Promoting sustainable livelihoods and climate change adaptation through Ecotourism: A case study of Darma Valley in the Indian Himalayan Region

Cumulative dissertation
with the aim of achieving a doctoral degree
at the Faculty of Mathematics, Informatics, and Natural Sciences
Department of Earth Sciences
At Universität Hamburg

submitted by Deepika Rawat
2023 in Hamburg

Department of Earth Sciences

Date of Oral Defense:	11.07.2023
Reviewers:	Prof. Dr. Udo Schickhoff Prof. Dr. Martina Neuburger
Members of Examination Commission:	Prof. Dr. Suraj Mal Prof. Dr. Poonam Kumria Prof. Dr. Uwe A. Schneider

Acknowledgements

I am filled with immense relief as I reach this significant milestone, and I want to extend my heartfelt gratitude to the exceptional individuals who have been instrumental in supporting me throughout my Ph.D. journey.

First and foremost, I owe an immense debt of gratitude to my supervisors for their unending support and allowing me intellectual independence in my work. I extend my sincere gratitude to Prof. Dr. Udo Schickhoff who welcomed me into his working group, consistently offering positive reinforcement and exposure to diverse opportunities that immensely bolstered my confidence. I am deeply grateful for the opportunity to embark on this undertaking, which has only intensified my fascination for the mountains. I want to give my deepest appreciation to Prof. Dr. Martina Neuburger who offered her generosity in her valuable feedback and critiques during the conception and implementation of my research project. Her intellect, compassion and empathy are something I hope to emulate as a woman, and she will always be someone I will look up to. In entirety, I cannot adequately express my gratitude for the mentorship, guidance, support and academic freedom provided by both of my supervisors, which have significantly shaped and nurtured my future career interests.

Many thanks to my examination committee members, Prof. Dr. Uwe A. Schneider, Prof. Dr. Suraj Mal, Prof. Dr. Poonam Kumria for their keen interest in my dissertation research. I would like to extend my sincere thanks to Prof. Dr. Suraj Mal for his valuable suggestions and inputs in completion of my published manuscript.

I must thank the reviewers of my published and submitted manuscripts for their constructive advice improving the quality of the manuscripts.

I would also like acknowledge the active support I received from Leo van Versendaal and Daria Kerssenbrock for supporting me in field data collection in India and Antonia Gollasch for extending her support with spatial analysis.

I am grateful for the funding sources, University of Hamburg Doctoral Scholarship, MIN Graduate School - MINGZ4all research stay abroad Scholarship, STIBET III Matching Funds Scholarship and Hamburglobal PhD, all of whom allowed me to smoothly pursue my research. Additionally, I would be remiss in not mentioning the experiences I received from European Institute of Innovation and Technology Climate-KIC Summer School Programme that has immensely supported in putting in an innovative approach to my research.

A special thanks to the warm and welcoming community of Darma valley, who graciously shared their experiences and opened their homes to me during my research. My heartfelt appreciation goes to all my informants for taking out their valuable time

and patiently helping me with my data collection journey. I am exceptionally grateful to Jayendra Singh, who played a pivotal role in my research journey as my field translator, guide, and friend. He introduced me to the beautiful Bhotia villages, their culture, and traditions, and I could not have completed this study without his indispensable support.

To my many friends and family, I want you all to know that I could not have achieved this milestone without your unwavering moral support and encouragement.

To Juliana, my colleague and dear friend – thank you for your constant motivation and cheer. Not only have you shared in my moments of joy and triumph, but you have also been a compassionate listener during my most challenging times.

To Sweety, Simran, and Shalini, my friends back home – it has been my greatest joy sharing my life's success and failures with you all for more than a decade.

To my wonderful sisters, Swati and Shruti – you have been my pillars of strength and confidantes. I am proud to be surrounded by such a powerful duo.

To both my grandmothers – I owe a debt of gratitude to both of you for igniting my love and passion for the mountains. To my paternal grandmother, I hope you are watching over me from above, and to my maternal grandmother, I eagerly anticipate the day when I can return and bask in your warm embrace.

To my biggest cheerleaders, my dearest parents – you always knew that this would be long and full of challenges, yet you never let me lose sight of my capabilities. You have never let me settle for less than what I am capable of, and for that reason, I am here today. Your tough love and belief kept my spirits high during these all years I have been away from home. Thank you for everything you have done and continue to do for me.

To Karan, my best friend, my partner and my family away from home – you have my profound gratitude for your unfailing support, continuous belief and greatest moments of joy that I shared with you in all these years.

Lastly, with immense gratitude in my heart and even greater zest to learn, I am excited to embark on the next chapter of my journey. However, for the time being, it is time for me to return to my home country and enjoy the sun - which is very rare in Hamburg!

Summary

The intersecting influences of globalization and climate change in mountainous regions worldwide have profound implications for local livelihoods. The diminishing of traditional practice of transhumant pastoralism in mountain communities is a major consequence of fast-paced urbanization, rapid globalization, political instability, and shifting climatic conditions and related environmental concerns. Consequently, pastoralists have experienced economic hardships, cultural transformations, and a shift towards non-pastoral livelihood options. Given the evolving circumstances, the pressing necessity of sustaining local livelihoods assumes a preeminent position, with a simultaneous emphasis on fostering adaptability through the implementation of alternative pathways for sustainable livelihoods. Thus, communities undertake a multifaceted range of off-farm livelihood endeavors as a strategy to confront and adjust to unfavorable risks posed by these inevitable forces.

Empirical evidence on climate projections in Indian Himalayan Region, including in Uttarakhand necessitates the critical importance of proactive adaptation strategies in effectively mitigating and responding to the impacts of these driving forces of change, all while ensuring the persistence of local livelihoods. Concurrently, the escalating tourism statistics in the region serve as an indicative measure of the local community's inclination to actively participate in diverse tourism segments, serving as viable alternatives to complement their conventional livelihood practices. Marked by a heightened degree of consensus, it is critical to recognize the inherent importance of harmoniously amalgamating tourism segments into economic purview, underpinned by the fundamental objective of bolstering the prevailing economic structures, rather than displacing or superseding them. In this particular milieu, albeit a substantial body of research has been dedicated to exploring various facets of ecotourism development in Uttarakhand and in the IHR, a notable paucity persists in terms of comprehensive empirical investigation that encompasses the potential and prospects of ecotourism as a means of sustainable livelihoods, more akin to a globalization adaptation and to a climate adaptation strategy that adeptly address the evolving impacts of socio-economic drivers and the amplified vulnerabilities presented by climate change within pastoral communities. As such, a marked scarcity persists in the scholarly literature concerning the exploration of the intricate dynamics involved in the transition of ecotourism progression into an entrepreneurial adaptation that simultaneously addresses the imperatives of economic viability and ecological sustainability.

To address these deficits, this research aimed at investigating the extent of changing climate, local community perception of consequent socio-economic dynamics and their inclination towards pursuing alternative livelihoods in Darma valley in Pithoragarh District, Uttarakhand in the IHR. Additionally, in light of the enormous expansion of the tourism sector, including ecotourism, in Uttarakhand, this study sought to broaden the comprehension surrounding the significance of ecotourism as a viable strategy to

foster livelihood diversification and support adaptation. In all three parts of this dissertation, to attain its overarching aims, the study employed a mixed method approach that included a combination of quantitative and qualitative research approaches as well as utilization of varied methodological approaches such as Mann-Kendall (MK) test, Normalized Difference Snow Index (NDSI), Sustainable Livelihoods Framework (SLF), Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis, Ecotourism Opportunity Spectrum (ECOS), Sustainable Business Model Canvas (SBMC) and REAS framework. The primary data was collected through Participatory Rural Appraisal (PRA) approaches consisting of questionnaire surveys, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), historical transects and direct observations. Additionally, supplementary data and information were gathered from relevant secondary sources such as official government records and publications published by the government of India and Uttarakhand.

The results inferred that the Darma region is currently witnessing climatic changes, particularly in temperature warming and erratic precipitation that are altering the local community's pastoral livelihoods. When coupled up with the underlying socio-economic dynamics caused by the confluence of continuous globalization, increasing urbanization, political influences and low levels of economic growth, substantial ramifications are evidently experienced by the Bhotia community in the region. This includes exacerbated economic instability, food instability, land abandonment, hastened outmigration, and social tensions over resources. In response, the local communities have devised inherent adaptive measures entailing the transition towards alternative modes of supplemental livelihoods, such as engaging in wage labor, tourism and recreational services, transportation services, as well as the collection and trade of rich medicinal and aromatic plants.

Given the foregoing and drawing on local community’s perception, the research findings conclude that Darma valley's unique natural landscapes and cultural legacy present potential prospects for ecotourism development as a viable entrepreneurial solution to supporting sustainable livelihoods and increasing local populations' adaptive ability and assets in response to changing socio-economic and climatic dynamics. Ecotourism, as a widely acknowledged means of diversifying livelihoods, has the potential to foster financial stability, environmental protection, and community empowerment. In tandem, it is indisputable that Uttarakhand has a significant superiority in nature-based tourism, and ecotourism has been designated as a niche segment for encouraging sustainable livelihoods, environmental protection as well as entrepreneurial development in state tourism plans and other regulatory agreements. Given the lack of formalized business models in the study region, the current study proffers an increased adoption of business models in cultivating ecotourism-oriented entrepreneurial ascendency within marginal systems. Alongside, the current research recognizes the ecotourism sector’s sensitivity to climate change due to its reliance on natural resources as well as the adverse consequences of ecotourism growth that may

curtail its success. Hence, the study fervently advocates for proactive involvement from governmental and private sector in providing substantial institutional infrastructure support, financial capital allocation, and efficient on-the-ground implementation of the policy frameworks, thereby ensuring the proliferation of ecotourism as a viable source of income generation for marginalized communities while minimizing adverse environmental impacts and fostering climate resilience.

The current research marks a significant milestone as the first of its kind in Uttarakhand and presents pioneering findings and distinctive perspective to scholarly community and policymakers on the potential opportunities that may arise from the current climate change scenario, albeit within a limited geographic scope. The findings of this research furnish a novel foundation for further investigations aimed at scrutinizing the entrepreneurial potential and prospects of ecotourism, which could, in turn, pave the way for the establishment of new globalization-resilient and climate-resilient livelihoods in the Himalayan regions.

This cumulative dissertation comprises of three studies, one of which has been published, one has been submitted, and the final one is intended for publication (refer to Appendix I and II for abstract and full articles):

Study 1: Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India
Author(s): Deepika Rawat and Udo Schickhoff
Published in: Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Sustainable Development Goals Series. Springer, Cham. pp. 429-447. Doi: 10.1007/978-3-030-70238-0_18

Study 2: Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region
Author(s): Deepika Rawat, Martina Neuburger and Udo Schickhoff
Submitted to: Journal of Ecotourism (Submission ID: 221679446)

Study 3: Exploring the integration of entrepreneurial ascendency into ecotourism development for livelihood adaptation
Author(s): Deepika Rawat and Martina Neuburger
Intent for submission

Zusammenfassung

Die sich überschneidenden Einflüsse der Globalisierung und des Klimawandels in Bergregionen weltweit haben tiefgreifende Auswirkungen auf die lokalen Lebensgrundlagen. Der Rückgang der traditionellen Praxis der Wanderweidewirtschaft in Berggemeinden ist eine wichtige Folge der schnellen Urbanisierung, der raschen Globalisierung, der politischen Instabilität sowie des Wandels der klimatischen Bedingungen und der damit verbundenen Umweltprobleme. Folglich haben Hirten wirtschaftliche Schwierigkeiten, kulturelle Veränderungen und eine Verschiebung zu nicht-pastoralen Lebensunterhaltsoptionen erlebt. Angesichts der sich entwickelnden Umstände nimmt die dringende Notwendigkeit, lokale Lebensgrundlagen zu erhalten, eine vorranginge Stellung ein, wobei gleichzeitig ein Schwerpunkt auf der Förderung von Anpassungsfähigkeit durch die Umsetzung alternativer Möglichkeiten für nachhaltige Lebensgrundlagen liegt. So ergreifen die lokalen Gemeinschaften eine vielschichtige Palette von außerlandwirtschaftlichen Lebensgrundlagen als Strategie, um den ungünstigen Risiken, die von diesen unvermeidlichen Kräften ausgehen, zu begegnen und sich anzupassen.

Empirische Erkenntnisse über Klimaprojektionen in der indischen Himalaya-Region und in Uttarakhand machen deutlich, wie wichtig proaktive Anpassungsstrategien sind, um den Auswirkungen dieser treibenden Kräfte des Wandels effektiv entgegenzuwirken und gleichzeitig die Fortbeständigkeit lokaler Lebensgrundlagen zu gewährleisten. Zugleich sind die steigenden Touristenzahlen in der Region ein Indikator für die Entwicklung der lokalen Bevölkerung, sich aktiv an verschiedenen Tourismussektoren zu beteiligen, die als alternative Ergänzung zu ihren herkömmlichen Lebensgrundlagen dienen. Es ist von entscheidender Bedeutung, angesichts eines hohen Maßes an Konsens die inhärente Wichtigkeit der harmonischen Integration von Tourismussegmenten in die wirtschaftliche Perspektive anzuerkennen, wobei das grundlegende Ziel darin besteht, die bestehenden wirtschaftlichen Strukturen zu stärken, anstatt sie zu verdrängen oder zu überwinden. In diesem speziellen Bereich gibt es zwar eine Vielzahl von Forschungsarbeiten, die sich mit den verschiedenen Facetten der Entwicklung des Ökotourismus in Uttarakhand und den IHR befassen, aber es besteht ein beachtlicher Mangel an umfassenden empirischen Untersuchungen, die das Potenzial und die Aussichten des Ökotourismus als Mittel zur nachhaltigen Sicherung des Lebensunterhalts umfassen. Es gibt in der wissenschaftlichen Literatur nach wie vor einen deutlichen Mangel an Untersuchungen, die die komplexen Dynamiken der Entwicklung des Ökotourismus zu einer unternehmerischen Anpassung untersucht und dabei gleichzeitig die Anforderungen an wirtschaftliche Rentabilität und ökologische Nachhaltigkeit erfüllt.

Um diese Defizite anzugehen, hatte diese Forschung das Ziel, den Umfang des sich ändernden Klimas, die Wahrnehmung der lokalen Gemeinschaft bezüglich der daraus resultierenden sozioökonomischen Dynamik und ihre Neigung zur Verfolgung

alternativer Lebensgrundlagen im Darma-Tal im Distrikt Pithoragarh, Uttarakhand in der IHR zu untersuchen. Zusätzlich sollte diese Studie angesichts der enormen Expansion des Tourismussektors in Uttarakhand, einschließlich des Ökotourismus, das Verständnis für die Bedeutung des Ökotourismus als tragfähige Strategie zur Förderung der Diversifizierung der Lebensgrundlagen und zur Unterstützung von Anpassungen erweitern. In allen drei Teilen dieser Dissertation wurde zur Erreichung ihrer übergeordneten Ziele eine Mixed-Methods-Ansatz verwendet, der eine Kombination quantitativer und qualitativer Forschungsansätze sowie die Nutzung verschiedener methodischer Ansätze wie dem Mann-Kendall (MK) Test, dem Normalized Difference Snow Index (NDSI), dem Sustainable Livelihoods Framework (SLF), der Strengths, Weaknesses, Opportunities, Threats (SWOT) Analyse, dem Ecotourism Opportunity Spectrum (ECOS), dem Sustainable Business Model Canvas (SBMC) und dem REAS Framework umfasste. Die Primärdaten wurden mittels partizipativer ländlicher Bestandsaufnahme (Participatory Rural Appraisal, PRA) erhoben, die Fragebogenumfragen, Fokusgruppendiskussionen (Focus Group Discussions, FGDs), Interviews mit Schlüsselpersonen (Key Informant Interviews, KIIs), historische Transekte und direkte Beobachtungen umfasste. Zusätzlich wurden ergänzende Daten und Informationen aus relevanten Sekundärquellen wie offiziellen Regierungsdokumenten und Publikationen der Regierung Indiens und Uttarakhands gesammelt.

Die Ergebnisse ergaben, dass die Darma-Region derzeit klimatische Veränderungen erlebt, insbesondere in Form von Temperaturerwärmung und unregelmäßigen Niederschlägen, die die traditionellen pastoralen Lebensgrundlagen der lokalen Gemeinschaft beeinflussen. Wenn dies mit den zugrundeliegenden sozioökonomischen Dynamiken durch kontinuierliche Globalisierung, zunehmende Urbanisierung, politischen Einflüssen und niedrigem wirtschaftlichem Wachstum kombiniert wird, ergeben sich offensichtlich erhebliche Auswirkungen auf die Bhotia-Gemeinschaft in der Region. Dies umfasst eine verstärkte wirtschaftliche Instabilität, Nahrungsmittelunsicherheit, Landflucht, beschleunigte Abwanderung und soziale Spannungen wegen lokaler Ressourcen. Als Reaktion darauf haben die lokalen Gemeinschaften angepasste Maßnahmen entwickelt, die den Übergang zu alternativen Formen von ergänzenden Lebensgrundlagen beinhalten, wie etwa die Arbeit in Lohnarbeit, Tourismus- und Freizeitdienstleistungen, Transportdienstleistungen sowie die Sammlung und der Handel mit medizinischen und aromatischen Pflanzen.

In Anbetracht der obigen Ausführungen und unter Berücksichtigung der Wahrnehmung der lokalen Gemeinschaft kommt die Forschung zu dem Schluss, dass die einzigartigen natürlichen Landschaften und das kulturelle Erbe des Darma-Tals potenzielle Chancen für die Entwicklung des Ökotourismus als eine tragfähige unternehmerische Lösung zur Unterstützung nachhaltiger Lebensgrundlagen bieten und die Anpassungsfähigkeit und Ressourcen der lokalen Bevölkerung angesichts sich ändernder sozioökonomischer und klimatischer Dynamiken erhöhen können. Ökotourismus, als anerkannte Option

zur Diversifizierung von Lebensgrundlagen, hat das Potenzial, finanzielle Stabilität, Umweltschutz und Gemeinschaftsstärkung zu fördern. Gleichzeitig steht außer Frage, dass Uttarakhand eine bedeutende Überlegenheit im naturnahen Tourismus aufweist und der Ökotourismus als Nischensegment zur Förderung nachhaltiger Lebensgrundlagen, Umweltschutz und unternehmerischer Entwicklung in den Tourismusplänen des Bundesstaates und anderen rechtlichen Vereinbarungen festgelegt wurde. Angesichts des Fehlens formalisierter Geschäftsmodelle in der untersuchten Region schlägt die vorliegende Studie eine verstärkte Übernahme von Geschäftsmodellen zur Förderung des ökotouristischen Unternehmertums in marginalisierten Systemen vor. Außerdem erkennt die vorliegende Forschung die Empfindlichkeit des Ökotourismussektors gegenüber dem Klimawandel aufgrund seiner Abhängigkeit von natürlichen Ressourcen sowie der nachteiligen Folgen des Wachstums des Ökotourismus, die seinen Erfolg beeinträchtigen können. Daher plädiert die Studie nachdrücklich für das proaktive Engagement der Regierung und des privaten Sektors bei der Bereitstellung substantieller institutioneller Infrastrukturunterstützung, der Zuteilung finanzieller Mittel und einer effizienten Umsetzung der politischen Rahmenbedingungen vor Ort, um die Verbreitung des Ökotourismus als eine tragfähige Einkommensquelle für marginalisierte Gemeinschaften zu gewährleisten, gleichzeitig aber negative Umweltauswirkungen zu minimieren und die Anpassungsfähigkeit an den Klimawandel zu fördern.

Die vorliegende Forschung markiert einen bedeutenden Meilenstein als erstmalige ihrer Art in Uttarakhand und liefert der wissenschaftlichen Gemeinschaft und den politischen Entscheidungsträgern wegweisende Erkenntnisse und eine einzigartige Perspektive auf die potenziellen Chancen, die sich aus der aktuellen Klimawandel-Situation ergeben können, wenn auch innerhalb eines begrenzten geografischen Rahmens. Die Ergebnisse dieser Forschung bieten eine neuartige Grundlage für weitere Untersuchungen zur Überprüfung des unternehmerischen Potenzials und der Perspektiven des Ökotourismus, die wiederum den Weg für die Etablierung neuer globalisierungsresilienter und klimaresilienter Lebensgrundlagen in den Himalaya-Regionen ebnen könnten.

Diese kumulative Dissertation besteht aus drei Studien, von denen eine veröffentlicht wurde, eine eingereicht wurde und die letzte zur Veröffentlichung vorgesehen ist (siehe Anhang I und II für Zusammenfassungen und Volltextartikel).

Studie 1: Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India
Autorinnen und Autoren: Deepika Rawat und Udo Schickhoff
Veröffentlicht in: Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Sustainable Development Goals Series. Springer, Cham. pp. 429-447. Doi: 10.1007/978-3-030-70238-0_18

Studie 2: Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region
Autorinnen und Autoren: Deepika Rawat, Martina Neuburger und Udo Schickhoff
Eingereicht bei: Journal of Ecotourism (Einsendungs-ID: 221679446)

Studie 3: Exploring the integration of entrepreneurial ascendency into ecotourism development for livelihood adaptation
Autorinnen und Autoren: Deepika Rawat und Martina Neuburger
Absicht zur Einreichung

Table of Contents

List of figures

List of tables

List of abbreviations

ADB	Asian Development Bank
BM	Business Model
BMC	Business Model Canvas
BRO	Border Road Organization
CBSE	Community-Based Social Enterprise
COVID	Corona Virus Disease
CPWD	Central Public Works Department
CRU TS	Climatic Research Unit Time Series
DDGUKY	Deen Dayal Upadhyay Grameen Kaushalya Yojana
DFID	Department for International Development
DHM	Department of Hydrology and Meteorology
ECOS	Ecotourism Opportunity Spectrum
EFEM	External Factor Estimation Matrix
EPLSTP	Entrepreneurship and Placement Linked Skill Training Programme
ETDC	Ecotourism Development Corporation Uttarakhand
ETM+	Enhanced Thematic Mapper Plus
FGD	Focus Group Discussions
GBP-NIHE	Govind Ballabh Pant National Institute of Himalayan Environment
GDP	Gross Domestic Product
GLOF	Glacial Lake Outburst Flood
GNH	Gross National Happiness
GoI	Government of India
GoU	Government of Uttarakhand
GSDP	Gross State Domestic Product
HKH	Hindu Kush Himalaya
HYV	High Yielding Variety
ICIMOD	International Centre for Integrated Mountain Development
IFEM	Internal Factor Estimation Matrix
IHR	Indian Himalayan Region
ILO	International Labor Organization
IPCC	Intergovernmental Panel on Climate Change
ITBP	Indo-Tibetan Border Police
KII	Key Informant Interviews
KMVN	Kumaon Mandal Vikas Nigam
KSL	Kailash Sacred Landscape
KSLCDI	Kailash Sacred Landscape Conservation and Development Initiative
MAP	Medicinal and Aromatic Plant
MK	Mann-Kendall
MSDE	Ministry of Skill Development and Entrepreneurship
MSME	Micro, Small, and Medium Enterprises
NDBR	Nanda Devi Biosphere Reserve

NDC	Nationally Determined Contribution
NDSI	Normalized Difference Snow Index
NGO	Non-governmental organization
NITI	National Institution for Transforming India
NSRST	National Strategy and Roadmap for Sustainable Tourism
NTFP	Non-timber Forest Products
OECD	Organization for Economic Cooperation and Development
OLI	Operational Land Imager
PMKVY	Pradhan Mantri Kaushal Vikaas Yojana
PRA	Participatory Rural Appraisal
REAS	Red de Redes de Economía Alternativa y solidaria
ROS	Recreation Opportunity Spectrum
SBM	Sustainable Business Model
SBMC	Sustainable Business Model Canvas
SDG	Sustainable Development Goals
SE	Social Entrepreneurship
SECURE	Securing Livelihoods, Conservation, Sustainable Use, and Restoration of High Range Himalayan Ecosystems
SEM	Structural Equation Modeling
SHG	Self-help Group
SL	Sustainable Livelihood
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihoods Framework
ST	Scheduled Tribe
SWIR	Shortwave infra-red
SWOT	Strengths, Weaknesses, Opportunities and Threats
TERI	The Energy and Resources Institute
TM	Thematic Mapper
TOS	Tourist Opportunity Spectrum
TSE	Tourism Social Enterprise
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UNTFSSE	United Nations Inter-Agency Task Force on Social and Solidarity Economy
UREDA	Uttarakhand Renewable Energy Development Agency
USGS	United States Geological Survey
UTDB	Uttarakhand Tourism Development Board
VCSGS	Vir Chandra Singh Garhwali Scheme
WCED	World Commission on Environment and Development
WTO	World Trade Organization

Synthesis of the cumulative thesis

1. Introduction

The livelihoods in the Himalayan regions have long been marked by vulnerability, intrinsic to the challenging circumstances prevalent in these regions (Wester et al. 2019; Tiwari et a. 2020). In recent times, the mountain livelihoods have been confronted with double exposure shocks that are linked to the processes of globalization and climate change (Thorpe and Figge 2018; Schickhoff et al. 2022). With that, a culmination of a myriad of change drivers[1] deeply rooted in modernization trends, expansion of roads, infrastructural development, trans-border conflicts, political instability, fast-paced urbanization, agricultural intensification, commercialization of land, communication network, land reforms, improved literacy, remittance payments, emergence of democratic institutions, introduction of cash economies, outmigration and profit-oriented market development and tourism have contributed to the diminishing of traditional livelihoods across the region. It is noteworthy that while climate change is a critical and pressing issue causing disruption to both biophysical environment and human civilization on the planet (IPCC 2022), with mountain regions being severely susceptible to the pronounced Anthropocene challenges (Mukherji et al. 2018; Schickhoff and Mal 2020; IPCC 2022; Schickhoff et al. 2022; Adler et al. 2022), the adversities caused by aforementioned non-climatic drivers cannot be overlooked. For instance, the alterations in land use and degradation as propelled by human-induced actions including deforestation, expansion of built-up areas, agricultural expansion, and infrastructure development, may often get intensified by the consequences of climate change leading to significant consequences for mountain communities and their livelihoods (Wang et al. 2019; Duan et al. 2019). As a result, the mounting influence of these formidable forces upon the lives and sustenance of the mountain communities necessitate a comprehensive understanding of the intricate dynamics at play and the development of targeted interventions to enhance their adaptive capacity and resilience.

1.1. Impacts of globalizing world on mountain livelihoods

Despite their geographical isolation, mountainous regions have not remained untouched by the forces of urbanization, globalization, and modernization trends. On the contrary, they have been subjected to extensive socio-economic transformation processes that have significantly impacted their traditional way of life (Schickhoff et al. 2022). For instance, the expansion of road networks in the marginalized mountain

[1] Negi 2007; Bhasin 2011; Gerwin and Bergmann 2012; Kreutzmann 2012; Singh et al. 2013; Namgay et al. 2013; 2014; Wu et al. 2014; 2015; Sati 2015; Tiwati and Joshi 2016; Dong et al. 2016; Gentle and Thwaites 2016; Pandey et al. 2017a; Bisht et al. 2018; Aryal et al. 2018; NITI Aayog 2018a; Bhatta et al. 2019; Wang et al. 2019; Tiwari et al. 2020; Singh et al. 2020a; KC and Race 2020; Singh et al. 2021; Ingty 2021; Namgay et al. 2021; Pasakhala et al. 2021; Tuladhar et al. 2021; Postigo 2021; Srichandan et al. 2021; Joshi and Rawat 2021; Rawat and Schickhoff 2022; Schickhoff et al. 2022; Bisht et al. 2022; Datey et al. 2023; Pasakhala et al. 2023

region can be seen as a manifestation of the larger trends of globalization and commercialization, facilitating the easy flow of goods, people, and capital across borders. This has led to an increase in market integration and the emergence of new economic opportunities for mountain communities (Bhatta et al. 2019; Wang et al. 2019). Driven by the desire for improved economic conditions that arise from these tendencies, communities often abandon their traditional livelihood means to shift to profit-maximizing practices, such as agriculture intensification through the cultivation of high-value cash crops as widely seen in the western Himalaya region (Singh et al. 2020; Sharma et al. 2022). Moreover, certain policies and institutional frameworks have generated heightened bureaucracy and complexities necessitating prioritized adjustments in traditional practices by successive generations, thus undermining their rights and engagement in the land management systems (Kreutzmann 2012; Tiwari et al. 2020). Similarly, the enforcement of land use policy reforms and unclear regulations have been observed to disregard and limit the traditional forest and rangeland use rights of native communities such the establishment of protected areas and the transfer of property rights to non-herding communities, resulting in a decreased incentive to sustain these practices (Kreutzmann 2012; Bergmann et al. 2012; Dong et al. 2016; Pandey et al. 2017a; Tiwari et al. 2020; Pasakhala et al. 2021; Ingty 2021; Singh et al. 2021; Bisht et al. 2022).

In addition, the existence of external limitations, such as political instabilities and trans-border conflicts, have been observed to lead to deprivation of traditional land-use practices, thereby leading to an increase in outmigration and a transition towards alternative means of livelihoods (Bergmann et al. 2012; Gerwin and Bergmann 2012; Singh et al. 2013; Pandey et al. 2017a; 2017b; Luxom et al. 2022; Pasakhala et al. 2021; Joshi and Rawat 2021; Srichandan et al. 2021; Rawat and Schickhoff 2022). Facilitated further with the advent of heightened access to education and more avenues of alternate income sources, outmigration is a growing trend in the highland regions, especially among male members (Dong et al. 2016; Tiwari et al. 2020; Luxom et al. 2022; Malhotra et al. 2022). As this ongoing trend persists, it has the potential to contribute to certain aspects of financial resilience and reduced reliance on labor-intensive traditional livelihoods while simultaneously placing increased burdens on women and triggering transformations in community dynamics (KC and Race 2020). Nonetheless, it has yielded several positive outcomes, including economic stability through remittances (Gentle and Thwaites 2016; Tuladhar et al. 2021) and enhanced social, economic and political empowerment of women through improved access to education, increased engagement in leadership positions, and active involvement in household decision-making (Tiwari and Joshi 2016).

The convergence of marginal systems with modernity has engendered a waning interest among younger generations, leading to the gradual erosion of cultural traditions and growing interest towards other income options such as tourism-based livelihoods, wage labor and selling of NTFPs (Namgay et al. 2013, 2014; Aryal et al. 2018; Tiwari et al. 2020; Tuladhar et al. 2021; Ingty 2021; Dorji et al. 2022; Rawat and Schickhoff 2022;

Malhotra et al. 2022). Consequently, in conjunction with varied market instabilities, mountain livelihoods have encountered labor scarcities, posing challenges to traditional livelihoods as evidenced from research among the Gaddi pastoralists in Himachal Pradesh in India (Malhotra et al. 2022), yak herding communities in Bhutan (Dorji et al. 2022) and Kailash Sacred Landscape in Nepal (Pasakhala et al. 2021). However, in times as such hiring shepherds has resulted in reduction of the household labor force, yet persistent concerns remain about the future prospects of these livelihoods (Ahmad et al. 2021).

1.2. Impacts of changing climate on mountain livelihoods

As the mountain ecosystems worldwide, including Hindu Kush Himalaya (HKH) region, continue to face observable and serious consequences due to rising temperatures, changes in weather patterns, reduced snow cover, accelerated loss of glacier mass, rapid thawing of permafrost and a growing number of glacier lakes (Wester et al. 2019; Singh et al. 2020b; Adler et al. 2022), some studies conclude that temperature increases are greater in the high elevation regions than in lowlands (Schickhoff et al. 2016). HKH is warming faster than the global average (Krishnan et al. 2019a). The region has undergone serious warming trends with a significant increase between 1901- 2014 (Ren et al. 2017; Sabin et al. 2020; Krishnan et al. 2019a). Several studies conducted in Himalayan regions have reported serious climatic changes in precipitation and temperature trends (Ren et al. 2017; Mishra 2017; DHM 2017; Karki et al. 2017; Shafiq et al. 2018; Krishnan et al. 2019a; Sabin et al. 2020) as well as glacial retreat and snow reduction (Bolch et al. 2019; Mal et al. 2019; Ren et al. 2020). Due to higher warming, most of the HKH glaciers are at an alarming rate of recession (Maurer et al. 2019; Bolch et al. 2019; Krause et al. 2019; Nie et al. 2021) as opposed to some glaciers in the Karakoram region, which are observed to be either slightly gaining mass since the 1970s or remain in a stagnant phase (Azam et al. 2018; Berthier and Brun 2019; Shean et al. 2020).

There is a rapidly growing literature on regional climate change impacts which indicates observations related to negative trends in snow accumulation (Bolch et al. 2019), treeline shifts (Schickhoff et al. 2015; Sigdel et al. 2018), water shortages (Lutz et al. 2019; Rasul and Molden 2019), changes in phenology (Roy and Rathore 2019), increased frequency and magnitude of disasters (Mohanty et al. 2019; Vaidya et al. 2019; Bhambri et al 2020), increase in vector-borne diseases (Dhimal et al. 2021), distribution of medicinal plants (Negi et al. 2021a), invasion of alien species (Tripathi et al. 2019), pest infestation (Paschapur et al. 2022) and increase in livestock diseases (Rayamajhi and Manandhar 2020) having serious socio-economic implications for the local mountain communities and livelihoods in HKH countries[2] including India, Nepal,

[2] India (Negi et al. 2012; Zomer et al. 2014; Wu et al. 2014; Rautela and Karki 2015; Ogra and Badola 2015; Negi et al. 2017; 2021a; 2021b; 2022; Pandey et al. 2017b; Negi et al. 2018; Dey et al. 2018; Feroze et al. 2019; Ramprasad et al. 2020; Sharma et al. 2020; Joshi and Rawat 2021; Ingty 2021; Platt et al. 2021; Kuniyal et al. 2021; Rawat and Schickhoff 2022; Datey et al. 2023); Bhutan (Namgay et al.

Bhutan, China, and Pakistan. Similar trends have been observed in other parts of the world such as from Kenya (Opiyo et al. 2015a; 2015b; Ndiritu et al. 2021), Ethiopia (Berhanu and Beyene 2015; Habte et al. 2022), Cameroon (Kongnso et al. 2021), Nigeria (Ayanda et al. 2013), Uganda (Mayanja et al. 2019) and Tanzania (Kimaro et al. 2018).

Likewise, home to nearly 42 million people, the Indian Himalayan Region (IHR) is a part of the HKH that stretches across India's northern border from the Indus River in the west to the Brahmaputra River in the east (NITI Aayog 2018a) and is reported to be warming at higher rates (Negi et al. 2022). The region has experienced enormous impacts of changing climate on the cryosphere in the past decades (Huggel et al. 2020; Bisht et al. 2020; Dimri et al. 2021; Kumar et al. 2021) as well as reported changes in the decline of rainfall (Bhutiyani 2016; Dimri et al. 2016) and the significant increase in temperatures (Singh et al. 2016; Dimri et al. 2018; Negi et al. 2018; Garg et al. 2022). When combined with the challenges posed by globalization, the cumulative impacts of these changes have been detrimental to the traditional agricultural and pastoral livelihoods of the local communities (Namgay et al. 2014; 2021; Dey et al. 2018; Bhatta et al. 2019; Wangchuk and Wangdi 2018; Wang et al. 2019; Tiwari et al. 2020; Rawat and Schickhoff 2022). Adapting to such changes, particularly considering the ensuing ramifications of pervasive poverty, population growth, inadequate economic development, rapid urbanization, and social transitions such as significant male outmigration, poses a formidable undertaking (Mamgain and Reddy 2017; Siddiqui et al. 2019; Gioli et al. 2019). Generally, as a response to cope, most pastoralist adaptation strategies revolve around modification in existing practices and diversified shifts to non-pastoral livelihood often leading to the diminishing of pastoral livelihood systems (Wu et al. 2014; 2015; Berhanu and Beyene 2015; Ogra and Badola 2015; Mayanja et al. 2019; Gioli et al. 2019; Ndiritu et al. 2021).

Overall, the combined effects of these impacts, coupled up with widespread poverty and marginalization in the region make Himalayan communities more vulnerable to climate change (Gerlitz et al. 2016; IPCC 2022). As the acclamation of both climatic and non-climatic driving forces continue to persist and reshape mountain livelihoods, it is imperative to acknowledge that the resultant effects are not uniformly distributed among mountainous communities. Particularly, disadvantaged groups including women and marginalized communities frequently bear a disproportionate burden of both environmental and socio-economic transformations (Ogra and Badola 2015; Tiwari and Joshi 2016; Gentle and Thwaites 2016; Resurrección et al. 2019; KC and Race 2020; Datey et al. 2023). Hence, acknowledging and remedying these

2014; Wu et al. 2014; Wangchuk and Wangdi 2018; Namgay et al. 2021); Nepal (Zomer et al. 2014; Wu et al. 2014; Gentle and Thwaites 2016; Sujakhu et al. 2016; Aryal et al. 2016; Uprety et al. 2017; Aryal et al. 2018; Rayamajhi and Manandhar 2020; Tiwari et al. 2020; Tuladhar et al. 2021; Pasakhala et al. 2021; 2023); China (Wu et al. 2014; Zomer et al. 2014; Wu et al. 2015; Dong et al. 2016); and Pakistan (Joshi et al. 2013; Wu et al. 2014; Ahmad et al. 2021)

discrepancies are essential in nurturing resilient and flourishing mountain communities amidst continuous environmental and social transformations.

1.3. Potential and risks of tourism in changing scenario

Unquestionably, mountain ecosystems are renowned for their awe-inspiring natural vistas and profoundly rich cultural heritage, which have experienced a notable surge in tourist arrivals in recent times. This upsurge in tourism and its sub-sectors coincide with the intricately intertwined dynamics of urbanization, globalization, and climate change, presenting both burgeoning prospects and formidable hurdles for this industry (Wang et al. 2019). Despite its significance as a supplemental livelihood option integrated into the existing economy, especially for marginalized communities in developing countries (Tao and Wall 2009b), it is noteworthy that tourism revenues primarily serve as supplementary income due to the seasonal and financially constrained nature of employment opportunities within the sector (Kim et al. 2019). Similarly, against the growing concerns of change stressors, niche-tourism components, such as ecotourism as a livelihood adaptation approach remain an essential mean of securing livelihoods amongst marginal communities across varied geographies (Ogara et al. 2013; Ogra and Badola 2015; Hoang and Pulliat 2019; Jamaliah and Powell 2018; Little and Blau 2018; Agyeman 2019; Dendup et al. 2022; Trang and Loc 2022).

Notwithstanding the beneficial consequences of globalization and modernization in facilitating heightened accessibility and connectivity to previously isolated and marginalized regions, resulting in a substantial increase in tourist influx and the emergence of novel tourism markets, it is imperative to undertake a thorough examination of the intricate challenges associated with these developments. In accordance, despite the fact that tourism industry in the HKH region holds significant promise as a catalyst for economic growth, but its progress has been hampered by a scarcity of knowledge and expertise, as indicated by insufficient prioritization of the sector in regional governments' national policy agendas (Rasul et al. 2019).

It is discernible that the contemporary urbanization processes in mountainous locations not only result in unconventional spatial use patterns but also in the domination of market economies and powerful external economic and social entities. This is exemplified by the commitment of state authorities in Uttarakhand's Nanda Devi Biosphere Reserve which is manifested through their adoption of a conventional conservationist approach with a slight emphasis on profitability, employed to cater to the increasing touristic interests and acknowledging the critical significance of such critical landscapes (Nautiyal 2003; Nautiyal and Kaechele 2007; Naitthani and Kainthola 2015). Similarly, Nepal has adeptly harnessed the inherent value of the niche-based tourism sector, recognizing its promising opportunities for driving social, economic, and environmental progress (Aryal et al. 2019a). For instance, ecotourism development, as a nature-based tourism endeavor, stands out as a sustainable alternative

to mass tourism, making it a potential catalyst for enticing community engagement, especially youth, in biodiversity conservation and fostering economic development (Aryal et al. 2019b). In order to optimize the advantages derived from ecotourism, various ecotourist sites have been established in Nepal, including those within the geographical boundaries encompassing national parks, conservation areas and indigenous community structures residing in their vicinities, such as in Chitwan National Park (Dahal et al. 2020; Upadhaya et al. 2022), Annapurna conservation area (KC et al. 2015), Bhadaure-Tamagi in Panchase Protected Forest Area (Neupane et al. 2021), and Ghalegaun in western Nepal (Walter et al. 2018; KC et al. 2021).

Bhutan epitomizes a congruent strategy by ardently embracing ecotourism through the implementation of policy measures that intricately interconnect with the philosophical underpinnings of Gross National Happiness (GNH)[3], which emanates from the fundamental tenets of Buddhism and the deeply embedded cultural values of Bhutanese society (Rinzin et al. 2007; Montes and Kafley (2022). Moreover, the nation's substantial endeavors to champion ecotourism align comprehensively with prevailing conservation discourses, while concurrently demonstrating conscientious efforts in tackling the multifaceted challenges entailing poverty alleviation and socio-economic inequities (Montes and Kafley 2022). In a comparable vein, in China, state-driven tourism initiatives market ecotourism as a successful strategy for rural economic growth and improved wellbeing of local communities. However, often times the imbalanced visitor numbers and increased pressures on natural resources indicate a dual impact of tourism, including ecotourism measures on sustainability, emphasizing the importance of caution in promoting initiatives that claim to be environmentally friendly but may not be sustainable (Newton and Franklin 2011).

In fact, the gradual expansion of tourism industry into rural Himalayan Mountain economies[4] is widely recognized for its significant contribution to the regional development, yet strenuous concerns remain regarding over dependence on the burgeoning tourism sector in remote Himalayan regions. Pasakhala et al. (2023) conducted a study among the pastoralists in Langtang valley in Nepal and found that pastoralists communities are progressively transitioning to diversified livelihoods and placing excessive reliance on the tourism sector, resulting in the gradual deterioration of their cultural values and heritage. Similarly, in the context of Nepal, the alluring prospects presented by the tourism sector and the phenomenon of labor migration have

[3] GNH is a comprehensive development index that encompasses the well-being and happiness of a nation's population. It seeks to evaluate the overall quality of life and extends beyond conventional economic indicators by incorporating social, cultural, environmental, and spiritual dimensions to assess a nation's progress.

[4] For instance: Bhutan (Rinzin et al. 2007; Newton and Franklin 2011; Montes and Kafley 2019), India (Kala and Maikhuri 2011; Anand et al. 2012; Balodi et al. 2014; Datta and Banerji 2015; Sarkar and Sinha 2015; Ogra and Badola 2015; Bhalla et al. 2016; Ingty 2021; Basak et al. 2021; Luxom et al. 2022), Nepal (KC et al. 2015; 2021; Walter et al. 2018; Dahal et al. 2020; Neupane et al. 2021; Upadhaya et al. 2022

precipitated a decrease in the count of households actively participating in traditional pastoral pursuits (Aryal et al. 2016; 2018; 2019a; 2019b; Tuladhar et al. 2021). While the noticeable advancement of tourism initiatives brings benefits to marginalized communities, there are considerable apprehensions surrounding the socio-cultural repercussions of the industry on traditional livelihoods, such as modifications to local norms and values (Shakya 2016; Tiwari et al. 2020; Pasakhala et al. 2023).

Conversely, leveraging the socio-cultural and environmental assets of the mountainous landscapes, communities continue to view tourism as playing a substantial role in creating viable alternative livelihood options (Tiwari and Joshi 2015). However, in light of the current climate change scenario noticeable shifts in weather patterns, glacial melt, and increased occurrence of extreme weather events, may adversely impact the availability and attractiveness of tourism resources (Nyaupane and Chhetri 2009; Dar et al. 2014; Alfthan et al. 2018; Wang et al. 2019; Scott et al. 2019; Scott 2021; Tuladhar et al. 2021; Leal Filho 2022; Steiger et al. 2022). The escalating climate projections and the consequent reduction in snow cover pose a growing predicament for the winter tourism sector, as elucidated by the research conducted in the Kashmir Valley, an internationally renowned destination for skiing tourism located in the Indian Himalayan state of Jammu and Kashmir (Dar et al. 2014). The findings substantiate the presence of significant upward temperature trends and a declining pattern in winter snow cover, thereby raising significant concerns regarding the long-term viability and sustainability of winter tourism in the region. Another comprehensive investigation carried out by Tuladhar et al. (2021) in the Langtang Valley of Nepal critically analyzed the transformative process of the social-ecological system, shaped by the intricate interplay between evolving cryospheric conditions and socio-economic dynamics. The empirical evidence uncovered an escalation in the vulnerabilities confronting farming and livestock breeding due to perceived alterations in the cryosphere by the local communities. Consequently, these communities have undertaken adaptive measures that have led to the convergence of livelihood sources, with tourism emerging as the paramount economic driver, attributed to its perceived advantages of enhanced profitability, reduced labor intensity, lower perceived risk, and increased financial gain.

In contrast, the rise in temperatures may present possibilities of shift in tourist preferences and extending the tourist summer season in the worldwide mountainous regions, enabling an elongated period for outdoor activities (Leal Filho 2022). This phenomenon is often regarded as a favorable outcome of shifting climatic conditions, offering a potential avenue to adapt. However, it is crucial to acknowledge that the upsurge in summer tourism may carry adverse implications, including the potential overload of carrying capacity in destinations, thereby exerting additional pressures on fragile landscapes. Therefore, comprehensive research that spans the whole spectrum of the touristic ecosystem is vital to identify the genuine aspects that could be characterized as ‘climate opportunities’ (Steiger et al. 2022).

Additionally, in the face of persisting changing conditions, inadequate management of tourism operations may amplify the degradation of ecosystems by virtue of uncontrolled solid waste deposition, heightened exploitation of local resources, and disturbance to soil and vegetation (Tiwari and Joshi 2015; Wang et al. 2019; Singh et al. 2021). Likewise, the anticipated escalation in vulnerability of mountainous regions to a range of climate-induced natural disasters, such as avalanches, glacial lake outburst floods (GLOFs), landslides, flash floods, and debris flows, not only poses significant risks to human lives but also threatens the integrity of essential and heavily invested tourism infrastructure (Nyaupane and Chhetri 2009). In addition to political instability and pandemic risks, which have emerged as significant factors affecting the tourism industry in recent times (Mulder 2020; Wang et al. 2022), it contradicts with the emerging notion that rural mountain tourism has been positively influenced by the pandemic, as tourists now prioritize safe destinations with low population density (Seraphin and Dosquet 2020) as well as niche-based tourism, which is still growing (Gajić et al. 2023).

Ultimately, taking note of the inherent vulnerability of the tourism sector to climate-induced influences (Scott et al. 2019; Scott 2021) as well as non-climatic factors as discussed above, it is crucial to establish robust governance frameworks and allocate considerable financial resources in order to facilitate its harmonization with the overarching objective of achieving sustainable development (Salgueiro et al. 2020; Becken and Loehr 2022). Quite evidently, mounting complexities pertaining to climate adaptation and mitigation demands a heightened level of participation from the tourism sector and relevant stakeholders to enable the streamlined integration of policies (Scott 2021), while also embracing the adoption of effective models of tourism governance (Block et al. 2019; Becken and Loehr 2022). Consequently, an escalating imperative arises to develop and fortify adaptation strategies and policies that comprehensively integrate emerging opportunities and externalities into their purview (Jamaliah and Powell 2018). In essence, an essential aspect to acknowledge for the countries in the HKH region lies in the imperative recognition of the transboundary implications of climate change. This is because while the comprehensive Nationally Determined Contributions (NDCs) of these countries effectively encompass adaptation strategies for diverse sectors, a noticeable void exists in addressing the distinctive exigencies of the tourism sector, including its sub-sectors (Alfthan et al. 2018). Hence, it is crucial for these countries to demonstrate a heightened level of commitment in order to effectively address the needs and challenges that arise in the context of the sustainable livelihood security in the tourism industry.

2. State of the art

2.1. Himalayan transhumant pastoralism under change and implications for Uttarakhand

The practice of pastoralism has historically played a crucial role in maintaining the social and ecological equilibrium in various regions across the globe extending well beyond its mere economic significance (Niamir-Fuller and Huber-Sannwald 2020; Manzano et al. 2021). Nevertheless, the profound transformations experienced by this traditional livelihood system in recent decades can be attributed to the intersecting influences of globalization and climate change (Thorpe and Figge 2018; Niamir-Fuller and Huber-Sannwald 2020; Postigo 2021) as reported worldwide, including in HKH countries[5] of India, Bhuta, Nepal, China, and Pakistan.

In the Himalayan context, pastoralism encompasses various forms, including nomadic, transhumant, and agro-pastoral practices (Bhasin 2011). Nomadic pastoralists display remarkable adaptability through their constant movement, continually utilizing foraging areas and water sources while adapting their pathways and destinations in response to changing natural resource availability. Transhumant pastoralists migrate along established routes on a seasonal basis, meticulously scheduling their moves to maximize access to ample feed across varied altitudinal and microclimatic gradients. Agro-pastoralists, on the other hand, use a hybrid livelihood approach, combining livestock keeping with sedentary agricultural activities, successfully combining crop cultivation and animal husbandry to ensure the viability of their subsistence strategies. The pastoralists rely significantly on their intimate understanding of local ecosystems and their capacity to adjust to the uncertainties posed by climatic variability and ecological dynamics for subsistence.

Several pastoral communities in the Indian Himalayan Region (IHR), including the *Anwals*, *Bakarwals*, *Kanets, Kaulis, Bhotias*, *Gujjars*, *Sherpas, Changpas*, *Monpas*, *Lepcha, Bhuttia*, *Buderas*, *Dokpas, Barpatiya, Pangwals*, *Kinnauras*, and *Gaddis* engage in this traditional practice, which involves the seasonal migration of livestock to alpine grasslands at high elevations during the summer months and descend to lower-lying regions during the winter season. These communities have evolved practices of sustainable resource utilization and confronting the inherent risks to their livelihoods

[5] India (Negi 2007; Singh et al. 2013; Ogra and Badola 2015; Rautela and Karki 2015; Pandey et al. 2017a; 2017b; Negi et al. 2017; Feroze et al. 2019; Ramprasad et al. 2020; Singh et al. 2020a; Sharma et al. 2020; 2022; Joshi and Rawat 2021; Ingty 2021; Srichandan et al. 2021; Negi et al. 2021a; 2021b; Rawat and Schickhoff 2022; Luxom et al. 2022; Malhotra et al. 2022), Bhutan (Wangchuk and Wangdi 2018; Namgay et al. 2014; 2021; Dorji et al. 2022), Nepal (Aryal et al. 2016; 2018; Gentle and Thwaites 2016; Sujakhu et al. 2016; Tiwari et al. 2020; Rayamajhi and Manandhar 2020; Tuladhar et al. 2021; Pasakhala et al. 2021; 2023), China (Dong et al. 2016), and Pakistan (Joshi et al. 2013; Ahmad et al. 2021).

while capitalizing on the spatial and temporal heterogeneity of the environment (Bhasin 2011). However, in the present-day context, pastoralist way of subsistence is being confronted with numerous challenges as discussed further in the following sections.

2.1.1. Socio-economic, political, institutional, and ecological factors

In Himalayan regions, the forces of globalization have had significant ramifications for transhumant pastoralism, resulting in transformations across economic, social, and cultural dimensions within pastoral communities. Historically, economic globalization has facilitated the integration of pastoral systems into global markets wherein the growing demand for livestock products driven by market forces has led to increased commercialization and specialization, posing challenges to the traditional self-sufficiency and diverse livestock portfolios of pastoralists (Thornton 2010). Consequently, this shift towards market integration and the pursuit of economic betterment has generated new avenues for economic growth within mountain communities (Bhatta et al. 2019; Wang et al. 2019; Pasakhala et al. 2021) wherefore, pastoral communities began relinquishing their traditional livelihood practices in favor of profit-oriented strategies, as exemplified by the agriculture expansion through horticulture and the cultivation of high-value cash crops (Singh et al. 2020a; Sharma et al. 2022).

This transformation has been accompanied by land conversion for plantations (Ramprasad et al. 2020), imposition of state-led policies (Singh et al. 2021) and the development of infrastructure (Wang et al. 2019; Pasakhala et al. 2021), resulting in large-scale alterations in land use, conversely, surfacing diverse avenues for livelihood diversification in the Himalayan regions. For instance, a study conducted by Ramprasad et al. (2020) among the Gaddi pastoralists in Himachal Pradesh in western Indian IHR revealed that the establishment of plantations has heightened the susceptibility of pastoralists by diminishing the accessibility of fodder, fostering the proliferation of invasive species, disturbing traditional migratory paths, and modifying land access arrangements.

In another study, Luxom et al. (2022) reported on the impact of road expansion and communication network development in the border regions of Sikkim in western Indian Himalayan Region (IHR) following the 1962 Sino-Indian war. The closure of the India-China border disrupted trade relationships, and the rapid construction of roads for military purposes resulted in the fragmentation of grazing areas and restricted the movement of the Dokpa community within their traditional grazing territories. These socio-economic changes, coupled with enhanced connectivity to the wider society, urban migration, shifting aspirations of the younger generation, government initiatives promoting education, and the emergence of alternative livelihood options, gradually contributed to the decline of traditional pastoralism. Similar patterns of socio-economic transformation resulting from trans-border conflicts have been reported from other

pastoral economies situated in the Himalayan border regions such as among Rupshu pastoralists in trans-Himalayan region of Ladakh (Singh et al. 2013), Lachen valley in Sikkim (Ingty 2021) and border regions of Uttarakhand (Negi 2007; Bergmann et al. 2008; 2012; Gerwin and Bergmann 2012; Pandey et al. 2017a; 2017b; Bisht et al. 2018; Srichandan et al. 2021; Joshi and Rawat 2021; Rawat and Schickhoff 2022).

In Uttarakhand, the traditional practice of pastoralism underwent a profound shift, primarily influenced by the implementation of the Zamindari Abolition and Land Reform Act of 1960[6]. This act was introduced with the objective of eradicating the exploitation of tenant cultivators by landlords and granting ownership rights to the tenants. Consequently, pastoral communities residing in the Bhotia belt of Uttarakhand encountered various challenges during this period, including the significant loss of agricultural lands in their winter settlements, limited access to pastures, and the displacement of settlements in the summer encampments. Pastoralists who held land rights in summer settlements transitioned towards a sedentary lifestyle in regions where the climate permitted habitation. However, the expansion of new frontiers and changes in the region led to a significant decline in seasonal migration in many pastoralists' valleys.

It is also important to note that, particularly in Uttarakhand, the decline of pastoralism is also attributed with the intrusion of contemporary institutions and political instabilities that caused as a result of trans-border conflicts. Pandey et al. (2017a) investigated the waning of pastoralism in the Kailash Sacred Landscape (KSL), encompassing regions in India, Nepal, and China, including parts of KSL in Uttarakhand. The research emphasized the impact of hybrid governance structures, involving *Van Panchayats*[7] and state institutions, which have resulted in restricted access to traditional rangelands, requiring the payment of nominal fees for herd grazing. As a result, communities in the KSL have altered their livelihood strategies in a variety of ways and endured outmigration (Srichandan et al. 2021; Joshi and Rawat 2021). The research also noted the prominence of geopolitical shifts, notably the Indo-China war of 1962, which had a substantial impact on trans-border pastoral trade links, gradually raising serious questions about the viability of migratory pastoral practices in the *Bhotia Shaukas*-inhabited valleys of KSL region in Pithoragarh (Uttarakhand). Pastoralists in the Johar valley experienced similar decline in livestock rearing, as well as related occupations such as wool crafting and freight shepherding (Negi 2007; Bisht et al. 2018). The heightened concerns that arose from the outbreak of war prompted significant interventions by the Indian government, including an extensive road-building network for defense purposes and the development of hill areas that had

[6] The act aimed to transfer agricultural land from *Zamindars*, who were large landowners, to the actual cultivators or tillers of the land, thereby ensuring land rights and security for rural farming communities.
[7] *Van Panchayats* are community-based forest management institutions in India. They empower local communities to participate in decision-making processes regarding forest management, ensuring their rights and interests are upheld.

previously been overlooked by mainstream developmental agendas. These interventions were deemed crucial in addressing the evolving strategic and developmental needs during that time wherein other public infrastructure such as schools and hospitals drastically began to be developed in Bhotia valleys of Gori and Darma in Uttarakhand (Gerwin and Bergmann 2012).

Furthermore, from an ecological vantage point, the geographic expansion of protected areas and national parks in alpine regions proffers a propitious juncture for ecological restitution and augmented conservation of biodiversity (Schickhoff et al. 2022). However, in Uttarakhand, earliest researches by Nautiyal (2003) and Nautiyal and Kaechele (2007) documented the implementation of governmental mandates targeting the establishment of such conservation enclaves that unintentionally yielded a land utilization framework incongruous with customary practices of transhumant pastoralism, for instance, as witnessed among the Bhotia tribal community in the designated UNESCO world heritage site of Nanda Devi Biosphere Reserve (NDBR) in the Chamoli district of the state. In recognition of the inherent uniqueness of the region in 1988 (Ogra and Badola 2015), the conservation ban engendered the peripheral displacement of communities and the imposition of stringent grazing restrictions, which have adversely affected the fiscal dividends derived from livestock rearing. Additionally, the encasement of communities within the buffer zone of the NDBR, coupled with inadequate conservation stewardship and the marginal acknowledgment of socio-ecological efficacy, exasperated the strain on limited resource availability and ultimately precipitated alterations in the village commons and in the overall pastoral praxis.

2.1.2. Climatic factors

While it is of paramount importance to acknowledge the multifaceted metamorphosis encountered by pastoral economies arising from the convergence of diverse socio-economic, political, institutional, and ecological catalysts of transformations. It is equally imperative to concede the indelible impact of climatic determinants that have magnified and propelled these profound transformations. Uttarakhand is currently facing threats posed by changing climate, including erratic patterns in precipitation and temperature (Mishra 2017; Krishnan et al. 2019b) as well as glacier flow and recession (Nainwal et al. 2016; Mal et al. 2019; Kuniyal et al. 2021) which are causing complex impacts on mountain livelihoods and related societal dynamics (Sati 2015; Upadhyay et al. 2021; NITI Aayog 2018a). The anticipated increase in extreme climate changes within the region, exacerbated by the ongoing patterns of climate change, is expected to have profound implications for the already vulnerable state of transhumant pastoralism, thus, disturbing the intricate equilibrium between ecosystems and local traditions.

The dynamic shifts in global climate patterns exert an adverse impact on transhumant pastoralism worldwide, manifesting in the form of resource scarcity and depletion, as substantiated by the extensive research (Ayanda et al. 2013; Joshi et al. 2013; Zomer et al. 2014; Wu et al. 2014; 2015; Aryal et al. 2016; Gentle and Thwaites 2016; Herrero et al. 2016; Negi et al. 2017; Negi et al. 2021b; Tiwari et al. 2020). This occurrence can be ascribed to the inherent correlation between the seasonal movement of livestock and the intricate interdependencies among biophysical factors such as rainfall timing, snow cover, water availability, and nutritive grass production, which are all highly sensitive to the influences of climate change (Aryal et al. 2016; Zomer et al. 2014; IPCC 2022). Owing to even slightest of alterations in temperature and precipitation patterns, amplified evaporation rates, and diminished snow coverage, there is an adverse impact on pasture productivity, that may culminate in reduced biomass generation (Tiwari et al. 2020). Consequently, escalated competition for available pastoral resources may often ensue, thereby exacerbating environmental degradation (Uddin and Kebreab 2020). Analogously, the decline in rainfall and heightened occurrence of prolonged dry periods impose significant strain on the availability and sustainability of pastoral resources (Habte et al. 2022). However, amidst these changes, certain possibilities may manifest, such as the prospect of an elongated grazing season due to early snowmelt, thereby allowing livestock to have access to pastures for a longer duration (Ning et al. 2013). Henceforth, the substantial dependency of marginalized communities on grazing territories has yielded far-reaching ramifications on various dimensions of their lives, including livestock management, pastoral productivity, and the broader socio-economic development (Joshi et al. 2013).

In response to these challenges, pastoral groups resort to adaptive measures, involving alterations in herd mobility and migration patterns (Opiyo et al. 2015a; 2015b), as well as the reduction in livestock populations (Habte et al. 2022). The evidence indicates that changing climate is anticipated to contribute to the escalation of livestock diseases as well as augment the proliferation of non-native invasive weeds intensifying competition with indigenous and nutrient-rich pasture grasses for livestock consumption, ultimately impeding livestock productivity (Bett et al. 2017; Kongnso et al. 2021). Under such circumstances, the absence of prior conditioning may precipitate catastrophic losses in cattle feedlots, resulting in substantial economic repercussions from cattle fatalities and reduced performance (Kimaro et al. 2018; Habte et al. 2022).

In the state of Uttarakhand, the sustenance, and the assurance of food security of the region are inextricably linked to sectors that are highly susceptible to climate variations, namely agriculture, livestock, and forestry, which exhibit intricate interdependencies (Negi et al. 2017). In their research conducted in the Nanda Devi Biosphere Reserve in Uttarakhand, Ogra and Badola (2015) advanced the proposition that increasing temperatures, irregular precipitation patterns, and changes in snowmelt dynamics not only present overarching challenges to the sustainability of agrarian and pastoral livelihoods but also undermine the specific livelihood assets of the vulnerable

communities, particularly women. It is readily apparent that women consistently bear a disproportionate burden of the consequential impacts arising from both socio-economic shifts and the augmented stresses of climate change, as evidenced by an additional study undertaken within the Upper Kosi catchment situated in the lesser Himalayan ranges of the region (Tiwari and Joshi 2016). Considerable scholarly inquiry has been dedicated to the examination of gendered implications resulting from underlying socio-economic dynamics and climate change-induced events in various regions of the IHR as evidenced by extensive research (Rautela and Karki 2015; Singh et al. 2017; Bhadwal et al. 2019; Datey et al. 2023).

In a perception-based study conducted by Negi et al (2017), compelling evidence emerged regarding the rising temperatures and depleting water resources utilized by livestock in alpine pastures, forests, and grazing areas in the high-altitude valleys of Niti and Mana in Chamoli district, as well as in the Chaudans, Drama, and Byans valleys in Pithoragarh in Uttarakhand. Likewise, Rautela and Karki (2015) unveiled similar trends from Byans and Niti, and Bhagirathi valleys, in addition to, increased incidences of livestock diseases and decline in agricultural productivity. In light of the prevailing deleterious ramifications encompassing ecological, financial, and social dimensions on the livelihoods of these communities, the imposition of climate-induced modifications has further necessitated a reduction in livestock populations. In both studies, the authors further underscored the intrinsic value of people's perceptions and comprehension of changing climate that often get overlooked, as a valuable resource for effectively planning of regulatory frameworks and the implementation of contemporary mitigation and adaptation strategies (Rautela and Karki 2015; Negi et al. 2017; Negi et al. 2021b). Along the same lines, the intricate interdependence between transhumance practices and other livestock-based livelihood systems within the KSL region in the Pithoragarh district of Uttarakhand highlights their pronounced vulnerability to the impacts of climate change, thereby engendering significant implications for both food security and livelihoods (Zomer et al. 2014).

In such circumstances, while transhumant pastoralism exhibits adaptability to fluctuations in the environment over both short and long timeframes (Dong et al. 2016), alterations caused by climatic factors frequently require adaptations in livestock management approaches and land utilization patterns that may result in conflicts over available resources (Joshi et al. 2013; Wu et al. 2015; Sujakhu et al. 2016; Ndiritu 2021) as well as livelihood adaptation to other forms of non-agrarian income sources (Rautela and Karki 2015; Negi et al. 2017; Wu et al. 2014; Berhanu and Beyene 2015; Ogra and Badola 2015; Pandey et al. 2017a; 2017b; Mayanja et al. 2019; Ndiritu et al. 2021; Kongnso et al. 2021; Mwasha and Robinson 2021). However, there still persists considerable uncertainties in regions characterized by heightened vulnerability to climate or environmental variability, compounded by limited socio-economic and institutional capacities to undertake effective adaptation measures (Bhatta et al. 2019; Niamir-Fuller and Huber-Sannwald 2020; Adler et al. 2022).

2.1.3. Transitioning to tourism-based livelihoods

In the context of IHR region, the rural livelihoods have persistently grappled with a multitude of unassailable forces. On one hand, the influence of globalization, economic changes, and evolving societal structures introduces novel dynamics that impact the future sustainability of these traditional livelihoods. Conversely, climate-induced ramifications, encompassing changes in precipitation patterns, fluctuating temperatures, and an upsurge in the occurrence of extreme weather events, present formidable obstacles to maintaining the delicate pastoral pursuits. Within the expanding body of literature examining the influence of these formidable forces and the evolving economic landscape, there has been a discernible focus among researchers and policymakers in developing nations on the significance of diversifying rural livelihoods as a means to adapt, reduce vulnerability, and alleviate poverty.

More so, as literature suggests there exists a critical imperative to situate sustainable tourism components, such as ecotourism development, within the framework of livelihood diversification, more akin to an adaptive strategy amidst this continually shifting outlook. Within this purview, it is noteworthy that while the tourism sector's innate reliance on natural resource availability makes it vulnerable to the changing climatic conditions, it also enables expansive opportunities for adaptation (Scott et al. 2019; Scott 2021; Steiger et al. 2022). This is supported by a body of empirical research that highlights its effectiveness as an adaptation strategy in household livelihood diversification for climate mitigation and adaptation, particularly in the vulnerable communities across developing countries, for instance in Bhutan (Dendup et al. 2022), Kenya (Ogara et al. 2013), Vietnam (Hoang and Pulliat 2019), India (Ogra and Badola 2015), Jordan (Jamaliah and Powell 2018), and protected areas in Ghana (Agyeman 2019). Additionally, site-specific studies concerning other forms of sustainable tourism practices in rural settings have demonstrated their potential as adaptive responses to the combined pressures of climate change, urbanization, and globalization (Little and Blau 2018; Trang and Loc 2022). However, there a dearth of comprehensive documentation and systematic inquiry into sustainable livelihoods, adaptation, and ecotourism nexus in Uttarakhand, including other IHR counterparts.

Furthermore, contrary to the lesser emphasis accorded to the western regions in IHR, the northeastern regions have garnered greater scrutiny in terms of affirmative research themes centered on participatory appraisal, ecotourism development and livelihood creation (Chakraborty and Ghosal 2022). Ecotourism research in eastern IHR encompasses a diverse range of investigations, including exploration of eco-cultural (Cajee 2014) and biotourism (Gogoi 2016) as a sub-set of ecotourism, community perceptions of market-based conservation models in ecotourism (Das and Hussain 2016), wildlife conservation through homestay-based approaches (Lama et al. 2010), assessment of sustainability in ecotourism (Ashok et al. 2019), business models underlying ecotourism experience (Sarkar and Sinha 2015), ecotourism in protected

areas (Singh et al. 2021), the correlation between ecotourism sustainability and tourist satisfaction (Basak et al. 2021) and consequent environmental degradation associated with ecotourism development (Datta and Banerji 2015).

On the other hand, in western IHR, particularly in Uttarakhand, the focus of ecotourism research has predominantly revolved around the homestay contribution to ecotourism development (Bhalla et al. 2016), women-centered homestay-based ecotourism livelihood adaptation (Ogra and Badola 2015), ecotourism contribution to household income security (Balodi et al. 2014), conflict resolution between people and protected areas through ecotourism development (Maikhuri et al. 2000; Singh and Singh 2004; Kala and Maikhuri 2011), conservation-oriented ecotourism models (Singh and Sondhi 2016), identification of visitation patterns through ecotourism spatio-temporal models (Bhalla et al. 2022), recognition of potential ecotourism sites using geospatial techniques (Chaudhary et al. 2022), adverse impacts of ecotourism development (Rastogi et al. 2015) and participatory management needs for ecotourism growth (Chaturvedi 2002; Mahapatra et al. 2012). In addition, in analogous western regions, scholarly investigations have amassed concerning the active involvement of communities in ecotourism endeavors pertaining to wildlife preservation (Vannelli et al. 2019), the formulation and prioritization of strategies aimed at advancing sustainable ecotourism development (Sahani 2021), and the endorsement of environmentally conscious ecotourism practices through the establishment of homestays (Anand et al. 2012).

In fact, Bhalla et al. (2016) in their study elucidated local communities' inclination to favoring livelihood diversification through participation in ecotourism-based homestays, which manifests in favorable ecotourism-related behaviors that incorporate an acute sense of ownership and active participation in conservation efforts. The study undertaken by Kala and Maikhuri (2011) within the Nanda Devi Biosphere Reserve (NDBR) espoused the notion that ecotourism yields a favorable impact through the proactive involvement and assimilation of the local community, facilitating their active participation in matters of local ownership and resource governance, thereby resulting in people-park conflict mitigation. In view of Sati (2023), the state harbors abundant untapped potential for the advancement of ecotourism, particularly within its extensive network of national parks, wildlife sanctuaries, and conservation reserves, and biosphere reserves. Consequently, the tourism sector, including recent developments in ecotourism sector, stands as a prominent economic prospect in Uttarakhand (Kotru et al. 2017; Uttarakhand Tourism Policy 2018; RDMC 2018; NITI Aayog 2018a; Sati 2020; Sati 2021). Nonetheless, despite this substantial expansion and amid the ongoing socio-economic transformation and climate change impacts on mountain livelihoods, there is a paucity of comprehensive understanding regarding the extent to which ecotourism can serve as a viable strategy for livelihood adaptation in Uttarakhand (Ogra and Badola 2015).

Hence, in light of the deficiencies in comprehensive scholarly inquiry concerning the intricate relationship between sustainable livelihoods, adaptation, and ecotourism in Uttarakhand, the primary objective of this study was to examine the magnitude of climate change, ascertain the local community's perception of the ensuing socio-economic dynamics, and assess their inclination towards pursuing alternative livelihood options in the culturally distinct and resource-abundant high-Himalayan region of Darma valley in Pithoragarh district in Uttarakhand. This is due to the ultimate recognition that mitigating the multidimensional challenges brought about by inexorable stressors of globalization and climate change on rural mountain livelihoods necessitates a comprehensive and nuanced approach that acknowledges the synergistic interdependencies between anthropogenic activities, environmental processes, underlying socio-economic dynamics, and the imperative for adaptive strategies to nurture, complement, and safeguard the unique traditions of the local communities.

3. Conceptual background

3.1. Adaptation to climate change through sustainable livelihood approach

Climate change is putting mountain ecosystems and livelihoods under additional stress due to the combined consequences of poverty, reliance on degraded natural resources, and high susceptibility to natural hazards (IPCC 2022). The Paris Agreement highly states adaptation to climate change as one of the highly prioritized negotiating agendas, however, adaptation initiatives currently underway are insufficient to address future hazards (IPCC 2022). Hence, in order to maintain livelihood systems, adaptation necessitates the application of the efficient and holistic approach that encompasses both socio-economic alterations and climate-induced threats (Ogra and Badola 2015; Opiyo et al. 2015; Negi et al. 2017; Agyeman 2019). As a result, understanding affected communities' perceptions of climate change and the elements that drive their adaptive behavior is critical before formulating adaptation strategies (Opiyo et al. 2015; Negi et al. 2017; Das 2022). In addition, acknowledging local communities' capacity to adjust to continually changing living conditions is crucial for a complete assessment of their susceptibility and the creation of locally relevant adaptation measures (McDowell et al. 2020) and ensuring sustainable livelihoods especially in marginal systems (Pandey et al. 2017b).

In order for a livelihood to be sustainable, “it must have the capability and assets to withstand stress and shocks, maintain or enhance its capabilities, and provide sustainable livelihood opportunities for the next generation” (Chambers and Conway 1992, p. 6). As a concept, sustainable livelihoods thinking began receiving recognition in late 1980s within the field of rural developmental studies. It was given stronger widespread attention with the development of concept of the Sustainable Livelihoods Approach (SLA) proposed by Chambers and Conway (1992). Chambers and Conway (1992) instigated a discourse within the realm of rural development by introducing and stimulating discussions on the concept, which is normatively grounded upon the notions of capability, equity, and sustainability. At its core, SLA elucidates underlying mechanisms and rationales that drive individuals' decision-making processes in the context of livelihoods, as well as their adaptive responses to changes as they emerge (Scoones 1998). Based on this, the British Department for International Development (DFID) developed the Sustainable Livelihoods Framework (SLF) in 1999 (Fig. 1).

For the pursuit of positive livelihood outcomes, SLF is built on five assets (or capitals), namely, natural (natural resource availability for livelihoods), human (skills, knowledge, and health), social (cooperation networks, collective representation, norms, trustworthy relationships), physical (infrastructure, tools, and technology) and financial (regular inflows of money and access to financial services). These assets are interconnected and complement one another, but they are mediated by transforming

structures and processes such as by institutions, social relations, and policies, as well as trends, shocks, and seasonality (vulnerability context). The vulnerability context determines trends (population growth, economic trends, resource stocks, technological trends, governance), shocks (epidemics, disaster, conflicts) and seasonality (prices, production cycle, employment) as components that can directly affect the livelihoods, both negatively and positively. Under such circumstances, opportunities to pursue a variety of livelihood strategies could be undertaken by the people that ultimately determine the livelihood outcomes (refer to Table 1 for components of SLF). Overall, the SLF provides an opportunity to systematically facilitate rural development by reinforcing a people-centered approach (DFID 1999).

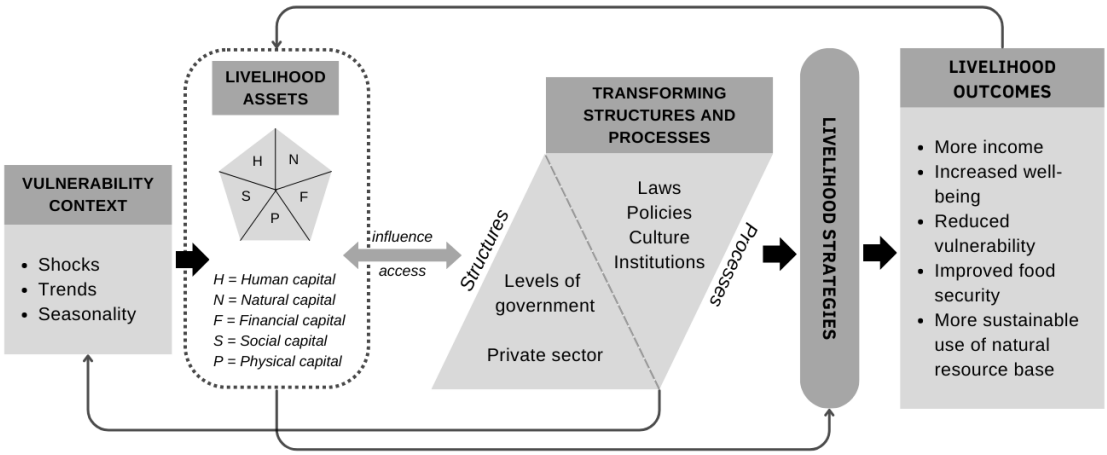


Figure 1 Sustainable Livelihood Framework (DFID 1999)

Table 1 Components of Sustainable Livelihood Framework (DFID 1999)

Component		**Description**
Vulnerability context	Insecurity in the well-being of individuals, households, and communities caused by changes in their external environment	• Shocks (conflict, illnesses, disasters, diseases) • Seasonality (prices, production cycle, employment opportunities) • Trends (demographic, environmental, economic, governance, and technological)
Livelihood assets or assets	Resources individuals, households, communities possess or have access to in order to pursue livelihoods	• Human (health, nutrition, education, knowledge and skills, capacity to work, capacity to adapt) • Social (networks, relations of trust, formal and informal groups, shared values and behaviors, collective representation, mechanisms for

		participation in decision-making, leadership) • Natural (natural resource stock, environmental goods, and services) • Physical (infrastructure, tools, and technology) • Financial (savings, formal and informal credit and debt, remittances, pensions, wages)
Transforming structures and Processes	Influential institutions, organizations, policies, and legislation that shape livelihoods	• Structure (government, development, research, NGOs and private institutions, Public-Private Partnerships) • Processes (government policies, schemes, rules, and regulations)
Livelihood strategies	Range and combination of activities individuals, households, communities undertake to achieve their livelihood goals	• Household activities • Livelihood diversification • On-farm and off-farm activities • Outmigration • Collective resource management • Community-owned enterprises
Livelihood outcomes	Desired achievements of livelihood activities	• Increased economic opportunities and income • Increased wellbeing (health status, access to services, sense of inclusion, improved education, and awareness levels) • Reduced vulnerability and improved resilience • Improved food security • Sustainable use of natural resource base

According to DFID (1999), SLA strives to reduce vulnerability, abate poverty, and enhance the adaptive capacity of at-risk groups by allowing for a more precise understanding and identification of conditions to withstand socio-economic and environmental pressures. According to Scoones (1998, p.3), the fundamental question when assessing sustainable livelihoods is determining the mix of livelihood resources or capitals that allow the adoption of certain livelihood strategies, as well as the ensuing outcomes in a given scenario. The framework also emphasizes the importance of institutional structures and processes in enabling or impeding strategy execution and achievement of targeted outcomes. In light of these concerns, wielding SLA, especially in the context of rural areas in low and middle-income countries (Scoones 1998; 2009; Tao and Wall 2009a) could ensure a bottom-up, people-centered adaptation approach

that addresses future climate change by lowering existing risks and vulnerabilities (Clay 2018). In their scholarly Clay (2018) presented a novel reflection on the conceptual and methodological intersections between livelihood and adaptation discourse. The author emphasized the innate potential inherent in SLA to reveal the underlying complexities involved in assessing adaptive capacity in changing human-environment systems. This includes probing into intra-household decision making, socially constructed gender norms within environmental governance and convoluted power relations which frequently evade comprehensive comprehension when employing traditional approaches.

