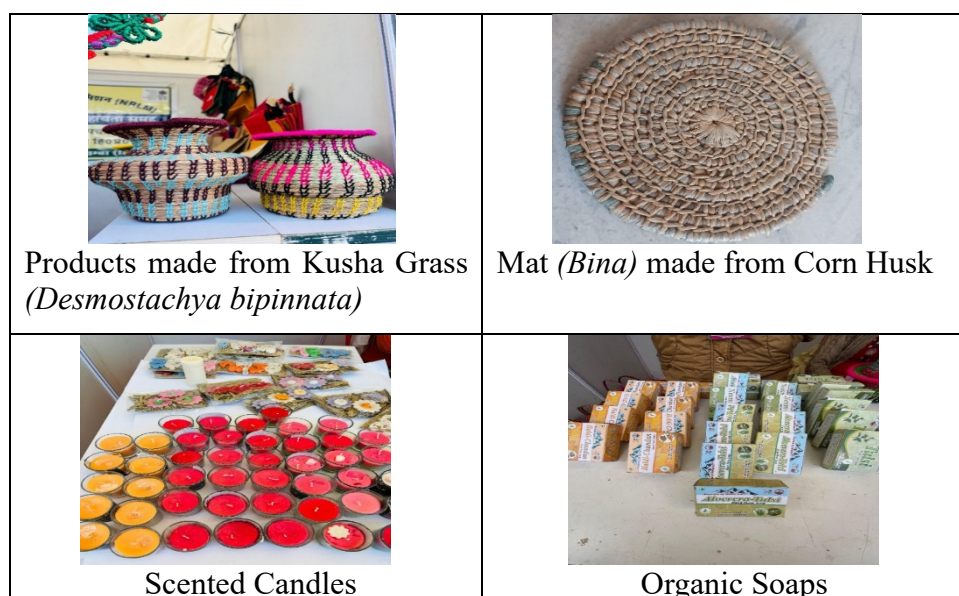


Figure 5 : Handicraft Products

Source: Clicked by Researcher during field survey, 2024

Tourism

Tourism in the Salooni region including eco, agro, adventure, and cultural tourism holds significant untapped potential. The natural beauty of the region, combined with cultural festivals, traditional cuisine, and village life, can attract domestic and international tourists. According to local respondents, traditional fairs like Nag Jatar, Triundi Mata Jatra, and Gadh Mata Jatra are held annually, with participation from every household in the region. These festivals offer tourists a unique opportunity to witness and engage with regional customs, including traditional dances, religious rituals, and centuries-old cultural practices. Highlighting the role of agro-tourism, a government official noted: *“While serving in Salooni, I witnessed the difficult living conditions of the people. To address this, the government introduced the Green Gold Mission, which aimed to diversify livelihood options by promoting the cultivation of high-value cash crops.”* This initiative not only supports sustainable income generation but also opens avenues for integrating agriculture with tourism, thereby enhancing the overall rural economy.

SWOT Analysis of Sustainable Livelihood Options in Salooni Block

The SWOT analysis of sustainable livelihood options in Salooni Block highlights how locally available natural and human resources can be effectively utilized while addressing existing constraints and external challenges. This approach aligns with the sustainable livelihoods framework, which emphasizes the interaction of assets, vulnerabilities, and institutional support systems (Robert Chambers & Gordon Conway, 1992; Food and Agriculture Organization, 2018). It further facilitates a holistic understanding of livelihood dynamics by integrating socio-economic and environmental dimensions into the analysis (Table).

Strengths: Salooni Block possesses significant natural and cultural strengths that support sustainable livelihoods. The region’s rich biodiversity, including medicinal herbs, forest produce, and fertile agricultural land, provides a strong base for activities such as organic farming and beekeeping. For instance, the availability of diverse flora supports high-quality honey production, which can be marketed as an organic product. Additionally, traditional ecological knowledge enables communities to sustainably manage natural resources (United Nations Development Programme, 2015). The scenic Himalayan landscape also enhances

opportunities for eco-tourism, including homestays and nature-based tourism, which are increasingly promoted under state development initiatives. Furthermore, the strong sense of community participation and indigenous practices fosters resilience and supports the long-term sustainability of livelihood strategies in the region.

Weakness: Despite these strengths, several internal limitations restrict livelihood expansion. Poor infrastructure, including weak road connectivity and lack of storage facilities, limits access to broader markets, forcing producers to sell at lower prices. For example, perishable agricultural products often face post-harvest losses due to inadequate cold storage. Additionally, lack of training in value addition, branding, and packaging restricts income potential from local products. Migration of youth due to limited employment diversification further weakens the local economy (Food and Agriculture Organization, 2018).

Opportunities: The region offers multiple opportunities to strengthen sustainable livelihoods through external support and emerging market trends. Eco-labeling and geographical indication (GI) tagging of local products such as honey, herbs, and handicrafts can enhance their market value. Promotion of homestays, local cuisine, and guided cultural tourism aligns with rural tourism strategies encouraged at national and state levels (Government of Himachal Pradesh). Furthermore, capacity-building initiatives for women's self-help groups (SHGs) and the use of digital platforms for marketing can significantly improve income generation (United Nations Development Programme, 2015).

Threats: External challenges pose risks to the sustainability of livelihoods in Salooni Block. Climate change impacts, such as erratic rainfall, landslides, and water scarcity, directly affect agriculture and tourism. Unregulated tourism may lead to environmental degradation and cultural dilution if not managed sustainably. Overexploitation of forest resources without proper conservation measures can threaten biodiversity. Additionally, dependence on external funding and weak institutional coordination among stakeholders can hinder long-term development outcomes (Food and Agriculture Organization, 2018; United Nations Development Programme, 2015).

Table 1: SWOT Analysis of Sustainable Livelihoods in Salooni Block

Strengths	Weaknesses
• Rich biodiversity and abundance of natural resources (forests, herbs, streams, fertile land) • Traditional knowledge and community familiarity with resource use and conservation. • Scenic landscape suitable for eco, agro, and adventure tourism. • Growing interest in organic farming, herbal products, and eco-tourism. • Support from NGOs and local governance structures.	• Limited infrastructure for transport, storage, and processing. • Poor market linkages and limited access for fair pricing. • Seasonal constraints on agriculture and tourism and natural hazards vulnerability. • Lack of training in value addition, branding, and packaging. • Youth migration due to lack of employment diversification.
Opportunities	Threats
• Scope for eco-labeling, Geographical Indication tagging, and branding of local products (e.g., honey, herbs, handicrafts, maize).	• Risk of overexploitation of natural resources without sustainable harvesting practices. • Climate change impacts such as erratic weather, landslides, and water scarcity.

• Promotion of homestays, local cuisine, and guided cultural tours. • Training and support for women-led SHGs and cooperatives. • Policy support for green livelihoods under climate adaptation and rural development programs. • Integration of digital platforms for marketing and e-commerce.	• Cultural dilution and environmental degradation due to unregulated tourism. • Dependence on external funding and lack of long-term local investment. • Institutional gaps in coordination among stakeholders (Government-NGO-community).
Source: <i>Compiled by Author</i>	

Discussion

The study conducted in Salooni Block of Chamba District, Himachal Pradesh, brought forth several critical insights regarding local livelihood patterns and the potential for integrating green and sustainable approaches. The discussion of these findings highlights the need to address a paradox prevalent in many Himalayan regions: ecological abundance coexisting with economic underdevelopment. The sustainable livelihoods framework, which emphasizes the optimal use of five capital assets natural, human, social, financial, and physical shows that while Salooni has a strong natural capital base, other forms of capital are severely underdeveloped. Promoting green livelihoods through sustainable agriculture, forest-based enterprises, and eco-tourism offers a feasible strategy to bridge this gap. Such an approach aligns well with the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land). Furthermore, the relevance of Sustainable Mountain Development (SMD) becomes critical in this context, as the region's fragility demands context-specific and community-sensitive interventions. The study also emphasized the rich traditional knowledge of local communities particularly elders regarding medicinal plants, agricultural practices, and ecological management, which remains inadequately documented or utilized. The systematic documentation, validation, and integration of such indigenous knowledge systems with scientific approaches can significantly strengthen adaptive capacity and promote contextually grounded sustainable development outcomes. Furthermore, institutional mechanisms must be developed to ensure the preservation and intergenerational transmission of this valuable knowledge base.

Conclusion

The research clearly establishes that local resource-based and sustainable livelihoods hold immense potential for transforming rural economies in the North-Western Himalayas. In Salooni Block of Chamba District, activities such as beekeeping, horticulture, handicrafts, and forest-based enterprises when integrated with traditional knowledge and modern techniques offer viable, green livelihood options. These are especially beneficial for women, youth, and marginalized communities. The diversified use of natural resources forests, farms, flowers, and crafts backed by institutional support, community participation, and capacity-building, can form the foundation of a resilient, inclusive development. While challenges such as market access, infrastructure gaps, and climate vulnerabilities persist, initiatives by SHGs, NGOs, and government schemes are showing good results. A SWOT analysis of the region underscores both its rich potential and the need for a context-specific, bottom-up approach. Tourism, if developed responsibly, can further enhance income opportunities while preserving ecological and cultural integrity. To ensure sustainable and equitable development in fragile mountain ecosystems like Salooni, a localized and participatory strategy must replace top-down models. This will not only strengthen rural incomes but also promote inclusive rural development.

Based on the findings from the study of sustainable livelihoods and natural resource management in the Salooni Block of Chamba District, a set of integrated policy recommendations emerges. First, resource-based green enterprises should be actively promoted by supporting local value addition of forest products, traditional foods, and herbal goods through financial and institutional interventions. There is an urgent need to strengthen institutional frameworks that support decentralized planning, capacity building, and participatory governance. Schemes such as Van Dhan Yojana and Startup India must be better aligned with the needs of the region. Eco-tourism should be prioritized by training youth in hospitality, nature guiding, and responsible tourism, while improving eco-friendly infrastructure like trekking routes, signage, and sanitation facilities. Specific support should be extended to women-led and youth-led initiatives to reverse outmigration and empower marginalized sections. Revitalizing traditional knowledge systems and integrating them with modern technologies can enhance resource efficiency and community ownership. Finally, interdepartmental coordination at the district level is crucial to ensure convergence of various schemes, and a comprehensive policy on integrated mountain development should be adopted. These recommendations, if implemented holistically, can transform Salooni into a replicable model for green livelihoods and sustainable resource management in the Himalayan context.

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Research Article**Quality Of Life and Psychological Well-Being Among the Aging Population in Pauri Town, Uttarakhand**¹Raiz Ahmed, ¹Veer Singh, ²Shahzad Chowdhary, ¹Anita Rudola¹Department of Geography, BGR Campus Pauri, HNB Garhwal University, Srinagar Garhwal, Uttarakhand²Department of Political Science, IEC University, H.P.**Abstract**

In India, the aging population is rapidly increasing, especially in hilly areas like Pauri Garhwal, a town in Uttarakhand. This research analyses the psychological well-being (PWB) and quality of life (QoL) of the aging population in Pauri Garhwal town. Physical health, social engagement, emotional well-being, and life satisfaction were evaluated using a descriptive cross-sectional research design. Using a stratified random sampling technique, 150 people aged 60 and older were selected as a representative sample from several wards in Pauri Garhwal town. Further stratification of the participants was based on their living arrangements (living alone, with a spouse, or with family) and gender. The results show that whereas most older adults reported moderate levels of physical health and social involvement, a sizable percentage had poor psychological well-being, especially in autonomy and life purpose.

Keywords: Physical health; Social engagement; Quality of life; Psychological well-being; Aging population.

Introduction

Human existence is a never-ending adventure. Every human being undergoes lifelong growth, development, and maturation. We progress from one stage of life to the next as we go about our lives (Sood & Bakshi, 2012). The process of growing older is inevitable and typical. The elderly's quality of life, lifestyle choices, and mental and physical health are all impacted by the physiological, psychological, and societal changes at this crucial era (Thakur et al., 2019). One of the realities of human life on this planet is aging, which people cannot avoid. Aging's biological components are the first step in the natural process, which also has a significant psychological impact on daily living. In biology, aging is the term used to describe the steady changes that mature, biologically active beings undergo in repressive environments as they progress through an ordered age group (Sood & Bakshi, 2012). Elderly people are more prone to mental illnesses due to a variety of issues, including physical health conditions, cerebral illness, and anatomical deterioration of brain structures. Social and economic factors include the breakdown of family support networks and dwindling financial resources (Khandelwal & Patel, 2015). The functional breakdown in terms of both physical and psychological impairment, financial reliance, and social cut off, compromises the youth's freedom and quality of life (Mohan, 2014).

Elderly persons are more likely to report a lower quality of life if they have to take many medications, experience chronic pain, or have limitations in their daily activities and interpersonal relationships. This is particularly true for older women (Johnson, 1994). It is essential to give everyone, throughout their life cycle, opportunities for self-fulfilment, learning, education, and an active existence to enhance the quality of life for older people and promote prosperity in an aging society. Boundaries between different life-cycle periods grow less clear and more fluid, and the linear model of school, employment, and retirement is becoming less relevant. There is disagreement over the definition of quality of life (QoL), despite earlier work in the psychological sciences, public policy, and public opinion (Shah, 1998). The quality of life of men and women residing in both institutional and non-institutional settings in the urban Bangalore District was assessed. The findings showed that older people

in institutional settings had a higher quality of life than those in non-institutional settings, and that older men and women in both settings differed significantly in the domains of physical, psychological, independence, social relationships, and environment (Asadullah et al., 2012). Male seniors had a higher quality of life than female seniors, according to Pandey's study on gender differences in quality of life among elderly people living in families (Pandey, 2016) .

One strategy to enhance the quality of life for the elderly, particularly those who are economically and socially challenged, is to establish more charity-based homes. Elderly people are often forced to live alone or relocate from their own homes in search of a better, more comfortable environment due to changes in family structure and contemporary shifts in the psychological matrix and values (Gupta et al., 2014). It has been highlighted that Quality of Life (QoL) has a significant influence on research and practice and is a complex, abstract, and diffuse notion that is challenging to describe (Walker, 2005). An investigation into the connection between attitudes toward aging and quality of life has been conducted. The study's findings show a strong correlation between older persons' attitudes toward aging and their quality of life. The psychological growth subscale of attitudes to aging and the sensory capacities subscale of QOL have the strongest significant association in this study (Lakshmi & Roopa, 2013).

Study Area

Pauri is a town in North India, the headquarters of the Pauri Garhwal district. Pauri is a beautiful hill station located in the lower-middle Himalayas. Pauri is the headquarters of the Garhwal Divisional Commissioner's office. Pauri is located at 30.15°N and 78. 78°E. It has an average elevation of 1765 meters, and tourists come to Pauri to watch the snow-capped peaks of the Greater Himalayas. Deodar trees are abundant around the city. Pauri experiences a subtemperate to temperate climate, with summers almost absent and winters freezing. The temperature range is very wide; during the day, sunlight heats the land quickly, but at night temperatures drop rapidly. Snow is recorded in this area during winter. The economy of Pauri depends on tourism, government offices, the central university, and the engineering college. Hemvati Nandan Bahuguna Garhwal Central University serves a sizable student body from all over the nation and is responsible for all the necessities people buy in the Pauri market, including photocopy shops, eateries, and stationery stores (Census of India 2011).

