Rangeland Management Strategy and Action Plan

of Karnali Province, Nepal (2026-2036)

Karnali Province Government
Ministry of Industry, Tourism, Forest and Environment
Birendranagar, Surkhet

A Yarsagunbu collector holding freshly harvested Yarsagunbu (*Ophiocordyceps sinensis*) in Ruppatan, Dolpa.
Photo: Uttam Babu Shrestha

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Preferred Citation
Ministry of Industry, Tourism, Forest and Environment. (2026). Rangeland Management Strategy and Action Plan of Karnali Province, Nepal, (2026-2036). Birendranagar Surkhet, Karnali Province, Nepal.

Technical Support
Global Institute for Interdisciplinary Studies (GIIS), Po.Box # 86. Lalitpur, Nepal
www.thegiis.org

Financial Support
International Center for Integrated Mountain Development (ICIMOD), Kathmandu Nepal and its Himalayan Resilience Enabling Action Programme (HI-REAP), funded by United Kingdom International Development
and USAID Biodiversity (Jal Jangal)

Published year: 2026

Approved by
Karnali Province Government, Ministry of Industry, Tourism, Forest and Environment
(By Minister Level decision)

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कर्णाली प्रदेश सरकार
उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालय
वीरेन्द्रनगर, सुर्खेत, नेपाल

पत्र-संख्या :

चलानी नम्बर : मिति :

माननीय मन्त्रीज्यूको भनाइ

कर्णाली प्रदेशका खर्क, पाटन तथा चरण क्षेत्र (Rangelands) हरू हाम्रो प्रदेशको महत्वपूर्ण प्राकृतिक सम्पदा हुन्। यी क्षेत्रहरूले जैविक विविधताको संरक्षण, स्थानीय समुदायको जीविकोपार्जन र समग्र आर्थिक विकासमा महत्वपूर्ण योगदान पुऱ्याउँदै आएका छन्। त्यसैले यी खर्क, पाटन तथा चरण क्षेत्रहरूको दिगो व्यवस्थापन आजको आवश्यकता मात्र नभई भविष्यको दायित्व पनि हो।

यसै सन्दर्भमा उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालयद्वारा तयार गरिएको "चरण क्षेत्र व्यवस्थापन रणनीति तथा कार्ययोजना (RMSAP)" अत्यन्तै महत्वपूर्ण दस्तावेजको रूपमा रहेको छ। यसले कर्णाली प्रदेशका विभिन्न जिल्लामा रहेका खर्क, पाटन तथा चरण क्षेत्रहरूको अवस्था, चुनौती तथा सम्भावनाहरूको विश्लेषण गरी दिगो व्यवस्थापनका लागि स्पष्ट मार्गदर्शन प्रदान गरेको छ।

यो कार्य सम्पन्न गर्न सहयोग पुऱ्याउनुहुने मन्त्रालयका सचिव अजित कुमार कर्ण, प्रदेश वन निर्देशनालयका निर्देशक शेरबहादुर श्रेष्ठ तथा मातहतका कर्मचारीहरु, विभिन्न राष्ट्रिय तथा अन्तर्राष्ट्रिय संस्थाहरू, विज्ञहरू, अध्ययन टोली, सरकारी निकायहरू तथा स्थानीय समुदायप्रति म हार्दिक आभार व्यक्त गर्दछु। विशेष गरी स्थानीय गोठाला, आदिवासी तथा समुदायका प्रतिनिधिहरूको सक्रिय सहभागिताले यस कार्यलाई अझ प्रभावकारी बनाएको छ।

म विश्वास गर्दछु कि यस रणनीति तथा कार्ययोजनाको प्रभावकारी कार्यान्वयनबाट कर्णाली प्रदेशका खर्क, पाटन तथा चरण क्षेत्रहरूको संरक्षण, पुनर्स्थापना तथा सदुपयोगमा महत्वपूर्ण योगदान पुग्नेछ। साथै, यसले स्थानीय समुदायको जीवनस्तर उकास्न र समग्र प्रदेशको दिगो विकासमा टेवा पुऱ्याउनेछ।

अन्त्यमा, यस महत्वपूर्ण कार्यमा संलग्न सम्पूर्ण व्यक्ति तथा संस्थाहरूलाई पुनः धन्यवाद ज्ञापन गर्दै, यसको सफल कार्यान्वयनका लागि सबै पक्षसँग सहकार्य र प्रतिबद्धताको अपेक्षा गर्दछु।

मानेनीय, सुरेश अधिकारी
मा. सुरेश अधिकारी
मन्त्री
उद्योग, पर्यटन, वन तथा वातावरण
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Acknowledgements

Rangelands are the dominant form of land use in Karnali Province, underpinning unique and rich biodiversity, while also supporting livelihoods and the local economy. To promote sustainable rangeland management and address the threats and challenges to these ecosystems, the Ministry of Industry, Tourism, Forests, and Environment (MoITFE) prepared the Rangeland Management Strategy and Action Plan (RMSAP).

Several organizations and individuals played pivotal roles in preparing this report. We are deeply grateful to those who contributed directly and indirectly in bringing this report to its final stage.

First, on behalf of MoITFE, I would like to express my sincere gratitude to the USAID Biodiversity Program for providing financial support to undertake this assessment in four districts (Humla, Jumla, Mugu, Kalikot). We would like to thank the International Centre for Integrated Mountain Development (ICIMOD) and its Himalayan Resilience Enabling Action Programme (HI-REAP), funded by United Kingdom International Development through its flagship Climate Action for a Resilient Asia (CARA) initiative, for providing financial support to study in three districts (Dolpa, Jajarkot, West Rukum) and Global Institute for Interdisciplinary Studies (GIIS) for their pro bono contribution to data analysis in three districts (Dailekh, Salyan, Surkhet).

I am thankful to the study team members Dr. Uttam Babu Shrestha (Lead), Dr. Bharat Babu Shrestha, Dr. Sujata Shrestha, Dr. Pushpa Raj Acharya, and Mr. Shiba Raj Ghimire for data collection, analysis, and report writing. Special thanks to Uma Dhungel, Tulasa Chaudhary, Sanjita Khanal, Shirish Maharjan, Suraj Joshi, Nishan Baral, Anuja Shrestha, Jeevan Prakash Katel and Sunita Rokaya of GIIS for their contributions to field data collection and report preparation.

I acknowledge Mr. Narayan Belbase, Dr. Baburam Lamichhane and Bhupendra Shahi (USAID Biodiversity), Dr. Yi Shaoliang, Dr. Tashi Dorji, Dr. Srijana Joshi, and Ramesh Timilsina (ICIMOD) and Mun Bahadur Rawat (DFO, Dolpa), Mahesh Kumain (DFO, Kalikot), and Tejendra Bahadur Rawal (DFO, Jumla) for their critical comments and inputs for improving this report. My sincere thanks go to Prof. Ram P. Chaudhary (Tribhuvan University), who graciously agreed to review the entire report and provided valuable feedback.

We are also thankful to all stakeholders including local herders, indigenous peoples and local communities, representatives from local municipalities, government officials (including division forest offices, veterinary service offices), NGOs, civil society organizations such as community forestry user groups, who participated in focus group discussions, key informant interviews, local consultations, and district-and Province-level workshops.

We extend our gratefulness to all the data providers who made their data open and accessible, without their contribution, this would not have been possible.

Last but not least, I extend my sincere thanks to Mr. Sher Bahadur Shrestha of the Provincial Forest Directorate for leading, coordinating, and guiding this effort on behalf of MoITFE.

Mr. Ajeet Kumar Karn
(Secretary)
Ministry of Industry, Tourism, Forests, and Environment

A domesticated yak in Limi, Humla
Photo: **Uttam Babu Shrestha**

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Rangeland area covered by *Rhododendron nivale* in Limi Valley, Humla
Photo: Uttam Babu Shrestha

Executive Summary

Rangelands, also called as '*Patan*', '*Lekh*', or '*Kharka*' in Nepali, are areas dominated by native grasses, forbs, shrubs and bushes that serve as a source of forage for native and domestic animals. Rangelands are vital for biodiversity and livelihoods, particularly in Karnali Province, which hosts 34% of the total rangelands of the country. These ecosystems are vital for supporting local economies, biodiversity, and cultural heritage but they face significant challenges such as land-use change, climate change, invasive species, overgrazing, abandonment of pastoral practices, and human-wildlife conflicts. Additional issues such as limited market access, inadequate technical capacity, and institutional barriers, pose challenges in maintaining the productivity and sustainable management of these rangelands.

Recognizing the urgency of addressing these pressing challenges faced by rangelands in Karnali Province, the Ministry of Industry, Tourism, Forests, and Environment (MoITFE) has developed the Rangeland Management Strategy and Action Plan (RMSAP). This comprehensive RMSAP aims to promote the sustainable use and management of rangelands by enhancing productivity, conserving biodiversity, maintaining ecosystem integrity, and supporting the livelihoods of local communities. The RMSAP outlines targeted strategies to mitigate threats to rangelands while maximizing their ecological and socioeconomic contributions.

This Rangeland Management Strategy and Action Plan (RMSAP) aims to promote the sustainable use and management of rangelands by enhancing productivity, conserving biodiversity, maintaining ecosystem integrity, and supporting the livelihoods of local communities.

The RMSAP for Karnali Province was developed through an extensive analysis of rangeland status and trends utilizing 23 years of remote sensing data along with secondary data on biodiversity, ecosystem services, and both anthropogenic and natural drivers of rangeland change. The approach involved a comprehensive review of scientific literature, policies, and case studies related to rangelands. Stakeholder consultations were conducted at local (eight), district (seven), and provincial (one) levels through workshops, focus group discussions (FGDs), and key informant interviews. These consultations included herders, Non- Timber Forest Products (NTFPs) traders, local leaders, government officials, non-governmental stakeholders, and experts, ensuring that the local perspectives and insights were included in RMSAP.

The RMSAP of Karnali Province is structured into seven chapters. **Chapter One** comprises the background, objectives, scope, and methodology of the RMSAP. **Chapter Two** provides the current state and trends of rangelands in the Province, covering their extent, changes in rangeland biodiversity, livestock-rearing practices, and identifies the key ecosystem services provided by rangelands. **Chapter Three** explores the direct drivers such as land-use change, climate change, invasive species, pollution, and direct extraction and indirect drivers including demographic and technological changes, economic, cultural, and social influences, as well as governance and institutional factors that impact rangelands both positively and negatively. **Chapter Four** outlines opportunities of sustainable rangeland management,

highlights past efforts, achievements, gaps and challenges. **Chapter Five** provides vision, mission, guiding principles and strategies for rangeland management along with the sectoral and cross-sectoral strategies to address the identified challenges and threats. **Chapter Six** presents the implementation framework, detailing implementing institutions, and funding and capacity needs and governance structures necessary for effective execution of RMSAP. **Chapter Seven** provides a monitoring, evaluation and learning framework to examine RMSAP's effectiveness and ensure alignment with national and international goals and targets.

Status and Trends of Rangelands in Karnali Province

Karnali Province, the largest among Nepal's seven Provinces, spans 30,211 km^2, constituting 20.7% of the country's total land area. Its topography is highly varied, with elevations ranging from 190 m to over 7,746 m. The terrain is characterized by steep slopes, deep valleys, plateaus and rugged mountains, with more than 40% of the area situated above 4,000 m. The Province features six distinct climatic zones: humid subtropical (Cwa), subtropical highland with monsoon influence (Cwb), humid continental (Dwb), subarctic or subpolar climate (Dwc), tundra (ET), and ice cap (EF). The varied topography, climate, and physiography make Karnali Province one of the most biologically diverse and unique regions in Nepal.

Karnali Province is a cultural mosaic, rich in ethnic diversity, with population of 1.69 million (5.79% of Nepal's total population) making the least populated Province in Nepal. The dominant ethnic group is the Kshetri (42.2%), followed by Bishwokarma (16.2%), Thakuri (10.5%), Magar (10.4%), and Brahmin-Hill (8%). Additionally, over 32 languages are spoken, with Nepali being the most widely spoken language (88.9%). The Sinja Valley in Jumla is considered as the origin of the Khas Nepali language. Economically, Karnali is one of the least developed Provinces in Nepal, contributing just 4.3% to the National Gross Domenstic Product (GDP) in the fiscal year 2080/81 BS. The Province has the highest levels of multi-dimensional poverty, with over 600,000 people living in poverty. The primary sectors contributing to the economy are agriculture, forestry, and fishing, which together account for 29.5% of Karnali's GDP. Only 56.8% of households in the Province have access to electricity to the national grid and road infrastructure is inadequate, with 717 km of blacktopped roads out of a total of 1,657 km national highway and feeder roads till 2023 AD.

Importance of Rangelands

Rangelands in Karnali Province cover 1,160,788 ha (11,607 km^2), accounting for 34% of Nepal's total rangeland area. These rangelands are rich in biodiversity, hosting 1,698 plant taxa from 104 families, including 995 forbs, 230 shrubs, 200 grasses, and 91 legumes. Additionally, 27 species of mushrooms have been reported from the high-elevation rangelands of Karnali Province. Rangelands also provide habitats for 41 mammals, 181 birds, 11 amphibians, and 94 butterflies. Among these flora and fauna, 79 plant species, 41 mammal species, 10 bird species, two amphibian species and one reptile species are listed under various categories of IUCN Red List.

Rangelands in Karnali Province harbor 92 traded medicinal species including 82 actively traded species in contemporary markets generating approximately 36 million Nepali rupees (~US$243,000) annually as revenue. The five most traded species by volume—*Zanthoxylum armatum, Polygonatum* spp., *Nardostachys jatamansi, Juniperus* spp., and *Bergenia ciliata*—account 67% of the total trade volume. Additionally, Karnali's rangelands also harbor 87 species of wild edible plants and seven species of edible mushrooms.

Rangelands in Karnali Province provide grazing grounds for over 2.16 million domestic animals. Livestock products such as milk, meat, and wool are vital to the local economy while also fulfilling the dietary needs of local people. High-elevation rangelands also serve as a critical source of household energy, regulate water resources for local and downstream communities and conserve soil. They play a critical role in carbon sequestration, although their full potential remains unquantified. These areas are home to diverse pollinators, supporting agricultural productivity in surrounding regions. Rangelands are also integral to the cultural identity, with traditions like transhumance and the presence of sacred and religious sites embedded in local practices. Furthermore, rangelands serve as living laboratories for scientific studies, offering unique research opportunities for scientists, researchers, and students.

Tourism is another important service provided by rangelands, with key trekking

routes and touristic destinations passing through rangelands attracting over 16,000 visitors annually. Twenty-seven key touristic destinations including monasteries/gompas, temples, cultural and natural landscape areas and water bodies and four major trekking routes in Karnali—namely the Limi Valley (Humla) Trek, Shey Phoksundo National Park (Dolpo), Rara Lake Trek, and Upper/Lower Dolpo Trek—pass through these rangelands. The scenic landscapes not only attract visitors for trekking but also support cultural tourism, benefiting the local economy.

Rangeland Changes

Karnali's rangelands are experiencing rapid changes in vegetation, livestock populations and species diversity. Satellite-derived Normalized Difference Vegetation Index (NDVI) data revealed that rangelands in Karnali Province have undergone significant transformations from 2000 to 2023. While 5.0% (526 km^2) of rangelands showed positive greenness trends, indicating improved vegetation, 1.6% (162 km^2) showed negative trends, reflecting vegetation loss.

The Province experienced mixed trends in livestock populations between 2011 and 2021. On average, the cattle, sheep, and buffalo populations declined by 9.18%, 9.33%, and 8.13% respectively while the goat population increased by 26.25%. According to the IUCN Red List assessment, 79 species primarily bird, plant and mammal species were identified with declining populations, 16 species showed increasing populations, and 176 species had stable populations.

Drivers of Rangeland Change

Rangelands are directly and indirectly affected by natural or human-induced factors. Direct drivers affecting rangelands include land-use change, climate change, invasive species, pollution, and resource extraction, forest fire and lightning. Indirect drivers, also called "underlying causes," include demographic, governance, economic, and technological factors that affect rangelands by influencing direct drivers.

Land use and land cover change such as agricultural expansion (roads), urbanization, infrastructure development, and changes in grazing practices (e.g., intensification or abandonment) have impacted rangelands. Karnali Province has seen a rapid growth in the length of roads from 842 km in 2004 to 1,657 km in 2023. The construction of roads and other infrastructure projects in and around the rangeland areas has led to massive soil erosion, landslides, and siltation problems in recent decades. The landslides have reduced the grazing areas, decreased soil-water storage, and increased runoff affecting the rangeland health. Encroachment of rangelands for agriculture albeit occurring on a smaller scale, is one of the major drivers of degradation.

Karnali Province has witnessed significant changes in average annual temperature and precipitation patterns from 1950 to 2023. Rangeland areas situated between 2,000 to 5,000 m elevation experienced significant warming with increased extreme heat indices. Similarly, annual precipitation has decreased in many parts of the Province, leading to increased dryness in recent years.

Out of the 30 species of invasive alien plant species (IAPs) reported in Nepal, 19 have already been identified in Karnali Province, with the region potentially suitable for 21 species. Although rangeland habitats are currently less impacted by IAPs, they pose future risks to rangeland biodiversity, ecosystem functions, and socioeconomic stability. Currently, high-elevation rangelands are increasingly dominated by shrubs, weeds and woody species, including *Rumex nepalensis* ('Halhale'), a native but non-palatable perennial herb.

Pollution in the high-elevation pastures, though currently on a smaller scale, is becoming an increasingly serious issue, especially due to the activities of NTFP collectors, the growing number of domestic tourists, and the increasing use of non-degradable materials by local communities. During the Yarsagunbu collection season, tens of thousands of harvesters visit high-elevation rangelands every year, impacting rangeland health and littering of non-degradable materials during the collection season.

Extractive activities such as the collection of medicinal plants, grazing, and hunting and poaching are direct drivers of rangeland change. Over-extraction of resources negatively impacts biodiversity, leading to the depletion of species and degradation of soil health in rangeland ecosystems. Despite the variation in livestock populations by locations, the overall livestock population is increasing, contributing

to overgrazing. Likewise, unsustainable and overharvesting of medicinal species driven by high market demand and prices has resulted in the population decline of commercially harvested species. Additionally, hunting and poaching of snow leopard, goral, and musk deer cause significant threats to their survival. Human-wildlife conflicts further exacerbate these challenges causing human deaths and injuries, livestock predation, and crop raiding which often lead to retaliatory killings of wildlife.

Fire incidents in rangelands across Karnali Province have increased by 80 cases annually over the past 23 years. Fires damage vegetation, degrade soil, and disrupt ecosystems, leading to long-term impacts on rangeland health. The increasing frequency and intensity of forest fires, driven by climate change and human activities, are a growing concern for rangeland management. However, controlled buring is useful for rangeland health. Furthermore, lightning is another major hazard, causing significant livestock losses, with more than 100 animals lost annually in the last five years. Endemic livestock diseases along with emerging diseases like Lumpy Skin Disease, cause significant economic losses for livestock farmers in the Province.

Traditionally, animal husbandry was an integral part of agriculture, home-based industries, and local trade in Karnali, with livestock holdings considered a symbol of wealth. However, with modernization, improved connectivity to the outside world, and increasing migration, this traditional view has shifted. Increasing youth migration has led to a significant shortage of traditional herding practices, overburdening remaining herders. Additionally, male migration has led to the feminization of agriculture and pastoralism, placing a heavier burden on women to manage households, agriculture and livestock. This shift has profound implications for both the pastoral system and the women who now bear the primary responsibility for these activities.