Along the same lines, Mabon et al. (2021) emphasize explicit links between sustainable livelihoods and adaptation to climate change as a people-centered approach that resonates most with disadvantaged and vulnerable groups' experiences, capabilities, and traditional knowledge converging together for sustainable livelihood transformations. In another study, Žurovec and Vedeld (2019) assessed SLA to determine and analyze its relevance for improving the resilience of rural livelihoods to sustain shifting internal dynamics and broader external factors, such as institutional, environmental, economic, and political influences amongst others.

Quite intrinsically, the perspective of livelihood in tourism literature is centered upon people, encompassing the internal knowledge and capacities of the local community, which define their coping mechanisms and adaptation methods (Scoones 1998; Tao and Wall 2009b). Alternatively, with regard to the expanding literature on livelihoods and climate adaptation emphasizes the importance of understanding the key drivers of livelihood decision-making in order to effectively manage climate risks and promote development, especially in poor and vulnerable populations (Pandey et al. 2017b; Clay 2018; Agyeman 2019; Hoang and Pulliat 2019; Mabon et al. 2021). For instance, according to Pandey et al. (2017b), SLF serves as a practical tool to identify actionable priorities and develop a comprehensive, integrated model for enhancing the resilience of rural mountainous households. Similarly, Mabon et al. (2021) identified connections between sustainable livelihood practices and climate change adaptation that are rooted in the embodied experiences and knowledge systems of local communities. Overall, the critical linkages between the SLF and adaptation underscore the need for a people-centered, participatory, and integrated approach to addressing the complex and multifaceted challenges of globalization and climate change.

Hence, drawing inspiration from the theoretical framework, the current study employs this approach to accord primacy to the local community as the central locus of analysis. It is of considerable significance to acknowledge that although the initial objective of the SLF pertain to the evaluation of livelihood capitals at the individual household level, its utility may transcend to encompass the appraisal of livelihoods at the wider communal level as well (Gutierrez-Montes et al. 2009). By doing so, we investigate the potential connections between ecotourism-based livelihood adaptation and

empowerment of the local communities in the context of evolving circumstances attributed to the forces of globalization and climate-related risks. This utilization of the framework has been employed as an analytical tool to critically evaluate the transformative effects of ecotourism development on the livelihoods of local communities, as demonstrated by studies conducted by Kunjuraman (2022) in Malaysia, Ogra and Badola (2015) in India, and Addinsall et al. (2015) in Pacific Islands. These studies exemplify the utilization of the SLF at the community level through the consideration of broader contextual factors, interdependencies, and communal endeavors whilst paying attention to encompass the collective assets, capabilities, and vulnerabilities of the community. In addition, this approach stems from our aim to ensure comprehensive consideration of the diverse needs, aspirations, and knowledge of the stakeholders when exploring the feasibility of ecotourism as an alternative livelihood activity, alongside conventional economic pursuits in the region (Tao and Wall 2009b). The present study further acknowledges the inherent advantages associated with livelihood diversification to ecotourism, provided that it facilitates in additional income generation and is effectively engaged with and overseen by the community.

In consonance, the study concurs with the notion that as an analytical approach, SLF facilitates a systematic assessment of multifaceted impacts and dynamics entailed in an ecotourism-based livelihood adaptation. By undertaking such an approach, it offers significant and discerning perspectives essential for enhancing livelihood resilience, well-being, policy formulation, and development planning within the study region. In light of this, the current study intends to make a valuable contribution to the existing body of scholarly research by emphasizing the necessity for further investigations employing the SLF to gather extensive and people-centric perspectives for thorough assessment of the potential of ecotourism as a viable and effective strategy for livelihood adaptation, specifically within the dearth of research on this subject matter in IHR state of Uttarakhand.

3.2. Contribution of ecotourism to sustainable livelihoods and climate adaptation

‘Our common future’ report by Brundtland Commission popularized the concept of sustainable development with its widely accepted definition, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, p. 43). The need for sustainable development in niche tourism segments (WTO-UNDP 2017) has received widespread acclamation for the fact that the sector is plagued with many paradoxes (Milano and Koens 2022). The recent global sustainable paradigm shift attributed to the UN SDGs suggests that, if well managed, the tourism industry has a great potential to accelerate progress, namely in terms of job creation, poverty reduction, and environmental conservation (UNWTO

2017), with critical investments in sustainable tourism development (OECD 2020) as well as fostering adaptation efforts (IPCC 2022).

Sustainable Tourism arose as a potential future blueprint for tourism in response to increased environmental awareness and mass tourism (Gössling and Scott 2012). As a subset of sustainable tourism, ecotourism emerged as a panacea concept of sustainable alternative tourism to mass tourism in the 1990s (Roblek et al. 2021), widely acknowledged in the formulation of policies wherein adding social values to preservation and development (Wearing and Wearing 1999; Wardle et al. 2021). In this sense, as reported by Eriksson and Lidström (2013), ecotourism is concerned with acknowledging sustainable tourism products and services that cater to economic, social, and environmental aspects of a society, if the trade-offs are managed properly. It aims to achieve a balanced link between environmental (biodiversity conservation and sustainable use of natural resources), social (preservation of traditional culture, customs, and lifestyle), and economic development (creation of employment, livelihood diversification, and financial security) in the same way as sustainable development does (KC et al. 2015; Chand et al. 2015; Açıksöz et al. 2016).

Honey (1999) viewed ecotourism as 'sustainable tourism', a people-centric approach capable of preserving resources, developing tourism, and alleviating poverty. Burneika and Kriaučiūnas (2007) and Lonn et al. (2018) accentuate ecotourism as a branch of tourism that promotes sustainable development and has a high potential for long-term livelihood security. The sector is associated with offering new opportunities economic development as well as environmental conservation (Roblek et al. 2021). In light of that, the concept of ecotourism is consistent with the sustainable livelihoods approach as long as it is organized as community-based or other forms of locally embedded tourism practices (Shi et al. 2022), quite often presenting benefits beyond just income generation (Tao and Wall 2009b). More recently, it is seen as an adaptation strategy to mitigate the adverse impacts of changing climatic conditions in regions bestowed with abundance of natural and cultural resources (Jamaliah and Powell 2018; Agyeman 2019). Much so, as one of the components of sustainable tourism, it is posited in the United Nation's Sustainable Development Goals (SDGs) (WTO-UNDP 2017). Although, advanced research in the assessment of role of sustainable development in facilitating sustainable tourism (Eriksson and Lidström 2013) as well as ensuring sustainable livelihood (Tao and Wall 2009a) is yet to gain momentum (Stephens 2021).

However, the results of this concept's execution over the last few decades paint a discordant picture and raise questions about its efficacy (Ashley et al. 2001; Hall 2007) as seen across different geographies influenced by diverse social, cultural, economic, and political factors (Zielinski et al. 2020). Research on the interaction between ecotourism and rural livelihoods in the context of national parks showcases conflicting outcomes in terms of providing sustainable livelihoods (Ashley 2000; Ashley et al. 2001; Goodwin and Roe 2001; Tao and Wall 2009b; Steinicke and Neuburger 2012;

Somarriba-Chang and Gunnarsdotter 2012), as opposed to other studies where ecotourism development was proven successful such as in Chile (Serenari et al. 2017), Ethiopia (Amano et al. 2017), Costa Rica (Koens et al. 2009), as well as in Himalayan regions of China (Newton and Franklin 2011), Bhutan (Rinzin et al. 2007; Gurung and Seeland 2011), Nepal (KC et al. 2015; 2021; Aryal et al. 2019a; 2019b), and Uttarakhand, India (Balodi et al. 2014; Ogra and Badola 2015; Rautela and Karki 2015). Notwithstanding that, while ecotourism development has a positive impact on the environment, however, in practice, it can impair both natural and cultural heritage (Parks et al. 2009). In addition, the insufficiency of comprehensive infrastructural planning and inadequate management has generated significant apprehensions for the achievement of ecotourism objectives, encompassing issues related to environmental degradation, conflicts among visitors, exceeding carrying capacity, inequitable benefit distribution, and lack of community cohesion (Datta and Banerji 2015; Sarkar and Sinha 2015; Dangi and Gribb 2018). Moreover, policymakers have been compelled to undertake a comprehensive review and reevaluation of ecotourism policies to effectively address the myriad challenges that arise during pandemic situations such as the ongoing COVID-19 crisis (Neupane et al. 2021).

In practice, addressing the socio-political dimensions of community-based ecotourism represent a holistic approach, emphasizing the bottom-up processes and expanding from the local to the national and global level (Dangi and Jamal 2016). Along the same lines, Açıksöz et al. (2016) argue that ecotourism as a developmental approach can substantially lead to poverty reduction and contribute to livelihood diversification. However, the danger of environmental overuse, when the numbers of tourists increase exponentially, is high. Nevertheless, the overall growth potential of ecotourism strongly suggests that it can effectively combine environmental conservation with economic empowerment in remote rural regions like Himalayan pasturelands, which provide captivating panoramas and enchanting scenic beauty (Ogra and Badola 2015). On the contrary, it is crucial to assign a priority to intensifying attention towards the prospective manifestation of income inequalities, which have the potential to be further aggravated by specific privileged factions endowed with superior access to resources that enable them to disproportionately reap the benefits of such developmental paradigms (Ma et al. 2019). Consequently, this occurrence culminates in the consolidation of wealth and influence within a delimited subset, giving rise to heightened social inequalities and a subsequent decline in active participation, ultimately leading to the state of disempowerment (Gurung and Seeland 2011).

Focusing on meeting three concurrent goals of biodiversity conservation, poverty reduction, and business viability in the ever changing world, a large and growing body of literature has assessed and analyzed varied aspects of the ecotourism development in the HKH regions, such as, in Nepal (KC et al. 2015; 2021; Walter et al. 2018; Aryal et al. 2019a; 2019b; Dahal et al. 2020; Neupane et al. 2021; Upadhaya et al. 2022), Bhutan (Rinzin et al. 2007; Gurung and Seeland 2011; Montes and Kafley 2022;

Dendup et al. 2022), China (Newton and Franklin 2011), and India (Kala and Maikhuri 2011; Anand et al. 2012; Balodi et al. 2014; Datta and Banerji 2015; Sarkar and Sinha 2015; Ogra and Badola 2015; Bhalla et al. 2016; Basak et al. 2021). Gurung and Seeland (2011) observed that although ecotourism endeavors may offer Bhutanese farmers the potential for supplementary off-farm income, thereby enhancing their sustainable livelihoods through the acquisition of additional cultivable land and expansion of livestock herds, there is a simultaneous concern regarding environmental degradation that undermines the initial appeal of the destination for ecotourists. In their investigation, Aryal et al. (2019a; 2019b) discerned the plentiful ecotourism prospects present in Nepal that may cultivate heightened community participation, specifically among unemployed youth, in ecotourism initiatives aimed at conservation of biodiversity and economic betterment.

Besides, women's empowerment and greater capacity to adapt to the consequences of climate change, supplement earnings, and boost in conservation efforts have been widely established in studies on community-based ecotourism focusing on homestay contribution (Anand et al. 2012; Ogra and Badola 2015; Bhalla et al. 2016; Basak et al. 2021). Whereas in an analysis of one of the first homestay host learning in community-based ecotourism in Nepal, Walter et al. (2018) identified complex dimensions of host learning based on a hosting curriculum that included aspects of environmental conservation, local culture, and homestay management. In another study in Nepal Upadhaya et al. (2022) investigated both positive and negative perceptions of the impact of ecotourism on infrastructure development and knowledge base. Sood et al. (2017), on the other hand, discovered that, despite the plethora of economic opportunities generated by homestays' popularity, local communities sometimes refrain from participating in homestay scheme implementations due to socio-cultural and practical concerns.

A study by Basak et al. (2021) examined the relationship between sustainable homestay tourism and tourist satisfaction using Structural Equation Modeling (SEM) and discovered that the two are linked in three ways: socio-cultural, economic, and environmental sustainability. A recent study by Montes and Kafley (2022) involved conceptualizing perceptions and values of Bhutanese communities that manipulate social and human-environment relations engaged in the ecotourism sector engrossed within the Gross National Happiness (GNH) and Sustainable Development discourses. Other research cited a lack of institutional, infrastructure, and unequal benefit sharing as barriers to the emergence of sustainable tourism in the Himalayas (Datta and Banerji 2015; Sarkar and Sinha 2015). However, in a systematic study of the global policy agenda of ecotourism development in the Global South, Regmi, and Walter (2017) argue that the focus of ecotourism development should shift away from a capitalist and modernist approach to more in favor of community-controlled and participatory approaches to be more relevant with sustainable development discourse.

Given the aforementioned critical perspectives and a dearth of systematic empirical research on the role of ecotourism as a livelihood adaptation strategy in the context of IHR, the present study attempts to underscore the abundant ecotourism potential in the Darma valley in Uttarakhand and examine how local community members, specifically youth and women, can benefit from the implementation of ecotourism initiatives in the region. As a result, it accentuates the imperative for in-depth investigation at the grassroots community level, delving into the intricacies of rural livelihoods, the willingness of local community engagement in ecotourism endeavors, and an extensive scrutiny of the cultural intricacies entwined with the simultaneous pursuit of ecotourism advantages from an indigenous vantage point.

3.3. Need for entrepreneurial business models in tourism (and ecotourism) sector

The role of entrepreneurship as a change agent has been identified as critical globally. The General Assembly resolution 73/225 on Entrepreneurship for Sustainable Development, proposed by the United Nations Conference on Trade and Development, was adopted in December 2018 to recognize the critical role of entrepreneurship in creating job opportunities, driving economic growth and innovation, improving social conditions, and addressing social and environmental challenges, thereby contributing to the 2030 Agenda for Sustainable Development (SDGs). To achieve these goals in the face of rapidly evolving global economic, social, and environmental challenges, it is necessary to address entrepreneurship as a means of bringing systemic transformation at the local, national, and international levels (UNCTAD 2017; Boluk et al. 2017).

According to Akinbami et al. (2019), entrepreneurship could facilitate rural economic development, considering that it can help improve responses to changing climate conditions and other stressors. Other scholars emphasize on recognition of entrepreneurial opportunities for effective climate adaptation interventions (Block et al. 2019; Akinbami 2021, Burch and Di Bella 2021). On the other hand, the concept of social entrepreneurship, a phenomenon derived from entrepreneurship, has emerged in the past few decades as an area of academic inquiry. It calls for the identification and development of business models that create positive social impact and community development (Kummitha et al. 2021; Aquino et al. 2021) while delivering the key principles of sustainable development (UNCTAD 2017). With the opportunities to create value with a social purpose amid the interaction of collaborative networks and market forces, social entrepreneurship can play an important role in sustainable transitions, unlike the traditionally recognized profit-oriented entrepreneurship approach (Buzinde et al. 2017; UNCTAD 2017). The fact remains, however, that social entrepreneurial ventures have facilitated social transformation that has benefited all stakeholders, particularly women in diverse social environments (Kimbu and Ngoasong 2016; Akinbami et al. 2019; Akinbami 2021).

Furthermore, tourism studies have begun to acknowledge the role of social entrepreneurship in tourism development (DeLange and Dodds, 2017; Wang et al. 2021; Aquino et al. 2021). The concept has marked its vital presence in the ecotourism sector (Kummitha et al. 2021; Day and Mody 2017; Murphy et al. 2017; Kasalak et al. 2016), in addition to its contribution to sustainable livelihood creation (Laeis and Lemke 2016). Many studies emphasize its importance to sustainable community development (Aquino et al. 2021; Murphy et al. 2017; Sheldon et al. 2017; Laeis and Lemke 2016), particularly in low-income and developing countries (Dahles et al. 2020).

Research conducted by Kummitha et al. (2021) undertook an examination of community perspectives on Tourism Social Enterprises (TSEs) and their contributions to the advancement of local community development and the development of ecotourism destinations. The findings revealed that economic advantages, including the generation of employment opportunities and improvements in income levels, significantly influenced the support of TSEs by local communities. Murphy et al. (2017) espoused the viewpoint that social entrepreneurship-based ecotourism models contribute to the enhancement of community capacity and instill a sense of self-esteem. Furthermore, the authors emphasized the pivotal role of community consensus, the dismantling of dependency culture, and the cultivation of capacity as essential elements for the prosperity of such entities.

Concurrently, Laeis and Lemke (2016) ascertained through their inquiry that rural social entrepreneurial development possesses a notable prowess in converting income into valuable assets for local communities' sustenance and betterment. By contextualizing it within the SLA framework, the authors further asserted that SLA facilitates an intricate exploration of the intricate interconnections and interdependencies among diverse stakeholders, providing valuable insights into how social entrepreneurship shape the ramifications of tourism on rural livelihoods. Nonetheless, challenges may emerge when enterprises overly rely on external funding and fail to establish effective reciprocal communication among stakeholders, thereby impeding the realization of their maximum potential.

In view of that, von der Weppen and Cochrane (2012) assert that tourism social enterprises must integrate social development, environmental stewardship, and financial objectives to create value for stakeholders. This, in turn, is sometimes determined by the applicability of relevant business model constructs (Daniele and Quezada 2017; Reinhold et al. 2017; Murphy and Harwood 2017; Scherrer 2020; Rosato et al. 2021; Szromek 2021; Galardi et al. 2022). though entrepreneurial tourism business models are still in their infancy (Sahebalzamani and Bertella 2018; Daniele and Quezada 2017; Reinhold et al. 2017). Daniele and Quezada (2017) advocate for the expansive application of the business model framework as a potential instrument for scrutinizing how enterprises can engender value for their stakeholders. Additionally, they affirm that employing such models empowers enterprises to adeptly tackle

pertinent social dilemmas, encompassing but not restricted to ameliorating poverty, mitigating unemployment, fostering social harmony, augmenting skills, promoting gender equality, preserving the environment, and engendering indirect advancements for community betterment.

Furthermore, Reinhold et al. (2017) put forth the notion that the adoption of business models in the tourism context has gained considerable prominence in managerial discussions, acting as a catalyst for innovation and the revitalization of outdated business practices. Sarkar and Sinha (2015) further underscored the imperative examination of the fundamental business models and their financial viability within the realm of ecotourism, a subject that remains inadequately explored in the Indian Himalayan context. By delving into the complexities of the business models that underlie ecotourism ventures within a community-based homestay arrangement in Sikkim, the authors unveiled that the triumph of ecotourism as a business model hinges upon the level of interest exhibited by the community and their willingness to cultivate the requisite proficiencies and capabilities for delivering ecotourism services. Furthermore, the authors argued that often ecotourism development entails a trade-off between environmental sustainability and financial profitability, particularly when the expansion of ecotourism operations is primarily driven by the imperatives of livelihood generation and income augmentation rather than by an inherent commitment to the preservation and conservation of nature.

In parallel, Galardi et al. (2022) extended the utilization of business model constructs as a methodological apparatus to foster the generation of innovative solutions for the multifaceted issues encountered by rural small-scale tourism enterprises, including limited financial resources, insufficient technological expertise, and ineffective customer retention strategies. Through participatory engagement, the authors asserted that the utilization of business model constructs enables the creation of avenues for collaborative formation of strategic domains for intervention and facilitates the exchange of dialogues among stakeholders.

In this context, it is worth acknowledging the conspicuous fact that an extensive and ever-expanding corpus of scholarly works underscores the efficacy of integrating business models as a means for tourism social enterprises to effectively tackle a wide array of social concerns. These encompass, but are not limited to, poverty alleviation, employment generation, social integration, skill development, gender parity, environmental sustainability, and the incidental advantages accrued within the communities they serve (Dahles et al. 2020; Scherrer 2020; Daniele and Quezada 2017; Murphy and Harwood 2017). Alongside, academic discourse has likewise begun to delve its focus towards the pervasive socio-ecological predicaments, including the escalating consequences of climate change, which necessitate a reconsideration of prevailing tourism frameworks to effectively confront these risks (Loehr and Becken 2021; Becken and Loehr 2022). In this context, the incorporation of business models

emerges as a crucial area of study, facilitating the advancement of entrepreneurial initiatives aimed at promoting sustainable growth and fortifying resilience (Burch and Di Bella 2021; Akinbami 2021).

Amidst this trajectory, the current investigation endeavors to acquire exploratory viewpoints in order to scrutinize the degree to which the amalgamation of entrepreneurship concepts and sustainable business models can engender the realization of ecotourism. In this pursuit, the study seeks to propose a prototype framework for a business model tailored to an ecotourism enterprise, with the overarching goal of fostering entrepreneurial ascendancy while simultaneously safeguarding the region's inherent natural and cultural heritage. This proposed model aims to serve as a guiding template, offering a strategic roadmap for emerging entrepreneurs and stakeholders in the region to embark on a path of entrepreneurial primacy. It is within this context that, given the challenges posed by a globalizing and ever-changing climate, the deliberate creation of enterprises holds promise as a means for rural communities to adapt to alternative livelihoods. This is because, this transition may not only promise economic stability but may also enhance the overall adaptive capacity of communities in the face of multifaceted socio-economic and environmental uncertainties. Nonetheless, meticulous attention must be devoted to striking a delicate balance between economic viability and environmental sustainability, effectively addressing constraints pertaining to available resources, and diligently preserving local cultural customs and traditions (Kummitha et al. 2021).

3.4. Relevance of solidarity paradigm in tourism (and ecotourism) entrepreneurial development

Solidarity-based economy serves as a representative platform with a notable influence in supporting entrepreneurship, business development, employment generation and social protection, particularly in rural regions (ILO 2017). This paradigm stresses community-based economic activities that emphasize communal ownership, democratic decision-making, and social and environmental responsibility (Sahakian and Dunand 2015), often achieved through rural entities such as social enterprises, foundations, cooperatives, and mutual benefit organizations (ILO 2017; Vargas Vasserot 2023). According to (Gómez Núñez 2019), it is associated with the aspiration for an economic system that prioritizes the preservation and advancement of values, while abstaining from exploitation and degradation of the natural environment. Similarly, ILO (2017) critiques conventional development methods that prioritizes economic expansion at the expense of social and environmental sustainability.

According to UNIDO (2017), the notion of solidarity economy pertains to an entrepreneurial approach that encompasses the production of goods and services motivated by communal and public welfare, while adhering to the principles of cooperation, solidarity, ethics, and self-governance and guaranteeing viability in the

commercial operations. In this sense, this approach prioritizes in achieving collective interests over individual ones (Forero and Saavedra 2022).

The emergence of the solidarity movement in the tourism sector coincided with discussions about fair trade, sustainable tourism, and ecotourism around the end of the 1990s (Caire 2007). Forero and Saavedra (2022) propounds the view that with foundations formed on the ideals of equity and associativity, often times the sense of oneness in the community allows for the development of tourism as a small-scale venture, commonly to as community-based tourism. With regard to this view, Esteves et al. (2021) proposes fostering local entrepreneurial development based on solidarity economy principles, particularly those owned and operated by marginalized populations.

Along the same lines, Bailey et al. (2018) urges leveraging Community-Based Social Enterprises (CBSEs) to attain this goal. In this context, Utting (2015) promotes constructive community rebuilding through solidarity-based development models that address the challenges posed by socio-economic uncertainties caused by a confluence of economic and environmental stressors. This is due to the fact that the solidarity economy-based model, as a comprehensive concept, is put out with emancipatory aspirations of participatory governance and collective efforts at multiple levels as a tool for social and environmental justice (UNTFSSE 2014), most of the time demonstrating evident synergy with the UN SDGs (Villalba-Eguiluz et al. 2020).

It is assenting that sustainable tourism development in rural areas, based on a solidarity-based ethos among local communities and visitors, presents significant opportunities (Doğan 2021). Nevertheless, achieving the firm objectives of this approach may not always be attainable owing to a multitude of constraints (Doğan 2021), such as restricted access to funds and resources, insufficient institutional support, and inadequate recognition by governance structures. In such instances, because they do not rely on traditional sources of investment, solidarity-based firms may have to resort to markets to secure economic viability (Avagianou et al. 2022). In addition, the recognition of policy and legislative inadequacies is paramount in understanding the significant hindrance that impedes the comprehensive utilization solidarity-based business entities. As a result, it becomes essential to embark upon a course of action involving the reformulation of policies, encompassing the incorporation of solidarity principles within institutional frameworks, thereby facilitating the substantial progress and development of such entities (Buendía-Martínez et al. 2020). Nonetheless, despite the fact that research has shown a critical relationship between entrepreneurial development of rural tourism, including ecotourism models, and the foundations of the solidarity economy (Vargas Vasserot 2023; Forero and Saavedra 2022; Morais and Bacic 2020; Bailey et al. 2018), more in-depth investigation is required to fully comprehend this relationship and advance the rhetoric (Forero and Saavedra 2022).

In this continuum, the present study endorses the notion that entrepreneurial models implemented in rural contexts possess the potential to inject novel dimensions into economic discourse, emphasizing the pervasive integration of solidarity principles across all facets of business operations. This is based on the understanding that such an approach is poised to provide support to marginalized populations historically excluded from the benefits of the conventional economic paradigm, particularly in the context of marginal Himalayan communities. The present investigation, in a broader sense, aimed to align with the pervasive uptake of sustainable business models within the context of ecotourism development in Darma valley, particularly when examined through the lens of the solidarity paradigm. This endeavor sought to reconceptualize tourism arrangements in response to the multifaceted risks posed by evolving socio-economic and environment conditions on the rural mountain livelihoods. This is because, scholarly research has consistently demonstrated the inherent objective of integrating the core principles of the solidarity paradigm in the tourism (including ecotourism) context, wherein the intention is to synergistically advance community development while concurrently fostering a symbiotic nexus between the natural environment and business enterprises (Bailey et al. 2018; Morais and Bacic 2020; Forero and Saavedra 2022; Vargas Vasserot 2023).

4. Research objective and questions

The burgeoning body of literature on climate projections in IHR, including Uttarakhand elucidates the prospective ramifications for the region. Simultaneously, when juxtaposed with the evolving socio-economic dynamics propelled by globalization and urbanization, the region unequivocally underscores the paramount significance of prioritizing proactive adaptation strategies to mitigate and adeptly respond to the transformative influences stemming from these inexorable forces. In view of that, safeguarding local livelihoods assumes utmost significance, while simultaneously, fostering adaptability through the provision of alternative avenues for livelihood emerges as a critical imperative.

In order to pursue this objective, particular emphasis is placed on the application of the Sustainable Livelihoods (SL) approach, which posits that individuals in marginalized and impoverished communities often rely on multiple livelihood sources for their sustenance (Scoones 1998; 2009; Ashley 2000; Ashley et al. 2001; Tao and Wall 2009a). This may be seen exemplified by the burgeoning tourism statistics in the IHR, which indicates the local community's willingness to engage in alternative livelihood practices linked to tourism and its sub-sectors, including cultural, spiritual, ecotourism, and adventure tourism (Uttarakhand Tourism Statistics 2015; NITI Aayog 2018a). However, it is crucial to accord priority to meticulously planned developmental strategies that foster the proliferation of sustainable tourism practices, thereby creating fresh avenues for livelihood diversification to effectively confront the challenges arising from the influences of globalization and climate change, and to mitigate the associated risks. In this purview, it is pertinent to recognize that tourism segments should be integrated into preexisting economies, with the aim of complementing and expanding them, rather than displacing them (Wall 2007). In doing so, it is essential to acknowledge the diverse needs, aspirations, and knowledge of the local community, as well as their ownership of traditional economic endeavors (Tao and Wall 2009a; 2009b).

As extensively expounded upon in preceding sections, prior investigations on ecotourism in IHR have primarily focused on development of homestays (Lama et al. 2010; Anand et al. 2012; Ogra and Badola 2015; Bhalla et al. 2016), adopting a conservation-oriented perspective in ecotourism development (Lama et al. 2010; Singh and Sondhi 2016; Vannelli et al. 2019; Das and Hussain 2016; Singh et al. 2021), resolving conflicts between people and parks over resource use through ecotourism initiatives (Maikhuri et al. 2000; Singh and Singh 2004; Kala and Maikhuri 2011), assessing the sustainability of ecotourism operations (Ashok et al. 2019; Basak et al. 2021), identifying factors impeding ecotourism growth (Datta and Banerji 2015; Rastogi et al. 2015; Sarkar and Sinha 2015), utilizing geospatial methods for site selection (Chaudhary et al. 2022), employing spatio-temporal models to analyze visitation patterns (Bhalla et al. 2022) and implementing conscientious management

practices to foster positive growth in ecotourism (Chaturvedi 2002; Mahapatra et al. 2012; Sahani 2021).

In contrast, despite the abundant ecotourism potential evident in the region (NITI Aayog 2018a), and particularly in Uttarakhand (Sati 2023), there remains a notable dearth of empirical studies contributing to the comprehensive understanding on the extent to which ecotourism can effectively serve as a viable strategy for livelihood adaptation (Ogra and Badola 2015). Furthermore, notwithstanding its heightened potential in enhancing adaptive capacity and resilience, as affirmed by Ogara et al. (2013), Ogra and Badola (2015), Jamaliah and Powell (2018), Little and Blau (2018), Hoang and Pulliat (2019), Agyeman (2019), Dendup et al. (2022), and Trang and Loc (2022), scholarly inquiry investigating the feasibility of ecotourism as a means to ensure sustainable livelihoods and facilitate climate adaptation remains scarce within the context of the IHR (Ogra and Badola 2015). More so, there remains a dearth of scholarly investigations concerning the comprehension of how the progression of ecotourism can be metamorphosed into an entrepreneurial adaptation that caters to both economic stability and ecological imperatives through the utilization of sustainable business models.

Hence, this research endeavors to address this void by examining the perceptions of pastoralists regarding climate change and associated socio-economic impacts and the need for necessary livelihood adaptations to foster resilience. Concomitantly, the study aims to advocate for a more comprehensive investigation into the ecotourism prospects and establishment of ecotourism-driven livelihoods through the implementation of entrepreneurial business models, underpinned by the principles of solidarity paradigm.

In doing so, the following research objectives and questions are addressed:

1) To determine changing climate scenario in high mountain regions and their impact on pastoralist communities (Study 1).

    a) How significant are the climatic changes occurring in the region?
    b) How do local communities perceive the magnitude of changing climate?
    c) What are the main adaptation strategies adopted by the community?

2) To examine the prospects of ecotourism as a source of sustainable livelihoods and adaptation strategy (Study 2).

    a) What are the key factors that determine the potential of ecotourism as a source of sustainable livelihoods among pastoral communities?
    b) How does the utilization of a Sustainable Livelihood Framework (SLF) enhance the understanding of ecotourism's potential as a means of livelihood adaptation?

3) To develop a sustainable business model prototype for a potential ecotourism enterprise for livelihood adaptation (Study 3).

    a) What strategies can be implemented to facilitate ecotourism development in the study region?
    b) To what extent the integration of concepts of entrepreneurship, sustainable business models and solidarity economy contribute to the realization of ecotourism in Darma valley?

5. Regional context

5.1. Study area

Bestowed with splendid beauty, Darma valley is situated in the Indian Himalayan Region (IHR), between 29° and 31° North latitude and 79° and 81° East longitude in Dhauliganga watershed, Dharchula subdivision, Pithoragarh District, Uttarakhand (Fig. 2). Bordering Tibet in the North and Nepal in the East, it lies at an altitude between 7500 and 14,000 ft, adjacent to Byans and Chaudans valley in Kailash Sacred Landscape (KSL) region of IHR. The high variation in the elevation gradient exhibits the region having a striking topography and diverse biomes from subtropical, and temperate to alpine vegetation.

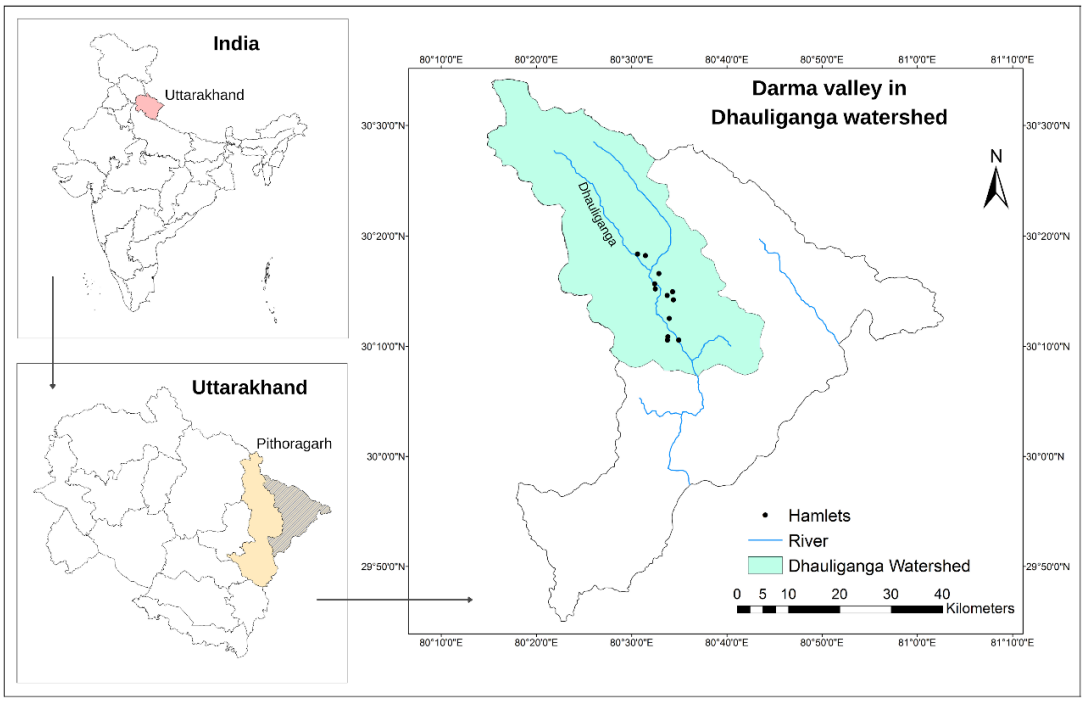


Figure 2 Location of study area

The region is inhabited by the semi-nomadic agro-pastoralists, *Bhotias*[8] *(*sub-tribes *Rung),* who practice mixed mountain agriculture, combining animal husbandry, crop farming, and forestry (Bergmann 2016). Utilizing alpine pasturelands, locally known as *bugyals* for transhumant grazing in the summer months between March and October

[8] The term *Bhotia* carries the literal connotation of resembling 'Tibetan like'. It specifically denotes individuals of Mongoloid descent with Tibetan origins, and this classification was imposed upon them during the British colonial era in India. The Bhotias in India primarily inhabited the high-altitude valleys of Darma, Byans, Chaudans, Johar, Niti, and Mana in districts of Chamoli, Uttarkashi and Pithoragarh in Uttarakhand, collectively known as the 'Bhot Pradesh' or the 'province of the Bhotias' (Sharma and Rikhari 1995).

end (Pandey et al. 2017a), they migrate to lower regions around Dharchula and Jauljibi in the winter months (October–beginning of November) and return to the valley again with their livestock as the snow begins to recede in the summer season (late March–beginning of April) (refer to Table 2). Leading the upward migration in '*Kunchas*[9]', Bhotias sow their crops and harvest the crops by the end of September in their high-altitude summer settlements. It is noteworthy that while both men and women engage in agricultural practices and wage labor, young men particularly largely work as porters, guides, and drivers.

Table 2 Summer and winter dwellings of Bhotia community in Darma valley

Summer settlement	Winter settlement
Sela	Ansigada
Chal	Dobat
Nagling	Galati, Nigalpani
Baling	Galati
Dugtu	Nigalpani, Jauljibi
Dantu	Nigalpani, Jauljibi
Baun	Charcham, Gothi
Philam	Charcham
Go	Balkot
Tidang	Kalika
Marcha	Galati
Sipu	Galati

The Bhotias belong to the Tibetan-Burman language family and are spread across 12 villages namely, Sela, Chal, Nagling, Baling, Dugtu, Dantu, Go, Philam, Bon, Tidang, Marcha, and Sipu. At present, the moderate climate in Sela, Chal, Baling, and Nagling provides an optimal living opportunity for the locals throughout the year. According to Census of India (2011), the present population in Darma valley comprises of 750 households (Table 3). Although most of the population primarily speak the local language known as *Darmani*[10]or *Darmiya*, they are also multilingual, fluent in Hindi, Pahari[11] and Nepali (Willis 2007).

The important alpine pasturelands or *bugyals* in the region are widespread across Dugtu (3672 m), Nagling (3445 m), Dhakar (3368 m), Baun (3595 m), Tidang (3503 m) and Sipu (4043 m) covered with abundant vegetation such as *Taraxacum officinale, Carex*

[9] *Kuncha* in local Tibeto-Burman Darma language refers to seasonal Bhotia transhumant pastoralists.
[10] *Darmani* is a Tibeto-Burman language spoken by Bhotias in Darma valley.
[11] *Pahari* carries the literal meaning of 'belonging to the mountains'. It is an Indo-Aryan language spoken by Hindu communities residing in the central Himalayas. The term also serves as a means to affirm the social group identity of individuals originating in this region.

obscura, Dracocephalum heterophyllum, Potentilla bifurca, Sibbaldia cuneata amongst others (Maiti et al. 2022). Sheep, goat, cow/oxen, yak, and yak hybrids locally known as *Jhubbu* (male) and *Jumma* (female) constitute the main livestock types in the region. Transhumant pastoralism also allows them to collect rare medicinal herbs and cultivate high altitude crops and vegetables such as buckwheat (*Fagopyrum esculentum*), barley, cabbage, and potatoes in the valley.

The considerable share of household income is also contributed by both men and women with the collection of wild medicinal plants such as Caterpillar Fungus (*Cordyceps sinensis*), locally known as *Keedajadi* or *Yarshagumba* and cultivation of medicinal plants such as Kutki (*Picrorhiza kurroa*), Atish (*Aconitum heterophyllum*), Hathazari (*Dactylorhiza hatagirea*), Kuth (*Saussurea costus*), Chippi (*Pleurospermum angelicoides*), Jambu (*Allium stracheyii*) and Kaala Jeera (*Carum carvi*).

Table 3 Demographic profile[12] of Bhotia population in Darma valley

Village	Village area (in hectares)	Number of households		Population (2011)		
		1981	2011	Males	Females	Total
Sela	174.06	32	63	114	97	211
Chal	134.9	25	38	110	110	220
Nagling	219.65	54	80	196	200	396
Baling	218.23	45	90	175	140	315
Dugtu	330.48	74	50	128	106	234
Dantu	319.62	32	13	29	26	55
Go	391.05	63	96	171	172	343
Baun	278.78	67	99	237	240	477
Philam	104.89	27	25	77	74	151
Tidang	413.9	24	121	191	105	296
Marchha	132.54	30	46	87	98	185
Sipu	204.69	31	29	59	77	136

Data source: District Census Handbook of Pithoragarh, Census of India (1981, 2011)

5.2. Historical socio-political background

Pastoralism enabled Bhotia communities to engage in trans-Himalayan trade with neighboring communities in Tibet[13] where sugar, grain, and wool were traded for borax and salt (Bergmann et al. 2008; 2012). This economic activity not only thrived but was

[12] The study relied on Census 2011 data as the primary reference due to the indefinite delay of the Census 2021. In addition, the lack of standardized indicators and inadequate data, particularly for land use categorization and workforce distribution limited the ability to fully leverage the census records from 1971, 1981, 2001, and 2011 for rigorous data comparisons.

[13] Taklakot and Gyanima in the Tibetan plateau served as prominent trade markets, referred to as *Mandi*, for the Bhotia people in Darma. The market in Taklakot continues to thrive in present times.

primarily controlled by the Bhotias, largely attributable to the decrease in taxes imposed by the colonial British government during the initial decades of the nineteenth century (Bergmann et al. 2012). Subsequently, the previously prosperous trade underwent a gradual decline as a result of the implementation of colonial forest policies, notably the establishment of 'Reserved Forests' which imposed restrictions on the utilization of the forest resources by the Bhotia community from the late nineteenth century until India achieved independence from British colonial rule in 1947. In addition, the British administration initiated the substitution of indigenous wool with imported wool sourced from Europe and the procurement of salt from the Indian coastal regions at more affordable prices, which had adverse effects on numerous pastoralists (Guha 1989; Roy 2003).

However, a significant setback to the customary practice of seasonal transhumance occurred in 1962 with the outbreak of the Indo-China war which had a profound impact on cross-border trade relations, leading to its gradual decline. As a result, in 1967, the government of India officially recognized the Bhotias as a 'Scheduled Tribe' (ST), granting them certain privileges such as reserved quotas in government positions and educational institutions (Bergmann et al. 2012). Hence, as per the Census of India (2011), the average literacy rate currently within the Bhotia community inhabiting the villages of Darma outperforms the national average of 74.04% (Table 4). Following this, Bhotias, largely men, embarked on migratory journeys to the nearby towns and cities in order to exploit favorable economic prospects. This also included their relocation to emerging marketplaces and administrative centers in former winter settlements such as in Dharchula that offered enhanced connectivity and promising non-agrarian employment opportunities (Gerwin and Bergmann 2012).

Concomitantly, during the initial years of the 1970s, the region witnessed the arrival of Gaddi pastoralists from the neighboring IHR state of Himachal Pradesh. These pastoralists brought with them larger herds and possessed the means to remunerate the local forest council, *Van Panchayat*, for grazing rights. As they gradually established their dominance over the winter grazing lands, the Bhotias began perceiving them as competitors, leading to a reduction in the size of their own herds. Eventually, the Bhotias even started employing Gaddis to manage their livestock (Pandey et al. 2017a).

Following the liberalization of Indian markets in 1991, as a result of heightened efforts by the Indian government, Lipu Lekh Pass located at the trijunction between Uttarakhand, Nepal, and Tibet was reopened for trade in 1992 and China emerged as one of the prominent trading partners (Vasan 2006). Subsequently, after years of agitation, Uttarakhand attained its independent federal status in 2000, having been newly carved out from the state of Uttar Pradesh. In order to secure substantial financial allocations for the recently formed state, the Uttarakhand government strategically presented a well-orchestrated agenda under the 'Border Area Development Program' that aimed to foster market-oriented approaches while simultaneously driving the

development of infrastructure, road network, tourism, education, hydro-energy, and agriculture in these peripheral regions. However, during this period, there was a slight discernible upturn in seasonal migration towards the elevated villages of Darma valley (Gerwin and Bergmann 2012).

Table 4 Literate and illiterate population in Darma villages

Village	Literate population (2011)			% of literate population	Illiterate population (2011)			% of illiterate population
	Males	Females	Total		Males	Females	Total	
Sela	92	54	146	69.19	22	43	65	30.8
Chal	79	71	150	68.18	31	39	70	31.81
Nagling	165	146	311	78.53	31	54	85	21.46
Baling	146	87	233	73.96	29	53	82	26.03
Dugtu	109	69	178	76.06	19	37	56	23.93
Dantu	23	19	42	76.36	6	7	13	23.63
Go	151	108	259	75.51	20	64	84	24.48
Baun	183	137	320	67.08	54	103	157	32.91
Philam	66	51	117	77.48	11	23	34	22.51
Tidang	171	95	266	89.86	20	10	30	10.1
Marchha	77	72	149	80.54	10	26	36	19.45
Sipu	48	63	111	81.61	11	14	25	18.38

Data source: District Census Handbook of Pithoragarh, Census of India (2011)

As traditional customs gradually diminished and the Bhotia community experienced a decline in livestock population (Table 5), they resorted to employing a solitary shepherd referred to as an *Anwal* to lead their herds to higher meadows. This change provided them with opportunities to explore alternative livelihood options, including the cultivation of medicinal and aromatic plants (MAPs) and engaging in the illicit collection and trade of Caterpillar Fungus. The harvesting of Caterpillar Fungus takes place during the months of May, June, and July in high-altitude grasslands, and the fungus is sold at exorbitant prices in China and Nepal, albeit illegally. Over the past two decades, there has been an increase in the collection of non-timber forest products (NTFPs) in the Darma and KSL region, regulated by the Van Panchayat, where both men and women participate in the gathering and sale of MAPs (Wallrapp et al. 2019). However, the unsustainable harvesting practices of NTFPs have raised concerns about biodiversity degradation in the region (Negi et al. 2015).

As evident from the data presented in Table 5, there exists considerable variation in the degree of decline observed in the sheep population across different villages. This discrepancy can be attributed, to a certain extent, to the influential communal dynamics that prevail within each village. For instance, in comparison to the other villages, the village of Sipu, located at the furthest end of the region and relatively isolated, typically used to witness the early movement of family migration attributed to the necessity of traversing longer distances with livestock and household belongings. As time

progressed, the challenging circumstances endured by the limited number of households in Sipu prompted their inclination towards sending their children to urban areas in pursuit of better educational and occupational prospects. The interplay of interfamily influence further contributed to this trend in Sipu, as indicated by the village's remarkable rise in literacy levels. In fact, the literacy rates observed in the last three villages surpass those of their counterparts, wherein, in present time, substantial number of individuals from these villages hold prominent positions in government services. Notably, in contrast, Baun emerges as the most populous settlement within the region, strategically situated in close proximity to the villages of Go, Philam, Dugtu, and Dantu. The prevalence of isolation as a determining factor holds minimal consideration, thus, underscoring the significance of communal influence in defining the relatively slower pace of decline of pastoral traditions. As the latest statistics indicate, Baun is characterized by the lowest literacy rates in the region.

Table 5 Trend of sheep population in selected villages between 1987-2012

Village	Sheep population			
	1987	1997	2003	2012
Nagling	898	415	345	349
Baling	930	471	220	138
Dugtu	3120	1933	875	684
Baun	3794	3491	1900	1411
Philam	842	1452	36	132
Go	2142	1598	80	550
Tidang	597	593	228	299
Marcha	664	495	73	299
Sipu	2339	1793	289	259

Data source: Maiti et al. (2022)

In summation, despite the migratory patterns observed among the Bhotia community and the subsequent decline in pastoral practices, it is important to emphasize that this does not necessarily imply a corresponding decrease in the number of households (as indicated in Table 3). This is because the prevalence of patrilineal household division is rooted in the longstanding custom of Indian culture, where the marriage and establishment of separate families by sons leads to the division of the original household (and land) into multiple nucleated entities. Consequently, each of these divided households acquires its distinct identity and recognition through the issuance of individual ration cards. Additionally, ancestral connections and ties to their cultural roots holds profound significance among Bhotias. The existence of an ancestral home in the high valley assumes a prominent emblematic role, embodying their rich cultural heritage and establishing a palpable link to their distinctive customs, religious beliefs, and collective sense of identity. Each year, the region becomes a witness to ceremonial processions, vibrant fairs, and festive celebrations where the household members return

to their ancestral abodes and actively engage in these communal rituals. This serves as vivid reflections of the profound cultural and social tapestry woven by these tribal communities in the Himalayan peripheral lands. Moreover, in present time, individuals who had previously relocated in pursuit of government employment opportunities, manifest a tendency to their native dwellings upon their retirement.

5.3. State of current climatic alterations

In addition to the aforementioned socio-economic and political drivers of change, the region has been posed with the challenges posed by current changing climate. The observed climate-driven environmental changes and the widespread poverty in the whole KSL region have presented risks to the lives and livelihoods of the local community (Zomer et al. 2014; Dalal et al. 2018; Pathak et a. 2017; Singh et al. 2018; Kuniyal et al. 2021; Negi et al. 2021b).

Kuniyal et al. (2021) in their study observed a notable upward trajectory in temperature patterns during the summer and winter months within the Dhauliganga basin spanning the years 1979 to 2014. In addition, the authors identified a discernible decline in seasonal precipitation levels during the winter months. In a separate investigation, Negi et al. (2021b) uncovered a substantial rise in both the maximum and minimum annual temperature trends, along with a growing trend of erratic rainfall occurrences between 1980 and 2015 in the KSL regions situated in the Pithoragarh district. Dalal et al. (2018) conducted an extensive inquiry encompassing the investigation of rainfall variability in the KSL region of Pithoragarh, covering the temporal span from 1901 to 2001. The authors emphasized the enduring pattern of decreasing rainfall over the course of the past century, imparting potential repercussions on the hydrological balance of river systems at the state level. Similar to the findings of Negi et al. (2021b), the authors also revealed the erratic nature of rainfall during the monsoonal months throughout the previous century.

Additionally, Singh et al. (2018) ascertained that the nearby glaciers in the Dhauliganga Basin experienced an approximate reduction of 35 km^2 from 1963 to 2016. Amidst mounting apprehensions, Zomer et al. (2014) observed that the KSL region is anticipated to undergo significant alterations in its bioclimatic conditions by the year 2050. The authors further documented the loss of habitat for endemic plant species, the proliferation of invasive species, and an overall decline in species richness in the region. Furthermore, the rising temperature trends observed within the study site correspond to the general patterns prevalent in the IHR and HKH regions, as outlined in prior sections (Bhutiyani et al. 2007; 2009; Bhambri et al. 2011b; Qi et al. 2013; Kattel and Yao 2013; Mishra 2014; Zomer et al. 2014; Dobhal et al. 2015; Bhutiyani 2016; DHM 2017; Mishra 2017; Shafiq et al. 2018; Mal et al. 2019).

Consequently, the convergence of multifaceted climate-induced changes has yielded noticeable repercussions that mold the adaptive strategies of pastoralist communities in diverse manners, including prolonged sojourns in elevated summer settlements, alterations in grazing schedules within alpine pastures, and reduction in size of herd (Negi et al. 2021b). Likewise, the erratic nature of precipitation poses detrimental impacts on various rainfall-dependent agricultural activities undertaken by these pastoralist communities, including tilling of land, field preparation, sowing of seeds and irrigation (Dalal et al. 2018). In this purview, it is judicious to contemplate the fact that the preexisting predicaments encountered by the pastoralist communities residing in Darma, stemming from the multifaceted repercussions of socio-economic and political factors on their customary modes of subsistence, are further magnified by the adversities imposed by the risks posed by climate change. This compounding of challenges my seen to serve as a catalyst for the diminishing of the traditional practice of transhumant pastoralism within the region. As a result, while the livestock population continuous to downward trajectory (Maiti et al. 2022), there is a discernible trend within the local community wherein Bhotias increasingly seek diverse means of sustenance, such as engaging in wage labor, providing tourism and recreational services, offering transportation services, participating in the collection and trade of medicinal plants, as well as the out-migration of men to urban centers.

5.4. Tourism prospects in the region

The natural splendor of Darma valley features a diverse array of landscapes, from alpine meadows, groves, forests, waterfalls, to glaciers making it an ideal destination for ecotourists, nature and adventure enthusiasts. Additionally, the region is abundant with a wide variety of flora and fauna, including rare and endangered species such as the snow leopard, blue sheep, and Himalayan musk deer. The soaring massif of Panchachuli peaks (Fig. 3), literally translate to ‘five-pointed oven’ and holds a great cultural significance.[14] Conversely, the local Bhotia community possesses a magnificent and unique richness in cultural practices, ethos, and values. Their traditional knowledge systems are inextricably linked to the natural environment and are based on a thorough understanding of the ecology and its relationship with humans. The scope of this knowledge is vast, encompassing ecological insights, resource usage practices, conservation approaches, ethnomedical knowledge, and artisanal skills (Srichandan et al. 2021). The age-old custom of maintaining sacred forests, locally known as *Shingul* and *Se Roa*, for example, is a crucial cultural practice that continues to be observed till today for the purpose of forest protection, biodiversity conservation and natural resource management. In accordance with enduring cultural traditions that have persisted for centuries, the village of Dugtu has been bestowed with the onus of

[14] According to Hindu mythology, the narrative holds that the *Pandavas* used these five peaks (*chulis*) as cooking hearths to make their last meal before ascending to heaven. Arranged sequentially from left to right, the five peaks symbolize the divine manifestations of the *Pandava* brothers: *Bhima*, *Nakul*, *Sahadeva*, *Arjuna*, and *Yudhishthira*.

protecting the neighboring forest of Betula utilis, the Himalayan Birch locally referred to as *Bhojpatra*[15], to mitigate the potential risks of avalanches. Moreover, a glimpse of the elusive Bhotia Rung culture is quite evidently seen in the recently established Rung Museum[16] in the Dharchula town (Fig. 4a-c). The museum showcases exquisite catalogue of ancient artifacts, art, craft, and manuscripts dating back to over 100 years that were willfully donated by the Bhotia community members across Darma, Byans and Chaudans valleys.

Figure 3 The great Panchachuli massif. From extreme right to left seen here are Panchachuli I (6355 m), Panchachuli II (6904 m), Panchachuli III (6312 m), Panchachuli IV (6334 m), Panchachuli V (6437 m). Meola glacier is located at the foot of five peaks, while Sona glacier is seen situated on the north of Meola, right below Panchachuli I.

Notwithstanding their migration to other regions, ancestral connections and ties to their cultural roots holds profound significance among Bhotias. The existence of an ancestral home in the high valley assumes a prominent emblematic role, embodying their rich cultural heritage and establishing a palpable link to their distinctive customs, religious beliefs, and collective sense of identity. Each year, the region becomes a witness to ceremonial processions, vibrant fairs, and festive celebrations that serve as vivid

[15] *Bhojpatra*, regarded as a sacred tree, holds prominent significance among the tree species used for the observance of religious ceremonies in the region. Each household maintains a customary presence of a tree trunk, referred locally as *Darchyo*, within their compound. It serves as devotional adoration and seeking blessings from, *Syang-se*, the paramount deity revered across all Darma villages. Alongside, Bhojpatra trees have garnered immense value for their therapeutic properties in the ancient Indian medical system, *Ayurveda*.

[16] Rung museum was ceremoniously inaugurated in 2017 in the town of Dharchula. Its growing recognition within Bhotia community converges to its attribution as a symbol of immense pride.

reflections of the profound cultural and social tapestry woven by these tribal communities in the Himalayan peripheral lands.

a.

b.

c.

Figure 4a-b-c Display of Rung artifacts in Rung Museum situated in Dharchula

Despite its exceptional topography, cultural richness, and enormous potential for ecotourism development, the Darma landscape has not yet gained widespread popularity (TERI 2019). Nonetheless, owing to the novel community-based homestay initiative led by the Kumaon Mandal Vikas Nigam (KMVN), the region has experienced noticeable increase in the number of tourists in recent years, particularly in summer months, leading many community members to engage in tourism and related services. KMVN is a Government of Uttarakhand affiliated entity responsible for tourism development in the Kumaon region dedicated to promoting sustainable tourism, job creation and community development. In the initial phase, about 64 registered homestays emerged, predominantly located in the villages of Dantu, Dugtu, Nagling, and Baling. At present, there are over 190 registered homestays spread across all the villages (Table 6), registered under government affiliated Panchachuli Homestay

Owners Welfare Society[17]. The society likely aims to empower homestay owners in Darma, Byans and Chaudans valleys by providing guidance and resources including initiatives such as training programs, capacity building and networking opportunities. The homestay program, so far, has been effective in empowering members of the local community, particularly women, who have assumed pivotal roles as key contributors to household income. Scholarly documentation across IHR attests to prevalence of women's leadership roles in homestay-based ecotourism services (Anand et al. 2012; Ogra and Badola 2015; Bhalla et al. 2016).

Table 6 Number of registered homestays in Darma villages

	Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Baun	Philam	Tidang	Marchha	Sipu
No. of homestays	8	9	25	15	28	23	3	20	23	4	24	17

Data source: Acquired from Panchachuli Homestay Owners Welfare Society

Young Bhotia men, in particular, exhibit a notable inclination toward pursuing diverse off-farm avenues of sustenance, including occupations as porters, guides, drivers, roadside shop owners, and contractual wage labor within government programs, displaying a discernible disinterest in traditional pastoral pursuits. Within the Darma villages, there exists a pattern of widely distributing household responsibilities among family and community members, thereby mitigating the potential for conflicts between tourism activities and peak workloads in sectors like agriculture, pastoralism, and the collection of wild medicinal plants. The care of livestock is largely entrusted to *Anwals* and Gaddis, while subsistence crops are promptly cultivated upon the onset of upward migration during the early summer months. This organizational structure enables community members who are not directly engaged in these endeavors to capitalize on the prospects emerging from tourism initiatives without disruption. Furthermore, the rise of homestays has created opportunities for small-scale tourism businesses to emerge, such as The Himalayan Bluesheep, The Mountain Ride, and The Himalayan Goats, which are run by local Bhotia youth that have expanded their operations to additionally include winter alpine adventure activities in order to capitalize on periods of pastoral and agricultural inactivity in the higher settlements, as well as reduce the impact of seasonal fluctuations.

In addition, in response to emerging threats as well as abundance opportunities for livelihood creation and diversification, the Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI), a collaborative transboundary programme by the

[17] Panchachuli Homestay Owners Welfare Society is a legally registered society operating under the Societies Registration Act of 1860, which falls under the jurisdiction of the Registrar of Firms, Societies, and Chits, a department of the Uttarakhand government. This Act enables the registration of organizations that primarily work for the betterment of society, encompassing areas such as education, health, and employment. The society's registration (starting June 2022) is subject to renewal every five years to ensure its continued legal recognition.

International Centre for Integrated Mountain Development (ICIMOD) seeks to promote conservation and development in the KSL regions of China, India, and Nepal. Among many initiatives aimed at improving mountain communities' socio-ecological resilience, the KSLCDI aims to tap into the potential of successful ecotourism development and mainstream its importance in the regional conservation and development strategy, as well as foster entrepreneurship in the region, particularly among women and youth (Kotru et al. 2017). Thus far, these initiatives have yielded few accomplishments in establishing community trust in cross-border collaboration and documentation centered on cultural exchange and exploring ecotourism opportunities.

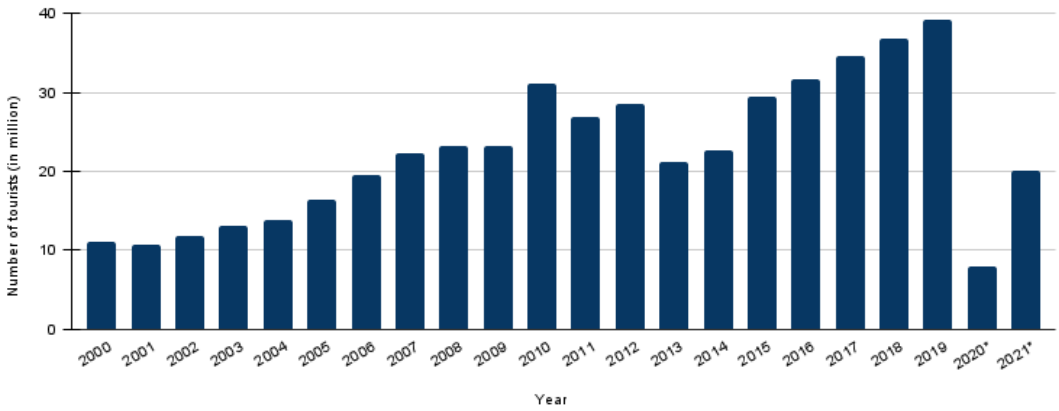
Likewise, the region is also one of the project areas of United Nations Development Programme's (UNDP) SECURE Himalaya program, which aims to promote the sustainable management of alpine pastures and forests in Himalayan ecosystems with the dual goals of conservation and sustainable livelihoods (such as ecotourism). This initiative has received immense youth engagement among the Bhotia communities in Darma and Byans, especially in SECURE Himalaya Youth Fellowship aimed at cultivating the next generation of conservation leaders. Thus, it is noteworthy that Darma valley boasts immense potential and basic prerequisites for ecotourism development, but proper planning, management, and implementation by all the relevant stakeholders are crucial to its full-scale realization as a sustainable livelihood adaptation strategy in response to emerging changes.

5.5. Current status of tourism, including ecotourism development in Uttarakhand

Despite the challenges posed by myriad of changes in the midst of current globalization times and changing climatic conditions, tourism is a booming sector in the Indian Himalayan Region (IHR), with a 7.9% annual growth rate projected from 2013 to 2023. (NITI Aayog 2018a). Similarly, it is one of the major economic activities in the IHR state of Uttarakhand, accounting for 40% of revenue and contributing the highest percentage to the state's GDP through cultural, spiritual, ecotourism, and adventure tourism (Uttarakhand Tourism Statistics 2015; NITI Aayog 2018a). The total tourist arrivals, including domestic and international increased from 26 million in 2011 to 39 million in 2019 and are expected to climb to 65 million by 2025 (Fig. 5) (NITI Aayog 2018a). This expansion is noteworthy, especially since 71% of the state's population relies on rain-fed agriculture, which is likely to be impacted by current and projected climatic impacts on water availability and agricultural productivity (Kuniyal et al. 2021; Upadhyay et al. 2021). This evident growth, thus, implies that tourism may create new opportunities for diverse livelihoods in the region (NITI Aayog 2018a; TERI 2019), while also necessitating the adoption of sustainable tourism practices to minimize negative outcomes and maximize profits in the face of climate change impacts on the sector (Scott et al. 2019; Scott 2021; Higham and Millar 2018).

Nevertheless, the sustainability of the tourism sector is susceptible to potential risks arising associated with political crisis and the outbreak of the pandemics (Mulder 2020; Neupane et al. 2021; Wang et al. 2022). This is evident from the observed decline in tourist numbers in Uttarakhand, as depicted in Figure 5. However, it is important to note that amidst these risks, there may also emerge opportunities for the growth of niche-based rural mountain tourism (Gajić et al. 2023). A pertinent example is the research conducted by Seraphin and Dosquet (2020), which illustrated the shift in travel preferences following the COVID-19 pandemic, with urban populations seeking mindful experiences in rural mountainous regions, ultimately benefitting the local communities.

Figure 5 Number of tourist arrivals in Uttarakhand (2000-2021)



*Note: *indicating Covid-19 years; Source: Uttarakhand Tourism Development board*

In Uttarakhand, ecotourism is viewed as a viable approach for boosting nature-based tourism (NITI Aayog 2018a). According to the most current developments in the state, the newly issued Uttarakhand Tourism Policy 2030 highlighted the state's environmental vulnerability and restricted land availability. As a result, the policy seeks to build a long-term strategy for the tourism sector's sustainable growth, as well as to nurture a safe and profitable environment for tourists, businesses, and indigenous stakeholders. It also envisages to promote the development of tourism circuits and destinations, as well as supporting infrastructure, while also employing private sector investments and heavily use digital technologies to enhance decision-making. As part of nationwide "Self-reliant India Initiative" or *Aatmanirbhar Bharat Abhiyan*[18], the policy promises to promote ecotourism growth in rural regions through a cluster approach, wherein groups of 5-7 villages with unique attributes will be identified and developed as a tourist destination. Some of the underlying themes for clustering

[18] In May 2020, the *Aatmanirbhar Bharat Abhiyan* was launched by the Government of India. The initiative aims to make India 'self-reliant' and promote self-sufficiency, resilience, and economic independence in various sectors of the country. It encompasses policies, reforms, and campaigns aimed at boosting domestic manufacturing, reducing dependence on imports, encouraging entrepreneurship, and fostering innovation in the country.

includes local crafts and cuisines; unique tribal culture; proximity to existing tourism circuits; and agro-tourism, alpine and cultural tourism. However, this act of favoring specific villages while excluding others can give rise to disparities in infrastructure and economic prospects, ultimately, to spatial inequalities and social conflicts (Kim 2008).

The heavy inclination towards ecotourism development is also demonstrated by the establishment of the Ecotourism Development Corporation Uttarakhand (ETDC) in 2017, as well as the inclusion of ecotourism development strategies in the Uttarakhand Tourism Master Plan 2007-2022. The state's 2007-2022 tourism master plan acknowledges ecotourism as a distinct area and outlines strategies to appeal to new ecotourism markets. Furthermore, the plan contains well-established measures for safeguarding, preserving, and enhancing ecotourism resources. The Uttarakhand Tourism Policy 2018 also prioritizes ecotourism, with the goal of encouraging village-based tourism, cultural tourism, community engagement, entrepreneurial skills, equal benefit sharing, and disaster-resilient tourist infrastructure. The strategy grants tourist sector status and delivers incentives and subsidies to Micro, Small, and Medium Enterprises (MSMEs) in Uttarakhand's undeveloped regions. The policy highlights provision for capital subsidy, stamp duty concession on tourism-related projects, tax incentives and interest subsidy for new tourism units (including cooperatives, associations, sole proprietorships, private and public limited companies).

In addition to these benefits, women entrepreneurs, and women-owned service-providing enterprises are offered special incentive schemes such as low-interest bank loans. These benefits become apparent with the latest guidelines of the Ministry of Tourism, Government of India (GoI) in the National Strategy for Ecotourism and National Strategy on Sustainable Tourism (2022) that emphasize heavily on the need to provide essential support to MSMEs across all economic sectors through funding schemes, training, marketing, and other enterprise requirements. This recognition is in line with the country's commitment to promote rapid entrepreneurship development nationwide through its "Make in India and Made in India" pan-India movement.

Alongside, sustainable mountain tourism has been identified as one of the priority sectors for intervention in IHR under the overarching mandate of the Ministry of Skill Development and Entrepreneurship (MSDE). The mandate is centered around promoting local skills and entrepreneurship for generating local employment and foster interest and ownership among local stakeholders through sustainable tourism practices. Furthermore, the MSDE recognizes the significance of "green skilling" in supporting adaptation and mitigation strategies in Uttarakhand (NITI Aayog 2018b). In recent years, the state of Uttarakhand has witnessed a strong entrepreneurial wave, leading to the introduction of various policies and initiatives for youth and women, aimed at promoting skill and enterprise development across all sectors, including ecotourism. Some of them are Deen Dayal Upadhyay Grameen Kaushalya Yojana (DDGUKY), Entrepreneurship and Placement Linked Skill Training Programme (EPLSTP), Pradhan

Mantri Kaushal Vikaas Yojana (PMKVY), Pradhan Mantri Employment Generation Programme, Vir Chandra Singh Garhwali Scheme (VCSGS), MSME Policy 2015, Mahila Uyami Vishesh Protsahan Yojana and Chief Minister Self-Employment Policy.

Despite a strong emphasis on ecotourism's potential to boost the local economy, the state has yet to adopt an ecotourism strategy, with the exception of the Uttarakhand Ecotourism Policy 2020 draft, which has received wide criticism. The proposed policy is questionable as it allows for significant forest areas to be opened up for ecotourism development and has been formulated with minimal contribution from the forest department, being mainly driven by the state tourism department. Conversely, it acknowledges the potential for local communities to fully participate in the sustainable planning and management of ecotourism enterprises and related entrepreneurial opportunities. Thus far, because of the likeliness of ecotourism to achieve dual objectives of economic growth and environmental conservation, particularly in Himalayan region[19], the increasing potential and prospects of ecotourism in Uttarakhand has begun to evidently reflect in state's developmental policies and schemes. However, the effectiveness of the government's management in addressing the needs of the growing tourism sector in Uttarakhand and the IHR remains uncertain, as there are gaps between the planning and consisted flow of financial resources for such developmental efforts (NITI Aayog 2018a).

[19] Rinzin et al. 2007; Newton and Franklin 2011; Kala and Maikhuri 2011; Anand et al. 2012; Balodi et al. 2014; Datta and Banerji 2015; Sarkar and Sinha 2015; Ogra and Badola 2015; KC et al. 2015; Bhalla et al. 2016; Walter et al. 2018; NITI Aayog 2018a; Aryal et al. 2019a; 2019b; Dahal et al. 2020; Montes and Kafley 2022; Basak et al. 2021; Neupane et al. 2021; KC et al. 2021; Upadhaya et al. 2022

6. Results and discussion

6.1. Study 1

In Study 1, we analyzed the extent of climate change in the region, the perspectives held by indigenous pastoral communities regarding climate change, and the socio-economic ramifications of climate change on the local populace and environment. For this purpose, we assessed the changing climate scenario in the Darma region and corroborated the results with local communities' perceptions and knowledge of climate variability and its impacts. This is because, in remote areas, communities often are subsistence-based and have limited access to communication, and their lived experiences and understanding of the local climate lead to their perceptions of the environment.

In this study, CRU TS climate data v4.02, a high-resolution gridded dataset for multiple variables on a 0.5° x 0.5° or finer grid developed by the Climatic Research Unit (University of East Anglia), was utilized to analyze the annual and seasonal temperature and precipitation trends spanning the period from 1975 to 2016. For the ease of convenience, the seasonal classification used by Mal et al. (2019) was adapted who denoted hot summer or pre-monsoon (March, April, May), Monsoon (June, July, August, September), Post-monsoon (October, November) and Winter (December, January, February). Temperature and precipitation trends were analyzed through Mann-Kendall (MK) trend test that has been widely used in previous studies in Uttarakhand and adjacent Himalayan regions (Mal et al. 2022; Karki et al. 2017; Hasson et al. 2017).

The climatic data, including the Mann-Kendall Test and linear regression analysis, as well as primary survey data were analyzed using XLSTAT and SPSS. In later stage, to delineate the trend of the snow presence in Darma valley (1990–2018), Normalized Difference Snow Index (NDSI) values were computed in SAGA GIS 7.0 and NDSI maps were generated in ArcGIS 10.6.1 using Landsat TM (Thematic Mapper), ETM+ (Enhanced Thematic Mapper Plus) and OLI (Operational Land Imager) imageries for the years 1990, 2001, 2011 and 2018. These were acquired from the United States Geological Survey (USGS) Landsat Missions website www.earthexplorer.org.

NDSI uses green spectral bands (high reflectance of the snow) and shortwave infra-red (SWIR) (low reflectance). For calculating NDSI, the equation used was: NDSI = (Green − SWIR)/ (Green + SWIR). Hall et al. (1995) suggests that NDSI values above 0.4 are a reliable threshold for snow mapping, as they usually indicate the presence of snow, which is represented in light color shades (usually close to white). In this study, the time period of 1990-2018 was chosen due to the lack of SWIR band in previous Landsat MSS (1972-1983) imageries.

Lastly, an extensive field survey based on qualitative research approaches such historical transect[20], household semi-structured interviews (*n*=200), KIIs (10), FGD (4) was conducted in 8 villages to examine the socio-economic attributes of the Bhotia community, their perceptions concerning climate change and impacts on their livelihoods and their response strategies. A pilot survey was initially conducted to pretest the questionnaire (see Appendix IV, Questionnaire 1) followed by actual survey later on. Thus, the acquired primary data concerning the local community's perspective on climatic fluctuations and patterns were correlated with the meteorological data and satellite imagery analysis in order to substantiate the occurrence of perceived climate variations and reappraise community's adaptive strategies. Similar methodological approach has been used in previous studies in Uttarakhand (Platt et al. 2021; Negi et al. 2017) and adjacent Himalayan regions of Nepal (Aryal et al. 2016; Uprety et al. 2017).

The overall MK results of the trend analysis are depicted in Table 7. The findings indicate a notable declining trend in annual, pre-monsoon and monsoon precipitation while post-monsoon and winter precipitation displayed no significant trend (Fig. 6). These results are found to be consistent with studies from other high-altitude regions in Uttarakhand (Bhambri et al. 2011b; Bhutiyani 2016; Mal et al. 2019). In Darma valley, however, overall temperature trends are found to be significantly increasing (Fig. 7 and 8). Between 1975-2016, the mean maximum temperature (annual, pre-monsoon and post-monsoon) increased, while there was no significant trend in monsoon and winter months. These results are consistent with the trends observed by studies conducted by Mishra (2014; 2017) in Uttarakhand and DHM (2017) in Darchula district of Nepal which lies in the closest proximity of the study area. A pronounced warming trend in mean annual temperature is also observed in other Himalayan regions such as in Kailash Sacred Landscape region (Zomer et al. 2014), northwest Himalayan regions (Bhutiyani et al. 2007; 2009; Bhutiyani 2016), Nepal (Qi et al. 2013; Kattel and Yao 2013; DHM 2017), Jammu and Kashmir (Shafiq et al. 2018). In addition, the warming temperature trends and declining precipitation trends in the study area is found to be consistent with previous studies in Uttarakhand (Bhutiyani et al. 2007; 2009; Mishra 2014; Dobhal et al. 2015; Mishra 2017; Mal et al.2019). Table 8 further depicts evidence from previous studies conducted in nearby regions that corroborate the findings of the present study in Darma valley.

Furthermore, the NDSI analysis reveal a marginal increment in the extent of snow-covered area from 1990 to 2011, followed by a decline by 2018 (Fig. 9). In totality, there has been a reduction in the extent of snow-covered area from 881.25 km^2 in 1990 to 664.41 km^2 in 2018 which corresponds to a drop of 216.84 km^2 and a decline of 24.6%. Although winter precipitation shows no significant trend, the NDSI analysis shows a significant decrease in the snow-covered area that can be explained by

[20] Historical transects facilitated the construction of a chronological narrative account, offering valuable insights into the Bhotia community's evolution over time in terms of social, cultural, economic, and environmental dynamics.

reinforced warming and melting processes as evidently researched by other scholars in the high-altitude Himalayan regions (Sharma et al. 2009; Zomer et al. 2016; Bhutiyani 2016; Bolch et al. 2019; Mal et al. 2019). These studies have observed reported change of snow to rain, in turn, causing reduced snow cover, rapid melting of snow and loss of glacial mass. Alongside, other glacial studies across different regions in Uttarakhand have also reported rapid snow recession rates (Bhambri et al. 2011a; 2011b; 2012; Nainwal et al. 2016; Mal et al. 2019). To substantiate the results of present study, Table 8 further depicts reported changes in climatic parameters from other studies conducted in regions located at close proximity to study area as well as from Uttarakhand, Western Himalayan regions, and Nepal.