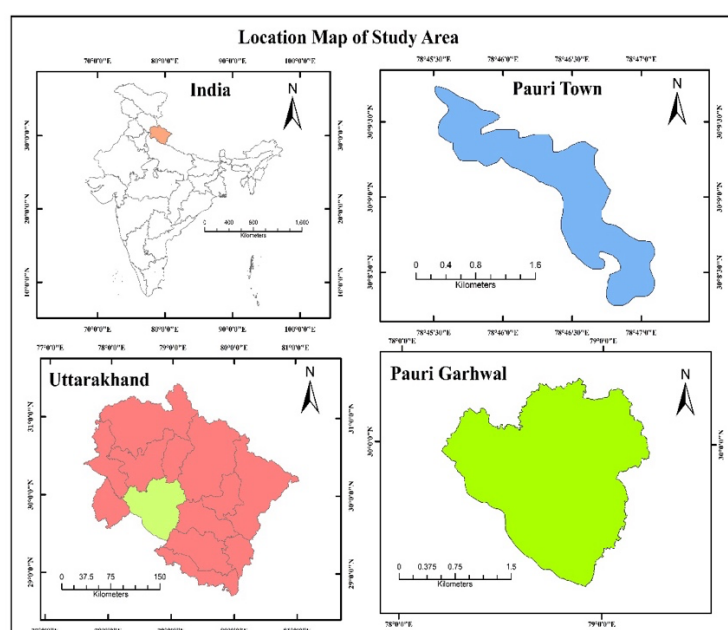


Figure 1: Location map of the study area

Objective: To analyze the quality of life and psychological well-being of the aging population in Pauri town. To study the perception level of the aging population, quality of life, and psychological well-being.

Methodology

To examine the quality of life (QoL) and psychological well-being (PWB) of the aging population, the current study employs a descriptive cross-sectional research design. This design is suitable for assessing current well-being conditions, patterns, and variations across sociodemographic groups at a single point in time. The study is based on both primary and secondary data sources. For the study, 150 individuals aged 60 or older were selected. To ensure representation from various segments of the population, a stratified random sampling technique was utilized. As the main sampling units, the town was split up into several wards. To ensure representativeness, respondents were selected proportionally from each ward. Additional stratification was done using living arrangement (living alone, with a spouse, or with family) and gender (male and female).

Data collection

A systematic interview schedule was used to gather primary data from the respondents. Face-to-face interviews were conducted to ensure responses were clear, reliable, and comprehensive, given the older population and literacy disparities. Primary data were collected through door-to-door surveys with well-structured questionnaires, and secondary data were collected from various journals and books to understand the mechanisms of quality of life and psychological well-being in the aging population. Subjective well-being was measured using a Likert-type scale. By combining responses from all pertinent parameters, PWB and QoL were created.

Data Analysis

Descriptive statistical methods were used to analyze the collected data, including frequency distributions, percentages, and perception levels (high, medium, and low). These techniques were applied to analyze trends and differences in PWB and QoL among various demographic groups. Identifying differences by living circumstances, gender, and age was the main goal of the analysis (Table 1).

Table 1: Variables in the study

Variable	Descriptions
Physical health level	Self-sufficiency and independence are directly impacted by physical well-being. Elderly people with poor physical health have a lower quality of life overall, are more dependent, and have less mobility. Quality of life refers to the ability to perform daily tasks independently and the overall functioning of the body.
Social health	Strong social ties reduce loneliness and enhance emotional support, whereas weak ties increase the risk of isolation and psychological distress among the elderly. Refers to the extent of social interaction, relationships, and participation in community life.
Mental health level	Resilience, decision-making, and life satisfaction are all improved by good mental health, whereas depression, loneliness, and diminished well-being can result from poor mental health. It signifies the emotional and mental state, especially the capacity to manage stress and preserve psychological equilibrium.
Physiological Well, being	Psychological health is crucial for meaningful aging. A lack of purpose and autonomy can lead to low motivation, dissatisfaction, and a poor overall quality of life. Refers to an individual's sense of purpose, autonomy, and overall psychological well-being.

Results

Demographic Status of the Aging Population

The age distribution shows that the young-old population predominates, with the majority of respondents aged 60–75. As people get older, the percentage declines, which is consistent with demographic trends. Although the prevalence of older age groups signals a growing demand for healthcare and support services, it also indicates that respondents engage in comparatively more physical and social activities (Table 2).

Table 2: Demographic status of the Ageing population

Attribute	Groups	Frequency	Percentage	Mean	Standard deviation
Age	60-75	76	46.06	50.00	27.055
	75-85	52	31.52		
	Above 85	22	13.33		
Education	Illiterate	20	12.12	25.00	6.450
	Primary	25	15.15		
	Secondary	30	18.18		
	Sr. secondary	35	21.21		
	Graduate	18	10.91		
	Other	22	13.33		
Marital Status	Married	80	48.485	27.60	29.670
	Unmarried	10	6.061		
	Widow	21	12.727		
	Widower	17	10.303		
	Seprated	10	6.061		
	Divorce	12	7.273		
Family type	Joint	101	61.212	82.5	21.92
	Single	49	29.697		

Source: Primary Survey

The educational profile shows that literacy levels are moderate, with the largest percentage in senior secondary education. Nonetheless, a sizable portion is still illiterate or has just completed elementary school. This indicates that older people have less access to higher education, which could affect their awareness, decision-making capacity, and access to social and health services. The fact that nearly half of the respondents are married suggests that spousal assistance is available. Nonetheless, a sizable percentage are bereaved or widowed, showing fragility brought on by a lack of companionship. Reduced percentages of single, separated, and divorced people draw attention to a variety of societal circumstances that could affect social security and emotional stability. The majority of respondents live in joint families, indicating the continued existence of conventional family structures that provide both social and financial support. Nonetheless, a significant percentage live in nuclear households, suggesting a slow change in family structure that could weaken support networks and raise the risk of isolation among the elderly.

Physical Level of the Aging Population

When the physical condition of the aging population is analyzed, significant gender differences are found in several health markers. Males have a higher prevalence of chronic conditions (60.00%) than females (40.00%), which may be related to lifestyle factors like smoking, alcohol consumption, and increased exposure to occupational stress, as well as comparatively lower participation in preventive healthcare practices. On the other hand, women exhibit greater mobility and functionality (56.66%) than men (43.33%), perhaps due to their ongoing participation in regular household tasks that support functional fitness and

physical mobility. Males appear to have a higher nutritional status (54.66%) than females (34.66%), which reflects long-term nutritional hardship among women and ongoing gender disparities in the allocation of food (Table 3).

Table 3: The physical level of the aging population

Attributes	Male Percentage	Female Percentage
Chronic condition	60.00	40.00
Mobility and functionality	43.33	56.66
Nutritional status	54.66	34.66
Sensory function	46.66	40.00
Pain level	51.33	44.00
Sleep Quality	61.33	38.66

Source: Primary survey

Similarly, males have slightly superior sensory function (46.66%) than females (40.00%), which may be related to easier access to medical facilities and assistive technology. Males report higher levels of pain (51.33%) than females (44.00%), which may be related to the long-term consequences of physically demanding jobs. However, disparities in pain reporting and perception cannot be ignored. Additionally, men have much higher sleep quality (61.33%) than women (38.66%), which may be related to fewer caring responsibilities and less psychological stress at a later age. Overall, these results show that a complex interplay of biological, socioeconomic, and gender-based determinants shapes the physical well-being of the senior population, underscoring the need for focused interventions to address these discrepancies.

Social Level of the Aging Population

Significant gender-based differences in important social variables are shown by the investigation of the social level of the aging population (Table 4). Females had significantly higher levels of social support (61.33%) than males (38.66%), which may be explained by women's stronger interpersonal ties, greater emotional attachment, and greater participation in family and community networks. Males (53.33%) report marginally better living conditions than females (46.66%), which may be due to men's historically higher economic control and decision-making authority. Females have greater access to basic services (54.66%) than males (45.33%), possibly because they interact more closely with local organizations such as welfare agencies and healthcare facilities. Males have substantially greater economic stability (60.66%) than females (39.33%), underscoring the ongoing gender differences in income, property ownership, and financial independence, especially in older age groups.

Table 4: Social level of the aging population

Social attributes	Male Percentage	Female Percentage
Social support	38.66	61.33
Living conditions	53.33	46.66
Access to basic services	45.33	54.66
Economic Stability	60.66	39.33
Participation in activities	42.66	57.33

Source: Primary survey

Additionally, women are more likely than men to participate in social and community activities (57.33% vs. 42.66%), indicating that women remain more socially engaged and integrated into community structures, whereas men may withdraw socially after retirement.

Overall, the results show that women have superior social integration and support networks, even if men typically have better living and economic circumstances. These trends highlight how cultural norms, gender roles, and socioeconomic disparities shape the social well-being of the aging population (Figure 2).

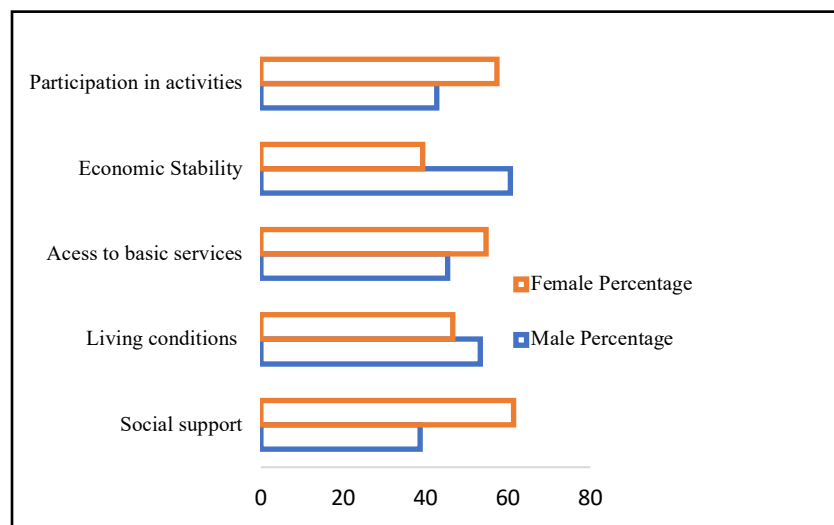


Figure 2. Percentage of social level of aging population

Mental Health Level of the Aging Population

There are substantial variations in gender in the evaluation of the mental health of the elderly population across important mental metrics. Males have a far higher rate of depression (70.00%) than females (30.00%), which may be related to things like stress after retirement, losing social duties, and men's diminished emotional expression. In a similar vein, stress levels are much higher in men (73.33%) than in women (26.66%), which may be due to financial obligations, worries about financial stability, and a lack of coping skills as one ages. On the other hand, Women are more likely than men to experience social isolation (67.33% versus 32.66%), which may be related to widowhood, higher life expectancy, and decreased mobility that results in less social engagement (Table 5).

Table 5: Mental health level of the aging population

Mental attributes	Male Percentage	Female Percentage
Depression	70.00	30.00
Social isolations	32.66	67.33
Stress level	73.33	26.66
Anxiety	26.00	74.00

Source: Primary Survey

Furthermore, anxiety levels are significantly higher in women (74.00%) than in men (26.00%), possibly as a result of increased emotional sensitivity, health-related worries, and sociocultural elements that restrict security and freedom in later life. Overall, the results indicate that women have higher levels of social isolation and anxiety, whereas men are more affected by stress and depression. These trends underscore the need for gender-sensitive mental health interventions by highlighting the intricate interactions between gender roles,

socioeconomic circumstances, and psychological coping strategies in determining the mental health of the senior population.

Psychological Well-being of the Aging Population

Psychological well-being among the elderly population shows clear gender differences and variation in quality of life. Women report higher levels of life satisfaction (54.00%) than men (46.00%), suggesting that, later in life, women may find greater emotional fulfilment in social interaction and family ties. In a similar vein, women have more pleasant mood states (61.33%) than men (38.66%), which could be explained by more robust social support networks and greater emotional expressiveness. Males, on the other hand, show somewhat higher levels of autonomy and control (52.00%) than females (48.00%), which is consistent with conventional gender roles in which men frequently maintain independence and decision-making authority. Males have much higher levels of self-efficacy (60.00%) than females (40.00%), which may be due to greater confidence stemming from lifetime social authority and economic involvement. Males have a moderate advantage in cognitive functioning (53.33%) compared to females (46.66%), which may be impacted by educational background and ongoing mental activity (Table 6).

Table 6: Psychological well-being of the aging population

Psychological attributes	Male Percentage	Female Percentage
Life Satisfaction	46.00	54.00
Moods states	38.66	61.33
Autonomy and control	52.00	48.00
Self-Efficiency	60.00	40.00
Cognitive functioning	53.33	46.66
Coping level	32.00	68.00

Source: Primary survey

Nonetheless, coping levels are significantly greater among women (68.00%) than among men (32.00%), suggesting that women may have more resilient coping mechanisms when faced with age-related difficulties. Overall, the results indicate that women have higher levels of life satisfaction, emotional well-being, and coping ability, while men typically show better levels of autonomy, self-efficacy, and cognitive performance. These patterns emphasize the importance of inclusive, gender-sensitive approaches to promoting healthy aging by highlighting the impact of gendered life experiences, social support, and adaptive mechanisms on psychological well-being among the elderly.

Perception Level of The Aging Population on Quality of Life and Physiological Well-Being

There is a varied pattern in the high, medium, and low categories of the perception-level analysis of psychological well-being and quality of life among the elderly population. Feelings of social isolation or loneliness (14.67%), trust in one's ability to make decisions (14.00%), and mental tension or anxiety (12.67%) are indicators that fall within the high level. The greater rates of stress and loneliness indicate that, despite retaining confidence in their ability to make their own decisions, a sizable portion of the elderly face psychological strain and emotional fragility. Feelings of happiness and contentment (10.67%), satisfaction with social interactions (10.00%), and overall quality-of-life satisfaction (11.33%) comprise the medium level group. These intermediate percentages suggest a balanced but subpar state of life satisfaction and social support, indicating an average level of well-being where people are neither extremely satisfied nor extremely dissatisfied (Table 7).

Table 7: The perception level of the aging population

Perception	Percentage	Level
How satisfied are you with your overall quality of life?	11.33	Medium
How would you rate your physical health condition?	8.67	Low
Do you feel happy and content in your daily life?	10.67	Medium
How often do you feel lonely or socially isolated?	14.67	High
How confident are you in making your own decisions?	14.00	High
Do you feel mentally stressed or anxious in daily life?	12.67	High
How satisfied are you with your social relationships (family/friends)?	10.00	Medium
How well are you able to cope with life challenges?	5.33	Low
Do you feel a sense of purpose or meaning in life?	6.00	Low
How satisfied are you with your living conditions and environment?	6.67	Low

Source: Primary Survey

On the other hand, several measures, such as physical health condition (8.67%), ability to cope with life's obstacles (5.33%), feeling of purpose or meaning in life (6.00%), and satisfaction with living conditions and environment (6.67%), are below the low level. These low percentages point to important areas of concern, especially in terms of resilience, existential well-being, and health status, indicating that many older people have difficulty adjusting to aging-related issues and leading fulfilling lives. Overall, the results show that the aging population faces significant challenges in physical health, coping strategies, and life satisfaction, highlighting the need for targeted interventions to improve their overall quality of life and psychological well-being, even though some aspects, such as confidence and social awareness, remain relatively strong.