The erosion of traditional customary practices related to rangeland management is a major concern in Karnali Province. The loss of traditional knowledge is often closely tied to the abandonment of local practices. The erosion of customary rights and the imposition of top-down management approaches have alienated local communities, diminishing their capacity to manage rangelands sustainably.

The governance of rangelands in Karnali Province is often hindered by the absence of rangeland-focused policies, weak institutional frameworks, and inadequate enforcement of existing sectoral policies and regulations. Additionally, the absence of clear land tenure systems and conflicting provisions between customary practices, statutory laws and new policies has impacted access, management and ownership of rangeland ecosystems.

Sustainable Rangeland Management

Although some efforts have been made to manage rangelands through sectoral policies, the integration of the rangeland component to national level strategies, along with programs related to awareness and capacity building and research, is essential for developing a comprehensive management strategy and action plan. This RMSAP outlines strategies and actions to address the challenges and harness opportunities of sustainable rangeland management in Karnali Province. By promoting sustainable practices, improving rangeland productivity, conserving biodiversity, and supporting the livelihoods of local communities, the plan aims to achieve the long-term sustainability of rangeland ecosystems.

This RMSAP is guided by eight guiding principles including sustainability, community empowerment, maximizing multiple benefits, inclusiveness and equitable, adaptive management, collaboration, integration and ecosystem-based approach.

The RMSAP is structured around five mutually reinforcing strategies that together establish a science-based, community-centered, and climate-resilient approach to rangeland management.

Strategy 1 focuses on integrated rangeland governance, planning, and data systems. It addresses long-standing gaps in tenure clarity, institutional coordination, and evidence-based decision-making by harmonizing rangeland-related policies across sectors and establishing a comprehensive, GIS-based rangeland information system. The strategy also strengthens Rangeland User Groups with inclusive representation, enabling local communities—particularly women, pastoralists,

and indigenous groups—to play a central role in defining grazing rules, resolving conflicts, and managing benefits in alignment with municipal and provincial plans.

Strategy 2 promotes sustainable grazing and livestock management based on ecological carrying capacity. Through systematic rangeland assessments, adaptive grazing systems, and community-based pasture monitoring, this strategy seeks to balance livestock numbers with forage availability, prevent further degradation, and support vegetation recovery. Complementary investments in mobile veterinary services, community animal health workers, fodder management, and herder safety aim to improve livestock productivity, reduce mortality, and enhance resilience in remote high-elevation rangelands.

Strategy 3 addresses ecosystem restoration and biodiversity conservation across rangelands. Using nature-based solutions and traditional practices, it targets the restoration of degraded rangelands, stabilization of erosion-prone areas, rehabilitation of wetlands and riparian zones, and control of invasive and unpalatable species. The strategy also prioritizes the conservation of biodiversity-rich rangelands, critical habitats, and wildlife corridors, including integration of rangeland management within protected areas through regulated grazing, co-management, and measures to reduce livestock–wildlife conflict. Wildfire risk management and post-fire recovery are embedded as essential components of ecosystem resilience.

Strategy 4 advances sustainable rangeland-based livelihoods and a green bio-economy. It promotes sustainable harvesting and governance of non-timber forest products (including high-value species), local value addition through processing, certification, and market linkages, and diversification of income through rangeland-based ecotourism and green enterprises. Incentive mechanisms such as Payment for Ecosystem Services (PES) are piloted to reward communities for stewardship of water, biodiversity, and carbon-related services, linking conservation outcomes with tangible economic benefits.

Strategy 5 strengthens capacity development, coordination, research, and awareness. This strategy builds the technical and institutional capacity of government agencies, local governments, and communities; establishes a provincial to local knowledge coordination platform; promotes applied research and innovation using advanced monitoring tools; and institutionalizes multi-level coordination through a Provincial Rangeland Management Committee. It also provides a framework for engaging federal authorities on transboundary grazing issues affecting northern Karnali districts.

The implementation of the RMSAP supported by the outlined institutional framework, adequate funding and capacity building will not only conserve and sustainably manage rangelands in Karnali Province but also help to achieving targets of Nepal's third National Biodiversity Strategy and Action Plan (NBSAP) (currently under preparation), national developmental plans such as Nepal's 16th Plan as well as global sustainability goals like Sustainable Development Goals (SDGs) and Kunming-Montreal Global Biodiversity Framework (GBF).

Kiang *(Equus kiang)* observed in Limi Valley, Humla
Photo: Uttam Babu Shrestha

Churpi, a traditional hard cheese made from chauri milk, recognized as one of the hardest cheeses in the world
Photo: Uttam Babu Shrestha

कार्यकारी सारांश

पृष्ठभूमी

मुख्यतः घाँस प्रजातिले ढाकेका तर फाट्टफुट्ट झाडी तथा ससाना रुखहरू पनि रहेका विशाल घाँसे मैदानी भूभागलाई नेपालीमा खर्क, पाटन वा लेक तथा अंग्रेजीमा रेन्जल्यान्ड (rangeland) भनिन्छ। यस्ता खर्कहरू मुख्यतः घरपालुवा पशुवस्तु तथा जङ्गली जनावरहरूको चरिचरनका लागि उपयोग हुँदै आएका छन्। नेपालको कुल भूभागको करिब १५ प्रतिशत हिस्सा यस्ता खर्क वा पाटन क्षेत्रले ओगटेको छ। प्रदेशगत रूपमा हेर्दा कर्णाली प्रदेशमा नेपालकै सबैभन्दा धेरै खर्क क्षेत्र रहेका छन्। कर्णाली प्रदेशले नेपालको कुल भूभागको करिब २० प्रतिशत क्षेत्रफल समेटे पनि देशको कुल खर्क क्षेत्रको ३४ प्रतिशत हिस्सा यही प्रदेशमा पर्दछ।

क्षेत्रफलको दृष्टिले मात्रै होइन, खर्क कर्णाली प्रदेशका लागि अत्यन्तै महत्वपूर्ण प्राकृतिक स्रोत र सामाजिक सम्पदा पनि हो। खर्कहरूले यहाँका बासिन्दाहरूका लागि पशुपालन, जडीबुटी सङ्कलनलगायत प्रत्यक्ष आय-आर्जन हुने कृयाकलापमा सहयोग पुऱ्याउनुका साथै प्रदेशको समृद्धि र जैविक विविधता संरक्षणमा समेत महत्वपूर्ण भूमिका खेल्दै आएका छन्। तर पछिल्ला वर्षहरूमा जलवायु परिवर्तन, भू-उपयोगमा आएको परिवर्तन, मिचाहा, झाडीदार, पशुस्तुले नखाने प्रजातिहरूको फैलावट, अधिक चरिचरन, अत्यधिक दोहन, पशुपालन गर्नेहरूको संख्यामा आएको कमी, मानव-वन्यजन्तु द्वन्द्व, चट्याङ, वन डढेलो लगायतका कारण हिमाली खर्कहरूको अवस्था क्रमशः खस्कँदै गएको छ र त्यहाँको जैविक विविधतामा ह्रास आइरहेको छ।

यसका साथै पशुपालक कृषक, जडीबुटी सङ्कलनकर्ता तथा व्यापारीजस्ता खर्कमा प्रत्यक्ष आश्रित समुदायहरूले उचित बजारको अभाव समेत झेलिरहेका छन्। खर्कसम्बन्धी कानुनी तथा संरचनागत अस्पष्टता, साथै यसको व्यवस्थापनका लागि आवश्यक आर्थिक र प्राविधिक क्षमताको कमीका कारण खर्कको दिगो उपयोग र प्रभावकारी व्यवस्थापन हुन सकेको छैन।

कर्णाली प्रदेशका खर्क तथा खर्कमा आश्रित जीवजन्तु र मानव समुदायले सामना गरिरहेका चुनौतीहरूको समाधानका लागि कर्णाली प्रदेश सरकारको उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालयले कर्णाली प्रदेश खर्क व्यवस्थापन रणनीति तथा कार्ययोजना (२०२६-२०३६) तयार पारेको हो। यस रणनीति तथा कार्ययोजनाले खर्कको उत्पादनशीलता वृद्धि गर्दै, जैविक विविधताको संरक्षण र पारिस्थितिकीय प्रणालीको अक्षुण्णता प्रवर्द्धन गर्दै, खर्कमा प्रत्यक्ष तथा अप्रत्यक्ष रूपमा आश्रित समुदायहरूको जीविकोपार्जनमा सहयोग पुऱ्याउने उद्देश्य लिएको छ।

यस रणनीतिक कार्ययोजना प्रतिवेदन तयार पार्न विभिन्न अध्ययन विधिहरू अपनाइएका छन्। प्रदेशका खर्कहरूको अवस्था र समयक्रमिक परिवर्तन मापन गर्न सन् २००१ देखि २०२३ सम्मका मोडिस (MODIS) भू-उपग्रहले खिचेका तस्बिरहरू विश्लेषण गरिएको छ। खर्कको जैविक विविधता, पारिस्थितिकीय सेवाहरू तथा खर्क परिवर्तनका मानवजन्य र गैर-मानवजन्य चालक वा कारकहरू (drivers) सम्बन्धी तथ्याङ्क विभिन्न माध्यमिक स्रोतहरूबाट सङ्कलन गरिएको छ।

यसका साथै राष्ट्रिय तथा अन्तर्राष्ट्रिय रूपमा प्रकाशित खर्क तथा खर्क व्यवस्थापनसम्बन्धी वैज्ञानिक लेख, नीतिगत दस्तावेज र खर्क सम्बन्धित घटनाहरूको अध्ययन तथा संलेषण पनि यसमा समावेश गरिएको छ। अध्ययनको क्रममा कर्णाली प्रदेशमा स्थानीय तहस्तर (८), जिल्लास्तर (७) र प्रदेशस्तर (१) गरी विभिन्न कार्यशाला गोष्ठीहरूको आयोजना गरिएको थियो। ती कार्यशाला गोष्ठीहरूमा खर्क विज्ञ, सम्बन्धित सरकारी निकायका अधिकारी, गैरसरकारी संस्थाका प्रतिनिधि, स्थानीय जन प्रतिनिधी, पशुपालक कृषक, जडीबुटी सङ्कलक तथा व्यापारी र नागरिक समाजका प्रतिनिधिलगायत विविध सरोकारवालाहरूको सहभागिता रहेको थियो।

त्यसका अतिरिक्त, खर्क क्षेत्रमा सामूहिक छलफल, पशुपालक तथा जडीबुटी सङ्कलकसँग प्रत्यक्ष प्रश्नोत्तर, खर्क अवलोकन, तथा त्यहाँ पाइने वनस्पति र वन्यजन्तुको अवस्था मापन जस्ता थप अनुसन्धानका विधिहरू पनि प्रयोग गरिएको थियो। यसरी विभिन्न स्रोत र विधिबाट सङ्कलित तथ्याङ्क, सूचना तथा सरोकारवालासँगको परामर्शबाट प्राप्त सुचना र अन्तर्दृष्टिहरूको निचोड यस प्रतिवेदनमा समावेश गरिएको छ।

यस प्रतिवेदनमा निम्नलिखित सात अध्यायहरू समावेश छन् ।

- **अध्याय** १ मा कर्णाली प्रदेशको खर्क व्यवस्थापन रणनीति तथा कार्ययोजनाको पृष्ठभूमि, उद्देश्य, दायरा, र अध्ययन कार्यविधि समावेश गरिएको छ ।
- **अध्याय** २ मा कर्णाली प्रदेशका खर्कहरूको वर्तमान स्थिति, फैलावट, तथा खर्कको प्राकृतिक-सामाजिक प्रणाली र त्यसमा आश्रित जैविक विविधताको अवस्था प्रस्तुत गरिएको छ । यस अध्यायमा पशुपालनका अभ्यासहरूमा भएका परिवर्तनहरूको व्याख्या गरिनुका साथै खर्कले स्थानिय र बाहिरका मानव समुदायका लागि प्रदान गर्ने विभिन्न प्रत्यक्ष तथा अप्रत्यक्ष पारिस्थितिक सेवासुविधा (ecosystem services) वा योगदानहरूको चर्चा पनि गरिएको छ ।
- **अध्याय** ३ मा खर्कको पारिस्थितिकीय प्रणाली, जैविक विविधता, तथा पशुपालनलाई प्रत्यक्ष र अप्रत्यक्ष रूपमा प्रभाव पार्ने चालकहरू समेटिएका छन् । यस अध्यायमा खर्कलाई सकारात्मक वा नकारात्मक रूपमा प्रभाव पार्ने प्रत्यक्ष चालकहरू–जस्तै भूउपयोग परिवर्तन, जलवायु परिवर्तन, झाडी तथा मिचाहा प्रजातिहरूको फैलावट, प्रदूषण, र मानवीय दोहन–र अप्रत्यक्ष चालकहरू–जस्तै जनसांख्यिक तथा प्राविधिक परिवर्तन, आर्थिक, सांस्कृतिक र सामाजिक प्रभावहरू, तथा शासकीय संस्थागत संरचनाहरू–बारे विस्तृत रूपमा व्याख्या गरिएको छ ।
- **अध्याय** ४ मा खर्कको दिगो व्यवस्थापनका अवसरहरू, त्यसका लागि विगतमा गरिएका प्रयासहरू, प्राप्त उपलब्धि, सुधार गर्नुपर्ने पक्षहरू, तथा खर्क व्यवस्थापनका प्रमुख चुनौतीहरू समेटिएका छन् ।
- **अध्याय** ५ मा खर्क व्यवस्थापनका दूरदृष्टि, अभियान, मार्गदर्शक सिद्धान्त, आवश्यक क्षेत्रगत तथा पार-क्षेत्रगत रणनीतिहरू, र ती रणनीति अन्तर्गतका कार्ययोजनाहरू समावेश गरिएको छ ।
- **अध्याय** ६ मा खर्क व्यवस्थापन रणनीतिको प्रभावकारी कार्यान्वयनका लागि आवश्यक संस्थागत संरचना, आर्थिक स्रोत, तथा क्षमता विकाससम्बन्धी विवरणहरू प्रस्तुत गरिएको छ ।
- **अध्याय** ७ मा खर्क व्यवस्थापन रणनीति कार्यान्वयनको प्रभावकारिता मुल्यांकन गर्न, तथा राष्ट्रिय र अन्तर्राष्ट्रिय लक्ष्य तथा उद्देश्यहरूसँग यस रणनीतिको समाञ्जस्यता सुनिश्चित गर्न आवश्यक अनुगमन, मूल्याङ्कन र सिकाइ (Monitoring, Evaluation and Learning—MEL) को रूपरेखा प्रस्तुत गरिएको छ ।

कर्णालीका खर्कहरुको वर्तमान स्थिति र परिवर्तन

नेपालका सात प्रदेशहरू मध्ये क्षेत्रफलको दृष्टिले सबैभन्दा ठूलो कर्णाली प्रदेशको क्षेत्रफल २०,२११ वर्ग किलोमिटर रहेको छ, जुन नेपालको कुल भूभागको २०.७% हो । यस प्रदेशको स्थलाकृतिमा व्यापक विविधता छ; यहाँको भूभाग समुद्री सतहदेखि १९० मिटरदेखि ७,७४६ मिटरसम्म फैलिएको छ । यहाँका भूभाग अति भिराला जमिनदेखि गहिरा उपत्यका, पठारयुक्त पहाड र अग्ला हिमालहरूले भरिएका छन् । तथापि प्रदेशको कुल क्षेत्रफलको ४०% भन्दा बढी भूभाग ४,००० मिटरभन्दा माथि अवस्थित छ ।

प्रदेशमा मुख्यतः छ वटा पृथक जलवायु क्षेत्रहरू पाइन्छन्– (क) आद्र उपोष्ण, (ख) मनसून प्रभावित उच्चभूमि उपोष्ण, (ग) आद्र महाद्वीपीय, (घ) उपध्रुवीय जलवायु, (ङ) टुन्ड्रा, र (च) हिमक्षेत्र । विविधतायुक्त स्थलाकृति, जलवायु र भौगोलिक विशेषताहरूले कर्णाली प्रदेशलाई जैविक विविधताको हिसाबले नेपालकै सबैभन्दा धनी र अद्वितीय प्रदेश बनाएको छ ।

जैविक विविधताको हिसाबले मात्रै होइन, कर्णाली प्रदेश एक सांस्कृतिक संगम पनि हो । यहाँ जातीय, धार्मिक र सांस्कृतिक विविधता प्रचुर मात्रामा पाइन्छ । पछिल्लो जनगणना अनुसार, यस प्रदेशको जनसंख्या १६ लाख ९० हजार (नेपालको कुल जनसंख्याको ५.७९%) रहेको छ । उक्त संख्या प्रदेशगत हिसाबले अन्य प्रदेशहरूको तुलनामा सबैभन्दा कम हो । यहाँका प्रमुख जातीय समूहहरूमध्ये सबैभन्दा धेरै क्षेत्री (४२.२%), विश्वकर्मा (१६.२%), ठकुरी (१०.५%), मगर (१०.४%) र पहाडे बाहुन (८%) छन् । प्रदेशभित्र ३२ भन्दा बढी भाषाभाषी प्रचलनमा भएतापनि नेपाली भाषा सबैभन्दा धेरै (८८.९%) बोलिने भाषा हो । यस प्रदेशको जुम्ला जिल्लाको सिन्जा उपत्यकालाई नेपाली खस भाषाको उद्गम स्थलको रूपमा लिइन्छ ।

आर्थिक दृष्टिले कर्णाली प्रदेश नेपालका सबैभन्दा कम विकसित प्रदेशहरूमध्ये एक हो । यस प्रदेशले आर्थिक वर्ष २०८०/८१ मा देशको कुल ग्राहस्थ उत्पादनमा केवल ४.३% मात्रै योगदान गरेको थियो । प्रदेशमा बहुआयामिक गरिबीको स्तर अत्यधिक छ; यहाँ ६ लाखभन्दा बढी मानिसहरू गरिबीमा जीवनयापन गरिरहेका छन् । प्रदेशको कुल उत्पादनमा कृषि, वन र मत्स्य क्षेत्रको योगदान बढी छ । र उक्त आर्थिक क्षेत्रले कर्णालीको कुल ग्राहस्थ उत्पादनको २९.५% हिस्सा ओगटेका छन् ।

पूर्वाधारको हिसाबले पनि कर्णालीको अवस्था राम्रो छैन । प्रदेशका केवल ५६.८% घरपरिवारमा मात्रै राष्ट्रिय प्रसारणबाट विद्युत् पहुँच पुगेको छ । सडक पूर्वाधार अपर्याप्त छ । सन् २०२३ सम्म राष्ट्रिय राजमार्ग र शाखा सडकको कुल लम्बाइ १,६५७ किमी पुगेको छ, जसमध्ये ७१७ किमी मात्र कालोपत्रे सडक रहेका छन् ।