The local community's perception of climatic variability and trends when validated with the meteorological data and NDSI analysis further revealed a broader context of the issue. Corroborating with the aforementioned findings, 82% of the respondents reported perceiving a noticeable upward trend in annual mean temperature. Similarly, a significant proportion of 78% and 85% of the respondents expressed observations of increasing temperature variations during the summer and winter months, respectively. The respondents' perception of precipitation patterns aligned with the observed trends, with the exception of winter months. Meteorological data indicated no significant trend in winter precipitation during the study period, whereas 64% of the respondents perceived a decline. Moreover, 69% of the respondents reported a decrease in overall precipitation, while 50.5% reported perceived changes in monsoon precipitation. These perceptions regarding temperature and precipitation changes were consistent with the actual observed trends. Additionally, the respondents noted a declining trend in the availability and occurrence of snowfall. The aforementioned findings can be found in the published manuscript (see Appendix II, Study 1).

For the majority of respondents, the perceived changes in climatic variables as expressed mainly indicated toward elevated temperatures in summer months, warmer winter months, reduced snow in winter, irregular rainfall patterns, scarcity of rainfall, depletion up of water sources, proliferation of invasive species in pasturelands, reduced availability of wild medicinal plants, heightened incidence of livestock diseases, diminished crop productivity, less nutritious forage, encroachment of shrub species, increased heat stress and increase in extreme events. The perceived socio-economic ramifications of these transformations within the local community encompass reduced livestock productivity, declining prices of pastoral goods, financial uncertainty, abandonment of land holdings, food insecurity, altered dietary patterns, high reliance on the market, migration outflows, and general decline in traditional transhumant practices.

Nevertheless, our analysis elucidates that the local community's interpretation of some of these ramifications primarily stems from historically embedded socio-political persuasion caused through the policy reforms and repercussions of war. Additionally,

they originate from the major contemporary alterations that arise from the influences of globalization, urbanization, and modernization, while climatic variations assume a peripheral position in driving these modifications forward. As a result, the community's response to adapt to these changes include reduction of herd size and adoption of diversified adaptive strategies. For instance, major adjustments are observed in the cropping patterns such as changed timing of agronomic practices, use of high yielding variety (HYV) seeds and cultivating less water-intensive crops also reported from other regional studies (Table 9). On the other hand, as a response strategy, mountain livelihoods are constantly diversifying by combing farm practices with non-farm activities such as daily wage labor, tourism services and accelerated labor migration (Rautela and Karki 2015; Ogra and Badola 2015; Tiwari and Joshi 2016; Negi et al. 2017; Gioli et al. 2019) as also evident from our findings in Darma valley.

In summation, the findings ascertained a substantial number of pastoralists apprehending climatic changes and its concomitant ramifications on their lives and livelihoods. Ultimately, conjoined with the underlying socio-political and economic dynamics, the customary pastoral practice in the region is waning, while fresh avenues for alternative income generation are persistently emerging. The authors additionally emphasized the imperative for effective sustainable adaptive measures, aiming to to strengthen local community's capacity to adapt to such changes. Nevertheless, the triumph of mitigation and adaptive strategies hinges upon their proactive adoption, implementation, and management.

Table 7 Findings from Mann-Kendall test for climatic (precipitation and temperature) trends between 1975–2016

Variable	Mann Kendall Statistic (S)	Kendall's Tau	Var (S)	p-value (two-tailed test)	alpha	Sen's slope	Test Interpretation	Trend
Precipitation								
Annual	-245	-0.285	8514.333	0.008	0.05	-4.505	Reject H0	Significant declining trend
Pre-monsoon	-118	-0.137	8518.333	0.021	0.05	-1.138	Reject H0	Significant declining trend
Monsoon	-181	-0.21	8514.333	0.049	0.05	-3.329	Reject H0	Significant declining trend
Post-monsoon	-81	-0.094	8514.333	0.388	0.05	-0.3	Accept H0	No significant trend
Winter	-68	-0.079	8513.333	0.461	0.05	-0.352	Accept H0	No significant trend
Minimum Temperature								
Annual	599	0.697	8510.333	< 0.0001	0.05	0.049	Reject H0	Significant increasing trend
Pre-monsoon	433	0.505	8506.333	< 0.0001	0.05	0.053	Reject H0	Significant increasing trend
Monsoon	660	0.771	8504.667	< 0.0001	0.05	0.047	Reject H0	Significant increasing trend
Post-monsoon	435	0.508	8503.667	< 0.0001	0.05	0.06	Reject H0	Significant increasing trend
Winter	370	0.434	8492.667	< 0.0001	0.05	0.04	Reject H0	Significant increasing trend
Maximum Temperature								
Annual	257	0.3	8507.667	0.005	0.05	0.02	Reject H0	Significant increasing trend
Pre-monsoon	239	0.28	8501	0.01	0.05	0.035	Reject H0	Significant increasing trend
Monsoon	138	0.161	8504.667	0.135	0.05	0.01	Accept H0	No significant trend
Post-monsoon	184	0.215	8504.667	0.046	0.05	0.021	Reject H0	Significant increasing trend
Winter	169	0.198	8497	0.067	0.05	0.025	Accept H0	No significant trend

Notes: Significance level (%): 5; Confidence level (%): 95
Source: Rawat and Schickhoff (2022)

Figure 6 Precipitation trends between 1975–2016 in Darma valley

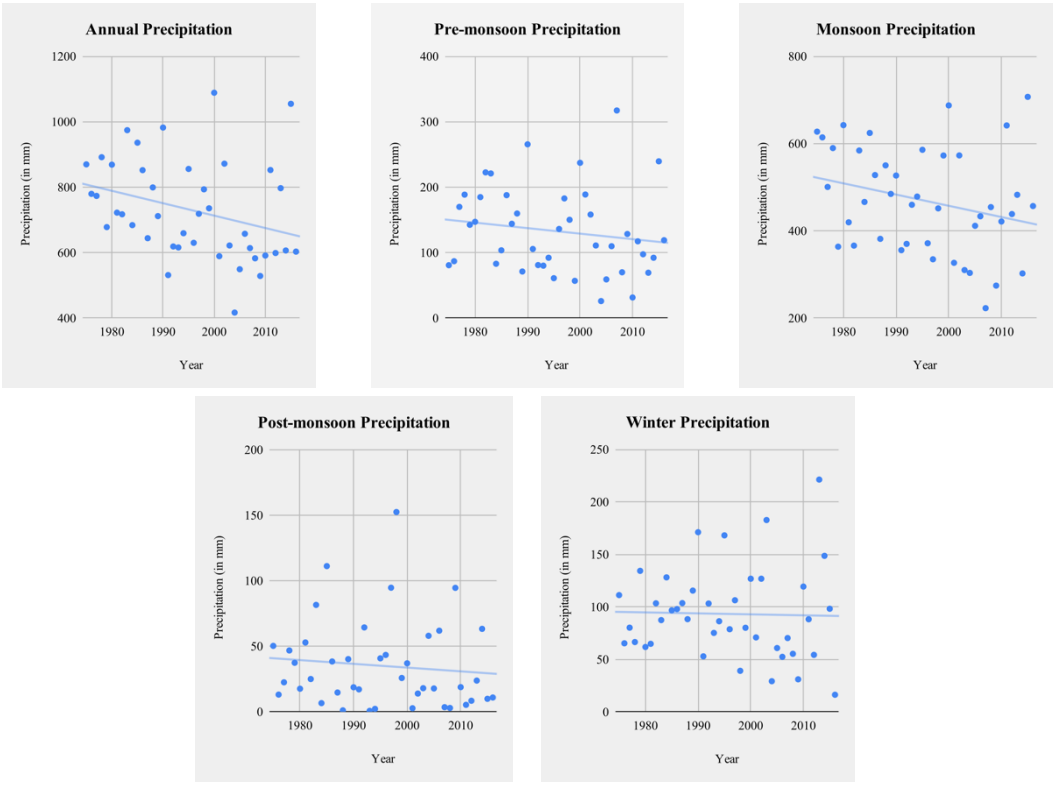
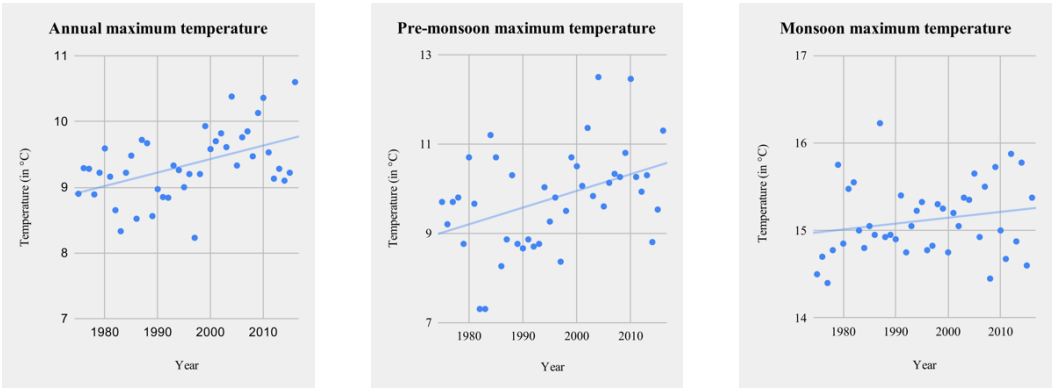


Figure 7 Maximum temperature trends between 1975–2016 in Darma valley



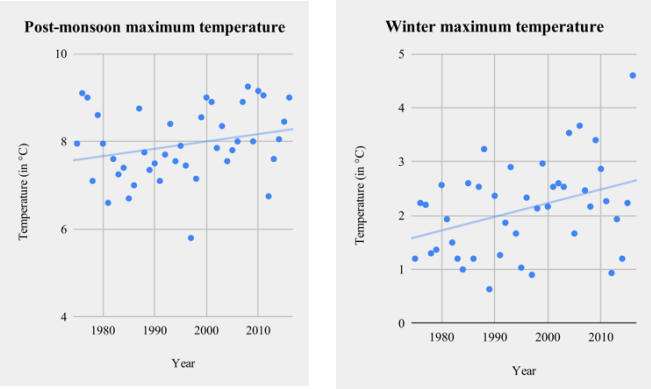


Figure 8 Minimum temperature trends between 1975–2016 in Darma valley

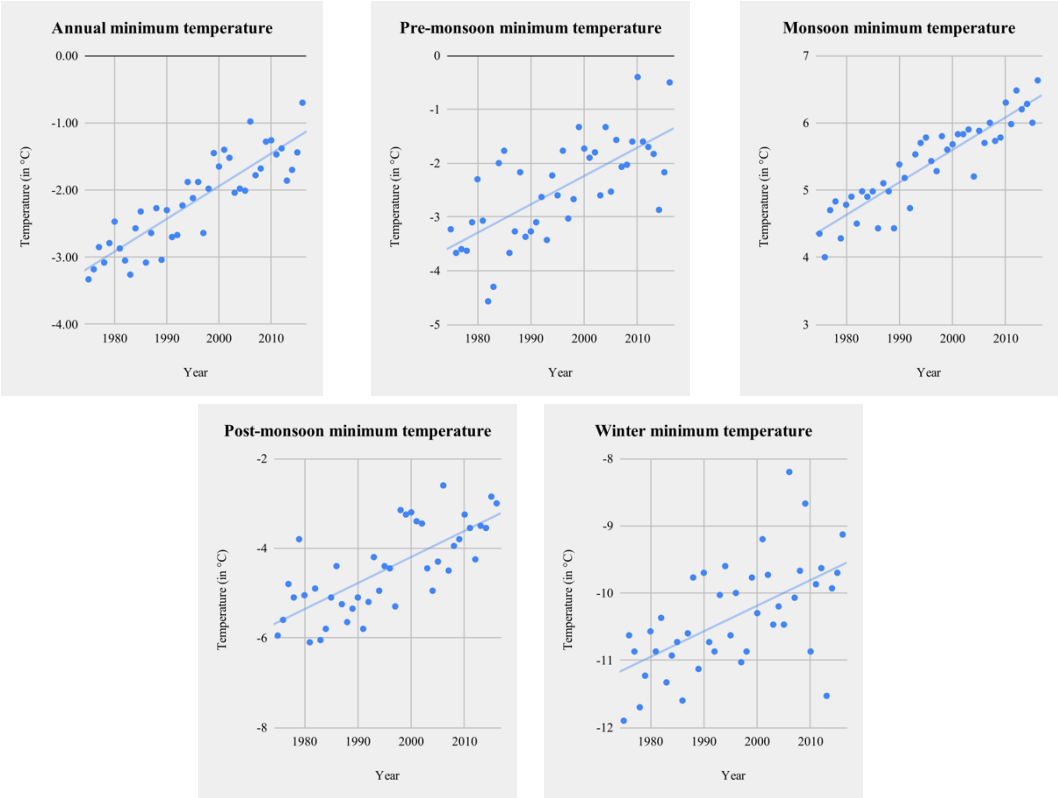
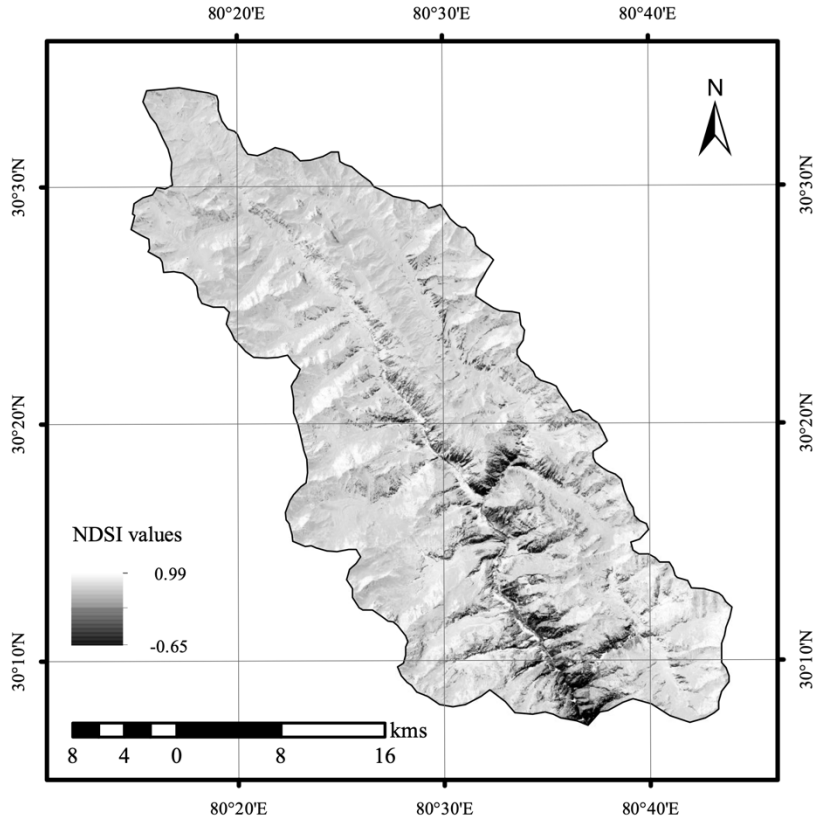
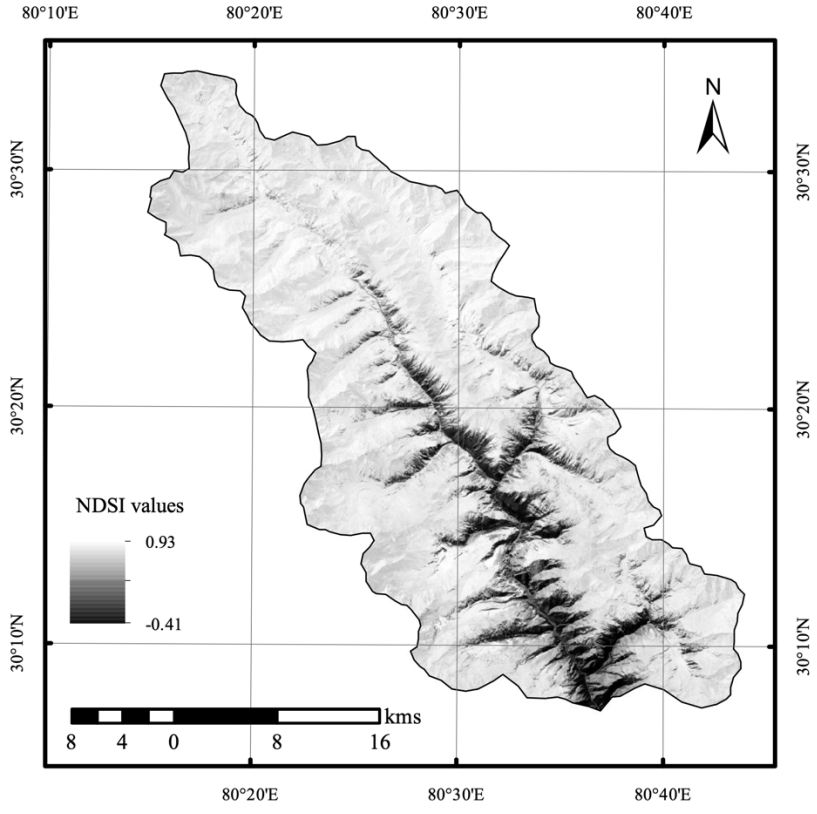


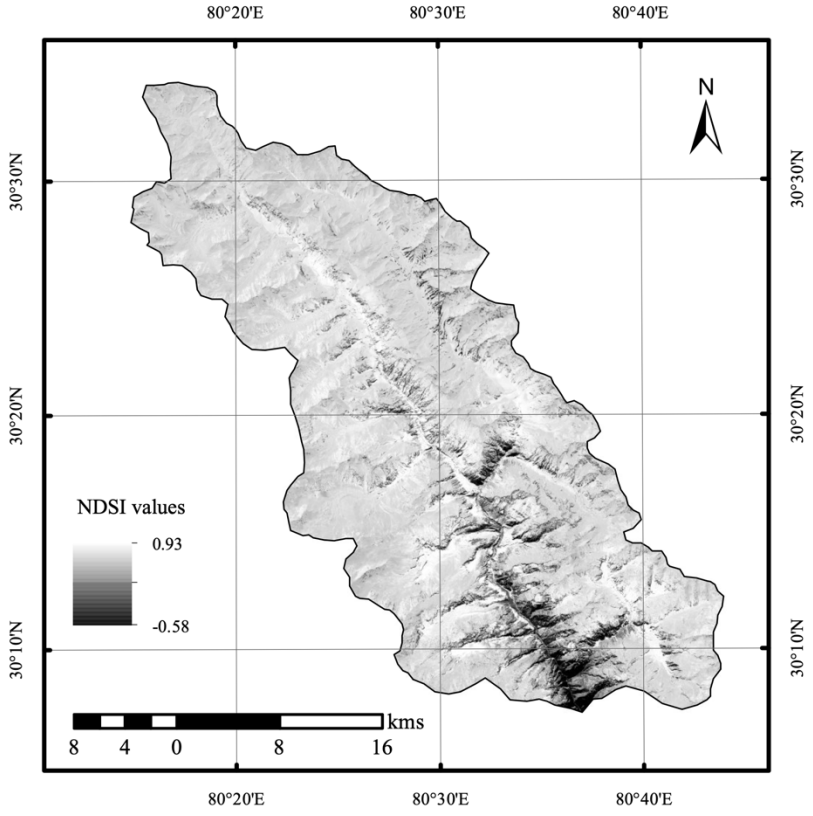
Figure 9 NDSI snow cover maps for selected years



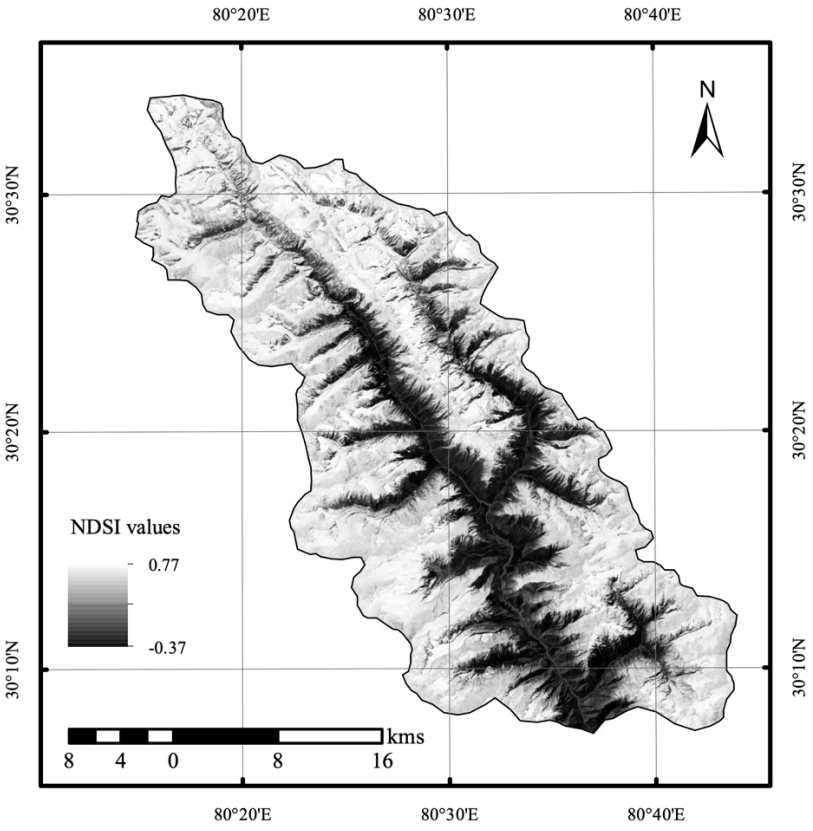
(a) 1990



(b) 2001


80°20'E
80°30'E
80°40'E
30°30'N
30°20'N
30°10'N
N
NDSI values
0.93
-0.58
kms
8 4 0 8 16

(c) 2011


80°20'E
80°30'E
80°40'E
30°30'N
30°20'N
30°10'N
N
NDSI values
0.77
-0.37
kms
8 4 0 8 16

(d) 2018

Table 8 Studies on changing climate scenario in Himalayan regions in close proximity to study region

Reported changes	Study region	Studies
Overall increase in mean annual temperature and warmer winters	Kailash Sacred Landscape (KSL)	Zomer et al. (2014)
	North-west Himalayan region	Bhutiyani et al. (2007; 2009); Bhutiyani (2016)
	Western Nepal	Kattel and Yao (2013)
	Pithoragarh (Uttarakhand)	Mishra (2014; 2017)
Warming trend in temperature and declining trend of precipitation	Uttarakhand	Bhutiyani et al. (2007; 2009); Mishra (2014; 2017); Dobhal et al. (2015); Mal et al. (2019)
	Jammu and Kashmir	Shafiq et al. (2018)
	Nepal	Qi et al. (2013); Kattel and Yao (2013); DHM (2017)
Decreasing monsoon and annual precipitation trends	North-western Himalaya	Bhutiyani (2016)
Increase in pre-monsoon maximum temperature	Darchula district (Nepal)	DHM (2017)
Reduced snowfall duration and snow cover	Western Himalayan region	Bhutiyani et al. (2009); Bhutiyani (2016)
Glacier recession	Milam glacier (Pithoragarh, Uttarakhand)	Mal et al. (2019)
	Satopanth glacier (Uttarakhand)	Nainwal et al. (2016)
	Bhagirathi and Gangotri glaciers (Uttarakhand)	Bhambri et al. (2011a; 2011b; 2012)

Table 9 Studies on socio-economic implications of changing climate on mountain livelihoods in Himalayan regions

Reported changes	Study region	Studies
Alteration in agronomic practices and cropping patterns	Uttarakhand	Sati (2015); Rautela and Karki (2015); Negi et al. (2017); Shukla et al. (2019)
	Himachal Pradesh	Basannagari and Kala (2013); Ndungu and Bhardwaj (2015); Loria and Bhardwaj (2016)
	Jammu and Kashmir	Batool et al. (2019)

Decline of transhumant pastoralism	Hindu Kush Himalayan region	Wu et al. (2014); Joshi et al. (2013)
	Uttarakhand	Negi (2007); Negi et al. (2012); Rautela and Karki (2015); Negi et al. (2017)
	Pakistan	Joshi et al. (2013)
	Bhutan	Namgay et al. (2014)
	Nepal	Aryal et al. (2014; 2016); Gentle and Thwaites (2016)
Outmigration	Hindu Kush Himalayan region	Banerjee et al. (2011); Siddiqui et al. (2019)
	Uttarakhand	Ogra and Badola (2015); Rautela and Karki (2015); Tiwari and Joshi (2016); Negi et al. (2017)
	Nepal	Gentle and Thwaites (2016)
	Bhutan	Namgay et al. (2014)
	Pakistan	Mueller et al. (2014)
	Eastern Himalaya	Sharma et al. (2009)
Increased pressure on women	Nepal	Gentle and Thwaites (2016)
	Nanda Devi Biosphere Reserve (Uttarakhand)	Ogra and Badola (2015)
	Bhutan	Namgay et al. (2014)
Livelihood diversification	Hindu Kush Himalayan region	Wu et al. (2014); Gioli et al. (2019)
	Nanda Devi Biosphere Reserve (Uttarakhand)	Ogra and Badola (2015)
	Nepal	Gentle and Thwaites (2016)

6.2. Study 2

In Study 2, we examined the potential and prospects of ecotourism as a source of sustainable livelihoods and adaptation strategy in the face of globalizing and changing climate scenario in Darma valley. The study involved use of descriptive and exploratory methodological approach based on extensive field surveys based on semi-structured interviews, FGDs, and KIIs were held with village heads, government officials, tourist guides, porters, homestay owners, local committee, and visitors. FGDs were held in four villages (Dugtu, Baling, Baun, and Sipu) with mixed groups of both men and women. 30 KIIs were held with diverse stakeholders, including village heads, government officials, tourist guides, porters, women homestay owners, local committee members, and visitors. The questionnaire (see Appendix IV, Questionnaire 2) pertained to take into consideration the local community's attitudes and views of tourism, their degree of awareness of the possible implications of ecotourism, and their willingness to engage in the planning and management of tourist operations. To this end, we examined a broader understanding of context and potential of ecotourism development, and its limitations using SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) and Ecotourism Opportunity Spectrum (ECOS) analysis.

First, SWOT analysis utilized internal factor estimate matrix (IFEM) and external factor estimate matrix (EFEM) to assess the potential strengths, weaknesses, opportunities, and threats of ecotourism development in the region (Mallick et al. 2020; Heshmati et al. 2022). This approach was conducted in conformity with its use in similar studies (Açıksöz et al. 2010; 2016; Demir et al. 2016). To pursue this, weights and ratings for SWOT factors were determined in consultation with experienced tourism operators and government officials during KIIs. The value of each weight ranged between 0 and 1, where 0 indicated a low importance factor and 1 indicated a high importance factor. The total value of weights should equal 1. The rating for IFEM ranged from 1 to 4, with 1 indicating a major weakness, 2 indicating a minor weakness, 3 indicating a minor strength, and 4 indicating a major strength. Likewise, the rating for EFEM also ranged from 1 to 4, with 1 indicating a major threat, 2 indicating a minor threat, 3 indicating a minor opportunity, and 4 indicating a major opportunity. The final weighted score was determined by multiplying weight of each factor by its rating. As a result, if the total sum of weighted scores of internal factors was more than 2.5, it depicted that strengths are more influential and dominating than weaknesses, whereas if the total sum of weighted scores of external factors was more than 2.5, it depicted opportunities are more influential and dominating than threats. Lastly, if the total sum of weighted scores of internal and external factors was less than 2.5, it depicts that weaknesses and threats dominate over strengths and opportunities, respectively.

Subsequently, ECOS was utilized as a practical tool to identify viable locales for ecotourism recreational activities and examine specialized ecotourism planning

requirements (Boyd and Butler 1996). Boyd and Butler (1996) developed the Ecotourism Opportunities Spectrum (ECOS) as a planning and assessment tool for ecotourism destinations. It provides a framework for evaluating a destination's appropriateness for ecotourism development based on its physical, ecological, and cultural characteristics, as well as the extent of development and management needed to render it a successful ecotourism destination. The ECOS criteria and sub-criteria used in the study were adapted and modified from Boyd and Butler (1996) and Açıksöz et al. (2010; 2016). The values for each sub-criteria were determined on a scale of 1-4 conformity scores. The detailed description of all the sub-criteria and scoring is highlighted in Appendix III, Table 1. The ECOS methodology incorporates elements from the Recreation Opportunity Spectrum (ROS) and the Tourist Opportunity Spectrum (TOS), all of which are widely accepted approaches for assessing the viability, design, and management of recreational and tourism initiatives.

Following this, we undertook systemic capital analysis of SLF assets to examine the accessibility to the core livelihood capitals in all the villages in Darma valley. The SLF reference indicators were adapted and modified from 'Guidance notes for the application of the Sustainable Livelihoods Framework in development projects' developed by UNDP (2017). A point-based scoring system ranging from 1-4 was used to assign values to each reference indicator. The detailed description of all the reference indicators and scoring is highlighted in Appendix III, Table 2.

In addition, a combination of participatory engagement with respondents and a thorough examination of secondary data from various sources, including the District Census Handbook of Pithoragarh, Census of India (2011), Department of Tourism, and other government research publications, was employed to establish the scoring for both ECOS analysis and SLF indicators. Ultimately, we modified the Sustainable Livelihood Framework (SLF) to examine and highlight potential connections between ecotourism-based adaptation, aiming to enhance community participation and empower the host communities.

SWOT results

The results from SWOT found (Table 10) that there is promising growing potential for nature and adventure activities, winter tourism activities, herbal tourism, and homestay services in the region. Furthermore, the evaluation result of key strategic SWOT factors as categorized into Internal Factor Estimation Matrix (IFEM) and External Factor Estimation Matrix (EFEM) informed that strengths (S) and opportunities (O) are more influential and dominating than weaknesses (W) and threats (T) in Darma valley. This is indicative from the total sum of weighted scores of internal (2.92) and external (2.76) factors which is higher than 2.5. The strengths primarily consisted of internal factors already in place that could potentially contribute to the growth of the ecotourism whereas the opportunities comprised of factors whom the local government, private

sector and local stakeholders could exploit in order promote sustainable ecotourism development in the region. Nevertheless, weaknesses and threats mainly included resource-related challenges as well as those attributed with disruptions caused by weather extremes, disasters, and lack of ecotourism policies at the local level which present significant problems as they constrain the ability of the households to engage actively in ecotourism practices. The comprehensive assessment of internal and external factors in the current analysis is essential for identifying viable strategy solutions for the development of ecotourism in the Darma region.

ECOS results

Results from the ECOS evaluation (Table 11) assisted in identifying the opportunities for potential ecotourism recreation development. The ECOS elements pertaining to the accessibility (C1), relationship between ecotourism and other resource uses (C2), attractions offered (C3) and presence of existing tourism infrastructure (C4) were determined from on-site study and observation. The remaining factors concerning level of skills and knowledge (C5), social interaction (C6) and acceptance of visitor impacts (C7) required interactions with the visitors and host community. The last factor concerning management regime (C8) needed to ensure ecotourism viability involved interactive dialogue with tourists, guides, local community, experts, and government officials.

According to the narratives generated from the FGDs and KIIs, Darma region has abundance of natural wealth as well as rich cultural heritage. Due to their proximity to the Panchachuli base camp, the availability of homestays and improved road infrastructure, Dugtu and Dantu are both the most appropriate villages for ecotourism development. The findings also suggest higher potential for ecotourism in Nagling and Baling. This can be attributed to the commendable road infrastructure developed by esteemed organizations such as the Border Road Organization (BRO)[21] and the Central Public Works Department (CPWD)[22]. The villages of Go, Philam, and Bon, on the other hand, are situated across from Dugtu. Despite offering a breathtaking view of the Panchachuli peaks, these locations attract a relatively lower influx of visitors in comparison to Dugtu and Dantu. This disparity can be attributed to the limited accessibility beyond Dantu, as the transportation services predominantly terminate at that point. The remaining villages of Tidang, Marchha, and Sipu must still be reached on foot. As a result, the predicament of limited accessibility beyond Dantu poses a challenge for visitors, specifically elderly tourists, and families with children, inhibiting their ability to explore beyond that point. This limitation ultimately leads to a decreased

[21] BRO plays a vital role in developing roads and infrastructure in India's border regions, including remote and strategic areas with difficult terrains. Its efforts are crucial for enhancing defense and security by enabling the seamless transportation of troops, equipment, and supplies to border areas.

[22] CPWD is India’s centralized and premier authority that oversees construction, maintenance, and management of public buildings and crucial infrastructure projects owned by the Government of India.

number of visitors in these villages during the peak tourist season. Nevertheless, the increasing presence of homestays in the villages of Baun, Philam, Marchha, and Sipu indicates a burgeoning appeal and recognition of these destinations among avid adventure enthusiasts seeking immersive experiences. Commencing from June 2022, the administration and facilitation of homestays in the Darma, Byans, and Chaudans valleys have been entrusted to the stewardship of the Panchachuli Homestay Owners Welfare Society.

Conversely, the relatively low ECOS scores assigned to the villages of Tidang, Marccha, Sipu, and Chal do not necessarily indicate their unsuitability for ecotourism development. Instead, they present opportunities to identify pivotal potential developmental efforts that must be considered. During the evaluation of the local community's response to community-led ecotourism development, it became apparent that respondents in all villages displayed a willingness to derive benefits from nascent tourism growth and did not perceive the incremental impacts of tourist presence as threatening. Nevertheless, given the existing tourism infrastructure and activities, a cognizance of the potential adverse effects stemming from the expansion of planned ecotourism endeavors exists, underscoring the pressing need for inclusive stakeholder engagement in management practices. Besides, it is imperative to acknowledge that rigorous oversight and control of the majority of ECOS assessment criteria are imperative to ensure the sustainable and enduring success of ecotourism development in the Darma region.

SLF capital analysis results

Moving forward, to situate the SLF in an ecotourism context, a systemic capital analysis was conducted based on 23 SLF reference indicators to examine and understand the accessibility to the core livelihood capitals upon which ecotourism-based development can potentially be built in Darma valley (Table 12). The SLF indicators as assessed for livelihood capitals report higher values for natural, human, and social capital stocks in overall villages in Darma. However, Dugtu with a highest score of 84, exhibited maximum access to the livelihood capitals, followed by Dantu (80) and Baling (77), whereas Marchha (62), Sipu (64), Philam (64), Sela (65) had the least access.

In relation to natural capital, the entire region boasts abundant biodiversity and awe-inspiring landscapes, which contribute to elevated values across all individual villages. In the context of this study, human capital represents local community’s educational status, provision to good health, capacity to acquire new skills and knowledge and awareness levels for income-generating activities. These factors collectively enable the community to vigilantly engage in diverse livelihood adaptation strategies. The overall growth in educational attainment among the Bhotia population can be attributed to their designation as a Scheduled Tribe (ST) in 1967, granting them privileged access to higher educational institutions and government positions. This is evident from the

above-average educational levels observed in all Darma villages, as well as the presence of Bhotia community members in key government departments at the national level. Through FGDs, we deduce that higher levels of education and heightened awareness foster a broader community perspective amidst the challenges posed by globalization, economic shifts, and environmental changes. The existing literature on linkages between human capital and climate adaptation evince the aforementioned (Zheng and Dallimer 2016; Ankrah et al. 2023).

In this study, social capital pertained specifically to the availability of social network resources, encompassing community engagement in NGOs, village committees, local village groups. It also encompasses community participation and their awareness of collective representation, that may contribute to the advancement of developmental objectives in Darma, particularly in relation to the creation of ecotourism-based livelihoods. Hence, the role of local community groups such as Panchachuli Homestay Owners Welfare Society*, Dilang Darma Sewa Samiti* and *Rung Kalyan Sanstha*[23], village committee groups, youth unions and women self-help groups (SHGs) is regarded as significant for the socio-economic upliftment and preservation of the Bhotia community in Darma as well as in the neighboring valleys of Byans and Chaudans. Furthermore, especially in rural areas, these closely knit social networks enable information sharing and facilitate collective action to deal with multitude of issues at the local level (Jamaliah and Powell 2018). The research findings indicate that local residents, youth groups, and women SHGs possess knowledge, positive perceptions, and a willingness to contribute to the development of ecotourism and the acquisition of related entrepreneurial skills, demonstrating a heightened level of collective community consciousness for tourism-related developmental initiatives in the region. This aligns with studies that explore the role of social capital in shaping community-based ecotourism development and entrepreneurship (Nugroho et al. 2021).

The findings of this study further reveal discernible variations in the levels of physical and financial assets, which are gauged by the availability of essential infrastructure and services, regular income streams, and access to institutions offering credit facilities. Financial capital, in particular, is the most versatile among the various livelihood assets, as it has the potential to be transformed into other forms of capital based on evolving structures and processes and can directly contribute to the attainment of favorable livelihood outcomes (DFID 1999). Nevertheless, it is observed that economically disadvantaged communities often exhibit limited access to financial capital assets, as is the case in the present scenario. Owing to the complex interplay of underlying

[23] *Rung Kalyan Sanstha*, established in 1989, is a social organization dedicated to the betterment of Rung tribal community residing in Darma, Chaudans and Byans valleys. The organization is driven by its commitment to advancing social welfare, preserving cultural heritage, fostering educational opportunities, and providing relief efforts among the Bhotia community.

influences of changing socio-economic and environmental dynamics, such circumstances often prompt communities to expand their range of livelihood options and partake in various diversified activities, encompassing both on-farm endeavors such as crop cultivation and animal husbandry, and off-farm income sources like wage labor, provision of tourism services, remittances, pensions, involvement in the transport business, and trade of wild medicinal plants.

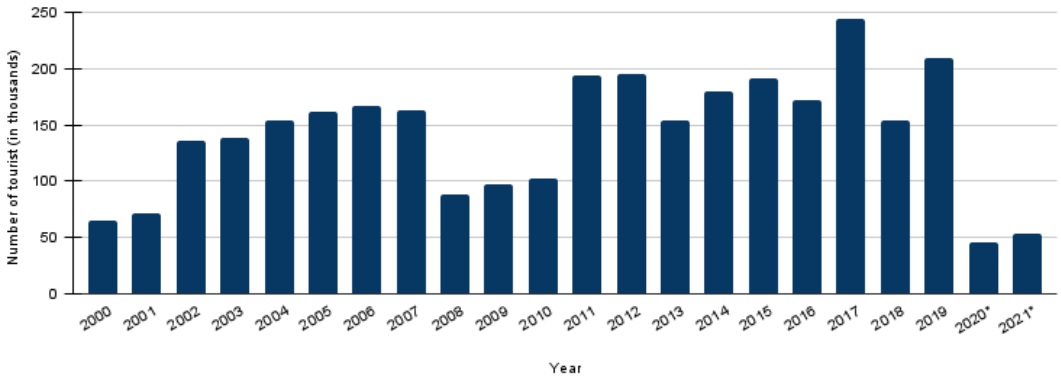
Noticeably, in the present context, focus group testimonies emphasized on non-farm activities in supplementing household income from limited on-farm activities, thus, portraying Bhotia community's inclination towards embracing diversified livelihood strategies. In this regard, through the implementation of sustainable tourism initiatives, a consensus emerged regarding the potential for substantial income growth within households and the subsequent reinvestment of profits to bolster tourism operations, thereby fostering capital gains at the household level. Furthermore, government intervention, in terms of economic and social development schemes and subsidies were observed to be contributing to the expansion of financial capital base. A substantial body of literature underscores pivotal influential role played by access to financial resources in shaping climate adaptation strategies, especially in the countries of Global South (Azad and Pritchard 2022; Ankrah et al. 2023).

On the contrary, the assessment of physical capital assets reveals a relatively lower availability of essential infrastructure and producer goods necessary to support livelihoods in the Darma villages. This includes lack of proper garbage disposal, phone network, access to community toilets and limited road connectivity. Nevertheless, significant advancements have emerged in the region, with the installment of three mobile towers facilitated by a private company. While these towers are on the brink of becoming fully functional, their enhanced mobile and internet connectivity possesses the potential to pique the curiosity of potential tourists in the area. During the first phase of the homestay program, the existence of homestays was limited to four particular villages: Dantu, Dugtu, Nagling, and Baling. However, the emergence of homestays is currently expanding across new villages, albeit still in smaller numbers in the villages of Sela, Chal, Go, and Tidang. Additional accommodations include tourist huts at the Panchachuli base camp, snow huts in Nagling hamlet, and igloo cottages in Baling.

While our comprehensive research highlights the considerable potential for ecotourism development in the Darma valley, it is crucial to acknowledge the climate-sensitive nature of the tourism sector (Scott et al. 2019; Scott 2021). As a result, substantial support in terms of institutional infrastructure, financial investment, and effective on-the-ground implementation is necessary (Salgueiro et al. 2020; Becken and Loehr 2022). Furthermore, it became evident that the emergence of unpredictable events, such as the outbreak of COVID-19, may directly impact the livelihood assets of the community, especially financial resources. For instance, the rapid growth in tourism statistics in Pithoragarh experienced a severe decline during the years affected by the

COVID-19 pandemic (Fig. 10). In such circumstances, it is imperative for the government to intervene at the organizational and regulatory levels to ensure the community's access to capital accumulation, thereby enabling them to pursue diverse livelihood strategies and safeguarding the vulnerable communities from adverse impacts (Singh et al. 2021).

Figure 10 Number of tourist arrivals in Pithoragarh (2000-2021)



*Note: *indicating Covid-19 years; Source: Uttarakhand Tourism Development board*

Despite these uncertainties, it is noteworthy that the increasing interest of tourists in adventure, religious, and homestay tourism in higher altitude Himalayan valleys, including in Darma landscape is gradually capturing the attention of both the state government and non-governmental organizations, leading to the promotion of sustainable tourism practices and the incorporation of relevant provisions in state tourism policies (TERI 2019). Our investigation also uncovered multitude of state-sponsored initiatives centered around sustainable tourism, forest conservation, livelihood development, handloom production, water conservation, and horticultural development that may be leveraged to stimulate ecotourism growth and potential in Darma landscape. Even so, at present, there is no immediate menace to the region due to the current pace of tourism development in Darma valley, it remains imperative for the governing authorities to exhibit meticulousness in confronting detrimental external factors. These factors largely encompass apprehensions pertaining to deficient provision of infrastructure (Datta and Banerji 2015; Sarkar and Sinha 2015), flawed environmental policies (Singh et al. 2021), as well as insufficiency of skilled labor and inadequate engagement of the local community (Mak et al. 2017; Chan et al. 2021).

To conclude, the comprehensive findings from SWOT, ECOS and SLF reference indicators can be integrated in the Sustainable Livelihood Framework (SLF). The utilization of the sustainable livelihood (SL) framework in the current study serves as a methodological tool to comprehend the local community's assets, vulnerabilities, and their perception regarding the potential of ecotourism as an adaptive strategy in response to culmination of diverse challenges (Fig. 11). In doing so, it became apparent

that to comprehensively examine the local community's perspective on the potential benefits of ecotourism in Darma, encompassing economic development, environmental conservation, and community resilience, it is imperative to employ multiple methodological approaches. However, further in-depth research particularly in this region and adjoining Himalayan valleys is highly required to advance knowledge on the intersection between ecotourism, sustainable livelihoods, and climate adaptation.

Table 10 Results of investigation into ecotourism potential in Darma valley using SWOT matrix

Internal Factor Estimation Matrix (IFEM)				External Factor Estimation Matrix (EFEM)			
Strengths	Weight	Rating	Weighted score	Opportunities	Weight	Rating	Weighted score
Richness of natural and cultural resources	0.07	4	0.28	Sustainable nature-based tourism	0.06	4	0.24
Tribal circuit tourism	0.06	4	0.24	Winter tourism activities	0.05	4	0.2
Various trekking trails in and around Darma valley	0.06	4	0.24	Expansion of ecotourism activities	0.06	4	0.24
Ethnic diversity	0.05	4	0.2	Environmental education and conservation	0.05	3	0.15
Local tribal cuisine	0.04	3	0.12	Active community participation	0.05	4	0.2
Favourable climatic conditions	0.04	4	0.16	Employment opportunities to women and youth	0.07	4	0.28
Unique traditional Bhotia architecture	0.04	3	0.12	Women participation in ecotourism services	0.05	4	0.2
Bhotia museum in Dharchula	0.02	3	0.06	Bigger market for local handicraft products	0.04	3	0.12
Existence of government rest houses and check posts	0.03	3	0.09	Preservation of local Bhotia culture and traditions	0.04	3	0.12
Diverse topographic forms	0.06	4	0.24	Collaborative ecotourism planning	0.05	3	0.15
Affordable homestay facilities	0.04	4	0.16	Ecotourism capacity building initiatives	0.04	3	0.12
Affordable transportation	0.04	3	0.12	Exchange of knowledge	0.02	3	0.06
Richness of ancient folklores	0.04	4	0.16	Improved basic infrastructure	0.05	4	0.2
Sustainable use of solar panels	0.03	3	0.09				
Market for local handicraft products	0.04	3	0.12				
Easy market access to Dharchula (nearest town)	0.02	3	0.06				
Weaknesses				Threats			
Lack of appropriate ecotourism planning and policies	0.06	1	0.06	Disruption caused by natural disasters	0.05	2	0.1
Inadequate basic infrastructure	0.05	1	0.05	Disruption caused by weather extremes	0.05	1	0.05
Limited number of guides, porters, operators	0.03	2	0.06	Weakened management and ineffective enforcemen	0.04	1	0.04
No network connectivity	0.03	2	0.06	Intrusion of wild animals (wild boar, leopards)	0.03	2	0.06
Inadequate funding for tourism activities	0.03	1	0.03	Exceeding carrying capacity	0.05	1	0.05
Unorganized tourism service provider	0.03	2	0.06	Natural resource exploitation	0.04	1	0.04
Lack of healthcare facilities	0.04	1	0.04	Revenue benefits to only a few individuals	0.03	1	0.03
Migration of youth population to urban areas	0.03	2	0.06	Uncontrolled tourism development	0.05	1	0.05
Seasonal tourism demands	0.02	2	0.04	Conflict of interest between government and locals	0.03	2	0.06
	1		**2.92**		**1**		**2.76**

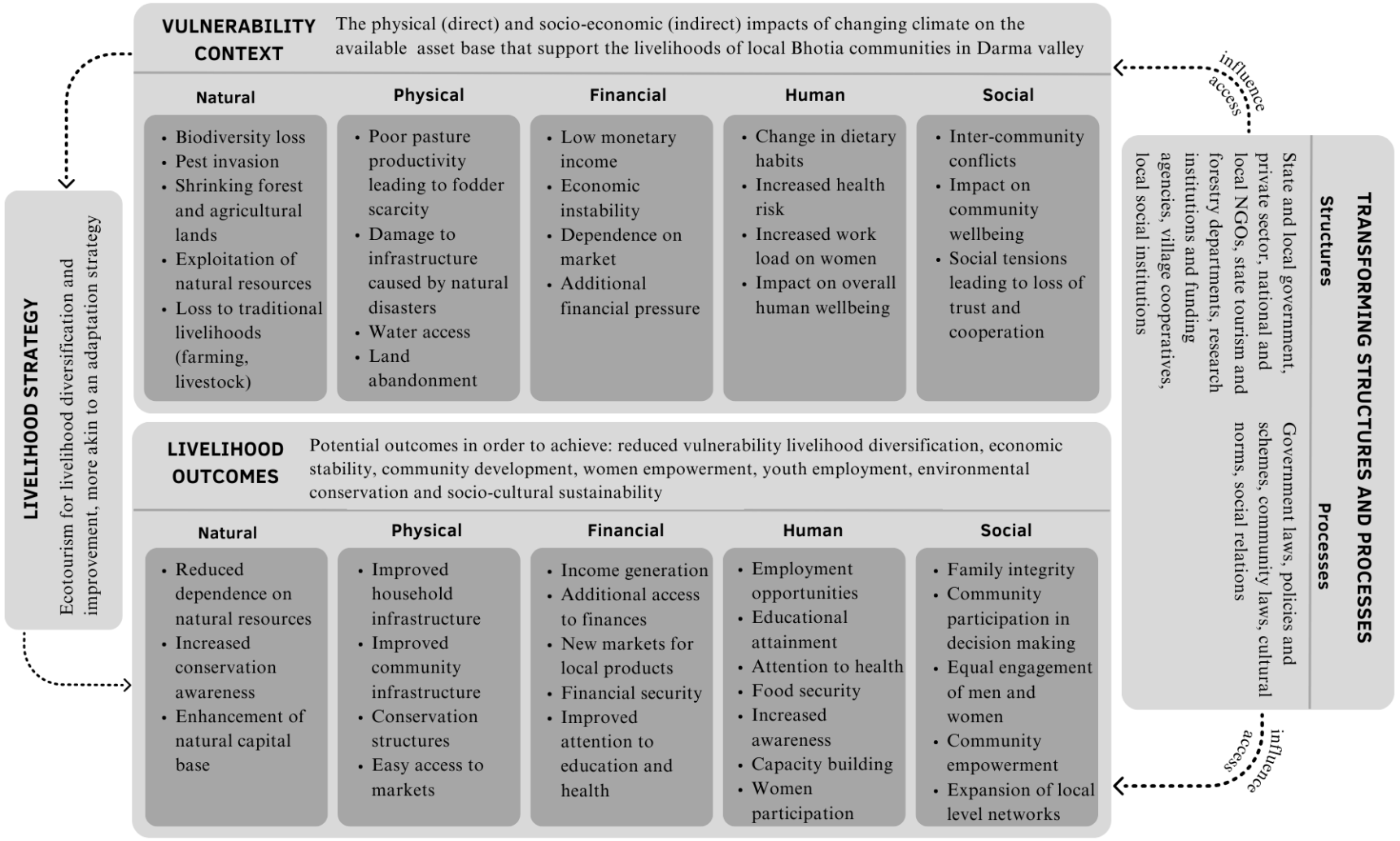
Table 11 Results of investigation into ecotourism potential in Darma valley using ECOS methodology

Criteria	Sub-criteria	Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Philam	Baun	Tidang	Marchha	Sipu
Accessibility (C1)	Accessibility to villages[1]	3	2	4	4	4	4	3	3	3	2	2	2
	Access to transportation[1]	3	3	4	4	4	4	2	2	2	1	1	1
	Distance to the market town (Dharchula)[4]	1	1	1	1	1	1	1	1	1	1	1	1
Relationship between ecotourism and other resource uses (C2)	Awareness regarding ecotourism[1]	3	3	4	4	4	4	3	4	4	3	3	3
	Opportunity to experience traditional customs[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Resource compatibility with tourism uses[1]	2	3	4	3	4	4	4	4	4	3	3	3
Attractions offered (C3)	Diversity of landforms[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Presence of forests in the proximity[1]	3	3	3	3	2	4	3	2	2	2	3	4
	Outstanding beauty[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Presence of historical-archeological sites[1]	1	1	1	1	4	4	1	1	4	1	1	4
	Proximity to Panchachuli base camp[2]	2	2	3	3	4	4	3	3	3	2	2	2
Existing tourism infrastructure (C4)	Accommodation facilities for tourists[1]	2	2	4	4	4	4	2	2	2	2	2	2
	Nearest primary health centre[4]	3	1	1	2	3	2	2	2	2	2	2	2
	Primary school[5]	4	4	4	4	4	4	4	4	4	4	4	4
	Availability of food (shops, hotels)[1]	3	1	4	3	4	4	2	2	2	1	1	1
	Existing recreational activities[1]	1	1	4	4	4	4	3	3	3	1	1	1
	Provision for drinking water[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Provision of power supply[1]	2	2	2	2	2	2	2	1	2	2	1	1
	Availability of human resources (potential workforce)[6]	2	2	3	3	2	1	3	1	4	2	1	1
Level of skill and knowledge (C5)	Educational status of local people[1]	2	2	3	3	3	3	3	3	2	4	4	4
	Availability of tourist guides[1]	2	2	3	3	4	4	2	2	2	2	2	2
	Knowledge of other languages[1]	2	2	2	2	3	3	2	2	2	2	2	2
Social interaction level (C6)	Frequency of interaction with tourists[1]	3	2	4	4	4	4	3	3	3	2	2	2
	Tourist attitude towards community and vice-versa[3]	4	4	4	4	4	4	4	4	4	4	4	4
Acceptance of visitor impact (C7)	Degree of impact on ecotourism resources[3]	4	4	4	4	3	3	4	4	4	4	4	4
Partnership and management for ecotourism viability (C8)	Community involvement in resource protection[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Government involvement in managing tours[1]	2	2	3	3	3	3	2	2	2	2	2	2
	Community involvement in managing tours[1]	4	3	4	4	4	4	2	2	2	2	2	2
		78	72	93	92	98	98	80	77	83	71	70	74

Table 12 Results of SLF capital analysis for determining ecotourism potential in Darma valley

Criteria	Reference indicators	Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Philam	Baun	Tidang	Marchha	Sipu
Natural (R1)	Natural resources availability[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Accessibility to natural resources[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Unique biodiversity[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Existence of forests in the proximity[1]	3	3	2	2	4	4	2	2	3	2	2	4
	Proximity to *Panchachuli base camp* (glacier)[1]	2	2	3	3	4	4	3	3	3	2	2	2
Human (R2)	Educational status[1]	2	2	3	3	3	3	3	3	2	4	4	4
	Awareness, skills, and trainings for income generating activities[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Nearest primary health centre[2]	2	4	4	3	2	3	3	3	3	3	3	3
Financial (R3)	On-farm income generating activities (crop and animal production)[1]	3	3	3	3	4	3	4	3	4	3	3	3
	Access to non-farm income generating activities (trekking, wage labor, etc.)[1]	3	3	3	3	4	4	3	3	3	2	2	2
	Regular inflow of money (remittances, pensions, etc.)[1]	3	3	3	3	3	3	3	3	3	3	3	3
Physical (R4)	Access to state subsidy programmes[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Access to drinking water[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Access to road and transportation facilities[1]	3	2	4	4	4	4	2	2	2	1	1	1
	Access to basic infrastructure services (waste disposal, sewage, etc.)[1]	2	2	2	4	4	3	2	2	2	2	3	3
	Access to power supply for domestic use[1]	4	4	4	4	4	1	4	1	4	4	1	1
	Access to communication (public phone booths)[1]	1	1	1	4	4	4	1	1	1	2	1	1
	Access to community toilets[3]	1	1	2	2	3	3	2	1	2	2	1	1
	Accommodation availability for tourists[1]	1	1	4	4	4	4	1	1	1	1	1	1
	Distance to the central market *(Dharchula)* [2]	1	1	1	1	1	1	1	1	1	1	1	1
Social (R5)	Organizational partnerships and memberships (NGOs, local committees, etc.)[1]	3	3	3	3	4	4	3	3	4	3	3	3
	Participation in formal groups[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Awareness of collective representation, networks and connections[1]	3	3	3	3	4	4	4	4	4	3	3	3
		65	66	73	77	84	80	69	64	70	66	62	64

Figure 11 SLF framework for developing ecotourism as a livelihood adaptation strategy in Darma valley



6.3. Study 3

In Study 3, we investigated the significance of utilizing Sustainable Business Models (SBMs) for the development of ecotourism in the Darma valley. Recognizing the lack of formalized business models tailored for tourism and/or ecotourism development in the region, the study undertook an exploratory approach to propose a prototype for a potential rural ecotourism enterprise in the region. This was achieved by utilizing the Sustainable Business Model Canvas (SBMC), a framework introduced by Basile et al. (2021) and adapted from the original Business Model Canvas (BMC) developed by Osterwalder and Pigneur (2010). The original BMC is built upon nine building blocks categorized majorly in triumvirate innovation aspects[24], namely, desirability, feasibility, and viability as illustrated in Figure 12 (Osterwalder and Pigneur 2010).

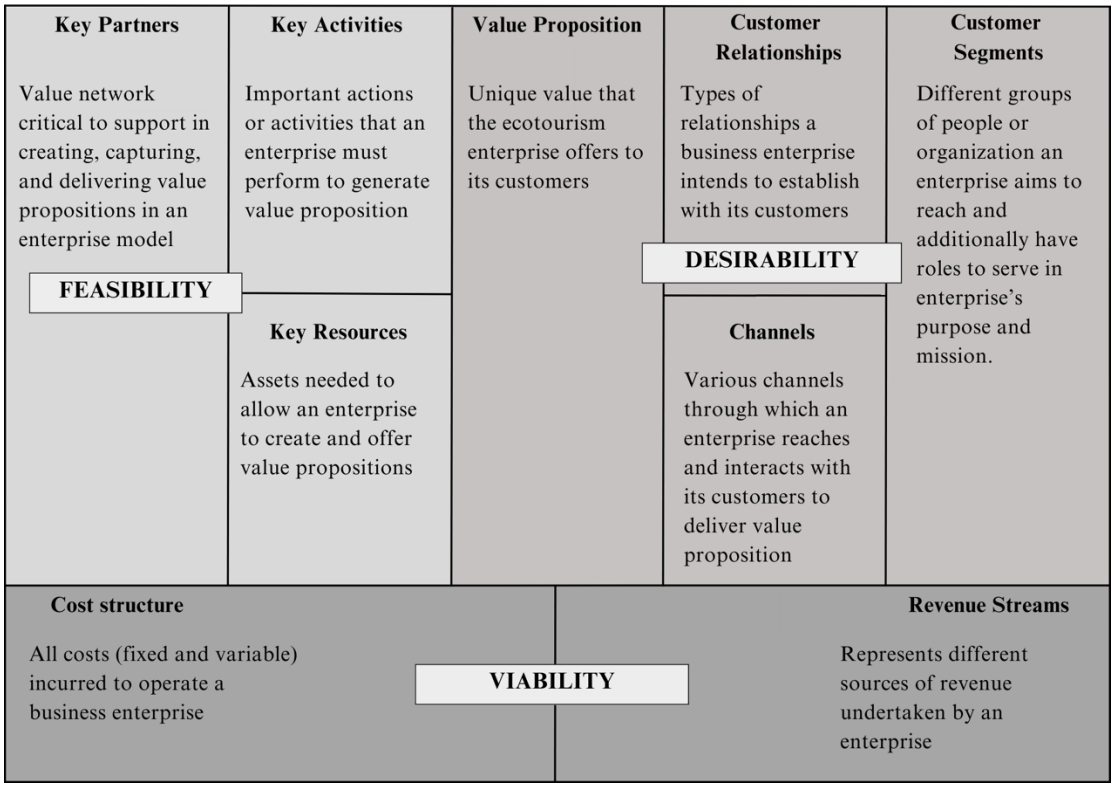


Figure 12 Original BMC illustrating triumvirate innovation aspects of an ecotourism enterprise (Osterwalder and Pigneur 2010)

The study objective was accomplished through participatory engagement with the local community and stakeholders to comprehend their needs, aspirations, and concerns pertaining to ecotourism development. Their valuable perspectives were then integrated

[24] Here, *Desirability* explores whether the service being offered is desirable and provides value to the customers (tourists). *Feasibility* aspect assesses the technical and operational feasibility of implementing the business model. Finally, *viability* evaluates the economic and financial viability of the business model.

into the canvas, as it became evident that existing small-scale tourist ventures in the region lack a comprehensive understanding of well-structured and systematic business development strategies. The data collection phase employed an inquiry-based conversational approach, employing in-depth semi-structured Key Informant Interviews (KIIs) involving a diverse set of stakeholders, including local tour operators and guides (5), homestay owners (5), village leaders (2), and government officials from the tourism department (2). Additionally, FGDs were conducted with participants comprising unemployed youth, women, and older individuals. The questions posed during both the KIIs and FGDs were tailored to address various aspects of the building blocks within the SBMC (see Appendix III, Table 3).

The study also sought to provide an integrated analysis of solidarity economy principles to guarantee that the proposed prototype aligns with the solidarity values and goals as espoused by the Network of Alternative and Solidarity Economy Networks (REAS 2011). In practice, the solidarity approach aspires to foster community development while fostering a symbiotic relationship between business production and the environment. Previous scholarly works have underscored the pivotal role of business models in rural ecotourism, acting as facilitators for realizing the fundamental tenets of the solidarity paradigm, which in turn, may contribute to the sustainability and resilience of both the enterprise and the communities it serves (Bailey et al. 2018; Morais and Bacic 2020; Forero and Saavedra 2022; Vargas Vasserot 2023).

In light of this consideration, the authors intended to demonstrate plausible linkages between the vital role of business models in rural ecotourism development and the fundamentals of the solidarity paradigm. Hence, the study utilized guiding principles outlined by REAS (2011) as an analytical framework (Table 13) to confirming the understanding gained from SBMC analysis. Ultimately, the subsequent stages will hinge upon the outcomes derived from the evaluation of the proposed prototype for enterprise conception and creation at the ground level. This will enable various stakeholders, including existing tour operators, aspiring young and women entrepreneurs, and community leaders, to assess and validate their assumptions, solicit feedback from potential visitor segments (e.g., adventure and eco-enthusiasts) and external stakeholders, as well as effectuate necessary adjustments to their business plans prior to wide-scale implementation.

Simultaneously, the insights from this study can serve as recommendations, guiding the establishment of novel ecotourism ventures in the Darma region, while also informing decision-making and policy formulation in analogous geographical contexts.

Table 13 REAS (2011) guiding principles and their implications for proposed SBMC prototype

REAS Principles	Key implications for propsoed SBMC ecotourism prototype
Equity	Does the proposed model recognize equal opportunities, conditions and treatment for all individuals? Does it consider fair distribution of obligations, resources and responsibilities? Does it eliminate discriminatory characteristics throughout the entire business operations?
Decent work	Does it promote decent work opportunities to the local community? Does it promote full and productive employment in an equitable manner? Does it facilitate social and economic inclusion incorporating the local communities to choose their work based on their abilities and desires?
Environmental sustainability	Is environmental sustainability an integral part of the proposed model? Does it acknowledge and consider the environmental constraints, given the uncertainties? Does it align with the objectives of promoting conscious, responsible, critical, and transformative production, distribution, and consumption models, while also pursuing economic benefits?
Cooperation	Does it promote cooperation among various stakeholders? Does it enable local communities' participation in decision-making and shared responsibilities? Does it encourage co-responsibility, collaborative work, collective deliberation, shared knowledge and mutual learning among stakeholders?
Fair sharing of wealth	Does it encourage and endorse transformative collective efforts and community solidarity mechanisms? Does it promote fair distribution of wealth within the local community? Does it offer reinvesting surpluses in the community's socio-economic and environmental development?
Territorial responsibility	Does it value the community's and region's resources, capacities, culture and potential? Does it encourage active and quality community participation for collective construction? Does it promote social and environmental awareness, mobilization and actions to transform the local economy? Is it capable of influencing public policies in order to develop strategies for the region's long-term development?

SBMC Prototype

The overall findings demonstrate that there is limited knowledge on business models among stakeholders, particularly among tour operators and homestay owners, who mostly operate outside the formalized business models commonly found in the literature. The participatory consultations, in this regard, resulted in a better understanding of the region's needs, aspirations, and concerns about ecotourism development. The acquired viewpoints, as described within the SBMC building blocks, were incorporated into the canvas to create an overall narrative about how ecotourism developed may potentially be achieved in the region (Table 14).

To elaborate, the proposed SBMC targeted the local Bhotia community as primary stakeholders and domestic and international tourists as secondary stakeholders (customer segment). Adventure, religious, and eco-enthusiast tourists were identified as different categories within the latter group. The participation of village youth and women as tour operators and service providers, as well as women-led local informal groups was recognized. Driven by an abundance of natural, cultural, and labor resource base, the proposed approach provides a unified value proposition that caters to the needs of both the host community and tourists. The community's priorities are centered around sustainable livelihood, employment opportunities, income generation, poverty alleviation, and conservational efforts. On the other hand, tourists are offered ecotourism services, cultural experiences, and opportunities for knowledge exchange.

The respondents identified wide range of ecotourism services (key activities) to generate revenue which include availability of adventure activities (trekking, hiking, and mountaineering), eco-activities (birdwatching, organic farming, horticulture, floriculture, and farm volunteer work) and rich Bhotia cultural experiences (homestay accommodation, handicraft sales, guided tours showcasing Bhotia craftsmanship and traditions). The region offers numerous nature trails in and around Darma valley, including *Panchachuli base camp, Mahadev cave, Achaari lake, Gabbe top, Baling pastures, Sinla pass, Parvati kund, Adi Kailash, Jolingkong*, and *Om Parvat viewpoint,* and is part of the newly recognized Bhotia tribal circuit, which also includes the adjacent Byans and Chaudans valleys. The region has seen the emergence of off-season winter snow adventure activities organized by local youth groups. This is a result of realization that the seasonal nature of tourism demands may affect the revenue streams. To overcome this challenge, the respondents proposed diversified activities that can attract tourists throughout the year such as bird watching, winter trekking and skiing in the winter season. In such manner, the year-round prospects can reduce the impact of seasonal fluctuations. Moreover, this can be achieved through marketing campaigns and offering incentives such as discounts and/or specialized tour packages.

In addition, paragliding, volunteer tourism, wildlife tourism, cultural tourism, religious tourism, and herbal tourism were also identified as having significant growth potential.

tribal festivals and fairs such as *Jauljibi mela*, *Pandali mela*, and *Gulaj mela*, among others, seemed to offer an intangible and ethereal sense of rich cultural legacy of the Bhotia community. Nonetheless, there is a critical requirement to strategically optimize pricing methods as needed to determine the profitability and sustainability of the potential enterprise (cost structure). Conversely, the village heads also highlighted the proposition on reinvesting the surplus ecotourism funds within the community for conservation efforts as well as for community welfare programs.

The findings of this study identified an array of avenues for communicating value propositions to visitors (channels), via social media platforms, internet advertising and word-of-mouth. Additionally, the involvement of state tourism authorities, such as KMVN, has emerged as crucial, as has the role of growing youth-led initiatives that extensively utilize social media platforms to gain potential visitors. While this strategy has yielded positive results, there is widely felt need for better knowledge and training in marketing skills among these service providers. Although this approach has produced favorable outcomes, there is a prevalent need for enhanced marketing knowledge and training among these service providers. With the adventure and homestay tourism services gaining attention in Darma valley and adjacent Bhotia valleys, service providers in the region focus heavily on giving exceptional and tailored services in order to build long-term customer relationships with visitors, resulting in repeat business prospects. As indicated by the respondents, to some extent, recurring business possibilities have been made feasible by the trust and comfort delivered by women in homestay services. As a result, customer happiness and feedback have been prioritized, providing possibilities to acquire and retain new customers.

Recognizing the wide range of ecotourism services for ensuring financial stability, the respondents also underlined the need of strategic collaborations (key partners) with governmental and private sector players, as well as non-profit organizations. The findings revealed in order to enable a broader availability of resources such as economic, social, and human capital, the role of the village council (*Gram Panchayat*[25]), forest council (*Van Panchayat*), State Tourism Department, Uttarakhand Tourism Development Board (UTDB), KMVN, Uttarakhand Renewable Energy Development Agency (UREDA), local social organizations (such as Panchachuli Homestay Owners Welfare Society*, Rung Kalyan Sansthan* and *Diling Darma Sewa Samiti*), international organizations and regional NGOs is crucial to establishing strategic alliance necessary for ensuring and strengthening the delivery of the socio-economic and environmental impact.

[25] *Gram Panchayat* is a pivotal local self-governance institution in India, operating at the village level. It assumes a crucial role in decentralized governance and administration, serving as a vital intermediary between the government and the villagers. It is headed by *Gram Pradhan* who is elected by the residents of a village through a democratic process.

At present, government institutions such as State Tourism Department and KMVN are providing support in the form of basic infrastructure, training, and promotion of homestay tourism in Darma valley. Similarly, the Panchachuli Homestay Owners Welfare Society is playing a crucial role in fostering the ongoing expansion of homestays within the three Bhotia valleys, so far having an impressive count of more than 190 registered homestays, with a notable number of active involvements from Bhotia women. Likewise, *Rung Kalyan Sanstha*'s efforts in its recent trans-boundary collaboration with ICIMOD and the Govind Ballabh Pant National Institute of Himalayan Environment (GBP-NIHE), an autonomous institute of the Ministry of Environment, Forest, and Climate Change, Government of India to position Bhotia's cultural heritage to public limelight has been instrumental.

Moreover, the Darma region as well as the nearby valleys of Byans and Chaudans have witnessed increased involvement of youth engagement owing to their incorporation into the United Nations Development Programme's (UNDP) SECURE Himalaya initiative aimed at sustainable management of alpine pastures and forests in the Himalayan ecosystems, with the twin goals of conservation and the advancement of sustainable livelihoods in the region. According to the respondents' perspectives, the mediation of different stakeholders as funders, partners and suppliers is primarily important for the expansion of ecotourism development in the region since they can foster knowledge exchange, offer technical and marketing support, and provide access to networks of stakeholders and potential customers as well as to address unforeseen risks associated with seasonal fluctuations in tourism demands, catastrophic mishaps or financial destitution that can impact revenue streams.

In totality, the proposed SBMC prototype emphasized the importance of utilizing an integrated blend of communication channels to effectively convey the value proposition to the target customer segments and establish strong customer relationships, thereby maximizing the use of key resources such as physical, financial, intellectual, and human resources. It also highlighted the significance of executing strategic activities crucial to fulfilling the value proposition while establishing a strong connection with the key resources to sustain customer relationships and generate revenue. The model prototype also indicated that the establishment of a value network or relationships that represent access to crucial resources, capacity to engage in critical activities, ability to decrease risks, and effect cost structures is critical to an enterprise's successful operation. In conclusion, the study emphasized the substantial practical significance of business model canvases in both establishing a new endeavor and reviewing and developing an existing one (Osterwalder and Pigneur 2010; Qastharin 2014; Joyce and Paquin 2016; Daniele and Quezada 2017; Cardeal et al. 2020; Szromek 2021; Basile et al. 2021; Galardi et al. 2022).

Solidarity principles in ecotourism context

Additionally, the applicability of these findings with the relevance inferred from the REAS (2011) guiding principles display a broader viewpoint, relying on permissibility issues regarding the application of business models in ecotourism planning in the research region. The six guiding principles of REAS (2011) are equity, decent work, environmental sustainability, cooperation, fair sharing of wealth and territorial responsibility. Studies have shown that fundamentals of solidarity paradigm are often intended to be combined together to promote community development while also establishing a harmonious relationship between the environment and business production. As with the tourism business models positioned in rural settings, incorporating solidarity principles have been observed to be contributing to the sustainability and resilience of both the enterprise and the communities it serves, as evidenced by some studies (Bailey et al. 2018; Morais and Bacic 2020; Forero and Saavedra 2022; Vargas Vasserot 2023).

In light of the current investigation, we concur that envisioned SBMC model prototype emphasizes the primacy of solidarity at the forefront of its operations. Such characteristics embedded within a business model may foster a conducive milieu of shared comprehension, facilitating collective resolution of challenges and nurturing entrepreneurial advancement within community frameworks. The elucidation of these characteristics can be delineated as:

i. Community participation and ownership: The proposed prototype prioritized community involvement and proprietorship, with a specific emphasis on incorporating women and proactive youth in its fundamental activities. This includes their active engagement in business operations, alongside the cultivation of necessary proficiencies and capabilities to foster the advancement of ecotourism. In addition, it guaranteed equitable allocation of diverse benefits arising from enterprise expansion, accentuating the imperative act of reinvesting surplus gains back into the community.

ii. Environmental sustainability: In a region characterized by abundantly rich natural and cultural capital stock, a core principle of ecotourism development relies on prioritization of enhancing comprehension and implementation of prudent resource management and environmental conservation which are also ingrained within their cultural ethos. This commitment may be intertwined with the objective of fostering a broad spectrum of livelihood options, as also indicated in the value proposition of the proposed model. Furthermore, the model underscores the strategic utilization of the plentiful incentives offered by external stakeholders, thereby enhancing the environmental sustainability of the enterprise operations, such as through the adoption of renewable energy sources and participating in the waste reduction initiatives.

iii. Social responsibility: This commitment signifies the potential for substantial social impact within the context of rural ecotourism development, encompassing principles of fairness, equity, social justice, heightened tolerance, and mutual trust. This is demonstrated in the current scenario through the enhanced empowerment of women in homestay operations, enabling their leadership and active involvement in decision-making processes (Panta and Thapa 2018). Moreover, the value proposition strongly emphasizes the promotion of cultural exchange between tourists and local communities, fostering an environment conducive to reciprocal understanding, trust, and respect.

iv. Democratic decision-making: The fundamental essence of the suggested prototype is shaped through the utilization of participatory scenario planning and the establishment of shared engagement and consensus, placing significant importance on addressing the community's needs and aspirations in the context of ecotourism development. While the indispensable support of government and regulatory entities is acknowledged, our investigation of SMBC emphasizes the significance of bottom-up collaboration, ensuring the comprehensive consideration of all stakeholders' perspectives and opinions.

v. Solidarity and cooperation: In alignment with the aforementioned aspects, the proposed SBMC model advocates for fostering a dynamic exchange of ideas and exemplary approaches among all relevant stakeholders. Such a conducive environment cultivates avenues for collaborative problem-solving and pioneering initiatives within the community structures, ensuring the active participation of all stakeholders in decision-making processes and equitable sharing of benefits resulting from the enterprise's achievements.

Unforeseen repercussions of ecotourism enterprise development

Despite the plethora of positive implications of ecotourism development in the region as discussed above, the research findings suggest that negative externalities can still occur that may impact the viability of the proposed prototype model for ecotourism. For instance, we found out that though the region boasts with great avenues for ecotourism development with great economic prospects, it can also create great dependency on the sector. To avoid sole dependency on ecotourism development, it is crucial to engage in diversified alternative economic sectors that align with the region's natural resources and cultural richness (Soliku et al. 2021). However, it is important to recognize that the success of a such diversified approach depend on various factors such as political support, access to finance, and effective governance. Thus, in order to achieve this, it is necessary to adopt a holistic and participatory approach that involves

all relevant stakeholders, including local communities, government agencies and private sector actors.

The research also noted that ecotourism can have unintended consequences, including economic inequality among local communities. This is due to the fact that certain groups, who have better access to resources, may be more capable of taking advantage of these development opportunities, leading to a concentration of wealth and power among a few individuals (Ma et al. 2019), thus, creating social tensions and conflicts within the communal structures, ultimately, deterioration of social capital (Rocca and Zielinski 2022). This narrative, in the context of Darma region, largely direct towards benefits accrued by community members actively engaged in tourism services in the villages of Dantu, Dugtu, Nagling, and Baling. This is mostly owing to their proximity to the Panchachuli base camp and better supply of lodging options (guest houses, rest houses and homestays) and accompanying amenities (hotels, road connectivity, shops, and phone booth), as opposed to settlements in other villages that caught up lately in having formalized accommodation options such as in the villages of Baun, Philam, Marchha and Sipu. Sela, Tidang, Chal and Go still lack in number of registered homestays as compared to other villages in the valley. Therefore, it is vital to ensure that ecotourism development is both sustainable and equitable and prioritizes inclusive growth and benefits that are shared by all stakeholders.

Another predominant concern that surfaced during research is about the commercialization of ecotourism in the region which could potentially lead to the phenomenon of “greenwashing”. The practice of greenwashing in tourism sector is referred to when businesses capitalize on the growing demands for services by presenting a misleading image of their environmental friendliness to attract environmentally conscious tourists (Hoang and Pulliat 2019). Greenwashing exacerbates the already-existing discrepancies between larger, more profitable sustainable tourism enterprises and smaller, less prosperous ones. This is because larger firms have greater financial assets to commit to marketing and promoting their environment conscious image, allowing them to succeed in acquiring eco-conscious customers. Smaller firms, on the other hand, may lack the financial means to indulge in marketing and may struggle to compete with bigger enterprises, even if they truly prioritize environmental sustainability. As a result, greenwashing exacerbates already-existing disparities in the sustainable tourism industry, favoring larger enterprises while impeding the growth of smaller ones. As a result, government and regulatory bodies should develop industry standards and enforce them through certification and auditing processes to prevent greenwashing in sustainable tourism sector (Hoang and Pulliat 2019).