Conclusion

A multifaceted pattern, influenced by physical, social, mental, psychological, and perceptual elements, is revealed in the overall evaluation of quality of life and well-being among the elderly population. Males have higher rates of chronic conditions and better nutritional status, while females have comparatively more mobility and functional capacity, according to the physical dimension, which shows significant gender differences. In terms of social support, women have stronger social networks and participate in more activities, whereas men have slightly better living conditions and greater economic stability. The outcomes indicate that, when it comes to mental health, men report higher levels of stress and despair, while women report higher levels of anxiety and social isolation. This implies that sociocultural roles and life experiences have an impact on psychological vulnerabilities that vary by gender. Males exhibit higher levels of autonomy, self-efficacy, and cognitive functioning in psychological well-being analysis, whereas females report higher levels of life satisfaction, positive mood states, and better coping skills. The findings of the perception-based investigation show a mixed picture: low levels of physical health, coping skills, and sense of purpose, high levels of loneliness, stress, and decision-making confidence, and moderate levels of happiness with life and relationships overall. These results show that although older people retain some abilities, they encounter significant challenges in resilience, health, and meaningful participation. To improve the overall quality of life for the elderly population, the study underscores the importance of comprehensive, gender-appropriate approaches that address social support, mental health, psychological resilience, and physical health.

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Research Article**जलवायु परिवर्तन व बाढ़ एक समग्र अध्ययन उत्तराखण्ड की सूखी नदी बेसिन के संदर्भ में**

सूरज कुमार, डॉ० कमला बोरा, अर्चना

सरदार भगत सिंह राजकीय स्नातकोत्तर महाविद्यालय रुद्रपुर, ऊधम सिंह नगर

सारांश

वर्षा जो कि, जलवायु व पर्यावरण पर निर्भर करती है अर्थात किसी भी प्रदेश की जलवायु और पर्यावरण उस क्षेत्र के वर्षा प्रतिरूप को प्रभावित करती हैं। जलवायु एक दीर्घकालिक घटित होने वाली प्रक्रिया का योग है जो, मानवीय और प्राकृतिक कारकों से प्रभावित होती है। प्राकृतिक रूप से जलवायु परिवर्तन होना प्रकृति का ही एक अभिन्न अंग है जो, सदैव प्रकृति के अनुकूल रहा है, परन्तु प्रकृति में बढ़ते मानवीय हस्तक्षेप एवं प्राकृतिक संसाधनों- वृक्षों, खनिजों, जल व मृदा आदि का आवश्यकता से अधिक दोहन होने के परिणाम स्वरूप जलवायु परिवर्तन हो रहा जो प्रकृति के अनुकूल नहीं है अतः इस जलवायु परिवर्तन का मानवीय समुदाय पर नकारात्मक प्रभाव अनियमित वर्षा, बाढ़ आपदा, और ताप वृद्धि आदि के रूप में दृष्टिगोचर हो रहा है।

कुंजी शब्द - अनियमित वर्षा व बाढ़**प्रस्तावना**

परिवर्तन प्रकृति का शाश्वत नियम है, परन्तु बढ़ती जनसंख्या और औद्योगिकीकरण के इस युग में मानव ने अपने स्वार्थ और आवश्यकताओं की पूर्ति के लिए प्रकृति का विदोहन जैसे वनों का कटान, कृषि भूमि का ह्रास, अति खनन जैसी क्रियाओं एवं प्रदूषण बहुत विस्तृत स्तर पर किया है। परिणाम स्वरूप प्रकृति ऐसी घटनाओं से प्रभावित होने लगी है जो, जलवायु परिवर्तन के रूप में स्पष्ट दृष्टिगत हो रहा है। जलवायु परिवर्तन के कारण ही प्राकृतिक आपदाओं जैसे बाढ़, सूखा, हिमस्खलन, वनाग्नि जैसी घटनाओं में वृद्धि हो रही है। Climate Risk Index. के अनुसार 2001 से 2018 के मध्य 74 प्रतिशत प्राकृतिक आपदाएं जल से सम्बन्धित रही हैं, जिसमें बाढ़ आपदा व सूखा पड़ने जैसी आपदा सर्वाधिक गम्भीर हैं। भारी वर्षा और पहाड़ियों या नदियों के आस-पास के इलाकों में बादल फटना व एक दिन में लगभग 15 सेमी. या उससे अधिक वर्षा का होना प्रमुख व आम घटनाएं हैं जो बाढ़ की विभीषिका को जन्म देती है। किसी क्षेत्र में बाढ़ की स्थिति तब उत्पन्न होती है जब जल की मात्रा सामान्य से अधिक हो जाती है। बाढ़ पर्यावरण, मानव जीवन एवं अर्थव्यवस्था को प्रभावित करती है। भारत की जलवायु उष्ण कटिबंधीय और मानसूनी है। यहाँ अधिक वर्षा मानसून काल के दौरान होती है इसी समय भारत के जिन क्षेत्रों व प्रदेशों में अत्यधिक वर्षा होती, वहाँ बाढ़ जैसे हालात उत्पन्न हो जाते हैं। वर्षा ऋतु के दौरान जब नदियों के जलागम क्षेत्र में अत्यधिक वर्षा होती है तब नदियाँ काफी मात्रा में जल ग्रहण कर लेती हैं। अतः वर्षा के जल को नदी अपने प्रवाह मार्ग द्वारा शीघ्र नहीं निकाल पाती और परिणाम स्वरूप जल की अधिकता ही बाढ़ का रूप धारण कर लेती है।

शोध प्रविधि

प्रस्तुत शोध पत्र में तथ्यों का एकत्रीकरण व्यक्तिगत सर्वेक्षण, साक्षात्कार, अवलोकन व निरीक्षण विधि द्वारा किया गया है एवं आँकड़ों के विश्लेषण के लिए विभिन्न सांख्यिकीय एवं मात्रात्मक विधियों का प्रयोग किया गया है। शोध पत्र में मानचित्रण का कार्य भारतीय भू-पत्रक सर्वेक्षण (53 P/9, 53 O/12, 53 O/11) और सुदूर-संवेदन (SRTM-मीटर Resolution) की सहायता से किया गया है। मानचित्र के लिए ArcGIS, ग्लोबल मैपर का तथा GIS का प्रयोग किया गया है। साथ ही गूगल अर्थ प्रो की भी सहायता ली गयी है।

विश्लेषण एवं परिणाम

सूखी नदी बेसिन क्षेत्र ऊपरी गंगा बेसिन का ही एक छोटा जलग्रहण क्षेत्र है। सूखी नदी मौसमी नदी होने के कारण केवल मानसून काल में ही जल उपलब्ध रहता है शेष ग्रीष्म ऋतु और शरद ऋतु में यह सूखी (जल विहीन) रहती है। सूखी नदी बेसिन की जलवायु उपोष्ण कटिबंधीय है।

भौगोलिक दृष्टि से सूखी नदी जलागम क्षेत्र का अक्षांशीय विस्तार $28^{\circ}52' 54''$ उत्तरी अक्षांश से $29^{\circ}16' 32''$ उत्तरी अक्षांश व देशान्तरीय विस्तार $79^{\circ}33' 29''$ से $79^{\circ}42' 19''$ पूर्वी देशान्तर के मध्य अवस्थित है जिसका कुल भौगोलिक क्षेत्रफल 313 km^2 व नदी कुल लम्बाई 61.89 km है। बेसिन की समुद्र तल से निम्नतम ऊँचाई 206 मीटर व अधिकतम ऊँचाई 1410 मीटर है। सूखी नदी बेसिन की प्राकृतिक सीमाएँ पूर्व में कैलाश नदी (नंधौर नदी) पश्चिम में गोला नदी तंत्र, उत्तर में भी गोला नदी तंत्र तथा दक्षिण में बैगुल जलाशय जिसमें सूखी नदी समाहित हो जाती है।

सारणी 1: ऊँचाई क्षेत्र (Altitude Zone) के आधार पर सूखी नदी बेसिन का धरातलीय स्वरूप

क्र.सं.	ऊँचाई मीटर में	कुल क्षेत्रफल	प्रतिशत	क्षेत्र का नाम
1.	200 मी. से कम	127.1	40.6	तराई क्षेत्र
2.	200-500 मी	124.8	39.7	भाबर क्षेत्र
3.	500 मी. से अधिक	61.1	19.6	पर्वतीय क्षेत्र
	कुल	313	100	

200 मी. से कम— सारणी संख्या 2 में आँकड़ों के अनुसार सूखी नदी जलागम क्षेत्र को धरातलीय ऊँचाई के आधार पर वर्गीकृत करने से स्पष्ट होता है कि, सर्वाधिक क्षेत्रफल 200 मीटर से कम ऊँचाई के मध्य आता है जो कि सम्पूर्ण क्षेत्रफल का 127.1 वर्ग किमी. है एवं 40.6 प्रतिशत तराई क्षेत्र है तराई क्षेत्र की बाढ़ द्वारा लाये गये अवसाद, गाद व बारीक कणों वाले पदार्थों के जमाव के परिणाम स्वरूप निर्मित हैं।

200 – 500 मी. - यह क्षेत्र तराई प्रदेश के उत्तर में स्थित है जो अध्ययन क्षेत्र सूखी नदी बेसिन के कुल क्षेत्रफल का 124.8 वर्ग किमी क्षेत्र अर्थात् 39.8 प्रतिशत भाबर क्षेत्र है यह 200 मी. से 500 मी. के मध्य फैला है जो कहीं-कहीं उबड़-खाबड़ मोटे कंकड़-पत्थरों व मिट्टी से निर्मित है यहाँ छोटी जल धाराओं का भूमि में लोप हो जाता है जो, पुनः तराई प्रदेश में कई बारीक छिद्रों से प्रकट होती हैं।

500 मी. से अधिक – इस क्षेत्र में मध्य मायोसीन तथा प्लायोसीन काल में निर्मित मृदा क्वार्टजाइट, कांग्लोमेरेट्स एवं शैल चट्टानें मिलती हैं घाटियाँ, गाड, गधेरा इस क्षेत्र में स्थित है। यह सूखी नदी बेसिन के कुल क्षेत्रफल का 61.1 वर्ग. किमी. अर्थात् 19.6 प्रतिशत ही भाग पर्वतीय क्षेत्र है। जहाँ गहरी घाटियाँ देखने को मिलती है। जिसे निम्न शिवालिक पर्वतीय क्षेत्र कहते हैं।

वर्षा (Rain Fall)

इंटर डिसिप्लीनेरी प्रोग्राम इन क्लाइमेट स्ट्रीज IIT बाम्बे की रिपोर्ट (2016) के आधार पर जंगलों के कटने से भारत में वर्षा के क्रम में परिवर्तन आया है। भारत के 238 जिलों में वर्षा का प्रतिरूप बदल गया है। कुल 632 जिलों में से 82 जिले में अधिक वर्षा तथा 156 जिलों में पहले से कम वर्षा होने लगी है।

सारणी 2: सूखी नदी बेसिन में औसत वर्षा

औसत वर्षा (मिमी. में) वर्ष 1991-2020				
क्र.स.	माह	1991-2000	2001-2010	2011-2020
1	जनवरी	33.92	22.46	43.56
2	फरवरी	36.78	42.74	35.74
3	मार्च	17.46	15.62	24.39
4	अप्रैल	10.84	19.66	18.61
5	मई	69.02	55.16	37.86
6	जून	172.6	222.08	218.41
7	जुलाई	359.84	429.7	452.1
8	अगस्त	449.9	522.62	388.57
9	सितंबर	292.36	317.32	179.87
10	अक्टूबर	58.18	36.54	13.94
11	नवंबर	3.74	4.9	3.54
12	दिसंबर	21.82	5.91	13.62
13	कुल औसत वर्षा	1526.46	1694.71	1430.21

स्रोत- मौसम विभाग पन्तनगर वि० वि० (वर्ष 2021)

सारणी संख्या 2 में दिये गये आंकड़ों के अनुसार वर्षा ऋतु में वर्ष 2001 से लेकर वर्ष 2010 तक के अगस्त माह में सर्वाधिक औसत 522.62 मिमी. वर्षा तथा वर्ष 1991 से लेकर 2000 तक के जून माह में सबसे कम औसत 172.6 मिमी. वर्षा दर्ज की गई है। जबकि, वर्ष 1991 से 2000 में कुल औसत वर्षा 1526.46 मिमी., वर्ष 2001 से 2010 में कुल औसत वर्षा 1694.71 मिमी. और वर्ष 2011 से 2020 में कुल 1430.21 मिमी. ही दर्ज की गई। अतः ग्राफ संख्या -1 से स्पष्ट होता है कि, प्रत्येक 10 वर्ष की औसत वर्षा पूर्व के वर्षों (1991-2000, 2001-2010) की अपेक्षा वर्ष 2011 से 2020 में काफी कम हुई।

सारणी 3 - तीस वर्षों (1991 - 2020) में मासिक वर्षा के कुल दिन

क्र.सं.	माह/वर्ष	1991-2000	2001-2010	2011-2020
1	जनवरी	33	23	31
2	फरवरी	36	38	24
3	मार्च	30	24	23
4	अप्रैल	31	22	23
5	मई	45	61	32
6	जून	93	97	80
7	जुलाई	169	162	182
8	अगस्त	193	164	158
9	सितंबर	123	100	83
10	अक्टूबर	21	18	9
11	नवंबर	11	6	3

12	दिसंबर	11	9	7
13	कुल	796	724	655

स्रोत- मौसम विभाग, पंतनगर विश्वविद्यालय, वर्ष 2021

बाढ़ उत्पन्न करने वाले प्रमुख घटकों में तीव्र वर्षा बाढ़ का प्रमुख कारण है इसलिए अध्ययन क्षेत्र में वर्षा की तीव्रता व दिनों के आधार पर बाढ़ तीव्रता का अध्ययन किया गया है। सारणी संख्या 3 और ग्राफ 2 से स्पष्ट है कि, वर्ष 1991 से 2000 के मध्य 10 वर्षों में वर्षा के कुल दिनों की संख्या 796 थी, जो वर्ष 2001 से 2010 के मध्य घटकर 724 दिन हो गई जबकि वर्ष 2011 से 2020 के मध्य वर्षा के कुल दिनों की संख्या में गिरावट दर्ज की गई जो कि 724 से घटकर मात्र 655 दिन ही दर्ज की गई है।

सारणी संख्या – 4. प्रत्येक दस वर्षों के अन्तराल पर औसत वर्षा एवं कुल दिन

क्र.स	वर्ष	अन्तराल वर्ष	वर्षा (मिमी.)	दिन की संख्या	दिनों का अंतर
1.	1991-2000	10	1526.46	796	0
2.	2001-2010	10	1694.71	724	72
3.	2011-2020	10	1430.21	655	69
औसत/योग	1999-2020	30	1550.46	2175	141