खर्कको बहुआयामिक महत्व

कर्णाली प्रदेशमा खर्कहरूले १,१६०,७८८ हेक्टर क्षेत्र ओगटेका छन्, जुन नेपालको कुल खर्क क्षेत्रफलको ३४% हो। यहाँका खर्कहरू जैविक विविधताले धनी छन् र विविध प्रकारका वनस्पति तथा जीवजन्तुका महत्वपूर्ण बासस्थान हुन्। यहाँका खर्कहरूमा १०४ वनस्पतिक परिवार अन्तर्गतका १,६९८ प्रजातिका वनस्पतिहरू हालसम्म पाइएका छन्। कर्णाली प्रदेशका उच्च हिमाली खर्कमा गरिएको सर्वेक्षणमा २७ प्रजातिका च्याउहरू पाइएका थिए। यहाँका खर्कहरूमा ४१ प्रजातिका स्तनधारी जनावर, १८१ प्रजातिका चरा, ११ प्रजाति उभयचर, र ९४ प्रजातिका पुतली पाइएको छ। पहिचान हुन बाँकी रहेका अझै धेरै वनस्पति, च्याउ तथा वन्यजन्तुहरू पनि यस प्रदेशका खर्कमा हुने विश्वास गरिन्छ।

यी वनस्पति तथा जीवजन्तुहरूमध्ये ७९ वनस्पति, ४१ प्रजातिका स्तनधारी, १० प्रजातिका चरा, २ प्रजातिका उभयचर र १ सरीसृप विश्व संरक्षण संघ (IUCN) को रातोसूची (Red List) अन्तर्गतका विभिन्न संकटपन्न वर्गहरूमा सूचीकृत छन्।

कर्णाली प्रदेशका खर्कहरू जडीबुटीका खानी पनि हुन्। खर्कहरूमा हाल बजारमा बिक्री-वितरण भइरहेका ९२ औषधीय प्रजातिका जडीबुटीहरू पाइएका छन्। ती जडीबुटीको व्यापारबाट वार्षिक रूपमा औसत करिब ३ करोड ६० लाख रुपैयाँ राजस्व सङ्कलन हुने गरेको छ। परिमाणका हिसाबले यस प्रदेशमा सबैभन्दा धेरै व्यापार हुने पाँच प्रजातिहरू–टिमुर, सेतकचिनी, जटामसी, धुपी र पाषाणवेद–ले कुल सङ्कलनको ६७% हिस्सा ओगटेका छन्। जडीबुटी मात्रै होइन, कर्णालीका खर्कहरूमा ८७ प्रजातिका जङ्गली खानयोग्य वनस्पति तथा ७ प्रजातिका खानयोग्य च्याउको पनि पहिचान भएको छ।

जडीबुटी तथा खाद्य प्रजातिहरूका अतिरिक्त, कर्णालीका खर्कहरूले प्रदान गर्ने सबैभन्दा महत्वपूर्ण पारिस्थितिकीय सेवा पशु चरन हो। यहाँका खर्कहरूमा २१ लाख ६० हजारभन्दा बढी घरपालुवा जनावरहरूले चरिचरन गर्दछन्। पशुपालन यहाँका अधिकांश मानिसहरूको जीविका र आर्थिक उत्पादनको आधार हो। पशुपालनबाट हुने दूध, मासु र ऊन आदि उत्पादनहरूले स्थानीय अर्थतन्त्रमा अत्यन्त महत्वपूर्ण भूमिका खेलेका छन्। साथै, यसले स्थानीय जनताको आहार आवश्यकतामा योगदान दिनुका साथै खेतबारीका लागि मलको आपूर्ति पनि गर्दछ। उच्च उचाइका खर्कहरूमा पाइने झाडीदार वनस्पति र गुइँठाले खाना पकाउनका लागि घरायसी ऊर्जाको स्रोतका रूपमा पनि प्रयोग हुने गर्दछ।

खर्कले स्थानीय बासिन्दाका लागि जडीबुटी र खाद्यान्नजस्ता सामग्री मात्रै होइन, तल्लो तटीय बासिन्दाका लागि पानी लगायतका पर्यावरणीय सेवाहरू पनि प्रदान गर्दछ। कर्णाली प्रदेशका उच्च भूभागका खर्कहरू पानीका मुहान हुन्। हिउँदमा हिउँ जम्ने त्यस्ता स्थानहरूमा वर्षायाममा हिउँ पग्लिएर आउने पानीले तल्लो तटीय क्षेत्रका खोलानालाहरूलाई निरन्तरता दिन मद्दत पुऱ्याउँछ। खर्कमा पाइने वनस्पतिले माटो बग्न नदिने र भूक्षय रोक्ने भएकाले माटो संरक्षणमा योगदान पुऱ्याउँछन्।

खर्कमा पाइने वनस्पतिले आफ्नो बोट र माटोमार्फत वायुमण्डलको कार्बन सञ्चित गर्ने भएकाले कार्बन सञ्चितीकरण गरी जलवायु परिवर्तन न्यूनिकरणमा पनि योगदान पुऱ्याउँछन्। यद्यपि खर्कका यस्ता नियमनकारी सेवाहरूको मापन र आर्थिक मूल्याङ्कन अझै हुन सकेको छैन। खर्कहरू विविध प्रकारका परागसेचन गर्ने किरा, पुतली तथा चराहरूका बासस्थान पनि हुन्। ती परागसेचकहरूले बाली-नालीमा फल लाग्न महत्वपूर्ण भूमिका निभाउने भएकाले कृषि प्रणालीलाई उत्पादनशील बनाउन सहयोग पुऱ्याउँछन्।

खर्कहरूसँग मौसमी रूपमा गोठ सार्दै चरिचरन गराउने उभौली-उद्यौली (transhumance) जस्ता थुप्रै परम्परागत अभ्यासहरू पनि जोडिएका छन्। यस प्रदेशका महत्वपूर्ण देवीदेवताका मन्दिर, गुम्बा आदि पवित्र धार्मिक स्थलहरू खर्कमै अवस्थित छन्। त्यसैले खर्कले स्थानीय धार्मिक-सांस्कृतिक पहिचानका लागि पनि महत्वपूर्ण भूमिका खेलेको छ।

यस्ता स्थलहरूको भ्रमण गर्न स्वदेशी तथा विदेशी पर्यटकहरू आउने गर्दछन्। यस प्रदेशका चार मुख्य पदमार्गहरू– लिमी भ्याली पदमार्ग (हुम्ला), शे-फोक्सुण्डो राष्ट्रिय निकुञ्ज पदमार्ग (डोल्पा), रारा ताल पदमार्ग (मुगु), तथा माथिल्लो/तल्लो डोल्पा पदमार्ग– थुप्रै खर्क हुँदै जाने गर्दछन्। यी पदमार्गका अतिरिक्त, प्रदेशका २७ प्रमुख पर्यटक आकर्षण स्थलहरू (जस्तैः मठ/गोम्पा, मन्दिर, सांस्कृतिक तथा प्राकृतिक परिदृश्य अवलोकनस्थल, ताल-तलैया आदि) खर्क क्षेत्रमा पर्दछन्। प्रदेशका दुई संरक्षित क्षेत्र शे-फोक्सुण्डो राष्ट्रिय निकुञ्ज र रारा राष्ट्रिय निकुञ्जमा वार्षिक रूपमा १६,००० भन्दा बढी पर्यटकहरू आउने-जाने गर्दछन्, जसले स्थानीय अर्थतन्त्रलाई फाइदा पुऱ्याएको छ।

खर्कको अर्को महत्वपूर्ण, तर प्रायः अदृश्य र गैर-मौद्रिक फाइदा भनेको यी क्षेत्रहरू जीवित प्रयोगशाला (living laboratory) जस्तै भएकाले वैज्ञानिक, अनुसन्धानकर्ता तथा विद्यार्थीहरूलाई अध्ययन-अनुसन्धान र अनुभवका अवसरहरू प्रदान गर्नु हो।

खर्क परिवर्तनका कारक वा चालकहरू

पछिल्ला केही दशकयता यस प्रदेशका खर्क तथा चरनहरू प्राकृतिक वा मानवजन्य कारणहरूले प्रत्यक्ष वा अप्रत्यक्ष रूपमा मासिँदै गइरहेका छन्। खर्कहरूमा प्रभाव पार्ने प्रत्यक्ष

कारकहरूमा भू-उपयोग परिवर्तन, जलवायु परिवर्तन, मिचाहा तथा झाडीदार प्रजातिहरूको फैलावट, प्रदूषण, मानवीय दोहन, वन डढेलो, र चट्याङ आदि पर्दछन्। "अन्तर्निहित कारक शक्ति" (underlying causes) पनि भनिने अप्रत्यक्ष चालकहरू– जस्तै जनसांख्यिक, आर्थिक तथा प्रविधिमा आएको परिवर्तन, साथै व्यवस्थापनका लागि अपनाइएका शासकीय नीति-नियम र कार्यक्रमहरू–ले प्रत्यक्ष कारकहरूलाई प्रभावित गरी खर्कको अवस्थालाई परिवर्तन गर्न अप्रत्यक्ष भूमिका खेल्दै आएका छन्।

यस प्रदेशका खर्क क्षेत्रमा खर्क मासेर खेती गर्ने, खर्कलाई असुरक्षित बनाउँदै सडक लगायतका भौतिक संरचना निर्माण गर्ने, तथा परम्परागत चरिचरन त्याग्ने जस्ता भू-उपयोग परिवर्तन देखिएका छन्। यस्ता अभ्यासहरूले खर्कको प्राकृतिक अवस्था र जैविक विविधतामा नकारात्मक असर पारेका छन्। कर्णाली प्रदेशमा सन् २००४ मा जम्मा ८४२ किमी पक्की सडक भएकोमा सन् २०२३ सम्म त्यो लगभग दोब्बर भई १,६५७ किमीसम्म पुगेको छ। स्थानीय तहमा निर्माण गरिएका सडकहरूको भने ठोस हिसाब-किताब उपलब्ध छैन।

खर्क क्षेत्रमा वातावरणीय तथा भौगोलिक संवेदनशीलता नबुझी जथाभावीसँग बनाइएका सडक लगायत पूर्वाधारहरूले ठूलो मात्रामा माटो कटान, भूस्खलन/पहिरो, तथा त्यसबाट बगेको माटोले खर्क पुरिने जस्ता समस्या निम्त्याएका छन्। पहिरो तथा भूस्खलनले चरन क्षेत्रहरू साँघुरिनुका साथै माटोको पानी सञ्चित गर्ने प्राकृतिक क्षमतालाई घटाएको छ र समग्र खर्कको स्वास्थ्यमा नकारात्मक असर पुऱ्याएको छ। प्रदेशका केही स्थानमा खर्क अतिक्रमण गरेर खेतीपाती गर्ने अभ्यास भएतापनि त्यो अहिले सानो स्तरमा छ, तर यसले सार्वजनिक खर्क क्षेत्रलाई खुम्च्याएको छ।

कर्णाली प्रदेशको सन् १९५० देखि २०२३ सम्मका मौसमी सूचकाङ्कहरू विश्लेषण गर्दा औसत वार्षिक तापक्रम र वर्षाको ढाँचामा महत्वपूर्ण परिवर्तनहरू देखापरेका छन्। विशेषगरी खर्क अत्यधिक भएका २,००० देखि ५,००० मिटर उचाइका क्षेत्रमा तातोपन उल्लेखनीय रूपमा बढेको छ, जसले चरम गर्मीका सूचकाङ्कहरूमा वृद्धि ल्याएको छ। साथै प्रदेशका धेरै भूभागमा वार्षिक औसत वर्षाको मात्रा घट्दै गएको र पछिल्ला वर्षहरूमा सुख्खापन बढिरहेको देखिन्छ। हावापानीमा भएको यस्तो फेरबदलले अन्यत्रका खर्कमा नकारात्मक असर पारेको सन्दर्भमा यहाँका खर्कमा पनि त्यस्तै प्रभाव परेको अनुमान गर्न सकिन्छ, यद्यपि यसको विशिष्ट अध्ययन सीमित छ।

मिचाहा, पशुवस्तुले नखाने झार तथा झाडीदार वनस्पतिको फैलावट खर्क खस्किनुको अर्को प्रमुख कारण हो। नेपालमा हालसम्म पहिचान भएका ३० प्रजातिका मिचाहा वनस्पति (invasive alien plant species) मध्ये १९ प्रजाति कर्णाली प्रदेशमा पाइएका छन्। तथापि हावापानी उपयुक्तताको आधारमा यस प्रदेशमा २१ प्रजातिसम्म फैलिन सक्ने सम्भावना रहेको देखिन्छ, त्यसकारण थप प्रजाति फैलिने जोखिम उच्च छ। हाल यस्ता मिचाहा प्रजातिहरू खर्क क्षेत्रमा धेरै नफैलिएका भएतापनि, खर्क भएका क्षेत्रमा झाडी/बुट्यान तथा गाईवस्तुले नखाने चाउले, हलहले (स्थानिय नाम) जस्ता वनस्पतिहरूको फैलावट भने उल्लेखनीय छ। यसले खर्कको जैविक विविधता र पारिस्थितिकीय स्वास्थ्यमा नकारात्मक असर पारिरहेको छ र खर्कमा आधारित आर्थिक-सामाजिक सम्बन्धहरूलाई पनि क्रमशः जोखिमतर्फ धकेलिरहेको छ।

उच्च हिमाली चरन क्षेत्रमा प्रदूषण (हाल सानो स्तरमा भएतापनि) निरन्तर बढ्दो छ। विशेष गरी यार्सागुम्बा लगायत जडीबुटी सङ्कलनकर्ताहरूका गतिविधि, घरेलु पर्यटकको संख्यामा वृद्धि, तथा स्थानीय समुदायमा तत्कालै नसड्ने/नगल्ने प्लास्टिकजस्ता सामग्रीको बढ्दो प्रयोगका कारण चरन क्षेत्रहरूमा फोहर र प्रदूषण बढिरहेको छ। यार्सागुम्बा सङ्कलन समयमा प्रत्येक वर्ष हजारौँ सङ्कलकहरूले उच्च भेगका खर्कमा छोड्ने चाउचाउ/बिस्कुटका खोल, थोत्रा कपडा, त्रिपालका टुक्रा, सिसा र प्लास्टिकका बोतलहरूले खर्कहरूलाई फोहर बनाउँदै लगिरहेका छन्, जसको कारण खर्कको स्वास्थ्यमा तथा त्यहाँ आश्रित जङ्गली जनावरको स्वास्थ्यमा नकारात्मक असर पुगिरहेको छ।

खर्कको दिगोपनका लागि अर्को चुनौती भनेको खर्कका स्रोतहरूको अत्यधिक मानवीय दोहन हो। अव्यवस्थित जडीबुटी सङ्कलन, अत्यधिक चरन, तथा वन्यजन्तुको चोरी र अवैध शिकार जस्ता दोहनकारी गतिविधिले खर्कको जैविक विविधतामा नकारात्मक असर पारिरहेका छन्। कर्णाली प्रदेशमा पाइने यार्सागुम्बा, सेतकचिनी, जटामसी, कुटकी लगायत केही जडीबुटीको बजारभाउ उच्च भएकाले तिनको सङ्कलन प्राकृतिक पुनःउत्पादन दरभन्दा बढी भइरहेको छ, जसका कारण ती प्रजातिको संख्या घट्दै गएको देखिन्छ।

त्यसैगरी, स्थानअनुसार पशु संख्यामा फेरबदल भएतापनि धेरै ठाउँमा पशु संख्या बढ्दो छ, र ती स्थानहरूमा खर्कको भारवहन क्षमता वा पशु संख्या धान्ने क्षमता (carrying capacity) भन्दा बढी चरिचरनका कारण घाँसहरू मासिँदै गएका छन्। यसले माटो क्षयीकरण बढाउने, खर्कको पारिस्थितिकीय स्वास्थ्य घटाउने, तथा मरुभूमीकरणलाई बढाउने जोखिम सिर्जना गरेको छ। तर कतिपय स्थानमा भारवहन क्षमताभन्दा कम चरिचरनका कारण झाडीदार वनस्पति तथा पशुवस्तुले नखाने वनस्पति बढिरहेको अवस्था पनि देखिन्छ।

हिँउ चितुवा, घोरल, झारल, कस्तुरी, डाँफे, मुनाल लगायत वन्यजन्तुको चोरी र अवैध शिकारले तिनको अस्तित्वमा गम्भीर खतरा निम्त्याएका छन्। साथै, वन्यजन्तुको आक्रमणबाट मानव मृत्यु/घाइते हुने, पशुमाथि आक्रमण, र बाली विनाश हुने जस्ता मानव-वन्यजन्तु द्वन्द्वका घटनाहरूले प्रतिशोधस्वरूप वन्यजन्तुलाई मार्ने जस्ता घटना पनि भएका छन्। यसका कारण कतिपय खर्क क्षेत्रमा पाइने संरक्षित जनावरको संख्यामा पनि फेरबदल हुने स्थिति सिर्जना भएको छ।

मोडिस नामक भू-उपग्रहबाट सङ्कलित डढेलो-सम्बन्धी सूचनाको विश्लेषण गर्दा कर्णाली प्रदेशका खर्कमा विगत २३ वर्षमा डढेलोका घटनाहरूमा वृद्धि भएको देखिन्छ (वार्षिक करिब ८० घटनाको दरले वृद्धि भएको उल्लेख गरिएको छ)। नियन्त्रित आगलागीले खर्कको स्वास्थ्यमा सकारात्मक असर पारे पनि डढेलोले खर्कमा आश्रित वनस्पति र वन्यजन्तुलाई नोक्सान पुऱ्याउँछ। निरन्तर डढेलो लागिरहेमा माटो बग्ने प्रक्रिया तीव्र भई भूस्खलन बढ्न सक्छ, जसको दीर्घकालीन असर खर्कको स्वास्थ्यमा गम्भीर हुन सक्छ। जलवायु परिवर्तनका कारण बढ्दो तापक्रम र सुख्खापनले डढेलोको आवृत्ति तथा तीव्रता पछिल्ला वर्षहरूमा बढाइरहेको छ, जुन खर्क व्यवस्थापनका लागि थप चिन्ताको विषय बनेको छ।

खर्कमा असर पुऱ्याउने अर्को महत्वपूर्ण प्राकृतिक कारक चट्याङ हो। चट्याङका कारण विगत पाँच वर्षमा कर्णालीका खर्कमा वार्षिक १०० भन्दा बढी पशुधनको मृत्यु भएको तथ्याङ्कले देखाउँछ। खर्कमा चर्ने पशुहरूमा समय-समयमा देखिने लम्पी स्किन जस्ता आयातित रोगहरूले पनि प्रदेशका पशुपालकहरूलाई ठूलो आर्थिक क्षति पुऱ्याइरहेका छन्।

खर्कलाई प्रभावित गर्ने विभिन्न अप्रत्यक्ष चालकहरू पनि छन्। बदलिँदो आर्थिक-सामाजिक रूपान्तरण त्यसमध्येको एक हो। कर्णालीमा परम्परागत रूपमा पशुपालन कृषि, घरेलु उद्यम र स्थानीय व्यापारको अभिन्न अङ्ग थियो। पशुधनलाई सम्पत्ति र सामाजिक प्रतिष्ठाको प्रतीक मानिन्थ्यो; अर्थात समाजका धनी र शक्तिशाली मानिसहरूसँग पशु संख्या धेरै हुने गर्थ्यो। तर पछिल्लो समयमा आधुनिकीकरण, यातायातमार्फत बाह्य संसारसँगको बढ्दो सम्पर्क, तथा आप्रवासनका कारण उक्त परम्परागत दृष्टिकोणमा फेरबदल आएको छ। धनी परिवारहरूको बसाइँसराइ र युवाहरूको बढ्दो आप्रवासनले परम्परागत पशुपालन अभ्यासमा परिवर्तन ल्याएको छ। कतिपय ठाउँमा, जस्तै हुम्लाको लिमी उपत्यकामा पशु संख्या पहिलेको तुलनामा अहिले निकै घटेको छ।