The overall results suggests that, taking into consideration the growing interest of both public and private actors in sustainable tourism investments and initiatives in Darma valley as well as in the Bhotia tribal circuit, the resulting blueprint can be adapted by

existing small-scale tourism enterprises in the region to operate within a concise framework, effectively allocate resources, focus on core competencies, and make informed decisions. Furthermore, this study can serve a basis for decision-making and policy development in similar topographical situations and provide recommendations for emerging sustainable tourism business enterprises. Lastly, given the limited research on the relationship between entrepreneurship, sustainable livelihoods and adaptation in the Indian context, especially in Uttarakhand, this research serves as a starting point for future investigations to establish and explore pathways for socio-economic and environmental value creation in the ecotourism sector.

Table 14 SBMC prototype for ecotourism enterprise development in Darma valley

<table>
<tr><th colspan="4">Value proposition</th></tr>
<tr><td colspan="4">For host community (primary stakeholders): Ecotourism as a sustainable livelihood promoting environmental conservation and socio-economic development.

For tourists' groups (secondary stakeholders): Offering ecotourism services through adventure activities, eco-activities, homestays experience and closely experiencing Bhotia culture and traditions.</td></tr>
<tr><th>Key partners</th><th>Key activities</th><th>Customer relationships</th><th>Channels</th></tr>
<tr><td>• Local authorities: village council (Gram panchayat) and forest Council (Van panchayat), Biodiversity Management Committee
• Tourism departments: UTDB, KMVN
• Panchachuli Homestay Owners Welfare Society
• Uttarakhand Renewable Energy Development Agency (UREDA)
• ICIMOD
• Local and national NGOs</td><td>• Diversified ecotourism services and cultural tours
• Employment to women and unemployed youth
• Socio-environmental sensitization initiatives
• Customer support
• Marketing and promotion
• Capacity building
• Building partnerships</td><td>• Customer service and satisfaction
• Sentimental attachment
• Customer feedbacks (online and offline mediums)
• Word-of-mouth referrals
• Socially engaging experiences through homestays</td><td>• Social media and networks
• Word of mouth (through tourists, local communities)
• Online advertising
• Promotion through local authorities:
- Village council (Gram Panchayat)
- Forest council (Van Panchayat)</td></tr>
</table>

<table>
<tr>
<td rowspan="2">

Rung Kalyan Sansthan
Diling Darma Sewa Samiti
International organizations such as Asian Development Bank (ADB), United Nations Development Program (UNDP)
National and government ministries
Funders, investors
Educational institutions such as GBP-NIHE

</td>
<td>Key resources</td>
<td>Customer segment</td>
<td rowspan="2">

- Uttarakhand Tourism Development Board (UTDB)
- Kumaon Vikas Mandal Nigam (KMVN)
- State tourism department
- Self-help groups (SHGs)
- Local social organization
- Local NGOs

Awareness events
Tour agencies

</td>
</tr>
<tr>
<td>

Human: Local leaders, SHGs, workforce, volunteer base
Physical: Basic infrastructures (roads, accommodation, public toilets)
Financial: Subsidies, donations, cash, lines of credit through consumption of services
Intellectual: Partnerships, customer databases, business knowledge, and skills

</td>
<td>

Primary stakeholders: local community (youth, women, old people), community cooperatives (SHGs)
Secondary stakeholders: tourists’ groups (domestic, international, adventure, religious, eco-enthusiasts, etc.)
Tour operators, service providers

</td>
</tr>
<tr>
<td colspan="2">Cost structure</td>
<td colspan="2">Revenue streams</td>
</tr>
<tr>
<td colspan="2">

Fixed cost: Logistics and operational costs (marketing, advertising), local taxes, employee salaries, skill development training and workshops, maintenance costs
Variable costs: Profit-sharing, commission to employees, cost of procuring raw materials

</td>
<td>

Eco-activities (trekking, hiking, mountaineering, bird watching, skiing)
Customized tours (summer and winter)
Homestay services
Handicrafts sales

</td>
<td>

Sale of medicinal plants
Food and beverages sales
Developmental grants/subsidies
Community reinvestment (micro loans)
Donations

</td>
</tr>
</table>

Eco-social costs	Eco-social benefits
• Social: Unequal profit sharing, social tensions, lack of skilled manpower • Environmental: Unsustainable resource utilization, pollution, carbon emissions, solid waste disposal	• Social: Family integrity, gender equality, cultural exchange, intercultural appreciation, community participation, women empowerment, sense of collectiveness • Environmental: Conscious attitude and behavior, environmental education and awareness, impact measurements, planning, and management *(Inclusion of eco-social benefits enhances the credibility of the value proposition and can potentially attract financial support from governmental and donor sources)*
Note: A Business Model Canvas (BMC) is a dynamic entity that evolves alongside the organization and its operating environment. Taking note of the current and future specifications of ecotourism (tourism) development, a BMC should undergo continuous review, testing and maintenance.	

7. Conclusion

This research attempted to make contributions to the academic discourse pertaining to the connections between globalization, climate change adaptation and sustainable livelihoods in the high Himalayan pasturelands. The research aimed at exploring entrepreneurial trajectories of socio-economic and environmental value creation in the ecotourism sector positioned in the rural settings. More specifically, it sought to address the limited understanding of the role of ecotourism as livelihood diversification strategy supporting climate adaptation, despite the tremendous growth of the tourism sector, including ecotourism in Uttarakhand and IHR.

The findings unveiled in this study expose the ongoing climatic transformations transpiring in Darma region. These changes were expressed in terms of severity of warming temperatures, erratic rainfall patterns, low snow cover availability, rainfall scarcity, drying up of water sources, presence of invasive species in pasturelands, increased incidences of livestock diseases, decline in crop productivity, less nutritious forage, encroachment of shrub species, increased heat stress and increased extreme events such as flashfloods and landslides. Simultaneously, the pressures of globalization, rapid urbanization, limited economic advancement, and deeply rooted processes of social and political transformation yield profound ramifications for the existence and subsistence of pastoral communities. The combined implications of these transformative dynamics have manifested as increased economic insecurity, threatened food availability, land abandonment, accelerated outmigration and societal discord over resource allocation. These multifaceted impacts collectively impinge upon diverse socio-economic facets within the local community underscoring the far-reaching consequences of these alterations. As a result, the response strategies adopted by the Bhotia communities encompass a repertoire of coping mechanisms and adaptive measures, encompassing participation in government-sponsored wage labor initiatives, tourism services, transport business, and collection and sale of wild medicinal plants. However, given the evolving dynamics, it becomes evident that the imperative pursuit of comprehensively grasping the manifold pathways of adaptation specific to the local milieu assumes paramount significance.

In this context, we accord that the abundantly rich natural scenic landscapes and cultural heritage in Darma valley offers potential and positive prospects of ecotourism as a viable supplementary option for contributing to sustainable livelihoods, more akin to a globalization adaptation and to a climate adaptation strategy to strengthen the livelihood assets and adaptive capacity of local communities. By acquiring an in-depth understanding of the nuanced lived experiences encountered by the indigenous community, we demarcated the complex interdependencies that exist between the progression of entrepreneurial ecotourism and the nurturing of sustainable livelihoods.

Consequently, our findings shed light on the potential of ecotourism endeavors to engender elevated levels of community involvement and empowerment the local host community in Darma valley.

Simultaneously, our comprehensive research ardently advocated for the widespread integration of sustainable business models that firmly embrace the principles ingrained within the solidarity paradigm. These models, functioning as a transformative framework, hold the capacity to reimagine the very foundations of tourism structures, effectively navigating the intricate tapestry of challenges emanating from socio-economic uncertainties and climate-induced repercussions. In this sense, the resultant prototype intricately elucidated the objectives, strategies, and actionable roadmap, encompassing the requisite preconditions to be considered for the facilitation of sustainable entrepreneurial ecotourism expansion in the region.

Undoubtedly, Uttarakhand undeniably occupies a distinctive position within the realm of nature-based tourism, with ecotourism unequivocally recognized in the state's meticulously devised tourism master plans and various governmental agreements as a promising domain capable of nurturing sustainable livelihoods for local communities while concurrently making significant strides towards environmental conservation. That said, we concur the viewpoint that the potential drawbacks associated with the advancement of ecotourism in the study area can impede its success as explicated by the following rationales:

i. First, this arises from the prevailing nature of tourism development endeavors, which primarily favor a limited group of prominent enterprises and corporations, thereby marginalizing the interests and contributions of local communities and small-scale businesses that may lack the requisite skills, education, and awareness. Moreover, the insufficient awareness regarding the comprehensive scope of government initiatives, subsidies, and incentives further compounds the issue, as seen among the community members in the region that have not fully harnessed the benefits offered by state programs. This is often times aggravated due to the complexity and bureaucracy surrounding these initiatives that make it arduous for local communities, especially women, to understand and properly utilize them, resulting in underutilization of available resources and missed opportunities.

ii. Second, it is important to consider that the expansion of tourism could potentially exacerbate economic inequalities, as certain segments of the population possessing greater access to resources, education, and cultural knowledge may be better positioned to exploit the opportunities presented by ecotourism compared to others (Ma et al. 2019).

iii. Lastly, the reliance on ecotourism as a primary source of income brings forth a set of challenges, including the difficulty in maintaining consistent revenue streams and reconciling economic benefits with environmental preservation, both of which can have significant implications for the long-term viability and sustainability of the ecotourism model (Soliku et al. 2021).

However, in order to ensure a comprehensive and viable culmination of this study, the following limitations must be acknowledged:

i. The meteorological data in Uttarakhand is sparse, inconsistent, and fragmented, particularly in remote and/or inaccessible areas, which can limit the ability to analyze long-term climate trends. Incomplete data records, lack and unavailability of historical climate data for the study region prompted the current study to utilize meteorological data available from Climatic Research Unit Time Series (CRU TS) data version 4.02.

ii. There were challenges concerned with the reliability of data, encompassing the limited availability of clear and unobstructed satellite images due to cloud cover, along with those characterized by restricted spatial resolution.

iii. Due to the inadequacy of meticulously organized record-keeping systems maintained by governmental entities in Uttarakhand, the retrieval of historical data concerning the livestock population presented considerable challenges. Therefore, we opted to rely on data derived from previously published studies, duly acknowledging, and citing the respective sources.

iv. Another formidable obstacle encountered pertained to the utilization of socio-economic data extracted from the Census of India. The Census of India is a decennial publication that is conducted every 10 years. We utilized the census 2011 data as the most current reference point, given the indefinite postponement of the census 2021, which would have otherwise served as the desired and up-to-date source for comprehensive analysis.

v. Due to data gaps and lack of standardized indicators, particularly in land use classification and workforce categories, hampered our ability to fully exploit the census records from 1971, 1981, 2001, and 2011 for thorough data analysis and meaningful comparisons.

vi. Given the constraints of time and logistical resources, the feasibility of working with a more expansive sample size for Study 2 and 3 was lacking. In addition, the limited engagement of women in tourism services (mainly in homestays) within the region restricted their inclusion and participation in these studies.

vii. Finally, it is important to acknowledge that the descriptive and exploratory nature of this study introduces potential limitations stemming from various sources of bias, including but not limited to selective memory, telescoping, attribution, and exaggeration.

While confined to a specific geographical context, our scholarly investigation strives to undertake a comprehensive exploration of the manifold ramifications of globalization and climate change on the rural livelihoods in the context on Indian Himalayan state of Uttarakhand. Furthermore, our research endeavors to provide a fresh and distinctive vantage point for scholars and policymakers, illuminating the potential livelihood adaptation prospects that emerge from the intricate interplay of globalization impacts and the prevailing state of climate change. This elucidation contributes to the collective understanding of how these interrelated factors may synergistically foster transformative change within marginalized communities. However, our findings indicate the need for in-depth research on the entrepreneurial development of ecotourism that can be leveraged to construct new avenues for climate and globalization-resilient livelihoods in marginalized Himalayan regions.

8. Bibliography

Açıksöz, S., Cetinkaya, G. C., Uzun, O., Nemutlu, F. E., & Ilke, E. F. (2016). Linkages among ecotourism, landscape and natural resource management, and livelihood diversification in the region of Suğla Lake, Turkey. *International Journal of Sustainable Development and World Ecology*, 23(1), 15–27.

Açıksöz, S., Görmüş, S., & Karadeniz, N. (2010). Determination of ecotourism potential in national parks: Küre Mountains National Park, Kastamonu-Bartın, Turkey. *African Journal of Agricultural Resources,* 5, 589–599.

Adler, C., P. Wester, I. Bhatt, C. Huggel, G.E. Insarov, M.D. Morecroft, V. Muccione, and A. Prakash, 2022: Cross-Chapter Paper 5: Mountains. In: Climate Change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Agyeman, Y. B. (2019). ecotourism as an adaptation strategy for mitigating climate change impacts on local communities around protected areas in Ghana. In: Leal Filho, W. (Eds.), *Handbook of Climate Change Resilience*. Springer, Cham. pp. 1–19.

Ahmad, Z., Postigo, J. C., Rahman, F., & Dittmann, A. (2021). Mountain pastoralism in the eastern Hindu Kush: the case of Lotkuh valley, Pakistan. *Mountain Research and Development*, 41(4), 16–28.

Akinbami, C. A. O. (2021). Climatepreneurship: adaptation strategy for climate change impacts on rural women entrepreneurship development in Nigeria. In Oguge, N., Ayal, D., Adeleke, L., & da Silva, I. (Eds.), *African Handbook of Climate Change Adaptation*. Springer, Cham. pp. 2143–2168.

Akinbami, C. A. O., Olawoye, J. E., Adesina, F. A., & Nelson, V. (2019). Exploring potential climate-related entrepreneurship opportunities and challenges for rural Nigerian women. *Journal of Global Entrepreneurship Research*, 9, 19.

Alfthan, B., Gupta, N., Gjerdi, H. L., Schoolmeester, T., Andresen, M., Jurek, M., & Agrawal, N. K. (2018). Outlook on climate change adaptation in the Hindu Kush Himalaya, Mountain Adaptation Outlook Series. United Nations Environment Programme. International Centre for Integrated Mountain Development. ICIMOD, Nepal.

Amano, T., Sultan, M., & Feseha, M. (2017). Ecotourism development in protected area: the case of Senkele Swayne's Hartebeest Sanctuary (SSHS), West Arsi zone, Oromia Region, Ethiopia. *Journal of Tourism, Hospitality and Sports, 25*, 2312–5187.

Anand, A., Chandan, P., & Singh, R. B. (2012). Homestays at Korzok: Supplementing rural livelihoods and supporting green tourism in the Indian Himalayas. *Mountain Research and Development*, 32(2), 126–136.

Ankrah, D. A., Anum, R., Anaglo, J. N., & Boateng, S. D. (2023). Influence of sustainable livelihood capital on climate variability adaptation strategies. *Environmental and Sustainability Indicators*, *18*, 100233.

Aquino, R. S., Lück, M., & Schänzel, H. A. (2021). Mapping the outcomes of social entrepreneurship and tourism on host communities: A three-dimensional approach. *Journal of Sustainable Tourism*, 1–22.

Aryal, C., Ghimire, B., & Niraula, N. (2019a). Tourism in protected areas and appraisal of ecotourism in Nepalese policies. *Journal of Tourism and Hospitality Education*, 9, 40–73.

Aryal, C., Niroula, N., & Ghimire, B. (2019b). Perspectives of Nepalese youth on ecotourism practiced at Rara national park, western Nepal. *Journal of Tourism and Adventure*, 2(1), 17–39.

Aryal, S., Cockfield, G. & Masareni, T. K. (2014): Vulnerability of Himalayan transhumant communities to climate change. *Climatic Change*, 125, 193–208.

Aryal, S., Cockfield, G., & Maraseni, T. N. (2016). Perceived changes in climatic variables and impacts on the transhumance system in the Himalayas. *Climate and Development*, 8(5), 435–446.

Aryal, S., Cockfield, G., & Maraseni, T. N. (2018). Globalisation and traditional social-ecological systems: understanding impacts of tourism and labour migration to the transhumance systems in the Himalayas. *Environmental Development*, 25, 73–84.

Ashley C. R. D., Roe, D., & Goodwin, H. (2001). Pro-poor tourism strategies: making tourism work for the poor-A review of experience. Nottingham, UK.

Ashley, C. (2000). The impacts of tourism on rural livelihoods: Namibia`s experience. (Working Paper No. 128). London: ODI.

Ashok, S., Behera, M. D., & Tewari, H. R. (2019). Evaluating the applicability of ESM (Ecotourism Sustainability Maximization) model to assess, monitor, and manage the ecotourism sustainability in mountain ecosystem (Mt. Kangchendzonga Base Camp Trek, India). *Environmental Monitoring and Assessment*, 191, 1–21.

Avagianou, A., Gourzis, K., Pissourios, I., Iosifides, T., & Gialis, S. (2022). Quite promising yet marginal? A comparative study of social economy in the EU South. *Comparative European Politics*, 20, 484–509.

Ayanda, I., Oyeyinka, R., Salau, S. & Ojo, F. (2013). Perceived effects of climate change on transhumance pastoralists inogun state, Nigeria. *Journal of Agricultural Science*, 5, 190.

Azad, M. J., & Pritchard, B. (2022). Financial capital as a shaper of households' adaptive capabilities to flood risk in northern Bangladesh. *Ecological Economics*, 195, 107381.

Azam, M., Wagnon, P., Berthier, E., Vincent, C., Fujita, K., & Kargel, J. (2018). Review of the status and mass changes of Himalayan-Karakoram glaciers. *Journal of Glaciology*, 64(243), 61–74.

Bailey, N., Kleinhans, R., & Lindbergh, J. (2018). The implications of Schumpeter's theories of innovation for the role, organisation, and impact of community-based social enterprise in three European countries. *Journal of Entrepreneurial and Organizational Diversity*, 7, 14–36.

Balodi, K., N., Naithani, S., Kaur, J., Singh, A., & Chauhan, A. S. (2014). Ecotourism: A sustainable livelihood option for mountainous communities in Uttarkashi, Uttarakhand, India. *Journal of Studies in Dynamics and Change,* 1(8), 320–327.

Banerjee, S., Gerlitz, J. Y., & Hoermann, B. (2011). Labour migration as a response strategy to water hazards in the Hindu Kush-Himalayas. International centre for integrated mountain development. ICIMOD. Nepal.

Basak, D., Bose, A., Roy, S., Chowdhury, I.R., & Sarkar, B. (2021). Understanding sustainable homestay tourism as a driving factor of tourist's satisfaction through structural equation modelling: A case of Darjeeling Himalayan region, India. *Current Research in Environmental Sustainability*, 3, 100098.

Basannagari, B., & Kala, C. P. (2013). Climate change and apple farming in Indian Himalayas: A study of local perceptions and responses. *PLoS One*, 8 (10).

Basile, V., Capobianco, N. & Vona, R. (2021). The usefulness of sustainable business models: Analysis from oil and gas industry. *Corporate Social Responsibility and Environmental Management,* 28(6), 1801–1821.

Batool, N., Shah, S. A., Dar, S. N., & Skinder, S. (2019). Rainfall variability and dynamics of cropping pattern in Kashmir Himalayas: A case study of climate change and agriculture. *SN Applied Sciences*, 1.

Becken, S. & Loehr, J. (2022) Tourism governance and enabling drivers for intensifying climate action. *Journal of Sustainable Tourism*, 1–19.

Bergmann, C. (2016). The Himalayan border region: Trade, identity, and mobility in Kumaon, India. Advances in Asian Human-environment Research. Springer, Cham.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2008). Living in a high mountain border region. The case of the 'Bhotiyas' of the Indo-Chinese border region. *Journal of Mountain Science*, 5, 209–217.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2012). State policy and local performance: pasture use and pastoral practices in the Kumaon Himalaya. *Pastoral practices in High Asia: Agency of development effected by modernisation, resettlement, and transformation*, 175-194.

Berhanu, W., & Beyene, F. (2015). Climate variability and household adaptation strategies in Southern Ethiopia. *Sustainability*, 7, 6353–6375.

Berthier, E., & Brun, F. (2019). Karakoram geodetic glacier mass balances between 2008 and 2016: persistence of the anomaly and influence of a large rock avalanche on Siachen Glacier. *Journal of Glaciology,* 65(251), 494–507.

Bett, B., Kiunga, P., Gachohi, J., Sindato, C., Mbotha, D., Robinson, T., Lindahl, J., & Grace, D. (2017). Effects of climate change on the occurrence and distribution of livestock diseases. *Preventive Veterinary Medicine*, 137, 119–129.

Bhalla, P., Bhattacharya, P., Areendran, G., & Raj, K. (2022). Ecotourism spatio-temporal models to identify visitation patterns across the Indian Himalayan Region. *GeoJournal*, 87(3), 1777–1792.

Bhalla, P., Coghlan, A. & Bhattacharya, P. (2016). Homestays' contribution to community - based ecotourism in the Himalayan region of India. *Tourism Recreation Research*, 41(2), 213–228.

Bhambri, R., Bolch, T., & Chaujar, R. K. (2011a). Mapping of debris-covered glaciers in the Garhwal Himalayas using ASTER DEMs and thermal data. *International Journal of Remote Sensing*, 32(23), 8095–8119.

Bhambri, R., Bolch, T., & Chaujar, R. K. (2012). Frontal recession of Gangotri Glacier, Garhwal Himalayas, from 1965 to 2006, measured through high-resolution remote sensing data. *Current Science*, 102(3), 489–494.

Bhambri, R., Bolch, T., Chaujar, R. K., & Kulshreshtha, S. C. (2011b). Glacier changes in the Garhwal Himalaya, India, from 1968 to 2006 based on remote sensing. *Journal of Glaciology*, 57(203), 543–556.

Bhambri, R., Watson, C.S., Hewitt, K., Haritashya, U. K., Kargel, J. S., Pratap Shahi, A., Chand, P., Kumar, A., Verma, A., Govil, H. (2020). The hazardous 2017–2019 surge and river damming by Shispare Glacier, Karakoram. *Scientific Reports*, 10, 4685.

Bhasin, V. (2011). Pastoralists of Himalayas. *Journal of Human Ecology*, 33(3), 147–177.

Bhatta, L. D., Shrestha, A., Neupane, N., Jodha, N. S., & Wu, N. (2019). Shifting dynamics of nature, society, and agriculture in the Hindu Kush Himalayas: Perspectives for future mountain development. *Journal of Mountain Science*, 16(5), 1133–1149.

Bhutiyani, M. R. (2016). Spatial and temporal variability of climate change in high-altitude regions of NW Himalaya. *Climate Change, Glacier Response, and Vegetation Dynamics in the Himalaya: Contributions Toward Future Earth Initiatives*, 87-101.

Bhutiyani, M. R., Kale, V. S., & Pawar, N. J. (2007). Long-term trends in maximum, minimum and mean annual air temperatures across the Northwestern Himalaya during the twentieth century. *Climatic Change*, 85(1-2), 159–177.

Bhutiyani, M. R., Kale, V. S., & Pawar, N. J. (2009). Climate change and the precipitation variations in the northwestern Himalaya: 1866–2006. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, *30*(4), 535–548.

Bisht, H., Kotlia, B. S., Kumar, K., Joshi, L. M., Sah, S. K., & Kukreti, M. (2020). Estimation of the recession rate of Gangotri glacier, Garhwal Himalaya (India) through kinematic GPS survey and satellite data. *Environmental Earth Sciences*, 13(6), 1–12.

Bisht, I. S., Mehta, P. S., Negi, K. S., Verma, S. K., Tyagi, R. K., & Garkoti, S. C. (2018). Farmers' rights, local food systems, and sustainable household dietary diversification:

A case of Uttarakhand Himalaya in north-western India. *Agroecology and Sustainable Food Systems*, 42(1), 77–113.

Bisht, M., Chandra Sekar, K., Mukherjee, S., Thapliyal, N., Bahukhandi, A., Singh, D., ... & Dey, D. (2022). Influence of anthropogenic pressure on the plant species richness and diversity along the elevation gradients of Indian Himalayan high-altitude protected areas. *Frontiers in Ecology and Evolution*, 10, 751989.

Block, D. de, Feindt, P. H., & van Slobbe, E. (2019). Shaping conditions for entrepreneurship in climate change adaptation: a case study of an emerging governance arrangement in the Netherlands. *Ecology and Society*, 24(1), 19.

Bolch, T., Shea, J. M., Liu, S., Azam, F. M., Gao, Y. et al (2019). Status and change of the cryosphere in the extended Hindu Kush Himalaya region. In: Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 209–255.

Boyd, B. W., & Butler, R. W. (1996). Managing eco-tourism: an opportunity spectrum approach, *Tourism Management,* 17(8), 557–566.

Buendía-Martínez, I., Álvarez-Herranz, A., & Moreira Menéndez, M. (2020). Business cycle, SSE policy, and cooperatives: The case of Ecuador. *Sustainability*, 12(13), 5485.

Burch, S. & Di Bella, J. (2021). Business models for the Anthropocene: accelerating sustainability transformations in the private sector. *Sustainability Science*, 16, 1963–1976.

Burneika, D., & Kriaučiknas, E. (2007). Some premises for balanced development of ecotourism on the territory of Lithuania. *Ekologija*, 53.

Buzinde, C., Shockley, G., Andereck, K., Dee, E., & Frank, P. (2017). Theorizing social entrepreneurship within tourism studies. In: Sheldon, P. J. & Daniele, R. (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice*. Cham: Springer International Publishing. pp. 21–34.

Caire, G. (2007). Tourisme solidaire, capacités et développement socialement durable. *Marché et organisations*, (1), 89–115.

Cajee, L. (2014). Eco-cultural tourism: a tool for environmental, cultural, and economic sustainability (a case study of Darap Village, West Sikkim). In SHS Web of Conferences (Vol. 12, p. 01029). EDP Sciences.

Cardeal, G., Höse, K., Ribeiro, I., & Götze, U. (2020). Sustainable business models–canvas for sustainability, evaluation method, and their application to additive manufacturing in aircraft maintenance. *Sustainability*, 12, 9130.

Chakraborty, P., & Ghosal, S. (2022). Status of mountain-tourism and research in the Indian Himalayan Region: a systematic review. *Asia-Pacific Journal of Regional Science*, 1–35.

Chambers, R., & Conway, G. R. (1992). Sustainable rural livelihoods: Practical concepts for the 21st Century. IDS Discussion Paper, 296, 29.

Chan, J. K. L., Marzuki, K. M., & Mohtar, T. M. (2021). Local community participation and responsible tourism practices in ecotourism destination: A case of lower Kinabatangan, Sabah. *Sustainability*, 13, 13302.

Chand, S., Singh, S., Parappurathu, S., Roy, S. D., & Kumar, A. (2015). Explaining the status and scope of ecotourism development for livelihood security: Andaman and Nicobar Islands, India. *International Journal of Sustainable Development and World Ecology*, *22*(4), 335–345.

Chaturvedi, G. (2002). Ecotourism in Gangotri region of the Garhwal Himalayas. *Tourism Recreation Research*, 27(3), 41–51.

Chaudhary, S., Kumar, A., Pramanik, M., & Negi, M. S. (2022). Land evaluation and sustainable development of ecotourism in the Garhwal Himalayan region using geospatial technology and analytical hierarchy process. *Environment, Development and Sustainability*, 1–42.

Clay N. (2018) Integrating livelihoods approaches with research on development and climate change adaptation. *Progress in Development Studies*, 18(1), 1–17.

Dahal, B., K C, A., & Sapkota, R. P. (2020). Environmental impacts of community-based homestay ecotourism in Nepal. *The Gaze: Journal of Tourism and Hospitality*, 11(1), 60–80.

Dahles, H., Khieng, S., Verver, M., & Manders, I. (2020). Social entrepreneurship and tourism in Cambodia: Advancing community engagement. *Journal of Sustainable Tourism*, 28(6), 816–833.

Dalal, N., Joshi, A.M., Soragi, B., Chaudhary, S., Sharma, S., Naidu, S., & Kazmi, Y. (2018). People's perception to climate change in remote Himalayan mountains and rainfall variability in the Kailash Sacred Landscape, India. *Journal of Climatology and Weather Forecasting*, 6(2), 1–6.

Dangi, T. B., & Gribb, W. J. (2018). Sustainable ecotourism management and visitor experiences: Managing conflicting perspectives in Rocky Mountain National Park, USA. *Journal of Ecotourism*, 17(3), 338–358.

Dangi, T. B., & Jamal, T. (2016). An integrated approach to "sustainable community-based tourism". *Sustainability*, 8(5), 475.

Daniele, R., & Quezada, I. (2017). Business models for social entrepreneurship in tourism. In P. J. Sheldon & R. Daniele (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice*. Cham: Springer International Publishing. pp. 81–100.

Dar, R. A., Rashid, I., Romshoo, S. A., & Marazi, A. (2014). Sustainability of winter tourism in a changing climate over Kashmir Himalaya. *Environmental Monitoring and Assessment*, 186, 2549–2562.

Das, D., & Hussain, I. (2016). Does ecotourism affect economic welfare? Evidence from Kaziranga National Park, India. *Journal of Ecotourism*, 15(3), 241–260.

Das, P. V. (2022). People's climate knowledge versus scientists' climate knowledge: a study of apple farming communities in Western Himalayas, India. *GeoJournal*, 87, 2227–2238.

Datey, A., Bali, B., Bhatia, N., Khamrang, L., & Kim, S. M. (2023). A gendered lens for building climate resilience: Narratives from women in informal work in Leh, Ladakh. *Gender, Work and Organization*, 30(1), 158-176.

Datta, D. & Banerji, S. (2015). Local tourism initiative in an eastern Himalayan village: sustainable ecotourism or small-scale nature exploitation? In: Szymańska, D. & Rogatka, K. (Eds.), Bulletin of Geography. Socio-economic Series 27, Toruń: Nicolaus Copernicus University, pp. 33–49.

Day, J., & Mody, M. (2017). Social entrepreneurship typologies and tourism: Conceptual frameworks. In Sheldon, P. & Daniele, R. (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice*. Cham: Springer International Publishing. pp. 57–80.

DeLange, D., & Dodds, R. (2017). Increasing sustainable tourism through social entrepreneurship. *International Journal of Contemporary Hospitality Management*, 29(7), 1977−2002.

Demir, S., Esbah, H. & AKGÜN, A. A. (2016). Quantitative SWOT analysis for prioritizing ecotourism-planning decisions in protected areas: Igneada case, *International Journal of Sustainable Development & World Ecology, 23*(5), 456–468.

Dendup, N., Tshering, K., & Choda, J. (2022). Community-based tourism as a strategy for building climate resilience in Bhutan. In: Haque, A.K.E., Mukhopadhyay, P., Nepal, M., & Shammin, M.R. (Eds.), *Climate Change and Community Resilience*. Springer, Singapore. pp. 387.

Dey, T., Pala, N. A., Shukla, G., Prabhat, K. P., Dar, G., & Chakravarty, S. (2018). Climate change perceptions and response strategies of forest fringe communities in Indian Eastern Himalaya. *Environment, Development and Sustainability*, 20, 925–93.

DFID, U. K. (1999). Sustainable livelihoods guidance sheets. London: DFID, 445.

Dhimal, M., Kramer, I. M., Phuyal, P., Budhathoki, S. S., Hartke, J., Ahrens, B., Kuch, U., Groneberg, D. A., Nepal, S., Liu, Q., Huang, C., Cissé, G., Ebi, K.L., Klingelhöfer, D., & Müller, R. (2021). Climate change and its association with the expansion of vectors and vector-borne diseases in the Hindu Kush Himalayan region: A systematic synthesis of the literature. *Advances in Climate Change Research*, 12, 421–429

DHM (2017). Observed climate trend analysis in the districts and physiographic regions of Nepal (1971–2014). Department of Hydrology and Meteorology, Kathmandu.

Dimri, A. P., Allen, S., Huggel, C., Mal, S., Ballesteros-Canovas, J. A., Rohrer, M., Shukla, A., Tiwari, P., Maharana, P., Bolch, T., Thayyen, R. J., Stoffel, M., & Pandey, A. (2021). Climate change, cryosphere and impacts in the Indian Himalayan Region. *Current Science*, 20(5), 774–790.

Dimri, A. P., Kumar, D., Choudhary, A., Maharana, P. (2018). Future Changes over the Himalayas: Maximum and Minimum Temperature. *Global and Planetary Change*, 162, 212–234.

Dimri, A. P., Yasunari, T., Kotlia, B. S., Mohanty, U. C. & Sikka, D. R. (2016). Indian winter monsoon: present and past. *Earth-Science Reviews*, 163, 297–322.

District Census Handbook of Pithoragarh (2011). Village and town wise primary census abstract (PCA). Series 6, Part XII-B, Census of India, Uttarakhand.

Dobhal, D. P., & Pratap, B. (2015). Variable response of glaciers to climate change in Uttarakhand Himalaya, India. In *Dynamics of Climate Change and Water Resources of Northwestern Himalaya*. Springer International Publishing. pp. 141–150.

Doğan, M. (2021). Can be solidarity paradigm a catalyst for the sustainability of tourism? In Turcanu-Carutiu, D. (Eds.), *Heritage-New Paradigm*. London. IntechOpen.

Dong, S., Yi, S. L., & Yan, Z. L. (2016). Maintaining the human–natural systems of pastoralism in the Himalayas of South Asia and China. In: Dong, S., Kassam, K. A., Tourrand, J., & Boone, R. (Eds.), *Building Resilience of Human-Natural Systems of Pastoralism in the Developing World: Interdisciplinary Perspectives*. Springer, Cham. pp. 93–135.

Dorji, N., Derks, M., Groot Koerkamp, P. W., & Bokkers, E. A. (2022). Transition towards sustainable yak farming in Bhutan: stakeholders' viewpoints and recommendations for future steps. *International Journal of Agricultural Sustainability*, 20(1), 68–87.

Duan, C., Shi, P., Song, M., Zhang, X., Zong, N., & Zhou, C. (2019). Land use and land cover change in the Kailash Sacred Landscape of China. *Sustainability*, 11(6), 1788.

Eriksson, F., & Lidström, M. (2013). Sustainable development in ecotourism: Tour operators managing the economic, social, and environmental concerns of sustainable development in Costa Rica.

Esteves, A.M., Genus, A., Henfrey, T., Penha-Lopes, G., East, M. (2021) Sustainable entrepreneurship and the sustainable development goals: community-led initiatives, the social solidarity economy, and commons ecologies. *Business, Strategy and Environment*, 30(3), 1423–1435.

Forero, J. A. M., & Saavedra, J. A. (2022). Community-based tourism as an approach to a solidarity economy. *European Conference on Management Leadership and Governance*, 18(1), 340–346.

Gajić, T., Đoković, F., Blešić, I., Petrović, M. D., Radovanović, M. M., Vukolić, D., Mandarić, M., Dašić, G., Syromiatnikova, J. A., Mićović, A. (2023). Pandemic Boosts Prospects for Recovery of Rural Tourism in Serbia. *Land*, 12*,* 624.

Galardi, M., Moruzzo, R., Riccioli, F., Granai, G., & Di Iacovo, F. (2022). Small rural enterprises and innovative business models: A case study of the Turin area. *Sustainability*, 14*,* 1265.

Garg, P. K., Shukla, A., Yousuf, B., Garg, S. (2022). Temperature and precipitation change over the glaciated parts of Indian Himalayan Region during 1901–2016. *Environmental Monitoring and Assessment*, 194(2), 84.

Gentle, P., & Thwaites, R. (2016). Transhumant pastoralism in the context of socioeconomic and climate change in the mountains of Nepal. *Mountain Research and Development*, 36(2), 173–182.

Gerlitz, J.-Y., Macchi, M., Brooks, N., et al. (2016). The multidimensional livelihood vulnerability index – an instrument to measure livelihood vulnerability to change in the Hindu Kush Himalayas. *Climate and Development*, 1–17.

Gerwin, M., & Bergmann, C. (2012). Geopolitical relations and regional restructuring: the case of the Kumaon Himalaya, India. *Erdkunde*, 91–107.

Gioli, G., Thapa, G., Khan, F., Dasgupta, P., Nathan, D., Chhetri, N., Adhikari, L., Mohanty, S., Aurino, E. & Scott, L. (2019). Understanding and tackling poverty and vulnerability in mountain livelihoods in the Hindu Kush Himalaya. In: Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 421–455.

Gogoi, J. (2016). Biotourism Potential in Northeast India. In: Purkayastha, J. (Eds.), *Bioprospecting of Indigenous Bioresources of North-East India*. Springer, Singapore.

Gómez Núñez, N. (2019). Economía solidaria, social y popular en América Latina. Miríada: *Investigación en Ciencias Sociales*, 11(15), 9–21.

Goodwin, H., & Roe, D. (2001). Tourism, livelihoods, and protected areas: Opportunities for Fair-trade Tourism in and Around National Parks. *International Journal of Tourism Research,* 3, 377–391.

Gössling, S., & Scott, D. (2012). Scenario planning for sustainable tourism: an introduction. *Journal of Sustainable Tourism*, 20(6), 773–778.

Guha, R. (1989). The unquiet woods: ecological change and peasant resistance in the Himalaya. New Delhi: Oxford University Press.

Gurung, D. B., & Seeland, K. (2011). Ecotourism benefits and livelihood improvement for sustainable development in the nature conservation areas of Bhutan. *Sustainable Development*, 19(5), 348–358.

Gutierrez-Montes, I., Emery, M., & Fernandez-Baca, E. (2009). The sustainable livelihoods approach and the community capitals framework: The importance of system-level approaches to community change efforts. *Community Development*, 40(2), 106–113.

Haarmann, C., & Haarmann, D. (2011). Solidarity economy – a chance for Southern Africa: an introduction to the concept and practical experience from Brazil, TARA Research Report.

Habte, M., Eshetu, M., Maryo, M., Andualem, D., & Legesse, A. (2022). Effects of climate variability on livestock productivity and pastoralists perception: The case of drought resilience in Southeastern Ethiopia. *Veterinary and Animal Science*, 16, 100240.

Hall, C. M. (2007). Pro-poor tourism: who benefits? Perspectives on tourism and poverty reduction. Clevedon, UK: Channel View Publications.

Hall, D. K., Riggs, G. A., & Salomonson, V. V. (1995). Development of methods for mapping global snow cover using moderate resolution imaging spectroradiometer data. *Remote sensing of Environment*, 54(2), 127–140.

Hasson, S., Böhner, J., & Lucarini, V. (2017). Prevailing climatic trends and runoff response from Hindukush-Karakoram-Himalaya, upper Indus Basin. *Earth System Dynamics*, 8, 337–355.

Herrero, M., Addison, J., Bedelian, C., Carabine, E., Havlík, P., Henderson, B., Van De Steeg, J., & Thornton, P. K. (2016). Climate change and pastoralism: impacts, consequences, and adaptation. *Revue scientifique et technique (International Office of Epizootics)*, 35(2), 417–433.

Higham, J., & Miller, G. (2018). Transforming societies and transforming tourism: Sustainable tourism in times of change. *Journal of Sustainable Tourism*, 26(1), 1–8.

Hoang, T., & Pulliat. G. (2019). Green for whom? exploring ecotourism as a climate-adaptation strategy in Trang An, Vietnam. In: Daniere, A., & Garschagen, M. (Eds.), *Urban*

Climate Resilience in Southeast Asia. The Urban Book Series. Springer, Cham. pp. 179–199.

Honey, M. (1999). Ecotourism and Sustainable Development: Who owns paradise? Washington DC. Island Press.

Huggel, C., Allen, S. J., Dach, S.W., Dimri, A. P., Mal, S., Linbauer, A., Salzmann, N., & Bolch, T. (2020). An integrative and joint approach to climate impacts, hydrological risks, and adaptation in the Indian Himalayan Region. In: Dimri, A., Bookhagen, B., Stoffel, M., Yasunari, T. (Eds.), *Himalayan Weather and Climate and their Impact on the Environment*. Springer, Cham. pp. 553–573.

ILO (2017). Building local development in rural areas through cooperatives and other Social and Solidarity Economy enterprises and organizations. Decent work in the rural economy policy guidance notes. International Labour Organization.

Ingty, T. (2021). Pastoralism in the highest peaks: Role of the traditional grazing systems in maintaining biodiversity and ecosystem function in the alpine Himalaya. *PLoS One*, 16(1), e0245221.

IPCC (2022). Climate Change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Jamaliah, M. M., & Powell, R. B. (2018). Ecotourism resilience to climate change in Dana Biosphere Reserve, Jordan. *Journal of Sustainable Tourism*, 26(4), 519–536.

Joshi, N. C., & Rawat, G. S. (2021). An integrated approach for the identification and prioritization of areas based on their livelihood vulnerability index: a case study of agro-pastoral community from Western Indian Himalaya. *Mitigation and Adaptation Strategies for Global Change*, 26(6), 27.

Joshi, S., Jasra, W. A., & Ismail, M. (2013). Herders' perceptions of and responses to climate change in Northern Pakistan. *Environmental Management*, 52, 639–648.

Joyce, A., & Paquin, R.L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, 135, 1474–1486.

Kala, C. P., & Maikhuri, R. K. (2011). Mitigating people-park conflicts on resource use through ecotourism: A case of the Nanda Devi Biosphere Reserve, Indian Himalaya. *Journal of Mountain Science*, 8(1), 87–95.

Karki, R., Hasson, S., Schickhoff, U., Scholten, T., & Boehner, J. (2017). Rising precipitation extremes across Nepal. *Climate*, 5(1), 4.

Kasalak, M. A., Akinci, Z., & Yurcu, G. (2016). Ecotourism entrepreneurship, the features of ecotourism entrepreneurship, problems, and solutions. In: Avcikurt, C., Dinu, M. S., Hacioglu, N., Efe, N., Soykan, A., & Tetik, N. (Eds.), *Global Issues and Trends in Tourism*. St. Kliment Ohridski University Press, Sofia. pp. 596–601.

Kattel, D. B., & Yao, T. (2013). Recent temperature trends at mountain stations on the southern slope of the central Himalayas. *Journal of Earth System Science*, 122, 215–227.

KC, A., Ghimire, S., & Dhakal, A. (2021). Ecotourism and its impact on indigenous people and their local environment: case of Ghalegaun and Golaghat of Nepal. *GeoJournal*, 86(6), 2747–2765.

KC, A., Rijal, K., & Sapkota, R. P. (2015). Role of ecotourism in environmental conservation and socioeconomic development in Annapurna conservation area, Nepal. *International Journal of Sustainable Development and World Ecology*, 22(3), 251–258.

KC, B., & Race, D. (2020). Outmigration and land-use change: A case study from the middle hills of Nepal. *Land*, 9(1), 2.

Kim, M., Xie, Y., & Cirella, G. T. (2019). Sustainable transformative economy: Community-based ecotourism. *Sustainability*, 11(18), 4977.

Kim, S. (2008). Spatial inequality and economic development: Theories, facts, and policies. *Urbanization and Growth*, 133–166.

Kimaro, E. G., Mor, S. M. & Toribio, JA. L. M. L. (2018). Climate change perception and impacts on cattle production in pastoral communities of northern Tanzania. *Pastoralism*, 8, 19.

Kimbu, A. N., & Ngoasong, M. Z. (2016). Women as vectors of social entrepreneurship. *Annals of Tourism Research*, 60, 63–79.

Koens, J. F., Dieperink, C., & Miranda, M. (2009). Ecotourism as a development strategy: experiences from Costa Rica. *Environment, Development and Sustainability*, 11, 1225–1237.

Kongnso, M. E., Buba, U. H., & Nfor, J. T. (2021). implications of climatic stressors on agro-pastoral resources among Mbororo communities along the slopes of Kilum-Ijim mountain, Northwest region, Cameroon. *Frontiers in Sustainable Food Systems*, 375.

Kotru, R., Chaudhari, S., Lemke, E., Mueller, M., Chettri, R., Basnet, S., … Shaoliang, Y. (2017). Kailash Sacred Landscape conservation and development initiative (2012–2017). Annual Progress Report 2016. Kathmandu. ICIMOD. Nepal.

Krause, L., Mal, S., Karki, R., & Schickhoff, U. (2019). Recession of Trakarding glacier and expansion of Tsho Rolpa lake in Nepal Himalaya based on satellite data. *Himalayan Geology*, 40, 103–114.

Kreutzmann, H. (2012). Pastoral practices in High Asia: agency of 'development' effected by modernisation, resettlement, and transformation. Dordrecht: Springer.

Krishnan, R., Sabin, T. P., Madhura, R. K., Vellore, R. K., Mujumdar, M., Sanjay, J., Nayak, S. & Rajeevan, M., (2019b). Non-monsoonal precipitation response over the Western Himalayas to climate change. *Climate Dynamics*, 52(7), 4091–4109.

Krishnan, R., Shrestha A. B., Ren, G., Rajbhandari, R., Saeed, S., Sanjay, J., Md. A. S., Vellore, R., Xu, Y., You, Q., & Ren, Y. (2019a). Unravelling climate change in the Hindu Kush Himalaya: rapid warming in the mountains and increasing extremes. In Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 57–97.

Kumar, V., Shukla, T., Mehta, M., Dobhal, D. P., Bisht, M. P. S., & Nautiyal, S. (2021). Glacier changes and associated climate drivers for the last three decades, Nanda Devi region, Central Himalaya, India. *Quaternary International*, 575, 213–226.

Kummitha, H. R., Kolloju, N., Jancsik, A., & Szal k, Z. C. (2021). Can tourism social entrepreneurship organizations contribute to the development of ecotourism and local communities: understanding the perception of local communities. *Sustainability*, 13, 11031.

Kuniyal, J. C., Kanwar, N., Bhoj, A.S., Rautela, K. S., Joshi, P., Kumar, K., Sofi, M.S., Bhat, S. U., Rashid, I., Lodhi, M. S., Devi, A., & Singh, H. B. (2021). Climate change impacts on glacier-fed and non-glacier-fed ecosystems of the Indian Himalayan Region: people's perception and adaptive strategies. *Current Science*, 120, 888–899.

Laeis, G. C., & Lemke, S. (2016). Social entrepreneurship in tourism: Applying sustainable livelihoods approaches. *International Journal of Contemporary Hospitality Management*. 28, 1076–1093.

Lama, W. B., Jackson, R., Wangchuk, R. (2010). Snow leopards and 'Himalayan Homestays': catalysts for community-based conservation in mountain areas. *Mountain Forum Bulletin*, 10, (1), 25–28.

Leal Filho, W. (2022). Will climate change disrupt the tourism sector? *International Journal of Climate Change Strategies and Management*. 14, 212–217.

Little, M. E. & Blau, E. (2020). Social adaptation and climate mitigation through agrotourism: a case study of tourism in Mastatal, Costa Rica. *Journal of Ecotourism*, 19(2), 97–112.

Loehr, J., & Becken, S. (2021). Leverage points to address climate change risk in destinations. *Tourism Geographies*, 1–23.

Lonn, P., Mizoue, N., Ota, T., Kajisa, T., & Yoshida, S. (2018). Evaluating the contribution of Community-based Ecotourism (CBET) to household income and livelihood changes:

a case study of the Chambok CBET Program in Cambodia. *Ecological Economics*, 151. 62–69.

Loria, N., & Bhardwaj S.K. (2016). Farmers' response and adaptation strategies to climate change in low- hills of Himachal Pradesh in India. *Nature Environment and Pollution Technology*, 15(3), 895–901.

Lutz, A. F., Maat, H. W., Wijngaard, R. R., Biemans, H., Syed, A., Shrestha, A. B., Wester, P., Immerzeel, W. W. (2019) South Asian River basins in a 1.5°C warmer world. *Regional Environmental Change*, 19, 833–847.

Luxom, N. M., Singh, R., Theengh, L., Shrestha, P., & Sharma, R. K. (2022). Pastoral practices, pressures, and human-wildlife relations in high altitude rangelands of eastern Himalaya: A case study of the Dokpa pastoralists of North Sikkim. *Pastoralism: Research, Policy, and Practice*, 12(1), 1–19.

Ma, B., Cai, Z., Zheng, J., & Wen, Y. (2019). Conservation, ecotourism, poverty, and income inequality–A case study of nature reserves in Qinling, China. *World Development*, 115, 236–244.

Mabon, L., Song Tung, N., Tram, P. T., Tuyet, T. T., Le, H. N., Huong, D. T. T., Ha, H. T. N., Natascha, M. H., & Vertigans, S. (2021). Elaborating a people-centered approach to understanding sustainable livelihoods under climate and environmental change: Thang Binh District, Quang Nam Province, Vietnam. *Sustainability Science*, 16, 221–238.

Mahapatra, P. S., Pandey, R., & Pradhan, S. (2012). River rafting in mountainous regions of Uttarakhand: Impacts, suggested mitigation measures and sustainability. *Journal of Mountain Science*, 9, 511–522.

Maikhuri, R. K., Rana, U., Rao, K. S., Nautiyal, S., & Saxena, K. G. (2000). Promoting ecotourism in the buffer zone areas of Nanda Devi Biosphere Reserve: An option to resolve people—policy conflict. *International Journal of Sustainable Development and World Ecology*, 7(4), 333–342.

Maiti, P., Kuniyal, J. C., Sekar, K. C., Satish, K. V., Singh, D., Bisht, N., Kumar, A., Arya, S. C., Nand, M., & Sundriyal, R. C. (2022). Landscape level ecological assessment and eco-restoration strategies for alpine and sub-alpine regions of the Central Himalaya. *Ecological Engineering*, 180, 106674.

Mak, B. K., Cheung, L. T., & Hui, D. L. (2017). Community participation in the decision-making process for sustainable tourism development in rural areas of Hong Kong, China. *Sustainability*, 9(10), 1695.

Mal, S., Arora, M., Banerjee, A., Singh, R. B., Scott, C. A., Allen, S. K., & Karki, R. (2022). Spatial variations and long-term trends (1901–2013) of rainfall across Uttarakhand Himalaya, India. In: Schickhoff, U., Singh, R. B. & Mal, S. (Eds.), *Mountain Landscapes in Transition: Effects of Land Use and Climate Change*. Sustainable Development Goals Series. Springer, Cham. pp. 163–183.

Mal, S., Mehta, M., Singh, R. B., Schickhoff, U., & Bisht, M. P. S. (2019). Recession and morphological changes of the debris-covered Milam glacier in Gori Ganga Valley, Central Himalaya, India, derived from satellite data. *Frontiers in Environmental Science*, 7, 42.

Malhotra, A., Nandigama, S. & Bhattacharya, K.S. (2022). Puhals: outlining the dynamics of labour and hired herding among the Gaddi pastoralists of India. *Pastoralism* 12, 30.

Mamgain, R. P., & Reddy, D. N. (2017). Out-migration from the hill region of Uttarakhand: magnitude, challenges, and policy options. In: Reddy, D., & Sarap, K. (Eds.), *Rural Labour Mobility in Times of Structural Transformation*. Palgrave Macmillan, Singapore. pp. 209–235.

Manzano, P., Burgas, D., Cadahía, L., Eronen, J. T., Fernández-Llamazares, Á., Bencherif, S., ... & Stenseth, N. C. (2021). Toward a holistic understanding of pastoralism. *One Earth*, 4(5), 651–66.

Maurer, J. M., Schaefer, J. M., Rupper, S., & Corley, A. (2019). Acceleration of ice loss across the Himalayas over the last 40 years. *Science Advances,* 5(6).
Mayanja, M. N., Rubaire-Akiiki, C., Morton, J., & Kabasa, J. D. (2019). Pastoral community coping and adaptation strategies to manage household food insecurity consequent to climatic hazards in the cattle corridor of Uganda. *Climate and Development.* 1–10.
McDowell, G., Harris, L., Koppes, M., Price, M. F., Kai, M.A.C., & Lama, D. G. (2020). From needs to actions: Prospects for planned adaptations in high mountain communities. *Climatic Change*, 163(2), 953–972.
Milano, C., & Koens, K. (2022). The paradox of tourism extremes. Excesses and restraints in times of COVID-19. Current Issues in Tourism, 25, 219–231.
Mishra, A. (2014). Changing climate of Uttarakhand, India. *Journal of Geological Geoscience, 3*(163), 2.
Mishra, A. (2017). Changing temperature and rainfall patterns of Uttarakhand. *International Journal of Environmental Sciences and Natural Resources*, 7(4).
Mohanty, A., Hussain, M., Mishra, M., Kattel, D.B., & Pal, I. (2019). Exploring community resilience and early warning solution for flash foods, debris flow and landslides in conflict prone villages of Badakhshan, Afghanistan. *International Journal of Disaster Risk Reduction*, 33, 5–15.
Montes, J., & Kafley, B. (2022). Ecotourism discourses in Bhutan: contested perceptions and values. *Tourism Geographies*, 24(6-7), 1173-1196.
Morais, L. P., & Bacic, M. J. (2020). Social and Solidarity Economy and the need for its entrepreneuring ecosystem: current challenges in Brazil. *CIRIEC-España revista de economía pública social y cooperativa,* 98, 5–30.
Mueller, V., Gray, C., & Kosec, K. (2014). Heat stress increases long-term human migration in rural Pakistan. *Nature Climate Change*, 4(3), 182–185.
Mukherji, A., Scott, C., Molden, D., & Maharjan, A. (2018). Megatrends in Hindu Kush Himalaya: climate change, urbanisation and migration and their implications for water, energy, and food. In: Biswas, A. K., & Tortajada, C. (Eds.), *Water Security under Climate Change*. Springer, Singapore. pp. 125–146.
Mulder, N. (2020). The impact of the COVID-19 pandemic on the tourism sector in Latin America and the Caribbean, and options for a sustainable and resilient recovery. International Trade series, No. 157 (LC/TS.2020/147), Santiago, Economic Commission for Latin America, and the Caribbean (ECLAC).
Murphy, H., & Harwood, S. (2017). Walking on country with Bana Yarralji Bubu: A model for aboriginal social enterprise tourism. In: P. J. Sheldon & R. Daniele (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice.* Cham: Springer International Publishing. pp. 295–314.
Murphy, J., Teo, A., Murphy, C., & Liu, E. (2017). The BEST society: from charity to social entrepreneurship. In: Sheldon, P. & Daniele, R. (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice*. Cham: Springer International Publishing. pp. 237–249.
Mwasha, S. I. & Robinson, Z. (2021). Building livelihoods resilience in the face of climate change: Case study of small-holder farmers in Tanzania. *African Handbook of Climate Change Adaptation*, Springer International Publishing. Cham. pp. 829–48.
Nainwal, H. C., Banerjee, A., Shankar, R., Semwal, P., & Sharma, T. (2016). Shrinkage of Satopanth and Bhagirath Kharak glaciers, India, from 1936 to 2013. *Annals of Glaciology*, 57, 131–139.
Naitthani, P., & Kainthola, S. (2015). Impact of conservation and development on the Vicinity of Nanda Devi National Park in the North India. *JAR/RGA Journal of Alpine Research/Revue deGéographie Alpine*, 103(3).

Namgay, K., Millar, J. E., & Black, R. S. (2021). The future of transhumants' sustainable resource use in Bhutan: Pressures and Policies. *Frontiers in Sustainable Food Systems*, 5, 1–13.

Namgay, K., Millar, J. E., Black, R. S., Samdup, T. (2014). Changes in transhumant agro-pastoralism in Bhutan: A disappearing livelihood? *Human Ecology*, 42, 779–792.

Namgay, K., Millar, J., Black, R., Samdup, T. (2013). Transhumant agro-pastoralism in Bhutan: Exploring contemporary practices and socio-cultural traditions. *Pastoralism: Research, Policy, and Practice*, 3(13).

Nautiyal, S., & Kaechele, H. (2007). Adverse impacts of pasture abandonment in Himalayan protected areas: Testing the efficiency of a Natural Resource Management Plan (NRMP). *Environmental Impact Assessment Review*, 27(2), 109–125.

Nautiyal, S., Rao, K. S., Maikhuri, R. K., & Saxena, K. G. (2003). Transhumant pastoralism in the Nanda Devi Biosphere Reserve, India. *Mountain Research and Development*, 23(3), 255-262.

Ndiritu, S. W. (2021). Drought responses and adaptation strategies to climate change by pastoralists in the semi-arid area, Laikipia County, Kenya. *Mitigation and Adaptation Strategies for Global Change*, 26, 10.

Ndungu, C., & Bhardwaj S. K. (2015). Assessment of people's perceptions and adaptations to climate change and variability in mid-hills of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*, 4, 47–60.

Negi, C. S. (2007). Changing face of polyculture in the Darma and Johaar valleys, Pithoragarh, Kumaun Himalayas. *International Journal of Sustainable Development and World Ecology*, 14 (4), 428–436.

Negi, C. S., Joshi, P., & Bohra, S. (2015). Rapid vulnerability assessment of Yartsagunbu (Ophiocordyceps sinensis [Berk.] GH Sung et al) in Pithoragarh district, Uttarakhand state, India. *Mountain Research and Development*, 35(4), 382–391.

Negi, G. C. S., Samal, P. K., Kuniyal, J. C., Kothyari, B. P., Sharma, R. K., & Dhyani, P. P. (2012). Impact of climate change on the western Himalayan mountain ecosystems: an overview. *Tropical Ecology*, 53(3), 345–356.

Negi, H.S., Neha, K., Shekhar M. S., Ganju, A. (2018). Recent wintertime climatic variability over the Northwest Himalayan cryosphere. *Current Science*, 114(4), 25.

Negi, V. S., Maikhuri, R. K., & Pharswan, D. (2017). Climate change in the Western Himalaya: People's perception and adaptive strategies. *Journal of Mountain Science*, 14(2), 403–416.

Negi, V. S., Maletha, A., Pathak, R., & Maikhuri, R. K. (2021a). Expansion of a native species and its impacts on alpine ecosystems, Indian Himalaya. *Biologia*, 76(3), 889–899.

Negi, V. S., Thakur, S., Dhyani, R., Bhatt, I. D., & Rawal, R. S. (2021b). Climate change observations of indigenous communities in the Indian Himalaya. *Weather, Climate, and Society*, 13(2), 245–257.

Negi, V. S., Tiwari, D. C., Singh, L., Thakur, S., & Bhatt, I. D. (2022). Review and synthesis of climate change studies in the Himalayan region. *Environment, Development and Sustainability,* 24, 10471–10502.

Neupane, R., K. C A, Aryal, M., & Rijal, K. (2021). Status of ecotourism in Nepal: a case of Bhadaure-Tamagi village of Panchase area. *Environment, Development, and Sustainability*, 23, 15897–15920.

Newton, J., & Franklin, A. (2011). Delivering sustainable communities in China: using a sustainable livelihoods framework for reviewing the promotion of "ecotourism" in Anji. *Local Environment,* 16(8), 789–806.

Niamir-Fuller, M., & Huber-Sannwald, E. (2020). Pastoralism and achievement of the 2030 agenda for Sustainable Development: A missing piece of the global puzzle. In: Lucatello, S., Huber-Sannwald, E., Espejel, I., & Martínez-Tagüeña, N. (Eds.),

Stewardship of future drylands and climate change in the Global South. Springer, Cham. pp. 41–55.
Nie, Y., Pritchard, H. D., Liu, Q. et al. (2021). Glacial change and hydrological implications in the Himalaya and Karakoram. *Nature Reviews Earth and Environment*, 2, 91–106.
Ning, W., Rawat, G. S., Joshi, S., Ismail, M., & Sharma, E. (2013). High-altitude rangelands and their interfaces in the Hindu Kush Himalayas. International Centre for Integrated Mountain Development. ICIMOD. Nepal.
NITI Aayog (2018a). Sustainable tourism in the Indian Himalayan contributing to sustainable development in Indian Himalayan region. Report of Working Group II. NITI Aayog, Government of India.
NITI Aayog (2018b). Strengthening skill and entrepreneurship landscape in Indian Himalayan Region. Report of Working Group IV. NITI Aayog, Government of India.
Nugroho, I., Hanafie, R., Negara, P. D., & Yuniar, H. R. (2021). Social capital and social capacity in rural ecotourism development. *The Indonesian Journal of Geography*, 53(1), 153–164.
Nyaupane, G. P., & Chhetri, N. (2009). Vulnerability to climate change of nature-based tourism in the Nepalese Himalayas. *Tourism Geographies*, 11(1), 95–119.
OECD (2020). OECD Tourism Trends and Policies 2020, OECD Publishing, Paris.
Ogara, O. W., Seneiya, J. O., Ongoro, E. B. (2013). Community based conservation and ecotourism as an environmental management practice for climate change adaptation in Ewaso Nyiro arid land ecosystem, Samburu County Kenya. *Journal of Environmental Science and Water Resources*, 2(4), 106–111.
Ogra, M. V., & Badola, R. (2015). Gender and climate change in the Indian Himalayas: global threats, local vulnerabilities, and livelihood diversification at the Nanda Devi Biosphere Reserve. *Earth System Dynamics*, 6, 505–523.
Opiyo F., Wasonga O., Nyangito M., Schilling J., & Munang R. (2015a). Drought adaptation and coping strategies among the Turkana pastoralists of northern Kenya. *International Journal of Disaster Risk Science*, 6(3), 295–309.
Opiyo, F., Wasonga, O. V., Nyangito, M. M., Mureithi, S. M., Obando, J., & Munang, R. (2015b). Determinants of perceptions of climate change and adaptation among Turkana pastoralists in Northwestern Kenya. *Environment, Development and Sustainability*, 23(5), 7393–7411.
Osterwalder, A., & Pigneur, Y. (2010). Business model generation: A handbook for visionaries, game changers, and challengers: John Wiley & Sons.
Pandey, A., Pradhan, N., Chaudhari, S., & Ghate, R. (2017a). Withering of traditional institutions? An institutional analysis of the decline of migratory pastoralism in the rangelands of the Kailash Sacred Landscape, Western Himalayas. *Environmental Sociology*, 3(1), 87–100.
Pandey, R., Jha, S. K. & Alatalo, J. M. (2017b). Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. *Ecological Indicators,* 79. 338–346.
Panta, S. K., & Thapa, B. (2018). Entrepreneurship and women's empowerment in gateway communities of Bardia National Park, Nepal. *Journal of Ecotourism*, 17(1), 20–42.
Parks, T. H., Parks, T. A., & Allen, C. (2009). The development of a framework for studying ecotourism. *International Journal of Management*, 26(1), 89–98.
Pasakhala, B., Ghate, R., Phuntsho, K., Gentle, P., Gurung, J., Shrestha, A., Gurung, K., & Thapa, S. (2021). Against the tide: the future of transhumant herders in the Kailash Sacred Landscape of Nepal. *Mountain Research and Development*, 41(4), 8–15.
Pasakhala, B., Maharjan, A., Tuladhar, S., & Mishra, A. (2023). Cryosphere changes, cascading disasters, and societies–A case in Langtang valley. In: Pradhan, P. K., Leimgruber, W. (Eds.), *Nature, Society, and Marginality: Case Studies from Nepal, Southeast Asia, and other regions*. Cham: Springer International Publishing. pp. 49–64.

Paschapur, A., Subbanna, A.R.N.S., Gupta, J., Parihar, M., Mishra, K. K. (2022). Insect pest scenario in Uttarakhand Himalayas, India, under changing climatic conditions. *International Journal of Biometeorology*, 66(7), 1445–1460.

Pathak, S., Pant, L., & Maharjan, A. (2017). De-population trends, patterns and effects in Uttarakhand, India – A gateway to Kailash Mansarovar. ICIMOD Working Paper 2017/22. Kathmandu: ICIMOD.

Platt, R.V., Ogra, M., Kisak, N., Manral, U., & Badola, R. (2021). Climate change perceptions, data, and adaptation in the Garhwal Himalayas of India. *Climate and Development*, 13(2), 95–106.

Postigo, J. C. (2021). Navigating capitalist expansion and climate change in pastoral social-ecological systems: impacts, vulnerability, and decision-making. *Current Opinion in Environmental Sustainability*, 52, 68–74.

Qastharin, A. R. (2014). Understanding the business model of social enterprise: a case study of Indonesia Mengajar, Master of Science, KTH Industrial Engineering and Management, Stockholm.

Qi, W., Zhang, Y., Gao, J., Yang, X., Liu, L., & Khanal, N. R. (2013). Climate change on the southern slope of Mt. Qomolangma (Everest) Region in Nepal since 1971. *Journal of Geographical Sciences*, 23, 595–611.

Ramprasad, V., Joglekar, A., & Fleischman, F. (2020). Plantations and pastoralists: afforestation activities make pastoralists in the Indian Himalaya vulnerable. *Ecology and Society*, 25(4).

Rastogi, A., Hickey, G. M., Anand, A., Badola, R., & Hussain, S. A. (2015). Wildlife-tourism, local communities, and tiger conservation: A village-level study in Corbett Tiger Reserve, India. *Forest Policy and Economics*, 61, 11–19.

Rasul, G., & Molden, D. (2019). The global social and economic consequences of mountain cryopsheric change. *Frontiers in Environmental Science*, 7, 91.

Rasul, G., Saboor, A., Tiwari, P. C., Hussain, A., Ghosh, N., & Chettri, G. B. (2019). Food and nutrition security in the Hindu Kush Himalaya: Unique challenges and niche opportunities. In Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 301–338.

Rautela, P., & Karki, B. (2015). Impact of climate change on life and livelihood of indigenous people of higher Himalayan Uttarakhand, India. *American Journal of Environmental Protection*, 3(4), 112–124.

Rawat, D., Neuburger, M. & Schickhoff, U. (in press): Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region. *Journal of Ecotourism*.

Rawat, D., & Schickhoff, U. (2022). Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India. In: Schickhoff, U., Singh, R. B. & Mal, S. (Eds.), *Mountain Landscapes in Transition: Effects of Land Use and Climate Change*. Sustainable Development Goals Series. Springer, Cham. pp. 429–447.

Rayamajhi, N., & Manandhar, B. (2020). Impact of climate change and adaptation measures on transhumance herding system in Gatlang, Rasuwa. *Air, Soil and Water Research*, 13, 1–10.

RDMC (2018). Nature-based tourism (ecotourism) in Uttarakhand: Analysis and recommendations. Rural Development and Migration Commission. Government of Uttarakhand.

REAS (2011). Red de Redes de Economía Alternativa y solidaria. Carta de la Economía Solidaria. Retrieved from https://www.economiasolidaria.org/carta-de-principios-de-la-economia-solidaria/

Regmi, K. D., & Walter, P. (2017). Modernisation theory, ecotourism policy, and sustainable development for poor countries of the global South: perspectives from Nepal.

International Journal of Sustainable Development & World Ecology, 24(1), 1–14.
Reinhold, S., Zach, F., & Krizaj, D. (2017). Business models in tourism: a review and research agenda. *Tourism Review*, 72(4), 462–482.
Ren, L., Duan, K., & Xin, R. (2020). Impact of future loss of glaciers on precipitation pattern: A case study from south-eastern Tibetan Plateau. *Atmospheric Research*, 242, 104984.
Ren, Y. Y., Ren, G. Y., Sun, X. B., Shrestha, A. B., You, Q. L., Zhan, Y. J., Rajbhandari, R., Zhang, P. F., Wen, K. M. (2017). Observed changes in surface air temperature and precipitation in the Hindu Kush Himalayan region over the last 100-plus years. *Advances in Climate Change Research*, 8, 148–156.
Resurrección, B. P., Goodrich, C. G., Song, Y., Bastola, A., Prakash, A., Joshi, D., ... & Shah, S. A. (2019). In the shadows of the Himalayan mountains: persistent gender and social exclusion in development. In Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 491–516.
Rinzin C, Vermeulen W, & Glasbergen P. (2007). Ecotourism as a mechanism for sustainable development: The case of Bhutan. *Environmental Sciences*, 4(2), 109–125.
Roblek, V., Drpi´c, D., Meško, M., & Milojica, V. (2021). Evolution of sustainable tourism concepts. *Sustainability*, 13, 12829.
Rocca, L. H. D., & Zielinski, S. (2022). Community-based tourism, social capital, and governance of post-conflict rural tourism destinations: the case of Minca, Sierra Nevada de Santa Marta, Colombia. *Tourism Management Perspectives*, *43*, 100985.
Rosato, P. F., Caputo, A., Valente, D., & Pizzi, S. (2021). 2030 Agenda and sustainable business models in tourism: A bibliometric analysis, *Ecological Indicators*, 121, 106978.
Roy, A., & Rathore, P. (2019). Western Himalayan forests in climate change scenario. In: Navalgund, R., Kumar, A., & Nandy, S. (Eds.), *Remote Sensing of Northwest Himalayan Ecosystems.* Springer, Singapore. Pp. 265–283.
Roy, T. (2003). Changes in wool production and usage in colonial India. *Modern Asian Studies*, 37 (2), 257–286.
Sabin, T. P., Krishnan, R., Vellore, R., Priya, P. Borgaonkar, H. P., Singh, B. B., & Sagar, A. (2020). Climate change over the Himalayas. In: Krishnan, R., Sanjay, J., Gnanaseelan, C., Mujumdar, M., Kulkarni, A., Chakraborty, S. (Eds.), *Assessment of Climate Change over the Indian Region*. Springer, Singapore. pp. 207–222.
Sahakian, M. D., & Dunand, C. (2015). The social and solidarity economy towards greater 'sustainability': learning across contexts and cultures, from Geneva to Manila. *Community Development Journal*, 50(3), 403–417.
Sahani, N. (2021). Application of hybrid SWOT-AHP-FuzzyAHP model for formulation and prioritization of ecotourism strategies in Western Himalaya, India. *International Journal of Geoheritage and Parks*, 9(3), 349–362.
Sahebalzamani, S. & Bertella, G. (2018). Business models and sustainability in nature tourism: a systematic review of the literature. *Sustainability*, 10, 322.
Salgueiro, J., Barbieri E., & Morgado, F. (2020). Climate change and ecotourism in the context of the 2030 Agenda for Sustainable Development. In: Leal Filho W., Azul A., Brandli L., Özuyar P., & Wall T. (Eds.), *Sustainable cities and communities. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. pp. 1–10.
Sarkar, R., & Sinha, A. (2015). The village as a social entrepreneur: Balancing conservation and livelihoods. *Tourism Management Perspectives*, 16, 100–106.
Sati, V. P. (2015). Climate change and socio-ecological transformation in high mountains: An empirical study of Garhwal Himalaya. *Change and Adaptation in Socio-ecological Systems*, 2, 45–56.
Sati, V. P. (2020). Himalaya on the Threshold of Change. Springer.
Sati, V. P. (2021). Trends and potential of eco-tourism development in Uttarakhand Himalaya. *Journal on Tourism and Sustainability*, 5(1).

Sati, V.P. (2023). National Parks, Wildlife Sanctuaries, and Conservation Reserves. In: *Sustainable Forest Management in the Himalaya*. Springer, Cham. pp. 31–50.
Scherrer, P. (2020). Tourism to serve culture: The evolution of an aboriginal tourism business model in Australia. *Tourism Review*, 75(4), 663–680.
Schickhoff, U., & Mal, S. (2020). Current changes in alpine ecosystems of Asia. Elsevier.
Schickhoff, U., Bobrowski, M., & Mal, S. (2022). The World's mountains in the Anthropocene. In Schickhoff, U., Singh, R. B. & Mal, S. (Eds.), *Mountain Landscapes in Transition: Effects of Land Use and Climate Change*. Springer, Cham. pp. 1–144.
Schickhoff, U., Bobrowski, M., Böhner, J., Bürzle, B., Chaudhary, R. P., Gerlitz, L., Heyken, H., Lange, J., Müller, M., Scholten, T., Schwab, N., and Wedegärtner, R. (2015). Do Himalayan treelines respond to recent climate change? An evaluation of sensitivity indicators. *Earth System Dynamics*, 6, 245–265.
Schickhoff, U., Singh, R.B. & Mal, S. (2016): Climate change and dynamics of glaciers and vegetation in the Himalaya: An overview. In: Singh, R.B., Schickhoff, U. & Mal, S. (Eds.), *Climate Change, Glacier Response, and Vegetation Dynamics in the Himalaya.* Contributions Toward Future Earth Initiatives. Springer, Switzerland. pp. 1–26.
Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. IDS Working Paper 72, Institute of Development Studies, Brighton.
Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, 36, 171–96.
Scott, D. (2021). Sustainable tourism and the grand challenge of climate change. *Sustainability*, 13(4), 1966.
Scott, D., Hall, C. M., & Gössling, S. (2019). Global tourism vulnerability to climate change. *Annals of Tourism Research*, 77, 49–61.
Seraphin, H., & Dosquet, F. (2020). Mountain tourism and second home tourism as post COVID-19 lockdown placebo? *Worldwide Hospitality and Tourism Themes*, 12(4), 485–500.
Serenari, C., Peterson, M. N., Wallace, T., & Stowhas, P. (2017). Private protected areas, ecotourism development and impacts on local people's well-being: a review from case studies in Southern Chile. *Journal of Sustainable Tourism,* 25(12), 1792–1810.
Shafiq, M. U., Rasool, R., Ahmed, P., & Dimri, A. P. (2018). Temperature and precipitation trends in Kashmir valley, Northwestern Himalayas. *Theoretical and Applied Climatology*, 135, 293-304.
Shakya, M. (2016). Tourism and social capital: case studies from rural Nepal. *Reframing Sustainable Tourism,* 217–239.
Sharma, A., Batish, D.R. & Uniyal, S.K. (2020). Documentation and validation of climate change perception of an ethnic community of the western Himalaya. *Environmental, Monitoring and Assessment*, 192, 552.
Sharma, A., Parkash, O., & Uniyal, S. K. (2022). Moving away from transhumance: The case of Gaddis. *Trees, Forests and People*, 7, 100193.
Sharma, E., Chettri, N., Tse-ring, K., Shrestha, A. B., Jing, F., Mool, P., & Eriksson, M. (2009). Climate change impacts and vulnerability in the Eastern Himalayas. ICIMOD, Kathmandu, Nepal
Sharma, S., & Rikhari, H. C. (1995). The Bhotias: The disruption in lifestyle of a nomadic community in the Indian Central Himalayas. *Nomadic Peoples*, 167–173.
Shean, D. E., Bhushan, S., Montesano, P., Rounce, D. R., Arendt, A., Osmanoglu, B. (2020). A systematic, regional assessment of High Mountain Asia glacier mass balance. *Frontiers in Earth Science*, 7, 363.
Sheldon, P. J., Pollock, A., & Daniele, R. (2017). Social entrepreneurship and tourism: Setting the stage. In Sheldon, P. & Daniele, R. (Eds.), *Social Entrepreneurship and Tourism: Philosophy and Practice*. Cham: Springer International Publishing. pp. 1–18.

Shi, H., Zhang, L., Song, B., & He, C. (2022). The impact of ecotourism on local rural households' livelihood around Wolong Nature Reserve. *Forestry Economics Review*, 4(1), 2–18.

Shukla, R., Agarwal, A., Gornott, C., Sachdeva, K., & Joshi, P. K. (2019). Farmer typology to understand differentiated climate change adaptation in Himalaya. *Scientific Reports*, 9(1), 20375.

Siddiqui, T., Bhagat, R. B., Banerjee, S., Liu, C., Sijapati, B., Memon, R., Thinley, P., Ito, M., Nemat, O., & Arif, G. (2019). Migration in the Hindu Kush Himalaya: Drivers, consequences, and governance. In Wester, P., Mishra, A., Mukherji, A., Shrestha A. B. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 517–544.