स्रोत - मौसम विभाग, पन्तनगर विश्वविद्यालय, वर्ष 2021

सारणी संख्या 4 में वर्ष 1991 से 2000 तक के 10 वर्षों में 796 दिनों में औसत वर्षा 1526.46 मिमी., अगले 10 वर्षों (2001-2010) में 724 दिनों में औसत वर्षा 1694.71 मिमी. और वर्ष 2011 से 2020 के मध्य 10 वर्ष में 655 दिनों में 1430.21 मिमी. वर्षा दर्ज की गयी। अतः स्पष्ट है कि, पूर्व के दस वर्षों (1991-2000) की अपेक्षा मध्य के दस वर्षों (2001-2010) में 72 दिनों का और मध्य के दस वर्षों (2001-2010) की अपेक्षा अंतिम के दस वर्षों (2011-2020) में 69 दिनों की कमी आई है। अतः देखा जाए तो वर्षा के दिनों संख्या में वर्ष 1991 से लेकर वर्ष 2020 तक के कुल तीस वर्षों में 141 दिनों की कमी दर्ज की गई है।

सारणी संख्या 5 - सूखी नदी बेसिन में बाढ़ की प्रमुख घटनाएँ (वर्ष 1990 – 2021)

क्र.सं.	बाढ़ का वर्ष	मास	वर्षा (मिमी. में)	वर्षा के दिनों की संख्या
1	1999	सितम्बर	763.2	21
2	2000	अगस्त	1154.6	20
3	2002	जुलाई	568.4	14
4	2004	अगस्त	560.2	15
5	2005	सितम्बर	530.6	10
6	2008	सितम्बर	414.4	7
7	2010	अगस्त	701	18
8	2011	अगस्त	773.8	18
9	2013	जून	603.4	8
10	2018	जुलाई	649.1	14
11	2019	जून	290.6	7

12	2021	अक्टूबर	427.5	4
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स्रोत - मौसम विभाग, पन्तनगर विश्वविद्यालय /सर्वेक्षण, वर्ष 2021

सारणी संख्या 5 दिए गए आंकड़ों में बाढ़ का वर्ष, वर्षा की मात्रा और बाढ़ आने के दिन से पूर्व वर्षा के दिनों की संख्या/मास आदि वर्णित है तथा दिये गये आंकड़ों और ग्राफ संख्या 3 से स्पष्ट होता है कि, वर्ष 1999 के सितम्बर माह में 763.2 मिमी. वर्षा कुल 21 दिनों में दर्ज की गई, वर्ष 2000 के अगस्त माह में 1154.6 मिमी. वर्षा कुल 20 दिनों में, वर्ष 2002 के जुलाई माह में 568.4 मिमी. वर्षा कुल 14 दिनों में, वर्ष 2004 के अगस्त माह में 560.2 मिमी. वर्षा कुल 15 दिनों में, वर्ष 2005 के सितम्बर माह में 530.6 मिमी. वर्षा कुल 10 दिनों में, वर्ष 2008 के सितम्बर माह में 414.4 मिमी. वर्षा कुल 7 दिनों में, वर्ष 2010 के अगस्त माह में 701 मिमी. वर्षा कुल 18 दिनों में, वर्ष 2011 के अगस्त माह में 773.8 मिमी. वर्षा 18 दिनों में, वर्ष 2013 के जून माह में 603.4 मिमी. वर्षा 8 दिनों में, वर्ष 2018 के जुलाई माह में 649.1 मिमी. वर्षा केवल 14 दिनों में, वर्ष 2019 के जून माह में 290.6 मिमी. वर्षा 7 दिनों में, और वर्ष 2021 के अक्टूबर माह में सर्वाधिक 427.54 मिमी. वर्षा 4 दिनों में दर्ज की गई है। जो बाढ़ का प्रमुख कारण है पिछले 10 वर्षों में सूखी नदी में बाढ़ क्रमशः वर्ष 2013, 2018, 2019, और वर्ष 2021 में आयी है। अतः आंकड़ों के तुलनात्मक अध्ययन विश्लेषण से यह स्पष्ट होता है कि, अधिक वर्षा कम दिनों में होना बाढ़ आपदा का प्रमुख कारण बन रहा है। और दिए गए आँकड़ों से यह भी स्पष्ट होता है कि, सर्वाधिक 1154.6 मिमी. वर्षा 20 दिनों में वर्ष 2000 की बाढ़ और वर्ष 2021 की बाढ़ के दौरान 4 दिनों में 427.5 मिमी. वर्षा हुई है।

सारणी संख्या 6 . सूखी नदी बेसिन में नदी तटीय बाढ़ प्रभाव क्षेत्र

क्र.सं.	क्षेत्र	चौड़ाई (मीटर में)	क्षेत्रफल (किमी) ²	प्रतिशत
1	नदी तटीय बाढ़ प्रभाव क्षेत्र	100 से कम	17.6	5.6
		200	3.3	1.1
		300	6.5	2.1
		400	34.6	11.1
2	अप्रभावित क्षेत्र	400 से अधिक	240	76.6
3	जलाशय	7000मीटर	11	3.5
		योग	313	100

स्रोत-ArcGIS व व्यक्तिगत सर्वेक्षण

सारणी संख्या 6 में दिये गये आँकड़ों से स्पष्ट होता है कि, अध्ययन क्षेत्र के उत्तर पर्वतीय भाग में स्थित तरूवा गाढ़, निन्नगलरी गदेरा, सूखी गाढ़, गाढ़ खर्क नाला, सूर्य नाला, पौरजीया नाला व असनी रौला नाला तथा तराई में स्थित नाले में बाढ़ प्रभावित क्षेत्र 100 मीटर विस्तार चौड़ाई में लिया गया है जिसका कुल क्षेत्र 17.6 वर्ग किलोमीटर (5.6%) तथा तराई क्षेत्र के बाराकोली रेंज में स्थित जंगली नाला जिसका प्रभाव क्षेत्र 200 मीटर में कुल क्षेत्र 3.3 वर्ग किलोमीटर (1.1%) में, जो मुख्यतः वर्षा ऋतु में बाढ़ आपदा से प्रभावित होता है। भाबर क्षेत्र में स्थित खेड़ा गाँव से रूपपुर तक नदी क्षेत्र अधिकतम 300 मीटर विस्तृत चौड़ाई जिसका कुल 6.5 वर्ग किलोमीटर (2.1%) क्षेत्र बाढ़ प्रभावित श्रेणी में आता है जबकि, मुख्य नदी धारा में ही हरिसिंहपुर/लच्छामपुर गाँव से लेकर बेगुल जलाशय तक नदी क्षेत्र 400 मीटर तक अत्यधिक

चौड़ाई में विस्तृत है जिसका कुल 34.6 वर्ग किलोमीटर (11.1%) क्षेत्र बाढ़ से अधिकांशतः प्रभावित श्रेणी में आता है, 400 मीटर से अधिक की विस्तृत चौड़ाई जिसका कुल 251 वर्ग किलोमीटर (76.6%) अप्रभावित क्षेत्र की श्रेणी के अंतर्गत सम्मिलित है और 11 वर्ग किमीटर (3.5%) क्षेत्र में बैगुल जलाशय है।

सारणी 7 - सूखी नदी बेसिन में नदी तट के समीप स्थित ग्राम

क्रमांक	गाँव का नाम	क्रमांक	गाँव का नाम
1	खेड़ा	15	हरिपुर/लच्छमपुर
2	किशान नगरी	16	रूद्रपुर
3	विजय पुर	17	पिपलहत्था
4	देवाल मल्ला	18	लालर खास
5	देवाल मल्ला सिमरे	19	सुरेन्द्रनगर
6	नया गाँव सम्भल	20	सिसौना
7	गजेपुर	21	निर्मल नगर
8	गौलापार	22	राज नगर
9	लच्छमपुर	23	प्रह्लाद पलसिय
10	हिमत्तपुर नकायल	24	बबन पुरी
11	ज्वाला पोखरी	25	बरूआ बाग
12	गंगापुर	26	अरविन्द नगर
13	जीतपुर रेकवाल	27	गोठा
14	लखनपुर	28	लौका

स्रोत- ArcGIS और व्यक्तिगत सर्वेक्षण वर्ष 2021

सारणी संख्या 7 के सभी 28 गाँव नदी तट के समीप स्थित हैं, जिन पर बाढ़ आपदा का खतरा वर्षा ऋतु में किसी न किसी रूप में बना रहता है, इन सभी गाँव को विभिन्न प्रकार की समस्याओं, भू-कटाव, गाँवों के सम्पर्क मार्ग बन्द हो जाना, सम्पर्क पुलों का टूट जाना, आवासों व खेतों में जल भराव का सामना करना पड़ता है। भोजन-पानी, आर्थिक व जान-माल की क्षति उठानी पड़ती है।

सारणी 8 ऊँचाई क्षेत्र(Altitude zone) के अनुसार बाढ़ में क्षतिग्रस्त आवासों का आंकलन

क्र.	क्षेत्र का नाम	परिवार	कच्चा आवास			पक्का आवास			कच्चा-पक्का भवन		
			आंशिक	मध्यम	पूर्ण	आंशिक	मध्यम	पूर्ण	आंशिक	मध्यम	पूर्ण
1	पर्वतीय क्षेत्र	75	0	0	0	0	0	0	0	0	0
2	भाबर क्षेत्र	254	0	0	0	0	0	0	1	0	0
3	तराई क्षेत्र	1265	176	123	12	49	20	0	180	57	4
4	योग	1594	176	123	12	49	20	0	181	57	4

स्रोत- व्यक्तिगत सर्वेक्षण वर्ष 2021

सारणी संख्या 8 में दिए गए आंकड़ों से स्पष्ट होता है कि, पर्वतीय क्षेत्र व भाबर क्षेत्र में बाढ़ आपदा में कोई भी आवास प्रभावित नहीं हुआ जबकि, तराई क्षेत्र में बाढ़ आपदा से कच्चे आवासों में 176 आवास आंशिक रूप से, 123 आवास मध्यम रूप से व 12 आवास पूर्ण रूप से प्रभावित या क्षतिग्रस्त हुए हैं, वहीं कुल पक्के आवासों में 49 आवास आंशिक रूप से 20 आवास मध्यम रूप से प्रभावित हुए जबकि, पूर्ण रूप से

क्षतिग्रस्त आवासों की संख्या नगण्य है। कच्चे-पक्के रूप में निर्मित आवासों में 181 आवास आंशिक, 57 आवास मध्यम तथा 4 आवास पूर्ण रूप से बाढ़ आपदा से प्रभावित हुआ है। अध्ययन क्षेत्र में कुल 622 आवास बाढ़ आपदा से किसी न किसी रूप में प्रभावित हुए हैं।

कृषि एवं किसान परिवार कल्याण मंत्रालय के मानदंड (Norms) के आधार पर धान का उत्पादन 2390 kg/hectare अर्थात् 23.90 क्विंटल प्रति हैक्टेयर माना जाता है क्योंकि सूखी नदी बेसिन अध्ययन क्षेत्र तराई के उपजाऊ मैदान में अवस्थित होने के कारण धान की फसल उत्पादन का महत्वपूर्ण क्षेत्र है किन्तु, बाढ़ आपदा के कारण कई-कई हैक्टेयर उपजाऊ भूमि बाढ़ के कारण जल में डूब जाती है और धान की फसल को अत्यधिक नुकसान उठाना पड़ता है। कृषि मंत्रालय के मानदंड के अनुसार 23.90 क्विंटल प्रति हैक्टेयर उत्पादन के और न्यूनतम समर्थन मूल्य (1940 Rs./ क्विंटल) के आधार पर सूखी नदी बेसिन में धान की पैदावार की क्षति का आंकलन सारणी संख्या 4.1 में किया गया है।

सारणी संख्या 9 सूखी नदी बेसिन में बाढ़ से क्षतिग्रस्त धान की फसल (है० में)

क्र.सं.	गाँव का नाम	परिवार संख्या	क्षतिग्रस्त फसल (है० में)	उत्पादन क्विंटल में	क्षति मूल्य
1	लौका	41	17	406.3	788222
2	गोठा	47	33	788.7	1530078
3	अरविन्द नगर	54	16	382.4	741856
4	राजनगर	12	3	71.7	139098
5	बरूआबाग	7	2	47.8	92732
6	लालर खास	2	0.5	11.95	23183
	योग	163	71.5	1708.85	3315169

स्रोत- व्यक्तिगत सर्वेक्षण वर्ष 2021

सारणी संख्या 9 में दिए गये आँकड़ों से स्पष्ट है कि, सूखी नदी बेसिन में वर्ष 2021 की बाढ़ आपदा में 163 परिवारों की 71.5 हैक्टेयर क्षेत्र में 1708.85 क्विंटल धान की फसल क्षति ग्रस्त हो गई, जिसका वित्तीय क्षति 33 लाख 15 हजार उन्हत्तर रुपये की का आँकलन किया गया। इसमें 17 हैक्टेयर धान की फसल लौका गाँव के 41 परिवारों की, 33 हैक्टेयर धान की फसल गोठा गाँव के 47 परिवारों की, 16 हैक्टेयर धान की फसल अरविन्दनगर के 45 परिवारों की, 3 हैक्टेयर धान की फसल राज नगर के 12 परिवारों की, 2 हैक्टेयर धान की फसल बरूआबाग के 7 परिवारों की और 0.5 हैक्टेयर धान की फसल लालर खास के 2 परिवारों की बाढ़ आपदा में क्षतिग्रस्त हो गई। इसके अलावा निर्वाहक कृषि में बैंगन, टमाटर और कहीं-कहीं सरसों की फसल भी क्षति ग्रस्त हो गयी है।

सारणी संख्या 10 सूखी नदी बेसिन की बाढ़ आपदा में मवेशियों की क्षति का वित्तीय आंकलन (रुपये में)

क्र.सं.	मवेशी	मवेशियों की संख्या	वित्तीय क्षति(रुपये में)
1.	गाय	13	390000
2.	बछिया	9	63000
3.	भैंस	7	210000
4.	पाड़ी	11	77000
5.	बकरी	17	51000
	योग	57	791000

स्रोत- व्यक्तिगत सर्वेक्षण(वर्ष 2021)

सारणी संख्या 10 दिए गए आंकड़ों के अनुसार सूखी नदी बेसिन में मवेशियों की क्षति का वित्तीय आंकलन जो कि, उत्तरदाताओं द्वारा बताए गये आंकड़ों के आधार पर किया गया है अक्टूबर वर्ष 2021 की बाढ़ आपदा में 13 गायों, 9 बछियों, 7 भैंसों, 11 कटियों (पाड़ी) और 17 बकरीयों की क्षति हुई, जिसमें 43 परिवारों के कुल 57 मवेशी मृत हुए जिनकी कुल वित्तीय क्षति 7 लाख 91 हजार रुपये की हुई है। इसके अतिरिक्त अक्टूबर वर्ष 2021 की बाढ़ में 7 छोटे मुर्गीपालन फार्म व 3 छोटे मत्स्य पालन (तालाबों) उद्योग भी प्रभावित हुए हैं। इसके अलावा सर्वाधिक अरविन्द नगर, घोठा, राजनगर, बरूआबाग तथा लौका गाँव के मवेशी बाढ़ की चपेट में आते हैं क्योंकि यह क्षेत्र डूब क्षेत्र की श्रेणी में भी आता है और चारागाह क्षेत्र भी यहाँ स्थित है।