पुरुषहरू रोजगारीका लागि भारत लगायतका मुलुकतर्फ जाने क्रमसँगै पशुपालनको जिम्मेवारी महिलामाथि आएको छ। घरायसी जिम्मेवारी तथा खेतीकिसानीसँगै पशुपालन व्यवस्थापनको बोझ थपिँदा महिलाहरू थप सकसमा परिरहेका छन्। खर्क व्यवस्थापनसँग सम्बन्धित परम्परागत दिगो अभ्यासहरूमा आएको तीव्र क्षयीकरण पनि अर्को चुनौती हो। युवा पुस्ता खर्कसम्बन्धी अभ्यासप्रति अनिच्छुक हुँदै पशुपालन त्याग्ने क्रममा परम्परागत ज्ञान, सिप र अभ्यास हराउँदै गएका छन्। यसले खर्कको उचित व्यवस्थापन गर्ने स्थानीय क्षमतामा ह्रास ल्याएको छ।

माथि उल्लेखित प्रत्यक्ष तथा अप्रत्यक्ष कारकहरूका साथै कर्णाली प्रदेशमा खर्क खस्किनुमा खर्कसम्बन्धी नीति-नियममा विद्यमान अस्पष्टता, खर्क केन्द्रित नीतिको अभाव, कमजोर संस्थागत संरचना तथा विद्यमान प्रादेशिक नीति-नियमको अपर्याप्त कार्यान्वयन पनि जिम्मेवार छन्। थप रूपमा, खर्क क्षेत्रको स्वामित्वसम्बन्धी कानुनी प्रावधान र स्थानीय अभ्यासबीचको द्वन्द्वपूर्ण अवस्था खर्क व्यवस्थापनलाई अझ चुनौतीपूर्ण बनाइरहेको छ।

खर्कको दिगो व्यवस्थापन

उपरोक्त चुनौतीहरूका बाबजुद पनि कर्णाली प्रदेशमा खर्क व्यवस्थापनका लागि कुनै प्रयास नभएका भने होइनन्। राष्ट्रिय रूपमा खर्क नीति निर्माण गरिएको थियो (यद्यपि उक्त नीति निर्माण भएपश्चात देशमा संघीयता लागू भएकाले सो नीति हाल प्रायः निष्प्रभावी जस्तै बनेको छ)। यसका अतिरिक्त, वन ऐन-२०७६ र स्थानीय सरकार सञ्चालन ऐन-२०७४ जस्ता कानुनी प्रावधानहरूमा खर्कसम्बन्धी विषयहरू आंशिक रूपमा समेटिएका छन्।

त्यसैगरी, कर्णाली प्रदेश सरकारले पनि पछिल्ला नीति तथा कार्यक्रमहरूमा खर्कसम्बन्धी सवालहरू समेट्ने प्रयासहरू गरेको छ। पशुपालनलाई प्रोत्साहन गर्न 'गोठालो भत्ता' जस्ता उत्प्रेरणामूलक कार्यक्रमहरू पनि लागू गरिएका छन्। तथापि, यस्ता कार्यक्रमहरू अस्थायी, परियोजनामुखी र छरिएका भएकाले अपेक्षित उपलब्धि हासिल गर्न सकिएको छैन।

यसै सन्दर्भमा, प्रदेशस्तरमा खर्कको दिगो उपयोग र उचित व्यवस्थापनका लागि एकीकृत, दीर्घकालीन र बहुआयामिक रणनीति आवश्यक भएको महसुस गरी यो कर्णाली प्रदेशको खर्क व्यवस्थापन रणनीति तथा कार्ययोजना तयार पारिएको हो।

यस रणनीति तथा कार्ययोजनाले सन् २०३५ सम्म कर्णाली प्रदेशका खर्कहरूको संरक्षण, पुनर्स्थापना र दिगो उपयोग मार्फत प्रदेशको समृद्धिमा योगदान पुऱ्याउने दीर्घदृष्टि बोकेको छ। यसले प्रकृतिमा आधारित र दिगो अभ्यासहरू अवलम्बन गरी खर्कको उत्पादकत्व सुधार गर्दै, जैविक विविधताको संरक्षण गर्दै, खर्कमा प्रत्यक्ष तथा अप्रत्यक्ष रूपमा आश्रित

समुदायहरूको जीविकोपार्जनलाई सुदृढ बनाउँदै, खर्कसँग जोडिएका आर्थिक तथा सामाजिक-सांस्कृतिक मूल्यहरूको अभिवृद्धि गर्ने लक्ष्य राखेको छ।

यस रणनीति तथा कार्ययोजनाले हाल खर्क व्यवस्थापनमा देखिएका चुनौतीहरूको उचित सम्बोधन गर्ने, खर्कसँग जोडिएका अवसरहरूको पहिचान र उपयोग गर्ने, तथा त्यसका लागि आवश्यक रणनीति र क्रियाकलापहरूको स्पष्ट रूपरेखा प्रस्तुत गरेको छ।

यो खर्क व्यवस्थापन रणनीति तथा कार्ययोजना निम्न आठ मार्गदर्शक सिद्धान्तहरू द्वारा निर्देशित छः दिगोपना, सामुदायिक सशक्तिकरण, बहुआयामिकता, न्यायसंगत समावेशीता, अनुकुलित व्यवस्थापन, सहकार्य, एकीकरण, र प्रकृतिमा आधारित समाधान (Nature-based Solutions, NbS)।

यी सिद्धान्तहरूको अवलम्बनमार्फत प्रदेशका खर्कहरूको दीर्घकालीन पारिस्थितिक, सामाजिक र आर्थिक स्थायित्व हासिल हुने विश्वास यस रणनीति तथा कार्ययोजनाले लिएको छ। साथै, यस रणनीतिको प्रभावकारी कार्यान्वयनले नेपालको राष्ट्रिय जैविक विविधता रणनीति, दिगो विकास लक्ष्य (SDGs), जैविक विविधता महासन्धी (CBD) का लक्ष्यहरू, तथा जलवायु परिवर्तनसम्बन्धी पेरिस सम्झौता लगायतका राष्ट्रिय तथा अन्तर्राष्ट्रिय दिगोपना, जैविक विविधता संरक्षण, र जलवायु अनुकूलन तथा न्यूनिकरणका लक्ष्यहरू प्राप्त गर्न योगदान पुऱ्याउने अपेक्षा गरिएको छ।

रणनीतिहरू

यस रणनीति तथा कार्ययोजना पाँचवटा एकआपसमा परिपूरक तथा परस्पर सहयोगी प्रमुख रणनीतिहरूमा आधारित छ, जसले खर्क क्षेत्र व्यवस्थापनका लागि विज्ञानमा आधारित, समुदाय-केन्द्रित तथा जलवायु-प्रवलनशिल उपायहरूलाई अवलम्बन गरेको छ।

रणनीति १: एकीकृत खर्क व्यवस्थापन योजना तथा तथ्यांक प्रणाली

यस रणनीतिले खर्क क्षेत्रसँग सम्बन्धित खर्कभूमिको स्वामित्व र उपयोग अधिकारको अस्पष्टता, संस्थागत समन्वयको कमजोरी तथा प्रमाण-आधारित निर्णय प्रक्रियामा रहेका दीर्घकालीन चुनौतीहरूलाई सम्बोधन गर्नेछ। यसका लागि कृषि, पशुपालन, वन तथा स्थानिय भूमि प्रशासनसँग सम्बन्धित नीति र नियमहरूबीच सामञ्जस्य कायम गरिनेछन्। भौगोलिक सुचना प्रविधीमा आधारित एकीकृत खर्क क्षेत्र सूचना प्रणालीको विकास गरिनेछ। साथै, महिला, गोठाला कृषक तथा आदिवासी/स्थानीय समुदायहरूको समावेशी प्रतिनिधित्व सुनिश्चित गर्दै खर्क उपभोक्ता समितिहरूलाई सुदृढ बनाइनेछ। उक्त समितिहरूले स्थानिय पालिका र प्रदेश सरकारका नितिनियमका अधिनमा रही चरिचरनका नियम निर्धारण, द्वन्द्व समाधान तथा लाभ बाँडफाँड व्यवस्थापनमा प्रमुख भूमिका खेल्नेछ।

रणनीति २: दिगो चरन र पशुपालन व्यवस्थापन

यस रणनीतिले खर्क क्षेत्रको पारिस्थितिक वहन क्षमताको आधारमा दिगो चरन र पशुपालनलाई व्यवस्थित गर्नेछ। खर्कक्षेत्रको भार क्षमता र स्वास्थ्यको नियमित मूल्याङ्कन गरी तथा समुदाय-आधारित चरनको अनुगमन मार्फत, पशुधन संख्या र घाँसको उपलब्धताबीच सन्तुलन कायम गरिनेछ। त्यस्ता अनुकुलित चरन व्यवस्थापनले खर्कभूमीलाई थप क्षय हुनबाट रोक्नेछ तथा वनस्पति पुनःस्थापनालाई सहयोग पुऱ्याउनेछ। साथै, घुम्ती पशुचिकित्सा सेवा विस्तार, सामुदायिक पशु स्वास्थ्य कार्यकर्ता, आहार व्यवस्थापन तथा गोठालाको सुरक्षासम्बन्धी तालिम लगायतका कृयाकलाप मार्फत पशुपालनको उत्पादकत्व वृद्धि हुनको साथै पशु मृत्युदरको न्यूनीकरण हुनेछ, जसले उच्च हिमाली तथा दुर्गम खर्क क्षेत्रका पशुपालक कृषकहरूको आयमा वृद्धि हुनेछ र जीविका सहज बन्नेछ।

रणनीति ३: खर्क क्षेत्र पारिस्थितिक पुनर्स्थापना र जैविक विविधता संरक्षण

यस रणनीतिले प्रकृतिमा आधारित समाधान तथा परम्परागत अभ्यासहरूको प्रयोगमार्फत खर्क क्षेत्रको पारिस्थितिक प्रणालीको पुनर्स्थापना र जैविक विविधता संरक्षणलाई जोड दिएको छ। यसअन्तर्गत क्षयग्रस्त खर्क क्षेत्रहरूको पुनर्स्थापना, भू क्षय-जोखिमयुक्त क्षेत्रहरूको स्थिरीकरण, ताल तलैया, सिमसार तथा नदीकिनार क्षेत्रहरूको पुनःस्थापना, र बाह्य मिचाहा तथा पशुवस्तुले नखाने प्रजातिहरूको नियन्त्रण र व्यवस्थापन गरिनेछ। साथै, जैविक विविधताले भरिपूर्ण खर्क क्षेत्र, वन्यजन्तुका महत्वपूर्ण बासस्थान तथा वन्यजन्तु मार्गहरूको संरक्षणलाई प्राथमिकता दिइनेछ। संरक्षित क्षेत्र तथा मध्यवर्ती क्षेत्रभित्र नियन्त्रित चरिचरन, सह-व्यवस्थापनको व्यवस्था तथा मानव-वन्यजन्तु द्वन्द्व न्यूनीकरणका उपायहरूमार्फत खर्क व्यवस्थापनलाई संरक्षित क्षेत्रका व्यवस्थापन कार्ययोजनामा समेटिनेछ। जैविक विविधताको संरक्षणको लागि वन डढेलो जोखिम व्यवस्थापन र डढेलो पश्चात पुनर्स्थापना कार्यलाई पनि कार्यान्वयन गरिनेछ।

रणनीति ४: दिगो खर्क-आधारित जीविकोपार्जन तथा हरित अर्थतन्त्र प्रवर्धन

यस रणनीतिले वातावरण माथिको दबाबलाई न्यूनीकरण गर्दै खर्कमा-आधारित उत्पादनहरूको मूल्य अभिवृद्धि र आय विविधीकरणमा जोड दिनेछ। गैर-काष्ठ वन पैदावारहरूको दिगो सङ्कलन तथा व्यवस्थापनलाई प्रवर्द्धन गरिनेछ। ती

प्रजातिहरूको प्रशोधन, प्रमाणीकरण तथा बजार पहुँचमार्फत स्थानीय मूल्यलाई बढाइनेछ। खर्कमा-आधारित पर्यटनहरू जस्तै गोठस्टे, यार्सागुम्बा पर्यटन, च्याउ पर्यटन तथा अन्य हरित उद्यमहरू प्रवर्द्धन गरी वैकल्पिक आम्दानीका अवसरहरू सिर्जना गरिनेछ। साथै, जलिय, जैविक विविधता तथा कार्बन सेवाको संरक्षणमा योगदान पुऱ्याउने समुदायलाई प्रोत्साहन गर्न पारिस्थितिक सेवा भुक्तानी (PES) जस्ता प्रोत्साहनका कार्यक्रमहरूको परीक्षणात्मक शुरूवात गरिनेछ।

रणनीति ५: क्षमता विकास, समन्वय, अनुसन्धान तथा जनचेतना अभिवृद्धि

यस रणनीतिले विभिन्न सरकारी निकाय, स्थानीय सरकार तथा समुदायहरूको प्राविधिक र संस्थागत क्षमता सुदृढ गर्दै खर्क व्यवस्थापनका लागि बहु-तहगत समन्वय र सहकार्यलाई संस्थागत गर्नेछ। अनुसन्धानबाट प्राप्त ज्ञान, परम्परागत ज्ञान, खर्कका मूल्यांकन तथा स्थानिय समुदायका निगरानीका नतिजा तथा उत्कृष्ट अभ्यासहरूलाई संस्थागत हिसाबले दस्तावेजीकरण र संरक्षण गर्न प्रदेश स्तरिय ज्ञान समन्वय इकाइ खडागरि सुरक्षितसाथ राखिनेछ, साथै ज्ञानको आदान प्रदानमा त्यसलाई उपयोग गरिनेछ। अत्याधुनिक प्रविधीहरूको प्रयोग गरि खर्क संरक्षण र व्यवस्थापनलाई उपयोगी हुने अनुसन्धान तथा नवप्रवर्तन प्रवर्द्धन गरिनेछ। साथै, प्रदेशस्तरीय खर्क व्यवस्थापन समिति मार्फत नीतिगत समन्वय, बजेट सुनिश्चितता गरिनेछ। कर्णाली प्रदेशका उत्तरी जिल्लाहरू (मुगु, डोल्पा, हुम्ला) मा देखिएका सीमापार चरनसम्बन्धी मुद्दाहरूलाई समाधान गर्न संघीय तहसँग संवादका लागि आवश्यक संस्थागत ढाँचाको निर्माण गरि त्यसलाई समाधान गर्न पहल गरिनेछ।

कार्यान्वयन, अनुगमन र निरन्तरता

माथि उल्लेखित विषयगत तथा पार-विषयगत रणनीतिहरूको प्रभावकारी कार्यान्वयनका लागि आवश्यक नीतिगत तथा संस्थागत संरचनाको निर्माण र सुदृढीकरण, आर्थिक स्रोतको परिचालन, क्षमता तथा जनचेतना अभिवृद्धि, साथै अनुसन्धान र सहकार्यलाई निरन्तरता दिइनेछ।

यस रणनीतिअन्तर्गत लागू गरिने कार्यक्रमहरूको आवधिक अनुगमन, मूल्याङ्कन र सिकाइ (MEL) गरिनेछ। त्यसका लागि यस रणनीतिमा आवश्यक संरचना, सूचक र कार्यविधिको स्पष्ट रूपरेखा तयार गरिएको छ।

A herder hand-spinning sheep wool, a commonly practiced traditional method among pastoral communities
Photo: Uttam Babu Shrestha

Acronyms and Abbreviations

CE	Critically Endangered
CFUG	Community Forest User Group
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRUTS	Climate Research Unit Time Series
CSF	Classical Swine Fever
DD	Data Deficient
DNPWC	Department of National Parks and Wildlife Conservation
ECMWF	European Centre for Medium-Range Weather Forecasts
EN	Endangered
ERA5	Fifth Generation European Centre for Medium-Range Weather Forecasts Atmospheric Reanalysis
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
FRTC	Forest Research and Training Center
GDP	Gross Domestic Product
GEE	Global Earth Engine
GIIS	Global Institute for Interdisciplinary Studies
HWC	Human-Wildlife Conflict
KII	Key Informant Interviews
IAP	Invasive Alien Plant
ICIMOD	International Centre for Integrated Mountain Development
ILRI	International Livestock Research Institute
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
LC	Least Concern
LULC	Land Use and Land Cover
MEL	Monitoring, Evaluation and Learning
MoITFE	Ministry of Industry, Tourism, Forest, and Environment
NbS	Nature-based Solutions
NCP	Nature's Contribution to People
NDVI	Normalized Difference Vegetation Index
NPP	Net Primary Productivity
NT	Near Threatened
NTFP	Non-Timber Forest Product
PES	Payment for Ecosystem Services
PPR	Peste des Petis Ruminants
RESTREND	Residual Trend Analysis
SOC	Soil Organic Carbon
TOC	Total Soil Nitrogen
UNEP	United Nations Environmental Programme
VU	Vulnerable
WWF	World Wide Fund for Nature

Horse grazing in Guthichaur, Jumla
Photo: Uttam Babu Shrestha

CHAPTER 1

Introduction

Rangelands are natural pastures, grasslands, and shrublands, extending from tropical grasslands to alpine meadows and arid steppes in Nepal. Although Karnali Province occupies 20% of Nepal's total land area, it comprises 34% of Nepal's total rangeland area.

Background

Rangelands represent the most extensive land cover type on Earth. Although various definitions of rangelands exist, the definition adopted in this report is by Stoddard et al. (1975), who define rangelands as 'those areas of the world which, due to physical limitations—such as low and erratic precipitation, rough topography, poor drainage, or cold temperatures—are unsuited to cultivation and serve as a source of forage for native and domestic animals, as well as a source of wood products, water, and wildlife'. Globally, rangelands cover approximately 25-54% of the terrestrial surface, depending on the definition used (Al-Bukhari et al. 2018; Gamoun et al. 2018; Tiscornia et al. 2019; Briske et al. 2020; ILRI, IUCN, FAO, WWF, UNEP and ILC 2021). These rangelands are critical socio-ecological systems due to their economic, environmental, and socio-cultural importance. They provide a substantial portion of the global forage supply, accounting for 70%, which supports 50% of the world's livestock and the livelihoods of about 800 million people worldwide (Brown and Thorpe 2008; Briske et al. 2020). Additionally, these expansive rangelands serve as essential habitats for wildlife and biodiversity (Kideghesho et al. 2013), and store up to 30% of the world's carbon (Al-Bukhari et al. 2018).

In Nepal, rangelands are defined as natural pastures, grasslands, and shrublands (GoN 2012). It is one of the dominant land use types, covering nearly 14.71% (FRTC 2022) of the country's total land area, extending from

tropical grasslands to alpine meadows and arid steppes. In this calculation, FRTC (2022) used Landsat images (30 m resolution). However, calculations based on higher-resolution (10 m Sentinel-2) global land-use and land-cover data from 2017–2024 (Karra et al., 2021) show that the stable rangeland area of Nepal is 3,417,858 ha (23.09%). This dataset is used throughout the report. Although Karnali Province occupies 20% of Nepal's total land area, it comprises 33.96% (1,160,788 ha) of Nepal's total rangeland area (Shrestha et al. 2024). Rangelands also known locally as '*Patan*', '*Lekh*', '*Kharka*' in Nepali that cover a variety of ecosystems, including grasslands, pastures, and shrublands, which are used by livestock and wildlife for grazing. Rangelands play a crucial role in supporting local livelihoods, culture and economy in Karnali Province. Despite their vast extent and socio-ecological importance, these socio-ecological systems currently face challenges such as land-use change, climate change, the encroachment of invasive species, over-exploitation of rangeland products, and the abandonment of pastoral practices. Additionally, issues like low productivity in the rangeland and livestock sector, limited market access for rangeland products, growing conflicts among users, human-wildlife conflicts, limited technical capacity, knowledge gaps, and policy and institutional challenges are hindering the sustainable management of rangelands.