Sigdel, S. R., Wang, Y., Camarero, J. J., Zhu, H., Liang, E., Penuelas, J. (2018). Moisture-mediated responsiveness of treeline shifts to global warming in the Himalayas. *Global Change Biology*, 24(11), 5549–5559.

Singh, A. P., & Sondhi, S. (2016). Butterflies of Garhwal, Uttarakhand, western Himalaya, India. *Journal of Threatened Taxa*, 8(4), 8666–8697.

Singh, D. K., Thakur, P. K., Naithani, B. P., & Kaushik, S. (2018). Temporal monitoring of glacier changes in Dhauliganga basin, Kumaun Himalaya using geo-spatial techniques. *ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 4(5).

Singh, N. J., Bhatnagar, Y. V., Lecomte, N., Fox, J. L., & Yoccoz, N. G. (2013). No longer tracking greenery in high altitudes: Pastoral practices of Rupshu nomads and their implications for biodiversity conservation. *Pastoralism: Research, Policy, and Practice*, 3, 1–15.

Singh, R. B., Kumar, S., & Kumar, A. (2016). Climate change in Pindari region, Central Himalaya, India. In: Singh, R., Schickhoff, U., Mal, S. (Eds.), *Climate Change, Glacier Response, and Vegetation Dynamics in the Himalaya*. Springer, Cham. pp. 117–135.

Singh, R. K., Zander, K. K., Kumar, S., Singh, A., Sheoran, P., Kumar, A., ... & Garnett, S. T. (2017). Perceptions of climate variability and livelihood adaptations relating to gender and wealth among the Adi community of the Eastern Indian Himalayas. *Applied Geography*, 86, 41–52.

Singh, R., Sharma, R. K., Babu, S., & Bhatnagar, Y. V. (2020a). Traditional ecological knowledge and contemporary changes in the agro-pastoral system of upper Spiti landscape, Indian Trans-Himalayas. *Pastoralism: Research, Policy, and Practice*, 10(1), 1–14.

Singh, R., Sharma, R.K., Bhutia, T. U., Bhutia, K.S., & Babu, S.C. (2021). Conservation policies, eco-tourism, and end of pastoralism in Indian Himalaya? *Frontiers in Sustainable Food Systems*, 5, 613998.

Singh, S. P., Thadani, R., Negi, G. C., Singh, R. D., & Gumber, S. (2020b). The impact of climate change in Hindu Kush Himalayas: Key sustainability issues. In: Dimri, A., Bookhagen, B., Stoffel, M., Yasunari, T. (Eds.), *Himalayan weather and climate and their impact on the environment.* Springer, Cham. pp. 453–472.

Singh, T. V., & Singh, S. (2004). On bringing people and park together through ecotourism: The Nanda Devi National Park, India. Asia Pacific *Journal of Tourism Research*, 9(1), 43–55.

Soliku, O., Kyiire, B., Mahama, A., & Kubio, C. (2021). Tourism amid COVID-19 pandemic: impacts and implications for building resilience in the eco-tourism sector in Ghana's Savannah region. *Heliyon*, 7(9), e07892.

Somarriba-Chang, M., & Gunnarsdotter, Y. (2012). Local community participation in ecotourism and conservation issues in two nature reserves in Nicaragua. *Journal of Sustainable Tourism*, 20(8), 1025–1043.

Sood, J., Lynch, P., & Anastasiadou, C. (2017). Community non-participation in homestays in Kullu, Himachal Pradesh, India. *Tourism Management*, 60, 332–347.

Srichandan, S., Pasupuleti, R. S., & Mishra, A. J. (2021). The transhumance route of Pithoragarh: A cultural route? *Environmental Challenges*, 5, 100291.
Steiger, R., Knowles, N., Pöll, K., & Rutty, M. (2022). Impacts of climate change on mountain tourism: A review. *Journal of Sustainable Tourism*, 1–34.
Steinicke, E., & Neuburger, M. (2012). The impact of community-based agro-alpine tourism on regional development. Case study Mt. Kenya. *Mountain Research and Development,* 32(4), 420–430
Stephens, S. (2021). Sustainable livelihood tourism: a potential framework to help humanity cope with the Anthropocene (Doctoral dissertation, The American University of Paris, France.
Sujakhu, N. M., Ranjitkar, S., Niraula, R. R., Pokharel, B. K., Schmidt-Vogt, D., & Xu, J. (2016). Farmers' perceptions of and adaptations to changing climate in the Melamchi Valley of Nepal. *Mountain Research and Development*, 36(1), 15–30.
Szromek A. R. (2021). The sustainable business model of spa tourism enterprise- results of research carried out in Poland. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), 73.
Tao, T. C. H., & Wall, G. (2009a). A livelihood approach to sustainability. *Asia Pacific Journal of Tourism Research*, 14(2), 137–152.
Tao, T. C. H., & Wall, G. (2009b). Tourism as a sustainable livelihood strategy. Tourism Management, 30(1), 90–98.
TERI (2019). Tourism baseline study for SECURE Himalaya project landscapes in Uttarakhand. Draft Report 2019. The Energy and Resources Institute. New Delhi.
Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2853–2867.
Thorpe, A., & Figge, F. (2018). Climate change and globalisation as 'Double Exposure': Implications for policy development. *Environmental Science and Policy*, 90, 54–64.
Tiwari, K. R., Sitaula, B. K., Bajracharya, R. M., Raut, N., Bhusal, P., & Senegal, M. (2020). Vulnerability of pastoralism: A case study from the high mountains of Nepal. *Sustainability*, 12(7), 2737.
Tiwari, P. C., & Joshi, B. (2017). Gender processes in rural outmigration and socio-economic development in the Himalaya. *Migration and Development,* 5(2), 330–350.
Trang, N. T. T., & Loc, H. H. (2022). Eco-agritourism as an Ecosystem-based adaptation (EBA) against climate change impacts for the Vietnamese Mekong Delta: a viewpoint. In *IOP Conference Series: Earth and Environmental Science*, 1028(1), 012003.
Tripathi, P., Behera, M. D., & Roy, P. S. (2019). Plant invasion correlation with climate anomaly: An Indian retrospect. *Biodiversity and Conservation*, 28(8–9), 2049–2062.
Tuladhar, S, Pasakhala, B., Maharjan, A., & Mishra, A. (2021). Unravelling the linkages of cryosphere and mountain livelihood systems: A case study of Langtang, Nepal. *Advances in Climate Change Research*, 12(1), 119–131.
Uddin, M. E. & Kebreab, E. (2020). Review: impact of food and climate change on pastoral industries. *Frontiers in Sustainable Food Systems*, 4, 543403.
UNCTAD (2017). Promoting entrepreneurship for Sustainable Development: A selection of business cases from Empretec network. United Nations publication.
UNDP (2017). Guidance notes for the application of the Sustainable Livelihoods Framework in development projects. United Nations Development Programme.
UNIDO (2017). The role of the social and solidarity economy in reducing social exclusion. Budapest Conference Report. United Nations Industrial Development Organization.
UNTFSSE (2014). Social and solidarity economy and the challenge of sustainable development. A position paper. United Nations Inter-Agency Task Force on Social and Solidarity Economy.
UNWTO (2017). Tourism and the Sustainable Development Goals – Journey to 2030. Madrid: UNWTO.

UNWTO (2018). Annual Report 2017, UNWTO, Madrid.
Upadhaya, S., Tiwari, S., Poudyal, B., Chhetri, S. G., & Dhungana, N. (2022). Local people's perception of the impacts and importance of ecotourism in Central Nepal. *PLoS One*, 17(5), e0268637.
Upadhyay, H., Vinke, K., Bhardwaj, S., Becker, M., Irfan, M., George, N. B., Biella, R., Arumugam, P., Murki, S. K., & Paoletti, E. (2021). Locked houses, fallow lands: climate change and migration in Uttarakhand, India. Potsdam Institute for Climate Impact Research (PIK), Potsdam and The Energy and Resources Institute (TERI), New Delhi.
Uprety, Y., Shrestha, U. B., Rokaya, M. B., Shrestha, S., Chaudhary, R. P., Thakali, A., Cockfield, G., & Asselin, H. (2017). Perceptions of climate change by highland communities in the Nepal Himalaya. *Climate and Development*, 9(7), 649–661.
Uttarakhand Tourism Policy (2018). Department of Tourism. Government of Uttarakhand.
Uttarakhand Tourism Statistics (2015). Tourism Corporation of Uttarakhand, Dehradun.
Utting, P. (2015). Social and solidarity economy beyond the fringe? Zed Books: London, UK.
Vaidya, R. A., Shrestha, M. S., Nasab, N., Gurung, D. R., Kozo, N, Pradha, N. S., Wasson, R. J. (2019) Disaster risk reduction and building resilience in the Hindu Kush Himalaya. In: Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 389–419.
Vannelli, K., Hampton, M. P., Namgail, T., & Black, S. A. (2019). Community participation in ecotourism and its effect on local perceptions of snow leopard (Panthera uncia) conservation. *Human Dimensions of Wildlife*, 24(2), 180–193.
Vargas Vasserot, C. (2023). Social enterprises in the European Union: Gradual recognition of their importance and models of legal regulation. In Peter, H., Vargas Vasserot, C., & Alcalde Silva, J. (Eds.), The International Handbook of Social Enterprise Law. Springer, Cham. pp. 27.
Villalba-Eguiluz, U., Egia-Olaizola, A., & Pérez de Mendiguren, J. C. (2020). Convergences between the social and solidarity economy and Sustainable Development Goals: case study in the Basque country. *Sustainability*, 12, 5435.
von der Weppen, J., & Cochrane, J. (2012). Social enterprises in tourism: An exploratory study of operational models and success factors. *Journal of Sustainable Tourism*, 20(3), 497–511.
Wallrapp, C., Keck, M., & Faust, H. (2019). Governing the yarshagumba 'gold rush': A comparative study of governance systems in the Kailash Landscape in India and Nepal. *International Journal of the Commons*, 13(1), 455–478.
Walter, P., Regmi, K. D., & Khanal, P. R. (2018). Host learning in community-based ecotourism in Nepal: The case of Sirubari and Ghalegaun homestays. *Tourism Management Perspectives*, 26, 49–58.
Wang, H., Khan, Y. A., Mouldi, A., Abou El Khier, B. S. & Guo, W. (2022). The impact of geopolitical and pandemic risks on tourist inflows: evidence from Asia-Pacific region. *Frontiers in Environmental Science,* 10, 850729.
Wang, M., Rasoolimanesh, S. M., & Kunasekaran, P. (2021). A review of social entrepreneurship research in tourism: knowledge map, operational experiences, and roadmaps. *Journal of Sustainable Tourism*, 1–22.
Wang, Y., Wu, N., Kunze, C., Long, R., & Perlik, M. (2019). Drivers of change to mountain sustainability in the Hindu Kush Himalaya. In: Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham. pp. 17–56.
Wangchuk, K., & Wangdi, J. (2018). Signs of climate warming through the eyes of yak herders in northern Bhutan. *Mountain Research and Development*, 38(1), 45–52.

Wardle, C., Buckley, R., Shakeela, A., & Castley, J. G. (2021). Ecotourism's contributions to conservation: analysing patterns in published studies. *Journal of Ecotourism*, 20(2), 99–129.

WCED (1987). Our Common Future. World Commission on Environment and Development. Oxford: Oxford University Press.

Wearing, S., & Wearing, M. (1999). Decommodifying Ecotourism: Rethinking global-local interactions with host Communities. *Society and Leisure*, 22, 39–70.

Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. B. (2019). The Hindu Kush Himalaya Assessment: Mountains, climate change, sustainability, and people. Springer Nature Switzerland AG, Cham.

Willis, C. M. (2007). A descriptive grammar of Darma: an endangered Tibeto-Burman language. The University of Texas, Austin.

WTO–UNDP (2017). Tourism and the sustainable development goals – Journey to 2030. World Tourism Organization and United Nations Development Programme. Madrid: UNWTO.

Wu, N., Ismail, M., Joshi, S., Yi, S. L., Shreshtha, R. M., & Jasra, A. W. (2014). Livelihood diversification as an adaptation approach to change in the pastoral Hindu- Kush Himalayan region. *Journal of Mountain Science*, 11(5), 1342–1355.

Wu, X., Zhang, X., Dong, S., Cai, H., Zhao, T., Yang, W., Jiang, R., Shi, Y. & Shao, J. (2015). Local perceptions of rangeland degradation and climate change in the pastoral society of Qinghai-Tibetan Plateau. *The Rangeland Journal*, 37(1), pp. 11–19.

Zheng, Y., & Dallimer, M. (2016). What motivates rural households to adapt to climate change? *Climate and Development*, 8(2), 110–121.

Zielinski, S. Jeong, Y., & Milanés, C. B. (2020). Factors that influence community-based tourism (CBT) in developing and developed countries. *Tourism Geographies,* 23(5–6), 1040–1072

Zomer, R. J., Trabucco, A., Metzger, M., Wang, M. C., Oli, K. P., & Xu, J. C. (2014). Projected climate change impacts on spatial distribution of bioclimatic zones and ecoregions within the Kailash sacred landscape of China, India, Nepal. *Climatic Change*, 125(3–4), 445–460.

Zomer, R. J., Wang, M., Trabucco, A., & Xu, J. (2016). Projected climate change impact on hydrology, bioclimatic conditions, and terrestrial ecosystems in the Asian highlands. *ICRAF Working Paper-World Agroforestry Centre*, 222.

Žurovec, O., & Vedeld, P. O. (2019). Rural livelihoods and climate change adaptation in laggard transitional economies: a case from Bosnia and Herzegovina. *Sustainability*, 11(21), 6079.

Appendix I

Abstracts and author contributions to original publications

Study 1

Rawat, D., & Schickhoff, U. (2022). Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India. In: Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Sustainable Development Goals Series. Springer, Cham. pp. 429-447.

Abstract
Climate change in the Himalayan region has serious implications for livelihood support systems and overall human well-being. In Darma valley (Uttarakhand, India), local people, known as Bhotias, use alpine pasturelands (bugyals) for transhumant grazing of their livestock. In the region, transhumant pastoralism has seen a tremendous decline due to various environmental and socio-economic changes. In the context of present climatic conditions, the article addresses the extent of climate change in the region, the perceptions of climate change among local pastoral communities and socio-economic dimensions of climate change impacts on the local communities and environment. A substantial step of the study is to investigate the local community's perceptions of climate change which affects their motivation to engage in alternative livelihood options. Socio-economic data on impacts of climate change were correlated with meteorological data (CRU TS climate data v4.02) and remote sensing-based indicators such as NDSI (Normalized Difference Snow Index) in order to validate the impacts of changing climate as experienced by the local community. The results suggest that a substantial number of pastoralists perceived climatic change and its associated impact on the environment and on their livelihoods.

Author contributions
Deepika Rawat: Study design, data collection and compilation, data analysis, interpretative writing and corresponding author

Udo Schickhoff: Discussion on results and revision of manuscript

Study 2

Submitted to: Journal of Ecotourism
Submission ID: 221679446

Abstract
In general, most pastoralists' adaptation strategies revolve around diversifying existing livelihood practices in response to the impacts of globalization and climate change. These strategies often involve transitioning to non-pastoral options that offer greater economic benefits, employment opportunities, and overall improved socio-economic conditions. Notably, ecotourism has emerged as a promising adaptation strategy, as previous research has highlighted its potential to address multiple challenges, including job creation, entrepreneurial prospects, poverty reduction, environmental conservation, and socio-cultural revitalization. In this study, we investigate the viability of ecotourism as a sustainable livelihood strategy in Darma Valley, Uttarakhand, Indian Himalayas, considering the ongoing socio-cultural and climatic transformations in the region. Our analysis incorporates the Strengths, Weaknesses, Opportunities, Threats (SWOT) framework and the Ecotourism Opportunity Spectrum (ECOS) analysis to assess the potential for ecotourism. Furthermore, we apply the Sustainable Livelihood Framework (SLF) to better comprehend the practical implication of ecotourism prospects in the study area. The findings indicate promising potential of ecotourism in the region, though, its success remains largely dependent on the willingness of local government authorities and administration to promote concrete ecotourism developmental strategies.

Author contributions
Deepika Rawat: Study design, data collection and compilation, data analysis, interpretative writing and corresponding author

Martina Neuburger: Discussion on results and revision of manuscript

Udo Schickhoff: Discussion on results and revision of manuscript

Study 3

Intended for submission

Abstract
The intertwined, multifaceted, and profound repercussions arising from the interplay of rapid urbanization, globalization and climate change have substantially reshaped the socio-economic and environmental dynamics within the Indian Himalayan Region (IHR). Despite such challenges, the region harbors bolstering avenues for diversifying livelihoods. In Uttarakhand, tourism assumes a central role as a significant economic pursuit, exerting the highest impact on the state's Gross Domestic Product (GDP). Despite the prominent ascent of the tourism sector, including ecotourism in the state, it remains unclear how locally placed small-scale rural businesses who are deemed to be fostering local leadership, capture, commodify and deliver value creation inherent within their business operations. To address this knowledge gap, the present study seeks to furnish a comprehensive understanding of the linkages between ecotourism development and entrepreneurship as a developmental approach to address ongoing challenges. Acknowledging the role of formalized business models in expediting entrepreneurial ascendancy to achieve transformative changes, the exploratory nature of the current feasibility study strives to construct a prototype Sustainable Business Model Canvas (SBMC) for a prospective ecotourism enterprise in Darma valley, Uttarakhand. Additionally, this study advocate for the widespread implementation of sustainable business models, as envisioned through the lens of the solidarity paradigm, commissioning their use in redesigning and reconfiguring tourism arrangements to be better able to respond to socio-economic and climate-induced risks.

Author contributions
Deepika Rawat: Study design, data collection and compilation, data analysis, interpretative writing and corresponding author

Martina Neuburger: Discussion on certain methodological aspects and revision of manuscript

Appendix II

Original publications

Study 1

'Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India'

Authors: Deepika Rawat and Udo Schickhoff

Published 2022 in Schickhoff, U., Singh, R. B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Sustainable Development Goals Series. Springer, Cham. pp. 429-447.

18 Changing Climate Scenario in High Altitude Regions: Comparison of Observed Trends and Perceptions of Agro-Pastoralists in Darma Valley, Uttarakhand, India

Deepika Rawat and Udo Schickhoff

Abstract

Climate change in the Himalayan region has serious implications for livelihood support systems and overall human well-being. In Darma valley (Uttarakhand, India), local people, known as Bhotias, use alpine pasturelands (bugyals) for transhumant grazing of their livestock. In the region, transhumant pastoralism has seen a tremendous decline due to various environmental and socio-economic changes. In the context of present climatic conditions, the article addresses the extent of climate change in the region, the perceptions of climate change among local pastoral communities and socio-economic dimensions of climate change impacts on the local communities and environment. A substantial step of the study is to investigate the local community's perceptions of climate change which affects their motivation to engage in alternative livelihood options. Socio-economic data on impacts of climate change were correlated with meteorological data (CRU TS climate data v4.02) and remote sensing-based indicators such as NDSI (Normalized Difference Snow Index) in order to validate the impacts of changing climate as experienced by the local community. The results suggest that a substantial number of pastoralists perceived climatic change and its associated impact on the environment and on their livelihoods.

Keywords

Transhumant pastoralism · Bhotia community · Socio-economic changes · Mountain livelihoods · Himalaya

18.1 Introduction

Climate change is an urgent and serious problem for human civilization. Globally, warming of approximately 1 °C above pre-industrial levels has been observed (IPCC 2018). It is also projected that with the current rate warming is expected to reach 1.5 °C between 2030 and 2050 (IPCC 2018). In the Himalayan region, an increasing trend of annual mean surface air temperatures has been observed between 1901 and 2014 (Ren et al. 2017), resulting inter alia in a considerable rate of recession of the majority of high altitude Himalayan glaciers (Bolch et al. 2019), and in earlier snowmelt and shorter winter seasons at higher altitudes. A significant amount of total annual precipitation is now received in the form of rain instead of snow (Sharma et al. 2009; Zomer et al. 2016; Bhutiyani 2016; Bolch et al. 2019; Mal et al. 2019). Other climatic

D. Rawat (✉) · U. Schickhoff
CEN Center for Earth System Research and Sustainability, Institute of Geography, University of Hamburg, Hamburg, Germany

U. Schickhoff et al. (eds.), *Mountain Landscapes in Transition*, Sustainable Development Goals Series, https://doi.org/10.1007/978-3-030-70238-0_18

change impacts in the Himalaya include water scarcity, altitudinal shifts of plant and animal species, changes in species compositions, changing productivity of pasturelands and agricultural lands, the emergence of insects and pests, and severe socio-economic implications (IPCC 2014).

Climate change has a wide array of socio-economic implications for the local population and their livelihood practices. Changing climatic conditions facilitate changes in traditional agricultural and pastoral practices of rural communities which need to cope with globalization effects, in particular with emerging consequences of high levels of poverty, rapid urbanization, population growth, low levels of economic development, and social transitions such as predominant male outmigration (O'Brien and Leichenko 2000; Sharma et al. 2009; Ogra and Badola 2015; Rautela and Karki 2015; Yi et al. 2007). It has been observed that climate change has adversely affected transhumant pastoralism in various socio-economic ways across the Himalayan region, such as in India (Negi et al. 2017; Sati 2015; Rautela and Karki 2015), Nepal (Aryal et al. 2014; Gentle and Thwaites 2016), Bhutan (Namgay et al. 2014), Gilgit-Baltistan Province of Pakistan (Joshi et al. 2013a), Tibetan Plateau (Wu and Yan 2002) and the extended Hindukush Himalayan region (Xu et al. 2009; Dong et al. 2010; Chaudhary and Bawa 2011) Transhumant pastoral communities who seasonally move with their livestock between fixed summer and winter pastures are particularly affected since they depend on alpine pasturelands which are among the most fragile ecosystems and most vulnerable to climate change (Sati 2015). The practice of transhumant pastoralism is based on a high dependence on natural resources and involves maintaining an ecologically balanced relationship between pastures, livestock, and people (Bhasin 2011). Pastoralists' seasonal migration is directly related to the timing of rainfall, snowfall, water availability, nutritive grass production and therefore, it is highly sensitive to any change in climate (Aryal et al. 2014). Pasture productivity is highly correlated with temperature and precipitation trends (Williams and Albertson 2006; Wilkes 2008; Eriksson et al. 2009). In general, warmer temperatures enhance pasture productivity as long as humidity and soil moisture is sufficient to compensate for higher evapotranspiration (Luo et al. 2004).

In mountain regions of Pakistan, reduced livestock productivity and diminishing pastoral practices was a result of increased occurrences of prolonged droughts which has led to degradation of pastures by reducing the vegetation cover (Afzal et al. 2008). In such circumstances, the absence of prior conditioning often leads to reduced cattle performance and livestock deaths, ultimately leading to economic losses (Mader 2003). Climate change also facilitates an upward shift of the treeline and encroachment of woody vegetation on alpine meadows, thus affecting principal alpine habitats and grazing land distribution (Schickhoff et al. 2015). Acute shortage of fodder is forcing pastoral communities to abandon traditional livestock-based livelihood systems and engage themselves in other forms of non-agrarian incomes (Wu et al. 2014; Berhanu and Beyene 2015). The practice of transhumant pastoralism, in general, is declining due to various climatic and non-climatic factors, as reported in other mountain regions of the world (Maikhuri et al. 2001; Intigrinova 2005; Afzal et al. 2008; Banerjee 2009; Kerven et al. 2012; Namgay et al. 2014; Schickhoff and Mal 2020). Studies show that the high dependence of pastoral communities on alpine pasturelands has affected different aspects of their lives such as livestock management, pastoral production and their overall socio-economic development (Joshi et al. 2013b; Wu and Yan 2002). Vasquez et al. (2010) and Gentle and Thwaites (2016) observed an increasing presence of exotic invasive weeds, potentially inducing outbreak of livestock diseases and potentially leading to lesser numbers of livestock, declining livestock productivity, and changes in seasonal migration patterns.

In the Himalayan state of Uttarakhand, complex climate change impacts have been observed at regional and local scales. The time period 2007–2012 was the warmest in all thirteen districts of Uttarakhand (Mishra 2014, 2017),

associated with glacier retreat and erratic patterns of precipitation (Bhutiyani et al. 2007; Mal and Singh 2014; Dobhal and Pratap 2015; Mal et al. 2019). In some villages in Uttarakhand, farmers have shifted to less water-intensive crops (such as cabbage, carrots, maize, and pumpkin) and to other sources of livelihood due to climate variability and water stress (Kelkar et al. 2008). High altitude villages of Niti and Mana valleys of Chamoli District, and of Chaudas, Darma and Byans valley in Pithoragarh District in Uttarakhand have experienced a shortage of water resources used by livestock over the last 15–20 years, enforcing pastoralists to reduce the livestock population as well as abandon their agricultural practices (Negi et al. 2017). Another study by Rautela and Karki (2015) in Johar, Byans, Niti and Bhagirathi valley highlighted that scarcity of fodder for the livestock has ultimately forced local people to purchase fodder from markets. Due to this extra financial pressure, most of the people have abandoned their pastoral livelihoods and have shifted to other sources of income.

Observations by Negi (2007) in Johar Valley highlighted a decline in the sheep population due to governing environmental and socio-economic factors, followed by a significant decline in the traditional art of weaving. Economic uncertainties, along with other push factors of demographic, political, environmental and social concerns have resulted in accelerated labor outmigration from villages to urban areas across Himalayan regions (Hoermann et al. 2010; IPCC 2014; Siddiqui et al. 2019) as also reported from the above mentioned valleys (Rautela and Karki 2015; Negi et al. 2017). In recent decades, labor outmigration has been a general trend in the Himalayan regions as a result of globalization and constraints posed by subsistence agriculture, especially the younger generation outmigrates in search of better livelihood opportunities (Hoermann and Kollmair 2009; Schickhoff and Mal 2020). Climate change is an additional stressor which is likely to influence the rate of outmigration (Hoermann and Kollmair 2009; Banerjee et al. 2011; Mueller et al. 2014; Namgay et al. 2014; Gentle and Thwaites 2016; Siddiqui et al. 2019). In Nepal (Gentle and Thwaites 2016) and Bhutan (Namgay et al. 2014), climate-driven socio-economic changes have modified demography as mostly male members out-migrate, leading to a higher workload on women and to a shift to non-pastoral livelihoods. In Pakistan, Mueller et al. (2014) found a positive relationship between adverse effects of increasing heat stress on farming and long-term migration of men. Another study by Banerjee et al. (2011) reports that labor migration is a viable strategy for adaptation to severe droughts and floods among mountain communities in India, Nepal, China, and Pakistan. In Uttarakhand, decreasing agricultural productivity has been a major reason for the accelerated migration of people to urban areas (Hoermann et al. 2010; Tiwari and Joshi 2016). Thus, outmigration can be perceived as an adaptive strategy of vulnerable pastoral communities to minimize economic hardship under globalization and climate change conditions (Wu et al. 2014; Hoermann et al. 2010).

In this regard, a deepened understanding of the local community's perception of climate change is needed which shapes their adaptation strategies (Vedwan and Rhoades 2001; Adger et al. 2009; Weber 2010; Chaudhary and Bawa 2011; Loria and Bhardwaj 2016). There have been many studies addressing local perceptions of climate change and its adverse impacts, the vulnerability of local communities, and their adaptations across Himalayan regions (for example, Chaudhary and Bawa 2011; Chaudhary et al. 2011; Gentle and Maraseni 2012; Shrestha et al. 2012; Macchi et al. 2015; Vidya et al. 2015; Loria and Bhardwaj 2016; Ndungu and Bhardwaj 2015; Aryal et al. 2016). A few of these studies have substantiated their results with quantitative data, and have found them quite consistent (for example, Sujakhu et al. 2016; Aryal et al. 2016). The *Bhotias* in Darma valley are subjected to adverse socio-economic changes, facilitated by ongoing fast-paced urbanization, predominant male outmigration, and various environmental concerns. In the context of the current climate change regime, it is necessary to understand the effects of changing climate on the pastoral economy and the obvious need to

adopt alternative sustainable livelihood strategies. To date, there has been no proper documentation on how transhumant pastoralists in the higher Himalayan regions of Uttarakhand have perceived climate change and socio-economic changes mainly because of its nearly inaccessible and remote location, especially in Darma valley. Therefore, this study aims to address the demand for more coherent research on examining (i) temperature trends, rainfall trends and snow availability; (ii) local community's perception regarding key climatic variables and their associated impacts; and (iii) comparison of meteorological trends with local community's perception of climate change; which is crucial for designing, planning and proper implementation of effective adaptation and mitigation strategies.

18.2 Methods

18.2.1 Study Area

The Darma valley lies in Kailash Sacred Landscape region, situated in the north of the Panchachuli mountain, between 29° and 31° North latitude and 79° and 81° East longitude in Dhauliganga watershed, Dharchula subdivision, Pithoragarh District, Kumaon region, Uttarakhand, India (Figs. 18.1 and 18.2a, b), bordering Tibet in the North and Nepal in the East. It consists of 12 villages namely, Sela, Chal, Nagling, Baling, Dugtu, Dantu, Go, Philam, Bon, Tidang, Marcha and Sipu. Having a striking topography and subtropical, temperate and alpine vegetation, the entire valley lies at an altitude between 7500 and 14,000 ft adjacent to Johar valley in the West and Byans valley in the East. Rainfall throughout these regions is significantly variable.

The valley is inhabited by an indigenous tribe, the *Bhotias* (sub-tribes: *Rang*) who are semi-nomadic agro-pastoralists, also locally known as *Darmya* or *Darmani*. Earlier, along with seasonal migration their main source of livelihood was cross-border trade with Tibet until the disruption caused by the Indo-China War in 1962. Products such as sugar, grain, and wool from India were exchanged for borax, wool, and salt from Tibet (Bergmann et al. 2008, 2011). After the distress caused by the war, the importance of agriculture, forest, and pasture use became even more of significant worth for their livelihood security (Bergmann et al. 2008). These migratory households practice mixed mountain agriculture, i.e., a mix of animal husbandry, crop farming, forest and pasture use (Ehlers and Kreutzmann 2000; Bergmann 2016) linked through seasonal migration (Nüsser 2006). The main livestock types include sheep, goat, cow/oxen, yak and yak hybrids locally known as *Jhubbu* (male) and *Jumma* (female) (Fig. 18.2g, h). At the beginning of winter season (October–November), they migrate to warmer regions in lower locations near Dharchula and they return to Darma valley in March–April to spend the summers with their livestock. Their seasonal migratory pattern is fully dependent on resource availability (nutritional fodder and water) for their livestock and extends over several altitudinal zones of the Kumaon Himalaya (Nüsser 2006). At different altitudinal belts, environmental conditions such as the duration of the snow cover or the onset of vegetation growth necessitate certain potentials and limitations for pastoral land use by the transhumant community (Bergmann et al. 2008).

Transhumant pastoralism also enables them to collect rare medicinal herbs and to utilize agricultural land in the summer villages to cultivate high altitude crops and vegetables such as buckwheat (*Fagopyrum esculentum*), barley, cabbage and potatoes (Fig. 18.2c–e, h). Due to the decline in the practice of transhumance in this region, collection of wild medicinal plants mainly Caterpillar Fungus (scientific name: *Cordyceps sinensis*; locally known as *Keedajadi* or *Yarshagumba*) and cultivation of medicinal plants like Kutki (*Picrorhiza scrophulariiflora*), Atish (*Aconitum heterophyllum*), Hathazari (*Dactylorhiza hatagirea*), Kuth (*Saussurea costus*), Chippi (*Pleurospermum angelicoides*), Jambu (*Allium stracheyii*), Kaala Jeera (*Carum carvi*), etc. as a form of subsistence has become prevalent in the study area, representing a considerable share of the household income (Fig. 18.2e, f).

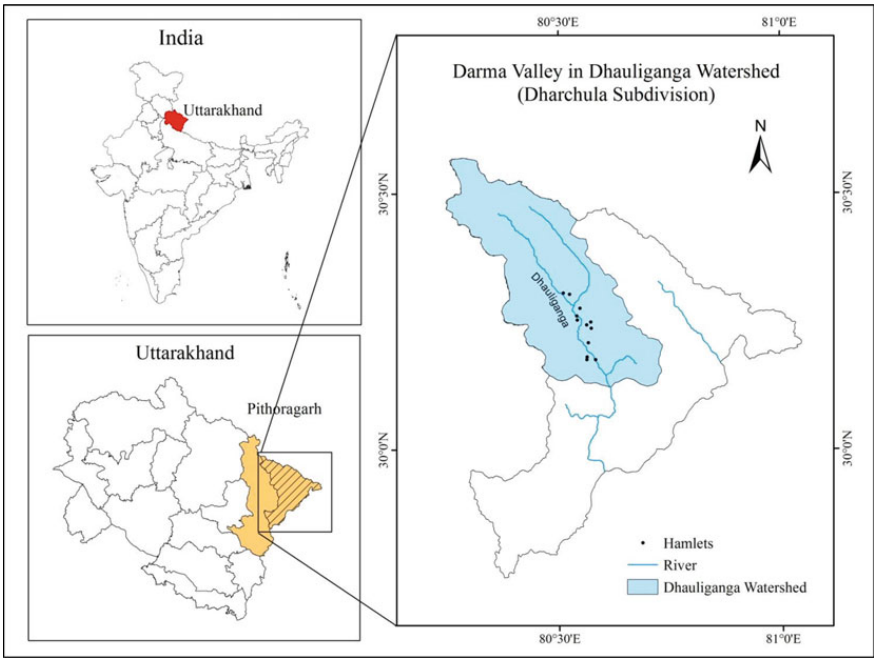


Fig. 18.1 Location of Darma valley in Dhauliganga watershed, Pithoragarh district, Uttarakhand. *Source* Own design

18.2.2 Data Collection and Analysis

For this study, the annual and seasonal temperature and precipitation trends were computed and analyzed through linear regression analysis for the time period between 1975 and 2016 with the CRU TS climate data v4.02 (0.5° × 0.5°, 1968–2016). It is a high-resolution gridded dataset for multiple variables on a 0.5° × 0.5° or finer grid developed by the Climatic Research Unit (University of East Anglia). The seasons were classified as hot summer or pre-monsoon (March, April, May), Monsoon (June, July, August, September), Post-monsoon (October, November) and Winter (December, January, February) to conveniently analyze temperature and precipitation trends. This seasonal classification is also used in other studies in Uttarakhand (Mal et al. 2019).

Data analysis for climatic data (Mann–Kendall Test and linear regression analysis) and information gathered through primary survey was computed and analyzed using XLSTAT and SPSS. In Mann–Kendall test, if p-value is less than the significance level α (alpha) = 0.05, H0 is rejected which means that there is no trend in the tested time series while accepting H0 indicates that no trend has been found in the time series. If Null Hypothesis (H0) is rejected it means the result is statistically significant. Moreover, in Mann–Kendall test, Kendall's tau represents a measure of correlation which has values between +1 and −1 where positive correlation indicates that both variables increase together as opposed to a negative correlation which indicates an increase in one variable and decrease in another. For both temperature and precipitation data, the null hypothesis is tested at 95% confidence level.

Fig. 18.2 **a** A view of Panchachuli range from Dugtu village, Darma valley; **b** Open pastureland near Panchachuli base camp; **c** and **d** Pastoral herders grazing sheep and goats in open fields in Sipu village, Darma valley; **e** Caterpillar Fungus (locally known as *Keedajadi* or *Yarshagumba*); **f** A group of Caterpillar fungus collectors; **g** and **h** Farmers ploughing the fields with Yak hybrids in Nagling and Dugtu village, respectively

To delineate the trend of the presence of snow in the study area over the period of last 28 years (1990–2018), Landsat satellite imageries were pre-processed and Normalized Difference Snow Index (NDSI) values were computed in SAGA-GIS 7.0. Subsequently, the NDSI values were reclassified and NDSI maps were generated in ArcGIS 10.6.1. Landsat TM, ETM+ and OLI imageries for the years 1990, 2001, 2011 and 2018 were acquired from the United States Geological Survey (USGS) Landsat Missions website www.earthexplorer.org for the snow-clad months of March (for 1990, 2001 and 2011) and April (for 2018). NDSI uses green spectral bands (high reflectance of the snow) and short-wave infra-red (SWIR) (low reflectance). For calculating NDSI, the equation used was: NDSI = (Green − SWIR)/(Green + SWIR). According to Hall et al. (1995), for an effective threshold of snow mapping, NDSI values above 0.4 typically indicate the presence of snow usually represented in light color shades (close to white). The time period 1990–2018 is chosen because of the absence of SWIR band in previous Landsat MSS (1972–1983) imageries.

An extensive field survey, based on qualitative research approaches (historical transect, semi-structured interviews, key informant interviews, focused group discussions, etc.), was also conducted in 8 villages of the study area, stratified by different altitudes. The main aim was to investigate the socio-economic characteristics of the affected community, their perceptions related to changing climate and its impacts on their livelihood and environment, and their local response strategies. A sample size of 200 respondents (household heads) was selected based on stratified random sampling representative of around 750 households (District Census Handbook of Pithoragarh, Census of India 2011). Initially, a pilot survey was done to pretest the questionnaire which was later followed by actual primary data collection. Focused Group Discussions (FGDs) were conducted in 4 villages with a group of 6–10 participants based on their availability (Fig. 18.3a–c). 10 Key Informant Interviews (KIIs) were held with village heads and a few government officials (Fig. 18.3d). Furthermore, the primary information gathered on the people's perception of climatic variability and trends was later correlated with the meteorological data and satellite imagery analysis in order to verify whether perceived climate changes are actually taking place and to reappraise adaptive strategies of the agro-pastoral community in the study area.

18.3 Results and Discussion

18.3.1 Precipitation and Temperature Trends

The results of the trend analysis for precipitation and temperature (Table 18.1) show that in Darma valley, annual, pre-monsoon and monsoon precipitation have significantly declined as compared to the post-monsoon and winter precipitation which showed no significant trend (Fig. 18.4). These results are consistent with studies from other high altitude regions in Uttarakhand such as Milam glacier (Mal et al. 2019), and Bhagirathi and Saraswati-Alaknanda basins (Bhambri et al. 2011b). Also, the decreasing trend of monsoon precipitation and overall annual precipitation is also observed in other north-western Himalayan regions (Bhutiyani 2016).

The overall temperature trends in the study area are significantly increasing (Figs. 18.5, 18.6). The mean maximum temperature (in annual, pre-monsoon and post-monsoon) showed an increasing trend while no significant trend is observed in monsoon and winter months between 1975 and 2016. An increase in pre-monsoon maximum temperature in the study area is consistent with a significant high warming trend (0.086 °C/yr) observed in Darchula district of Nepal (DHM 2017) which lies in the closest proximity of the study area. Moreover, there is an overall seasonal and annual rise in the mean minimum temperature for the same time period. These results are consistent with the study conducted by Mishra (2014, 2017) in all 13 districts of Uttarakhand between 1911 and 2012, which showed an increase in annual mean temperatures

Fig. 18.3 **a** FGD with mixed group of respondents (household heads) in Dugtu village; **b** FGD in Sipu village; **c** FGD with male household heads in Philam village; and **d** KII with village heads in Dugtu village

in Pithoragarh, where the present study area lies. Considerable warming trend in mean annual temperature increase (between 1968 and 2016) is also observed in nearby Himalayan regions in India (Bhutiyani et al. 2007, 2009; Zomer et al. 2014; Mal et al. 2019; Shafiq et al. 2018) and in Nepal (Qi et al. 2013; Kattel and Yao 2013; DHM 2017). At higher altitudes, the temperature increase has changed precipitation patterns (from snow to rain), causing cascading effects on the snow cover and glacial mass and leading to recession of glaciers (Sharma et al. 2009; Zomer et al. 2016; Bhutiyani 2016; Bolch et al. 2019; Mal et al. 2019). Thus, such changes in temperature and precipitation patterns can have severe socio-economic implications on the life and livelihood of the local community.

18.3.2 Snow Cover Availability

In Darma valley, there has been a decline in the snow-covered area from 881.25 km^2 in 1990 to 664.41 km^2 in 2018 (March–April). When analyzing the values of the snow-covered areas in the valley, it is apparent that the share of land covered by snow slightly increased from 1990 to 2011 and then eventually decreased by 2018 (Fig. 18.7). This corresponds to a drop of 216.84 km^2 and a decline of 24.6% in total of the snow-covered area. For the representation of snow-covered areas (Fig. 18.8), only four Landsat imageries could be used due to the unavailability of cloud-free satellite imageries for the selected months (March and early April) in the selected time period. To substantiate our results, reference from other studies has been taken.

Table 18.1 Mann–Kendall test for precipitation and temperature trends (1975–2016)

Varible	Mean Kendall Statistic (S)	Kendall's Tau	Var (S)	*p*-value (two-tailed test)	Alpha	Sen's slope	Test interpretation	Trend
Precipitation								
Annual	−245	−0.285	8514.333	0.008	0.05	−4.505	Reject H0	Significant declining trend
Pre-monsoon	−118	−0.137	8518.333	0.021	0.05	−1.138	Reject H0	Significant declining trend
Monsoon	−181	8514.333	8514.333	0.049	0.05	−3.329	Reject H0	Significant declining trend
Post-monsoon	−81	−0.094	8514.333	0.388	0.05	−0.3	Accept H0	No significant trend
Winter	−68	−0.079	8513.333	0.461	0.05	−0.352	Accept H0	No significant trend
Minimum temperature								
Annual	599	0.697	8510.333	<0.0001	0.05	0.049	Reject H0	Significant declining trend
Pre-monsoon	433	0.505	8506.333	<0.0001	0.05	0.053	Reject H0	Significant declining trend
Monsoon	660	0.771	8504.667	<0.0001	0.05	0.047	Reject H0	Significant declining trend
Post-monsoon	435	0.508	8503.667	<0.0001	0.05	0.06	Reject H0	Significant declining trend
Winter	370	0.434	8492.667	<0.0001	0.05	0.04	Reject H0	Significant declining trend
Maximum temperature								
Annual	257	0.3	8507.667	0.005	0.05	0.02	Reject H0	Significant declining trend
Pre-monsoon	239	0.28	8501	0.01	0.05	0.035	Reject H0	Significant declining trend
Monsoon	138	0.161	8504.667	0.135	0.05	0.01	Accept H0	No significant trend
Post-monsoon	184	0.215	8504.667	0.046	0.05	0.021	Reject H0	Significant declining trend
Winter	169	0.198	8497	0.067	0.05	0.025	Accept H0	No significant trend

Significance level (%): 5; Confidence level (%): 95
Source Own study

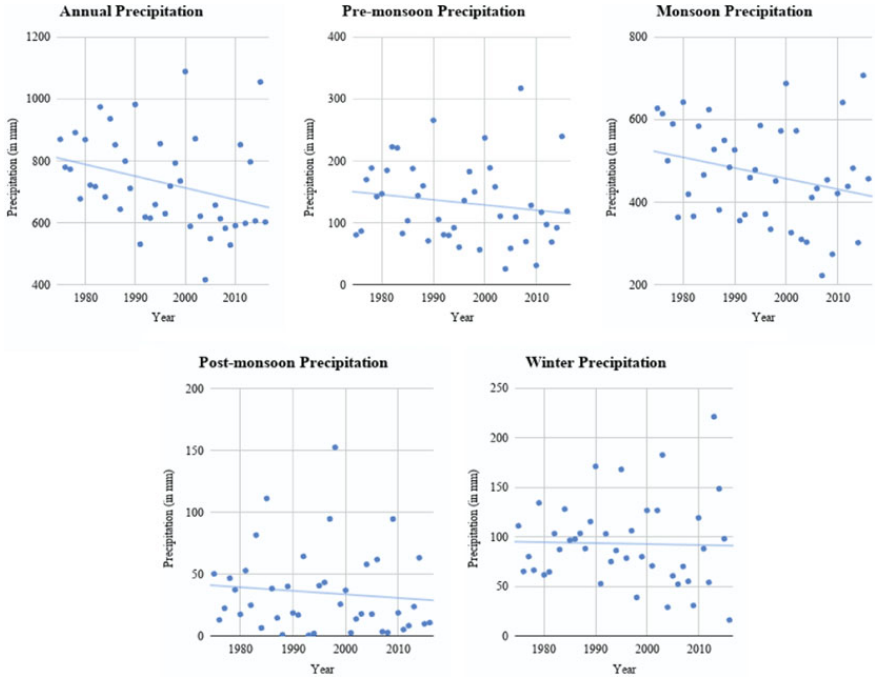


Fig. 18.4 Precipitation trends in Darma valley (1975–2016)

In our analysis, although winter precipitation shows no significant trend, the NDSI analysis shows a considerable decline in the snow-covered area. This can be explained by reinforced warming and melting processes. Studies on glacier flow and recession (Sharma et al. 2009; Zomer et al. 2016; Bhutiyani 2016; Bolch et al. 2019; Mal et al. 2019) reported change of snow to rain due to warming temperatures in the high altitude Himalayan regions, causing reduced snow cover, melting of snow, and loss of glacial mass. Bhutiyani et al. (2009) and Bhutiyani (2016) reported reduced snowfall duration and less snow cover due to increased warming in pre- and post-monsoon seasons in higher altitudes of western Himalaya. A study conducted by Mal et al. (2019) on Milam glacier in the Gori Ganga valley, Pithoragarh district, Uttarakhand, which is close to the present study area, observed a slower recession rate (21.1 ± 1.7 m a-1) between the time period of 2001 and 2017. Over time, other glaciers in Uttarakhand have also shown recessions, such as Satopanth (Nainwal et al. 2016) Bhagirathi, and Gangotri glaciers (Bhambri et al. 2011a, b, 2012).

18.3.3 People's Perceptions Towards Climate Variable

The majority of the respondents perceived changes in precipitation, snowfall, and temperature (Table 18.2). 82% of the respondents perceived increasing change in annual mean temperature whereas 78 and 85% of the respondents perceived increasing changes in average temperature in summer and winter months, respectively. This corresponds to the assessed overall rise in temperature in the study area. Moreover, the perception of respondents about

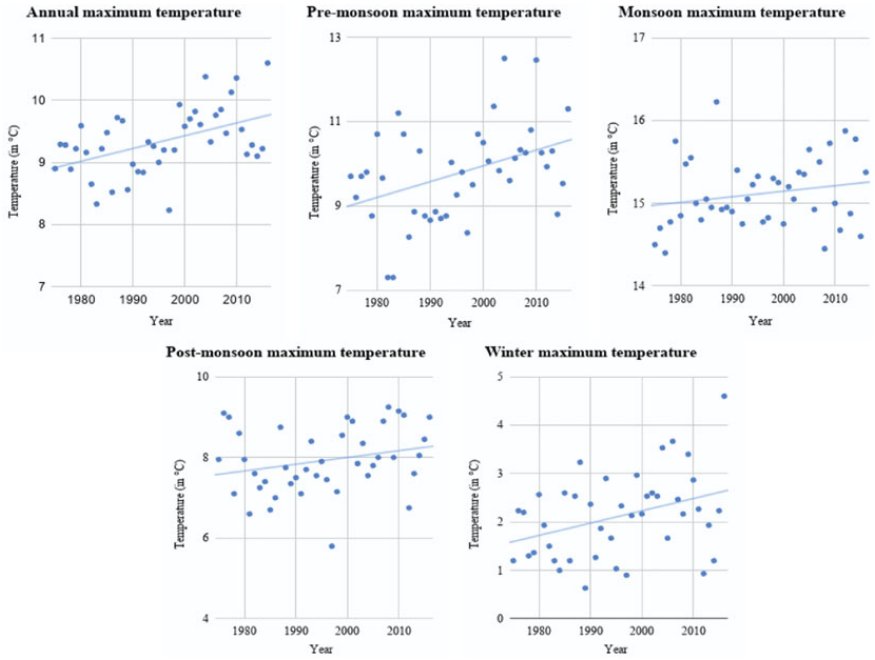


Fig. 18.5 Maximum temperature trends in Darma valley (1975–2016)

precipitation patterns was also in line with the actual trends except for winter months. The meteorological evidence shows that there has been no significant trend in the pattern of winter precipitation over the study period whereas 64% of respondents perceived a decline in precipitation. 69% of the respondents perceived a decrease in overall precipitation while 50.5% of the respondents perceived a change in precipitation in monsoon months. These observations of the respondents about change in temperature and precipitation were reconcilable with the actual observed trends. In addition, the respondents also perceived a declining trend in snowfall availability or occurrence.

Furthermore, various impacts of climate change as perceived by the respondents are depicted in Figs. 18.9 and 18.10. For the majority of respondents, the perceived changes in climatic variables are expressed mainly in the pattern of higher temperatures in summer months, warmer temperatures in winter months, less amount of snow in winter months, unpredictable rainfall patterns, rainfall scarcity, less number of rainy days, increased heat stress and higher intensity of extreme events like flash-floods, landslides, etc. An overall decline in precipitation has been perceived by respondent.

Additionally, during questionnaire survey, FGDs and KIIs respondents reported other perceived climate change impacts such as drying up of water sources, presence of invasive species in pasturelands, lesser availability of wild medicinal plants, increase in livestock diseases (foot-and-mouth disease), change in flowering and maturing season, decline in crop productivity, rapid melting of snow in the pasturelands, less nutritious forage, encroachment of shrub species, etc. As mentioned by the respondents, these changes have affected the socio-economic aspects of the pastoral communities. Implications include a decline in livestock production, diminishing

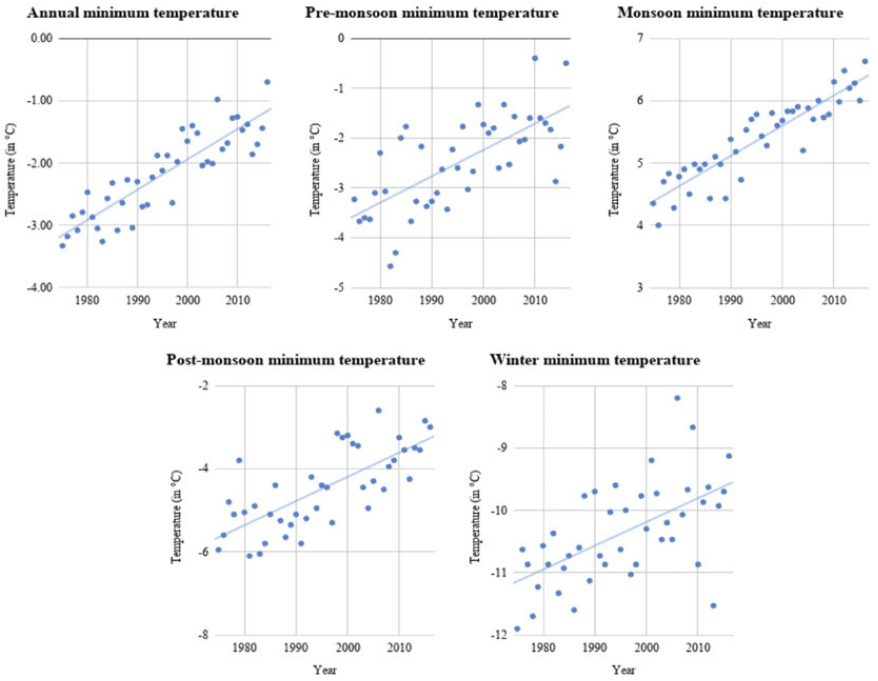


Fig. 18.6 Minimum temperature trends in Darma valley (1975–2016)

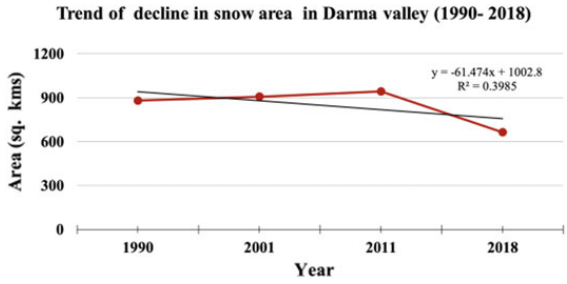


Fig. 18.7 Trend in the snow-covered area in the study area between 1990 and 2018

prices of pasture products, financial uncertainty, land abandonment due to low agricultural productivity, food insecurity, change in dietary habits, high dependence on the market for food and fodder, etc. Environmental and socio-economic changes have consequently resulted in a decline in the overall practice of transhumance while also leading to the male-dominated rural exodus and increased pressure on women, and social tensions within the community.

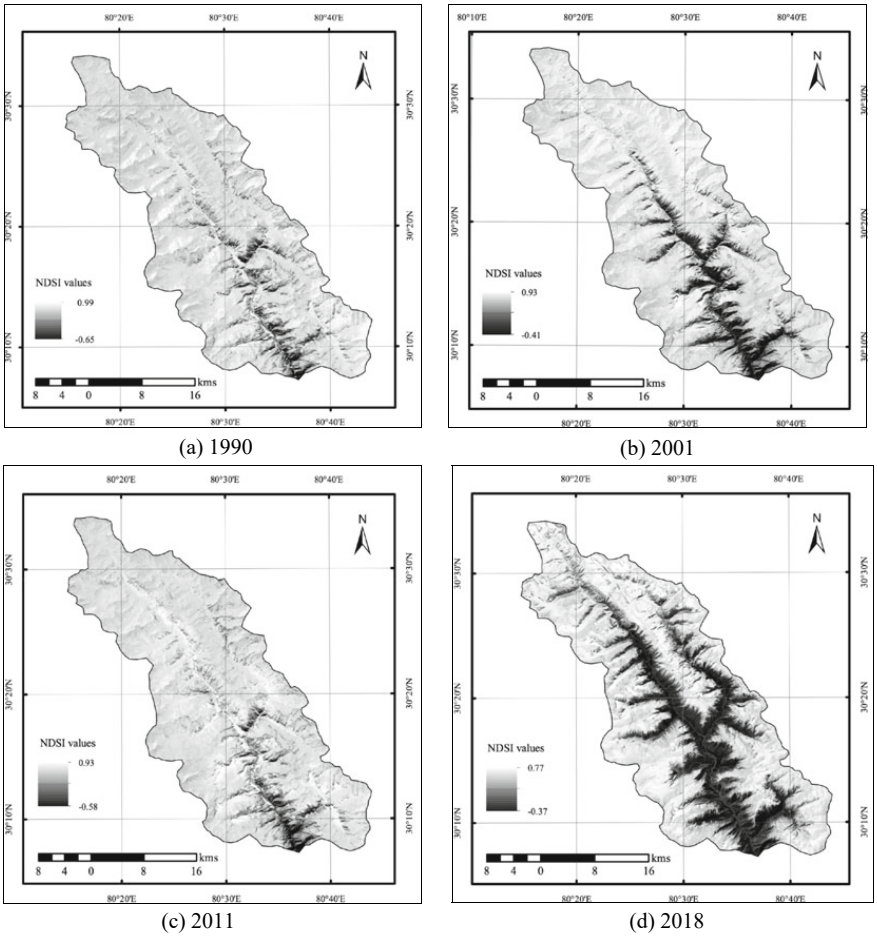


Fig. 18.8 NDSI snow cover maps for the years 1990, 2001, 2011 and 2018

18.3.4 Comparison of Observed Trends and People's Perceptions

The results show that the majority of respondents have experienced changes in climate in Darma valley. Their perceptions in relation to the pre-monsoon and winter (maximum and minimum) temperature correspond to the assessed changes in temperatures based on the CRU TS meteorological dataset. Perceived changes in precipitation for the winter months, however, could not be substantiated by the meteorological evidence which does not show a significant trend in the pattern of winter precipitation over the study period. However, people's response to adverse changes in precipitation patterns has affected the cropping patterns of the transhumant community

Table 18.2 Perception of transhumant pastoralists towards climatic variables

	Variable	Increasing	Decreasing	Unpredictable	No change	Don't know
1	Annual mean temperature	164 (82)	3 (1.5)	27 (13.5)	3 (1.5)	3 (1.5)
2	Temperature in summer (pre-monsoon) months	156 (78)	13 (6.5)	29 (14.5)	0 (0)	2 (1)
3	Temperature in winter months	170 (85)	2 (1)	17 (8.5)	7 (3.5)	4 (2)
4	Annual precipitation	3 (1.5)	138 (69)	55 (27.5)	4 (2)	0 (0)
5	Monsoon precipitation	9 (4.5)	101 (50.5)	82 (41)	2 (1)	6 (3)
6	Winter precipitation	5 (2.5)	128 (64)	56 (28)	3 (1.5)	8 (4)
7	Snowfall availability/occurrence	3 (1.5)	154 (77)	37 (18.5)	3 (1.5)	3 (1.5)

Note $n = 200$; the brackets indicate percentage of respondents

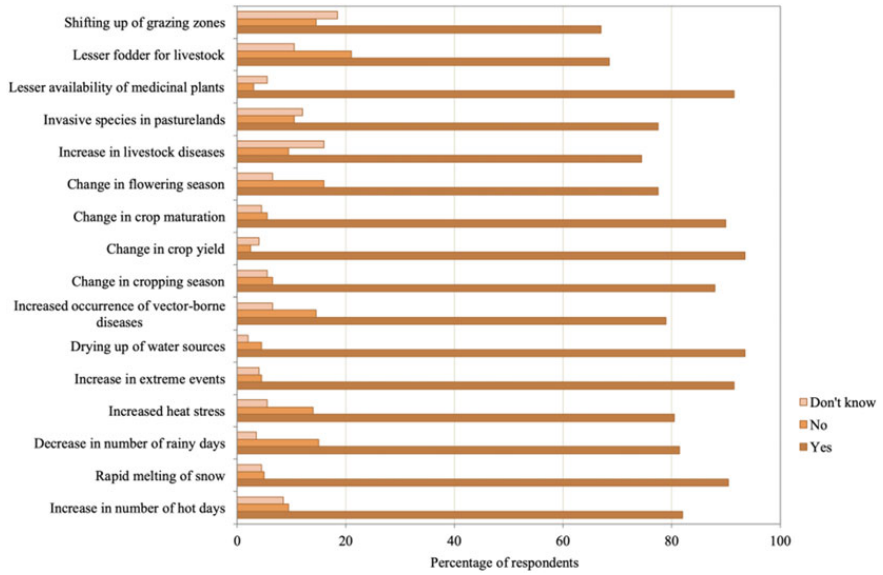


Fig. 18.9 Transhumant pastoralists' level of agreement towards different statements

in the study area. Major changes in cropping patterns include changed timing of agronomic practices (sowing, harvesting, irrigation frequency, etc.), use of HYV seeds and cultivating less water-intensive crops (beans, potatoes, colocasia, cabbage, carrots, maize, etc.) to cope up with ongoing changes in climate. More recently, there has been a shift to horticulture (apple farming), supported by incentives given by the government. Similar kind of alterations in cropping patterns have also been observed in similar to other regions in Uttarakhand (Sati 2015; Rautela and Karki 2015; Shukla et al. 2019) and other Himalayan states of Jammu and Kashmir (Batool et al. 2019) and Himachal Pradesh (Basannagari and Kala 2013; Ndungu

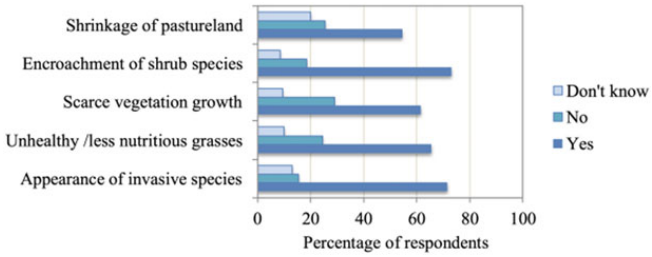


Fig. 18.10 Transhumant pastoralists' level of agreement towards pasture productivity

and Bhardwaj 2015; Loria and Bhardwaj 2016). The observed results regarding overall increase in mean annual temperature and warmer winters are consistent with recent studies in Kailash Sacred Landscape region of India by Zomer et al. (2014), North-west Himalayan region over the last century (Bhutiyani et al. 2007, 2009; Bhutiyani 2016), and upto 0.6 °C/decade between 1980 and 2009 in western Nepal regions (Kattel and Yao 2013). Additionally, the warming trend of temperature and declining trend of precipitation in the study area is found to be consistent with previous studies in Uttarakhand (Bhutiyani et al. 2007; Bhutiyani et al. 2009; Mishra 2014; Dobhal et al. 2015; Mishra 2017; Mal et al. 2019), in Kashmir valley, Jammu and Kashmir (Shafiq et al. 2018) and Nepal (Qi et al. 2013; Kattel and Yao 2013; DHM 2017). Another study by Negi et al. (2012) in Uttarakhand reveals that precipitation and temperature trends affect the discharge, volume, and availability of water which in turn affects the farmer's communities. In Ladakh, agriculture is being affected due to reduced snow and ice as farmers are experiencing an acute shortage of water for irrigating the crops (Clouse et al. 2017). In the study area, increased incidences of extreme events (landslides, flash-floods, forest fires, etc.) were also perceived by the respondents. The 2013 flood in Uttarakhand led to wide-scale misery and havoc in the lives of people all across the state, killing more than 5000 people (Rautela 2013; Awasthi et al. 2014), including people in the study area.

18.4 Conclusion

The adverse changes in climatic variables, especially temperature, precipitation and snow cover in Himalayan regions have altered the socio-economic dynamics of the marginalized local communities. At the same time, ongoing globalization, rapid urbanization, low levels of economic development, and other social transition processes have significant implications on the lives and livelihoods of mountain communities. The combined effects of socio-economic change and changing precipitation patterns, rise in temperatures and less snowfall availability have resulted in water scarcity, crop loss, less nutritive pastures, fodder scarcity, change in cropping patterns, emergence of insects and pests, and low livestock production. This has further led to economic uncertainties, food insecurities, abandonment of land holdings, accelerated outmigration and societal conflicts over resources, affecting various socio-economic aspects of mountain pastoral communities.

Across Himalayan regions, mountain livelihoods are constantly adapting to change, diversifying and evolving. People are combining farm with non-farm activities (such as daily wage labour, tourism services and labor migration) to gain more economic benefits (Gioli et al. 2019) and further to adapt to socio-economic and environmental changes being experienced by them. Over time, environmental and socio-economic changes (a particular stressor was the

Indo-China war of 1962) have resulted in a decline of traditional practices of transhumance and sedentary agriculture among the pastoral community in Darma valley. People have diversified their livelihoods by engaging in government wage labor schemes, tourism services (trekking and homestay), transport business, and collection and selling of medicinal plants to name a few. Considering the potential impacts of climate change on mountain livelihoods, there is an urgent need to mitigate and adapt to these environmental changes. Local community's perception of climate change can be crucial for policy makers to better plan and implement mitigation and adaptation strategies at regional, national and global levels as perception-based studies can substantially complement the observed climate change evidences for remote data-deficient locations like Darma valley in Uttarakhand. Also, in the face of the current climate change scenario, building the capacity for the affected pastoral communities to adapt and strengthen the socio-ecological system through effective sustainable adaptation measures demands attention. However, whether these benefits are realized depends on how well these mitigation and adaptation measures are proactively adopted, implemented and managed.

Acknowledgements The authors are thankful to Dr. Suraj Mal for his valuable suggestions and inputs. We are also thankful to Antonia Gollasch for extending her support with satellite data. Our heartiest gratitude lies with the people of Darma valley who provided their great support during field data collection.

References

Adger N, Dessai S, Goulden M, Hulme M, Lorenzoni I, Nelson R, Naess O, Wolf J, Wreford A (2009) Are there social limits to adaptation to climate change? Clim Change 93:335–354

Afzal J, Ahmed M, Begum I (2008) Vision for development of rangelands in Pakistan: a policy perspective. Q Sci Vis 14(1):53–58

Aryal S, Cockfield G, Masareni TK (2014) Vulnerability of Himalayan transhumant communities to climate change. Clim Change 125:193–208

Aryal S, Cockfield G, Maraseni TN (2016) Perceived changes in climatic variables and impacts on the transhumance system in the Himalayas. Clim Dev 8 (5):435–446

Awasthi IC, Mehta GS, Mamgain RP (2014) Uttarakhand disaster: lessons and way forward, Occasional-6. Gri Institute of Development Studies, Lucknow, India

Banerjee S (2009) Shift from transhumance and subtle livelihood patterns of the Bhotia community and its impact on Tibetan sheep population in Sikkim (India). World Appl Sci J 7(12):1540–1546

Banerjee S, Gerlitz JY, Hoermann B (2011) Labour migration as a response strategy to water hazards in the Hindu Kush Himalayas. ICIMOD, Kathmandu

Basannagari B, Kala CP (2013) Climate change and apple farming in Indian Himalayas: a study of local perceptions and responses. PLoS One 8(10):e77976

Batool N, Shah SA, Dar SN, Skinder S (2019) Rainfall variability and dynamics of cropping pattern in Kashmir Himalayas: A case study of climate change and agriculture. SN Appl Sci 1:1–9

Bergmann C (2016) The Himalayan border region: trade, identity and mobility in Kumaon, India. In: Advances in Asian human-environment research. Switzerland, Springer, Cham

Bergmann C, Gerwin M, Nüsser M, Sax WS (2008) Living in a high mountain border region. The case of the 'Bhotiyas' of the Indo-Chinese border region. J Mt Sci 5(3):209–217

Bergmann C, Gerwin M, Sax WS, Nüsser M (2011) Politics of scale in a high mountain border region: being mobile among the Bhotiyas of the Kumaon Himalaya, India. Nomadic Peoples 15:104–129

Berhanu W, Beyene F (2015) Climate variability and household adaptation strategies in Southern Ethiopia. Sustainability 7:6353–6375

Bhambri R, Bolch T, Chaujar RK (2011a) Mapping of debris-covered glaciers in the Garhwal Himalayas using ASTER DEMs and thermal data. Int J Remote Sens 32:8095–8119

Bhambri R, Bolch T, Chaujar RK, Kulshreshtha SC (2011b) Glacier changes in the Garhwal Himalaya, India, from 1968 to 2006 based on remote sensing. J Glaciol 57:543–556

Bhambri R, Bolch T, Chaujar RK (2012) Frontal recession of Gangotri Glacier, Garhwal Himalayas, from 1965 to 2006, measured through high resolution remote sensing data. Curr Sci 102:489–494

Bhasin V (2011) Pastoralists of Himalayas. J Human Ecol 33(3):147–177

Bhutiyani MR (2016) Spatial and temporal variability of climate change in high-altitude regions of NW Himalaya. In: Singh RB, Schickhoff U, Mal S (eds) Climate change, glacier response, and vegetation dynamics in the Himalaya. Springer, Cham, pp 87–101

Bhutiyani MR, Kale VS, Pawar NJ (2007) Long-term trends in maximum, minimum and mean annual air temperatures across the Northwestern Himalaya during the twentieth century. Clim Change 85:159–177

Bhutiyani MR, Kale VS, Pawar NJ (2009) Climate change and precipitation variations in the Northwestern Himalaya: 1866–2006. Int J Climatol 30:535–548

Bolch T, Shea JM, Liu S, Azam FM, Gao Y, Gruber S et al (2019) Status and change of the cryosphere in the Extended Hindu Kush Himalaya Region. In: Wester P, Mishra A, Mukherji A, Shrestha AB (eds) The Hindu Kush Himalaya assessment: mountains, climate change, sustainability and people. Springer, Cham, pp 209–255

Chaudhary P, Bawa KS (2011) Local perceptions of climate change validated by scientific evidence in the Himalayas. Biol Lett 7:767–770

Chaudhary P, Rai S, Wangdi S, Mao A, Rehman N, Chettri S, Bawa KS (2011) Consistency of local perceptions of climate change in the Kangchenjunga Himalaya landscape. Curr Sci 101(4, 25):504–513

Clouse C, Anderson N, Shippling T (2017) Ladakh's artificial glaciers: climate-adaptive design for water scarcity. Clim Dev 9(5):428–438

DHM (Department of Hydrology and Meteorology) (2017) Observed climate trend analysis in the districts and physiographic regions of Nepal (1971–2014), Government of Nepal, Kathmandu

District Census Handbook of Pithoragarh (2011) Village and town wise primary census abstract (PCA). Series 6, Part XII-B, Census of India, Uttarakhand

Dobhal DP, Pratap B (2015) Variable response of glaciers to climate change in Uttarakhand Himalaya, India. In: Joshi R, Kumar K, Palni LMS (eds) Dynamics of climate change and water resources of Northwestern Himalaya, Springer, Cham, pp 141–150

Dong S, Wen L, Zhu L, Li X (2010) Implication of coupled natural and human systems in sustainable rangeland ecosystem management in HKH region. Front Earth Sci China 4(1):42–50

Ehlers E, Kreutzmann H (2000) High mountain ecology and economy: potential and constraints. In: Ehlers E, Kreutzmann H (eds) High mountain pastoralism in Northern Pakistan. Erdkundliches Wissen 132:9–36

Eriksson M, Jianchu X, Shrestha AB, Vaidya RA, Nepal S, Sandström K (2009) The changing Himalayas: impact of climate change on water resources and livelihoods in the Greater Himalayas. ICIMOD, Kathmandu, Nepal

Gentle P, Maraseni TN (2012) Climate change, poverty, and livelihoods: adaptation practices by rural mountain communities in Nepal. Environ Sci Policy 21:24–34

Gentle P, Thwaites R (2016) Transhumant pastoralism in the context of socioeconomic and climate change in the mountains of Nepal. Mt Res Dev 36(2):173–182

Gioli G, Thapa G, Khan F, Dasgupta P, Nathan D, Chhetri N, Adhikari L, Mohanty S, Aurino E, Scott L (2019) Understanding and tackling poverty and vulnerability in mountain livelihoods in the Hindu Kush Himalaya. In: Wester P, Mishra A, Mukherji A, Shrestha AB (eds) The Hindu Kush Himalaya assessment. Springer, Cham, pp 421–425

Hall DK, Riggs GA, Salomonson VV (1995) Development of methods for mapping global snow cover using moderate resolution imaging spectroradiometer data. Remote Sens Environ 54:27–140

Hoermann B, Banerjee S, Kollmair M (2010) Labour migration as a responses strategy to water hazards in the Hindu Kush Himalayas—understanding a livelihood strategy in the context of socioeconomic and environmental change. ICIMOD, Kathmandu, Nepal

Hoermann B, Kollmair M (2009) Labour migration and remittances in the Hindu Kush-Himalayan region. ICIMOD, Kathmandu

Intigrinova T (2005) Transhumance in transition: consequences of socio-economic reform. A case study of Khoito Gol, Buryatia. Inner Asia 7(1):87–105

IPCC (2014) Impacts, adaptation, and vulnerability, part B: regional aspects. In: Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom, New York

IPCC (ed) (2018) Global warming of 1.5 °C. An IPCC special report. IPCC, Geneva

Joshi S, Jasra WA, Ismail M (2013a) Herders' perceptions of and responses to climate change in Northern Pakistan. Environ Manage 52:639–648

Joshi L, Shrestha RM, Jasra AW (2013b) Rangeland ecosystem services in the Hindu Kush Himalayan Region. In: Wu N, Rawat GS, Joshin S (eds) High-altitude Rangelands and their Interfaces in the Hindu Kush Himalayas, Kathmandu, ICIMOD, pp 157–175

Kattel DB, Yao Y (2013) Recent temperature trends at mountain stations on the southern slope of the central Himalayas. J Earth Syst Sci 122:215–227

Kelkar U, Narula K, Sharma V, Chandna U (2008) Vulnerability and adaptation to climate variability and water stress in Uttarakhand State, India. Global Environ Change 18:564–574

Kerven C, Steimann B, Dear C, Ashley L (2012) Researching the future of pastoralism in central Asia's mountains: examining development orthodoxies. Mt Res Dev 32(3):368–377

Loria N, Bhardwaj SK (2016) Farmers' response and adaptation strategies to climate change in low-hills of Himachal Pradesh in India. Nat Environ Pollut Technol 15(3):895–901

Luo T, Pan Y, Ouyang H, Shi P, Luo J, Yu Z, Lu Q (2004) Leaf area index and net primary productivity along subtropical to alpine gradients in the Tibetan Plateau. Glob Ecol Biogeogr 13:345–358

Macchi M, Gurung AM, Hoermann B (2015) Community perceptions and responses to climate variability and change in the Himalayas. Clim Dev 7(5):414–425

Mader TL (2003) Environmental stress in confined beef cattle. J Anim Sci 81(2):110–119

Maikhuri RK, Rao KS, Semwal RL (2001) Changing scenario of Himalayan agroecosystems: loss of agrobiodiversity, an indicator of environmental change in Central Himalaya, India. Environmentalist 21(1): 23–39

Mal S, Singh RB (2014) Changing glacial lakes and associated outburst floods risks in Nanda Devi Biosphere Reserve, Indian Himalaya: Proc. IAHS 364: 255–260

Mal S, Mehta M, Singh RB, Schickhoff U, Bisht MPS (2019) Recession and morphological changes of the debris-covered Milam glacier in Gori Ganga Valley, Central Himalaya, India, derived from satellite data. Front Environ Sci 7:42

Mishra A (2014) Changing climate of Uttarakhand, India. J Geol Geosci 3(4):163

Mishra A (2017) Changing temperature and rainfall patterns of Uttarakhand. Int J Environ Sci Nat Resour 7(4):90–95

Mueller V, Gray C, Kosec K (2014) Heat stress increases long-term human migration in rural Pakistan. Nat Clim Change 4:182–185

Nainwal HC, Banerjee A, Shankar R, Semwal P, Sharma T (2016) Shrinkage of Satopanth and Bhagirath Kharak glaciers, India, from 1936 to 2013. Ann Glaciol 57:131–139

Namgay K, Millar J, Black R, Samdup T (2014) Changes in Transhumant Agropastoralism in Bhutan: a disappearing livelihood? Human Ecol 42:779–792

Ndungu C, Bhardwaj SK (2015) Assessment of people's perceptions and adaptations to climate change and variability in mid-hills of Himachal Pradesh, India. Int J Curr Microbiol Appl Sci 4:47–60

Negi CS (2007) Declining transhumance and subtle changes in livelihood patterns and biodiversity in the Kumaon Himalaya. Mt Res Dev 27(2):114–118

Negi G, Samal P, Kuniyal J, Kothyari B, Sharma R, Dhyani P (2012) Impact of climate change on the western Himalayan mountain ecosystems: an overview. Tropical Ecol 53(3):345–356

Negi VS, Maikhuri RK, Pharswan D (2017) Climate change in the Western Himalaya: People's perception and adaptive strategies. J Mt Sci 14(2):403–416

Nüsser M (2006) Ressourcennutzung und nachhaltige Entwicklungim Kumaon-Himalaya (Indien). Geographische Rundschau 58:14–22

O'Brien KL, Leichenko RM (2000) Double exposure: assessing the impacts of climate change within the context of economic globalization. Global Environ Change 10:221–232

Ogra MV, Badola R (2015) Gender and climate change in the Indian Himalayas: global threats, local vulnerabilities, and livelihood diversification at the Nanda Devi Biosphere Reserve. Earth Syst Dyn 6:505–523

Qi W, Zhang Y, Gao J, Yang X, Liu L, Khanal NR (2013) Climate change on the southern slope of Mt. Qomolangma (Everest) Region in Nepal since 1971. J Geog Sci 23:595–611

Rautela P (2013) Lessons learnt from the deluge of Kedarnath, Uttarakhand, India. Asian J Environ Disaster Manage 5(2):43–51

Rautela P, Karki B (2015) Impact of climate change on life and livelihood of indigenous people of higher Himalayan Uttarakhand, India. Am J Environ Protect 3(4):112–124

Ren YY, Ren GY, Sun XB, Shrestha AB, You QL, Zhan YJ (2017) Observed changes in surface air temperature and precipitation in the Hindu Kush Himalayan region during 1901–2014. Adv Clim Change Res 8(3):148–156

Sati VP (2015) Climate change and socio-ecological transformation in high mountains: an empirical study of Garhwal Himalaya. Change Adapt Socio Ecol Syst 2:45–56

Schickhoff U, Mal S (2020) Current changes in alpine ecosystems of Asia. In: Goldstein MI, DellaSala DA (eds) Encyclopedia of the world's biomes, Vol. 1. Elsevier, Amsterdam, pp 589–598

Schickhoff U, Bobrowski M, Böhner J, Bürzle B, Chaudhary RP, Gerlitz L, Heyken H, Lange J, Müller M, Scholten T, Schwab N, Wedegärtner R (2015) Do Himalayan treelines respond to recent climate change? An evaluation of sensitivity indicators. Earth Syst Dyn 6:245–265

Shafiq MU, Rasool R, Ahmed P, Dimri AP (2018) Temperature and precipitation trends in Kashmir valley, North Western Himalayas. Theoret Appl Climatol 135:293–304

Sharma E, Chettri N, Tse-ring K, Shrestha AB, Jing F, Mool P, Eriksson M (2009) Climate change impacts and vulnerability in the Eastern Himalayas. ICIMOD, Kathmandu, Nepal

Shrestha UB, Gautam S, Bawa KS (2012) Widespread climate change in the Himalayas and associated changes in local ecosystems. PLoS One 7(5):e36741

Shukla R, Agarwal A, Gornott C, Sachdeva K, Joshi P (2019) Farmer typology to understand differentiated climate change adaptation in Himalaya. Sci Rep 9:20375

Siddiqui T, Bhagat RB, Banerjee S, Liu C, Sijapati B, Memon R, Thinley P, Ito M, Nemat O, Arif G (2019) Migration in the Hindu Kush Himalaya: Drivers, consequences, and governance. In: Wester P, Mishra A, Mukherji A, Shrestha AB (eds) The Hindu Kush Himalaya assessment. Springer, Cham, pp 517–544

Sujakhu NM, Ranjitkar S, Niraula RR, Pokharel BK, Schmidt-Vogt D, Xu J (2016) Farmers' perceptions of and adaptations to changing climate in the Melamchi Valley of Nepal. Mt Res Dev 36(1):15–30

Tiwari PC, Joshi B (2016) Gender processes in rural outmigration and socio-economic development in the Himalaya. Migr Dev 5(2):330–350

Vasquez EA, James JJ, Monaco TA, Cummings DC (2010) Invasive plants on rangelands: a global threat. Rangelands 32:3–5

Vedwan N, Rhoades RE (2001) Climate change in the Western Himalayas of India: a study of local perception and response. Clim Res 19:109–117

Vidya ARK, Mahajan PK, Negi YS, Bhardwaj SK (2015) Trend analysis of weather parameters and people perception in Kullu district of western Himalayan region. Environ Ecol Res 3(1):24–33

Weber EU (2010) What shapes perceptions of climate change? Wiley Interdisc Rev Clim Change 1:332–342

Wilkes A (2008) Towards mainstreaming climate change in grassland management policies and practices on the

Tibetan Plateau. Working paper No. 67. World Agroforestry Centre, ICRAF-China, Beijing
Williams CA, Albertson JD (2006) Dynamical effects of the statistical structure of annual rainfall on dryland vegetation. Glob Change Biol 12(5):777–792
Wu N, Yan Z (2002) Climate variability and social vulnerability on the Tibetan Plateau. Dilemma on the road of pastoral reform. Erdkunde 56:2–14
Wu N, Ismail. M., Joshi S, Yi SL, Shreshtha RM, Jasra AW (2014) Livelihood diversification as an adaptation approach to change in the pastoral Hindu-Kush Himalayan region. J Mt Sci 11(5):1342–1355
Xu J, Grumbine RE, Shrestha A (2009) The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. Conserv Biol 23:520–530
Yi SL, Ning W, Peng L, Qian W, Fusun S, Geng S et al (2007) Changes in livestock migration patterns in a Tibetan-style agro-pastoral system. Mt Res Dev 27 (2):138–145
Zomer RJ, Trabucco A, Metzger MJ, Wang M, Oli KP, Xu J (2014) Projected climate change impacts on spatial distribution of bioclimatic zones and ecoregions within the Kailash sacred landscape of China, India. Nepal. Clim Change 125(3–4):445–460
Zomer RJ, Wang M, Trabucco A, Xu JC (2016) Projected climate change impact on hydrology, bioclimatic conditions and terrestrial ecosystems in the Asian highlands. (ICRAF Working Paper 222). World Agroforestry Centre East and Central Asia, Kunming, China

Study 2

'Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region'

Authors: Deepika Rawat, Martina Neuburger and Udo Schickhoff

Submitted in 2022: Journal of Ecotourism (Submission ID: 221679446)

Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region

Deepika Rawat[1], Martina Neuburger[2] and Udo Schickhoff[3]

Abstract

In general, most pastoralists' adaptation strategies revolve around diversifying existing livelihood practices in response to the impacts of globalization and climate change. These strategies often involve transitioning to non-pastoral options that offer greater economic benefits, employment opportunities, and overall improved socio-economic conditions. Notably, ecotourism has emerged as a promising adaptation strategy, as previous research has highlighted its potential to address multiple challenges, including job creation, entrepreneurial prospects, poverty reduction, environmental conservation, and socio-cultural revitalization. In this study, we investigate the viability of ecotourism as a sustainable livelihood strategy in Darma Valley, Uttarakhand, Indian Himalayas, considering the ongoing socio-cultural and climatic transformations in the region. Our analysis incorporates the Strengths, Weaknesses, Opportunities, Threats (SWOT) framework and the Ecotourism Opportunity Spectrum (ECOS) analysis to assess the potential for ecotourism. Furthermore, we apply the Sustainable Livelihood Framework (SLF) to better comprehend the practical implication of ecotourism prospects in the study area. The findings indicate promising potential of ecotourism in the region, though, its success remains largely dependent on the willingness of local government authorities and administration to promote concrete ecotourism developmental strategies.