निष्कर्ष

वर्ष 1991 से 2000 तक के कुल 796 दिनों में औसत 1526.46 मिमी. वर्षा दर्ज की गई इसी प्रकार अगले 10 वर्षों (2001-2010) में 724 दिनों में औसत 1694.71 मिमी. वर्षा और वर्ष 2011 से 2020 के मध्य 655 दिनों में 1430.21 मिमी. वर्षा दर्ज की गयी। अतः आंकड़ों के अध्ययन से स्पष्ट है कि, वर्ष 1991 से लेकर वर्ष 2000 तक की अपेक्षा मध्य के दस वर्षों (2001-2010) में 72 दिनों की और मध्य के दस वर्षों (2001-2010) की अपेक्षा अंतिम के दस वर्षों (2011-2020) में 69 दिनों की कमी दर्ज की गई है। इस प्रकार देखा जाए तो वर्षा के दिनों की संख्या में वर्ष 1991 से लेकर वर्ष 2020 तक के कुल तीस वर्षों में 141 दिनों की कमी दर्ज की गई है।

बाढ़ आपदा के दौरान अगस्त माह, वर्ष 2000 में सर्वाधिक 20 दिनों में 1154.6 मिमी. वर्षा दर्ज की गई जबकि, वर्ष 2021 की बाढ़ के दौरान 4 दिनों में 427.5 मिमी. वर्षा दर्ज हुई है अतः सारणी संख्या 4 से स्पष्ट होता है कि, वर्ष 2011 के बाद बाढ़ आपदा के दौरान हुई वर्षा के कुल दिनों की संख्या में कमी दर्ज की गई है, जिसमे अधिकतम वर्षा भी दर्ज हुई है। अतः अध्ययन से स्पष्ट होता है कि, कम दिनों में अधिक वर्षा का होना जलवायु परिवर्तन का परिणाम है जिसके फलस्वरूप अनियमित वर्षा और बाढ़ आपदा की घटनाएं बढ़ रही हैं जिसका नकारात्मक प्रभाव मानव समाज पर पड़ रहा है। 28 गाँव नदी तट के समीप स्थित है, जिन पर बाढ़ आपदा का खतरा वर्षा ऋतु में किसी न किसी रूप में बना रहता है अध्ययन क्षेत्र में कुल 622 आवास बाढ़ आपदा से किसी न किसी रूप में प्रभावित हुए हैं। सूखी नदी बेसिन में वर्ष 2021 की बाढ़ आपदा में 163 परिवारों की 71.5 हेक्टेयर क्षेत्र में 1708.85 क्विंटल धान की फसल क्षति ग्रस्त हो गई, जिसका वित्तीय क्षति 33 लाख 15 हजार उन्हत्तर रुपये की का आँकलन किया गया, जिसमें 43 परिवारों के कुल 57 मवेशी मृत हुए जिनकी कुल वित्तीय क्षति 7 लाख 91 हजार रुपये की हुई है।

सुझाव

1. मानव द्वारा प्राकृतिक संसाधनों का दोहन कम किया जाए।
2. मानव को अपनी महत्वाकांक्षी आवश्यकताओं में कटौती करनी चाहिए।
3. सतत विकास की नीति को आत्मसात करना चाहिए।
4. नदी के दोनों तटों को 35-40 मी. संरक्षित करना चाहिए। बाढ़ सुरक्षा के सभी प्रकार के उपाय किये जाने चाहिए।
5. सड़क मार्गों के किनारे, नदियों के किनारे और बंजर भूमि आदि पर वृक्षारोपण किया जाना चाहिए।

6. पुराने वृक्षों का संरक्षण किया जाना चाहिए।
7. शासन और प्रशासन के द्वारा जंगलों के कटान पर रोक लगाना चाहिए।
8. शासन, प्रशासन और गैर सरकारी संस्थाओं के सहयोग से जागरूकता कार्यक्रम चलाएं जाएं।

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Research Article**उत्तराखंड के ऊपरी अलकनंदा बेसिन में प्रवासन के कालिक पक्ष का अध्ययन**

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सारांश

प्रवास का अर्थ किसी व्यक्ति या समूह द्वारा अपने मूल स्थान को छोड़कर किसी दूसरे स्थान पर स्थायी या अस्थायी रूप से बसना है। उत्तराखंड में यह एक गंभीर समस्या रही है, जहाँ 2001-2011 के बीच अल्मोड़ा और पौड़ी जैसे पहाड़ी जिलों में जनसंख्या में गिरावट देखी गई है। प्राचीन काल से ही बाहरी जातियाँ, तपस्वी, आर्य और राजनैतिक अशांति से बचने वाले लोग इस क्षेत्र में आकर बसे हैं। वर्तमान में भी मजदूर और व्यापारी यहाँ आते हैं। 1804-1815 के गोरखा काल में शोषण के कारण भारी बाह्य प्रवासन हुआ। वर्तमान में रोजगार, शिक्षा और सुविधाओं की कमी के कारण शिक्षित वर्ग बाहर जा रहा है, जिससे "मनीआर्डरवादी अर्थव्यवस्था" को बढ़ावा मिल रहा है। कोल, किरात, खस और द्रविड़ जैसी जातियों का आगमन हुआ। शंकराचार्य (8वीं सदी) का आगमन और विभिन्न राजपूत व ब्राह्मण जातियों का राजनैतिक व धार्मिक कारणों से बसना। गोरखा शासन में पलायन बढ़ा, जबकि ब्रिटिश काल में सैनिकों को तराई क्षेत्रों में बसाया गया। सड़क मार्ग और शिक्षा के विकास के साथ अन्तः और बाह्य दोनों प्रवासों में तीव्रता आई। तकनीकी शिक्षा की कमी, आर्थिक संसाधनों का अभाव, रोजगार के अवसरों का आकर्षण और आधारभूत सुविधाओं की कमी इस क्षेत्र से बाह्य प्रवासन के प्रमुख कारण हैं।

प्रस्तावना

प्रवास का अर्थ है किसी व्यक्ति या समूह का अपने मूल स्थान को छोड़कर किसी दूसरे स्थान पर स्थाई या अस्थायी रूप से रहने के लिए चले जाना प्रवास कहलाता है। जैसे शिक्षा, रोजगार, व्यवसाय, विवाह सुरक्षा जैसे कारणों से प्रवास होता है। साधारण शब्दों में जब कोई व्यक्ति अपने रहने के स्थान को छोड़कर कहीं दूसरे स्थान पर देश से बाहर या भीतर रहने जाता है उसे प्रवास कहते हैं।

उत्तराखंड सरकार ने राज्य में पलायन की समस्या को समझने और उसके समाधान हेतु अगस्त 2017 में ग्रामीण विकास और पलायन निवारण आयोग का गठन किया था वर्ष 2022 में इसका नाम बदलकर ग्राम विकास एवं पलायन निवारण आयोग कर दिया गया। उत्तराखंड में प्रवास एक गंभीर समस्या है। 2001 और 2011 की जनगणना की आंकड़ों का तुलनात्मक अध्ययन में राज्य की अधिकांश पर्वतीय जिलों में जनसंख्या की दशकीय वृद्धि दर अधिक धीमी रही है ल 2001 और 2011 के बीच अल्मोड़ा और पौड़ी गढ़वाल जिलों की जनसंख्या में कमी आई है जो पार्वती अंचलों से बड़े पैमाने पर प्रवास की दर में वृद्धि दर्शा रहा है। वर्तमान आंकड़े बताते हैं कि देहरादून, उधम सिंह नगर, नैनीताल, हरिद्वार जिलों में दशकीय जनसंख्या वृद्धि अधिक है। जबकि पौड़ी और अल्मोड़ा जिलों में नकारात्मक है। टिहरी, बागेश्वर, चमोली, रुद्रप्रयाग और पिथौरागढ़ जिलों में असामान्य रूप से कम है। राज्य में ग्रामीण विकास और प्रवासन आयोग का गठन राज्य में ग्रामीण क्षेत्र की लक्षित विकास के लिए एक दृष्टिकोण विकसित किया जा सके

प्रागैतिहासिक युगों से ही मानव वर्गों का प्रवासन होता रहा है। मानव प्रजातियां आदिकाल से ही अपने उदगम प्रदेश से बाहर को प्रवासित होती रही हैं। मानव प्रजातियों के प्रवास जलवायु परिवर्तनों व हिमयुगों में होते रहे हैं। सभ्यता के विकास के क्रम में नदी वेदिकाओं की ओर मानव प्रवास होता रहा है।

इसी क्रम में उत्तराखंड में भी आदिकाल में आर्यों का पदार्पण गंगा आदि नदियों के उदगम क्षेत्रों की ओर, पंजाब व गंगा के मैदानी क्षेत्रों से अन्तः प्रवासन के रूप में होता रहा फलतः यहां की आदिवासी जातियों पर आर्यों का प्रभुत्व होने से उनका राज्य स्थापित हुआ। कालान्तर में वैदिक युग, प्राचीनकाल, मुगल काल, स्थानीय शासकों के समय, गोरखाकाल, ब्रिटिशकाल, स्वातंत्रोत्तर समय में भी निरन्तर अन्तः प्रवासन की प्रक्रिया चलती आ रही है परन्तु प्रवासन का सर्वाधिक स्वरूप वर्तमान में बाह्य प्रवासन के रूप में इस क्षेत्र में देखने को मिलता है। कोई समूह या व्यक्ति अकाकरण प्रवासित नहीं होता है। फिर भी मानव में स्थानान्तरण के लिये बल प्रदान करती है। इस क्षेत्र में प्रवासन हेतु अपकेन्द्रीय शक्ति एवं अभिकेन्द्रीय शक्ति दोनों की क्रियाशील रही है।

उत्तराखंड में वर्तमान प्रवासन की प्रक्रिया बहुप्रयोजनीय रही है जब प्रवासन स्वैच्छिक होता है तो उसके पीछे आर्थिक लाभ, शिक्षा, सुरक्षा, सामाजिक प्रतिष्ठा आदि प्रयोजन प्रमुख अभिप्रेरक होते हैं। स्वतंत्र प्रवासन एकाकी एवं सामूहिक दोनों प्रकार का मिलता है, जब वह सामूहिक प्रवास का रूप ले ले लेता है तो इसका प्रभाव दोनों छोरों पर पड़ता है।

प्रारम्भ में इस क्षेत्र में अन्तः प्रवासन के कारण बस्तियों का विकास हुआ, कृषि व पशुपालन कार्य विकसित हुये एवं आत्मनिर्भरता मूलक अर्थव्यवस्था बनी तदुपरान्त तपस्वी • एवं आर्यों के आगमन, राजाओं व शासकों के काल में धार्मिकता व राजनैतिक आधार पर अन्तः प्रवासन की प्रक्रिया से क्षेत्रीय जन दबाव बढ़ा। 1790 में कुमायूं में गोरखाओं के प्रभुत्व व शासन हुआ तदुपरान्त 1804 से 1815 तक गढ़वाल के सभी क्षेत्र भी गोरखा शासन के अन्तर्गत आ गये इस काल में तीव्र बाह्य प्रवासन उत्तरांचल से हुआ जिससे क्षेत्रीय जनसंख्या में 20-30 प्रतिशत तक की कमी आ गई। 1815 के उपरान्त ब्रिटिश काल में द्वितीय विश्वयुद्ध के बहादुर सैनिकों को पुरस्कार स्वरूप भूमि प्रदान कर गढ़वाल के तराई-भावर में प्रवासित किया गया 1947 के भारत के विभाजन के उपरान्त प्रवासन एक प्रकार की भौगोलिक प्रवासित या स्थानीय प्रवासिता है, जिसमें रहने का मूल अथवा पहुंचने का स्थान, दोनों भिन्न-भिन्न होते हैं इस प्रकार का प्रवासन स्थाई होता है क्योंकि इसमें मानव का निवास स्थान स्थाई रूप से परिवर्तित हो हो जाता है।

प्रवासन के प्रकार: वेसिन में प्रवासन के निम्न दो रूप मिलते हैं।

अन्तः प्रवासन: अन्तः प्रवास के अंतर्गत प्राचीनकाल में बाहरी जातियां इस क्षेत्र में प्रवासित हुई तथा बस्तियों का वसाव प्रारम्भ हुआ। वर्तमान समय में भी बाहरी लोग इस क्षेत्र में मजदूरी, राजमिस्त्री, व्यापारी आदि कारणों से अन्तः प्रवासित होकर यहीं बस रहे हैं। जिनमें कुछ लौट भी जाते हैं। अन्तः प्रवासन की सर्वाधिक तीव्रता प्राचीनतम में प्राचीन जातियों के आगमन, आर्यों के आगमन, रजवाड़ों की स्थापना के रूप में अधिक हुई। धार्मिक कारणों से अन्तः प्रवासन की तीव्रता 700- 1600 ई0 के मध्य सर्वाधिक रही इसमें तमिलनाडु,

आन्ध्र, केरल, गुजरात, कर्नाटक, मध्य प्रदेश व राजस्थान से आये तीर्थ यात्री वापस न लौट सकने के कारण यहीं बस गये। जिन्होंने बाद में स्थानीय हिस्सेदारी व जागीरदारी प्रथा में अंश प्राप्त किया।

राजनैतिक अन्तः प्रवासन के रूप में 1200-1600 ई० में मैदानी भाग में राजनैतिक अशान्ति के कारण व मुस्लिम शासकों के आतंक से कई राजपूत व ब्राह्मण परिवार यहां आकर बस गये जिसमें पंजाब, मध्यप्रदेश के धारानगरी, उज्जैन, मालवा तथा दक्षिण में कर्नाटक व पुरी से एवं गुजरात व राजस्थान से राजपूत व ब्राह्मण परिवार यहां आकर बसे इस समय 69 राजपूत व ब्राह्मण जातियां यहां आकर बसीं। वर्तमान में भी मजदूर व्यापारी, नौकरी पेशा व्यक्ति यहां आकर प्रवासित होकर बस रहे हैं।

बाह्य प्रवासन: इस क्षेत्र में बृहद् बाह्य प्रवासन का समय 1804 1815 ई० का रहा जब गोरखाली आक्रमण व शोषण से बाह्य प्रवासन तीव्रतर हुआ। ब्रिटिश काल में 1815-1947 की अवधि में अन्तः प्रवासन की गति कम रही तथा बाह्य प्रवासन भी सामान्य रहा इस समय द्वितीय विश्वयुद्ध में भाग लेने वाले सैनिकों को तराई-भावर क्षेत्रों में पुरस्कार स्वरूप भूमि प्रदान कर बसाया गया। स्वतंत्रता उपरान्त बाह्य प्रवासन में तीव्रता आई तथा अन्तः प्रवासन से व्यापारी, नौकरी पेशा, व मजदूरों के आने से क्षेत्रीय सांस्कृतिक विभिन्नतायें जन्म लेने लगीं।