In this context, the Rangeland Management Strategy and Action Plan (RMSAP) of Karnali Province aim to provide a comprehensive framework for the sustainable use and management of rangelands in Karnali Province. The plan offers strategies to address the pressing threats and challenges these socio-ecological systems face while enhancing their ecological functions and socioeconomic contributions. The RMSAP aims to ensure the long-term sustainability and resilience of rangelands in Karnali Province by integrating stakeholders' perspectives, traditional knowledge, modern scientific approaches, and adaptive management practices. The plan seeks to improve rangeland productivity, conserve biodiversity, maintain ecosystem integrity, and support the livelihoods of local communities that depend on these ecosystems. It also aims to align local management practices and provincial regulatory mechanisms with national and international climate and development goals and conservation targets.

The Constitution of Nepal (2015) assigns the responsibility of managing and protecting rangelands and barren lands to the provincial government (Schedule 6). In line with this constitutional mandate, the MoITFE of Karnali Province has prepared this RMSAP to manage the rangeland areas within the Province. This provincial RMSAP is particularly significant, as the Government of Nepal, through its second Nationally Determined Contribution (NDC) for the period 2021-2030 under the Paris Agreement, has committed to preparing a National Rangeland Policy and developing plans for the sustainable management of rangelands by 2025. Therefore, this provincial strategy and action plan for rangeland management could lay the foundation for the revision of the National Rangeland Policy. Additionally, the United Nations has designated 2026 as the International Year of Rangelands and Pastoralists (IYRP) (https://www.fao.org/newsroom/detail/un-names-2026-as-the-international-year-of-rangelands-and-pastoralists/en).

This designation emphasizes the importance of healthy rangelands (SDG-15) and sustainable pastoralism (SDG-12) in achieving the Sustainable Development Goals (SDGs). Furthermore, healthy rangeland ecosystems (Target 3), sustainable use of rangeland biodiversity (Target 10) and restoration of degraded rangeland ecosystems (Target 2) are crucial for fulfilling the commitments and targets under the Kunming-Montreal Global Biodiversity Framework (GBF). Sustainable management of rangeland is also critical for the United Nations Framework Convention on Climate Change (UNFCCC) due to its role in climate change mitigation, adaptation, and biodiversity conservation. Thus, the RMSAP aims to contribute to achieving Nepal's third National Biodiversity Strategy and Action Plan (NBSAP) (currently under preparation), Nepal's national targets envisioned in 16th plan for biodiversity conservation and sustainable management of ecosystem, development of green economy, mainstreaming and localization of environment and climate issues, as well as climate adaptation and risk reduction, ensuring that rangeland management practices support both local and global sustainability goals.

Along with the national commitments and global targets and goals, the significance of the RMSAP lies in its potential to address the local challenges associated with rangeland degradation, such as overgrazing, over-harvesting of Non-Timber

Forest Products (NTFPs), including high-valued medicinal species from the rangelands, invasive alien species, climate change, land use change, and socioeconomic drivers. By setting clear strategies, guidelines, and actions, RMSAP will serve as a critical tool for provincial policymakers, local government representatives, governmental agencies, and local communities including transhuman herders, and medicinal herb collectors to work collaboratively towards the sustainable use and management of rangelands and their resources.

The RMSAP for Karnali Province was developed through a comprehensive analysis of rangeland status and trends using 23 years of remote sensing data, along with the collection and analysis of secondary data on rangeland biodiversity and associated ecosystem services and both anthropogenic and non-anthropogenic drivers of rangeland change. This process included a thorough review of relevant scientific literature and policy documents, including national and provincial policies, strategies, and plans as well as case studies on rangeland management. Stakeholder consultations were conducted at local (eight), district (seven), and provincial (one) levels through workshops, focus group discussions, and key informant interviews to collect information, and insights and incorporate the voices of the stakeholders, including herders, local government leaders, government and non-governmental officials, and experts. Limited field observations were also carried out in selected rangeland sites of the Province to gain insights into the social, ecological, and economic dimensions of the Province's rangelands. The qualitative and quantitative data were analyzed using methods and tools from geospatial science, ecology, and social sciences.

1.1. Defining Rangelands: Ecological and Social Elements

The RMSAP considers rangelands as socio-ecological systems, recognizing them as ecosystems dominated by native shrubs and bushes, grasses, and forbs, primarily used for grazing livestock and wildlife (UNCCD 2024). These landscapes, found mainly in high-elevation regions, are characterized by low and erratic rainfall, rough topography, cold temperatures, shallow soils, and vegetation adapted to arid and semi-arid conditions and are unsuitable for cultivation. However, rangelands are not solely natural systems; they are also socio-ecological systems, shaped by the dynamic interactions between human communities including transhuman herders, agro-pastoralists, herb collectors and their environment (Hruska et al. 2017).

Ecologically, rangelands in Karnali Province are vital for maintaining aquatic and terrestrial biodiversity, supporting a diverse array of plant and animal species, some of which are endemic or threatened. These rangelands also serve as critical habitats for migratory species such as birds and mammals. They provide essential ecosystem services, including provisioning services such as food, forage, fiber, and medicinal species that are crucial for the livelihoods of local communities, including herders and herb collectors. Regulating services like carbon sequestration, water regulation, soil conservation, and nutrient cycling contribute to environmental stability. Supporting services, such as soil formation and primary production, are fundamental to the sustainability of other ecosystem services. Additionally, rangelands hold significant cultural, spiritual, and recreational value, offering a sense of place and identity for many communities. The RMSAP recognizes the importance of these services and aims to enhance their provision through sustainable management practices, balancing ecological health with socioeconomic requirements.

Socially, rangelands are integral to the livelihoods of herders, herb collectors, and agro-pastoralist communities of Karnali Province who depend on these lands for grazing livestock, harvesting medicinal species, including the highly valued Yarsagunbu (Shrestha and Bawa 2013) and engaging in other traditional practices such as religious and cultural ceremonies. The herders and agropastoral communities of Karnali Province practice subsistence agriculture and raise sheep, goats, cattle, horses/donkeys, yaks/naks, or harvest wild species. The rangelands also hold deep cultural significance, with many communities maintaining spiritual and historical connections to the rangelands and sites located in the rangelands. The social aspects of rangelands encompass the traditional knowledge and local practices that have sustained these ecosystems for generations, as well as the contemporary challenges brought about by modernization, migration, and

economic development. RMSAP acknowledges the interconnectedness of ecological and social elements and seeks to balance ecological health, economic viability, and social well-being through an integrated and holistic approach to rangeland management in Karnali Province.

1.2. Conceptual Framework of the Rangeland Management Strategy and Action Plan

The RMSAP views rangelands as socio-ecological systems shaped by the dynamic interactions between local communities and their environment. Rangeland ecosystems provide vital ecosystem services to the local communities of Karnali Province, but their health and integrity are significantly influenced by activities such as livestock grazing, hunting, medicinal species harvesting and collection of fuelwood, water management, fire control, and the regulation of predators, pests, and weeds. Local communities have developed formal and informal institutions and their rules and practices that shape their interactions with rangeland ecosystems. These socio-ecological systems are inherently dynamic, often occurring in remote areas with sparsely distributed, marginalized populations. The RMSAP adapts to the drivers of ecosystem change identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Watson et al. 2019). Direct drivers include land use change (e.g., conversion of rangelands, habitat degradation), climate change (e.g., altered precipitation patterns, increased temperatures, extreme weather events exacerbating rangeland degradation), overexploitation (e.g., unsustainable harvesting of medicinal species, overgrazing), pollution (e.g., contamination with plastics, solid wastes, and chemicals in pastures), and invasive species (e.g., non-native species reducing biodiversity and altering ecosystem functions and services). Indirect drivers influencing these direct impacts include demographic changes (e.g., population growth in some areas and depopulation in others due to migration), economic drivers (e.g., trade, consumption patterns, market forces shaping the local extraction), technological change (e.g., machinery in road construction, mobile communication for trading medicinal species), cultural and social drivers (e.g., shifts in societal values, norms, and lifestyle choices), institutional and governance factors (e.g., policies, laws, international agreements, and customary rights driving collective action to conserve, sustainably manage and restore rangelands), and knowledge and awareness (e.g., research, education, and communication influencing local actions that mitigate or exacerbate impacts on rangelands) (**Figure 1**).

The management options and actions outlined in RMSAP aim to address both ecological and socioeconomic challenges and threats to rangelands in Karnali Province. The primary objectives of the management strategy are to enhance biodiversity, improve ecosystem services, and increase resilience to environmental changes while sustaining livelihoods. The strategy also seeks to boost rangeland productivity through sustainable use and diversification of rangeland-based ecosystem services, strengthen community cohesion, preserve cultural heritage, and build capacity for adaptive management. The proposed management options include initiatives such as sustainable rangeland management projects that promote best practices in grazing, collection of medicinal species, and rangeland restoration. Additionally, the development of robust legal, policy, and institutional frameworks with clear guidelines and regulations is essential for supporting sustainable rangeland use while securing tenure and recognizing the customary rights of local communities, particularly herders and indigenous groups. Technical support, along with adequate investment and financial mechanisms, is crucial to effectively implement these strategies, ensuring equitable access to necessary resources for local communities. Capacity building and knowledge sharing are vital to enhance the skills and understanding of all stakeholders, fostering a collaborative approach to rangeland management. Long-term research, data collection, and monitoring are key to informing adaptive management practices, ensuring that interventions are evidence-based. Finally, equity, gender responsiveness and inclusion are prioritized, with specific efforts to engage youth, women, and marginalized groups, ensuring their voices are heard and their needs addressed in rangeland management decisions. After implementing the management options, the RMSAP aims to build resilient rangelands in Karnali Province with equitable access to rangeland resources among stakeholders.

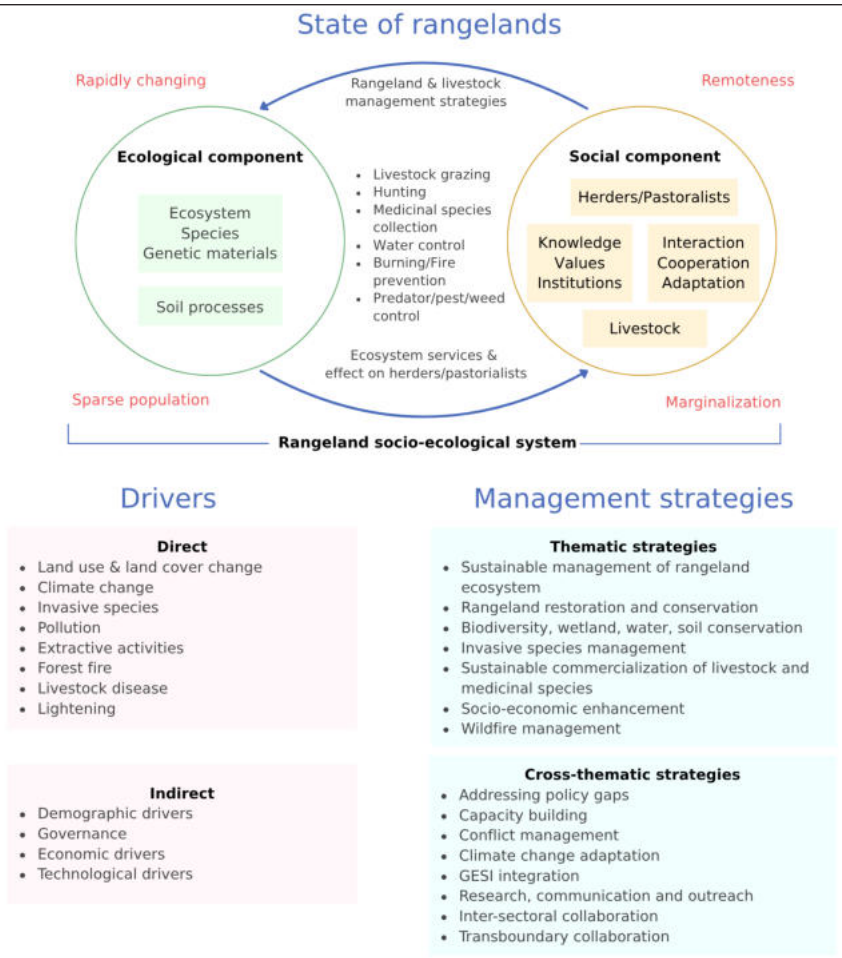

Figure 1. Conceptual framework of the Rangelands Management Strategy and Action Plan.

1.3. Structure of the Rangeland Management Strategy and Action Plan

The RMSAP of Karnali Province is structured into seven chapters, each addressing different aspects of rangeland use and management. **Chapter One** introduces the background, objectives, scope, and methodology of RMSAP, defining rangelands as socio-ecological systems, presenting the conceptual framework, and outlining the contents of the subsequent chapters. **Chapter Two** provides an in-depth analysis of the current state and trends of rangelands in the Province, covering their extent, changes in rangeland flora (angiosperms and gymnosperms) and fauna (mammals, birds, herpetofauna, butterflies), livestock rearing practices, and identifying the key ecosystem services provided by the rangelands. **Chapter Three** explores the direct drivers (such as land use change, climate change, invasive species, pollution, and resource extraction) and indirect drivers (including demographic and technological changes, economic, cultural, and social influences, as well as governance and institutional factors, and knowledge and awareness) that impact rangelands both positively and negatively. **Chapter Four** outlines' opportunities of sustainable rangeland management, highlights past efforts, achievements, gaps and challenges in existing policy and institutional frameworks, and lessons learned. **Chapter Five** provides vision, mission, guiding principles and strategies for rangeland management along with the sectoral and cross-sectoral strategies to address the identified challenges and threats, focusing on ecosystem restoration, biodiversity conservation, livelihood enhancement, and policy harmonization. **Chapter Six** presents the implementation framework, detailing implementing institutions, and funding and capacity need and governance structures necessary for effective execution of RMSAP. The last **Chapter Seven** provides monitoring, evaluation and learning framework to examine RMSAP's effectiveness and ensure alignment with broader national and international goals and targets.

Mountain seen from the Ruppatan, Jumla
Photo: Uttam Babu Shrestha

A group of Yarsagunbu collectors in Ruppatan, Dolpa
Photo: Uttam Babu Shrestha

CHAPTER 2

Status and Trends of Rangelands in Karnali Province

Karnali Province, the largest province of Nepal, is characterized by diverse topography and a varied climate, with land use predominantly consisting of rangelands rich in biological and cultural diversity.

Background

Karnali Province, situated in the mid-western region of Nepal, is the largest of the country's seven Provinces, covering an area of 30,211 km^2, equivalent to 20.7% of Nepal's total land area. The Province is bounded by Lumbini Province to the south and east, Sudurpaschim Province to the west, Gandaki Province to the east, and the Tibet Autonomous Region of China to the north. The Province is a repository of natural and cultural wealth, deeply intertwined with its unique geography and diverse climate. Despite its rich natural and cultural assets, Karnali Province faces significant developmental challenges, including a relatively low human development index, underdeveloped physical infrastructure, and widespread poverty compared to other Provinces in Nepal.

Topography: Karnali Province is characterized by its varied topography, with elevation ranging from the lowlands at around 190 m to the high Himalaya exceeding 7,746 m based on the Digital Elevation Model (NASA 2013). The landscape is marked by steep slopes, deep valleys, plateaus and rugged mountains, with over 40% of the Province's area lying above 4,000 m (Acharya and Paudel 2020). The topographic and elevational variations significantly influence the distribution of vegetation, biodiversity, and land use and land cover patterns. The physiographic diversity of Karnali Province encompasses the Siwalik or Chure region, Middle Mountains, High Mountains, and the Trans-Himalayan regions (**Figure 2**). This variation in elevation and topography contributes to Karnali Province's rich ecosystem diversity, particularly its extensive rangeland cover.

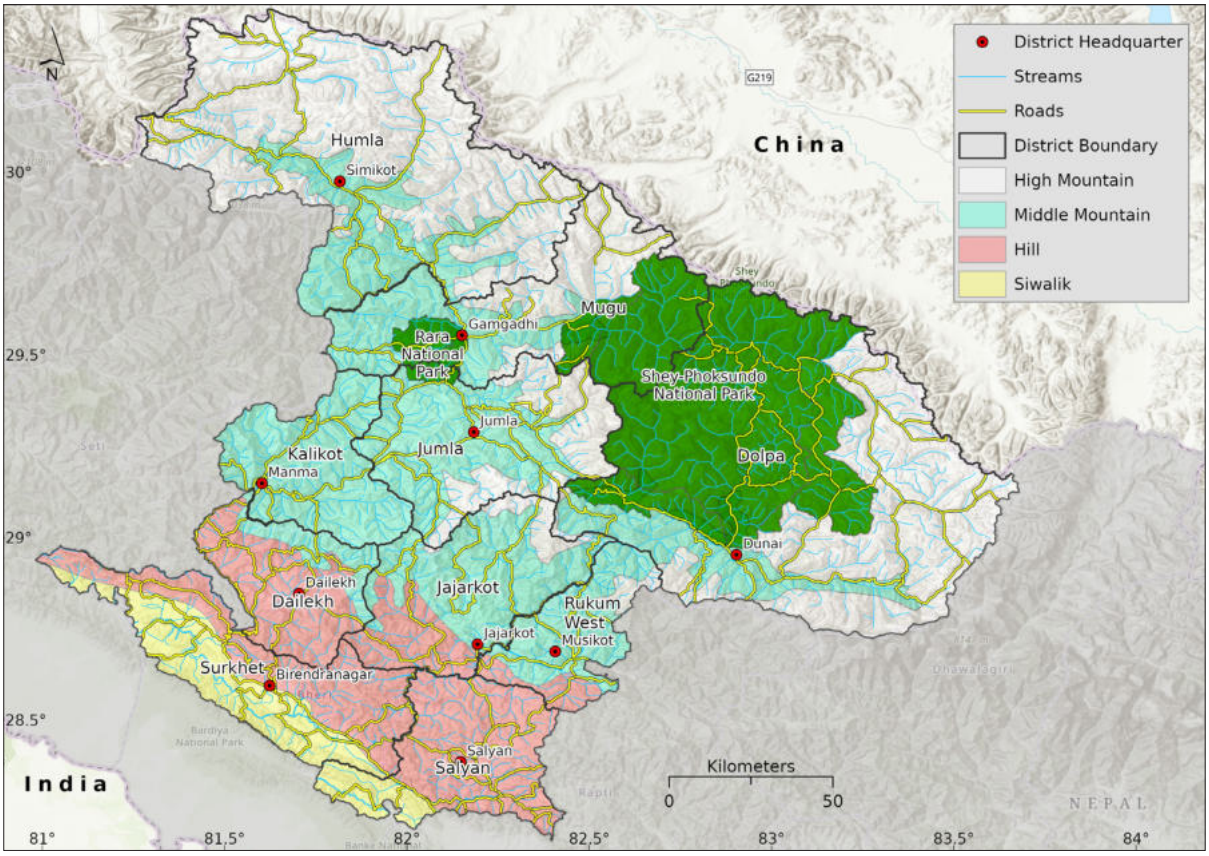

Figure 2. Topographic map of Karnali Province.