Keywords: SWOT analysis, Sustainable livelihood framework, Ecotourism opportunity spectrum (ECOS), Uttarakhand, Indian Himalayan Region

1. Introduction

Mountain regions across the world are highly susceptible to the ongoing challenges presented by the Anthropocene (Schickhoff et al. 2022; IPCC 2022). Studies conducted across Himalayan regions have reported above-average climate warming and substantial effects on the cryosphere and hydrosphere (Ren et al. 2017; Krishnan et al. 2019; Bolch et al. 2019; Schickhoff & Mal 2020; Schickhoff et al. 2022), having implications on the traditional agricultural and pastoral practices of rural communities, as obvious from studies in India (Rautela & Karki 2015; Ogra & Badola 2015; Negi et al. 2017), Nepal (Gentle & Thwaites 2016; Tiwari et al. 2020), Bhutan (Chhogyel & Kumar 2018), and northern Pakistan (Joshi et al. 2013). In addition, a wide range of underlying factors including globalization, rapid urbanization, trans-border conflicts, population growth and related social-ecological dynamics are contributing to the diminishing of pastoral economies (Gentle & Thwaites 2016; Pandey et al. 2017; Pathak et al. 2017; Tiwari et al. 2020; Rawat & Schickhoff 2022). In response,

mountain communities are continually diversifying livelihoods by combining farm and non-farm activities to adapt to such changes (Gioli et al. 2019). Furthermore, economic uncertainties driven by colossal demographic, political, environmental, and social factors is coercing labor outmigration from villages to urban areas for better livelihood prospects (Siddiqui et al. 2019), with future rates of outmigration predicted to be heavily influenced by rapidly changing climate (Gentle & Thwaites 2016; Negi et al. 2017; Upadhyay et al. 2021). A prime example is Uttarakhand, located in the western Indian Himalayan Regions (IHR) and currently threatened by changing climate having direct implications on rural livelihood practices (Mishra 2017; Mal et al. 2019; Kuniyal et al. 2021; Tyagi et al. 2022). Given the pressing challenges, there is a rising consensus on adaptation strategies to necessitate mainstreaming alternative forms of sustainable livelihoods into policy frameworks (NITI Aayog 2018), such as ecotourism (Ogra & Badola 2015). Likewise, elaborating empirical understanding on linkages between sustainable livelihoods thinking and climate adaptation in poor and vulnerable communities is receiving widespread recognition (Mabon et al. 2021).

As one of the fastest growing industries globally, tourism contributes significantly to the economic growth particularly in developing economies (OECD 2020). Despite growing concerns, it is an emerging sector in the IHR, projected to grow 7.9% annually from 2013 to 2023 (NITI Aayog 2018). With the highest contribution to the gross state domestic product (GSDP), it is one of the major economic means of livelihood in Uttarakhand (NITI Aayog 2018) accounting for over 40% of revenues generated by underlying sub-sectors such as cultural, spiritual, medical, ecotourism, and adventure tourism (Uttarakhand Tourism Statistics 2015). The state's 2007-2022 tourism master plan recognizes ecotourism as a separate niche with strategies in place to attract new ecotourism markets. Measures to protect, conserve and enhance ecotourism resources are well instated. Of late, the strong links between ecotourism and sustainable development have opened livelihood avenues for rural communities, simultaneously supporting environmental conservation and local control over development (Gurung & Seeland 2011; Chand et al. 2015; Açıksöz et al. 2016; Price 2017; Agyeman 2019; Salgueiro et al. 2020).

Vision 2030, another government policy document with objectives in consonance with the United Nations Sustainable Development Goals (SDGs) enthrall to accelerate development in four thematic areas in the state, including sustainable livelihoods, human development, social development, and environmental sustainability. In addition, it envisions harnessing rural ecotourism potential with meticulous planning, branding, and capacity-building at all levels, among other focus areas (IHD 2018). Quite remarkably, even though tourism, including ecotourism sector, has been recording exuberant growth in Uttarakhand, with total tourist (domestic and international) arrivals rising from 26 million in 2011 to 39 million in 2019, and projected to rise to 65 million by 2025, it remains highly unregulated, neglected, and ineffective in dealing with evident challenges such as the current climate crisis (NITI Aayog 2018; Salgueiro et al. 2020). Even so, amid ongoing socio-economic and climatic transformations, it continues to remain a vital source of livelihood adaptation strategy in marginalized communities, as evidenced by scholarly work in Kenya (Ogara et al. 2013), Vietnam

(Hoang & Pulliat 2019), Ghana (Agyeman 2019), Bhutan (Dendup et al. 2022), and Jordan (Jamaliah & Powell 2018).

Notwithstanding the demonstrable capacity of ecotourism to fortify resilience, as substantiated by empirical investigations, there exists a significant scarcity of comprehensive records and methodical investigation concerning the interconnection between sustainable livelihoods, ecotourism, and adaptation in Uttarakhand, including its IHR counterparts. However, in Uttarakhand, a study by Ogra and Badola (2015) within the Nanda Devi Biosphere Reserve revealed ecotourism's potential to foster livelihood diversification, thereby effectively addressing the intricate interplay between climate change and gender dynamics. Yet, the role of ecotourism as an adaptation strategy remains mostly undervalued by policymakers and existing knowledge remains limited in Uttarakhand (Ogra & Badola 2015).

Previous studies concerning ecotourism in IHR have predominantly focused on ecotourism-centered community-driven homestays that enable livelihood diversification (Anand et al. 2012; Ogra & Badola 2015; Bhalla et al. 2016). Ecotourism research in IHR encompasses a diverse range of investigations, including, exploration of eco-cultural (Cajee 2014) and biotourism (Gogoi 2016) as a sub-set of ecotourism, ecotourism-based conservation models (Lama et al. 2010; Das & Hussain 2016; Singh & Sondhi 2016; Vannelli et al. 2019), resource-centric conflict resolution in protected areas through ecotourism (Maikhuri et al. 2000; Singh & Singh 2004; Kala & Maikhuri 2011), evaluation of sustainability aspects in ecotourism (Ashok et al. 2019), relationship between tourist satisfaction and ecotourism sustainability (Basak et al. 2021), ecotourism's contribution to household income security (Balodi et al. 2014), identification of potential ecotourism sites employing geospatial techniques (Chaudhary et al. 2022), adverse impacts of ecotourism development (Sarkar & Sinha 2015; Rastogi et al. 2015; Datta & Banerji 2015), and the formulation of strategies aimed at facilitating the advancement of sustainable ecotourism development (Chaturvedi 2002; Mahapatra et al. 2012; Sahani 2021). In contrast, studies on livelihoods, participatory appraisal, and ecotourism have received more attention in the north-eastern regions than in the western counterpart in IHR (Chakraborty & Ghosal 2022).

Consequently, given the insufficiencies observed in the realm of comprehensive scholarly examination pertaining to the evaluation of ecotourism's feasibility in establishing sustainable livelihoods and fostering climate adaptation, the present study endeavors to address this research gap by employing a diverse range of descriptive and exploratory methodological approaches. More specifically, the primary objective of this study is to examine the advantages derived from ecotourism and its prospective supplementary contribution to the stimulation of local livelihoods and the regional economy, while concurrently investigating the perceptions of the local community regarding ecotourism development in Darma valley in Uttarakhand. Furthermore, the study aims to discern the influence of ecotourism-based livelihoods on households' capital utilization and overall livelihood outcomes, particularly in light of underlying socio-economic factors and the dynamic nature of climate change.

2. Literature review

2.1. Adaptation to climate change through sustainable livelihoods

Adaptation to climate change has been one of the highly prioritized negotiating agendas stated under the Paris Agreement (IPCC 2022; United Nations 2020). In light of escalating future development issues and global environmental change, integrating livelihood thinking and understanding of local settings are critical (Scoones 2009), wherein, recognizing the traditional capacity of local communities to adapt is requisite for a thorough assessment of their vulnerability and development of locally appropriate adaptation strategies (McDowell et al. 2020). Chambers and Conway (1991) pioneered the Sustainable Livelihoods Approach (SLA). Based on this, the British Department for International Development (DFID) created the Sustainable Livelihoods Framework (SLF) in 1999 (Fig. 1).

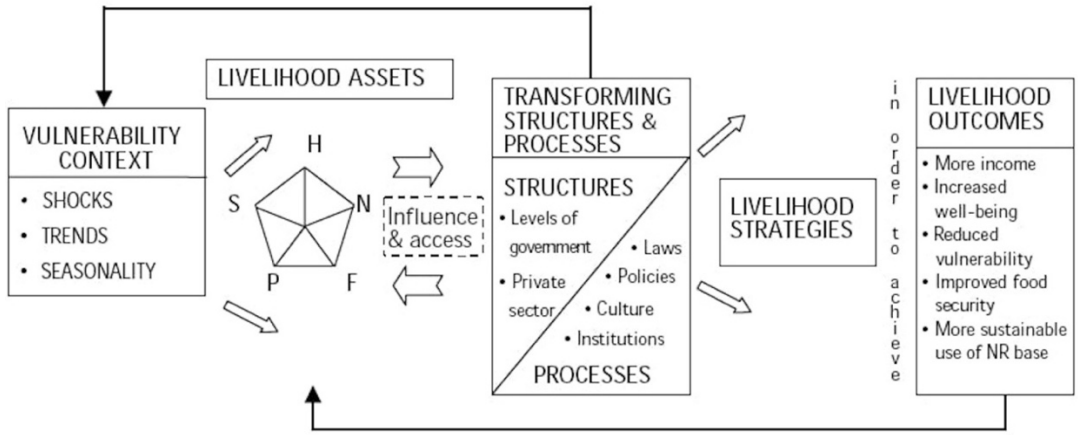


Figure 1: Sustainable Livelihood Framework (DFID 1999)

Figure 1 Alt Text: Schematic representation of DFID's Sustainable livelihoods framework depicting complex interactions and interlinkages between its different components.

For the pursuit of positive livelihood outcomes, a sustainable livelihood is built on five assets or capitals (Table 1), namely, natural (natural resource availability for livelihoods), human (skills, knowledge, and health), social (cooperation networks, collective representation, norms, trustworthy relationships), physical (infrastructure, tools, and technology) and financial (regular inflows of money and access to financial services). These assets are interconnected and complement each other but are critically dependent on transforming structures and processes. Transforming structures comprise of public and private sectors at various levels whereas laws, policies, culture, institutions, and power relations constitute processes that shape livelihood assets and outcomes in the sustainable livelihood system (DFID 1999). The vulnerability context determines trends (population growth, economic trends, resource stocks, technological trends, governance), shocks (epidemics, disaster, conflicts) and seasonality (prices, production cycle, employment) as components that can directly affect the livelihoods, both negatively and positively. Opportunities to pursue a variety of livelihood strategies are based on assets and shaped by transforming structures and processes, as well as the

vulnerability context. These could be activities or decisions that ultimately determine the livelihood outcomes.

DFID (1999) assert that SLA endeavors to mitigate vulnerability, alleviate poverty, and bolster the adaptive capacity of marginalized groups through a comprehensive comprehension and identification of circumstances conducive to withstanding socio-economic and environmental stressors. When evaluating sustainable livelihoods, Scoones (1998, p.3) emphasize the primary concern of ascertaining the composition of livelihood capitals necessary for implementing specific strategies and the subsequent consequences in a given context. For instance, Ankrah et al. (2023) conducted a study among smallholder crop farmers in southern Ghana and unveiled that informational, financial, and human capital exerted significant influences on the adoption of household climate variability adaptation strategies. In view of that, utilization of SLA, particularly within rural settings of low and middle-income countries (Scoones, 1998; 2009; Tao & Wall 2009), espouses its potential to establish a grassroots-driven, community-centric adaptation framework (Hammill et al. 2005).

Table 1: Livelihood assets in SLF (DFID 1999)

Capital assets	
Natural	It consists of natural resource stocks that provide valuable flows and services for livelihoods are derived such as land, water, forests, wildlife and other environmental resources.
Human	It represents good health, knowledge, skills, information and ability to labour which allow individuals to pursue various livelihood strategies and achieve their desired outcomes.
Financial	It denotes financial resources that are useful for achieving diversified livelihood objectives such as availability of cash stocks and regular remittances or pensions, savings and supplies of credit.
Physical	It comprises of basic infrastructure that enable individuals or community to pursue their livelihoods. This includes affordable and secure access to water, sanitation, energy, transport, market, housing, education, health and communications.
Social	It consists of those assets upon which individuals draw in seeking for their livelihood outcomes such as relationships of trust and networks of local informal institutions, religious groups, cooperatives, self-help groups and access to wider institutions.

In a comparable vein, Žurovec and Vedeld (2019) advocate for the pertinence of SLA in augmenting the resilience of rural livelihoods, considering the intricate interplay of multifaceted elements such as institutional arrangements, environmental dynamics, economic factors, and political forces. Clay (2018) further underscore the inherent capacity of SLA to unveil the intricate intricacies encompassing intra-household decision-making processes, socially constructed gender norms within environmental governance, and intricate power dynamics entailed in the evaluation of adaptive capacity within evolving human-environment systems. These complexities, often neglected by conventional approaches, elicit the importance of SLA in comprehensively addressing the multifaceted dimensions of adaptive capacity assessment.

Noting the linkages between sustainable livelihoods and climate change adaptation, Mabon et al. (2021) highlight its significance as a people-centered approach that

resonates with the experiences, capabilities, and traditional knowledge of disadvantaged and vulnerable groups, that ultimately converge together for transformative livelihood outcomes. In essence, the overall advancing literature on sustainable livelihoods and adaptation literature accentuates understanding pre-eminent drivers of livelihood decision-making to better address climatic risks and foster development, particularly in poor and vulnerable communities.

2.2. Ecotourism, sustainable livelihoods, and adaptation

Since the 1990s, the concept of community-based tourism has emerged as a viable future blueprint for tourism in developing countries, focusing on the participation and empowerment of local communities (Hall 2007). Honey (1999) viewed ecotourism as 'sustainable tourism', a people-centric approach capable of resource conservation, tourism development, and poverty alleviation. Ecotourism strives for a harmonious balance of environmental, social, and economic development (Chand et al. 2015; Açıksöz et al. 2016; Agyeman 2019; Salgueiro et al. 2020). It had been reckoned that local community participation and active stakeholder participation is critical to ecotourism development for their ability to influence its success or failure (Chan et al. 2021). Burneika and Kriaučiūnas (2007) emphasize the role of ecotourism as a facet of the tourism industry that fosters sustainable development and holds substantial promise for ensuring enduring livelihood security. In recent times, it is increasingly recognized as an adaptive approach to mitigating the detrimental effects of evolving climatic conditions in regions blessed with abundant natural and cultural assets (Jamaliah & Powell 2018; Agyeman 2019). Accordingly, the concept of ecotourism is consistent with SLA if it is organized as community-based or other forms of locally embedded tourism practices (Tao & Wall 2009; Shi et al. 2022).

A substantial and growing corpus of academic research has explored and analyzed the diverse aspects of ecotourism development for livelihood diversification, placing particular emphasis on the concurrent pursuit of biodiversity conservation, poverty alleviation, and economic sustainability. It is noteworthy that tourism earnings primarily assume a supplementary role (Tao & Wall 2009) owing to the seasonal and financially restricted nature of employment prospects inherent in the industry (Kim et al. 2019). However, in practice, its effectiveness has been called into question over the last few decades due to contradictory results (Singh et al. 2021). Zielinski et al. (2020) proffered multifarious socio-economic, legislative, and administrative factors influencing its success in many developing and developed countries.

Similarly, studies on the relationship between ecotourism and rural livelihoods have produced mixed findings in terms of ensuring sustainable livelihoods (Ashley et al. 2001, Goodwin & Roe 2001, Tao & Wall 2009, Steinicke & Neuburger 2012). For instance, planned ecotourism development has shown to increase economic gains in Chile (Serenari et al. 2017), Ethiopia (Amano et al. 2017), China (Newton & Franklin 2011), Bhutan (Rinzin et al. 2007; Gurung & Seeland 2011; Montes & Kafley 2022; Dendup et al. 2022), Nepal (KC et al. 2021; Walter et al. 2018; Aryal et al. 2019a; 2019b; Dahal et al. 2020; Neupane et al. 2021; Upadhaya et al. 2022) and India (Kala & Maikhuri 2011; Anand et al. 2012; Balodi et al. 2014; Datta & Banerji 2015; Sarkar

& Sinha 2015; Ogra & Badola 2015; Bhalla et al. 2016; Basak et al. 2021). Studies on community-based ecotourism, specifically in the context of homestay contribution, have extensively documented the significant role of women's empowerment in enhancing their adaptive capacity towards climate change impacts, augmenting their income generation opportunities, and fostering conservation endeavors (Anand et al. 2012; Ogra & Badola 2015; Bhalla et al. 2016; Basak et al. 2021).

In contrast, unwieldy institutional planning, lack of infrastructure, and inadequate community participation are known to otherwise impede its success (Datta & Banerji 2015; Sarkar & Sinha 2015; Mak et al. 2017; Brandt et al. 2019; Singh et al. 2021). Açıksöz et al. (2016) highlighted the considerable potential of ecotourism as a strategy for reducing poverty and diversifying livelihoods. However, they cautioned that its effectiveness might be hindered by resource overuse due to unregulated carrying capacity. In addition, it is imperative to prioritize addressing the potential exacerbation of income inequalities by privileged groups with superior resource access (Ma et al. 2019), as such disparities lead to the concentration of wealth and influence, heightened social inequalities, reduced participation, and eventual disempowerment of communities (Gurung & Seeland 2011).

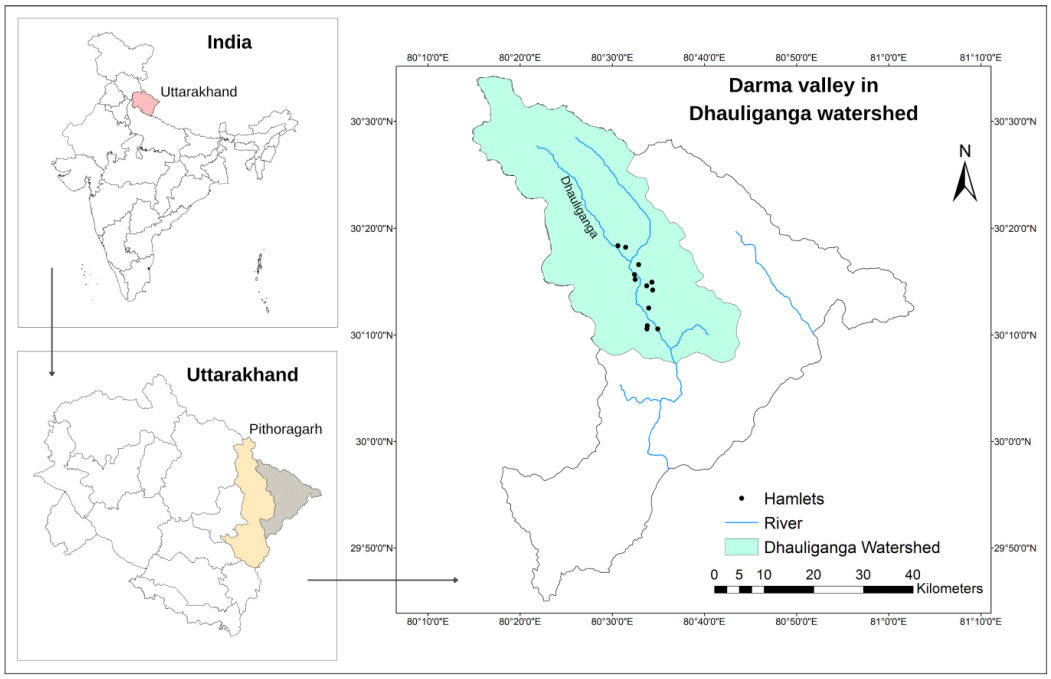
Considering the aforementioned perspectives, the burgeoning body of literature on ecotourism studies reveals significant possibilities for enhancing local livelihoods and fostering broader economic advancement. However, a notable research gap persists regarding the empirical exploration of ecotourism's role as a strategy for livelihood adaptation within the context of emerging socio-economic and climatic challenges in IHR, especially in Uttarakhand, warranting further systematic investigation (Ogra & Badola 2015). Recognizing the observed proliferation, it becomes apparent that ecotourism possesses the potential to amalgamate environmental preservation and economic upliftment within rural landscapes, particularly in regions characterized by captivating scenic beauty and panoramic landscapes (Ogra & Badola 2015; Dendup et al. 2022). In addition, there arises a pressing need for meticulous exploration of grassroots community dynamics, encompassing the complexities surrounding rural livelihoods, the level of local community participation in ecotourism initiatives, and a comprehensive analysis of the intricate cultural dimensions interwoven with the simultaneous pursuit of indigenous perspectives on the benefits of ecotourism.

3. Methodology

3.1. Study area

Darma valley, located in Dharchula Subdivision in Pithoragarh District (Kumaon administrative division) of Uttarakhand in IHR, border Tibet in the North and Nepal in the East (fig. 2a-c). The valley is situated at an altitude between 7500 and 14,000 ft in Kailash Sacred Landscape (KSL) region and is inhabited by an indigenous semi-nomadic agro-pastoralist tribe, *Bhotia (*sub-tribes *Rung)*, across 12 villages namely, Dugtu, Dantu, Sela, Chal, Baling, Nagling, Go, Philam, Bon, Tidang, Marcha and Sipu. Adapting to the distinct topography and biodiversity of the region, Bhotias practice mixed mountain agriculture, combining animal husbandry, crop farming and forestry

(Bergmann et al. 2008; 2012). Utilizing alpine pasturelands or *bugyals* for transhumant grazing, Bhotias migrate to warmer lower regions around Dharchula in the winter months (October-November) and return to the valley with their livestok in the summer season (late March-April). Seeped in Indian myths and legends along rich tribal culture, floral variety, alpine meadows, soaring glaciers, and shimmering rivulets, Darma valley is endowed with a distinct charm of its own.



a.

b.

c.

Figure 2: a. Location of study area; b. Baling village in month of May; c. View of Panchachuli peaks from Dantu in month of November

Figure 2 Alt Text: a. Schematic representation of location of Uttarakhand in India on top left, Pithoragarh in Uttarakhand on bottom left and Darma valley in Dhauliganga watershed in Dharchula on right; b. The quaint village of Baling, here pictured in the summer month of May, surrounded by fields and high mountain peaks; c. Early onset of snowfall in November, providing a picturesque view of snow-clad Panchachuli peaks as seen from Dantu village.

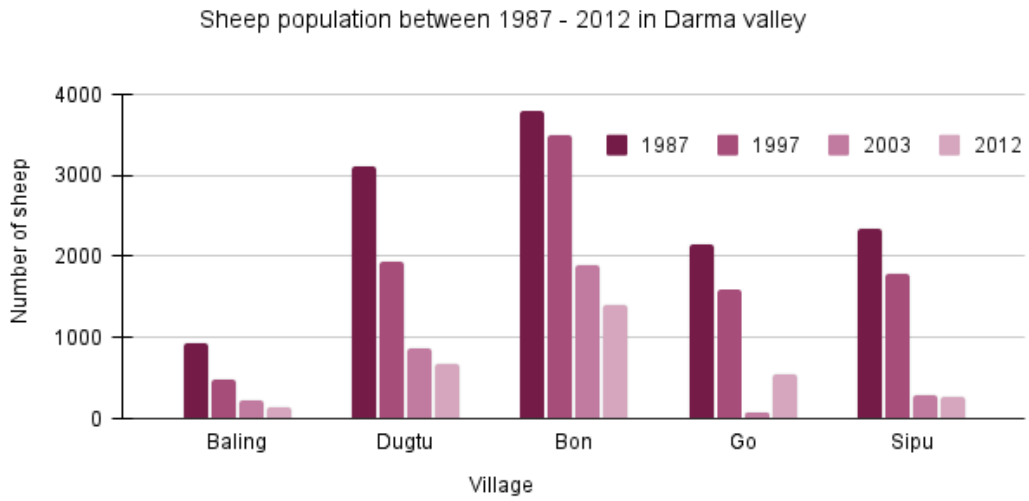
The Bhotia community in Darma heavily relied on cross-border trade with Tibet as a primary livelihood source during which farming, pasture use and forest utilization

became regarded as important sources of livelihood security (Bergmann et al. 2008). Subsequently, the implementation of colonial forest policies, including the establishment of "Reserved Forests," imposed limitations on the community's access to forest resources (Bergmann et al. 2012). Furthermore, the British administration introduced the substitution of indigenous wool with imported wool from Europe and the procurement of salt from Indian coastal regions at more affordable prices, negatively impacting the regional pastoralist economy (Guha 1989; Roy 2003). The Indo-China war in 1962 further exacerbated the situation by disrupting cross-border trade relations and gradually diminishing interest in customary seasonal transhumance practices (Bergmann et al. 2012). During this time, the region witnessed a surge in military deployment who embarked on the construction of intricate road networks penetrating these peripheral territories. In 1967, Bhotias were officially designated as a 'Scheduled Tribe' (ST) by the Indian government, entitling them to privileges like reserved quotas in government and academic institutions. Following this, driven by the pursuit of enhanced employment prospects, a significant outmigration trend prevailed among Bhotia men who relocated to emerging marketplaces and administrative hubs within the state. After gaining autonomous federal status in 2000, Uttarakhand witnessed the advent of globalizing influences, prompting the state government to adopt market-oriented strategies through its Border Area Development Program which aimed to bolster infrastructure, road networks, tourism, education, hydro-energy, and agriculture in this border region (Gerwin & Bergmann 2012).

In summation, the confluence of diverse socio-economic and political factors progressively contributed to the decline of the traditional pastoral livelihood in the area (Pathak et a. 2017; Pandey et al. 2017). Nonetheless, the present decline in livestock population and overall practice in the region (Maiti et al. 2022) has been further exacerbated by climate-related pressures (Fig. 3a, 3b) (Pathak et a. 2017; Rawat & Schickhoff 2022) as clearly manifested in the entirety of KSL region (Zomer et al. 2014; Dalal et al. 2018; Kuniyal et al. 2021). As a result, local community's adaptive strategies include engaging in wage labor, tourism and recreational services, transportation services, collection and selling of medicinal plants and out-migration (Pathak et al. 2017; Rawat & Schickhoff 2022). Local handicrafts (Fig. 3c), pulses, and medicinal plants are sold at the nearest town market at Dharchula for extra income, while the surplus production is peddled to the major markets in Haldwani, Dehradun, and Pithoragarh. In addition, other sources of income generation are on gradual rise, such as unregistered and unsustainable seasonal collection of *Yarsagumba* or Caterpillar-fungus which is exported at higher prices to Nepal and China.

At present, to promote employment opportunities, foster sustainable community development, and enhance tourism prospects in the area, Kumaon Mandal Vikas Nigam (KMVN), a Government of Uttarakhand (GoU) enterprise launched a homestay initiative in 2017. This initiative aimed to tribal-circuit tourism connecting Darma with adjacent Byans and Chaudans valleys. In the initial phase, the scheme adopted a few households in Nagling, Baling, Dugtu and Dantu and provided residents with necessary house renovations, bedding sets, sanitation facilities, and homestay trainings. At present, the Panchachuli Homestay Owners Welfare Society (PHOWS), driven by a comprehensive range of strategic initiatives, actively support homestay growth in these

Bhotia valleys. Thus far, the homestay initiative has demonstrated its efficacy in empowering individuals within the local community, specifically women, who have assumed pivotal positions as significant contributors to household income. With enormous ecotourism potential, however, the region is still far from realizing its potential (TERI 2019).



a.

b.

c.

Figure 3: a. Livestock population in selected villages (data adapted from Maiti et al. 2022); b. Pasturelands near Baun village; c. Traditional Bhotia handicrafts

Figure 3 Alt Text: a. Bar graphs representation of decadal decline of sheep population in five villages in Darma valley; b. A flock of sheep grazing in open green pasturelands in the village of Baun; c. Keeping the tradition alive, pictured here is a traditional handloom used for carpet weaving by the Bhotias in Darma valley.

3.2. Data collection and analysis

This study adopted to descriptive and exploratory mixed methodological approach based on extensive field surveys, semi-structured interviews, focused group discussions (FGDs) and key informant interviews (KIIs). FGDs with a group of 6-10 participants were conducted in in Dugtu, Baling, Baun and Sipu. 30 KIIs led by semi-structured interviews were held with village heads, tourist guides, porters, homestay owners, government officials, local committee, and available visitors. Participation of women and members of youth groups involved in tourism practices was highly encouraged. On the other hand, field observation helped in understanding narrative account of the respondents and ensuring information accuracy. The questionnaire sought to address and encompass the attitudes and opinions of the local communities towards ecotourism development, their level of awareness regarding its potential consequences, and their readiness to participate in the strategic planning and administration of ecotourism activities (Table 2).

Table 2: Sample questions from survey questionnaire

Primary category	Sub-questions
Livelihood related challenges	• What are the most significant challenges that your community faces? • How do these challenges impact your livelihoods? • What are some of the current economic activities that individuals engage in your community?
Current tourism growth and potential	• What are the main tourist attractions in the region? • What types of tourists currently visit Darma valley? • Which infrastructure developments specifically associated with tourism growth have been implemented in the region? • What is the average duration of tourist stays in various accommodation facilities? • What is the estimated average expenditure of guests utilizing different accommodation services? • What tourism-related employment opportunities are available to residents? • Which community members are most actively engaged in tourism-related activities? • Has tourism contributed to the development of small businesses and entrepreneurship in the local community? • What types of tourism businesses are currently operating in the region? • Is there a specific peak season when tourist numbers are higher? • How do you manage operations during periods of lower tourist arrivals? • How do you perceive the government's efforts in facilitating tourism growth in Darma? • What is the community's response to the increasing interest in tourism development in the region?

Potential and prospects of tourism	• Is there a perceived demand for ecotourism in Darma valley? • What ecotourism activities or attractions are most appealing to visitors? • What are the primary strengths and opportunities of the region that may contribute to the development of ecotourism? • Which ecotourism activities or initiatives may facilitate cultural exchange between visitors and the local community, and how do they seem to impact the community? • How do you perceive the role of local communities in the development and management of an ecotourism in the region? • How significant is women's involvement in ecotourism-related services? • What skills and capacities are required within the community to foster ecotourism growth? • How do you envision prioritizing resources for community development and environmental conservation projects? • What are the existing tourism and ecotourism policies and regulations in the region, and how successful are they in promoting sustainable tourism development?
Challenges related to tourism/ ecotourism growth	• What specific socio-cultural, economic, and environmental challenges have emerged because of tourism activities in the region? • What are the major threats and challenges that currently hinder the tourism (and may hinder ecotourism) development in this region? • Have conflicts or tensions arisen among different stakeholders due to tourism growth? • Are there concerns regarding the local economy's dependency on tourism and ecotourism as the primary source of income?

Following this, SWOT analysis was conducted in conformity with its use in similar studies (Açıksöz et al. 2010; 2016; Demir et al. 2016), in addition to assessment of SWOT factors using Internal Factor Estimate Matrix (IFEM) and External Factor Estimate Matrix (EFEM) (Mallick et al. 2020; Heshmati et al. 2022) to identify potential strengths, weaknesses, opportunities and threats in proposed ecotourism development in the region (Table 3).

In later stage, Ecotourism Opportunity Spectrum (ECOS) framework was used as a convenient practical tool to identify potential areas for developing ecotourism recreational activities, investigate unique needs for ecotourism planning and create a conceptual management approach (Boyd & Butler 1996). It consists of assessment of 8 criteria crucial to ecotourism development which are (i) accessibility, (ii) attractions in a region, (iii) existing tourism infrastructure and facilities, (iv) relationship between ecotourism and other resource uses, (v) stakeholders' skill, experience and knowledge, (vi) social interaction between host community and tourists, (vii) visitor control, impacts and consequences of resource use, and (viii) stakeholder partnership and management for effective ecotourism development. In this study, these factors were

further subdivided to 28 parameters and evaluated on a scale of 1-4 conformity scores adapted from studies conducted in Turkey (Açıksöz et al. 2010; 2016). These studies highlighted the role of ECOS framework in analyzing ecotourism potential for natural resource management and sustainable livelihood diversification particularly in protected areas. ECOS incorporates concepts drawn from Recreation Opportunity Spectrum (ROS) and Tourism Opportunity Spectrum (TOS), widely recognized tools for assessing viability, planning, and management of recreational and tourism activities.

Table 3: Step-by-step assessment of SWOT factors

1. Weights and ratings were determined in association with experienced tourism operators and government officials during KIIs.
2. Value of each weight ranged between 0 and 1 (0 = low importance factor; 1 = high importance factor)
3. Total value of weights should equal 1.
4. Rating for IFEM should be between 1 and 4 (1 = major weakness; 2 = minor weakness; 3 = minor strength; 4 = major strength)
5. Rating for EFEM should be between 1 and 4 (1 = major threat; 2 = minor threat; 3 = minor opportunity; 4 = major opportunity)
6. Final weighted score was determined by multiplying weight of each factor by its rating
7. If total sum of weighted scores of IF is more than 2.5, it depicts strengths are more influential and dominating than weaknesses.
8. If total sum of weighted scores of EF is more than 2.5, it depicts opportunities are more influential and dominating than threats.
9. If total sum of weighted scores of IFEM and EFEM is less than 2.5, it depicts that weaknesses and threats dominate over strengths and opportunities, respectively.

Additionally, adapted from 'Guidance Note for the Application of the Sustainable Livelihoods Framework in Development Projects' (UNDP 2017), a systemic capital analysis based on 23 SLF reference indicators was conducted to examine the accessibility to the core livelihood capitals in Darma valley. Each reference indicator was assigned point-based values from 1-4 scoring system, with 1 indicating lowest value and 4 indicating highest value. Such a methodological tool, in practice, could be leveraged in planning and evaluating of developmental initiatives in view of strengthening community resilience especially in the context of developing countries (UNDP 2017).

Scoring for both ECOS analysis and SLF indicators were based on primary data collection and systemic review of secondary data acquired from District Census Handbook of Pithoragarh, Census of India (2011), Department of Tourism, and other published government research reports.

4. Results and discussion

4.1. SWOT Analysis

The overall findings from SWOT analysis are depicted in Table 4. The assessment of strategic SWOT factors as depicted in Table 5, further revealed that strengths (S) and opportunities (O) exert a greater influence and prevail over weaknesses (W) and threats (T) in the context of Darma valley. The findings in entirety espoused high promising

avenues for nature and adventure activities, with possible opportunities reposed in burgeoning winter tourism activities, cultural tourism, herbal tourism, and women participation in cultural homestay services (Fig. 4a–g). As per respondents, the strengths primarily consisted of inherent internal factors that are presently established and hold the capacity to foster the expansion of ecotourism. Conversely, the opportunities encompassed factors that the local government, private sector, and local stakeholders may harness to advance the sustainable development of ecotourism in the region.

Major challenges as highlighted lie in disruption caused by weather extremes and natural disasters, natural resource exploitation and lack of appropriate ecotourism planning and policies at the local level. These issues pose significant obstacles as they limit the ability of households and communities to actively engage in ecotourism practices. The comprehensive assessment of internal and external factors conducted in this analysis is crucial for identifying viable strategic solutions for the development of ecotourism in the Darma region.

Table 4: SWOT analysis for ecotourism potential in Darma valley

Internal factors influencing ecotourism development	
Strength (S)	Weakness (W)
S1: Richness of natural and cultural resources S2: Tribal circuit tourism connecting Darma, Byans and Chaudans valleys S3: Various trekking trails in and around Darma valley–*Panchachuli base camp, Mahadev cave, Achaari lake, Gabbe top, Baling pastures, Sinla pass, Parvati kund, Mapang Tal, Om Parvat viewpoint, Narayan Ashram, Sinla pass* *S4: Ethnic diversity (local tribal fairs and festivals–Jauljibi mela, Pandali mela, Sanshey Puja, Rung festival, Gulaj mela*) S5: Local tribal cuisine S6: Favourable climatic conditions S7: Unique traditional Bhotia architecture S8: Bhotia museum in Dharchula S9: Existence of government rest houses and check posts S10: Diverse topographic forms S11: Affordable homestay facilities S12: Affordable transportation S13: Richness of ancient folklores S14: Sustainable use of solar panels S15: Market for local handicraft products S16: Easy market access to Dharchula (nearest town)	W1: Lack of appropriate ecotourism planning and policies W2: Inadequate basic infrastructure (roads, sewage, electricity, waste disposal) W3: Limited number of guides, porters, operators W4: No network connectivity W5: Inadequate funding for tourism activities W6: Unorganized tourism service provider W7: Lack of healthcare facilities W8: Migration of youth population to urban areas W9: Seasonal tourism demands

External factors influencing ecotourism development	
Opportunity (O)	Threat (T)
O1: Sustainable nature–based tourism (herbal, cultural, spiritual) O2: Winter tourism activities O3: Expansion of ecotourism activities (bird watching, organic farming, eco-treks, farm volunteer works) O4: Environmental education and conservation O5: Active community participation O6: Employment opportunities to women and youth O7: Women participation in ecotourism services O8: Bigger market for local handicraft products–benefitting women O9: Preservation of local Bhotia culture and traditions O10: Collaboration of government and local organizations for sustainable ecotourism planning O11: Ecotourism capacity building trainings and workshops O12: Exchange of knowledge O13: Improved basic infrastructure	T1: Disruption caused by natural disasters T2: Disruption caused by weather extremes T3: Weakened management and ineffective law enforcement T4: Intrusion of wild animals (wild boar, leopards) T5: Exceeding carrying capacity leading to environmental degradation (air and land pollution, improper waste disposal) T6: Natural resource exploitation (forests, water, pastures) T7: Revenue benefits to only a few individuals T8: Uncontrolled tourism development T9: Conflict of interest between government and local community

Table 5: Evaluation of strategic SWOT factors

	Weight	Rating	Weighted score
Internal Factor Estimation Matrix (IFEM)			
Strengths (S)			
S1	0.07	4	0.28
S2	0.06	4	0.24
S3	0.06	4	0.24
S4	0.05	4	0.2
S5	0.04	3	0.12
S6	0.04	4	0.16
S7	0.04	3	0.12
S8	0.02	3	0.06
S9	0.03	3	0.09
S10	0.06	4	0.24
S11	0.04	4	0.16
S12	0.04	3	0.12
S13	0.04	4	0.16
S14	0.03	3	0.09

S15	0.04	3	0.12
S16	0.02	3	0.06
Weaknesses (W)			
W1	0.06	1	0.06
W2	0.05	1	0.05
W3	0.03	2	0.06
W4	0.03	2	0.06
W5	0.03	1	0.03
W6	0.03	2	0.06
W7	0.04	1	0.04
W8	0.03	2	0.06
W9	0.02	2	0.04
	1		**2.92**
External Factor Estimation Matrix (EFEM)			
Opportunities (O)			
O1	0.06	4	0.24
O2	0.05	4	0.2
O3	0.06	4	0.24
O4	0.05	3	0.15
O5	0.05	4	0.2
O6	0.07	4	0.28
O7	0.05	4	0.2
O8	0.04	3	0.12
O9	0.04	3	0.12
O10	0.05	3	0.15
O11	0.04	3	0.12
O12	0.02	3	0.06
O13	0.05	4	0.2
Threats (T)			
T1	0.05	2	0.1
T2	0.05	1	0.05
T3	0.04	1	0.04
T4	0.03	2	0.06
T5	0.05	1	0.05
T6	0.04	1	0.04
T7	0.03	1	0.03
T8	0.05	1	0.05
T9	0.03	2	0.06
	1		**2.76**

a.

b.

c.

d.

e.

f.

g.

Figure 4: **a.** KMVN tourist rest houses near Panchachuli base camp; **b.** Bhotia women heading homestays; **c.** Central Public Works Department (CPWD) tourist guest house in Dugtu pictured in the month of November; **d.** Church ruins near Baun village, a newly identified tourist attraction; **e.** Cultivation of medicinal and aromatic plants (MAPs) in village ruins; **f.** Ongoing road construction led by CPWD near Nagling; **g.** Provision of solar panels in Dugtu

Figure 4 Alt Text: a. View of white igloo huts, built by KMVN and located on the way to Panchachuli base camp; b. Two Bhotia women cooking food in traditional mud stoves and graciously serving the guests; c. Central Public Works Department's guest house in Dugtu village surrounded by mountains covered in fresh snow in November; d. Clustered church ruins, a growing tourist attraction, believed to be built by British colonists prior to Indian independence near Baun; e. Abandoned house ruins provide a secure site for cultivation of medicinal and aromatic plants, seen in most villages in Darma; f. Pictured here is a CPWD–led motor road construction in Nagling village, which has resulted in improved connectivity in the area; g. A woman walking past solar panels in Dugtu village, one of the viable options for energy access in the region.

4.2 ECOS assessment

According to the findings of ECOS (Table 6) both Dugtu and Dantu stand out as most suitable sites for ecotourism development due to their proximity to Panchachuli base camp, KMVN registered homestays availability, and improved road and transportation facilities. Nagling and Baling also indicate higher ecotourism potential due to presence of homestays and access to road. The notable road infrastructure advancements are facilitated by Border Road Organization (BRO) and the Central Public Works Department (CPWD). These organizations, known for their dedicated efforts in improving road networks in challenging border regions and overseeing construction, maintenance, and management initiatives nationwide, have played instrumental roles in enhancing connectivity in this region.

The villages of Go, Philam, and Bon, situated opposite Dugtu and Dantu, offer a captivating view of the Panchachuli peaks. Despite this, they receive a relatively lower volume of visitors. This disparity can be ascribed to the constrained mobility beyond Dantu, where transportation services predominantly cease. Moreover, to reach the remaining villages of Tidang, Marchha, and Sipu, visitors must traverse on foot. Consequently, the challenge of restricted accessibility poses a hindrance for certain visitors, particularly elderly tourists, and families with children, as it limits their ability to explore further. In the duration of this study, no homestays were officially recorded within these later villages. However, presently, the progressive proliferation of homestays in the villages of Baun, Philam, Marchha, and Sipu signifies a burgeoning allure and acknowledgment of these villages among adventure enthusiasts.

Table 7 further demonstrates each criterion's significance calculated as simple weighted arithmetic mean scores across all villages. Low scores, in this case, do not necessarily imply unsuitability for ecotourism development; rather, they indicate opportunities to identify potential arenas for important prioritization and development considerations that must be considered.

Table 6: ECOS analysis for ecotourism development in Darma valley

Criteria	Sub-criteria parameters	Villages in Darma valley											
		Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Philam	Bon	Tidang	Marchha	Sipu
Accessibility (C1)	Accessibility to villages[1]	3	2	4	4	4	4	3	3	3	2	2	2
	Access to transportation[1]	3	3	4	4	4	4	2	2	2	1	1	1
	Distance to the market town (Dharchula)[4]	1	1	1	1	1	1	1	1	1	1	1	1
Relationship between ecotourism and other resource uses (C2)	Awareness regarding ecoutourism[1]	3	3	4	4	4	4	3	4	4	3	3	3
	Opportunity to experience traditional customs[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Resource compatibility with tourism uses[1]	2	3	4	3	4	4	4	4	4	3	3	3
Attractions (C3)	Diversity of landforms[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Presence of forests in the proximity[1]	3	3	3	3	2	4	3	2	2	2	3	4
	Outstanding beauty[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Presence of historical-archeological sites[1]	1	1	1	1	4	4	1	1	4	1	1	4
	Proximity to Panchachuli base camp[2]	2	2	3	3	4	4	3	3	3	2	2	2
Existing tourism infrastructure (C4)	Accommodation facilities for tourists[1]	2	2	4	4	4	4	2	2	2	2	2	2
	Nearest primary health centre[4]	3	1	1	2	3	2	2	2	2	2	2	2
	Primary school[5]	4	4	4	4	4	4	4	4	4	4	4	4
	Availability of food (shops, hotels)[1]	3	1	4	3	4	4	2	2	2	1	1	1
	Existing recreational activities[1]	1	1	4	4	4	4	3	3	3	1	1	1
	Provision for drinking water[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Provision of power supply[1]	2	2	2	2	2	2	2	1	2	2	1	1
	Availability of human resources (potential workforce)[6]	2	2	3	3	2	1	3	1	4	2	1	1
Level of skill and knowledge (C5)	Educational status of local people[1]	2	2	3	3	3	3	3	3	2	4	4	4
	Availability of tourist guides[1]	2	2	3	3	4	4	2	2	2	2	2	2
	Knowledge of other languages[1]	2	2	2	2	3	3	2	2	2	2	2	2
Social interaction level (C6)	Frequency of interaction with tourists[1]	3	2	4	4	4	4	3	3	3	2	2	2
	Tourist attitude towards community and vice-versa[3]	4	4	4	4	4	4	4	4	4	4	4	4
Acceptance of visitor impact (C7)	Degree of impact on ecotourism resources[3]	4	4	4	4	3	3	4	4	4	4	4	4
Partnership and management for ecotourism viability (C8)	Community involvement in natural resource protection[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Government involvement in managing tours[1]	2	2	3	3	3	3	2	2	2	2	2	2
	Community involvement in managing tours[1]	4	3	4	4	4	4	2	2	2	2	2	2
		78	72	93	92	98	98	80	77	83	71	70	74

Notes: Parameters adapted from Boyd and Butler (1996) and Açıksöz et al. (2010; 2016)

[1] includes 21 parameters with 1-4 scoring system which includes: 1 as none, 2 as low, 3 as fair and 4 as high.

[2] includes 1 parameter with 1-4 scoring system which includes: 1 as very far, 2 as far, 3 as close and 4 as very close.

[3] includes 2 parameters with 1-4 scoring system which includes: 1 as none, 2 as bad, 3 as fair and 4 as good.

[4] includes 2 paramters with 1-4 scoring system which includes: 1 as 10+ kms, 2 as 5-10 kms, 3 as <5 kms and 4 as very close.

[5] includes 1 parameter with 1-4 scoring system which includes: 1 as 10+ kms, 2 as 5-10 kms, 3 as <5 kms and 4 in the village.

[6] includes 1 parameter with 1-4 scoring system which includes: 1 as ≤ 200, 2 as 200- 300, 3 as 300-400 and 4 as ≥ 400.

Table 7: Arithmetic mean scores of individual ECOS criteria

Criteria	Villages in Darma valley											
	Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Philam	Bon	Tidang	Marchha	Sipu
C1	2.3	2	3	3	3	3	2	2	2	1.3	1.3	1.3
C2	3	3.3	4	3.6	4	4	3.6	4	4	3.3	3.3	3.3
C3	2.8	2.8	3	3	3.6	4	3	2.8	3.4	2.6	2.8	3.6
C4	2.6	2.1	3.2	3.2	3.3	3.1	2.7	2.3	2.8	2.2	2	2
C5	2	2	2.6	2.6	3.3	3.3	2.3	2.3	2	2.6	2.6	2.6
C6	3.5	3	4	4	4	4	3.5	3.5	3.5	3	3	3
C7	4	4	4	4	3	3	4	4	4	4	4	4
C8	3.3	3	3.6	3.6	3.6	3.6	2.6	2.6	2.6	2.6	2.6	2.6
	23.5	22.2	27.4	27	27.8	28	23.7	23.5	24.3	21.6	21.6	22.4

4.3 SLF reference indicators

The SLF reference indicators, assessed in Table 8, depict that Dugtu has the maximum access to livelihood capitals followed by Dantu and Baling, whereas Marchha, Sipu, Sela and Chal have the least access. The findings, however, suggest that all villages have relatively high stocks of natural, human, and social capitals. Mapping livelihood assets is essential in assessing feasible strategies for adapting to challenges and reducing vulnerabilities. This crucial endeavor is based on the understanding that increased access to assets is vital for successfully adopting a range of favorable livelihood strategies.

The entirety of the region encompasses abundant biodiversity and captivating landscapes, as evident from higher values for natural capital for each individual village. In this study, human capital essentially encompasses the educational attainment, health provision, skill acquisition capacity, and awareness levels of the local community, all of which enable them to actively pursue various livelihood adaptation strategies. The Bhotia community exhibits an average literacy rate that surpasses the national average of 74.04% (Census of India 2011). This can be attributed to their Scheduled Tribe (ST) status which has bestowed upon them quota privileges to access higher educational institutions and secure government positions. Additionally, community engagement and collective awareness are integral aspects of social capital, hence, role of local organizations like PHOWS, *Dilang Darma Sewa Samiti*, *Rung Kalyan Sanstha* (established in 1989), village committees, youth unions, and women self-help groups (SHGs) in promoting socio-economic progress and preserving the cultural heritage isi highly regarded in Darma, Byans, and Chaudans valleys.

The values recorded for physical and financial capitals, measured by access to basic infrastructure and services, regular inflow of money, and access to credit-providing institutions, were comparatively lower. The prevailing tourism infrastructure (homestays, guest houses, rest houses, road, and mobile network) in the region exhibits a gradual increment, albeit necessitating additional institutional investments for its comprehensive development. Financial capital, however, is the most versatile of all and is essential to reinforce human capital and boost physical capital assets (DFID 1999) such as improvement of adequate basic infrastructure that can be accessed readily by the community and visitors. Due to the intricate interaction of evolving socio-economic

and environmental factors, marginalized communities often demonstrate constrained entry to financial capital assets, as is evident in the current context. Nevertheless, under such conditions, a variety of livelihood opportunities, related to on-farm and off-farm, have emerged as strategies to strengthen adaptive capacity among the Bhotia community.

Table 8: SLF reference indicators assessed for livelihood capitals

Capital	Reference indicators	Villages in Darma valley											
		Sela	Chal	Nagling	Baling	Dugtu	Dantu	Go	Philam	Baun	Tidang	Marchha	Sipu
Natural (R1)	Natural resources availability[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Accessibility to natural resources[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Unique biodiversity[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Existence of forests in the proximity[1]	3	3	2	2	4	4	2	2	3	2	2	4
	Proximity to *Panchachuli base camp* (glacier)[1]	2	2	3	3	4	4	3	3	3	2	2	2
Human (R2)	Educational status[1]	2	2	3	3	3	3	3	3	2	4	4	4
	Awareness, skills, and trainings for income generating activities[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Nearest primary health centre[2]	2	4	4	3	2	3	3	3	3	3	3	3
Financial (R3)	On-farm income generating activities (crop and animal production)[1]	3	3	3	3	4	3	4	3	4	3	3	3
	Access to non-farm income generating activities (trekking, wage labor, etc.)[1]	3	3	3	3	4	4	3	3	3	2	2	2
	Regular inflow of money (remittances, pensions, etc.)[1]	3	3	3	3	3	3	3	3	3	3	3	3
Physical (R4)	Access to state subsidy programmes[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Access to drinking water[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Access to road and transportation facilities[1]	3	2	4	4	4	4	2	2	2	1	1	1
	Access to basic infrastructure services (waste disposal, sewage, etc.)[1]	2	2	2	4	4	3	2	2	2	2	3	3
	Access to power supply for domestic use[1]	4	4	4	4	4	1	4	1	4	4	1	1
	Access to communication (public phone booths)[1]	1	1	1	4	4	4	1	1	1	2	1	1
	Access to community toilets[3]	1	1	2	2	3	3	2	1	2	2	1	1
	Accommodation availability for tourists[1]	1	1	4	4	4	4	1	1	1	1	1	1
	Distance to the central market *(Dharchula)* [2]	1	1	1	1	1	1	1	1	1	1	1	1
Social (R5)	Organizational partnerships and memberships (NGOs, local committees, etc.)[1]	3	3	3	3	4	4	3	3	4	3	3	3
	Participation in formal groups[1]	4	4	4	4	4	4	4	4	4	4	4	4
	Awareness of collective representation, networks and connections[1]	3	3	3	3	4	4	4	4	4	3	3	3
		65	66	73	77	84	80	69	64	70	66	62	64

Note: Adapted and modified from 'Guidance Note for the Application of the Sustainable Livelihoods Framework in Development Projects' (UNDP 2017)

[1] includes 20 parameters with 1-4 scoring system which includes: 1 as none, 2 as low, 3 as fair and 4 as high.

[2] includes 2 paramters with 1-4 scoring system which includes: 1 as 10+ kms, 2 as 5-10 kms, 3 as <5 kms and 4 as none.

[3] includes 1 parameters with 1-4 scoring system which includes: 1 very low, 2 as low, 3 as fair and 4 as high.

4.4 Overall ecotourism scenario: potential, challenges and recommendations

In recognition of livelihood thinking, adapting to SLF as a foundation for the advancement of ecotourism development is apt, as it endeavors to foster linkages between adaptive strategies, participation, and empowerment of the host communities. Figure 5a–5b serves as a visual representation illustrating an ecotourism-focused framework. This depiction highlights the intricate interrelationships and interdependencies among the different SLF components, aiming to enhance the practical implementation and understanding of the concept.

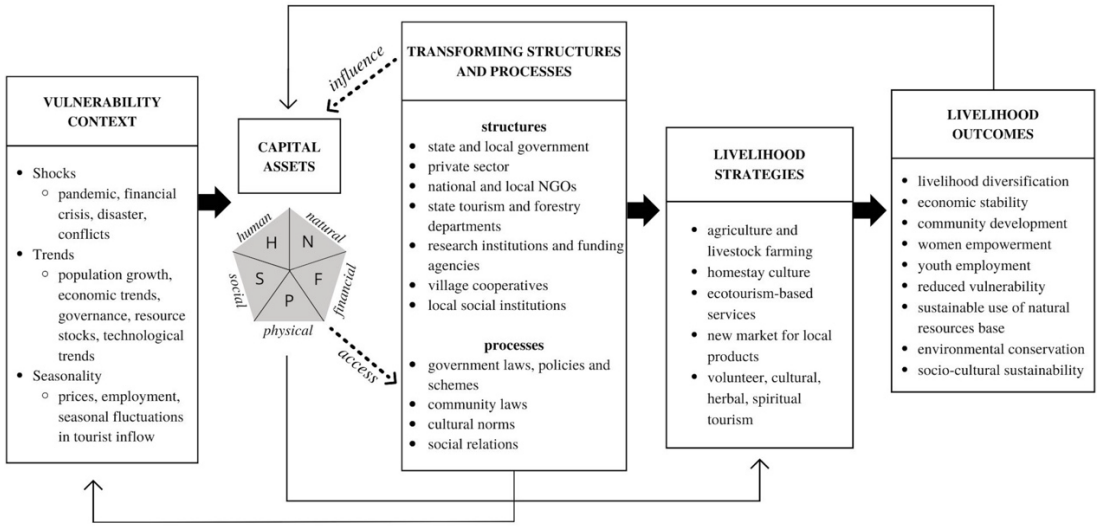


Figure 5a: Linkages in SLF (adapted from DFID 1999)

Figure 5a Alt Text: Schematic representation of SLF in ecotourism context, depicting interlinkages between its various components whilst facilitating community participation and empowerment.

The vulnerability context, however, presents key challenges regarding ecotourism developmental opportunities. This is because people have limited or no control over trends, shocks and seasonality that may directly impact community's livelihood assets, for instance, challenges posed by pandemic outbreak (COVID–19), changing climatic trends and macro-economic conditions among others. Nonetheless, access to capitals can be increased at organizational and regulatory levels by bringing in reforms and their effective implementation by financial service organizations, government agencies and social institutions allowing communities to engage in diversified livelihood strategies. For instance, our analysis elicited background and nature of ongoing state-sponsored developmental and subsidy schemes for provision of basic necessities. Sustainable tourism, forest conservation, livelihood development, handloom production, water conservation and horticulture development that may be leveraged for augmenting the range of capital stocks and ultimately, scale up ecotourism development (Table 9). Other initiatives for implementing sustainable tourism practices, livelihood generation and environmental conservation in the region are led by the International Centre for Integrated Mountain Development (ICIMOD) and United Nations Development Programme (UNDP). Alongside, local community and social organizations play an active role in advancing socio-economic and cultural well-being in Darma and the neighboring Bhotia valleys. These institutions collectively are instrumental in guiding the region's nascent sustainable tourism growth (Table 10).

The cumulative findings of this investigation underscore the significance of systematically mapping ecotourism opportunities in relation to enhancing living conditions, generating revenue, fostering entrepreneurial prospects, promoting environmental conservation, and facilitating overall socio-cultural development. Presently, trekking, mountaineering, and homestay tourism are experiencing a surge in popularity within the Darma region. Homestays have also demonstrated their potential in contributing to community development and women empowerment in other Himalayan areas (Bhalla et al. 2016; Neupane et al. 2021; Basak et al. 2021). Even so,

detailed surveys and discussions with the stakeholders revealed that ecotourism development in Darma valley requires major collaborative institutional and infrastructural inputs as well as improved ground-level implementation.

Ultimately, while the preceding discourse suggests a multitude of prospects, there are certain challenges associated with the ecotourism development. Particularly in Himalayan regions, the seasonality factor exerts significant influence over the tourism industry (NITI Aayog 2018), and often, road network suffers from disruptions caused by landslides and cloudbursts, especially, during heavy monsoon outpours. The expansion of transportation infrastructure to facilitate ecotourism may result in deforestation (Brandt et al. 2019). Unregulated influx of visitors during peak seasons may lead to adverse effects such as pollution, environmental degradation, unsustainable resource utilization, water scarcity, and solid waste accumulation. Similarly, inadequate infrastructure, deficient planning, flawed implementation, and insufficient management have been observed as barriers to effective ecotourism development (Datta & Banerji 2015; Sarkar & Sinha 2015). Conservation policies led by the state that lack inclusivity and proper planning contribute to socio-ecological exploitation and serve as impediments (Singh et al. 2021). Inadequate community participation and lack of skilled manpower may also impede its progress (Mak et al. 2017; Chan et al. 2021). Besides, political instability, pandemic outbreaks and environmental extremities may pose further restraints to the sector's success.

To surmount these hurdles, particularly within developing economies, proactive government intervention is imperative in needed. Public-private partnerships, local entrepreneurship, stakeholder's collaboration, capacity building, community participation and ownership rights should also be emphasized to meticulously manage community-based ecotourism development models. Furthermore, while the state of Uttarakhand aligns with globally recognized sustainable tourism criteria outlined by UNWTO (2004), in reality, there is still substantial room for the sector to evolve and persist amidst challenging circumstances (NITI Aayog, 2018).

To accord priority to the burgeoning tourism figures in Pithoragarh District and the wider state, it is imperative to integrate a robust ecotourism model and policy initiatives into the comprehensive framework of the state tourism policy. Moreover, successful ecotourism development depends on the state of natural ecosystems, which are vulnerable to climate change. The climate-sensitive nature of the tourism sector (Scott 2011; Scott et al. 2019) requires significant governance arrangements and financial investments to contribute to broader commitment to sustainable development (Salgueiro et al. 2020; Becken & Loehr 2022). Nonetheless, overcoming constraints also creates a mélange of opportunities that stages ecotourism as a livelihood diversification strategy that support climate adaptation among vulnerable communities (Ogara et al. 2013; Ogra & Badola 2015; Jamaliah & Powell 2018; Hoang & Pulliat 2019; Agyeman 2019; Dendup et al. 2022). Thus, reinforcing adaptive strategies and policies that integrate emerging opportunities is increasingly crucial.

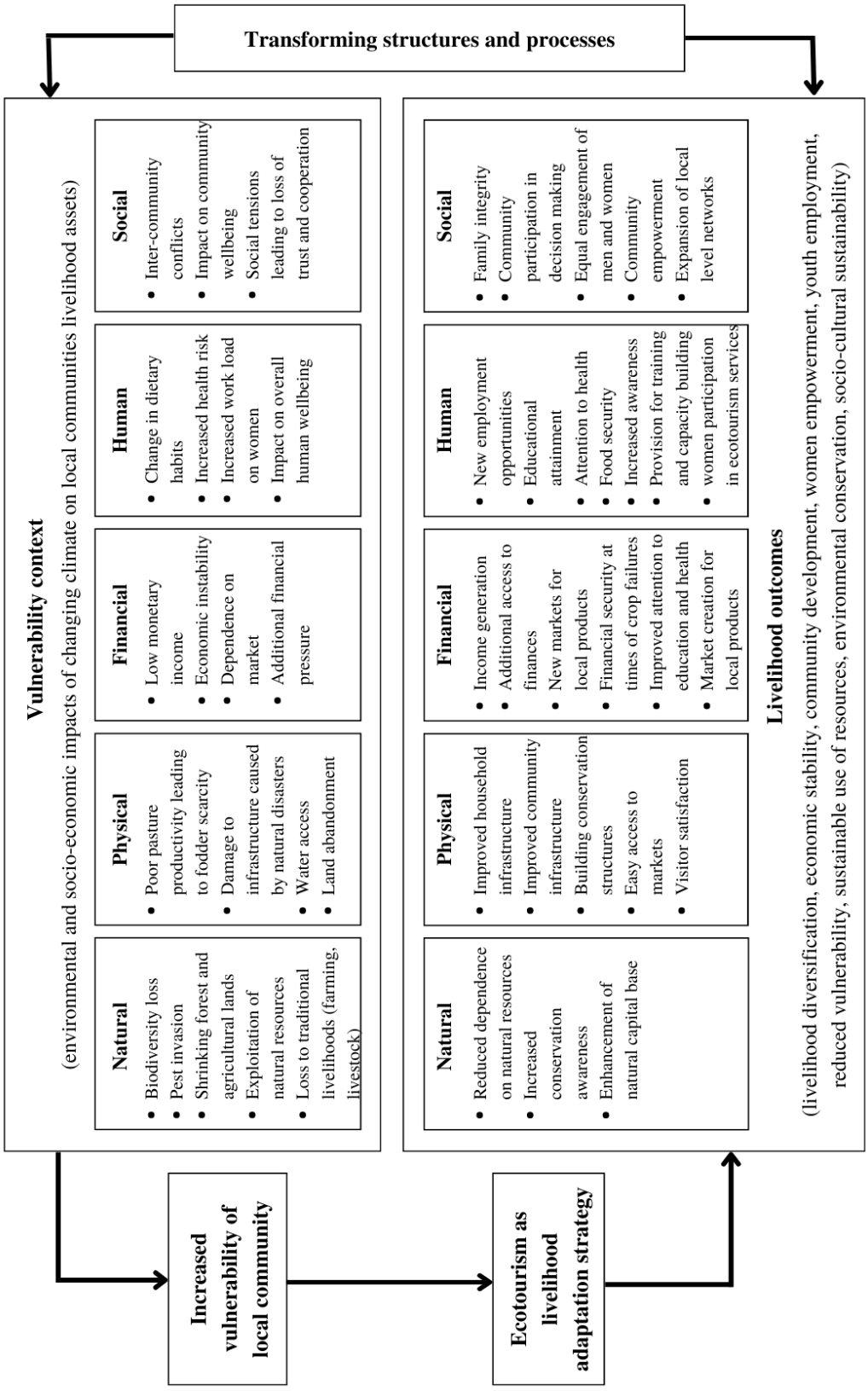


Figure 5b: Application of SLF model for ecotourism in Darma valley

Figure 5b Alt Text: Schematic representation of the application of SLF model for developing ecotourism as a livelihood adaptation strategy in Darma.

Table 9: Key policy framework relevant to ecotourism development in Darma valley

Current developmental schemes/ policy initiatives	
Scheme/ Policy initiatives	Strategies
Kumaon Mandal Vikas Nigam (KMVN)	Tribal-circuit tourism, homestay development, house renovations, provision for sanitation facilities, trainings and workshops
Gramin Paryatan Uthan Yojana by Uttarakhand Tourism Development Board (UTDB)	Promotion of sustainable ecotourism, livelihood generation through homestays, biodiversity conservation, sensitization on health, sanitation and solid-waste management
Uttarakhand Renewable Energy Development Agency (UREDA)	Promotion of renewable energy, provision for single bulb connection and solar streetlights
Uttarakhand Handloom and Handicraft Development Council (UHHDC)	Trainings on design development, promotion of quality certifications for livelihood diversification and women empowerment
National Rural Livelihood Mission (NRLM)	Handloom, mushroom farming, micro-credit
Border Area Development Programme (BADP)	Building infrastructure (rest house, clean drinking water, rain shelter, toilet, link road), promoting rural tourism, use of biogas, small scale industries, skill development
14th Finance commission	Provision for doorstep water supply and sanitation facilities
Deen Dayal Upadhyay Grah Aawas (Homestay) Scheme	Job creation at local level, affordable homestay accommodation, rich traditional experience to visitors, capital subsidies for entities
Swajal Yojana	Provision for doorstep water supply and sanitation facilities
Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)	Building infrastructure such as protection wall, check dam, use of biogas, community or personal toilet
Compensatory Afforestation Fund Management and Planning Authority (CAMPA)	Promotion of afforestation and regenerative practices, catchment area treatment, wildlife management, strengthening of Van Panchayats
Biodiversity Conservation and Rural Livelihood Improvements Project (BCRLI)	Capacity and institution building, landscape conservation approaches, Van Panchayat micro plan
Swachh Bharat Mission	Provision of safe drinking water and sanitation practices
Van Panchayat - Uttarakhand Forest Department	Community-based Forest management, formation of village ecotourism committee
National Medicinal Plants Board (NMPB)	Trainings related to cultivation and sustainable NTFP collection for biodiversity conservation and livelihood diversification
Other policy initiatives/ guidelines in Uttarakhand	

National Tourism Policy (2002)	Promotion of village and adventure tourism, tax exemptions for tourism industry, driving economic growth through sustainable tourism practices
Uttarakhand Tourism Policy (2018)	Building sustainable tourism infrastructure, new ecotourism markets, guidelines for community participation, measures to protect, conserve and enhance ecotourism resources
Uttarakhand Tourism Policy (2030)	Promote development of tourism circuits, indigenous tourism businesses, infrastructure, private sector investments, heavy use of digital technologies
National Strategy on Sustainable Tourism (2022)	Mainstream sustainability into the nationwide tourism sector
Uttarakhand Tourism Development Master Plan (2007-2022)	Promotion of village and adventure tourism, tax exemptions for tourism industry, driving economic growth through sustainable tourism practices
Uttarakhand Livelihoods Improvement Project for the Himalayas (ULIPH)	Promotion of livelihoods, strengthening of local institutions, capacity building of local communities
Forest Conservation Act (1980)	Conservation of forests, compensatory afforestation, use of forests only for forestry purposes
Wildlife Protection Act (1972)	Conservation of wildlife, curb the illegal trade in wildlife, minimize human interference in natural parks and protected areas
Urban Municipal Solid Waste Management Action Plan	Zero waste state by 2040, proper collection and management of waste, waste segregation, recycling system, in situ composting
State Disaster Management Plan	Disaster prevention, mitigation, preparedness and management
State Action Plan on Climate Change	Developing adaptation and mitigation interventions, climate proofing of vulnerable sectors, green development-carbon neutral growth strategy, capacity development
Veer Chandra Singh Garhwali Tourism Self Employment Scheme	Opportunities for self-employment, tourism-related infrastructural development, capital subsidies for entities
Supreme court order on ban on plastic (2017)	Sensitization and complete ban on sale, use and storage of single-use plastics
Uttarakhand Tourism and Travel Trade Registration Rules (2014)	Recognition and employment to entities in tourism sector

Table 10: Current status of tourism practices in Darma valley

Criteria	Existing sustainable tourism practices
Natural tourism resources	Presence of glaciated mountain peaks and waterfalls Presence of *Chir* (Pinusroxburghii) and *Bhojpatra* (Betula utilis) forests Presence of vast stretches of alpine meadows

	Presence of rare and endangered species such as snow leopard
	Abundantly rich and unique biodiversity
Cultural tourism resources	Traditional fair and festivals
	Richness of traditional Bhotia folklores, rituals and customs
	Uniqueness in handicraft products
	Traditional *Chaliya* dance traditions
	Availability of local produce
Physical infrastructure and amenities	Availability of homestays and rest houses
	Mobile network connectivity
	Presence of certified guides
	Willingness of local communities to develop homestay
	Existence and maintenance of trek routes
	Transportation facilities
	Presence of toilets
	Presence of rescue facilities in emergencies
Available utilities and services for tourists	Availability of information centres
	Presence of trained guides
	Information from online sources such as GoU tourism website
	Affordable accommodation facilities
	Presence of tourist information signboards
	Availability of adventure activities (hiking, trekking, mountaineering)
	Ease of obtaining permits for both domestic and international tourists
	Presence of tourist sensitization programmes
Economic growth parameters	Employment opportunities for local community
	Women participation in homestay services
	Opportunities to re-invest gains elsewhere
	Higher product sales during peak tourist season
	Presence of better living conditions
Conservation efforts	State-affiliated schemes on forest, environment and wildlife protection
	Efforts to protect forests through maintaining 'sacred groves'
	Existence of community customs related to conservation
	Presence of strict rules and regulations by *Van Panchayat*
Management and monitoring	Existence of rules and regulations and guidelines for tourists
	Presence of homestay management and welfare society
	Presence of garbage management systems
	Efforts to encourage minimizing of resource utilization
	Adequate decision-making role of local people
	Awareness on heath and hygienic practices among local population
	Awareness on conservation values among local population
	Active role of local social institutions
	Efforts to preserve of local art, culture and traditions

5. Conclusion and a way forward

Uncertainties arising from inevitable forces of globalization and changing climate impact the lives and livelihoods in Himalayan regions, emphasizing the need to explore diverse avenues for adaptation opportunities. Given these uncertainties, our findings validate the potential of ecotourism for economic progress, conservation, and community empowerment in the Darma region. The present study highlights the integration of ecotourism as a supplementary livelihood means within the existing economy. The current research additionally emphasizes on important recommendations for policymakers (Table 11). However, further research is needed using rigorous methodologies to understand the potential of ecotourism for livelihood creation and climate adaptation, while considering community perspectives. This is essentially vital for ecologically fragile regions undergoing changes yet posing varied possibilities for adaptation and subsequently, contribute to the UN SDGs in long run.