वर्तमान में भी रोजगार, आर्थिक कारणों, आधारभूत सुविधाओं की कमी, व्यावसायिक शिक्षा की कमी, बाहरी क्षेत्रों के आकर्षण आदि कारणों से जनसंख्या का शिक्षित वर्ग, बौद्धिक वर्ग तीव्रता से बाहरी क्षेत्रों की ओर प्रवासित हो रहा है। जिससे क्षेत्रीय समाज खोखला हो रहा है तथा मनीआर्डरवादी अर्थव्यवस्था भी बाजार केंद्रित आत्मनिर्भरता को जन्म देकर क्षेत्रीय विकास को अवरुद्ध कर रही है। उत्तरांचल राज्य बनने के बाद भी कमोवेश यही स्थिति है।

अन्तः प्रवासन का कालिक पक्ष: इस क्षेत्र में अन्तः प्रवासन की प्रक्रिया प्राचीन काल से वर्तमान समय में विभिन्न स्वरूपों एवं उद्देश्य से निरन्तर बनी मिलती है जिसमें निम्न समय मुख्य है।

प्राचीन जातियों का आगमन

किंवदन्ती है कि सप्तऋषियों ने जल प्रलय के बाद विष्णुगंगा अपवाह क्षेत्र के माणा (बदरीनाथ) स्थान में प्राण रक्षा की तथा पुनः सृष्टि रचना में लग गये। इन्हीं सप्तऋषियों मरीचि, अंगीरा, अत्री, अगस्त्य, भृगु, वशिष्ठ एवं मनु से उनके वंशचले। प्राचीन षड्दर्शन के प्रवर्तकों में से चार ने इसी वेसिन में अपने मतों का प्रतिपादन किया। जिसमें गौतम ऋषि ने मन्दाकिनी तट पर व्यास एवं जैमिनी ने सरस्वती नदी के तट पर कपिलमुनी ने बररिकाश्रम को अपने मतों के प्रतिपादन स्थल के रूप में चुना था।

प्राचीन काल में इस क्षेत्र में आदिवासी कौल, यक्ष, भील, आदि निवास करती थी। स्कन्ध पुराण के अनुसार श्रीनगर कोलासुर की राजधानी थी। कोलासुर कोल जाति से सम्बन्धित था जो इस क्षेत्र में भी राज्य करता था। कोल आदि उपरोक्त जातियों के बाद आखेटक जाति किन्नर, गन्धर्व, किरात ने यहां घुसकर कोल व मुण्ड जातियों को आत्मसात कर लिया था। किरात जाति का सम्बन्ध इस क्षेत्र से लम्बे समय तक रहा। ऋग्वेदिक काल में भागीरथी नदी का नाम किराती था। किरात जाति को कृषि की जानकारी थी यह मंगोलाइड जनजाति थी जो पूर्व से इस क्षेत्र में आखेट व पशुचारण हेतु प्रविष्ट हुई। इनके कुल देवताओं में रुद्र, भेरव, घंटाकरण थे।

(वैदिक आर्यों को भीकिरातों के रूद्र ने आतंकित किया था। फलस्वरूप आर्यों ने इनके रूद्र को अपने उपास्यों में स्थान दिया था। पर्वत शिखरों, निर्जन घाटियों एवं बीहड़ वनों में ईश्वरीयकव्यना के श्रेय इसी जाति को है किरात जाति के अवशेष ही राहुल के अनुसार भोटियाजनजाति है। किरात जाति के बाद इस क्षेत्र में खस जाति का आगमन हुआ सिने किरातको हिमालय के उच्च भागों में धकेल दिया हिमालय को देव रूप में मानने का श्रेय इसी खस जाति को है यह जाति पशुचारण व कृषि कार्य करती थी। गंगोत्री, बदरीनाथ, केदारनाथ आदि प्राकृतिक स्थल विकसित किये।

खस जाति के द्रविड़ जाति ने प्रवेश किया तथा मन्दिर व मूर्ति निर्माण प्रारम्भ किया। कोल भिण्ड किरात द्रविड़ जातियों की उपरोक्त धार्मिक मान्यतायें व मान्यताओं के कारण धार्मिक मान्यताओं का प्रचलन प्रारम्भ हो गया था।

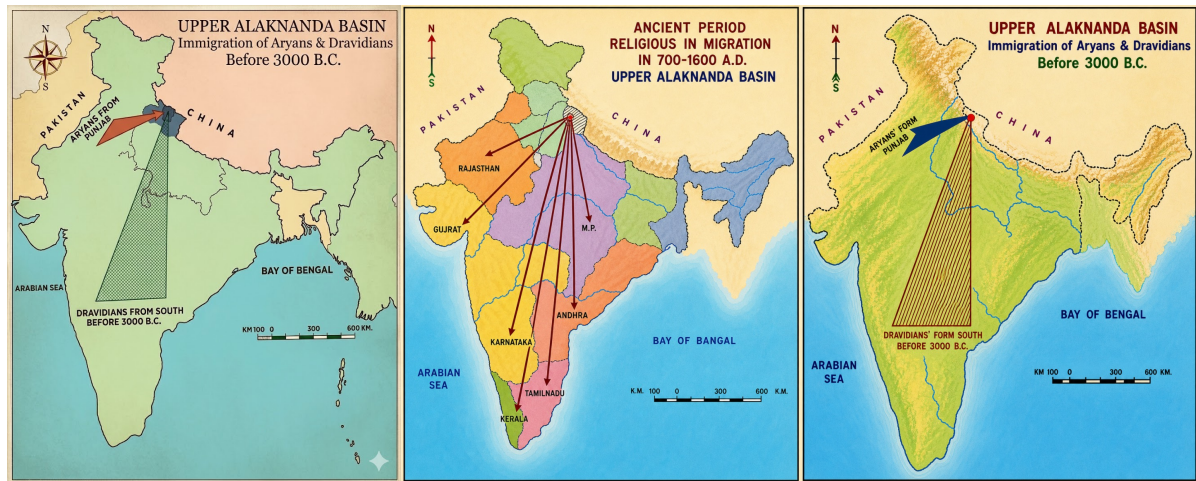
तपस्वियों का आगमन

सभी पुराण यह स्वीकार करते हैं कि वैदिक धर्म के प्रवर्तक ब्रह्मा का स्थान राजस्थान का पुष्कर तीर्थ है। उनके एक पुत्र का नाम धर्म था जिनकी पत्नी मूर्तिसे 'नारायण' एवं पूर्व पत्नी से 'नर' नामक पुत्र उत्पन्न हुये। दोनों पत्नियों दक्ष प्रजापतिकी पुत्रिया थी। नर-नारायण न इस बेसिन के आटामान उप बेसिन क्षेत्र में आदीबदी स्थान पर तप किया जिसमें उर्वशी द्वारा विघ्न डालने पर ये तपस्वी योगबदरी व ध्यान बदरी होकर बदरीकाश्रम तपस्या करने लगे। शंकर दिग्विजय के अनुसार शंकराचार्य ग्यारह वर्ष की आयु में बदरीकाश्रम आये यहा सोलह भाषा लिखे तथा जोशीमठ में तप करके 788-820 ई० में ज्योर्तिमठ की स्थापना की थी।

बदरीकाश्रम जी की यात्रा वैदिक काल में 1000-2400 ई० पूर्व ही प्रारम्भ हो चुकी थी तथा यह क्षेत्र ज्ञान, ध्यान का उत्तम केन्द्र बन चुका था। व्यास मुनि के सुझाव पर पाण्डव अपने प्रयाग हेतु इस क्षेत्र में आये। नरनारायण ऋषियों की तपस्थली कृतयुग के प्रारम्भ में बनी थी जिसे उस समय मुक्ति प्रदान करने वाला, द्वापर में विशाला तथा कलयुग में बदरीकाश्रम कहा जाने लगा।

आर्यों का आगमन: इस बेसिन में आर्यों का आगमन 3000 बी०सी० से पूर्व माना जाता है। इस समय निम्न प्रमुख प्रवास हुये।

बाह्यमिक युग में: इस समय सजऋषि ब्राह्मण, तपस्वी आदि ज्ञान हेतु इस क्षेत्र में आये। जिससे इस क्षेत्र को इस समय ब्रह्मऋषि देश कहा जाने लगा। इस समय आर्यों ने पंजाब क्षेत्र से इस क्षेत्र की ओर बढ़ना प्रारम्भ कर दिया था। इस समय जाति कुल गोत्र का स्वरूप भी जन्म ले चुका था इसी समय 24 ऋषियों पर आधारित गोत्र का विकास हुआ।



इपिक युग: आर्यों ने यहां आकर आदिवासी जातियों पर विजय प्राप्त कर पंचाला राज्य नाम से शासन किया। यह समय वैदिक युग के अन्त अर्थात् 2500 वी०सी० के आसपास का माना जाता है। पंचाला राज्य के साथ ही यह क्षेत्र देवभूमि कहलाने लगा, परन्तु कुरुक्षेत्र युद्ध (1600-1200 वी०सी०) के कारण पंचाला राज्य दो हिस्सों में बंट गया जिसमें उत्तरी भाग द्रोणाचार्य द्वारा दुपद से छीन कर कौरवों को दिया गया तथा दक्षिणी भाग दुपद के पास ही रहा। उत्तरी पंचाला में ही यह वेसिन भी स्थित था। कालान्तर में आर्यों ने आदिवासियों से विवाह सम्बन्ध भी बनाये जिससे सभ्य आदिवासी आर्यों से मिश्रित होने लगे कुरुक्षेत्र युद्ध के बाद यहां की पुरानी आर्य जाति व शासकों का अन्त हो गया तथा नई जातियां इस क्षेत्र में आती गईं।

बुद्धिस्टिक युग: इस समय इस बेसिन के उत्तरी भाग में किरात र तगण जातियों का शासन हुआ। उस समय यह पूरा क्षेत्र टेंगनोई नाम से जाना जाता था कुरुक्षेत्र युद्ध के बाद पाण्डव यहां तब तक राज्य करते रहे जब तक कि वे कैलाश को नहीं चले गये।

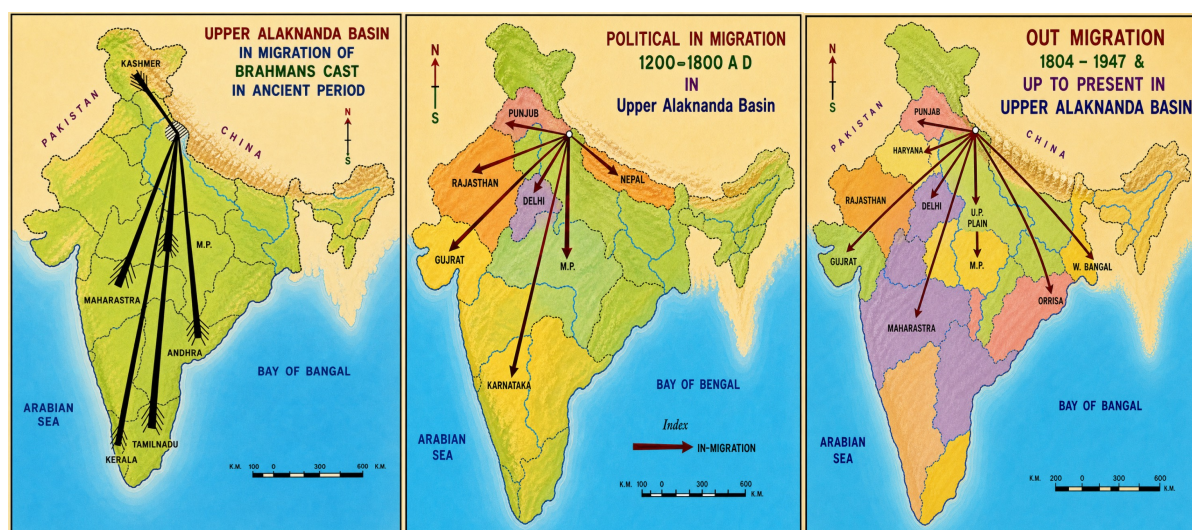
बौद्ध धर्म का प्रभाव: 260 वी०सी० में बन्द्रगुप्त के पुत्र अशोक ने यहां भी बौद्ध धर्म का प्रचार किया जिसके प्रभाव से ही बदरीकाश्रम को बदरीनाथ कहा जाने लगा पिण्डर बेसिन की बौद्धायन पट्टी, प्रभाव की स्मृतियां हैं बाद में इस क्षेत्र में बौद्धधर्म की समाप्ति पर शिव और विष्णु से सम्बन्धित स्थल तीर्थों के रूप में उभरने लगे।

जब अशोक ने ऊपरी दूरस्थ क्षेत्रों से सेना वापस बुलानी प्रारम्भ की ती उत्तरी-पश्चिमी क्षेत्र से विदेशी जातियां घुसने लगी तदुपरान्त छोटे-छोटे रजवाड़े बनने लगे। इसी समय यवन भी ज्योतिषियों के रूप में ओत रहे उनकी कन्या इस वेसिन में जोशीमठ व पाण्डुकेश्वर तथा तुगनाथ मन्दिरों की नक्काशी में मिलती है कहा जाता है कि ये यवन यहां 150 वी०सी० से 450 ए०डी० तक यहां रहे।

लगभग 126 वी०सी० में स्याई धियान जाति हिमालयी दरों से यहां प्रविष्ट हुई जिन्हें यहां शक कहा गया। विद्वानों के अनुसार स्थायीधियांग व राजपूत जातियों के मिश्रण से ही 'खसिया' जाति यहां जन्मी है। चन्द्रगुप्त ने अनेक नागवंशी राजाओं से युद्ध किये थे लेकिन बाद में इन्हीं नागकुल में जन्मी कुबेर नागा नागवंश व गुप्तवंश मिल गये।

स्थानीय शासकों के समय

स्थानीय शासकों ने सोनपाल उत्तर पश्चिमी गढ़वाल में शासन करता था तथा उत्तर पूर्वी भाग के इस वेसिन में कत्यूरी शासकों का राज्य था। इस समय दक्षिणी गढ़वाल मोरध्वज, पाण्डुवाला एवं ब्रह्मपुरा राज्यों के अन्तर्गत था। पाण्डुवाला एवं ब्रह्मपुरा राज्यों के अन्तर्गत था। सम्वत् 756 में मालवा के चन्द्रवंशीय परिवार से राजा कनकपाल जब यहां आये तो राजा सोनपाल ने अपनी पुत्री की शादी व आधा राज्य कनकपाल को दे दिया। बाद में धीरे-धीरे कनकपाल ने छोटे राज्यों को भी मिला लिया तथा गढ़वाल को अपने अधिकार में कर राजधानी श्रीनगर बनाई थी। इस अवधि में निम्न प्रमुख जातियों का अन्तःप्रवासन इस क्षेत्र में हुआ।



बाह्य जातियों का आगमन

स्थानीय शासकों के राज्यावधियों के अन्तर्गत ब्राह्मण जातियां मध्यप्रदेश, गौड़ क्षेत्र, कश्मीर, दक्खिन, केरल, तमिलनाडु क्षेत्रों से यहां अधिक प्रविष्ट हुई हालांकि ये जातियां ब्राह्मिक युग से ही आती रही थी परन्तु इस समय सर्वाधिक आई। कनकपाल राजघराने ने ही ब्राह्मणों के दो वर्ग सिरोला व गंगाडी बनाये। अधिकांश बाहरी ब्राह्मण जातियां याला एवं धार्मिकता के कारण यहीं बस गई। इसी परिप्रेक्ष्य में बदरीनाथ जी के रावल को आज भी केरल से शंकराचार्य जी द्वारा नम्बूदरी परिवार से मनोनीत किया जाता है।