Climate: Karnali Province exhibits a wide range of climatic conditions due to its significant elevational gradient. According to the Köppen climate classification, one of the most widely used climate classification systems globally (Kottek et al. 2006; Beck et al. 2023), Karnali Province encompasses six distinct climatic zones: humid subtropical (Cwa), subtropical highland with monsoon influence (Cwb), humid continental (Dwb), subarctic or subpolar climate (Dwc), tundra (ET), and ice cap (EF) (**Figure 3**). The lowland areas have a humid subtropical climate characterized by hot summers and mild, dry winters. The Middle and High Mountain regions experience a temperate climate, with cold summers and dry winters. In the Trans-Himalayan region (High Himalaya), including areas such as Dolpa and Humla, the climate ranges from alpine to tundra, characterized by harsh winters with heavy snowfall and short, cool summers. A relatively smaller part of the Province has tundra, where temperatures remain extremely cold throughout the year, snow cover persists for most of the year, and vegetation is sparse.

To create the climatology of the entire Province, ERA5, the fifth-generation European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis of the global climate covering

Karnali Province encompasses six distinct climatic zones including humid subtropical (Cwa), subtropical highland with monsoon influence (Cwb), humid continental (Dwb), subarctic or subpolar climate (Dwc), tundra (ET), and ice cap (EF).

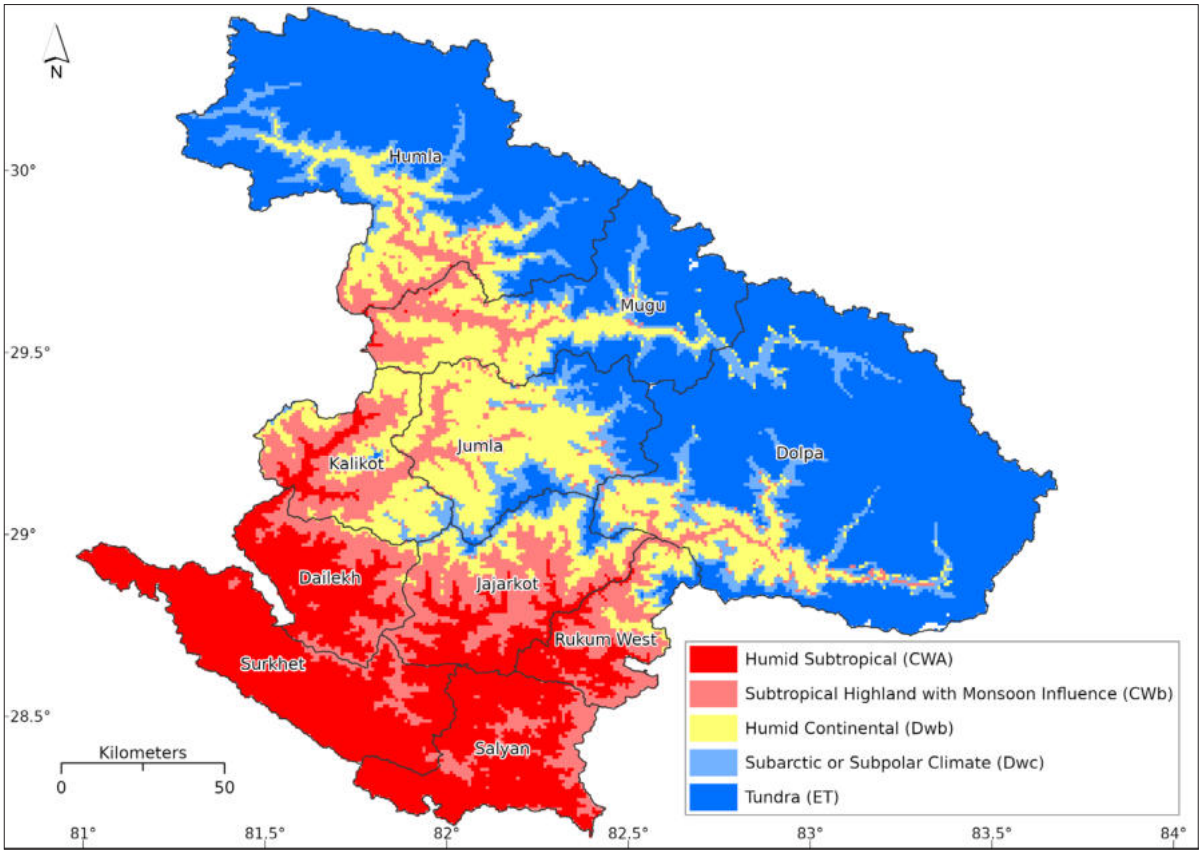

Figure 3. Climatic zones in Karnali Province.

the period from January 1950 to the present (Muñoz Sabater 2019), was used. The ERA5-land daily aggregated data, produced by the Copernicus Climate Change Service (C3S) at ECMWF, provides comprehensive climate data combining model data with observations from across the world at 9-km spatial resolution (Hersbach et al. 2020). Based on climatic variables derived from ERA5 data from 1950-2023, the average annual minimum and maximum temperatures in Karnali Province are 0.29 (-0.99-1.90) °C and 10.16 (8.67-11.64) °C, respectively (**Figure 4c**). However, there is a huge variation in average temperature in the Province. In some regions of Karnali Province, the average annual temperature reaches up to 22.01°C while the average annual temperature is -12.27°C (**Figure 4a**). Similarly, the average annual precipitation in Karnali Province is 1,520mm (1,090mm–2,140mm), with significant variation across the Province (**Figure 4b**). The western and northern parts, particularly the Trans-Himalayan regions like Limi Valley of Humla and northern Dolpa, receive less rainfall due to the rain-shadow effect of the Himalaya. In contrast, areas such as Surkhet and Jajarkot experience higher rainfall, especially during the monsoon season. The wettest region of the Province even receives up to 2,740 mm of rainfall annually while the driest region receives only 450 mm of rainfall annually. Most of the rainfall occurs from June to September during the monsoon, but the amount of precipitation varies significantly across the region.

Land use: A global land-use and land cover map from 2017-2024 with a 10-meter resolution, produced by analyzing the Sentinel-2 satellite with state-of-the-art accuracy (Karra et al. 2021), was utilized. Only stable land-use and land cover data from this period were used. According to this data, Karnali Province has seven major land use classes: grassland or rangeland (1,160,788 ha, 37.9%), forest or trees (831,149 ha, 27.1%), bare ground (431,613 ha, 13.5%), snow/ice (252,650 ha, 8.2%), agriculture land or crops (24,066 ha, 0.8%), urban or built area (15,819 ha 0.5%), water bodies

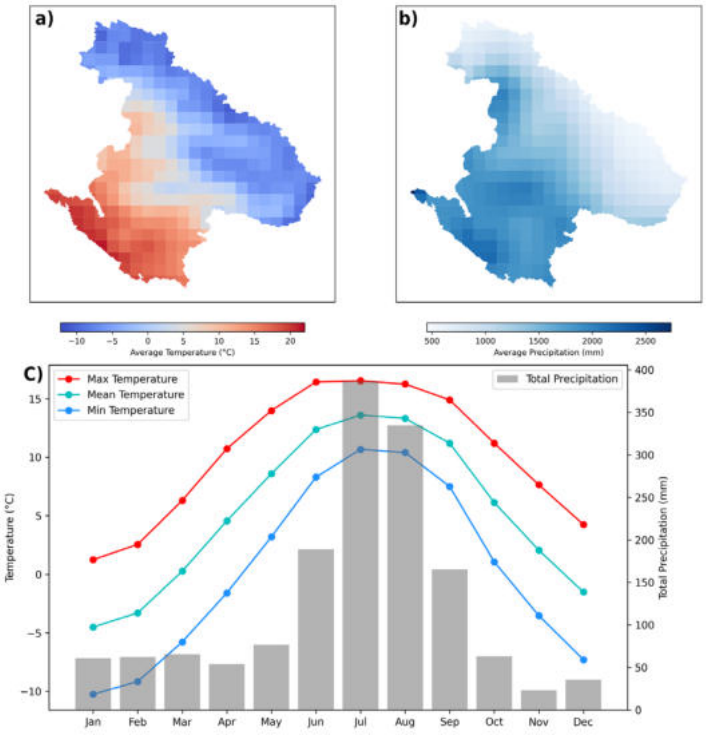

Figure 4. Climatology of Karnali Province a) average temperature, b) average precipitation, c) monthly climatology based on climate data from 1950-2023.

(11,415 ha, 0.4%) and others or unstable (356,416 ha, 11.6%) (**Figure 5**). Agriculture in Karnali Province is predominantly terraced farming with limited irrigation. Due to harsh climatic conditions, steep terrain, and low productivity, a significant portion of the land is unsuitable for cultivation and is instead used as pasture. These grasslands occur primarily at higher elevations where agriculture is less viable. These pastures are crucial for herder communities, who rely on them for grazing livestock.

Biodiversity: Karnali Province is one of the most biologically diverse regions in Nepal, home to a substantial proportion of the country's flora and fauna. Recent estimates suggest that Karnali Province potentially harbors 2,589 species of flowering plants, 19 species of gymnosperms, 89 species of mammals, 410 species of birds, 75 species of fishes, 14 species of reptiles, 25 species of amphibians, and 144 species of butterflies (Acharya and Paudel 2020).

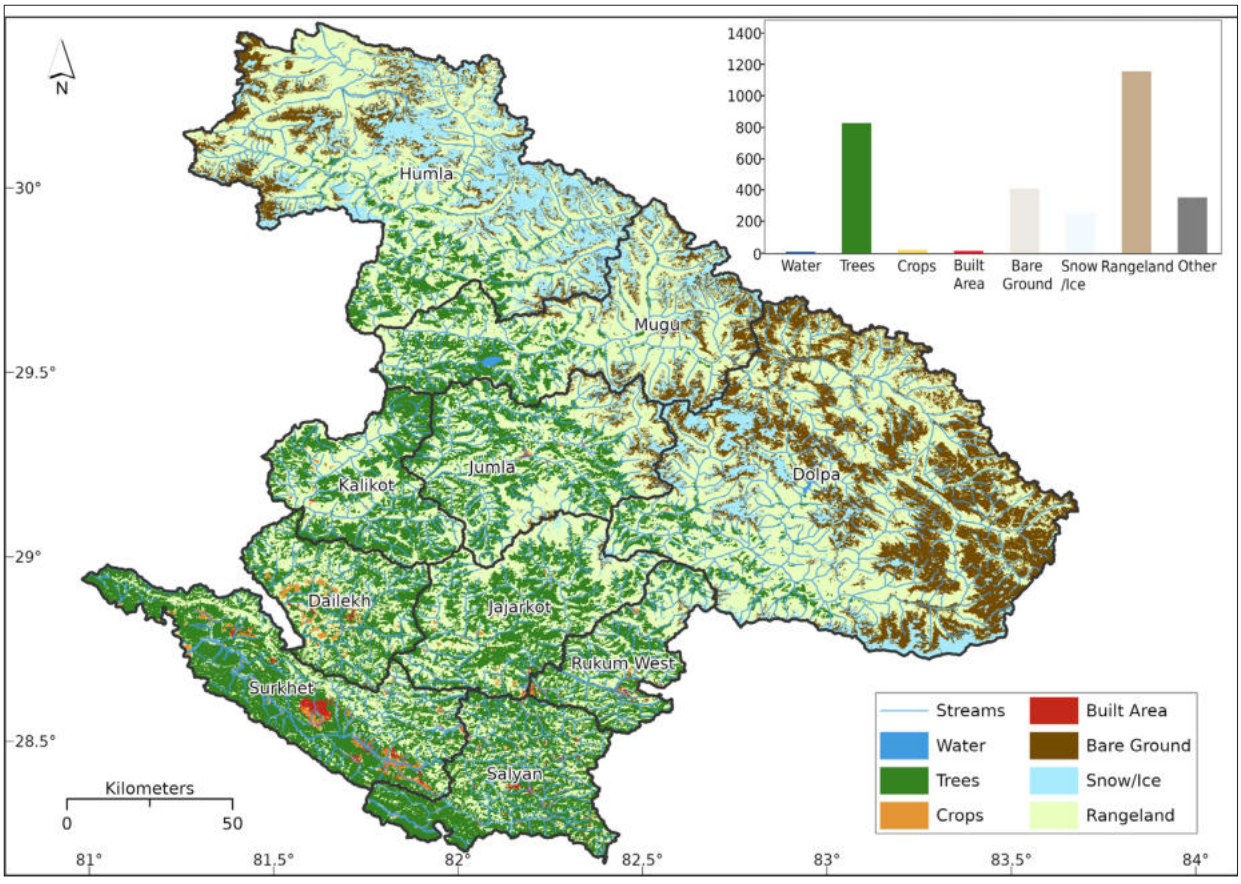

Figure 5. Land use and land cover map of Karnali Province.

The rich biodiversity is supported by the Province's diverse climate, topography, and ecosystems, ranging from alpine meadows to dense subtropical forests and freshwater systems.

Karnali Province is also famous for its rich agrobiodiversity, adapted to its unique agro-climatic conditions. Different varieties of traditional crops, including Jumli Marshi *rice, chino/kaguno, uwa/naphal, phapar* (Buckwheat), latte (*amaranth*), finger millet, wheat, *simi* (bean) are cultivated exclusively in the region (Adhikari 2008).

Socio-economy: Karnali Province is a cultural mosaic, rich in ethnic diversity, languages, and traditions. The region is home to a wide variety of cultural practices and traditions, many of which have been preserved due to its relative isolation. The Province has a population of 1.69 million people which shares the lowest population of the country (5.79%), with 51.2% being female and 48.8% male (NSO 2021). Population density is low, particularly in the High Mountain and Trans-Himalayan regions, where settlements are sparse and scattered. As shown in **Figure 6**, the northern municipalities have a population less than 10,000 people according to the National Population Census 2021 (NSO 2021).

Among the 10 districts of Karnali Province, Surkhet has the highest population, followed by Dailekh and Salyan, while Dolpa has the lowest population, followed by Humla and Mugu (**Table 1**).

The dominant ethnic group in Karnali Province is the *Kshetri*, comprising 42.2% of the population, followed by *Bishwokarma* (16.2%), *Thakuri* (10.5%), *Magar* (10.4%), and *Brahmin-Hill* (8%), *Pariyar* (4.1%) and *Mijar* (2.8%) (NSO 2021). This Province has the highest population of *Dalits* in Nepal and is home to endangered ethnic groups like the *Raute* and *Raji*, who maintain unique cultural practices and nomadic lifestyles.

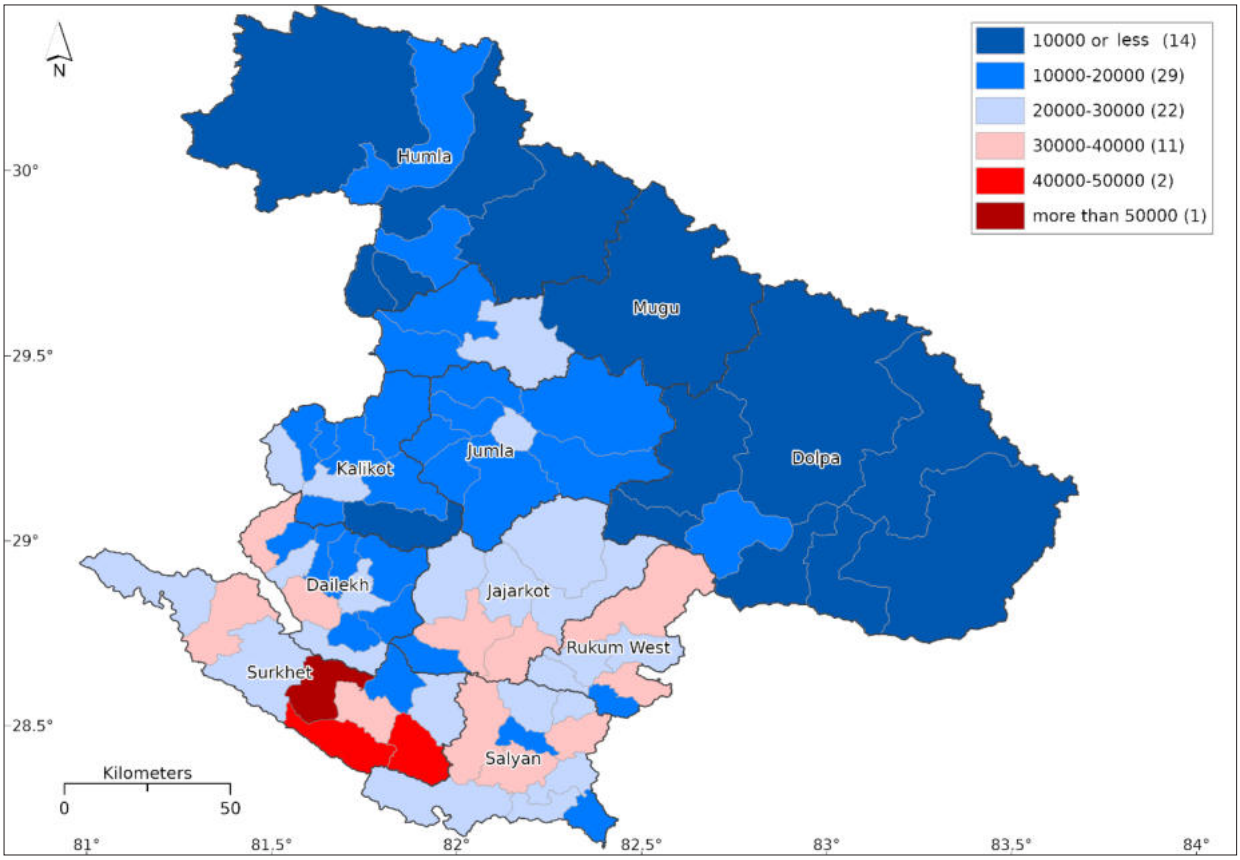

Figure 6. Municipal level population distribution in Karnali Province based on National Population Census 2021.

Table 1. Number of households and population in 10 districts of Karnali Province

District	Household	Total Population	Male	Female
Dailekh	54,594	251,647	120,157	131,490
Dolpa	9,380	42,164	20,803	21,361
Humla	11,204	53,884	26,819	27,065
Jajarkot	37,453	188,301	93,111	95,190
Jumla	24,422	117,268	58,238	59,030
Kalikot	26,770	144,828	71,797	73,031
Mugu	12,430	63,858	31,895	31,963
Rukum West	37,290	165,460	79,886	85,574
Salyan	54,672	237,387	113,954	123,433
Surkhet	97,822	410,407	195,645	214,762
Total	366,037	1,675,204	812,305	862,899
Data source: National Population and Housing Census 2021 (NSO 2021)				

The Province is also linguistically diverse, with over 32 different languages spoken (NSO 2021). However, Nepali is the most widely spoken language in Karnali Province, with 88.9% of the population using it as their mother tongue, followed by *Khash* (6.3%) and *Magar Dhut* (1.6%) (NSO 2021). The Sinja Valley in Jumla district is particularly noteworthy as the origin of the Khas Nepali language, which is now the official language of Nepal.