Table 11: Recommendations for ecotourism development in Darma valley

Priority areas	Proposed recommendations
Product and strategy development	Appropriate feasibility mapping of ecotourism potential Establishment of eco-trek routes and nature trails Year-round ecotourism planning with diversified products and services Promotion of unique traditional wooden architecture Environmental education for local community and visitors Sustainable use of resources while developing ecotourism services Building cooperation and networking among tour operators and service providers Institutional strengthening of local social institutions Customized tourism strategy based on aspects of sustainable development Inclusion of women in ecotourism services
Infrastructure development	Investment in necessary infrastructure such as sewage, drinking water, sanitation, waste disposal facilities Restoration of religious, archaeological or historical sites Improve appropriate infrastructures such as interpretive signboards, garbage bins, informative center, marked trekking routes Promotion/investment of renewable energy resources
Human resources development	Capacity building and skill development trainings and workshops Guide/homestay hospitality training for host community Special skill training provision for women
Marketing	Creating ecotourism marketing communication channels Creating strategies to encourage responsible visitors' behavior Raising awareness for sustainability and conservation among hosts and tourists Promotion of sustainable ecotourism practices and products Promotion of homestay culture
Education and	Sensitization on natural and cultural values

awareness	Sensitization on heath and hygienic practices Awareness and educational programmes for local communities and visitors Awareness programme on waste management
Safety measures	Regular risk assessments and safety checks Emergency/rescue trainings for tour operators and guides Creating safety guidelines and operating protocols
Monitoring and management	Ensuring ecotourism revenue benefits local community Ensuring all safety norms and procedures are followed Assessment of carrying capacity Regulation and monitoring of tourist inflow Track the socio-economic outcomes (benefit-sharing, employment targets)

References

Açıksöz, S., Cetinkaya, G. C., Uzun, O., Nemutlu, F. E., & Ilke, E.F. (2016). Linkages among ecotourism, landscape and natural resource management, and livelihood diversification in the region of Suğla Lake, Turkey. *International Journal of Sustainable Development & World Ecology*, 23(1), 15–27.

Açıksöz, S., Görmüş, S., & Karadeniz, N. (2010). Determination of ecotourism potential in national parks: Küre Mountains National Park, Kastamonu-Bartın, Turkey. *African Journal of Agricultural Resources, 5*, 589–599.

Agyeman, Y. B. (2019). Ecotourism as an Adaptation Strategy for Mitigating Climate Change Impacts on Local Communities Around Protected Areas in Ghana. In: Leal Filho W. (Eds.), Handbook of Climate Change Resilience (pp. 1-19). Springer, Cham, pp. 537–555.

Amano, T., Sultan, M., & Feseha, M. (2017). Ecotourism development in protected area: the case of Senkele Swayne's Hartebeest Sanctuary (SSHS), West Arsi zone, Oromia Region, Ethiopia. *Journal of Tourism, Hospitality and Sports, 25*, 2312–5187.

Anand, A., Chandan, P., & Singh, R. B. (2012). Homestays at Korzok: Supplementing rural livelihoods and supporting green tourism in the Indian Himalayas. *Mountain Research and Development*, 32(2), 126–136.

Ankrah, D. A., Anum, R., Anaglo, J. N., & Boateng, S. D. (2023). Influence of sustainable livelihood capital on climate variability adaptation strategies. Environmental and Sustainability Indicators, 18, 100233.

Ashley C. R. D., Roe, D., & Goodwin, H. (2001). Pro-poor tourism strategies: making tourism work for the poor-A review of experience. Nottingham, UK.

Balodi, K., N., Naithani, S., Kaur, J., Singh, A., & Chauhan, A. S. (2014). Ecotourism: A sustainable livelihood option for mountainous communities in Uttarkashi, Uttarakhand, India. *Journal of Studies in Dynamics and Change, 1*(8), 320–327.

Basak, D., Bose, A., Roy, S., Chowdhury, I. R., & Sarkar, B. (2021). Understanding sustainable homestay tourism as a driving factor of tourist's satisfaction through structural equation modelling: A case of Darjeeling Himalayan region, India. *Current Research in Environmental Sustainability*, 3, 100098.

Becken, S., & Loehr, J (2022). Tourism governance and enabling drivers for intensifying climate action. *Journal of Sustainable Tourism*, 1–19.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2008). Living in a high mountain border region. The case of the 'Bhotiyas' of the Indo-Chinese border region. *Journal of Mountain Science, 5*, 209–217.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2012). State policy and local performance: pasture use and pastoral practices in the Kumaon Himalaya. Pastoral practices in High Asia: Agency of development effected by modernisation, resettlement, and transformation, 175–194.

Bhalla, P., Coghlan, A. & Bhattacharya, P. (2016). Homestays' contribution to community-based ecotourism in the Himalayan region of India. *Tourism Recreation Research*, 41(2), 213–228.

Bolch, T., Shea, J. M., Liu, S., Azam, F. M., Gao, Y., Gruber, S., ... Racoviteanu, A. (2019). Status and change of the cryosphere in the Extended Hindu Kush Himalaya Region. In Wester, P., Mishra, A., Mukherji, A., Shrestha AB (Eds.), The Hindu Kush Himalaya Assessment: Mountains, climate change, sustainability, and people. Springer, Cham, pp. 209–255.

Boyd, B. W., & Butler, R. W. (1996). Managing eco-tourism: an opportunity spectrum approach, *Tourism Management, 17*(8), 557–566.

Brandt, J. S., Radeloff, V., Allendorf T., Butsic V., & Roopsind A. (2019). Effects of ecotourism on forest loss in the Himalayan biodiversity hotspot based on counterfactual analyses. *Conservation Biolgoy*, 33(6), 1318–1328.

Burneika, D., & Kriaučiknas, E. (2007). Some premises for balanced development of ecotourism on the territory of Lithuania. *Ekologija*, 53.

Cajee, L. (2014). Eco-cultural tourism: a tool for environmental, cultural, and economic sustainability (a case study of Darap Village, West Sikkim). In SHS Web of Conferences (Vol. 12, p. 01029). EDP Sciences.

Chakraborty, P., & Ghosal, S. (2022). Status of mountain-tourism and research in the Indian Himalayan Region: a systematic review. *Asia- Pacifc Journal of Regional Science*, 1–35.

Chambers, R., & Conway, G. R. (1991). Sustainable Rural Livelihoods: Practical concepts for the 21st Century. *IDS Discussion Paper, 296*, 29.

Chan, J.K.L., Marzuki, K.M., & Mohtar, T.M. (2021). Local community participation and responsible tourism practices in ecotourism destination: a case of lower Kinabatangan, Sabah. *Sustainability*, 13, 13302.

Chand, S., Singh, S., Parappurathu, S., Roy, S.D., & Kumar, A. (2015). Explaining the status and scope of ecotourism development for livelihood security in Andaman and Nicobar Islands, India. *International Journal of Sustainable Development & World Ecology, 22*, 335–345.

Chaturvedi, G. (2002). Ecotourism in Gangotri region of the Garhwal Himalayas. *Tourism Recreation Research*, 27(3), 41–51.

Chaudhary, S., Kumar, A., Pramanik, M., & Negi, M. S. (2022). Land evaluation and sustainable development of ecotourism in the Garhwal Himalayan region using geospatial technology and analytical hierarchy process. *Environment, Development and Sustainability*, 1–42.

Chhogyel, N., & Kumar, L. (2018). Climate change and potential impacts on agriculture in Bhutan: a discussion of pertinent issues. *Agriculture & Food Security,* 7, 79.

Clay N. (2018) Integrating livelihoods approaches with research on development and climate change adaptation. *Progress in Development Studies*, 18(1), 1–17.

Dahal, B., K C, A., & Sapkota, R. P. (2020). Environmental impacts of community-based homestay ecotourism in Nepal. The Gaze: *Journal of Tourism and Hospitality*, 11(1), 60–80.

Dalal, N., Joshi, A.M., Soragi, B., Chaudhary, S., Sharma, S., Naidu, S., & Kazmi, Y. (2018). People's perception to climate change in remote Himalayan mountains and rainfall variability in the Kailash Sacred Landscape, India. *Journal of Climatology and Weather Forecasting, 6(2)*, 1–6.

Das, D., & Hussain, I. (2016). Does ecotourism affect economic welfare? Evidence from Kaziranga National Park, India. *Journal of Ecotourism*, 15(3), 241–260.

Datta, D. & Banerji, S. (2015). Local tourism initiative in an eastern Himalayan village: sustainable ecotourism or small-scale nature exploitation? In Szymańska, D. & Rogatka, K. (Eds.), Bulletin of Geography. Socio-economic Series 27, Toruń: Nicolaus Copernicus University, pp. 33–49.

Demir, S., Esbah, H. & AKGÜN, A. A. (2016). Quantitative SWOT analysis for prioritizing ecotourism-planning decisions in protected areas: Igneada case, *International Journal of Sustainable Development & World Ecology, 23*(5), 456–468.

Dendup, N., Tshering, K., & Choda, J. (2022). Community-based btourism as a strategy for building climate resilience in Bhutan. In Haque, A.K.E., Mukhopadhyay, P., Nepal, M., Shammin, M.R. (Eds.), Climate Change and Community Resilience. Springer, Singapore, pp. 387–398.

DFID (1999). Sustainable Livelihoods Guidance Sheets. Department for International Development. London.

District Census Handbook of Pithoragarh (2011). Village and town wise primary census abstract (PCA). Series 6, Part XII-B, Census of India, Uttarakhand.

Gentle, P., & Thwaites, R. (2016). Transhumant pastoralism in the context of socioeconomic and climate change in the mountains of Nepal. *Mountain Research and Development 36*(2), 173–182.

Gerwin, M., & Bergmann, C. (2012). Geopolitical relations and regional restructuring: the case of the Kumaon Himalaya, India. Erdkunde, 91–107.

Gioli, G., Thapa, G., Khan, F., Dasgupta, P., Nathan, D., Chhetri, N., Adhikari, L., Mohanty, S., Aurino, E. & Scott, L. (2019). Understanding and tackling poverty and vulnerability in mountain livelihoods in the Hindu Kush Himalaya. In Wester, P., Mishra, A., Mukherji, A., Shrestha A. B. (Eds.), The Hindu Kush Himalaya Assessment (pp. 421-455). Springer, Cham, pp. 421–455.

Gogoi, J. (2016). Biotourism Potential in Northeast India. In: Purkayastha, J. (Eds.), Bioprospecting of Indigenous Bioresources of North-East India. Springer, Singapore.

Goodwin, H., & Roe, D. (2001). Tourism, livelihoods, and protected areas: Opportunities for Fair-trade Tourism in and Around National Parks. *International journal of tourism research, 3*, 377-391.

Guha, R. (1989). The unquiet woods: ecological change and peasant resistance in the Himalaya. New Delhi: Oxford University Press.

Gurung, D. B., & Seeland, K. (2011). Ecotourism benefits and livelihood improvement for sustainable development in the nature conservation areas of Bhutan. *Sustainable Development,* 19(5), 348–58.

Hall, C. M. (2007). Pro-poor tourism: who benefits? Perspectives on tourism and poverty reduction. Clevedon, UK: Channel View Publications.

Hammill, A., Leclerc, L., Myatt-Hirvonen, O., & Salinas, Z. (2005). Using the sustainable livelihoods approach to reduce vulnerability to climate change. *Tropical forests and adaptation to climate change*, 71.

Hoang, T., & Pulliat. G. (2019). Green for Whom? Exploring Ecotourism as a Climate-Adaptation Strategy in Trang An, Vietnam. In Daniere, A., Garschagen, M. (Eds.), Urban Climate Resilience in Southeast Asia. The Urban Book Series. Springer, Cham, pp. 179–199.

Honey, M. (1999). Ecotourism and Sustainable Development: Who owns paradise? Washington DC. Island Press.

IHD (2018). Uttarakhand: Vision 2030. Department of Planning, Government of Uttarakhand. New Delhi.

IPCC (2022). Climate change 2022: impacts, adaptation, and vulnerability. Contribution of Working Group II to the sixth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.

Jamaliah, M. M., & Powell, R. B. (2018). Ecotourism resilience to climate change in Dana Biosphere Reserve, Jordan. *Journal of Sustainable Tourism*, 26(4), 519–536.

Joshi, S., Jasra, W. A., & Ismail, M. (2013). Herders' perceptions of and responses to climate change in Northern Pakistan. *Environmental Management, 52*, 639–648.

Kala, C. P., & Maikhuri, R. K. (2011). Mitigating people-park conflicts on resource use through ecotourism: A case of the Nanda Devi Biosphere Reserve, Indian Himalaya. *Journal of Mountain Science*, 8(1), 87–95.

KC, A., Ghimire, S., & Dhakal, A. (2021). Ecotourism and its impact on indigenous people and their local environment: case of Ghalegaun and Golaghat of Nepal. *GeoJournal*, 86(6), 2747-2765.

Kim, M., Xie, Y., & Cirella, G. T. (2019). Sustainable transformative economy: Community-based ecotourism. Sustainability, 11(18), 4977.

Krishnan, R., Shrestha, A.B., Ren, G., Rajbhandari, R., Saeed, S. et al. (2019). Unravelling climate change in the Hindu Kush: Rapid warming in the mountains and increasing extremes. In Wester, P., Mishra, A., Mukherji, A., Shrestha, A. (Eds.), The Hindu Kush Himalaya assessment. Springer, Cham, pp. 57–97.

Kuniyal, J. C., Kanwar, N., Bhoj, A.S., Rautela, K. S., Joshi, P., Kumar, K., Sofi, M.S., Bhat, S. U., Rashid, I., Lodhi, M. S., Devi, A., & Singh, H.B. (2021). Climate change impacts on glacier-fed and non-glacier-fed ecosystems of the Indian Himalayan Region: people's perception and adaptive strategies. *Current Science,* 120, 888–899.

Lama, W. B., Jackson, R., Wangchuk, R. (2010). Snow leopards and 'Himalayan Homestays': catalysts for community-based conservation in mountain areas. *Mountain Forum Bulletin*, 10, (1), 25–28.

Ma, B., Cai, Z., Zheng, J., & Wen, Y. (2019). Conservation, ecotourism, poverty, and income inequality–A case study of nature reserves in Qinling, China. *World Development*, 115, 236–244.

Mabon, L., Song Tung, N., Tram, P. T., Tuyet, T. T., Le, H. N., Huong, D. T. T., Ha, H. T. N., Natascha, M. H., & Vertigans, S. (2021). Elaborating a people-centered approach to understanding sustainable livelihoods under climate and environmental change: Thang Binh District, Quang Nam Province, Vietnam. *Sustainability Science*, 16, 221–238.

Mahapatra, P. S., Pandey, R., & Pradhan, S. (2012). River rafting in mountainous regions of Uttarakhand: Impacts, suggested mitigation measures and sustainability. *Journal of Mountain Science*, 9, 511–522

Maikhuri, R. K., Rana, U., Rao, K. S., Nautiyal, S., & Saxena, K. G. (2000). Promoting ecotourism in the buffer zone areas of Nanda Devi Biosphere Reserve: An option to resolve people—policy conflict. *International Journal of Sustainable Development and World Ecology*, 7(4), 333–342.

Maiti, P., Kuniyal, J. C., Sekar, K. C., Satish, K. V., Singh, D., Bisht, N., Kumar, A., Arya, S. C., Nand, M., & Sundriyal, R. C. (2022). Landscape level ecological assessment and eco-restoration strategies for alpine and sub-alpine regions of the Central Himalaya. *Ecological Engineering*, 180, 106674.

Mak, B. K., Cheung, L. T., & Hui, D. L. (2017). Community participation in the decision-making process for sustainable tourism development in rural areas of Hong Kong, China. *Sustainability*, 9(10), 1695.

Mal, S., Mehta, M., Singh, R. B., Schickhoff, U., & Bisht, M. P. S. (2019). Recession and morphological changes of the debris-covered Milam glacier in Gori Ganga Valley, Central Himalaya, India, derived from satellite data. *Frontiers in Environmental Science, 7,* 42.

Mallick, S. K., Rudra, S., & Samanta, R. (2020). Sustainable ecotourism development using SWOT and QSPM approach: A study on Rameswaram, Tamil Nadu. *International Journal of Geoheritage and Parks*, 8(3), 185–193.

McDowell, G., Harris, L., Koppes, M., Price, M. F., Chan, K. M. A., & Lama, D. G. (2020). From needs to action prospects for planned adaptations in high mountain communities. *Climatic Change,* 163(2), 953–972.

Mishra, A. (2017). Changing temperature and rainfall patterns of Uttarakhand. *International Journal of Environmental Sciences and Natural Resources 7*(4).

Montes, J., & Kafley, B. (2022). Ecotourism discourses in Bhutan: contested perceptions and values. *Tourism Geographies*, 24(6-7), 1173–1196.

Negi, V. S., Maikhuri, R. K., & Pharswan, D. (2017). Climate change in the Western Himalaya: People's perception and adaptive strategies. *Journal of Mountain Science, 14*(2), 403–416.

Neupane, R., K. C A, Aryal, M., & Rijal, K. (2021). Status of ecotourism in Nepal: a case of Bhadaure-Tamagi village of Panchase area. *Environment, Development, and Sustainability*, 23, 15897–15920.

Newton, J., & Franklin, A. (2011). Delivering sustainable communities in China: using a sustainable livelihoods framework for reviewing the promotion of "ecotourism" in Anji. *Local Environment, 16*(8), 789–806.

NITI Aayog (2018). Sustainable tourism in the Indian Himalayan contributing to sustainable development in Indian Himalayan region. Report of Working Group II. NITI Aayog, Government of India.

OECD (2020). OECD Tourism Trends and Policies 2020, OECD Publishing, Paris.

Ogara, O. W., Seneiya, J. O., Ongoro, E. B. (2013). Community based conservation and ecotourism as an environmental management practice for climate change adaptation in Ewaso Nyiro arid land ecosystem, Samburu County Kenya. *Journal of Environmental Science and Water Resources,* 2(4), 106–111.

Ogra, M. V., & Badola, R. (2015). Gender and climate change in the Indian Himalayas: global threats, local vulnerabilities, and livelihood diversification at the Nanda Devi Biosphere Reserve. *Earth System Dynamics, 6*, 505–523.

Pandey, A., Pradhan, N., Chaudhari, S., & Ghate, R. (2017). Withering of traditional institutions? An institutional analysis of the decline of migratory pastoralism in the rangelands of the Kailash Sacred Landscape, western Himalayas. *Environmental Sociology, 3*(1), 87–100.

Pathak, S., Pant, L., & Maharjan, A. (2017). De-population trends, patterns and effects in Uttarakhand, India – A gateway to Kailash Mansarovar. ICIMOD Working Paper 2017/22. Kathmandu: ICIMOD.

Rastogi, A., Hickey, G. M., Anand, A., Badola, R., & Hussain, S. A. (2015). Wildlife-tourism, local communities, and tiger conservation: A village-level study in Corbett Tiger Reserve, India. *Forest Policy and Economics*, 61, 11–19.

Rautela, P., & Karki, B. (2015). Impact of climate change on life and livelihood of indigenous people of higher Himalayan Uttarakhand, India. *American Journal of Environmental Protection, 3*(4), 112–124.

Rawat, D., & Schickhoff, U. (2022). Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India. In Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Springer, Cham, pp. 429–447.

Ren, Y.Y., Ren, G.Y., Sun, X.B., Shrestha, A.B., You, Q.L. et al. (2017). Observed changes in surface air temperature and precipitation in the Hindu Kush Himalayan region over the last 100-plus years. *Advances in Climate Change Research, 8*, 148–156.

Rinzin, C., Vermeulen, W. J. V., & Glasbergen, P. (2007). Ecotourism as a mechanism for sustainable development: the case of Bhutan. *Environmental Sciences, 4*(2), 109–125.

Roy, T. (2003). Changes in wool production and usage in colonial India. Modern Asian Studies, 37 (2), 257–286.

Sahani, N. (2021). Application of hybrid SWOT-AHP-FuzzyAHP model for formulation and prioritization of ecotourism strategies in Western Himalaya, India. *International Journal of Geoheritage and Parks*, 9(3), 349–362.

Salgueiro, J., Barbieri, E., Morgado, F. (2020). Climate change and ecotourism in the Context of the 2030 Agenda for sustainable development. In Leal Filho, W., Azul, A., Brandli, L., Özuyar, P., & Wall, T. (Eds.), Sustainable cities and communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham, pp. 81–90.

Sarkar, R., & Sinha, A. (2015). The village as a social entrepreneur: Balancing conservation and livelihoods. *Tourism Management Perspectives*, 16, 100–106.

Schickhoff, U. & Mal, S. (2020): Current changes in alpine ecosystems of Asia. In: Goldstein, M.I. & DellaSala, D.A. (Eds.), Encyclopedia of the World's Biomes, Vol. 1, Elsevier, Amsterdam, pp. 589–598.

Schickhoff, U., Bobrowski, M., Mal, S., Schwab, N. & Singh, R.B. (2022). The world's mountains in the Anthropocene. In Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Springer, Cham, pp. 1–144.

Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. IDS Working Paper 72, Institute of Development Studies, Brighton.

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, 36, 171–96.

Scott, D. (2011). Why sustainable tourism must address climate change. *Journal of Sustainable Tourism, 19*(1), 17–34

Scott, D., Hall, C. M., & Gössling, S. (2019). Global tourism vulnerability to climate change. *Annals of Tourism Research*, 77, 49–61

Serenari, C., Peterson, M. N., Wallace, T., & Stowhas, P. (2017). Private protected areas, ecotourism development and impacts on local people's well-being: a review from case studies in Southern Chile. *Journal of Sustainable Tourism, 25*(12), 1792–1810.

Shi, H., Zhang, L., Song, B., & He, C. (2022). The impact of ecotourism on local rural households' livelihood around Wolong Nature Reserve. *Forestry Economics Review,* 4(1), 2–18.

Siddiqui, T., Bhagat, R. B., Banerjee, S., Liu, C., Sijapati, B., Memon, R., Thinley, P., Ito, M., Nemat, O., & Arif, G. (2019). Migration in the Hindu Kush Himalaya: Drivers, consequences, and governance. In Wester, P., Mishra, A., Mukherji, A., Shrestha A. B. (Eds.), The Hindu Kush Himalaya Assessment. Springer, Cham, pp. 517–544.

Singh, A. P., & Sondhi, S. (2016). Butterflies of Garhwal, Uttarakhand, western Himalaya, India. *Journal of Threatened Taxa*, 8(4), 8666–8697.

Singh, R., Sharma, R.K., Bhutia, T.U., Bhutia, K.S., & Babu, S.C. (2021). Conservation Policies, Eco-Tourism, and End of Pastoralism in Indian Himalaya? Frontiers in Sustainable Food Systems. 5:613998.

Singh, T. V., & Singh, S. (2004). On bringing people and park together through ecotourism: The Nanda Devi National Park, India. *Asia Pacific Journal of Tourism Research*, 9(1), 43–55.

Steinicke, E., & Neuburger, M. (2012). The impact of community-based agro-alpine tourism on regional development. Case study Mt. Kenya. *Mountain Research and Development, 32*(4), 420–430

Tao, T. C. H., & Wall, G. (2009). Tourism as a sustainable livelihood strategy. Tourism Management 30(1): 90–98.

TERI (2019). Tourism baseline study for SECURE Himalaya project landscapes in Uttarakhand. Draft Report 2019. Submitted to UNDP. The Energy and Resources Institute.

Tiwari, K. R., Sitaula, B. K., Bajracharya, R. M., Raut, N., Bhusal, P., & Senegal, M. (2020). Vulnerability of pastoralism: A case study from the high mountains of Nepal. *Sustainability, 12*(7), 2737.

Tyagi, N., Jayal, T., Singh, M., Mandwal, V., Saini, A., Nirbhav, Sahu, N., & Nayak, S. (2022). Evaluation of observed and future climate change projection for Uttarakhand, India, using CORDEX-SA. *Atmosphere*, 13, 947.

UNDP (2017). Guidance notes for the application of the Sustainable Livelihoods Framework in development projects. United Nations Development Programme.

United Nations (2020). The Sustainable Development Goals Report 2020. UN, New York.

UNWTO (2004). Indicators of sustainable development for tourism destinations: A guidebook. World Tourism Organization.

Upadhaya, S., Tiwari, S., Poudyal, B., Chhetri, S. G., & Dhungana, N. (2022). Local people's perception of the impacts and importance of ecotourism in Central Nepal. PLoS One, 17(5), e0268637.

Upadhyay, H., Vinke, K., Bhardwaj, S., Becker, M., Irfan, M., George, N. B., Biella, R., Arumugam, P., Murki, S. K., & Paoletti, E. (2021). Locked houses, fallow lands: climate change and migration in Uttarakhand, India. Potsdam Institute for Climate Impact Research (PIK), Potsdam and The Energy and Resources Institute (Teri), New Delhi.

Uttarakhand Tourism Statistics (2015). Tourism Corporation of Uttarakhand, Dehradun. India

Vannelli, K., Hampton, M. P., Namgail, T., & Black, S. A. (2019). Community participation in ecotourism and its effect on local perceptions of snow leopard (Panthera uncia) conservation. *Human Dimensions of Wildlife*, 24(2), 180–193.

Walter, P., Regmi, K. D., & Khanal, P. R. (2018). Host learning in community-based ecotourism in Nepal: The case of Sirubari and Ghalegaun homestays. *Tourism Management Perspectives*, 26, 49–58.

Zielinski, S. Jeong, Y., & Milanés, C. B. (2020). Factors that influence community-based tourism (CBT) in developing and developed countries. *Tourism Geographies, 23*(5-6), 1040–1072

Zomer, R. J., Trabucco, A., Metzger, M. J., Wang, M., Oli, K. P., & Xu, J. (2014). Projected climate change impacts on spatial distribution of bioclimatic zones and ecoregions within the Kailash Sacred Landscape of China, India. Nepal. *Climatic change, 125*(3-4), 445–460.

Žurovec, O., & Vedeld, P. O. (2019). Rural livelihoods and climate change adaptation in laggard transitional economies: a case from Bosnia and Herzegovina. *Sustainability*, 11(21), 6079.

Study 3

‘Exploring the integration of entrepreneurial ascendency into ecotourism development for livelihood adaptation’

Authors: Deepika Rawat and Martina Neuburger

Exploring the integration of entrepreneurship into ecotourism development for livelihood adaptation

Deepika Rawat[1] and Martina Neuburger[2]

Abstract

The intertwined, multifaceted, and profound repercussions arising from the interplay of rapid urbanization, globalization and climate change have substantially reshaped the socio-economic and environmental dynamics within the Indian Himalayan Region (IHR). Despite such challenges, the region harbors bolstering avenues for diversifying livelihoods. In Uttarakhand, tourism assumes a central role as a significant economic pursuit, exerting the highest impact on the state's Gross Domestic Product (GDP). Despite the prominent ascent of the tourism sector, including ecotourism in the state, it remains unclear how locally placed small-scale rural businesses who are deemed to be fostering local leadership, capture, commodify and deliver value creation inherent within their business operations. To address this knowledge gap, the present study seeks to furnish a comprehensive understanding of the linkages between ecotourism development and entrepreneurship as a developmental approach to address ongoing challenges. Acknowledging the role of formalized business models in expediting entrepreneurial ascendancy to achieve transformative changes, the exploratory nature of the current feasibility study strives to construct a prototype Sustainable Business Model Canvas (SBMC) for a prospective ecotourism enterprise in Darma valley, Uttarakhand. Additionally, this study also advocates for the widespread implementation of sustainable business models, as envisioned through the lens of the solidarity paradigm, commissioning their use in redesigning and reconfiguring tourism arrangements to be better able to respond to socio-economic and climate-induced risks.

Keywords: Social business model canvas (SBMC), solidarity economy, sustainable livelihoods, livelihood diversification, Uttarakhand, Indian Himalayan Region

1. Introduction

As one of the fastest-growing economic sectors globally, tourism yields significant contributions to economic expansion, particularly in developing economies (OECD 2020), thereby constituting 10.2% of the global Gross Domestic Product (GDP) (WTTC 2017). According to UNWTO (2018), the volume of international tourist arrivals is projected to experience an annual growth rate of 3.3% between 2010 and 2030, eventually surging to 1.8 billion arrivals by 2030. Despite recording exuberant growth, the tourism sector is faced with evident challenges including inevitable adversities posed by the climate crisis (Salgueiro et al. 2020; Scott 2021; Becken & Loehr 2022), political instability and pandemic risks (Mulder 2020; Wang et al. 2022), amongst others. Regardless, tourism continues to serve as a significant supplementary source of sustenance, integrated within the existing economy of marginalized communities, particularly in developing economies (Tao & Wall 2009). This is

primarily because tourism-generated revenues often contribute merely to supplemental income, mainly attributable to the sector's highly seasonal nature and its tendency to offer low-wage employment opportunities (Kim et al. 2019). Against this backdrop, the traditional agricultural and pastoral livelihoods of rural communities in the Indian Himalayan Region (IHR) currently grapple with a myriad of transformations amidst the backdrop of contemporary globalization and shifting climatic conditions (Schickhoff & Mal 2020; Tiwari et al. 2020; Namgay et al. 2021; Rawat & Schickhoff 2022). In order to confront the escalating challenges, strategies for adaptation often advocate for a transition towards non-pastoral livelihoods capable of offering alternative sources of income and employment, thereby enhancing the overall socio-economic conditions (Gioli et al. 2019).

Despite these formidable obstacles, tourism has emerged as a burgeoning sector within the Indian Himalayan Region (IHR), projecting an average annual growth rate of 7.9% from 2013 to 2023 (NITI Aayog 2018a). Similarly, in the state of Uttarakhand in the Indian Himalayas, where 71% of the population relies on rain-fed agriculture, the region is susceptible to the impacts of current and projected climate changes on water availability and agricultural productivity (Kuniyal et al. 2021; Upadhyay et al. 2021), consequently reshaping the socio-economic dynamics and presenting new prospects for diversified livelihoods (Ogra & Badola 2015; Rautela &Karki 2015; Negi et al. 2017; Pandey et al. 2017a; Bhattacharjee et al. 2018; NITI Aayog 2018a; TERI 2019). Despite this, tourism emerges as a prominent economic activity and a significant source of livelihood, making the highest contribution to the state's GDP (NITI Aayog 2018a), and generating over 40% of revenue through diverse forms such as cultural, spiritual, ecotourism, and adventure tourism (Uttarakhand Tourism Statistics 2015). At the same time, the susceptibility of the tourism sector to climate impacts (Scott et al. 2019; Scott 2021) prescribes embedding of sustainable tourism practices in developmental scenarios that are of critical importance for attaining maximum profits and significantly mitigating adverse outcomes within the scope of transformational system changes in the tourism industry (Higham & Millar 2018). In alignment with this, the recent global shift towards sustainable paradigms, as exemplified by the United Nations Sustainable Development Goals (SDGs), underscores the substantial potential of well-managed tourism to expedite progress, particularly in terms of job creation, poverty reduction, and environmental preservation (UNWTO 2017), contingent upon critical investments in sustainable tourism development (OECD 2020) and systemic adaptation endeavors (IPCC 2022).

In this sense, as a form of sustainable tourism, ecotourism is a growing niche market encompassing the acknowledgement to sustainable tourism products and services that cater to economic, social and environmental aspects of society, provided that trade-offs are appropriately managed. Demonstrating promising potential to enhance adaptive capacity and resilience, ecotourism's efficacy as an adaptation strategy in diversifying household livelihoods has yielded positive implications for vulnerable communities, particularly in the Global South (Ogara et al. 2013; Ogra & Badola 2015; Jamaliah & Powell 2018; Hoang & Pulliat 2019; Agyeman 2019; Dendup et al. 2022). Similarly, the development of other forms of sustainable tourism initiatives as adaptive responses to the combined pressures of climate variability, urbanization, and globalization has

also been investigated (Little & Blau 2018; Trang & Loc 2022). At its essence, ecotourism fundamentally seeks to establish a harmonious connection between environmental objectives (such as biodiversity conservation and sustainable utilization of natural resources), social goals (including the preservation of traditional culture, customs, and lifestyle), and economic development (encompassing job creation, livelihood diversification, and financial security), mirroring the principles underpinning the concept of sustainable development (Chand et al. 2015; Açıksöz et al. 2016).

In the state of Uttarakhand, ecotourism has been recognized as a suitable framework for fostering nature-based tourism (NITI Aayog 2018a). This is manifested through the establishment of the Ecotourism Development Corporation Uttarakhand (ETDC) in 2017, which serves as an institutionalized platform for implementing ecotourism practices. Additionally, the Uttarakhand Tourism Master Plan 2007-2022 outlines explicit strategies for the development of ecotourism in the state. Despite the extensive recognition of ecotourism's capacity to bolster the local economy, Uttarakhand has thus far lacked a comprehensive ecotourism policy, apart from the scrutinized draft of the Uttarakhand Ecotourism Policy 2020. The aforementioned policy draft is fraught with inherent issues, particularly concerning the expansive allocation of forested areas for ecotourism purposes, and is primarily influenced by the state tourism department, with limited consideration for the forest department's perspective. On the contrary, it acknowledges the potential for entrepreneurial endeavors that enable the active involvement of local communities in the sustainable planning and management of ecotourism enterprises. Even so, as evident from state tourism policies and master plans, the industry remains largely unregulated (Kotru et al. 2017; Uttarakhand Tourism Policy 2018; RDMC 2018; Sati 2020) and lacks comprehensive business models and investments that effectively address the prevailing global challenges and adapt to changing circumstances changes (NITI Aayog 2018a). This deficiency is particularly evident in remote areas, which fail to adequately benefit from the current management practices of the tourism industry within the state.

Of late, quite evidently entrepreneurial development in varied tourism sub-sectors is surfacing progressively, emulsifying its relatedness with the aspects of sustainability (Kasalak et al. 2016; Laeis & Lemke 2016; Sheldon et al. 2017; Day & Mody 2017; DeLange & Dodds, 2017; Buzinde et al. 2017; Wang et al. 2021; Aquino et al. 2021; Kummitha et al. 2021) though, is still in its inception with finite case study research and limited entrepreneurial tourism business models research (Reinhold et al. 2017; Sahebalzamani & Bertella 2018; Galardi et al. 2022). It is imperative to acknowledge that, in practice, ecotourism as a market segment primarily operates under the purview of small and medium-sized enterprises situated within naturally abundant landscapes (Chang, 2011), though often confronting with a myriad of challenges that may hinder their growth and sustainability (Yoshino & Taghizadeh-Hesary 2016). These challenges encompass limited market access, financial constraints, technological and infrastructural deficiencies, as well as a dearth of knowledge and skills. In order to alleviate these obstacles, the adoption of sustainable business models often affords small enterprises in rural regions the prospect of cultivating value generation for local communities, thereby simultaneously advancing environmental stewardship and

resilience (Galardi et al. 2022). In light of this, the recent directives set forth in the National Strategy for Ecotourism and National Strategy on Sustainable Tourism, developed by the Ministry of Tourism, Government of India (2022), emphasize the imperative provision of essential assistance to Micro, Small, and Medium Enterprises (MSMEs) in terms of funding initiatives, training programs, marketing strategies, and other essential enterprise requisites. These measures further entail the establishment of national and state resource centers, aimed at enabling local communities to attain a greater share of profits. The MSMEs sector in Uttarakhand, known as the 'nursery of entrepreneurship,' manifests a crucial role in job creation with low capital investment and sustainable utilization of local resources in the tourism sector (IHD 2018). In line with recent endeavors undertaken by the state government under the Uttarakhand Tourism Policy of 2018, MSMEs in Uttarakhand, including those operating in the tourism sector, have been granted investment incentives, along with exemptions and benefits facilitated through government subsidies. These incentives also acknowledge the provision of additional support to women and youth entrepreneurs, aiming to bolster rural business enterprises and foster alternative livelihood sources in a concerted effort to mitigate rates of out-migration in the state.

In continuation, within an entrepreneurial framework, particularly in rural environments, the advancement of products and services is frequently stimulated by a shared and inclusive inclination that conforms to the tenets of cooperation, solidarity, ethics, equity, and self-governance, thereby simultaneously aiming to ensure sustainability in business undertakings (UNIDO 2017). In essence, when situated within a localized context, this compelling sense of collective unity and decision-making autonomy fundamentally propel the adoption of sustainable grassroots initiatives, thereby amplifying their overall influence and impact (Morais & Bacic 2020). Indeed, it becomes necessary to pay attention to the inherent triad aspects of sustainability while developing business growth models that go beyond exploitative, mainstream and traditional form of economic attainment, and instead remain embedded in the basic principles of solidarity economy, particularly in rural and vulnerable areas (UNTFSSE 2014). This is because, enterprises that are rooted in solidarity needs and values focus on overall socio-cultural and economic inclusion to ensure that marginalized communities have access to necessary resources and support to navigate environmental stressors.

Along the same lines, Doğan (2021) emphasized that rural tourism, for instance, in forms of agrotourism, nature-based, and ecotourism, has transformative potential for fostering a solidaristic, cooperative and sustainable mindset among locals and visitors. The author additionally emphasized the significance of integrating principles of solidarity into the processes of tourism planning and development. Likewise, in their empirical investigation into the impact of community-based tourism on the promotion of solidarity practices, Forero and Saavedra (2022) discovered that communities are progressively pursuing avenues for income diversification, which often result in the realization of their territorial connectedness and cultural identity. This realization, in turn, motivates their active engagement in collective approaches to income generation and the equitable distribution of profits. Nevertheless, certain potential constraints associated with the solidarity paradigm remain inadequately investigated, including the

intricacies of reconciling solidarity principles with the economic exigencies inherent in the tourism industry. Moreover, despite the intuitive interconnectedness between sustainable tourism business models and the solidarity economy, a comprehensive comprehension of their interdependencies remains under-researched (UNTFSSE 2014).

In this trajectory, we acknowledge the scholarly dearth in investigations delving into the integration of entrepreneurship concepts and sustainable business models that have the potential to foster the realization of ecotourism, specifically in Uttarakhand. Consequently, the primary objective of the present study is to underscore the significance of prioritizing the utilization of Sustainable Business Models (SBMs) for the advancement of ecotourism in the naturally and culturally resource rich regions in IHR. In pursuit of this objective, the exploratory nature of this study puts forth a prospective prototype for a potential rural ecotourism enterprise in IHR region of Darma valley in Uttarakhand, while aligning with the sustainable business model canvas (SBMC) developed by Osterwalder and Pigneur (2010).

Furthermore, this study endeavors to foster an integrated consideration of the principles encompassing the solidarity economy, with an aim of ensuring that the proposed prototype aligns harmoniously with the solidarity values and ideals. The foundation of this study is rooted in prior research conducted in the region (Rawat & Schickhoff 2022; Rawat et al., in press), which shed light on the evolving socio-economic and climatic conditions and underscored the imperative for alternative livelihood adaptation strategies for the local community in Darma region. Acknowledging the paucity of research that establishes connections between entrepreneurship ascendency and adaptation to sustainable livelihoods in the Indian context, particularly in Uttarakhand, the present study serves as a starting point for future research endeavors, facilitating the development and exploration of pathways for socio-economic and environmental value creation within the tourism sector.

2. Literature review

2.1. Business models in tourism context

Globally, entrepreneurship has garnered significant recognition as a catalyst for transformative change, with its crucial role in generating employment opportunities, driving economic growth and innovation, enhancing social conditions, and addressing social and environmental challenges, thereby making substantial contributions towards achieving the Sustainable Development Goals (UNCTAD 2017). In recent years, the concept of social entrepreneurship, which emanates from the broader field of entrepreneurship, has been progressively gaining momentum in both theoretical discourse and practical applications within the domain of tourism studies (DeLange & Dodds 2017; Wang et al. 2021; Aquino et al. 2021), including in ecotourism discourse (Kasalak et al. 2016; Day & Mody 2017; Murphy et al. 2017; Kummitha et al. 2021) and its contribution to sustainable livelihood creation (Laeis & Lemke 2016). The concept entails recognizing and developing innovative and SBMs for creating discernible positive social impact and community development (Kummitha et al. 2021)

whilst delivering the key principles of sustainable development (UNCTAD 2017). Contrary to the conventional profit-driven approach to entrepreneurship, social entrepreneurship centers on value creation driven by a social purpose, operating within interconnected collaborative networks and market dynamics, thereby playing a pivotal role in advancing sustainability transitions (Buzinde et al. 2017; UNCTAD 2017). Moreover, it has demonstrated itself as a valuable and irreplaceable means for achieving economic sustainability and environmental preservation, offering innovative pathways to attain sustainable community development (Laeis & Lemke 2016; Murphy et al. 2017; Sheldon et al. 2017; Aquino et al. 2021), notably in low-income and developing countries (Dahles et al. 2020).

Conversely, it is irrefutably evident that social entrepreneurial endeavors facilitate holistic societal transformation, particularly in empowering women within diverse social contexts (Kimbu & Ngoasong 2016; Akinbami 2021). However, the effective integration of social development, environmental stewardship, and financial objectives in order to generate value for stakeholders is intrinsically tied to the success of tourism social enterprises, often contingent upon the applicability of relevant business model constructs (Daniele & Quezada 2017; Reinhold et al. 2017; Murphy & Harwood 2017; Scherrer 2020; Rosato et al. 2021; Szromek 2021; Galardi et al. 2022). Numerous scholarly investigations have advanced the conceptualization of business model formulation by incorporating sustainability-driven elements. For instance, the triple layer business model canvas (Joyce & Paquin 2016) and Sustainable Business Model Canvas (SBMC) (Basile et al. 2021), adapted from the original business canvas developed by Osterwalder and Pigneur (2010). Furthermore, the relevance of business models has been widely recognized across multiple disciplines (Osterwalder & Pigneur 2010) and within the purview of developing adaptation practices in the local context (Burch & Di Bella 2021; Akinbami 2021).

In spite of its infancy, entrepreneurial tourism business models remain an intriguing area of research among researchers (Daniele & Quezada 2017; Reinhold et al. 2017; Sahebalzamani & Bertella 2018). Previous investigations have demonstrated that promoting the adoption of SBMs may significantly enhance an enterprise's capacity to address critical societal concerns, including poverty alleviation, unemployment, social inclusivity, skill development, gender inequality, and environmental sustainability within the target communities (Daniele & Quezada 2017; Murphy & Harwood 2017; Dahles et al. 2020; Scherrer 2020). The emergence of this imperative transition stems from the prevailing profit-centric business models that place greater emphasis on the priorities of large corporations, often disregarding the needs and aspirations of local communities. Consequently, this approach engenders deleterious practices such as resource overexploitation, environmental pollution, and the displacement of indigenous communities.

While there is no doubt that SBMs are crucial for the long-term sustainability of the tourism industry, their scalability to encompass larger operations poses challenges, thereby impeding their capacity to exert a substantial influence on the industry as a whole (Baldegger 2020). Furthermore, their implementation may entail higher costs, rendering them less attainable for smaller enterprises and poor communities. Although

their development places emphasis on community involvement and the engagement of various stakeholders, critiques suggest that these models may not adequately encompass inclusivity, potentially disregarding the diverse needs and aspirations of all stakeholders (Schoneveld 2020).

In sum, while their significance within the tourism sector is widely acknowledged, hurdles pertaining to implementation and widespread adoption persist. Addressing these challenges necessitates a collaborative endeavor involving all stakeholders in the tourism industry, encompassing businesses, investors, regulatory bodies, consumers and beneficiaries.

2.2. Solidarity economy paradigm and tourism

Solidarity economy (SE) represents a distinctive economic framework that upholds the principles of social and environmental sustainability, prioritizing them over the pursuit of profit maximization (Doğan 2021). As elucidated by Sahakian and Dunand (2015), SE underscores the significance of locally rooted economic endeavors that emphasize collective ownership, democratic decision-making processes, and the fulfillment of social and environmental obligations. These objectives are commonly pursued through community-centric ownership structures, including cooperatives, mutual benefit societies, social enterprises, and foundations (Vargas Vasserot 2023).

From an entrepreneurial standpoint, the notion of solidarity economy encompasses the creation of goods and services propelled by a shared and overarching interest, while steadfastly upholding principles of cooperation, solidarity, ethics, self-governance, and operational sustainability (UNIDO 2017). In a similar vein, Esteves et al. (2021) advocate for the promotion of local entrepreneurship rooted in solidarity economy, with a particular emphasis on enterprises owned and operated by marginalized communities. One approach to realize this objective, as suggested by Bailey et al. (2018), involves the establishment of Community-Based Social Enterprises (CBSEs), which are managed exclusively by the "local community" within a specific "geographical area," utilizing "locally accessible and procured resources." Expanding on this, Haarmann and Haarmann (2011) assert that guided by principles of democracy, transparent decision-making, egalitarianism, and non-hierarchical structures, the solidarity economy endeavors to foster reciprocal, equitable, cooperative, and mutually advantageous relationships in the domains of production, distribution, consumption, and financing.

The solidarity model, according to Utting (2015), exhibits a distinctive approach to sustainable development for the productive transversal reconstruction of communities, encompassing economic well-being, and establishing business amid the emerging intersection of multilevel crisis of economic upheaval, emerging inequalities, and climate change, all of which are inherent to achieving UN SDGs. This is because as a multifaceted concept, SE model is laid out with emancipatory objectives of participatory governance and collective actions at various levels, serving as a mechanism for promoting social and environmental justice (UNTFSSE 2014), most times, displaying clear synergy with the SDGs (Villalba-Eguiluz et al. 2020).

Doğan (2021) further explicated the view that a significant opportunity for tourism development in rural areas exists for the development of a solidarity-based and sustainable ethos among the local community and visitors. The author further expounded on the recognition of the solidarity paradigm as a tool for driving transformative change and facilitating holistic development. However, the firm objectives set forth by SE often remain elusive under certain pretenses. For instance, Avagianou et al. (2022) discovered that the social economy sector in southern European countries, as examined in their investigation, holds significant promise in terms of its potential to generate employment opportunities and promote social inclusion. Nevertheless, it also confronts various challenges, including limited access to funding and resources, inadequate institutional support, and a lack of visibility and acknowledgment at both national and European levels.

In another scenario, SE enterprises, given their divergence from conventional investment models, frequently find themselves compelled to engage with markets in order to ensure economic viability (Avagianou et al. 2022). In conclusion, the incorporation of solidarity economy concepts and the development of sustainable business models appear as an intriguing possibility to advance livelihood diversification in rural settings. Realizing this potential necessitates additional scholarly research and the cultivation of collaborative endeavors among various stakeholders, with the intention of delving into and enacting innovative strategies that harness the inherent potency of solidarity and sustainability, ultimately improving the well-being and long-term prosperity of rural populations.

3. Study area

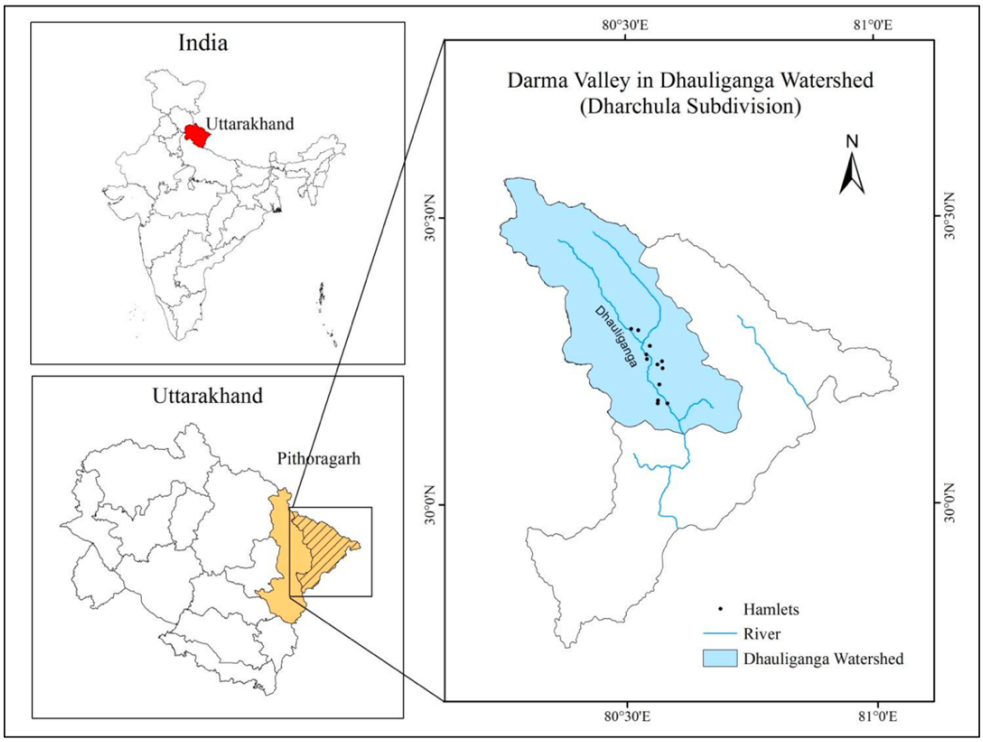


Figure 1: Location of study area (Rawat & Schickhoff 2022)

Situated in the enchanting expanse, the Darma valley lies in proximity to the Byans and Chaudans valleys, within the Kailash Sacred Landscape (KSL) region, in Dharchula subdivision of Pithoragarh district, Uttarakhand (Fig. 1). Bordered by Nepal to the East and Tibet to the North, this valley serves as the dwelling place for semi-nomadic agro-pastoralists known as *Bhotias*, who engage in a combination of agricultural pursuits, which encompass the amalgamation of animal husbandry, crop cultivation, and forestry activities (Bergmann et al. 2008; 2012). Bhotias inhabit 12 villages in the valley, namely, Sela, Chal, Nagling, Baling, Dugtu, Dantu, Go, Philam, Bon, Tidang, Marcha and Sipu. The Bhotias residing in Darma valley, along with their counterparts in Byans and Chaudans valley, self-identify as part of the *Rung-Shaukas* sub-tribe group, belonging to the Tibetan-Burman language family. While their primary language is Darmani or Darmiya, they exhibit multilingual proficiency in Hindi, Nepali, and *Pahari* (Willis 2007). During the onset of winter season, typically in the beginning of October and November, they undertake migratory movements to lower altitudes in the vicinity of the town of Dharchula, only to return to the valley during the summer season in late March or early April. With this seasonal ascent, Bhotias sow their crops, ensuring a bountiful harvest that reaches maturity by the conclusion of September.

Historically, the primary source of sustenance for the Bhotias relied on cross-border trade with Tibet, which constituted their predominant means of livelihood until the Indo-China war of 1962. Subsequently, the cessation of such trade activities triggered significant shifts in the socio-economic dynamics of the region. Concurrently, political instabilities, instructional reforms, globalization and rapid urbanization, in conjunction with environmental challenges, notably climate change, resulted in the outmigration trends (especially among men) and consequent decline of traditional transhumant livelihood practices (Pandey et al. 2017b; Rawat & Schickhoff 2022). Additionally, over time, the Bhotias underwent a transition towards alternative livelihood strategies in the area, encompassing wage labor, tourism-related occupations such as tour guides and porters, and the collection of valuable medicinal and aromatic plants (MAPs), including the esteemed Caterpillar Fungus (Ophiocordyceps Sinensis), locally referred to as Keedajadi (Rawat & Schickhoff 2022).

In the contemporary times, as traditional practices wane and livestock numbers continue to diminish, Bhotias commonly employ the services of a communal shepherd, locally referred to as *Anwal*, who guides the livestock to higher pastures, thereby affording the villagers the opportunity to pursue a range of livelihood alternatives. Furthermore, the current trend indicates a decrease in the number of households partaking in the annual migration, and those who still undertake the journey are predominantly involved in wage labor, collection of MAPs, the provision of tourism-related services, the operation of homestays, and the establishment of small-scale enterprises.

Despite its remarkable topography, abundant cultural resources, and immense potential for ecotourism, the Darma landscape has not yet gained widespread recognition as a preferred destination for nature and adventure enthusiasts. The valley boasts with diverse varied and diverse landscapes, ranging from alpine meadows, groves, forests, waterfalls to glaciers. The region is also home to a wide variety of flora and fauna,

including rare and endangered species such as the snow leopard, blue sheep, and Himalayan musk deer.

Conversely, the local Bhotia community's cultural practices, ethos, and values are unparalleled in their uniqueness and richness. The indigenous knowledge systems prevalent in this region are intricately interconnected with the surrounding natural environment, grounded in a profound comprehension of the local ecology and its intricate interactions with human societies. The breadth of this knowledge is extensive, covering aspects of ecological insights, resource use practices, conservation techniques, ethnomedicine knowledge, and craftsmanship. For instance, the institution of sacred forests locally known as *Shingul* and Se *Roa* serves as prominent mechanisms of biodiversity conservation and natural resource management in the region.

For a considerable period of time, the region's tourism potential remained largely unrecognized, but in recent years, there has been a modest upswing i n the arrival of tourists in recent years. This trend can be attributed, at least in part, to the implementation of an innovative community-based homestay initiative by the Kumaon Mandal Vikas Nigam (KMVN) since 2017, which has garnered significant support from the local community in the valley. KMVN, a government enterprise of Uttarakhand, plays a pivotal role in fostering tourism development, employment generation, and sustainable community advancement in the Kumaon region of the state. Currently, there are more than 190 officially registered homestays in the area, overseen by the Panchachuli Homestay Owners Welfare Society. To date, the homestay initiative has demonstrated commendable achievements in enhancing the agency of community members, with a specific emphasis on women who have emerged as pivotal agents in augmenting the collective household income. The significant participation of women in leadership roles within the realm of homestay-centered ecotourism services has likewise been extensively substantiated in other parts of IHR (Anand et al. 2012; Ogra & Badola 2015; Bhalla et al. 2016).

Simultaneously, the proliferation of the homestay culture has opened up avenues for indigenous small-scale tourism enterprises, exemplified by ventures such as The Himalayan Bluesheep, The Mountain Ride, and The Himalayan Goats, which are spearheaded by local Bhotia youth collectives. Notably, these enterprises have expanded their scope to encompass alpine adventure pursuits during the winter season. While these businesses are recognized for their contribution to nurturing local leadership, a conspicuous gap lies in their understanding of how they capture, commodify, and generate value through their business operations. The absence of formalized business models and the limited knowledge surrounding them have created a significant knowledge gap in this regard.

That said, in light of emerging challenges and alternative trajectories of development, the Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI), an integrated transboundary program initiated by the International Centre for Integrated Mountain Development (ICIMOD), endeavors to promote both conservation and development in the KSL regions spanning China, India, and Nepal. With the objective of enhancing resilience among mountain communities, the KSLCDI seeks to harness

the potential of successful ecotourism ventures, while integrating their significance into the regional conservation and development strategy. Additionally, the initiative aims to foster entrepreneurship in the region, with a particular focus on empowering women and youth (Kotru et al. 2017). So far, these endeavors have achieved modest accomplishments in establishing confidence among communities in cross-border cooperation and capturing the essence of cultural interchange and the potential of ecotourism. Nevertheless, the efficacy of sustainable tourism, specifically ecotourism, in mitigating the susceptibility of communities to socio-economic and climate change impacts and ameliorating poverty remains largely unexplored in terms of viable developmental trajectories in Uttarakhand (Rawat et al., in press). Moreover, it is crucial to investigate whether the expansion of such initiatives may inadvertently exacerbate disparities within local communities. This arises from the realization that certain groups endowed with superior resource accessibility are more likely to derive advantages from such developmental frameworks, leading to the concentration of wealth and influence in the hands of a privileged few (Ma et al. 2019). Consequently, it becomes critical to ensure that the progression of tourism is both sustainable and equitable, with a deliberate emphasis on fostering inclusive growth and equitable distribution of benefits among all relevant stakeholders.

4. Methodological framework

4.1. Sustainable Business Model Canvas (SBMC)

The Business Model Canvas (BMC), renowned for its strategic and innovative design, stands as one of the foremost business model frameworks and value creation tools employed widely across various sectors (Osterwalder & Pigneur 2010). However, while the BMC primarily focuses on profit generation, it falls short in adequately capturing the broader societal and environmental value that businesses can offer (Cardeal et al. 2020). Thus, in this current study, the Sustainable Business Model Canvas (SBMC) is adopted as a conceptual adaptation (Basile et al. 2021) of the original BMC, aimed at developing a prototype model for value creation within the realm of ecotourism development, while also identifying the diverse challenges that may impede its success in the Darma valley. Previously, Basile et al. (2021) utilized SBMC construct to generate value for wider range of stakeholders and assess social and environmental perspectives. In the tourism context, similar approach based on BMC has been adopted to investigate the success of tourism business enterprises in Poland (Szromek 2021) and Indonesia (Qastharin 2014). Likewise, Daniele & Quezada (2017) explored the applicability of BMC within the context of tourism social enterprises, highlighting the potential for its expanded utilization in the tourism sector through the use of case studies.

The BMC, founded on its original nine building blocks, is structured around three principal dimensions of innovation: desirability, feasibility, and viability (Table 1). The trifecta represents a business model's ability to serve a unique proposition to meet essential needs while remaining feasible and financially viable. The building blocks are (i) value propositions; (ii) customer segments; (iii) customer relationships; (iv) channels; (v) key resources; (vi) key activity; (vii) key partnership; (viii) cost structure;

and (ix) revenue stream. The additional building blocks in SBMC as proposed by Basile et al. (2021) are (i) eco-social costs; and (ii) eco-social benefits.

Serving as a visual instrument, the canvas provides a structured and systematic approach to business model development, facilitating the identification of inherent advantages, limitations, prospects, and challenges within the initial prototype iteration. The subsequent course of action, ultimately, hinges upon the outcomes derived from testing the proposed prototype, thereby enabling beneficiary stakeholders (including established tour operators, aspiring entrepreneurs, and engaged community leaders in our specific context) to scrutinize and authenticate their assumptions, elicit feedback from potential clients and stakeholders, and effectuate requisite adaptations to their business model prior to its comprehensive deployment.

Table 1: Detailed BMC architecture summarized from Osterwalder & Pigneur (2010)

<table>
<tr><th colspan="2">Model dimension</th><th>Internal analysis</th><th>External analysis</th></tr>
<tr><td rowspan="2">Feasibility</td><td rowspan="2">Infrastructure</td><td>Key resources: Assets needed to allow an enterprise to create and offer a value proposition.</td><td rowspan="2">Key Partnerships: Value network critical to support in creating, capturing, and delivering value propositions in an enterprise model.</td></tr>
<tr><td>Key activities: Important actions that an enterprise must perform to generate value proposition.</td></tr>
<tr><td rowspan="3">Desirability</td><td>Value proposition</td><td colspan="2">Identification of problem and distinct value proposition within an enterprise.</td></tr>
<tr><td rowspan="2">Customer</td><td rowspan="2">Customer segment: Different groups of people or organization an enterprise aims to reach and additionally have roles to serve in enterprise’s purpose and mission.</td><td>Channels: Represents how a value proposition is communicated and delivered to customer segments.</td></tr>
<tr><td>Customer relationship: Types of relationships (transactional, long-term, self-service, and co-creation) an enterprise establishes with specific customer segment.</td></tr>
</table>

Viability	**Finance**	**Cost structure:** All costs (fixed and variable) incurred to operate a business enterprise	**Revenue streams:** Represents how cash (transactional or recurring) is generated from business operations.

4.2. REAS principles of solidarity economy

In the current investigation, the principles of the solidarity economy as promulgated by the Network of Alternative and Solidarity Economy Networks (REAS) are additionally employed to substantiate the primary objective of formulating the Sustainable Business Model Canvas (SBMC) for a prospective ecotourism enterprise within the examined study region. These principles furnish a comprehensive framework for evaluating the social, economic, and environmental repercussions of tourism models, thereby facilitating the identification of inherent strengths and weaknesses across various dimensions. The six guiding principles are (REAS 2011): (i) equity; (ii) work; (iii) environmental sustainability; (iv) cooperation; (v) fair distribution of wealth; and (vi) territorial responsibility. This research endeavor, hence, seeks to validate and advocate for the integration of business models in ecotourism planning within the study region by leveraging these guiding principles as an analytical tool (Table 2).

The selection of REAS principles as the basis for analysis stems from their substantial convergence with the tripartite principles underpinning sustainable practices in business models. Scholarly literature has emphasized on the symbiotic relationship between business models and the solidarity paradigm which possesses the potential to foster the sustainability and resilience of both the enterprise itself and the communities it seeks to benefit (Bailey et al. 2018; Morais & Bacic 2020; Forero & Saavedra 2022; Vargas Vasserot 2023). In essence, the comprehensive conclusions of this study hold considerable significance for its valuable recommendations for supporting emerging ecotourism enterprises within the Darma region.

Table 2: Guiding principles and their implications (adapted from REAS 2011)

Principle	Implications for proposed SBMC ecotourism model
Equity	Does the proposed model recognize equal opportunities, conditions, and treatment? Does it have implications for the fair distribution of obligations, resources, and responsibilities? Does if defy all discriminatory characteristics in whole business operations?
Work	Does it promote decent work opportunities to the local community? Does it promote full and productive employment in an equitable and sustainable manner?

	Does it facilitate social and economic inclusion incorporating the local communities to choose their work based on their abilities and desires?
Environmental sustainability	Is environmental sustainability an integral part of the proposed model? Given the uncertainties, does it recognize its environmental limits? Does it adhere to the goals of conscious, responsible, critical, and transformative production, distribution, and consumption models whilst economic gains?
Cooperation	Does it promote cooperative work between different stakeholders? Does it offer local communities' participation in decision-making and shared responsibilities? Does it promote co-responsibility, collaborative work, collective deliberation, shared knowledge, and mutual learning between stakeholders?
Fair distribution of wealth	Does it encourage and support transformative collective initiatives and mechanisms of community solidarity? Does it promote fair distribution of wealth among the local community? Is it capable of reinvesting surpluses in the community's socioeconomic and environmental development?
Territorial responsibility	Does it value the community's and region's resources, capacities, culture, and potential? Is it capable of identifying regional needs, inequalities, and injustices in order to promote development? Does it encourage active and quality community participation for collective construction? Does it promote social and environmental awareness, mobilization, and actions to transform the local economy? Is it capable of influencing public policies in order to develop strategies for the region's long-term development?

4.3. Data collection and analysis

In this scholarly inquiry, the employed research methods encompassed exploratory and descriptive approaches for data acquisition, wherein Focused Group Discussions (FGDs) and in-depth semi-structured Key Informant Interviews (KIIs) were utilized to comprehensively grasp and scrutinize the social, environmental, and economic dimensions pertaining to the prospects of ecotourism enterprises within the region. The overarching objective entailed gaining an in-depth understanding of the needs and preferences of the Bhotia community (hosts) and potential customers (visitors), in conjunction with an evaluation of the existing resources and infrastructure within the rural tourism milieu. In accordance with the framework outlined in the Sustainable Business Model Canvas (SBMC), particular attention was dedicated to acquiring diverse viewpoints, insights, and active engagement from a range of stakeholders involved in the formulation and design of the envisaged ecotourism model.

The key informants included individuals closely associated with the local tourism economy, namely, tour operators and guides (5), homestay proprietors (5), village heads (2), and governmental officials from tourism department (2). With consideration to participant availability and willingness, 4 FGDs were conducted with a group of 6-10 participants primarily comprising unemployed youth, women, and elderly people. The interviews followed an inquiry-based conversational approach (Table 3) centered around pertinent inquiries pertaining to the constituent components (building blocks) of the Sustainable Business Model Canvas (SBMC), thereby allowing respondents to elucidate their requirements, preferences, and experiences.

From a distinct standpoint, supplementary interviews were undertaken with military personnel from the Indo-Tibetan Border Police (ITBP) stationed in Baling and Tidang. These interviews aimed to gain additional insights into the magnitude of tourism effects and the challenges pertaining to tourism development and services within the region. ITBP is responsible for the national security, and the welfare of the local community as well as leading rescue operations at times of calamities in the harshest terrains across Indian border regions. In addition, secondary data from interim project reports, tourism master plans, and government documents was included in the analysis.

Subsequently, the study attempted to validate the proposed prototype model, considering its inherent congruity with the fundamental principles of the solidarity economy. This significant undertaking constituted a crucial step towards comprehensively assessing the accomplishments of community-centered enterprises situated in rural contexts (UNTFSSE 2014; UNIDO 2017; Galardi et al. 2022).

Table 3: Sample questions pertaining to each SBMC building block

Building block	Key questions
Value proposition	What value do you want to deliver to the customers (visitors)? What is unique about proposition you are offering? What bundles of products and services are you offering to each customer segment? Which customer needs are you satisfying?
Customer segments	For whom are you creating value? Who are your most important customers? How do you see your value offer aligning with the needs of customer segments?
Customer relationships	What type of relationship does each of your customer segments expect you to establish and maintain? What types of relationships have you already established? How will your potential enterprise interact with visitors? What relationship does the visitor expect with you and your business? How important are visitor relations to the value of the experience?

	How will visitor relations be integrated into the experience, and how much will it cost your business?
Channels	How should the customer relationship be formed? Which communication and distribution channels are suitable to form trustworthy relationships with visitors? What is the current state of your website, social media and other promotional tools? How would you describe the strengths and weaknesses of your strategy to reach potential visitors? How could you raise awareness about your products and services?
Key resources	What key resources do your value propositions require? What resources must your business own (or control) to make the prototype model work? Describe in terms of intellectual (partnerships), human (know-how, specialized skills), physical (location, logistics), and financial (cash, lines of credit).
Key activities	Which key competencies and activities are required to fulfill your value propositions? Which key activities do you want your partners carry out?
Key partnership	Who are your key partners? Which key resources are you acquiring from partners? Which key activities do your partners bring? What kind of partners are you seeking to deliver your proposition? How can you optimize these partnerships to extend your business capabilities and attract new visitors?
Cost structure	What are the costs of your key activities/resources? What are the fixed and variable costs? Will you offer different prices to different visitor segments or different seasonal rates? What major investments do you need to make? Can costs be reduced through savings in resource consumption?
Revenue stream	How will your business enterprise generate revenue? What are the visitors currently paying? How much could they be willing to pay for your servcies? What are the current competitive offerings?
Eco-social costs	What ecological or social costs could your business model create? Which key activities could use significant number of resources? How could your model adversely impact society (and certain community members) through its activities?
Eco-social benefits	What ecological or social benefits does your business model provide?

	Who are the beneficiaries of these benefits? Does your business model emphasize on conservation practices? Which of your key resources are renewable or otherwise more sustainable? Is your business model generating additional local value, such as new job opportunities (especially for vulnerable groups) or reduced pollution?

5. Results and discussion

5.1. Applicability of SBMC building blocks in ecotourism enterprise creation

Given the prior scholarly investigations conducted in the Darma valley (Rawat & Schickhoff 2022; Rawat et al: in press), which shed light on the dynamic interplay of socio-economic and climate change factors in the region, as well as the imperative of implementing alternative livelihood adaptation strategies for the local community, the present study endeavored to construct a prototype for a prospective ecotourism enterprise. This is because, there is an absence of clear understanding on the concise and structured business development strategies among the existing small tourism businesses in the region.

To introduce the developed prototype, the data collection procedures employed in the present study encompassed the identification of both current and prospective resources, assets, and prospects for the advancement of ecotourism in the region. Simultaneously, active involvement with the local community and relevant stakeholders facilitated a comprehensive understanding of their desires, aspirations, and apprehensions pertaining to ecotourism development, thereby enabling the integration of their diverse perspectives into the conceptual framework.

The empirical evidence reveals a notable lack of comprehensive understanding regarding business models among the stakeholders, particularly among tour operators and homestay owners. In addition, they mostly operate outside the scope of formalized business models widely known in the literature. In response to these apprehensions, and as an outcome of the participatory consultations, the proposed model (Fig. 3) is developed. Given the increasing attention from stakeholders towards sustainable tourism investments in the region, the resultant blueprint holds the potential for applicability not only to new small-scale tourism enterprises but also to existing ones in the region. Concurrently, it may serve as a prescriptive framework within rural tourism sector, intended towards efficient resource allocation, focus on core competencies, and informed decision-making in similar topographical settings

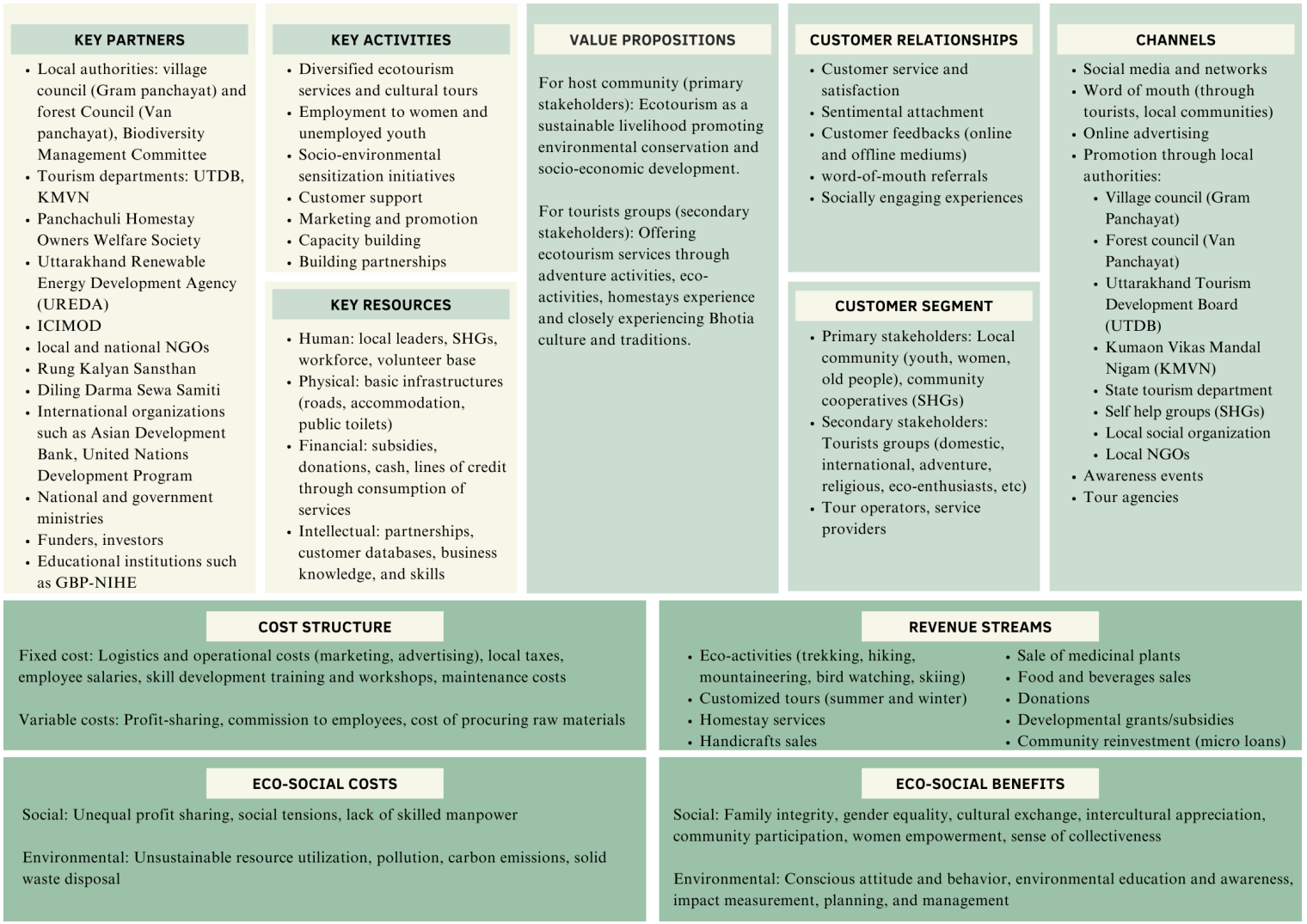


Figure 3: SBMC prototype for ecotourism enterprise in Darma valley

5.1.1. Customer segments

The proposed SBMC aimed to serve two distinct customer segments, the local Bhotia community as primary stakeholders and domestic and international tourists as secondary stakeholders. Among the latter group, various categories of tourists were identified, including adventure tourists, religious tourists, and eco-enthusiasts. Within the host community, as direct beneficiaries, the participation of village youth and women as tour operators and service providers was identified. Additionally, existing women-led local informal groups such as Self-Help Groups (SHGs) involved in grassroots rural development and livelihood generation formed an important constituent within the customer segment group. Whilst integrating the host community as direct beneficiaries in the value chain, the proposed model intended to create employment opportunities, thus, fostering social integration and contributing to the overall economic development of the community. Notably, we found out that the ability to understand customers or target groups can facilitate the creation of social value at ease to aggrandize employment opportunities and empower vulnerable groups, such as women.

5.1.2. Value proposition

The proposed model offered a multi-faceted and integrated value proposition that focuses on creating a positive social, economic, and environmental impact while fostering cooperation and benefits for all. The value proposition is, hence, designed for two key stakeholder groups: the local host community and tourists.

During the KIIs, a salient point of emphasis emerged, underscoring the value proposition inherent in fostering ecotourism as a sustainable means of livelihood that maximizes employment opportunities, income generation, poverty alleviation, nature conservation, and community revitalization. Meanwhile, within the customer segment comprising tourists, the identified value proposition encompasses a plethora of ecotourism services, such as adventure activities (trekking, hiking, and mountaineering), eco-activities (bird watching, organic farming, horticulture, floriculture, and farm volunteer work), homestay tourism for experiencing the local Bhotia culture, craftsmanship, and traditions, and knowledge exchange. Moreover, tribal festivals and fairs such as *Jauljibi mela*, *Pandali mela* and *Gulaj mela* amongst others seemed to offer an intangible and ethereal experience of the rich cultural heritage of the Bhotia community in Darma valley. Thus far, the value proposition, in this case, is driven by abundance of natural, cultural, and historical resource base as well as availability of labor resources.

5.1.3. Channels

Channels refer to the diverse means of disseminating value propositions widely and efficiently to the customer segment. The research findings unveiled a cohesive blend of channels presently operational in the region, encompassing promotional efforts through social media platforms, online advertising, word-of-mouth recommendations, and promotion through local tour agencies and local authorities such as village council

(*Gram Panchayat*), forest council (*Van Panchayat*), Kumaon Vikas Mandal Nigam (KMVN), State Tourism Department, local social organizations like *Rung Kalyan Sansthan* and *Dilang Darma Sewa Samiti*.

Presently, KMVN is committed to the promotion of ecotourism and the provision of homestay experiences in the Darma valley; however, there exists potential for further realization of the region's ecotourism prospects by harnessing the power of social media and online advertising. In contemporary times, social media platforms have assumed paramount importance in shaping tourists' choices of destinations, whereas word-of-mouth recommendations have proven effective in attracting tourists, particularly, domestic visitors. For instance, emerging ventures led by local youth, namely The Himalayan Bluesheep, The Mountain Ride, and The Himalayan Goats, predominantly advertise and promote tailored offerings through their Facebook and Instagram platforms. While this approach has yielded positive outcomes, there is a widely recognized need for enhanced knowledge and training in marketing competencies among these service providers.