राजपूत जातियों का आगमन

पुराणों के अनुसार राजपूत इस क्षेत्र में आने वाली नई जातियां रही है। ये राजपूत जातियां राजा कनकपाल के समय तक भारी मात्रा में आईं तथा उसके बाद भी इस क्षेत्र में आती रही है। जो उत्तराखण्ड में प्रविष्ट होकर पुनः उत्तराखण्ड में इधर-उधर गढ़वाल कुमायू में बसती रही है।

विभिन्न शासकों के समय प्रवासन का स्वरूप

नागवंश (तीसरी शदी) इसका शासन क्षेत्र मन्दाकिनी व अलकनन्दा नदियों का मध्यवर्ती भाग रहा इसी समय विरसा के नागराजा गणपति नाग ने गोपेश्वर का मन्दिर बनवाया जिसे उसा समय रुद्र महालय कहा जाता था। इस समय बाहरी जातियों का धार्मिक प्रवासन ही हुआ।

गुप्त राजवंश (375-407 ई.) इस अवधि के दौरान, धार्मिक उपदेशों और तीर्थस्थलों के विकास ने आंतरिक प्रवास को मजबूत किया। इस समय गढ़वाल-कुमाऊँ पर चन्द्रगुप्त द्वितीय का शासन था। उसका प्रतीक चिन्ह गरुड़ था तथा इस समय शिखर वाले मन्दिर बने। हूण देश तिब्बत के आक्रमणों से यहां की सभ्यता व संस्कृति को हानि पहुंची तदुपरान्त कहीं हूण जातियां यहां बस गईं। इस समय स्थायी बस्तियों के साथ-साथ धर्मोपदेशक व पुजारियों के निवास स्वच्छ व मठ बनने से अन्तः प्रवासन भी बढ़ा।

खसः (700-850 ई०) इनकी राजधानी कार्तिकेयपुर (जोशीमठ) की टकणपुर (पीपलकोटी) प्रशासनिक केन्द्र था तथा इस कनकपाल का शासन चादपुर क्षेत्र में था।

कत्यूरी (850-1300 ई०) सातवीं से तेरहवीं सदी तक कत्यूरी शासन रहा बेसिन में इनकी राजधानी कार्तिकेयपुर (जोशीमठ) थी। बाद में गढ़वाल के उत्तरी सीमा के खसिया सरदारों का राज्य जीतकर कत्यूरियों ने कार्तिकेयपुर राज्य में मिला दिया। तदुपरान्त चांदपुर के राजा ने खसिया व अन्य सभी राजपूत राजाओं को साथ लेकर कत्यूरों पर आक्रमण किया फलतः कत्यूरी हार कर कुमायूं चले गये जहां वैजनाथ को राजधानी बनाया।

मुगल आक्रमण गढ़वाल से कत्यूरी साम्राज्य के अन्त के समय मुहमद तुगलक दिल्ली के सुल्तान का आक्रमण कुमायूं में हुआ इस मुगल आक्रमणों के भय से कई परिवार यहां आकर बस गये तथा मुसलमानों के प्रभाव से कई आदिवासी जातियां भी मुसलमान बनीं।

पंवार वंश (1415-1804) कनकपाल के बाद गढ़वाल राज्य के संस्थापक राजा अजयपाल के शासन के अन्तर्गत यह पूरा बेसिन भी सम्मिलित था। अजयपाल की मृत्यु के बाद उनके वंशज 1804 तक राज्य करते रहे पंवार वंशी राज्य काल में बाहरी मैदानी क्षेत्र से अनेक राजपूत जातियों एवं जातियों का अन्तः प्रवासन हुआ।

रुहेलों का आक्रमण 1742 एवं 1772 ई० के आसपास इस क्षेत्र में रुहेलों के आक्रमण से मन्दाकिनी उप बेसिन में ऊखीमठ-गुप्तकाशी तक लूटपाट व तबाही हुई।

गोरखा काल (1804-1815) में इस समय कुमायूं में 1790 में गोरखा शासन स्थापित हो गया था। तदुपरान्त 1804 में गोरखाओं ने गढ़वाल पर आक्रमण कर इस बेसिन को भी अपने राज्य में मिला लिया तदुपरान्त सम्पूर्ण गढ़वाल में ही गोरखा शासन हो गया। इनकी शोषण की नीति के परिणामस्वरूप इस समय बाह्य प्रवासन ही अधिक हुआ।

ब्रिटिश काल में (1815-1947) गढ़वाल के शासकों ने गोरखाओं को भगाने 6. हेतु ब्रिटिश सरकार से मदद मांगी तथा बदले में आधा राज्य जनपद गढ़वाल अंग्रेजों को दे दिया जिसमें यह बेसिन भी सम्मिलित था। तब से हमें ब्रिटिश गढ़वाल कहा जाने लगा इस समय प्रशासनिक कार्यों के कारण अत्यधिक अन्तः प्रवासन हुआ। ऊपरी अलकनन्दा के इस बेसिन का प्रशासनिक केन्द्र 1840 तक अल्मोडा ही रहा, बाद में गैरसैण को तहसील बनाया गया तदुपरान्त 1844 में गैरसैण के स्थान पर चमोली को तहसील बनाया गया। अंग्रेजों ने शोषण की नीति के फलस्वरूप यातायात मार्गों का शिकस नदी घाटी क्षेत्रों के अनुरूप किया फलतः अन्तः प्रवासन को भी तीव्र गति मिली।

स्वतंत्रयोत्तर समय (1947 से अब तक) स्वतंत्रता के उपरान्त यातायात शैक्षिक, प्रशासनिक, आर्थिक, सांस्कृतिक आदि गतिविधियों के बढ़ने से अन्तः प्रवास को सर्वाधिक बल मिला। 1947 में कर्णप्रयाग तक, 1950 में चमोली तक, 1960 में जोशीमठ तक पहली बस पहुंचते ही अन्तः प्रवास भी तीव्रतर होता गया। 1965 में पिण्डर घाटी क्षेत्र में बस पहुंची। स्थानीय तकनीक को प्रोत्साहन न मिलने से बाहरी श्रमिक मिस्त्री, तकनीकी व्यक्ति व्यापारी वर्ग निरन्तर अन्तः प्रवासित हो रहे हैं।

उत्तरांचल राज्य निर्माण का प्रभाव: वर्ष 2000 के नवम्बर में उत्तरांचल राज्य का निर्माण हुआ तबसे अब तक विकासात्मक गतिविधियां अधिक नहीं बढ़ी है फलतः पूर्ववर्ती व्यवसाय के अनुरूप ही व्यापारिक, आर्थिक, श्रमिकों, मजदूरों आदि के रूप में अन्तः प्रवासन जारी है।

बाह्य प्रवासन का कालिक पक्ष

प्राचीन ऐतिहासिक काल में बाह्य प्रवासन

प्राचीन पूर्व वैदिक काल, वैदिक काल, मध्यकाल में इस क्षेत्र में बाहरी जातियों के आने से अन्तः प्रवासन ही अधिक सक्रिय रहा। परन्तु गढ़वाल के शासकों के समय राजसत्ता में प्रशासनिक आधार पर बाह्य प्रवासन कम ही हुआ केवल प्राचीन रजवाड़े के व्यक्ति अपनी हार के कारण बाहर प्रवाहित हुए। इसी तरह कनकपाल ने इस क्षेत्र में एक क्षेत्र एक राज्य स्थापित करने हेतु कत्यूरियों को हरा कर कुमायूं क्षेत्र के लिये बाह्य प्रवासित किया। इस समय उपजाऊ जमीन के कारण तराई क्षेत्रों में भी बसने हेतु प्रलोभन दिया जाता था।

गोरखाकाल में (1804-1815) तक का समय गोरखाली शासन के अन्तर्गत इनकी शोषण, मारकाट की नीति के कारण अत्यधिक भयावह होने से इस समय सर्वाधिक बाह्य प्रवासन इस क्षेत्र में हुआ। इस समय गढ़वाल में तीस हजार लोगों टेक्स न देने के कारण 'दास' के रूप में कार्य हेतु खरीदा गया तथा अस्सी हजार व्याक्तियों को 1811-1821 की अवधि में मैदानी भागों में नीलाम किया गया।

ब्रिटिश काल (1815-1947) इस समय द्वितीय विश्वयुद्ध में भाग लेकर लौटे सैनिकों को वीरता स्वरूप पुरस्कार के रूप में तराई-भावर क्षेत्रों में बसाया गया। आत्मारिक वेसिन क्षेत्रों से सेना में भर्ती होने, रोजगार व शिक्षा प्राप्ति हेतु गांवों से बाह्य प्रवासन को गति मिली।

स्वतंत्रत भारत में (1947 से अब तक) स्वतंत्रता प्राप्ति के उपरान्त इस क्षेत्र की विकास गतिविधियां जहां तीव्रतर हुई उसी के साथ-साथ बाहरी व्याक्तियों में आकर्षण, रोजगार प्राप्ति, रहन सहन के स्तर, आधारभूत सुविधाओं की सुविधा आदि कारणों से बाह्य प्रवासन अधिक होता गया। इसमें रोजगार की प्राप्ति मुख्य कारण रही है जिसके कारण आज यह क्षेत्र मनीआर्डरवादी अर्थव्यवस्था के कारण बाजार केन्द्रित आत्मनिर्भरता को अपनाने से खोखला हो गया है।

उत्तरांचल राज्य स्थापना के बाद: 09 नवम्बर 2000 को उत्तरांचल राज्य स्थापित हो गया परन्तु अभी सीमांत क्षेत्रों में इस क्षेत्र में रोजगार के साधनों का अभाव बना है। फलतः पलायन की वही पूर्व प्रवृत्ति बनी है। राजधानी देहरादून होने से भी इस वेसिन से अधिकांश बौद्धिक वर्ग स्थाई रूप से देहरादून बसने लगा है जिससे बाह्य प्रवासन की गति इस क्षेत्र में बढ़ी है। सरकार की पलायन संबंधी योजनाओं का प्रभाव उत्तराखंड

में देखने का मिलता है। वर्तमान (2025-26) प्रवास की प्रवृत्ति पारंपरिक पलायन से हटकर रिवर्स माइग्रेशन (वापसी) की ओर झुक रही है। राज्य के पर्वतीय ग्रामों में, विशेषकर युवाओं (25-35 आयु वर्ग) द्वारा रिवर्स पलायन और कृषि, होमस्टे जैसे स्वरोजगार के अवसरों के कारण, अगस्त 2025 तक 6,282 से अधिक लोग अपने गांवों में लौटे हैं, जो एक सकारात्मक बदलाव है।

इस क्षेत्र में बाह्य प्रवासन हेतु आज भी निम्न कारण उत्तरदायी रहे हैं - तकनीकी ज्ञान एवं शिक्षा हेतु बाह्य प्रवासन। आर्थिक संसाधनों की कमी से। रोजगार की अधिक सुविधाओं का आकर्षण। इस क्षेत्र में आधारभूत सुविधाओं की कमी से। उत्पादकता की कमी व श्रम साध्य जीविका से बाह्य प्रवासन। क्षेत्रीय आत्मनिर्भरता की कमी से बाह्य प्रवासन। बाहरी क्षेत्रों का आकर्षण। नौकरी में कम श्रम से ही अधिक मुद्रा की प्राप्ति का आकर्षण। जीविकापार्जन हेतु बाह्य प्रवासन। सेवा उपरान्त जन उपयोगी सुविधाओं के आकर्षण से आदि।

सन्दर्भ ग्रन्थ सूची

नन्द व कुमार दि होली हिमालया 1989

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Research Communication

The indigenous Lepcha story of Divine Creators, Animism and Shamanism practices in protecting the mountain environment of Darjeeling Himalaya

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Abstract

This research communication describes the indigenous Lepcha story of divine creators, animism, and shamanism practiced in the mountain environment of Darjeeling Himalaya. Lepchas are the ancient tribes of the Eastern Himalaya, dependent on traditional agricultural and livestock farming for their livelihood. They also practice traditional arts and crafts. This study was conducted based on field observations and interviews with the heads of households of Lepcha tribes living in the Darjeeling Himalaya. It reveals that Lepcha tribes are rich in culture and cultural heritage, and they preserve their culture and customs traditionally. However, they are economically poor people. Meanwhile, they continue to preserve their traditionally practiced arts and crafts, which are their unique feature.

Keyword: Indigenous Lepcha; Animism; Mountain environment; Darjeeling Himalaya.

Introduction

The Lepchas, one of the ancient mountain tribes of the Eastern Himalayan region, have distinct cultural practices, like most other indigenous groups of this region. Their way of living is centered around nature and natural entities and believed to be protected by the divine creators. Though Lepcha religious practices are different from animistic beliefs, certain rituals, customs and narrations depict similar forms of animism. Lepcha Shamans, often termed as Mun and Bongthing, are the spiritual practitioners and healers who are graced with special powers to communicate with the outer world of human territory, good and evil spirits, as well as non-human elements of nature. Present-day Lepchas are influenced by syncretism under Lamaism and converted to Christianity. Still Lepcha priests, often regarded as Shamans' presence hold importance from birth to death till date in Lepcha society. This form of belief, where rituals, ceremonies are performed by Shamans, is a way of harnessing balance between man and nature while protecting the mountain environment of Darjeeling Himalaya (Figure 1).

The study aims to understand the notions of creator deities and its relation to animism and shamanism. The work is based on a conceptual framework while doing fieldwork in the Darjeeling Himalaya and acquiring knowledge about various practices performed by a mountain tribe of the Eastern Himalaya, the Lepchas.

How do we see Animism and Shamanism?

The term animism is believed to have been coined by the Western mind and matter. Tylor (1913) initially distinguished animism from religion and considered animism as the foundation of religious beliefs. Later, animism as philosophy and religion has been shown under different lights. It is believed that all South East Asian diversity, like ethnicities, religions, livelihoods, cultural practices, and all forms of alterity, coexist with the animistic beliefs. Animism is believed to be present in indigenous communities across the globe. The very knowledge of our surroundings has an interrelation between the environment and other forms of beings, like animals, plants, natural and geographical entities, and even unexplainable supernatural beings. Animistic beliefs thus maintain an ecological understanding by preserving, protecting, and respecting natural elements.



Figure 1. A Lepcha lady is offering thanksgiving to the guardian deity Mt. Khangchendzonga, for the monsoon crops (by offering the first crop of the field to the deity, such as banana, pineapple, corn, cardamom, and bamboo). Photo by Pem Kit Lepcha.

Shamanism has been seen in all human societies, including in primitive societies. Eliade (1964) famously reviewed ethnographic descriptions of shamans around the world, documenting similarities in practice and mythology between Siberian shamanism on the one hand and practitioners in Asia, the Americas, and Oceania, on the other hand. In general, shamanism is a form of practice evolved through cross-cultural inclusivity. A shaman is an individual who makes people believe that he or she can exchange and communicate with invisible forces beyond mankind who control all unpredictable, extraordinary events on earth and beyond. Shamanism is a combined effect of individuals' claims of having special powers of interacting with other worlds or invisible agents and a cultural interpretation of the trance state of one's being.