Economically, Karnali Province is one of the least developed Provinces in Nepal, contributing only 4.3% to the national GDP in the fiscal year 2080/81(NSO 2024). Among Nepal's seven Provinces, Karnali has the highest level of multi-dimensional poverty, with more than 600,000 people living in multi-dimensional poverty (NPC 2020). Despite the low suitability of the land for cropping in the Province, the economy is predominantly agrarian, with agriculture and livestock farming being the main sources of livelihood, particularly in the high-elevation regions where agricultural productivity is low. Agriculture, forestry, and fishing account for 29.5% of Karnali's GDP, with major crops including paddy, wheat, maize, buckwheat, and barley (NSO 2024). The transhumance system, which involves the seasonal movement of livestock between different grazing areas, is common in these regions. Livestock products, including meat, milk, and wool, are important sources of income and nutrition for local communities.

Along with the high levels of poverty, food insecurity and limited access to basic services such as healthcare, education, and clean water are prevalent in Karnali Province. Only 56.8% of households in the Province have access to electricity to the national grid (NEA 2022), and road infrastructure is inadequate, with 717 km of blacktopped roads out of a total of 1,657 km national highway and feeder roads till 2023 (DoR 2023). The average literacy rate in the Province is 76.1%, with a significant gender gap: the literacy rate is 83.3% for males and only 69.4% for females (NSO 2021). The Province has the highest level of gender inequality in Nepal (NPC 2020). Healthcare infrastructure in Karnali Province is also inadequate, with limited access to medical facilities and trained health professionals. Child malnutrition rates are alarmingly high, with more than 36% of children stunted, 4% wasted or too thin, and 18% underweight (MoSD 2023). Limited access to roads,

electricity, and basic services hampers economic development and quality of life for the Province's residents.

Protected areas: The Province hosts two National Parks namely Shey Phoksundo National Park and Rara National Park. Shey Phoksundo National Park, the largest National Park in Nepal, plays a crucial role in the conservation of rangelands in Karnali Province. Covering an area of 3,555 km^2 as park and 1,349 km^2 as buffer zone, the Park encompasses a diverse range of ecosystems, including high-elevation rangelands, which occupy 15.1% of the park (537 km^2) and 87.5% of the buffer zone (1,180 km^2). These rangelands support a variety of flora and fauna, including endangered species like the Snow Leopard, which are emblematic of the region's unique biodiversity. The park is also home to several traditional herding communities that rely on the rangelands for grazing their livestock. Additionally, Shey Phoksundo National Park is a key destination for ecotourism, with the Upper Dolpa and Shey Phoksundo Treks attracting trekkers from around the world. Shey Phoksundo Lake, a Ramsar site, is the

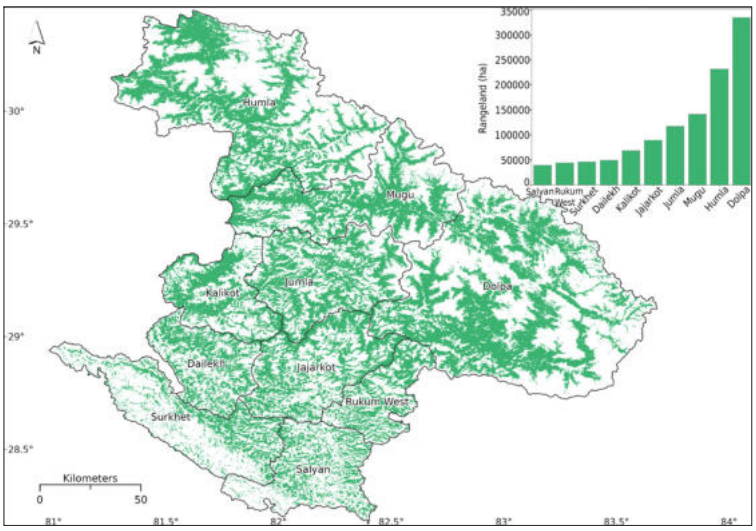

Figure 7. Extent and distribution of rangelands in Karnali Province.

primary attraction of this National Park. The protection and sustainable management of these rangelands within the Park not only contribute to biodiversity conservation but also support the livelihoods of local people through ecotourism, traditional pastoralism, and the collection of medicinal species including Yarsagunbu. There were 273 vascular plants, 32 mammals, 200 species of birds, six species of reptiles/amphibians reported from this National Park (Bhuju et al. 2007).

Rara National Park, located in Mugu and Jumla districts of Karnali Province, is a vital protected area that harbors a significant portion of rangelands. Spanning an area of 106 km^2 as a park and a 198 km^2 buffer zone, the Park is home to the pristine Rara Lake, the largest lake in Nepal, and encompasses diverse ecosystems, including significant high-elevation rangelands. About 21.7% of the park area (23 km^2) and 43.9% of the Buffer Zone (87 km2) of Rara National Park are covered by rangelands. These rangelands are crucial for wildlife, providing habitat for species such as the Red Panda, Himalayan Black Bear, and various species of deer, as well as for the traditional pastoralist communities that graze their livestock here. The park's rangelands are integral to the livelihoods of these communities, offering grazing grounds for sheep, goats, and yaks. Additionally, Rara National Park is a growing ecotourism destination, with the Rara Lake Trek attracting visitors who wish to experience the region's natural beauty and cultural diversity. There were 423 vascular plants, 51 mammals, 214 species of birds, and two species of reptiles/amphibians reported from Rara National Park (Bhuju et al. 2007).

2.1. State of Rangelands

Extent and Coverage: Rangelands are the dominant form of land use in Karnali Province, covering 1,160,788 ha, which accounts for 34% of the total rangeland area in Nepal (**Figure 7**). However, the distribution of rangelands across the districts of Karnali Province is uneven. Dolpa alone accounts for 29% of the total rangeland area in Karnali Province, followed by Humla with 20% and Mugu with 12%, Jumla with 10%, while Jajarkot and Kalikot each contribute more than 5% and Salyan, Surkhet, Rukum West, and Dailekh each contribute about less than 5% of the Province's rangeland area (**Figure 7**). The highest rangeland areas are found in Namkha Rural Municipality (113,011 ha) of Humla, followed by Shey Phoksundo Rural Municipality (106,002 ha) of Dolpa, Mugum Karmarong (88,694 ha) of Mugu, and Chharka Tangsong Rural Municipality

(60,459 ha) of Dolpa whereas Bheriganga Municipality of Surkhet, Tribeni Rural Municipality of Salyan have less than 2,000 ha of rangeland. Rural municipalities in the high-elevation districts have the highest rangeland coverage, with some reporting that over 80% of their land area is classified as rangeland.

Rangelands in Karnali Province are primarily located in the High Himalaya and High Mountain regions, characterized by low rainfall and harsh climatic conditions. These rangelands typically consist of alpine meadows, grasses, forbs, and

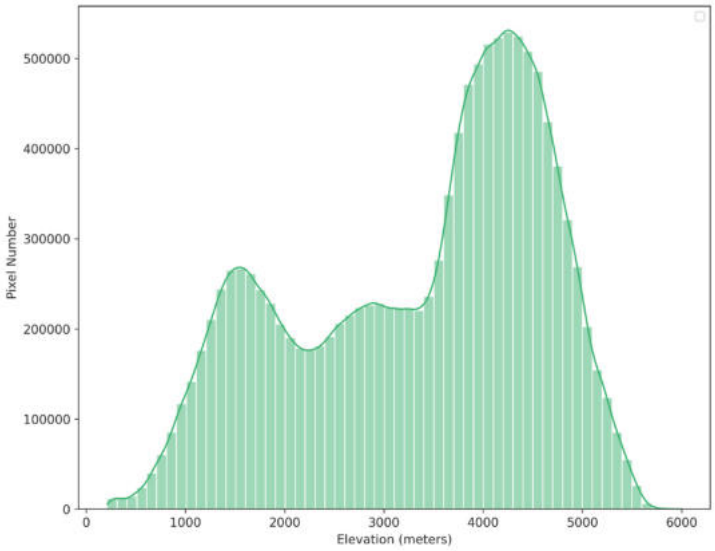

Figure 8. Distribution of rangelands across elevation gradients in Karnali Province.

sparsely vegetated shrubs. Along the elevation gradient, approximately 57% of Karnali's rangelands are situated between 3,000 and 5,000 m, while about 20% are found at elevations between 1,000 and 2,000 m (**Figure 8**).

- **High Himalaya Region:** This region, which includes districts such as Dolpa, Mugu Humla, and Jumla has extensive rangelands (559,853 ha or 48% of the total rangelands in Karnali Province). This region also includes Trans-Himalayan region of Dolpa and Humla where vegetation is sparse with grasses and herbs adapted to low rainfall. Other rangelands here are characterized by alpine meadows and shrublands, which are vital for summer grazing.

- **High Mountain Region:** Lower to the High Mountain region, the region of middle mountains also has extensive rangelands (450,808 ha or 39% of the total rangelands in Karnali). Upper belt of Jumla, Jajarkot, West Rukum and Kalikot fall under this physiographic region.

- **Middle Mountain:** This physiographic region of Karnali Province contains approximately 142,481 ha, or 12% of the Province's rangelands, which are primarily found alongside forests and near agricultural fields used for grazing cattle. Majority of the rangelands in Dailekh and Salyan fall under the physiographic region

- **Siwalik:** This region has a very small rangeland area, covering around 1% (7,645 ha) of the total rangelands. These rangelands are mainly subtropical grasslands of Surkhet and Salyan districts and open pasture areas located near agricultural fields.

The high-elevation rangelands used for herding livestock are locally known as *Patan* or *Kharka*. Based on the consultations and seven district-level workshops, names of 864 *Kharka* (*Patan*) were collected across the seven districts of

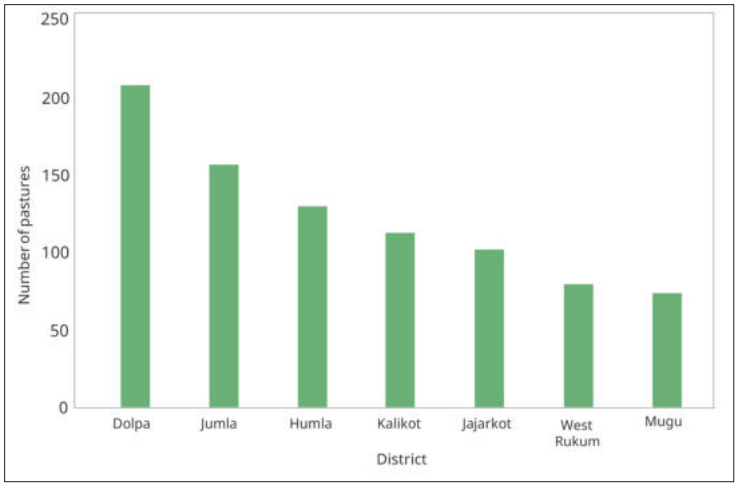

Figure 9. Number of grazing pastures in seven districts of Karnali Province.

Karnali Province. The highest number of Kharka was recorded in Dolpa (208), followed by Jumla, while the lowest number was found in Mugu (74), followed by West Rukum (80) (**Figure 9**).

Among the municipalities, Patrasi RM in Jumla, Simkot RM in Humla, Soru RM in Mugu, and Patala RM in Kalikot district have the highest number of grazing pastures. In contrast, Tatopani RM in Jumla, Sanni Tribeni RM in Kalikot, and Namkha RM in Humla have the lowest numbers. However, these figures are based on consultations and may contain omission errors in identifying and documenting rangelands.

2.2. Seasonality of Rangeland Dynamics

Rangelands in Karnali Province show fluctuating vegetation greenness according to different seasons. The ridge plot shows the seasonal dynamics of rangeland in the Province based on variations in Normalized Difference Vegetation Index (NDVI) values across different months (**Figure 10**). For example, the curves might be taller in certain months, indicating higher vegetation greenness, while in other months, the curves are shorter and shifted towards lower NDVI values, indicating lower vegetation greenness. This seasonal dynamic of rangeland greenness is highly dependent on temperature and precipitation. As spring arrives, temperatures start to increase, and warmer temperatures lead to the melting of snow, creating favorable conditions for seed germination and re-sprouting. Concurrently, with increased temperatures, photosynthesis rates rise, leading to a surge in vegetation growth, as reflected in the NDVI values.

Similarly, the monsoon precipitation in June, July, and August, combined with warmer temperatures, fuels further growth in rangeland vegetation, resulting in the peak of vegetation greenness. Plants can maximize photosynthesis due to the abundance of water and suitable temperatures. This period is typically reflected in the NDVI plot by a broad and high-density curve, indicating a high NDVI value spread across a significant portion of the area.

As summer ends and autumn begins, temperatures start to decline slightly, and precipitation decreases, reducing soil moisture. With less available water, some plants may begin to reduce their growth rates or enter a senescence phase. The NDVI values might start to decline gradually as vegetation cover becomes less dense or less vigorous.

With the onset of winter, frost/snow starts to occur in the high mountain rangelands, effectively ending the growing season for most plants. As a result of low temperatures and minimal precipitation, NDVI values decrease, reflecting the reduction in active vegetation. The curves in the

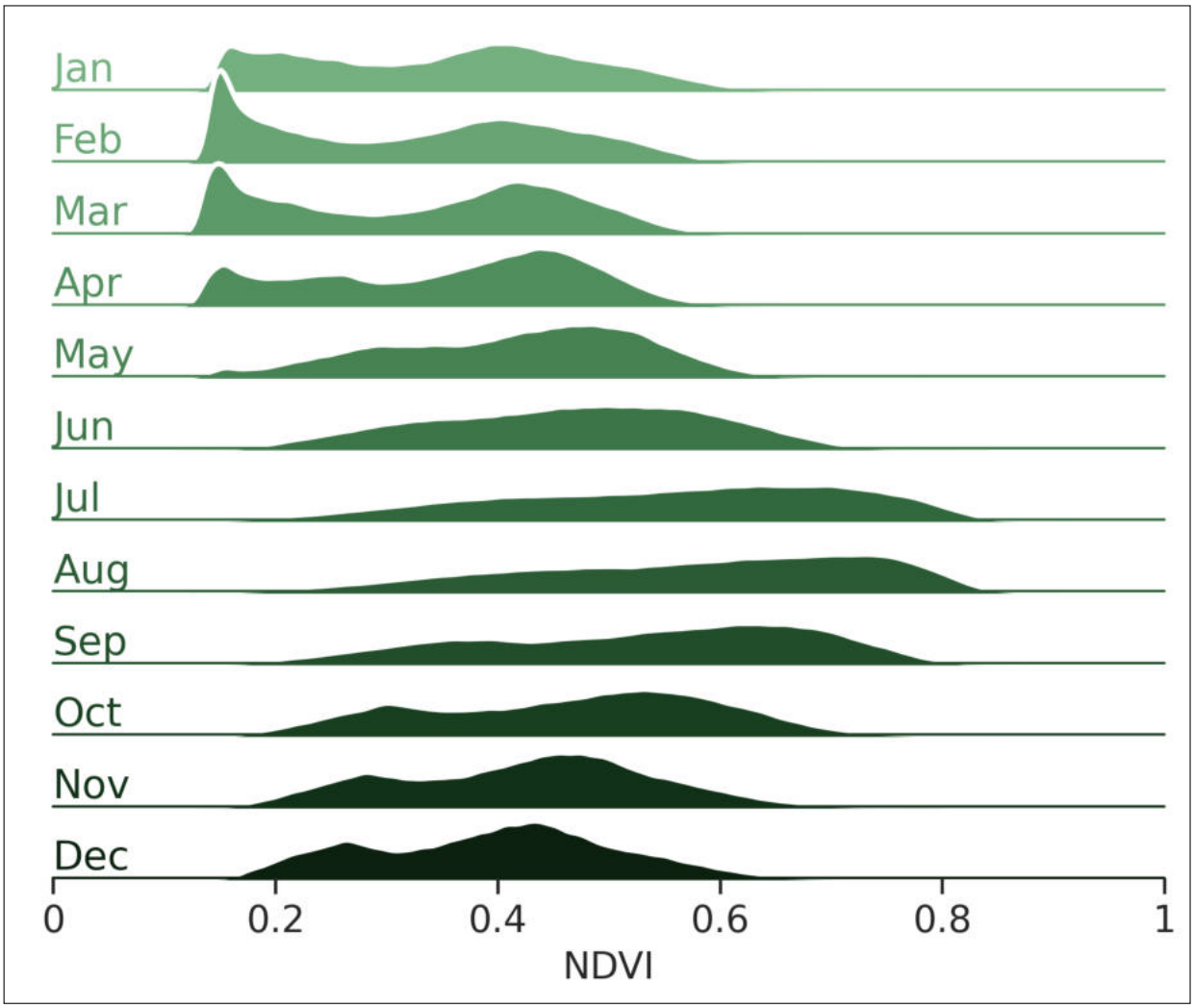

Figure 10. Seasonal dynamics of rangelands in Karnali Province showing monthly values of NDVI and their distribution in X-axis (colors shedding is done to differentiate the categories of Y-axis).

NDVI plot move towards lower values, indicating the dying back of vegetation or the transition to dormancy. The phenological cycle continues with the onset of spring, triggering increased vegetation greenness.

2.3. Ecosystem Services Provided by Rangelands

Rangelands in Karnali Province provide a wide range of critical Ecosystem Services (ES) or Nature's Contribution to People (NCP) as defined by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[1] (Watson et al. 2019). NPC or ES that are categorized into materials, regulating and non-materials, all of them are integral to the livelihoods and well-being of local communities (**Figure 11)**. Material services include food (vegetables, edible fruit, fungi) and feed for livestock, medicinal plants, fuelwood, animal dung for household energy and other materials used for construction. Regulating services incorporates the role of rangelands in maintaining biodiversity, including many endemic or threatened species of fungi, flora and fauna. Rangeland contributes to soil conservation, nutrient recycling, and water regulation, particularly in the steep, erosion-prone landscapes of Karnali, thereby enhancing environmental stability. By acting as carbon sinks, these rangelands also contribute to climate regulation, helping to mitigate climate change. Beyond their ecological functions, rangelands provide non-material services including cultural, spiritual, and recreational values, offering a sense of place and identity for many communities.

2.3.1. Habitat for Flora and Fauna

Floral diversity: Karnali Province's rangelands host a rich diversity of plant species. Based on the compilation of floral data from secondary sources (Acharya and Paudel 2020; Shrestha et al. 2022; GBIF 2024) as well as the field studies, there could be 1,625 species and 73 intraspecies of flowering plants belonging to 104 families found in the rangelands of Karnali. Among these plant species, it was found that 1,452 species are herbs, 226 are shrubs, 8 are shrubs or trees, 8 are herbs or shrubs, and 6 are under shrubs. The most species-rich families found in the rangelands of Karnali Province include Asteraceae (228 species), Poaceae (121 species), Fabaceae (91 species), Ranunculaceae (91 species) and Rosaceae (86 species) (**Figure 12**). Based on the forage classification, 995 species can be categorized as forbs, 230 as shrubs, 200 as grasses, and 91 as legumes. Additionally, 27 species of mushrooms have been reported from the high-

Figure 11. Various contribution of rangelands for the well-being of local communities of Karnali Province.

(1) IPBES is an independent intergovernmental body established to strengthen the interface between science and policy on biodiversity and ecosystem services and the global assessment report of IPBES defined 18 different types of NCP.