5.1.4. Customer relationships

This building block is concerned with maintaining long-term and up-to-date relationships with customers, i.e., visitors, in this case. According to the participants' perspectives, the maintenance of relationships is deemed crucial to the prosperity of their business operations. Consequently, tour operators and homestay proprietors in the Darma region place considerable emphasis on fostering enduring bonds with tourists by aiming to deliver high-quality, personalized and satisfactory services. This is because building and improving relationships with customers are of utmost importance for customer acquisition and hold potential to incentivize their subsequent visits (Osterwalder & Pigneur 2010).

In addition, service providers in the Darma region frequently depend on customer feedback garnered from online social platforms to effectively engage with prospective clientele. Notably, the active involvement of women as primary hosts in homestay services within Darma has proven instrumental in cultivating robust relationships and fostering trust among visitors, thereby leading to recurrent business prospects and favorable recommendations through word-of-mouth. Noteworthy observations from visitors further indicate a discerning consumption of services, driven by a sense of satisfaction and a genuine eagerness to delve into local Bhotia culture and traditions.

5.1.5. Revenue streams

As posited by Osterwalder and Pigneur (2010), an enterprise's revenue stream is crucial to its ability to generate significant profit and become financially sustainable through diversified means. In the context of this study, a diverse range of services has been identified as potential sources for revenue generation, encompassing fees from adventure activities, eco-activities, homestays, guest house accommodation, handicraft sales, and customized guided tours services. Nonetheless, the revenue stream of business operations may be susceptible to fluctuations driven by seasonal demands. To

surmount this challenge, the respondents put forth the proposition of diversifying activities capable of enticing tourists throughout the year, encompassing pursuits like bird watching, winter trekking, and skiing.

Alongside, the augmentation of revenue can be bolstered through the provision of financial resources (donations, grants and subsidies) and tangible assistance obtained via strategic alliances with public and private entities, as well as national and international nonprofit organizations. The respondents, additionally, underscored the potential for excess revenue to be reinvested or allocated within the community, for instance, through the facilitation of microloans aimed at fulfilling social and environmental objectives. In this sense, the findings, thus, imply that entrepreneurial achievement may potentially be coproduced by the accordance and mediation of different stakeholders.

5.1.6. Key resources

Key resources are assets or capital needed for business operations which may be categorized as physical, financial, human, or intellectual. These resources may be owned, leased, or acquired; and are essential to delivering the value proposition and establishing significant customer relationships (Osterwalder & Pigneur 2010). The present study identified the local community leaders, youth leaders, SHGs, workforce, and volunteer base as pivotal human resources. However, intellectual resources such as partnerships, customer databases, business knowledge, and skills were found to be limited.

Tangible physical resources encompassing basic infrastructure, such as roads, accommodation, and community toilets, were identified as key components supported by government ministries, institutions, and international organizations like the Asian Development Bank (ADB) and United Nations Environmental Programme (UNEP) within the region.

Expert interviews shed light on the increasing tourism statistics and corresponding demands in Uttarakhand, which have garnered the attention of government entities. As a result, these entities have begun providing loans, grants, and subsidies to micro, small, and medium rural enterprises, recognizing their significance in the overall economic landscape. Moreover, the relaxation of regulations within the state creates a favorable environment for rural enterprises to obtain financial support from an array of financial institutions, such as public sector banks, private sector banks, cooperative banks, and microfinance institutions. As a result, it becomes imperative for local communities to remain well-informed and cognizant of the available resources, benefits, and opportunities, as this knowledge may empower them to establish and nurture profitable businesses, thereby fostering resilient and prosperous economies.

5.1.7. Key activities

Considering the opulent endowment of natural and cultural assets within Darma valley, the primary ecotourism offerings, as identified include trekking, mountaineering, bird

watching, and affordable homestay experiences. Supplementary engagements entail immersive participation in organic farming, horticulture, floriculture, and farm volunteer work. The region also offers prolific nature trails in and around Darma valley such as Panchachuli base camp, *Mahadev cave, Achaari lake, Gabbe top, Baling pastures, Sinla pass, Parvati kund, Adi Kailash, Jolingkong*, and *Om Parvat* viewpoint and forms a part of newly recognized Bhotia tribal-circuit with adjacent Byans and Chaudans valleys. In recent years, a handful of indigenous youth groups have initiated organizing wintertime snow-based adventure escapades in the region. Discussion with the respondents also highlighted a substantial prospect for skiing, paragliding, birdwatching, volunteer tourism, wildlife tourism, cultural tourism, religious tourism, and herbal tourism in and around Darma region.

Given the labor-intensive nature of the tourism sector, other key activities as delineated comprised of increased participation and creation of employment opportunities for the disadvantaged group such as women and unemployed youth. Furthermore, it has been observed that tour guides in the region are cognizant of fully leveraging the entrepreneurial opportunities focused on skill and capacity building training such as Uttarakhand Skill Development Mission and National Skill Qualification Framework.

Further noteworthy undertakings, as acknowledged, involve implementation of socio-environmental sensitization initiatives for both tourists and local communities, delivering high-quality customer support services that that adequately fulfill the requisites and aspirations of tourists, formulating efficacious marketing strategies to attract tourists, and establishing partnerships for the purposes of fund development, technical assistance and knowledge dissemination.

5.1.8. Key partnerships

The findings revealed that the village council (*Gram Panchayat),* forest council (*Van Panchayat*), State Tourism Department, UTDB, KMVN, Uttarakhand Renewable Energy Development Agency (UREDA), local social organizations (such as *Rung Kalyan Sansthan* and *Diling Darma Sewa Samiti*) and regional NGOs occupy indispensable roles as financiers, collaborators, and providers for the potential ecotourism enterprise in the region.

At present, government institutions are providing preferential assistance for basic infrastructure, training, and promotion of homestay tourism. However, substantial efforts are still required to establish a comprehensive ecotourism infrastructure. In advancing this vision, impact partnerships are seen to be instrumental in enabling broader availability of resources such as economic, social, and human capital that can be leveraged to create innovative development strategies. For instance, the efforts of *Rung Kalyan Sanstha* in uplifting the local Bhotia community has been instrumental. Much recently, under the KSLCDI, the institution partnered with ICIMOD and Govind Ballabh Pant National Institute of Himalayan Environment (GBP-NIHE), an autonomous institute of Ministry of Environment, Forest and Climate Change (MOEFCC), Government of India for a comprehensive documentation of cultural heritage of Rung community, marking a milestone in their shared efforts. In parallel, a

recent surge in youthful engagement has been discerned in the Darma region and adjoining valleys, owing to the efforts of United Nations Development Programme's (UNDP) SECURE Himalaya initiative. The initiative is geared towards fostering sustainable management of alpine pastures and forests in the Himalayan ecosystems, simultaneously pursuing the dual objectives of conservation and the promotion of sustainable livelihoods and socio-economic welfare of the local populace.

The respondents' views, in this regard, concur that such partnerships hold significant potential for fostering the advancement of ecotourism in the region by facilitating the exchange of knowledge, offering technical support, aiding in marketing efforts, and providing access to networks of stakeholders and potential customers. Furthermore, there is a consensus that forging partnerships in the local context may serve as a means of enhancing preparedness and resilience against unforeseen risks, for instance, during disaster mishaps or financial destitution.

5.1.9. Cost structure

Toward operating a business, the cost structure pertains to the financial outlays undertaken by an enterprise in order to operate and maintain its activities, thus, playing a vital role in in ascertaining the profitability and enduring viability of an enterprise. It describes all fixed and variable costs and expenses incurred for creating and delivering the value proposition, maintaining customer relations, and generating revenue (Osterwalder & Pigneur 2010).

In the current scenario, the fixed costs primarily include expenses that remain constant over a period of time, such as those related to logistics and operations such as maintenance costs, employee salaries, marketing, advertising, skill development training and workshops. Conversely, variable costs refer to the expenses that may fluctuate seasonally in proportion to the level of service provision and visitor demand. These may include a commission to employees, the cost of procuring raw materials, transportation costs associated with the delivery of tourist and activities (fuel costs or vehicle rental costs), provision for meals and accommodations, and profit-sharing within the local community. A well-defined cost-structure can enable an enterprise to identify its expenses, optimize its pricing strategy, and ensure that it is financially sustainable. Given the potential prospects of ecotourism enterprise development in Darma, a strategic approach to managing the business operations is required that combines the short-term benefits of ecotourism with the long-term sustainability of the local environment and people.

5.1.10. Eco-social benefits

An essential facet in establishing a resilient enterprise that fulfills its mission is the recognition of environmental and social benefits that extend beyond mere economic value. The proposed SBMC delineated a multitude of social benefits for overall community cohesion, well-being and development. These benefits incorporate promotion of family integrity, gender equality, cultural exchange and appreciation, community representation, women empowerment, collectiveness, assured livelihood,

and equitable benefit distribution. Additionally, the envisaged model also highlights environmental advantages entailing efficient utilization of available resources, shifting towards renewable resources, promoting recycling, and advocating for sustainable consumption patterns. These efforts, however, involve integrating adaptive measures and strategies to minimize the ecological footprint in the overall business plan. Integrating such measures may contribute to conscious attitude and behavior towards nature and increased environmental awareness among the community and visitors alike. Ultimately, it is postulated that the acknowledgment of eco-social benefits have the potential to enhance the perceived authenticity and reliability of the envisioned value proposition among the intended audience (visitors in our case), thereby bolstering their trust. This emphasis on eco-social benefits may also serve as a catalyst for securing financial backing from governmental bodies, donors, or external stakeholders, thereby abetting the overall success and viability of the enterprise.

5.1.11. Eco-social costs

In conjunction with recognizing favorable eco-social impact, the identification of adverse eco-social externalities assumes a pivotal role in constructing a viable and enduring enterprise framework. Eco-social costs are the environmental and social repercussions of a business's operations, which are often not reflected in traditional accounting measures. The ramifications of these costs extend beyond the business itself, exerting substantial influence on its sustained viability, as well as the wider community and ecological system within which it operates. These challenges may include the confrontation of societal complexities arising from the disagreement on profit distribution and community ownership entitlements. These may further pertain to the multifaceted challenges associated with the unsustainable exploitation of resources, the environmental deterioration precipitated by visitors, the inadequate management of waste, as well as the contamination of air, land, and water, ultimately exerting adverse effects on the well-being of both communities and the overall environment. Consequently, it is important that the business strategy must consider effective strategies to adapt to the dynamic and evolving environment and societal dynamics. Equally crucial is the convening of influential stakeholders to identify these detrimental impacts and devise tangible solutions for mitigating these externalities.

5.2. Legitimacy, ripple effects and challenges

The examination of SBMC building blocks elucidated the significance of these components in enterprise formation, with particular emphasis placed on their alignment with the three conceptual pillars of creation, delivery, and capture. This entailed not only the generation of economic gains but also the preservation of environmental integrity and the promotion of social value. The study also accentuated the eminence of the integrated mix of channels' assist in bringing the value proposition to the customer segment and fostering customer relationships to maximize the key resources, namely, physical, financial, intellectual, and human. It also emphasized upon the significance of strategically executing pivotal activities to effectively deliver its value proposition, recognizing the intrinsic interdependencies with the key resources to uphold customer relationships and generate revenue. The findings revealed that

successful operation of an enterprise often hinges on the establishment of a value network or partnerships that provide access to crucial resources, the capacity to engage in essential activities, the capability to mitigate risks, and the potential to influence cost structures. In light of this perspective, while working within a formalized business framework, existing small businesses in Darma region may form collaborative alliances to acquire better access to resources and expertise. Further, the assessment of eco-social costs and benefits further determined the viability of the enterprise's operations, negotiating occurrence of any trade-offs and availing stakeholder participation in the decision-making. In summary, the findings underscored the significant practical implications of employing business model canvases in the design of new ventures and the assessment and enhancement of existing ones (Osterwalder & Pigneur 2010; Qastharin 2014; Joyce & Paquin 2016; Daniele & Quezada 2017; Cardeal et al. 2020; Szromek 2021; Basile et al. 2021; Galardi et al. 2022)

Considering the convergence of extraordinary transformations stemming from historical socio-economic disruptions and compounded by the persistent impact of climate change in the area (Rawat & Schickhoff 2022), the introduction of the SBMC prototype offers a viable avenue for both enhancing the well-being of the local community and exploring possibilities for diversified livelihood options. Nevertheless, it is crucial to undertake a rigorous assessment of the prospects of diversifying livelihoods, specifically within the realm of ecotourism endeavors in Darma, while carefully deliberating upon potential conflicts arising from intensified workloads during peak periods within other economic sectors, such as agriculture, pastoralism, or the extraction of medicinal plants from the wild. In Darma region, it is apparent that this is not the case. The household responsibilities are generally broadly distributed across the family members and community that reduces the potential for conflicts. For instance, the care of livestock is generally entrusted to the Anwals, while subsistence crops are cultivated promptly after the commencement of upward migration in the early summer months. This allows members of the households and community who are directly not involved in these practices to take advantage of opportunities arising from tourism activities, thus avoiding potential conflicts. In addition, capitalizing on periods of agricultural inactivity, particularly during the peak winter months, the local youth are increasingly recognizing significant potential and engaging in alpine tourism activities.

Linkages between solidarity principles and SBMC prototype

Furthermore, drawing upon permissibility concerns over the practice of business models in ecotourism planning in the study region, the relevance drawn from the REAS (2011) guiding principles (as shown in Table 2) portrays a broader perspective. Grounded in these principles, the study aimed to conceptualize the establishment of a rural ecotourism enterprise from a solidarity-oriented perspective, as these principles are consolidated to foster community development while simultaneously fostering a symbiotic relationship between the environment and business operations (Vargas Vasserot 2023; Forero & Saavedra 2022; Morais & Bacic 2020; Bailey et al. 2018). Taking this into consideration, the authors elucidated the subsequent plausible linkages between the essential role of business models in rural ecotourism development and the

fundamentals of the solidarity paradigm in order to confirm the understanding gained via SBMC analysis:

i. Community participation and ownership: The envisaged model epitomizes the paramountcy accorded to community participation and ownership at the forefront of its operations. Within the purview of rural ecotourism, this connotes the proactive engagement of community in the intricate domains of strategizing, executing, and deciding upon tourism endeavors, thereby ensuring the impartial distribution of commercial gains among community members. Ultimately, adopting this approach, the existing tour operators as well as nascent small-scale enterprises, can forge an environment that is more inclusive and cooperative, promoting economic progress within the region.

ii. Environmental sustainability: A foundational principle underpinning the development of rural ecotourism resides in its inherent dependence upon natural resources, while concurrently prioritizing the advancement of knowledge and praxis pertaining to judicious resource management and environmental safeguarding, all the while supporting a diversified array of livelihood opportunities. Within this context, it becomes imperative to ensure that the pursuits associated with these enterprises impart minimal adverse effects upon the environment. In the proposed model, the inherent the value proposition entails forthcoming enterprises accentuating the cultivation of sustainable ecotourism activities and methodologies, harnessing renewable energy sources, curtailing waste generation, and actively bolstering conservation endeavors. The attainment of this endeavor can potentially be realized through the utilization of their engagement in existing institutional schemes and subsidy frameworks.

iii. Social responsibility: The promotion of equity, fairness, tolerance and social justice at the grassroots level constitutes a fundamental facet of rural ecotourism development. This entails the steadfast commitment of businesses to prioritize the establishment of dignified employment opportunities for workers, while ensuring that their activities and methodologies confer substantial benefits upon local communities and stakeholders. For instance, this is evident from the proposed SBMC model, which places heightened emphasis on augmenting the participation of women in the operations of homestays, facilitating their assumption of leadership positions, and engaging them in decision-making processes (Panta & Thapa 2018). In addition, the social dimension within the value proposition also becomes manifest, as it accentuates the significance of fostering cultural interchange between tourists and local communities, thereby engendering a positive milieu of mutual comprehension, trust, and reverence.

iv. Democratic decision-making: The proposed prototype strategy is firmly anchored in the acknowledgment of community needs and aspirations. While the aid of governmental and regulatory institutions proves indispensable in this regard, our research underscores the community's central role as both a proactive contributor and beneficiary of decision-making outcomes (Bailey et

al. 2018). To encourage public engagement and reach a consensus, this prototype was developed via the prism of participatory scenario planning and collaborative efforts, placed within inclusive and bottom-up sphere, rather than centralized and top-down, thereby encompassing the views and opinions of all stakeholders.

v. Solidarity and cooperation: Owing to the tightly knit fabric of rural communities, local entities frequently foster co-responsibility, collaborative endeavors, collective deliberation, shared wisdom, and reciprocal knowledge acquisition among all pertinent stakeholders. In creation of BMs for community-focused approach to ecotourism enterprise development, these preexisting relationships can be harnessed to cultivate a sense of indigenous ownership and custodianship over natural and cultural resources. This often involve the establishment of learning networks or communities of practice that allow for the exchange of ideas and best practices, while simultaneously creating opportunities for joint troubleshooting and innovative problem-solving within communal frameworks. Additionally, in such scenario, transparency and open channels of communication may empower relevant stakeholders who tend to voice their perspectives in decision-making processes and partake in the dividends arising from the enterprise's achievements.

Acknowledging externalities and a way forward

The research findings, however, indicate that despite the establishment of a business model rooted in sustainability, adverse externalities can persist and, in many instances, are unavoidable. This realization stems from the observation that the advantages of the prevailing mode of tourism development often disproportionately benefit a select few entities, such as large businesses, while disregarding local communities and businesses due to their perceived deficiencies in skills, education, and awareness. Furthermore, within societal frameworks, the advancement of tourism may intensify prevailing disparities, as certain factions may possess a more advantageous position to derive advantages from tourism in comparison to others. For instance, individuals endowed with superior access to resources, education, and cultural acumen are more apt to leverage the prospects afforded by ecotourism ventures than those lacking such privileges. The resultant outcome can entail the accumulation of wealth and authority within a select few, thereby exacerbating the marginalization of already vulnerable factions, particularly women (Ma et al. 2019). Contradictions may also appear in the lack of government intervention, inequitable distribution of resources as well as the attitudes of tourists and the community toward ensuring sustainability measures. This realization underscores the need for stakeholders' active involvement to comprehend and establish the intricate interconnections among dimensions of sustainability within the planning process (NITI Aayog 2018b; Burch & Di Bella 2021). Hence, the role of the local community, institutional and private stakeholders in the planning, creation, and ensuring measures in the ecotourism enterprise model is fundamental to its success.

In addition, it is important to engage in ongoing monitoring and evaluation to ascertain the extent to which the eco-social objectives are being effectively achieved over time.

It is worth considering that the revenue streams may not be sustainable in the long term, and there may be risks associated with over-reliance on ecotourism activities as the primary source of income (Soliku et al. 2021). There may also be challenges in maintaining a balance between economic benefits and environmental conservation, which could potentially affect the long-term sustainability of the presented ecotourism model. Succinctly put, an ardent partake of the local stakeholders and institutional propensity in sustainable business model planning and creation may enhance the likelihood of entrepreneurial success in the pursuit of livelihood diversification and adaptation strategies, not only within the region but also in broader contexts.

Of particular interest is the fact that the Ministry of Tourism, Government of India, in its endeavors, has devised the National Strategy and Roadmap for Sustainable Tourism (NSRST) in 2021, whereby ecotourism has been acknowledged as a distinctive domain within sustainable tourism segments, warranting dedicated efforts for its advancement across the nation. This strategic framework underscores the significance of community-driven development and the adoption of pro-poor tourism methodologies, with a focal point on fostering rural and women entrepreneurship, ultimately culminating in the attainment of Sustainable Development Goals (SDGs). Furthermore, the Uttarakhand Tourism Policy of 2018 incorporates the pivotal concept of ecotourism, which assumes a significant role in promoting a range of objectives such as reverse-migration, village-centered tourism, cultural immersion, active community engagement, fostering entrepreneurial aptitude, ensuring equitable sharing of benefits, and establishing resilient tourist infrastructure to withstand potential disasters. Notably, the policy confers industry status upon the tourism sector and provides an array of incentives and subsidies to MSMEs operating in less-developed regions of Uttarakhand. Specifically, the district of Pithoragarh is accorded the highest priority and is positioned in the topmost category, thereby enabling the local communities to access substantial advantages, including capital subsidies and interest subsidies for newly established tourism units, concessions on stamp duty for projects related to tourism, and tax incentives. Moreover, there are dedicated incentive programs, such as low-interest bank loans, tailored to support women entrepreneurs and enterprises that are owned and operated by women, particularly in the service sector. Nonetheless, the operational directives outlined in both the aforementioned policies demonstrate certain deficiencies, particularly in terms of inadequate enforcement mechanisms designed to ensure strict adherence to the prescribed guidelines. Moreover, although the policies underscore the significance of sustainable tourism practices, they fail to delineate explicit objectives or tactics for attaining desired environmental outcomes, thereby potentially giving rise to detrimental consequences on natural resources and biodiversity.

Besides, in our analysis, it became evident that despite these efforts, the complete potential of the available schemes is yet to be realized owing to the lack of knowledge and awareness among inhabitants in Darma region. In addition, the intricate and bureaucratic nature of these schemes may create hurdles for communities to comprehend and utilize them to their full capacity, leading to under-utilization of available resources and missed opportunities. Yet, quite remarkably, KSLCI efforts in endorsing ecotourism as an adaptation strategy to climate change in the KSL region in

Uttarakhand and beyond have been instrumental in sparking the regional collaboration, prioritizing livelihood diversification, fostering entrepreneurship, and promoting balanced environmental conservation.

Considering the exponential rise in tourist influx both in Pithoragarh and across Uttarakhand, as indicated by the data presented in Table 3, this study aligns with the notion that the responsible state entities in Uttarakhand, specifically the State Tourism Department, Ministry of Tourism, Uttarakhand Tourism Development Board (UTDB), Kumaon Mandal Vikas Nigam (KMVN), Uttarakhand Renewable Energy Development Agency (UREDA), and the relevant departments (such as agriculture and fisheries), ought to exhibit resolute dedication in fostering the advancement of sustainable tourism, particularly emphasizing the strategies pertaining to enterprise and skill development within the region. Such commitment is not only imperative for the overall progress of the tourism sector but also holds significant potential for contributing substantially to the attainment of the Sustainable Development Goals (SDGs). The alliance among these institutions is also pivotal in bolstering the resilience of communities against impending climatic and environmental uncertainties, as well as the challenges posed by pandemics such as the COVID-19 outbreak. However, it is crucial to acknowledge that the post-pandemic landscape has witnessed the emergence and continued expansion of niche-based tourism, particularly in rural regions, which presents a promising market for future growth (Gajić et al. 2023). Hence, it is critical to allocate significant financial resources and make substantial investments in infrastructure development and policy measures in Uttarakhand, going beyond the mere inclusion of commitments and provisions in policies and master plans for the tourism and ecotourism sector.

Expanding upon this, the findings of this study indicate that while favorable provisions for tourism enterprise development exist, a close examination of the interrelationship between social entrepreneurship and ecotourism could provide mutual benefits and shared success for sustainable inclusive growth in the region. To conclude, the establishment of social enterprises is frequently fraught with concerns about legitimacy and long-term viability. It is therefore critical to understand the fundamental concepts underlying the operations of these social enterprises from the standpoint of their success in overall mission in order to ensure their long-term viability.

6. Conclusion

Amidst the flux of contemporary circumstances posed by globalization and climatic challenges, the indigenous Bhotia community in Darma valley demonstrates a keen willingness of the ample natural resources and cultural heritage present in the region, recognizing their potential for optimization and transformation into sustainable into sustainable income-generating paths. In response to the diminishing significance of pastoral and agricultural pursuits, the local community in Darma endeavors to diversify their sources of revenue by engaging in non-agricultural activities. In this regard, the proposed Sustainable Business Model Canvas (SBMC) prototype emerges as a preferred blueprint for ecologically conscious development, underpinned by a distinctive value proposition derived from the region's abundant natural, cultural,

historical, and labor resources. However, the realization of this vision hinges upon the collaborative efforts of diverse stakeholders and the forging of key partnerships.

Although geographically limited in scope, to a broader extent, the outcomes of the present study contribute to the existing burgeoning literature on niche-based rural tourism entrepreneurship as a means for adaptation to emerging contemporary stressors. In essence, this scholarly paper offers insights into a business model creation and presents potential avenues for conducting thorough investigations that would culminate in the formulation of a comprehensive framework for future ecotourism development strategies in Uttarakhand and the contiguous high-altitude Himalayan regions. Additionally, it is vital to recognize and address any constraints or domains necessitating further research to comprehensively grasp the ramifications of the findings. Therewithal, sustainability, in its broader scope, is another aspect of great significance that needs to be considered while creating sustainable business models for future-oriented rural developmental paradigms and accomplishing the ambitious objectives set forth in the United Nations 2030 Agenda.

References

Açıksöz, S., Cetinkaya, G. C., Uzun, O., Nemutlu, F. E., & Ilke, E. F. (2016). Linkages among ecotourism, landscape and natural resource management, and livelihood diversification in the region of Suğla Lake, Turkey. International Journal of Sustainable Development & World Ecology, 23(1), 15-27.

Agyeman, Y. B. (2019). Ecotourism as an Adaptation Strategy for Mitigating Climate Change Impacts on Local Communities Around Protected Areas in Ghana. In Leal Filho W. (Eds.), Handbook of Climate Change Resilience (pp. 1-19). Springer, Cham.

Akinbami, C. A. O. (2021). Climatepreneurship: adaptation strategy for climate change impacts on rural women entrepreneurship development in Nigeria. In Oguge, N., Ayal, D., Adeleke, L., & da Silva, I. (Eds.), African Handbook of Climate Change Adaptation. Springer, Cham.

Anand, A., Chandan, P., & Singh, R. B. (2012). Homestays at Korzok: Supplementing rural livelihoods and supporting green tourism in the Indian Himalayas. Mountain Research and Development, 32(2), 126–136.

Aquino, R. S., Lück, M., & Schänzel, H. A. (2021). Mapping the outcomes of social entrepreneurship and tourism on host communities: a three-dimensional approach. Journal of Sustainable Tourism, 1-22.

Avagianou, A., Gourzis, K., Pissourios, I., Iosifides, T., & Gialis, S. (2022). Quite promising yet marginal? A comparative study of social economy in the EU South. Comparative European Politics, 20, 484–509.

Bailey, N., Kleinhans, R., & Lindbergh, J. (2018). The implications of Schumpeter's theories of innovation for the role, organisation and impact of community-based social enterprise in three european countries. Journal of Entrepreneurial and Organizational Diversity, 7, 14–36.

Baldegger, R. (2020). How a business model's sustainability and scalability interact. Journal of the International Council for Small Business, 1:3-4, 126-138.

Basile, V., Capobianco, N. & Vona, R. (2021). The usefulness of sustainable business models: Analysis from oil and gas industry. Corporate Social Responsibility and Environmental Management, 28(6), 1801–1821.

Becken, S. & Loehr, J. (2022) Tourism governance and enabling drivers for intensifying climate action. Journal of Sustainable Tourism, 1-19.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2008). Living in a high mountain border region. The case of the 'Bhotiyas' of the Indo-Chinese border region. Journal of Mountain Science, 5, 209-217.

Bergmann, C., Gerwin, M., Nüsser, M., & Sax, W. S. (2012). State policy and local performance: pasture use and pastoral practices in the Kumaon Himalaya. Pastoral practices in High Asia: Agency of development effected by modernisation, resettlement, and transformation, 175-194.

Bhalla, P., Coghlan, A. & Bhattacharya, P. (2016). Homestays' contribution to community -based ecotourism in the Himalayan region of India. Tourism Recreation Research, 41(2), 213-228.

Burch, S. & Di Bella, J. (2021). Business models for the Anthropocene: accelerating sustainability transformations in the private sector. Sustainability Science, 16, 1963–1976.

Buzinde, C., Shockley, G., Andereck, K., Dee, E., & Frank, P. (2017). Theorizing social entrepreneurship within tourism studies. In Sheldon, P. J. & Daniele, R. (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 21–34). Cham: Springer International Publishing.

Cardeal, G., Höse, K., Ribeiro, I., & Götze, U. (2020). Sustainable business models–canvas for sustainability, evaluation method, and their application to additive manufacturing in aircraft maintenance. Sustainability, 12, 9130.

Chand, S., Singh, S., Parappurathu, S., Roy, S. D., & Kumar, A. (2015). Explaining the status and scope of ecotourism development for livelihood security: Andaman and Nicobar Islands, India. International Journal of Sustainable Development & World Ecology, 22(4), 335-345.

Chang, J. (2011). Introduction: entrepreneurship in tourism and hospitality: the role of SMEs. Asia Pacific Journal of Tourism Research, 16(5), 467-469.

Dahles, H., Khieng, S., Verver, M., & Manders, I. (2020). Social entrepreneurship and tourism in Cambodia: Advancing community engagement. Journal of Sustainable Tourism, 28(6), 816-833.

Daniele, R. (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 1-18). Cham: Springer International Publishing.

Daniele, R., & Quezada, I. (2017). Business models for social entrepreneurship in tourism. In P. J. Sheldon & R. Daniele (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 81-100). Cham: Springer International Publishing.

Day, J., & Mody, M. (2017). Social entrepreneurship typologies and tourism: Conceptual frameworks. In Sheldon, P. & Daniele, R. (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 57-80). Cham: Springer International Publishing.

DeLange, D., & Dodds, R. (2017). Increasing sustainable tourism through social entrepreneurship. International Journal of Contemporary Hospitality Management, 29(7), 1977−2002.

Dendup, N., Tshering, K., & Choda, J. (2022). Community-Based Tourism as a Strategy for Building Climate Resilience in Bhutan. In Haque, A.K.E., Mukhopadhyay, P., Nepal, M., & Shammin, M.R. (Eds.), Climate Change and Community Resilience. Springer, Singapore.

Doğan, M. (2021). Can be solidarity paradigm a catalyst for the sustainability of tourism? In Turcanu-Carutiu, D. (Eds.), Heritage - New Paradigm. London. IntechOpen.

Esteves, A.M., Genus, A., Henfrey, T., Penha-Lopes, G., East, M. (2021) Sustainable entrepreneurship and the sustainable development goals: community-led initiatives, the social solidarity economy and commons ecologies. Business, Strategy and Environment, 30(3), 1423–1435.

Forero, J. A. M., & Saavedra, J. A. (2022). Community-based tourism as an approach to a solidarity economy. European Conference on Management Leadership and Governance, 18(1), 340-346.

Gajić, T., Đoković, F., Blešić, I., Petrović, M. D., Radovanović, M. M., Vukolić, D., Mandarić, M., Dašić, G., Syromiatnikova, J. A., Mićović, A. (2023). Pandemic Boosts Prospects for Recovery of Rural Tourism in Serbia. Land, 12, 624.

Galardi, M., Moruzzo, R., Riccioli, F., Granai, G., & Di Iacovo, F. (2022). Small rural enterprises and innovative business models: A case study of the Turin area. Sustainability, 14, 1265.

Gioli, G., Thapa, G., Khan, F., Dasgupta, P., Nathan, D., Chhetri, N., Adhikari, L., Mohanty, S., Aurino, E. & Scott, L. (2019). Understanding and tackling poverty and vulnerability in mountain livelihoods in the Hindu Kush Himalaya. In Wester, P., Mishra, A., Mukherji, A., & Shrestha A. B. (Eds.), The Hindu Kush Himalaya Assessment (pp. 421-455). Springer, Cham.

Haarmann, C., & Haarmann, D. (2011). Solidarity economy – a chance for Southern Africa: an introduction to the concept and practical experience from Brazil, TARA Research Report.

Higham, J., & Miller, G. (2018). Transforming societies and transforming tourism: Sustainable tourism in times of change. Journal of Sustainable Tourism, 26(1), 1-8.

Hoang, T., & Pulliat. G. (2019). Green for Whom? Exploring Ecotourism as a Climate-Adaptation Strategy in Trang An, Vietnam. In Daniere, A., & Garschagen, M. (Eds.), Urban Climate Resilience in Southeast Asia. The Urban Book Series (pp. 179-199). Springer, Cham.

IHD (2018). Uttarakhand: Vision 2030. Institute for Human Development, Department of Planning, Government of Uttarakhand. New Delhi.
IPCC (2022). Climate Change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
Jamaliah, M. M., & Powell, R. B. (2018). Ecotourism resilience to climate change in Dana Biosphere Reserve, Jordan. Journal of Sustainable Tourism, 26(4), 519-536.
Joyce, A., & Paquin, R.L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. Journal of Cleaner production, 135, 1474-1486.
Kasalak, M. A., Akinci, Z., & Yurcu, G. (2016). Ecotourism entrepreneurship, the features of ecotourism entrepreneurship, problems and solutions. In Avcikurt, C., Dinu, M. S., Hacioglu, N., Efe, N., Soykan, A., & Tetik, N. (Eds.), Global issues and trends in tourism (pp. 596-601). St. Kliment Ohridski University Press, Sofia.
Kim, M., Xie, Y., & Cirella, G. T. (2019). Sustainable transformative economy: Community-based ecotourism. Sustainability, 11(18), 4977.
Kimbu, A. N., & Ngoasong, M. Z. (2016). Women as vectors of social entrepreneurship. Annals of Tourism Research, 60, 63-79.
Kotru, R., Chaudhari, S., Lemke, E., Mueller, M., Chettri, R., Basnet, S., … Shaoliang, Y. (2017). Kailash Sacred Landscape conservation and development initiative (2012–2017). Annual Progress Report 2016. Kathmandu. ICIMOD.
Kummitha, H. R., Kolloju, N., Jancsik, A., & Szal k, Z. C. (2021). Can tourism social entrepreneurship organizations contribute to the development of ecotourism and local communities: understanding the perception of local communities. Sustainability, 13, 11031.
Kuniyal, J. C., Kanwar, N., Bhoj, A.S., Rautela, K. S., Joshi, P., Kumar, K., Sofi, M.S., Bhat, S. U., Rashid, I., Lodhi, M. S., Devi, A., & Singh, H. B. (2021). Climate change impacts on glacier-fed and non-glacier-fed ecosystems of the Indian Himalayan Region: people's perception and adaptive strategies. Current Science, 120, 888-899.
Laeis, G. C., & Lemke, S. (2016). Social entrepreneurship in tourism: Applying sustainable livelihoods approaches. International Journal of Contemporary Hospitality Management. 28, 1076–1093.
Little, M. E. & Blau, E. (2020). Social adaptation and climate mitigation through agrotourism: a case study of tourism in Mastatal, Costa Rica. Journal of Ecotourism, 19(2), 97-112.
Ma, B., Cai, Z., Zheng, J., & Wen, Y. (2019). Conservation, ecotourism, poverty, and income inequality–A case study of nature reserves in Qinling, China. World Development, 115, 236-244.
Morais, L. P., & Bacic, M. J. (2020). Social and Solidarity Economy and the need for its entrepreneuring ecosystem: current challenges in Brazil. CIRIEC-España revista de economía pública social y cooperativa 98, 5-30.
Mulder, N. (2020). The impact of the COVID-19 pandemic on the tourism sector in Latin America and the Caribbean, and options for a sustainable and resilient recovery. International Trade series, No. 157 (LC/TS.2020/147), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).
Murphy, H., & Harwood, S. (2017). Walking on country with Bana Yarralji Bubu: A model for aboriginal social enterprise tourism. In P. J. Sheldon & R. Daniele (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 295-314). Cham: Springer International Publishing.
Murphy, J., Teo, A., Murphy, C., & Liu, E. (2017). The BEST society: from charity to social entrepreneurship. In Sheldon, P. & Daniele, R. (Eds.), Social entrepreneurship and tourism: Philosophy and practice (pp. 237-249). Cham: Springer International Publishing.
Mwasha, S. I. & Robinson, Z (2021). Building livelihoods resilience in the face of climate change: Case study of small-holder farmers in Tanzania. African Handbook of Climate Change Adaptation, 829–48. Cham: Springer International Publishing.
Namgay, K., Millar, J. E., & Black, R. S. (2021). The future of transhumants' sustainable resource use in Bhutan: Pressures and Policies. Frontiers in sustainable food systems, 5, 1-13.
Negi, V. S., Maikhuri, R. K., & Pharswan, D. (2017). Climate change in the Western Himalaya: People's perception and adaptive strategies. Journal of Mountain Science, 14(2), 403-416.
NITI Aayog (2018a). Sustainable tourism in the Indian Himalayan contributing to sustainable development in Indian Himalayan region. Report of Working Group II. NITI Aayog, Government of India.

NITI Aayog (2018b). Strengthening skill and entrepreneurship landscape in Indian Himalayan Region. Report of Working Group IV. NITI Aayog, Government of India.
OECD (2020). OECD Tourism Trends and Policies 2020, OECD Publishing, Paris.
Ogara, O. W., Seneiya, J. O., Ongoro, E. B. (2013). Community based conservation and ecotourism as an environmental management practice for climate change adaptation in Ewaso Nyiro arid land ecosystem, Samburu County Kenya. Journal of Environmental Science and Water Resources, 2(4), 106-111.
Ogra, M. V., & Badola, R. (2015). Gender and climate change in the Indian Himalayas: global threats, local vulnerabilities, and livelihood diversification at the Nanda Devi Biosphere Reserve. Earth System Dynamics, 6, 505-523.
Osterwalder, A., & Pigneur, Y. (2010). Business model generation: A handbook for visionaries, game changers, and challengers: John Wiley & Sons.
Pandey, A., Pradhan, N., Chaudhari, S., & Ghate, R. (2017b). Withering of traditional institutions? An institutional analysis of the decline of migratory pastoralism in the rangelands of the Kailash Sacred Landscape, Western Himalayas. Environmental Sociology, 3(1), 87-100.
Pandey, R., Jha, S. K. & Alatalo, J. M. (2017a). Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. Ecological Indicators, 79. 338-346.
Panta, S. K., & Thapa, B. (2018). Entrepreneurship and women's empowerment in gateway communities of Bardia National Park, Nepal, Journal of Ecotourism, 17:1, 20-42.
Qastharin, A. R. (2014). Understanding the Business Model of Social Enterprise: A Case Study of IndonesiaMengajar, Master of Science, KTH Industrial Engineering and Management, Stockholm.
Rautela, P., & Karki, B. (2015). Impact of climate change on life and livelihood of indigenous people of higher Himalayan Uttarakhand, India. American Journal of Environmental Protection, 3(4), 112-124.
Rawat, D., Neuburger, M. & Schickhoff, U. (in press): Potential of ecotourism to secure sustainable livelihood and support climate adaptation in Indian Himalayan Region. Journal of Ecotourism.
Rawat, D., & Schickhoff, U. (2022). Changing climate scenario in high altitude regions: comparison of observed trends and perceptions of agro-pastoralists in Darma Valley, Uttarakhand, India. In Schickhoff, U., Singh, R.B. & Mal, S. (Eds.), Mountain Landscapes in Transition: Effects of Land Use and Climate Change. Springer, Cham.
RDMC (2018). Nature-based tourism (ecotourism) in Uttarakhand: Analysis and recommendations. Rural Development and Migration Commission. Government of Uttarakhand.
REAS (2011). Red de Redes de Economía Alternativa y solidaria. Carta de la Economía Solidaria. Retrieved from https://www.economiasolidaria.org/carta-de-principios-de-la-economia-solidaria/
Reinhold, S., Zach, F., & Krizaj, D. (2017). Business models in tourism: a review and research agenda. Tourism Review, 72(4), 462-482.
Rosato, P. F., Caputo, A., Valente, D., & Pizzi, S. (2021). 2030 Agenda and sustainable business models in tourism: A bibliometric analysis, Ecological Indicators, 121, 106978.
Sahakian, M. D., & Dunand, C. (2015). The social and solidarity economy towards greater 'sustainability': learning across contexts and cultures, from Geneva to Manila. Community Development Journal, 50(3), 403–417.
Sahebalzamani, S. & Bertella, G. (2018). Business models and sustainability in nature tourism: a systematic review of the literature. Sustainability, 10, 3226.
Salgueiro, J., Barbieri E., & Morgado, F. (2020). Climate change and ecotourism in the context of the 2030 Agenda for Sustainable Development. In: Leal Filho W., Azul A., Brandli L., Özuyar P., & Wall T. (Eds.), Sustainable cities and communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham.
Sati, V. P. (2020). Himalaya on the Threshold of Change. Springer.
Scherrer, P. (2020). Tourism to serve culture: The evolution of an aboriginal tourism business model in Australia. Tourism Review, 75(4), 663-680.
Schickhoff, U., & Mal, S. (2020). Current changes in alpine ecosystems of Asia. In Goldstein, M., & DellaSala, D. (Eds.), Encyclopedia of the World's Biomes. Elsevier.
Schoneveld, G.C. (2020). Sustainable business models for inclusive growth: Towards a conceptual foundation of inclusive business. Journal of Cleaner Production, 277, 124062.

Scott, D. (2021). Sustainable tourism and the grand challenge of climate change. Sustainability, 13(4), 1966.
Scott, D., Hall, C. M., & Gössling, S. (2019). Global tourism vulnerability to climate change. Annals of Tourism Research, 77, 49-61.
Sheldon, P. J., Pollock, A., & Daniele, R. (2017). Social entrepreneurship and tourism: Setting the stage. In Sheldon, P.
Soliku, O., Kyiire, B., Mahama, A., & Kubio, C. (2021). Tourism amid COVID-19 pandemic: impacts and implications for building resilience in the eco-tourism sector in Ghana's Savannah region. Heliyon, 7(9), e07892.
Szromek A. R. (2021). The Sustainable Business Model of Spa Tourism Enterprise- Results of Research Carried Out in Poland. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 73.
Tao, T. C. H., & Wall, G. (2009). Tourism as a sustainable livelihood strategy. Tourism Management, 30(1), 90-98.
TERI (2019). Tourism baseline study for SECURE Himalaya project landscapes in Uttarakhand. Draft Report 2019. The Energy and Resources Institute. New Delhi.
Tiwari, K. R., Sitaula, B. K., Bajracharya, R. M., Raut, N., Bhusal, P., & Senegal, M. (2020). Vulnerability of pastoralism: A case study from the high mountains of Nepal. Sustainability, 12(7), 2737.
Trang, N. T. T., & Loc, H. H. (2022). Eco-agritourism as an Ecosystem-based adaptation (EBA) against climate change impacts for the Vietnamese Mekong Delta: a viewpoint. In IOP Conference Series: Earth and Environmental Science, 1028(1), 012003.
UNCTAD (2017). Promoting Entrepreneurship for Sustainable Development: A selection of business cases from Empretec network. United Nations publication.
UNIDO (2017). The role of the social and solidarity economy in reducing social exclusion. Budapest Conference Report. United Nations Industrial Development Organization.
UNTFSSE (2014). Social and solidarity economy and the challenge of sustainable development. A position paper. United Nations Inter-Agency Task Force on Social and Solidarity Economy.
UNWTO (2017). Tourism and the Sustainable Development Goals – Journey to 2030, UNWTO, Madrid.
UNWTO (2018). Annual Report 2017, UNWTO, Madrid.
Upadhyay, H., Vinke, K., Bhardwaj, S., Becker, M., Irfan, M., George, N. B., Biella, R., Arumugam, P., Murki, S. K., & Paoletti, E. (2021). Locked houses, fallow lands: climate change and migration in Uttarakhand, India. Potsdam Institute for Climate Impact Research (PIK), Potsdam and The Energy and Resources Institute (TERI), New Delhi.
Uttarakhand Tourism Policy (2018). Department of Tourism. Government of Uttarakhand.
Uttarakhand Tourism Statistics (2015). Tourism Corporation of Uttarakhand, Dehradun.
Utting, P. (2015). Social and solidarity economy beyond the fringe? Zed Books: London, UK.
Vargas Vasserot, C. (2023). Social Enterprises in the European Union: Gradual Recognition of Their Importance and Models of Legal Regulation. In Peter, H., Vargas Vasserot, C., & Alcalde Silva, J. (Eds.), The International Handbook of Social Enterprise Law. Springer, Cham.
Villalba-Eguiluz, U., Egia-Olaizola, A., & Pérez de Mendiguren, J. C. (2020). Convergences between the social and solidarity economy and Sustainable Development Goals: case study in the Basque country. Sustainability, 12, 5435.
Wang, H., Khan, Y. A., Mouldi, A., Abou El Khier, B. S. & Guo, W. (2022). The impact of geopolitical and pandemic risks on tourist inflows: evidence from Asia-Pacific region. Frontiers in Environmental Science. 10, 850729.
Wang, M., Rasoolimanesh, S. M., & Kunasekaran, P. (2021). A review of social entrepreneurship research in tourism: knowledge map, operational experiences, and roadmaps. Journal of Sustainable Tourism, 1-22.
Willis, C. M. (2007). A descriptive grammar of Darma: an endangered Tibeto-Burman language. The University of Texas, Austin.
WTTC (2017). Travel and tourism: global economic impact and issues. World Travel and Tourism Council, London.
Yoshino, N. & F. Taghizadeh-Hesary. (2016). Major challenges facing small and medium sized enterprises in Asia and solutions for mitigating them. ADBI Working Paper 564. Tokyo: Asian Development Bank Institute.

Appendix III

Supplementary material: Tables

Appendix III: Table 1

Criteria and sub-criteria parameters for ECOS assessment in Darma valley

Criteria	Sub-criteria	Description
Accessibility (C1)	Accessibility to villages[1]	This constitutes the level of ease or difficulty in accessing a potential ecotourism destination based on factors such as distance, travel time, transportation and the availability of information and services for visitors.
	Access to transportation[1]	
	Distance to the market town (Dharchula)[4]	
Relationship between ecotourism and other resource uses (C2)	Awareness regarding ecoutourism[1]	This relates to the consideration about how ecotourism operations might coexist with other resource uses and/or activities in a particular destination.
	Opportunity to experience traditional customs[1]	
	Resource compatibility with tourism uses[1]	
Attractions offered (C3)	Diversity of landforms[1]	This refers to the available natural, cultural, and historical characteristics in a destination that may be leveraged to draw visitors and meet the expectations.
	Presence of forests in the proximity[1]	
	Outstanding beauty[1]	
	Presence of historical-archeological sites[1]	
	Proximity to Panchachuli base camp[2]	
Existing tourism infrastructure (C4)	Accommodation facilities for tourists[1]	It refers to the presence and sufficiency of physical structures and services needed to enable ecotourism activities in a potential ecotourism destination. Existing infrastructure may have a considerable impact on the amount and type of ecotourism development that can occur in a given location, as well as the quality of the visitor experience.
	Nearest primary health centre[4]	
	Primary school[5]	
	Availability of food (shops, hotels)[1]	
	Existing recreational activities[1]	
	Provision for drinking water[1]	
	Provision of power supply[1]	
	Availability of human resources (potential workforce)[6]	

Criteria	Sub-criteria	Description
Level of skill and knowledge (C5)	Educational status of local people[1]	It comprises of skills and knowledge that host community must have in order to participate in ecotourism activities.
	Availability of tourist guides[1]	
	Knowledge of other languages[1]	
Social interaction level (C6)	Frequency of interaction with tourists[1]	It describes the degree of connection and involvement that visitors have with the local community. High levels of social interaction typically result in beneficial socio-cultural outcomes.
	Tourist attitude towards community and vice-versa[3]	
Acceptance of visitor impacts (C7)	Degree of impact on ecotourism resources[3]	It pertains to the willingness of host community to endure the inherent environmental and social repercussions of ecotourism operations.
Partnership and management for ecotourism viability (C8)	Community involvement in natural resource protection[1]	This component refers to the level of support and engagement exhibited by the local community and other stakeholders in the area's ecotourism management regime. Aspects such as effective communication and consultation, transparency in decision-making, and equitable sharing of benefits can affect the level of acceptance of the management regime.
	Government involvement in managing tours[1]	
	Community involvement in managing tours[1]	

Note: ECOS parameters adapted and modified from Boyd and Butler (1996) and Açıksöz et al. (2010; 2016)

[1] includes 21 parameters with 1- 4 scoring system which includes: 1 as none, 2 as low, 3 as fair and 4 as high.

[2] includes 1 parameter with 1- 4 scoring system which includes: 1 as very far, 2 as far, 3 as close and 4 as very close.

[3] includes 2 parameters with 1- 4 scoring system which includes: 1 as none, 2 as bad, 3 as fair and 4 as good.

[4] includes 2 parameters with 1- 4 scoring system which includes: 1 as 10+ kms, 2 as 5-10 kms, 3 as <5 kms and 4 as very close.

[5] includes 1 parameter with 1- 4 scoring system which includes: 1 as 10+ kms, 2 as 5-10 kms, 3 as <5 kms and 4 in the village.

[6] includes 1 parameter with 1- 4 scoring system which includes: 1 as ≤ 200, 2 as 200-300, 3 as 300-400 and 4 as ≥ 400.

Appendix III: Table 2

SLF reference indicators used for livelihood capital analysis in Darma valley

Capital	Reference indicators	Description
Natural (R1)	Natural resources availability[1]	Refers to natural resource stocks that provide resource flows and services beneficial for pursuing livelihoods.
	Accessibility to natural resources[1]	
	Unique biodiversity[1]	
	Existence of forests in the proximity[1]	
	Proximity to Panchachuli base camp (glacier)[1]	
Human (R2)	Educational status[1]	Refers to knowledge, skills, and health that individuals possess, which enable them to pursue their livelihoods effectively.
	Awareness, skills, and trainings for income generating activities[1]	
	Nearest primary health centre[2]	
Financial (R3)	On-farm income generating activities (crop and animal production)[1]	Refers to financial resources that individuals or community utilize to support their livelihoods.
	Access to non-farm income generating activities (trekking, wage labor, etc.)[1]	
	Regular inflow of money (remittances, pensions, etc.)[1]	
Physical (R4)	Access to state subsidy programmes[1]	Refers to the basic infrastructure that enable individuals or community to pursue their livelihoods.
	Access to drinking water[1]	
	Access to road and transportation facilities[1]	
	Access to basic infrastructure services (waste disposal, sewage, etc.)[1]	
	Access to power supply for domestic use[1]	

	Access to communication (public phone booths)[1]	
	Access to community toilets[3]	
	Accommodation availability for tourists[1]	
	Distance to the central market *(Dharchula)* [2]	
	Organizational partnerships and memberships (NGOs, local committees, etc.)[1]	
Social (R5)	Participation in formal groups[1]	Refers to the social relationships, networks, and institutions that facilitate livelihoods
	Awareness of collective representation, networks and connections[1]	

Note: Adapted and modified from 'Guidance Note for the Application of the Sustainable Livelihoods Framework in Development Projects' (UNDP 2017)

[1] includes 20 parameters with 1- 4 scoring system which includes: 1 as none, 2 as low, 3 as fair and 4 as high.

[2] includes 2 paramters with 1- 4 scoring system which includes: 1 as 10+ kms, 2 as 5- 10 kms, 3 as <5 kms and 4 as none.

[3] includes 1 parameters with 1- 4 scoring system which includes: 1 very low, 2 as low, 3 as fair and 4 as high.

Appendix III: Table 3

Questions concerning each building blocks in the SBMC (adaptation from original BMC by Osterwalder and Pigneur (2010)

<table>
<tr>
<td>Key Partners
Who are your key partners and suppliers?
Which key resources are you acquiring from partners?
Which key activities do your partners bring?
Are you going to partner to deliver your experience?
Are some business activities going to be outsourced?
How can you optimize these partnerships to extend your business capabilities and attract new visitors?</td>
<td>Key Activities
For whom are you creating value?
Who are your most important customers?
How will your business offer align with their needs?
Is your business idea focusing on potential customers or new needs?
Key Resources
What key resources do your value propositions require?
What resources must your enterprise own (or control) to make the prototype model work?
What kinds of resources already exists?</td>
<td>Value Propositions
What value do you deliver to the customers?
What is unique about the value proposition?
Which one of your customer's problems are you helping to solve?
What bundles of products and services are you offering to each customer segment?
Which customer needs are you satisfying?</td>
<td>Customer relationships
What types of relationships have you already established?
How will your potential enterprise interact with visitors?
What relationship does the visitor expect with you and your business? How important are visitor relations to the value of the experience?
customer segment
For whom are you creating value? Who are your most important customers?
How will your business offer align with their needs?
Is your business idea focusing on potential customers or new needs?</td>
<td>Channels
How should the customer relationship be formed?
Which communication and distribution channels are suitable to form trustworthy relationships with visitors?
What is the current state of your website, social media and other promotional tools?
How would you describe the strengths and weaknesses of your strategy to reach potential visitors?
How could you raise awareness about your products and services?</td>
</tr>
<tr>
<td colspan="3">Cost Structure
What are the costs of your key activities/resources?
What are the fixed and variable costs?
What major investments do you need to make?
Will you offer different prices to different visitor segments or different seasonal rates?
Can costs be reduced through savings in resource consumption?</td>
<td colspan="3">Revenue Streams
How will your business generate revenue?
What are visitors willing to pay?
What are the visitors currently paying?
What are the current competitive offerings?
How much does each key activity contribute to overall revenue?</td>
</tr>
<tr>
<td colspan="3">Eco-social costs
What ecological or social costs does your business model create?
Which of your key resources are non-renewable?
What major investments do you need to make?
Can costs be reduced through savings in resource consumption?</td>
<td colspan="3">Eco-social benefits
What ecological or social benefits does your business model provide?
Who are the beneficiaries of these benefits?
Which of your key resources are sustainable?
Does your business model emphasize on conservation practices?
Is your business model generating additional local value, such as new job opportunities or reduced pollution?</td>
</tr>
</table>

Appendix IV

Supplementary material: Questionnaires

Appendix IV: Questionnaire 1

Questions developed to perform semi-structured interviews on studying perceived impacts of climate change [Household survey]

Date: _____ Questionnaire number: _____ Time taken (in mins): _____

Basic information

Respondent's name: _____ Age: _____ Caste: _____
Gender: (a) Male _____ (b) Female _____ Winter village: _____ Summer village name: _____ Distance from market (km): _____ Distance from road (km): _____

1. Educational profile:
   (a) Primary _____ (b) Secondary _____ (c) High school _____ (d) Intermediate _____ (e) Bachelor and above _____ (f) Never attended _____
2. Main occupation: (a) Crop cultivation _____ (b) Livestock herding _____ (c) Government service _____ (d) Manual labor _____ (e) Homestay owner _____ (f) Roadside hotel/shop _____ (g) Tourist operator/guide/porter _____ (h) Other _____
3. Secondary (seasonal) occupation: (a) Crop cultivation _____ (b) Livestock herding _____ (c) Government service _____ (d) Manual labor _____ (e) Homestay owner _____ (f) Roadside hotel/shop _____ (g) Tourist operator/guide/porter _____ (h) Other _____
4. Yearly household income (in rupees):
   (a) On-farm (livestock production, crop sales, poultry, cultivation and sale of medicinal plants, beekeeping, wool production, etc.) i. Less than 100,000 _____ ii. 100,000- 200,000 _____ iii. 200,000- 300,000 _____ iv. More than 300,000 _____
   (b) Off-farm (wage labor, government job, private jobs, small business enterprise, collection and sale of medicinal plants from the wild, remittances, etc.) i. Less than 100,000 _____ ii. 100,000- 200,000 _____ iii. 200,000- 300,000 _____ iv. More than 300,000 _____
5. Livestock details: Total _____
   (a) Goat _____ (b) Sheep _____ (c) Cattle _____ (d) Horse _____ (e) Mule _____ (f) Yak _____ (g) Hybrid _____
6. Distance traveled with herd in summer season for good pastures (in kms): (a) 5-10 _____ (b) 10-20 _____ (c) More than 20 kms _____
7. Source of cooking: (a) Fuelwood _____ (b) Kerosene _____ (c) LPG _____
8. Availability of toilet: (a) Yes _____ (b) No _____
9. How often do you visit market to purchase goods? (a) 1-2 times/month _____ (b) 2-5 times/month _____ (c) more than 5 times/month _____
10. Do you sell dairy products? (a) Yes _____ (b) No _____
11. Do you produce wool? (a) Yes _____ (b) No _____

Perception regarding climate change

1. Have you noticed any change in the following categories of land-use during last 30 years?

Land use type	Increase	Decrease	No change
Built-up land			
Forests			
Roads			
Agricultural land			
Grazing land			
Water bodies			
Wasteland			

2. Have you heard about climate change (*Jal Vayu Parivartan*)? (a) Yes _____ (b) No _____ (if yes, where have you heard it from?
3. What are the main sources of climate change information in the region?
4. What do you think causes climate change?
5. How important is the issue of climate change to you personally? (a) Very important _____ (b) Not much important _____ (c) Don't know _____
6. What do you think about rainfall trends over the last 30-40 years?

Months	Increa-sed	Decrea-sed	Unpredi-ctable	No change	Don't know
Summer (March, April, May)					
Monsoon (June, July, August, September)					
Post-monsoon (October, November)					
Winter (December, January, February					
Total annual					

Other comments _____

7. What do you think about temperature trends over the last 30-40 years?

Months	Increa-sed	Decrea-sed	Unpredi-ctable	No change	Don't know
Summer (March, April, May)					
Monsoon (June, July, August, September)					
Post-monsoon (October, November)					
Winter (December, January, February					
Total annual					

Other comments _____

8. What do you think about rainfall frequency in the last 30-40 years? (a) Increasing _____ (b) Decreasing _____ (c) No change _____ (d) Unpredictable _____ (e) Don't know _____ (e) Other comments _____
9. What do you think about the length of the rainy season in last 30-40 years? (a) Increasing _____ (b) Decreasing _____ (c) No change _____ (d) Unpredict-able _____ (e) Don't know _____ (e) Other comments _____

10. What do you think about snowfall availability/occurrence over the last 30-40 years? (a) Increasing _____ (b) Decreasing _____ (c) No change _____ (d) Unpredict-able _____ (e) Don't know _____ (e) Other comments _____
11. Have you seen any changes have you seen in pastureland productivity? If yes, can you indicate the changes from the following: (a) Early maturing of vegetation _____ (b) Appearance of invasive species _____ (c) Unhealthy/ less nutritious grasses _____ (d) Scarce vegetation growth _____ (e) Encroachment of shrub species _____ (f) Increase in extent of pastureland _____ (g) Decrease in extent of pastureland _____ (h) No change _____ (i) Other comments _____
12. Please indicate your level of agreement on the following perceived changes in the past 30-40 years:

Variable	Yes	No	Don't know
Highly erratic rainfall			
Warming temperature			
Early onset of summer			
Change in cropping season			
Increase number of hot days			
Rapid melting of snow			
Decrease in number of rainy days			
Increased heat stress			
Increase in extreme events			
Drying up of water sources			
Increased occurrence of vector-borne diseases			
Change in cropping pattern			
Change in crop yield			
Change in crop maturation			
Change in flowering season			
Invasive species in pasturelands			
Increase in livestock diseases			
Lower availability of medicinal plants			
Lesser fodder for livestock			
Shifting up of grazing zones			

Other comments _____

13. Please indicate your level of agreement on the following perceived changes towards pasture productivity in the past 30-40 years:

Variable	Yes	No	Don't know
Shrinkage on pastureland			
Encroachment of shrub species			
Scare vegetation growth			
Unhealthy/less nutritious grass			
Appearance of invasive species			

Other comments _____

14. Do you think that less and low-quality fodder is affecting milk production? (a) Yes _____ (b) No _____ (c) Don't know _____

15. Do you think there has been a decline in the availability of medicinal plants from wild? If this is the case, what factors do you think are contributing to this decline? (a) Climate change _____ (b) Over-exploitation _____ (c) Both _____ (d) Any other _____ Other comments _____

Information on changing socio-economic dynamics

1. Have you reduced your herd size in the past/ recent years? (a) Yes _____ (b) No _____ If yes, please indicate your reason(s): _____
2. Are there any livestock diseases prevalent in this region? (a) Yes _____ (b) No _____ If yes, please indicate _____
3. Were there any livestock diseases 30 years ago? (a) Yes _____ (b) No _____ (c) Don't know _____ Other comments _____
4. Have you made any alterations to your seasonal migration pattern? (a) Yes _____ (b) No _____ If yes, please indicate your reason(s): _____
5. How much risk do you think rainfall and temperature variability is causing to the practice of transhumance? (a) High _____ (b) Medium _____ (c) Low _____ (d) Don't know _____
6. Do you depend on market for fodder/hay requirements? (a) Yes _____ (b) No _____ Other comments _____
7. What is/are your means of financial security during crop failure?
8. In last 30 years, what are the changes have you brought in crop production?
9. Are there activities that men/women used to perform before (when) that are not performed anymore? If so, why?
10. Do you think climate change has put an extra burden on women (for example, going distances for fetching water, fodder, etc.)? (a) Yes _____ (b) No _____ (c) Don't know _____ If yes, please indicate your reason(s): _____
11. Do you think climate change has created financial security within your community? (a) Yes _____ (b) No _____ (c) Don't know _____ Other comments _____
12. Do you think that there is a greater dependency on the market for food? (a) Yes _____ (b) No _____ (c) Don't know _____ If yes, please indicate your reason(s): _____
13. Do you think there has been a change in your dietary habits? (a) Yes _____ (b) No _____ (c) Don't know _____ If yes, please indicate your reason(s): _____
14. Do you think lack of resources (perhaps of water, fodder, food, etc.) have resulted in the social tensions within your community? (a) Yes _____ (b) No _____ (c) Don't know _____ If yes, please elaborate: _____
15. Do you think if the community has altered their means of livelihood in the past 20-30 years? If so, please elaborate on what novel means of livelihood have they adopted, and which ones have been abandoned?
16. Do you think if there are any impacts of perceived climatic changes on the community's overall wellbeing (including health, food and water, and income security)? If so, please elaborate.
17. Based on your understanding, what are the most severe changes the community is currently facing due to change in the climate?

18. Have any members of your family migrated to urban or semi-urban areas? If so, what were the reasons for their migration?
19. What adaptation measures have you taken (at household level) to cope up with the current climate variability? Please indicate your response from the following:

Measures	Yes/No	Additional comments
Delay in migration to summer settlements		
Change in migration route		
Changes livestock size and feeding practices		
Increased mobility (distance and frequency)		
Stocking up hay/fodder		
Increased use of agricultural residue for fodder/fuelwood		
Market dependency for fodder and food		
Crop diversification/ expansion (cash crops production)		
Changes in planting time of crops		
Cultivation of less water-intensive crops		
Use of chemical fertilizers/ pesticides for crop production		
Increased irrigation practices		
Land abandonment (fallow lands)		
Cultivation of medicinal plants in abandoned lands		
Collection and sale of non-timber forest products		
Collection and sale of wild medicinal plants		
Out-migration to urban/semi-urban areas		
Shift to non-pastoral livelihoods		

20. Have you encountered any barriers/challenges while adopting to aforementioned adaptive solutions? Please elaborate.
21. Please indicate your level of agreement on the following perceived hindrances to climate change adaptation:

Variable	Yes	No	Don't know
Lack of awareness to climate change			
Lack of knowledge regarding adaptation methods			
Lack of access to reliable information			
Lack of information dissemination methods			
Inadequate government support			

Inadequate external support from donor agencies, development agencies and NGOs			
Lack of community knowledge on adaptative strategies			
Insufficient financial resources to adapt to alternate strategies			
Limited technical knowledge and skills to develop and implement adaptation measures			
Lack of coordination and collaboration among stakeholders at different levels			

22. Do you believe that the changing climate dynamics will have a personal impact on you, either currently or in the future? If yes, how do you anticipate it will affect you?
23. Are there any government, non-government, private and/or NGO(s) institution working in your region for environmental protection and/or livelihood creation? If so, please elaborate.
24. Based on your understanding, who do you think should be responsible for financing measures to address climate change in the region? Please indicate all that apply: (a) State government _____ (b) National government _____ (c) Donor agencies _____ (d) NGOs _____ (e) Private sector _____ Other comments _____
25. Are there any additional environmental concerns that you believe should be considered as top priorities for the region? If so, please elaborate.
26. Any further comments?

Thank you for your cooperation!

Appendix IV: Questionnaire 2

Key questions to be discussed to study perceived impacts of climate change during Focus Group Discussions and Key Informant Interviews

1. According to you, do you think that there are different understandings or beliefs about the causes and impacts of climate change?
2. Can you elaborate in detail on any perceived annual and seasonal variability in rainfall? Please provide examples.
3. What is your opinion on increasing or decreasing of extreme rainfall events?
4. Have you noticed variations in winter/summer temperature trends in past years? Please provide examples.
5. Have you experienced increased frequency in the extreme events (such as drought patterns, hailstorms, thunderstorms, etc.) as well as hazardous events (such as flashfloods, landslides, etc.) in the past years?
6. What are the major extreme weather events you have experienced over the past years?
7. In what ways have extreme weather events, such as droughts, floods, and storms, affected the health and safety of people in the community? Have there been any significant impacts on vulnerable groups, such as women, children, and the elderly?
8. How has climate change affected the natural resources that people depend on for their livelihoods, such as water, soil, forests, and wildlife? How has this impacted food security and income generation?
9. Have changing climate affected the agricultural production and food security in the region? If yes, in what ways?
10. Have changes in weather patterns and extreme events affected access to water resources? If so, how?
11. Have changing climate impacted human health and well-being in your community? If so, how?
12. Have changing climate affected the local ecosystems and biodiversity? If yes, in what ways?
13. How has climate change affected traditional knowledge and practices in your community?
14. What kind of changes have you observed for the following? In your opinion, what are the most important climate-related challenges facing this community?

Variable	Comments
Highly erratic rainfall	
Warming temperature	
Early onset of summer	
Change in cropping season	
Increase number of hot days	
Rapid melting of snow	
Decrease in number of rainy days	
Increased heat stress	
Increase in extreme events	

Drying up of water sources	
Increased occurrence of vector-borne diseases	
Change in cropping pattern	
Change in crop yield	
Change in crop maturation	
Change in flowering season	
Invasive species in pasturelands	
Increase in livestock diseases	
Lower availability of medicinal plants	
Lesser fodder for livestock	
Shifting up of grazing zones	

15. Do you think that changes in weather patterns and availability natural resources affected the social and cultural fabric of the community, such as social relationships, gender roles, and community norms and values?
16. What are your thoughts on the increased workload burden on women as an indirect consequence of climate change?
17. Do you think that climate change impacts have intersected with other social and economic factors, such as migration, poverty, and gender inequality? If so, could you describe how have these factors influenced people's ability to cope with and adapt to climate change impacts?
18. Do you agree that changes in weather patterns and natural resources affected the aspirations and hopes for the future of the community, particularly for young people?
19. What are the adaptation measures taken up by you/ or as a community to cope up with climate change impacts?
20. Are there any opportunities for new economic activities or strategies that have emerged as a result of changing climate?
21. What kind of external support (from government, non-government, and private institutions) has the local community received and/or has been receiving for adaptation efforts?
22. How have government policies and programs affected the community's ability to cope with climate change impacts? Based on your understanding, do you think that these policies and programs adequately addressed the needs and concerns of the community?
23. What types of support or resources would be most helpful to this community in adapting to the impacts of climate change?
24. How could existing coping and adaptive strategies be strengthened and further developed in order to overcome these difficulties?
25. Looking ahead, what do you see as the biggest challenges and opportunities for this community in relation to climate change?
26. Please provide further information you consider relevant in the context of this survey.

Thank you for your cooperation!

Appendix IV: Questionnaire 3

Key questions developed to study the potential and prospects of ecotourism during Focus Group Discussions and Key Informant Interviews

I. Livelihood related challenges

1. What are the most significant challenges that your community faces? How do these challenges impact your livelihoods?
2. What are some of the current economic activities that individuals engage in your community?

II. Tourism potential and growth

1. From your understanding, when did the region initially witness an upsurge in tourism?
2. What are the main tourist attractions in the region?
3. Currently, what types of tourists visit Darma valley? Are they international tourists, domestic tourists, cultural tourists, or others?
4. In your opinion, have there been infrastructural developments directly influenced by tourism in the Darma region? For instance, roads, buildings, facilities, etc.
5. How would you assess the infrastructure development in your area compared to the past 5-10 years? What kinds of improvements have you observed?
6. What are the available options for accommodations in the area? For instance, guest houses, rest houses, homestays, hotels, etc.
7. On average, how long do tourists typically stay at these accommodation facilities?
8. Please provide an estimate of the average expenditure of guests utilizing different accommodation services.
9. What modes of transportation are available for tourists to reach Darma valley?
10. How do you facilitate bookings for accommodations and excursions for visitors?
11. Does tourism contribute to job creation for local residents? If yes, what types of employment opportunities are available?
12. Which members of the community are most actively involved in tourism-related activities?
13. Do you think tourism has contributed to the development of small businesses and entrepreneurship in the local community?
14. Are there any tourism businesses currently operating in the region? If so, kindly provide the names of these businesses and describe the activities they offer.
15. Is there a particular time of year when you experience a higher number of tourists?
16. During which time of the year do you observe the lowest number of tourists? How do you manage during such periods to sustain your operations?

17. Is there a consistent demand for your leisure activities throughout the year?
18. From your perspective, what kind of opportunities have emerged due to the presence of tourism in the region? (*This can include participation in government subsidy programs, skills development, capacity building, and other relevant aspects*)
19. Are you currently participating in any government subsidy programs that aim to promote tourism-related development in the region?
20. How has your life been impacted since you became involved in the tourism industry? Please elaborate on the economic gains and improvements in your quality of life.
21. How do you perceive the government's efforts in facilitating the growth of tourism in Darma?
22. Do you believe that the government has provided sufficient attention and support for maintaining the tourism infrastructure and attractions in the region?
23. Is there a perceived need for further infrastructural development in the area? If yes, please specify.
24. Do you believe that the protection of natural resources and tourism can coexist harmoniously?
25. Do you believe that the preservation of local heritage and tourism can be compatible?
26. Based on your understanding, how do you see the community response to the burgeoning interest in tourism development in the region?

III. Ecotourism potential and prospects

1. Do you believe that there is potential to develop ecotourism as an additional source of income?
    i. If yes, what are the reasons for your belief?
    ii. If no, what alternative recommendations would you propose?
2. Is there a perceived demand for ecotourism activities in and around Darma valley?
3. What ecotourism activities or attractions do you think would be most appealing to visitors?
4. Considering the abundant natural and cultural offerings of the region, what are the primary strengths that you see contributing to the development of ecotourism in this region?
5. What are the significant opportunities that you see for the growth of ecotourism in this region?
6. What kind of activities or initiatives do you think are most suitable to facilitate cultural exchange between visitors and the local community?
7. How do you perceive the impact of these interactions on cultural exchange and understanding between visitors and the local community?
8. How do you envision an ecotourism enterprise contributing to sustainable livelihoods in your community?
9. How do you perceive the role of local communities in the development and management of an ecotourism enterprise?
10. From your perspective, what is the significance of women's involvement in ecotourism-related services?

11. What kind of skills and capacities do you believe are required within the community to foster the growth of ecotourism in the region?
12. What are your thoughts on prioritizing the allocation of some resources for community development and environmental conservation projects?
13. What are the existing tourism (including ecotourism) policies and regulations in the region, and how successful are they in encouraging sustainable tourism development in the region?

IV. Challenges related to tourism/ecotourism growth

1. Are there any specific environmental challenges or concerns that have emerged due to tourism activities in the region?
2. What are the major threats and challenges that you currently observe or anticipate as obstacles to the development of tourism/ecotourism in this region? Please specify challenges related to:
    i. community engagement and participation
    ii. management and regulation
    iii. marketing and promotion
    iv. socio-cultural challenges
3. Have there been any conflicts or tensions arising between different stakeholders (e.g., local communities, government, tourists) due to tourism growth?
4. How have the livelihoods and traditional practices of local communities been impacted by tourism/ecotourism growth in the region?
5. Based on your understanding, how can the negative impacts of tourism (e.g. waste generation, resource depletion, cultural exploitation) be mitigated or minimized?
6. Do you think there exist challenges or concerns regarding the dependency of the local economy on tourism/ecotourism as the main source of income?

V. Recommendations

1. What are the potential strategies or solutions that you believe could address the challenges and support sustainable tourism/ecotourism growth in the region?
2. Are there any additional comments or suggestions you would like to provide regarding the challenges related to tourism/ecotourism growth in the region?

Thank you for your cooperation!

Appendix V

Photographs from field studies

Figure 1 Bhotia women during field interviews

Figure 2 A group of young people in Baun village enjoying playing sports, Panchachuli peaks can be seen at the backdrop

Figure 3 A significant number of Bhotia women engage in wage labor in a government-affiliated construction work in the region

Figure 4 Both men and women preparing fields for cultivation upon their arrival in April in Marchha village

Figure 5 Strategic placement of logs on the doors is commonly observed across all villages to protect the house from wildlife intrusion

Figure 6 In preparation for the provision of homestay services, a significant proportion of houses in the region have undergone recent renovations, reflecting their readiness to accommodate guests.

Figure 7 A Bhotia couple in Philam excavating soil to plant apple saplings. Facilitated by the government, the apple cultivation in the region is in a trial phase.

Figure 8 A young girl seen helping her father, a Shephard, in Sipu. Young children often return to their ancestral homes in Darma and participate in household chores.

Figure 9 Village Tidang as seen from returning from Sipu

Figure 10 Villagers from Sipu and Marccha are compelled to undertake extensive journeys beyond the Indo-Tibetan Border Police (ITBP)[26] checkpoint near Tidang. As depicted here, two women can be seen crossing an aged bridge with burdens on their backs.

[26] ITBP operates in the challenging border areas to maintain the security and integrity of India's borders with Tibet and China. It is also involved in various humanitarian and rescue operations, especially during natural disasters and emergencies.

Figure 11 KMVN igloos near Panchachuli base camp are largely operated by local guides and porters

Figure 12 The whole valley is surrounded by magnificent towering peaks adorned with glistening snow

Figure 13 An awe-inspiring sight unfolds with towering peaks adorned with lush forests near Sela

Figure 14 The region boasts with numerous waterfalls spread across all the villages

Figure 15 A female tourist accompanied with a guide traversing their way into the higher reaches of the valley

Figure 16 The majestic Panchachuli peaks come alive with the arrival of the first snowfall in the month of November

Figure 17 Newly constructed homestay in the village of Dugtu

Figure 18 Traditional Bhotia kitchen in a homestay in Dantu village

Figure 19 A glimpse of Bhotia museum in the nearest town of Dharchula

Figure 20 The traditional Bhotia craftsmanship exhibits the exquisite artistry and intricate techniques rooted in their tribal culture

Figure 21 A team of young Bhotia people returning to valley in November for preparation for alpine activities for adventure tourists

Figure 22 Separate washroom facilities for women (left) and men (right) in a homestay in Dugtu

Figure 23 ITBP personnel in Baling extending their transportation assistance to tourists in their military trucks (above) and communication support to local Bhotia community (below). In addition, ITBP frequently undertake rescue missions for both tourists and locals, especially during unforeseen and severe weather conditions.

Figure 24 An acquaintance with Gaddi pastorist from Himachal Pradesh near Go village

Figure 25 A local resident near Dantu carrying 'Darchyo' for religious ceremony

Figure 26 Solar powered streetlamps are seen in all villages in the valley

Figure 27 Ongoing road construction work between Nagling and Dugtu

Figure 28 The villages in Darma heavily lack in proper disposal of waste

Figure 29 Numerous sign boards along tourist routes in the valley are placed by UNEP, ADB, and the Government of Uttarakhand, promote cleanliness and discourage littering

Figure 30 FGD consultation sessions were conducted in most villages to comprehend community perspectives on regional transformations and evaluate the ecotourism potential.

Eidesstattliche Versicherung | Declaration of oath

Hiermit erkläre ich an Eides statt, dass ich die vorliegende Dissertationsschrift selbst verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe.

|

I hereby declare upon oath that I have written the present dissertation independently and have not used further resources and aids than those stated.

Hamburg | 08.06.2023

Deepika Rawat