The Lepcha's different approach to animistic beliefs in the Eastern Himalayan Region

Along with its geographical diversity, India has its deep-rooted cultural diversity reflected through cultural practices spread across the majestic Himalayan region, the lustrous Western Ghats, and to the secluded islands of Andaman and Nicobar. However, it is found that animism is present in indigenous communities profoundly, in the form of showing gratitude towards natural entities, referred to as guardian deities protecting humans, settlements, and livelihoods. Across the Himalayan region from west to east, there are all forms of entities, including rivers, forests, lakes, and peaks, which are worshipped by communities as they are intertwined with human lives and form a single whole identity. Indigenous communities of Eastern Himalaya have a transformative relationship between their landscape and associated traditional practices, which are formed with animism and persist with shamanism. Lepchas are such indigenous group who are referred to as *Rongkup* or *Rongpa*, meaning "children of God," inhabit the Eastern Himalaya and are distributed mainly across Sikkim and the northern parts of West Bengal. They considered themselves the children of the snowy peaks of Mt. Khangchendzonga, and their folk narratives revolve around elements of nature, reflected in their nature-based practices. Their socio-cultural setup is influenced by animistic beliefs and practices, which are primitive in nature.

In the Darjeeling Himalayas, there is an active participation and continuous involvement of local people in practicing rituals, which are reflected through their festivals (Figure 2). The Lepchas are often known for their indigenous ecological knowledge present in the form of divine creators, animism, and are often more sustainable, resilient in environmentally fragile regions of Darjeeling, Kalimpong, and Pedong. However, it is interesting to know how they are precariously trying to maintain this belief system as the words of Mr. G. Gorer who wrote 'Himalayan Village' and Indira Awasty amplified the fact that 'to present the kind of original Lepcha culture after the influence of Lamaism, the predominance of Nepalis and the inroads that Christianity has made on the Lepchas, is enormous'. From historical evidence, undoubtedly Lepcha beliefs are severely influenced by Lamaistic Buddhism, which has travelled from Kham province of Tibet, and animistic practices modified by such intrusion. The original religion of the Lepchas is Animism, performed by Lepcha female and male priests called '*Mun*' and '*Bongthing*', and also sometimes called "*Mun-bongthingism*" has a resemblance to Zoroastrian monotheism. It is a shamanistic form of worshipping supernatural powers. It has other names, such as the Bong cult and Mun religion.



Figure 2. The Namsoong folk dance performance is to welcome the new agricultural year (Lepcha Calendar) and honour the harmonious relationship with nature. Photo by Pem Kit Lepcha

The Divine Creators

It is believed that the Lepcha clan originated from *Itbo-mu*, the ancient mother, and her husband *Debu*, who is believed to have created the first Lepcha man and woman from the snows of Mt. Kanchandzonga (Figure 3), and they started living in the sacred land called Mayel Lyang and gave birth to their progenitor, believed to be the Lepcha god Tak-bo-thing. *Kongchen* is the presiding deity, and from its snow sacred rivers, *Rongit* and *Rongnyu* were created. The place above the sky is called Rum-Lyang, where Rum or God resides, and beneath that is said to be a place of water, fire, and wind. Even the existence of many malevolent spirits, demons, and devils is considered, who reside in trees, rocks, mountains, etc. As the Lepchas are firm believers of the supreme God and concurrently the presence of evils, they believed the special powers of Mun and Bongthing, who are the medium of communication between Rum, human beings, and spirits.



Figure 3. A replica of guardian deity Mt. Mt. Khangchendzonga which has similarity with Hindu deity 'Lord Shiva' and the 'Trishul (Trident)' signifies it. Photo by Author

Role of Shamans in performing rituals

Rong beliefs are mythological and philosophical at the same time. Their beliefs have different facets centered around offerings, sacrifices, fairy tales, performing ceremonies governed by the spirits, evil, and good. Lepchas or *Rongs*, being one of the oldest primitive people of *Mayel Lyang*, possess primordial beliefs often similar to Taoism but not often categorised as a religion where rituals hold a significant place to narrate philosophical and social ethos. This has made them a distinctive indigenous group of the Darjeeling Himalaya, where more than eleven other communities share cultural and geographical spaces. Lepcha Mun and Bongthings are practices by acquiring a priesthood through the possession of supernatural power. They are the Shamans who interact with the supreme God as well as evil spirits, along with the common people. *Mun*, together with *bongthing*, often called *padem* in Nepali, mostly perform with the belief in the presence of spirits in natural objects like trees, streams, mountains, and lakes. To eradicate the sufferings from one's life and render relief,

these shamans or priests perform ceremonies to ward off evil spirits, often called malevolent or black magic or *mung sek mun*. But there is another form, which is benevolent or white magic or *tuang ti mun*. Muns are often found to practice various rituals to deal with harmful evil spirits, which cause calamities, illness, and also, they perform rituals to connect with good spirits who are responsible for good harvest, curing illness, and bringing prosperity. In all the vital moments of life, from birth to marriage to last rites, the presence of muns is mandatory in the Lepcha tradition. Muns are mostly female (Figure 4), but it's gender-neutral, as male priests are often termed mun in the Lepchas Mun religion, if it is considered as a religion. They use *sadaer logs or sadaer long*, black thunder stones to cure labour pain as a talismanic power of magic can be compared with the faith of burning tree trunks in Celtic, German, and Slavic culture in Pagan belief to bring good luck, or like Hinduism, often worshipped as a sacred form of deity. However, Lepcha healing and curing medical ailments are completely dependent on the existence of supernatural power. Locally found specific plants, leaves, tree trunks, flowers, bark, and roots are respected by Lepchas as they have properties of curing people from diseases and acute illnesses. Shamans like Mun and Bongthings become healers while diagnosing and curing people by providing ethno medicines. Traditionally, these Muns and Bongthings possess the traditional knowledge of the uses of medicinal plants as well as healing procedures. They are often called to address any form of illness, which is different from their religious practices. So, there is always a dubious connotation of Shamanistic practices while referring to Lepcha society and traditions.



Figure 4. The author is interviewing Lepcha Mun (Shaman), Bibina Lepcha.

Lepcha Munism and Lamaism

Lamaism entered the Khangchendzonga landscape in the 17th century, and Lamaistic fanaticism was intertwined with Lepcha, a traditional animistic form of religious beliefs. Immigration of 'Khamba' and Tibetans drives the religious conversion of Lepchas to

Buddhism by Tibetan monks. They destroyed Rong scripts as well as their written form of practices. Rong mythology and philosophy got a new shape and format, and a symbiotic relationship formed between muns, lamas, rums, and moongs. Lepcha scripts were replaced; Tibetan religious books and scripts were converted to Lepcha scripts to propagate Lamaism. Lamaism is also practiced by priests, but it is also mixed with tantrism, which is considered an impure form of Buddhism. These Red Hats, who are followers of old tantric beliefs and modes of dress, and had a denial of change in beliefs, had incorporated into mun religion. Even the priest craft is learnt in Lamaism, which fundamentally lacks intellectuality. The same belief system of the presence of good, evil, mixture of good and evil, is followed by lamas like muns. Lamas and muns have become fortune tellers, predictors who have dreams of futuristic events, and they can foretell future events. Gorer described typical dreams like gathering sand, collecting wood, are symbols of a good harvest, often called lucky, whereas dreaming of a sick person lying on a bed means a bad harvest, drinking wine means heavy rains are signs of unlucky dreams. However, Munism or Bongthism revolves around Lepcha traditional beliefs of supernatural powers in the form of God, evil, and good spirits who have the power to create and destroy Lepcha society. Till today, Lepchas follow this belief system but are influenced by the Lamaistic practices (Figure 5), which are complicated. The importance of the Shamanistic practices of *Mun* and *Bongthing* has reduced, and they have only remained as traditional healers.



Figure 5. Pang Lhabso, a festival to pay homage to Mt. Khangchendzonga as the guardian deity, which is also associated with Lamaism in this region. Photo by Pem Kit Lepcha

Protecting Mountain Environment

In the Darjeeling Himalayan region, Lepchas are mostly found in secluded villages, except few modernised city dwellers. They are not socially well organised, and the functioning of the Lepcha social organisations is also influenced by multiple factors. However, traditional environmental practices of the Lepchas are well ingrained in their folklore and reflected through their ceremonies and festivals. Nowadays, Lepchas in the Kalimpong Darjeeling region are under Christian missionaries, and the practices of the old Mun religion are restricted

to a few. The nature-centric Mun-Bongthing religion also consists of scientific values in its indigenous knowledge system and practice of medicinal plants to cure diseases and illnesses (Figure 6). For centuries, these practices protected the fragile environment and distinguished the identity of this indigenous community. Such beliefs help in protecting the natural entities in the form of worshipping them. Integration of these knowledge systems can be useful in the conservation of biodiversity and local ecology. However, these practices are slowly losing importance with the dominance of other communities. Losing their cultural environmental practices is a threat to their survival and the mountain environment.



Figure 6. Crofton Weed (*Ageratina adenophora*) Plant is used by Muns (Lepcha priests and healers) to heal wounds. Photo by Surajit Banerjee

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Book Review

Mountain Tourism, Altitude and Host-Guest Relationships

Apollo, M. (2026). London: Routledge. <https://doi.org/10.4324/9781032623375>, ISBN 9781032623351, 190 Pages, 13 B/W Illustrations, €67.99

This authoritative monograph by Michal Apollo examines how elevation influences interactions between mountain tourism and local communities, proposing sustainable destination development paths for ecologically sensitive high-altitude regions. Building on his earlier work that uncovered a relationship between altitude and the host-guest relationship, this volume extends the theory into the world's foremost high-altitude destination for mountaineering, hiking, trekking, and technical climbing. Drawing on empirical fieldwork conducted in Nepal's Mount Everest region, against the backdrop of Sagarmatha National Park, it analyses contemporary mountain tourism dynamics and trends including activity diversification, commodification, and commercialization while examining potential benefits for economically marginalized highland populations.

As trekkers wind their way up the Khumbu Valley to reach the base camp of the world's tallest mountain, the volume progresses systematically through seven chapters to examine the influence of altitude on host-guest dynamics in Himalayan Mountain tourism. Chapter 1 establishes foundational concepts linking mountain tourism to altitude-based horizontal zoning affecting interactions between locals and visitors to Sherpa communities. The Direct Zone (0–10 m removed from the main trail to Everest Base Camp) is compared and contrasted with the Intermediate (10–50 m) and Remote Zones (50 m or more off the main trail).

Chapter 2 presents the theoretical framework and research methodology underpinning the investigation of host-guest relations in mountainous regions. A mix of *quantitative* (a diagnostic study to measure the phenomenon) and *qualitative* methods (in-depth interviews to triangulate ground-level understanding) were conducted to collect data in extant Sherpa villages ranging in height from Phakding (2,610 m) to Dingboche (4,410 m). The empirical core comprises Chapters 3–5. Chapter 3 employs quantitative analysis to examine spatial and altitudinal factors shaping host-guest relationships, while Chapter 4 utilizes grounded interviews to explore lived realities of altitude's impact on interactions between local Sherpa and trekking tourists. Chapter 5 synthesizes findings, identifying causal mechanisms linking altitude, zoning, and relationship dynamics.

Chapter 6 translates research findings into practical management recommendations for sustainable development of mountain tourism. The concluding Chapter 7 applies Doxey's (1975) Irritation Index framework to analyse Sherpa sentiment trajectories—from initial euphoria to potential antagonism—across various highland contexts, providing critical insights for destination managers and policymakers. The findings are interestingly ambivalent, with host-guest relations invariably revealed as not uniform across all communities but differing depending on the settlement's elevation and the respondent's distance off the “beaten track” to Everest Base Camp. In all three zones (A, B, C), local residents tend to judge tourists more harshly in terms of cultural knowledge as the altitude of residence increases while nonetheless showing increasing appreciation of trekkers' respect for local culture. Yet insights from the horizontal zoning model can also preclude simple solutions to certain antagonistic sentiments. For example, Sherpa communities at higher altitudes seem more concerned by annoying tourist behaviours in the direct trekking zone “A” closest to the trail. A similarly significant relationship holds tourists more responsible for environmental pollution in zone “A” at higher altitudes, but for the introduction of foreign norms by tourists and their subsequent uptake, results were indistinguishable between direct zone “A” and intermediate zone “B”. Conversely, at higher altitudes local residents recognize the positive impact of tourism in terms of

improving quality of life yet simultaneously these most sensitive sites are said to be the priority for “overtourism” counter-strategies.

There are a couple of features of the book’s focus that could be deemed limitations or taken as the impetus for future research. First, the commendable efforts to put the Sherpa people at the heart of this story should not preclude further investigation of the touristic dimension. Follow-up studies could triangulate trekkers’ and tour operators’ perceptions on some of the same said “overtourism” issues. Ultimately, it is the demand-side dynamics that seem set to drive the development trajectories of high-altitude trekking meccas such as this one that are increasingly reliant on tourism. Second, the cross-sectional nature of this monograph leaves the door open for future longitudinal studies, not least because many of the host-guest feelings must surely fluctuate across time as well as space. A follow-up study, for example, could compare the oscillations from euphoria to hostility (and back?) before, during and after the coronavirus pandemic when the drastic swings in demand ensured that factors other than altitude or distance from the main trail must have also affected the market for mountain tourism.

Overall, the book serves as essential reading for researchers, students, tourism professionals, and policy practitioners engaged with mountain tourism and host-guest relations in remote regions. The Himalayas have long since played a prominent role in adventure and exploration narratives, yet the prevailing discourse celebrates mountaineers’ achievements while marginalizing perspectives of resident populations. *Mountain Tourism, Altitude and Host-Guest Relationships* address this critical gap by examining broader consequences for Sherpa communities. If mountain tourism is to be made more sustainable, we must prioritize benefits for indigenous populations whose livelihoods depend on these environments. Apollo’s sustained ethnographic engagement with Himalayan highland communities demonstrates exceptional cultural sensitivity and analytical sophistication, achieving a level of scholarly commitment that matches the geographical elevation of its subject matter.

Reviewed by Prof. T.E. Jones

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Japan



In this Volume.....

Volume 2 (Issue 1) comprises a total of eleven scholarly contributions, including eight full-length research articles, one research communication, and one book review. The research articles collectively address a diverse range of themes, reflecting the multifaceted socio-economic and environmental dynamics of the Himalayan region. These themes include transformations in farming systems in Arunachal Pradesh; patterns of income growth and social development in Uttarakhand; and traditional agricultural practices in the Garhwal Himalaya.

Additional studies examine landslide susceptibility zonation in Himachal Pradesh, assess the quality of life in Uttarakhand, and explore sustainable livelihood strategies in Himachal Pradesh. Climate change and its regional implications in Uttarakhand also form a critical area of inquiry within this issue. The research communication focuses on the Lepcha community of the Darjeeling Himalaya, offering valuable ethnographic insights. Furthermore, the volume includes a review of the book *Mountain Tourism*, which adds a broader conceptual perspective to the discussions presented.

The contributions in this volume are rich in content and demonstrate in-depth analysis of their respective themes. They offer meaningful insights and practical implications, making the issue a valuable resource for a wide range of stakeholders, including students, researchers, academicians, planners, and policy makers engaged in Himalayan studies and related disciplines.

Editor-in-Chief



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