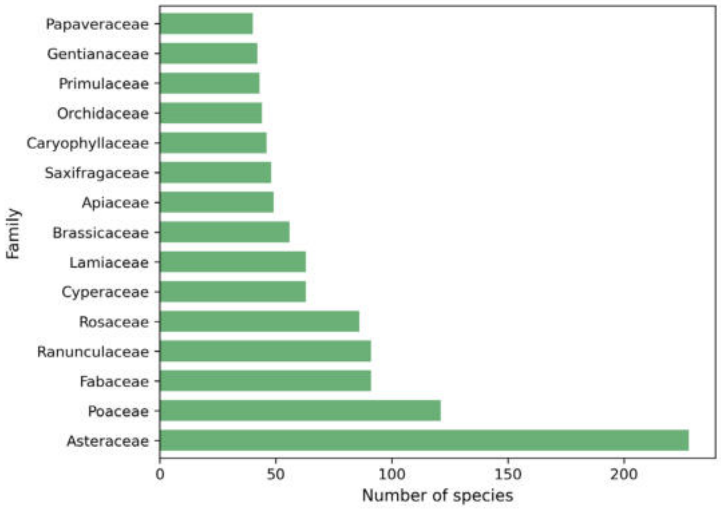

Figure 12. The most species rich plant families (top 15) found in the rangelands.

elevation rangelands of Karnali Province (Devkota 2008), along with 16 species of pteridophytes. Although these areas are rich in non-flowering plants such as bryophytes and lichens, there are no authentic records of these plants in the rangelands of Karnali Province.

Endemism is one of the key features of rangelands in Karnali Province. According to the most recent records of endemic plants, 312 species are endemic to Nepal (Tiwari et al. 2019), of which 78 species and 9 infra species are potentially found in the rangelands of Karnali Province, showing the conservation importance and uniqueness of the rangelands.

Faunal diversity: The rangelands of Karnali Province also support a diverse range of faunal species, including mammals, birds, herpetofauna, and butterflies (**Figure 13**). Based on a compilation of various sources, 41 species of mammals from 16 families (Jnawali et al. 2011; Ghimirey et al. 2014; Acharya et al. 2016; Kusi et al. 2019) and approximately 181 bird species (Baral et al. 2014; Grimmett et al. 2016; Kusi et al. 2018) inhabit these rangelands. Notable mammalian species include the Wild horse Kiang (*Equus kiang*), Wild yak (*Bos mutus*), Himalayan blue sheep or Bharal (*Pseudois nayaur*), Musk deer (*Moschus chrysogaster*), Gray Wolf (*Canis lupus*), Tibetan gazelle (*Procapra picticaudata*), Himalayan marmot (*Marmota himalayana*), Altai Weasel (*Mustela altaica*), Wolly hare (*Lepus oiostolus*), Plateau Pika (*Ochotona curzoniae*), Argali (*Ovis ammon*), White-lipped deer (*Cervus albirostris*), Snow leopard (*Panthera uncia*), Himalayan wolf (*Canis chanco*), Eurasia Lynx (*Lynx lynx*), Red Fox (*Vulpes vulpes*), Tibetan fox (*Vulpes ferrilata*), Steppe Polecat (*Mustela eversmansii*), Brown bear (*Ursus arctos isabellinus*), and many others.

Among the birds, the Fringillidae family, which includes finches, is the most represented with 27 species, followed by the Muscicapidae family (24 species of passerines) and the Accipitridae family (15 species of raptors). The open grasslands and their edges provide ideal habitats for these birds, offering seed-bearing plants for finches, accessible areas for passerines to find insects and seeds, and favorable hunting grounds for raptors. Notable avian species found in Karnali's rangelands include the nationally protected Himalayan monal (*Lophophorus impejanus*) and the globally critically endangered Red-headed vulture (*Sarcogyps calvus*).

The rangelands are also home to 11 amphibian species (Acharya and Paudel 2020), including the globally near-threatened *Scutiger nepalensis* that inhabits alpine streams, and 8 reptile species, including the globally vulnerable Ophiophagus hannah.

Butterfly diversity is notable in the region, with approximately 94 species from five families (Acharya and Paudel 2020), 26 of which are known to specifically inhabit alpine rangelands.

Furthermore, Karnali river basin and its sub-watersheds, encompassing major rivers, streams, and lakes—including high-elevation lakes beside these rangelands—support 93 species of fish (Acharya and Paudel 2020), including 5 endemic species: *Balitora eddsi*, *Pseudecheneis serracula*, *Schizothorax nepalensis*, *Schizothorax raraensis*,

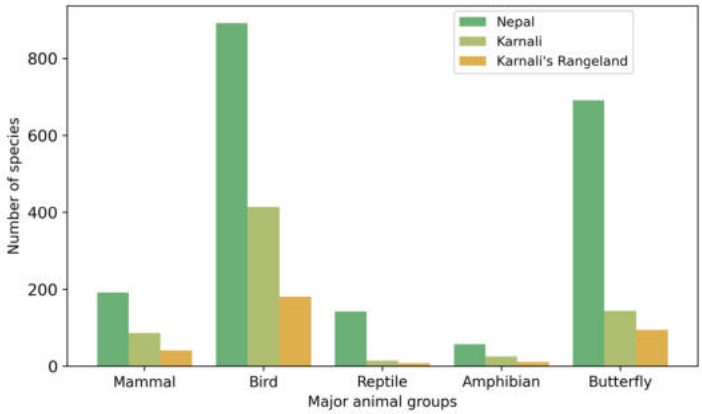

Figure 13. Number of species of five faunal groups found in Nepal, Karnali Province and the rangelands in Karnali Province.

and *Schizothorax macrophthalmus*.

Conservation status of flora and fauna: Many of the species found in Karnali Province's rangelands are under threat due to habitat degradation, overgrazing, and poaching. The International Union for Conservation of Nature's Red List of Threatened Species (IUCN Red List) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provide crucial frameworks for the conservation of these species. Additionally, Nepal's National Parks and Wildlife Conservation Act include provisions for the protection of wild species.

The IUCN Red List, which provides detailed information on species' ranges, population sizes, and threats, serves as a critical indicator of biodiversity health, informing and catalyzing action for conservation (IUCN 2024). In the rangelands of Karnali Province, 79 plant species are listed on the IUCN Red List. Among these, four species—*Trillium govanianum*, *Cypripedium himalaicum*, *Dactylorhiza hatagirea*, and *Taxus contorta*—are classified as endangered (EN), while *Nardostachys jatamansi* is critically endangered (CR). Five species—*Impatiens serratifolia*, *Ephedra gerardiana*, *Fritillaria cirrhosa*, *Paris polyphylla*, and *Cypripedium cordigerum*—are considered vulnerable (VU). Additionally, 64 plant species from Karnali Province's rangelands are categorized as least concern (LC) by the IUCN.

Regarding the fauna, 41 mammal species found in Karnali Province's rangelands are listed under various IUCN Red List categories: two are endangered (EN), four are vulnerable (VU), four are near threatened (NT), and 31 are of least concern (LC). Similarly, among 181 bird species found in Karnali Province's rangelands assessed by the IUCN, one is critically endangered (CR), three are endangered (EN) three are vulnerable (VU), three are near threatened (NT), and 171 are of least concern. For amphibians, one species (*Nanorana rostandi*) is vulnerable, one (*Scutiger nepalensis*) is near threatened, and nine are of least concern. Among reptiles, one species (*Ophiophagus hannah*) is vulnerable and seven are of least concern.

Many plant and animal species from Karnali Province's rangelands are also listed in the appendices of CITES[2]. CITES is an international agreement, to which Nepal is a party, aimed at ensuring that international trade in wild animals and plants does not threaten their survival. To protect species from overexploitation, CITES lists species in three appendices: Appendix I includes species that are threatened with extinction; Appendix II includes species that are not necessarily threatened with extinction but may become so unless trade is closely controlled; and Appendix III includes species protected in at least one country that has asked other CITES Parties for assistance in controlling trade (https://cites.org/eng/disc/species.php).

Altogether, 22 mammal species from Karnali Province's rangeland are listed in CITES appendices: nine species in Appendix I, five in Appendix II, and eight in Appendix III. Among birds, 34 species found in Karnali's rangelands are listed in the CITES Appendices including five in Appendix I, 27 in Appendix II, and four in Appendix III. In total, 50 plant species are listed in CITES Appendix II.

Nationally, the Department of National Parks and Wildlife Conservation (DNPWC) recognizes 26 mammal species, nine bird species, three reptile species (https://dnpwc.gov.np), and 14 plant species (DPR 2012) as protected. Among the protected mammals, birds, and reptiles, five mammals—namely Red panda (*Ailurus fulgens)*, Musk deer (*Moschus chrysogaster*), Wild yak (*Bos mutus*), Snow leopard (*Panthera uncia*), Indian pangolin (*Manis pentadactyla*), and two birds namely Cheer pheasant (*Catreus wallichii*) and Himalayan monal (*Lophophorus impejanus*) are found in the rangelands of Karnali Province. Among the protected plants, Panchaule (*Dactylorhiza hatagirea*) is banned for collection, transportation, and trade, while Kutki (*Neopicrorhiza scrophulariiflora*) is banned for export without identification and certification. Similarly, Jatamansi (*Nardostachys jatamansi*) and Sugandhawal (*Valeriana jatamansi*) are banned for export outside the country without processing (DPR 2012).

2.3.2. Medicinal Species

Medicinal plants, fungi, and lichens are the key products in Karnali Province. Pyakurel et al. (2019) reported that 300 species of plants, fungi, and lichens are currently traded in Nepal, and among them, the rangelands in Karnali Province harbor 92 traded medicinal species, accounting for 31% of the total. Of these 92 species, 82 are actively traded in contemporary markets, and 10 species are not currently traded. Based on the revenue records of medicinal plants and other non-timber forest products, Karnali Province has 38 species/items that are part of the revenue system, all of which are found exclusively in rangelands (MoITFE 2023). High-valued

medicinal species such as such as Yarsagunbu (*Ophiocordyceps sinensis*), Jatamansi (*Nardostachys jatamansi*), Setakchini/Khiraula (*Polygonatum verticillatum*), Kutki (*Neopicrorhiza scrophulariiflora*), Padamchal (*Rheum australe*), Pakhanved (*Bergenia ciliata*), Ban lasun (*Fritillaria cirrhosa*), Atis (*Delphinium himalayae*), Sunpati (*Rhododendron anthopogon*), Dhupi (*Juniperus spp.*), Jimmbu (*Allium hypsistum*), Chuk (*Hippophae salicifolia*), Dale chuk (*Hippophae tibetana*), Ghuchii chayu (*Morchella spp.*), Rato chayu (*Ganoderma spp.*), Panchaule (*Dactylorhiza hatagirea*), and Satuwa (*Paris polyphylla*) are exclusively found in rangelands. Based on herbal trade data from the past five fiscal years (2074 to 2079), the trade of medicinal species in Karnali Province generates approximately 36 million Nepali rupees annually in revenue, with a range from 25 million to 44 million Nepali rupees (MoITFE 2023). The Province supplies around 1.4 million kg of various medicinal herbs each year on average, with trade volumes ranging from 1.1 million kg to a maximum of 2.0 million kg (**Figure 14**).

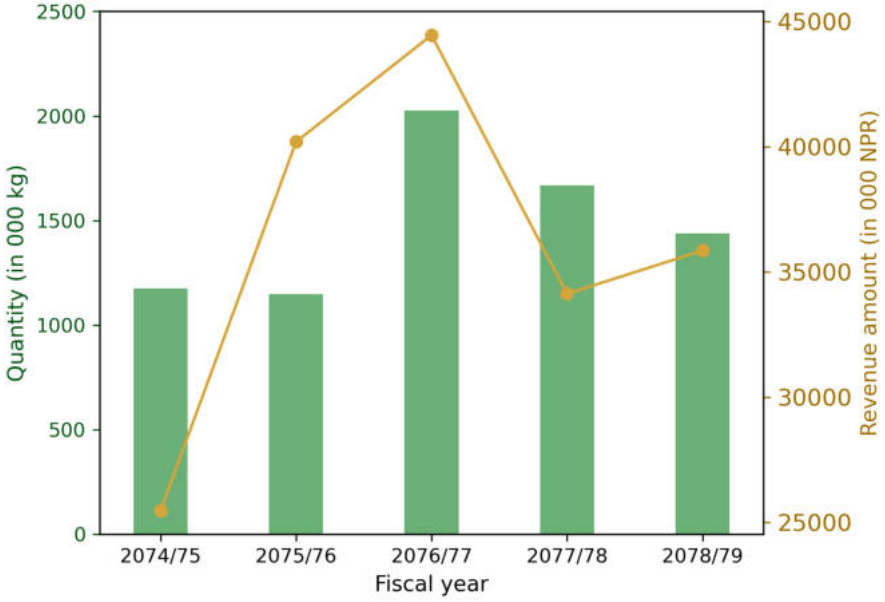

Figure 14. Quantity and revenue amount of medicinal species collected from rangelands in Karnali over the last five years.

Of the 38 medicinal species traded from Karnali Province, the 15 most collected herbs (**Figure 15**) account for 95% of the trade volume. The five most traded species by volume—*Zanthoxylum armatum*, *Polygonatum spp.*, *Nardostachys jatamansi*, *Juniperus spp.*, and *Bergenia ciliata*—contribute 67% of the total trade volume.

Revenue from the top 15 species constitutes nearly 98% of the total revenue generated from the 38 traded herbs (**Figure 16**). Among these, the five species generating the most revenue—*Ophiocordyceps sinensis*, *Nardostachys jatamansi*, *Polygonatum spp.*, *Zanthoxylum armatum*, and *Neopicrorhiza scrophulariiflora*—collectively account for 84.4% of the total revenue.

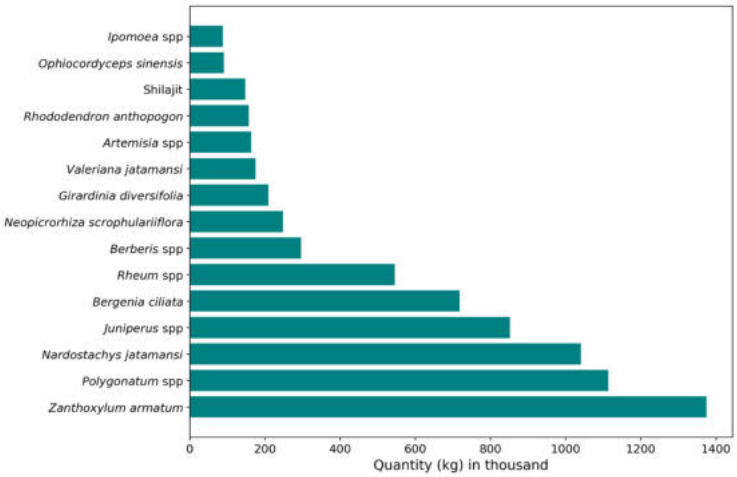

Figure 15. Top 15 highest collected medicinal species.

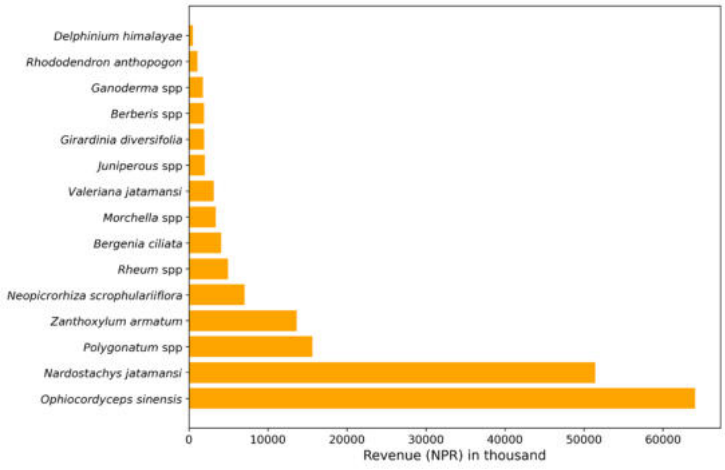

Figure 16. Top 15 highest revenue generating medicinal species.

Box I. Yarsagunbu-Himalayan Gold and Karnali 's Prosperity

Yarsagunbu, also known as Yarsa, Yarcha or Kira, and commonly referred to as caterpillar fungus (scientific name: *Ophiocordyceps sinensis*), is an endo-parasitic complex formed by the parasitic relationship between the Cordyceps fungus and the caterpillar of a Himalayan ghost moth belonging to the genus Thitarodes (Shrestha and Bawa 2013). It is renowned for its unique life cycle, exclusive distribution in high-elevation regions, various traditional and medicinal uses, and significant economic value in trade.

The life cycle of *Ophiocordyceps sinensis* begins when spores from the parasitic fungus infect the larvae of ghost moths, which reside in the soil of high-elevation grasslands. The fungal spores invade the larva's body, grow inside it, and eventually kill the host (Shrestha and Bawa 2013). After killing the larva, the fungus consumes the host's tissues, mummifying the body. The fungal mycelium then emerges from the host's head and develops into a dark brown or black spore-producing fruiting body (stroma) that protrudes from the soil. Collectors identify and harvest the stroma by uprooting it, along with the dead caterpillar buried beneath the soil.

If left uncollected, the mature fruiting body releases spores into the environment, which can then infect new larvae, continuing the cycle. This entire life cycle spans several months, typically beginning with infection in late summer or early autumn and culminating in the appearance of the fruiting body the following spring or early summer (**Figure 17**). The uninfected caterpillar of the moth develops into a pupa and then to an adult and continues its lifecycle.

Yarsagunbu is primarily found in the Himalayan region, including Nepal, Bhutan, India (Sikkim), and the Tibetan Plateau in China. It thrives in cold, alpine rangelands (grasslands and meadows) at elevations between 3,000 and 5,000 m. It is reported to be found in 27 of Nepal's 77 districts (Shrestha 2019), with Karnali Province, particularly the Dolpo region, producing a significant portion of Nepal's total Yarsagunbu supply (Shrestha and Bawa 2013).

Figure 17. Yarsagunbu in its habitat showing the fungal stalk, the mummified caterpillar is buried under the soil.
Photo: Uttam Babu Shrestha

Yarsagunbu has been used for various therapeutic purposes in traditional Chinese medicine. It is primarily used as a tonic to boost energy, stamina, and immune function. It is believed to improve lung and kidney function, enhance sexual performance, and combat fatigue (Winkler 2009). It is widely traded as an aphrodisiac, often referred to as "Himalayan Viagra."

Yarsagunbu is one of the most expensive natural products in the world. According to one estimate, the current global market for Yarsagunbu might range between 5 and 11 billion US dollars, with an estimated annual global production of 85–185 tons (Shrestha 2012). More than 95% of this production occurs in China, with the remaining coming from Nepal, Bhutan, and India (Shrestha and Bawa 2013).

The fungus is typically harvested during early summer when the fruiting body emerges from the soil. Local communities in Karnali Province migrate to high-elevation pastures to collect Yarsagunbu. In some regions of Karnali Province, up to 72% of household cash income comes from Yarsagunbu harvesting alone (Shrestha and Bawa 2014).

Based on revenue records, Yarsagunbu is collected in five districts of Karnali Province: Dolpa, Jumla, Humla, Kalikot, and Mugu. On average, about 480 kg of Yarsagunbu has been collected annually from Karnali Province over the past five years, generating approximately 12.8 million Nepali rupees in revenue per year (**Figure 18**).

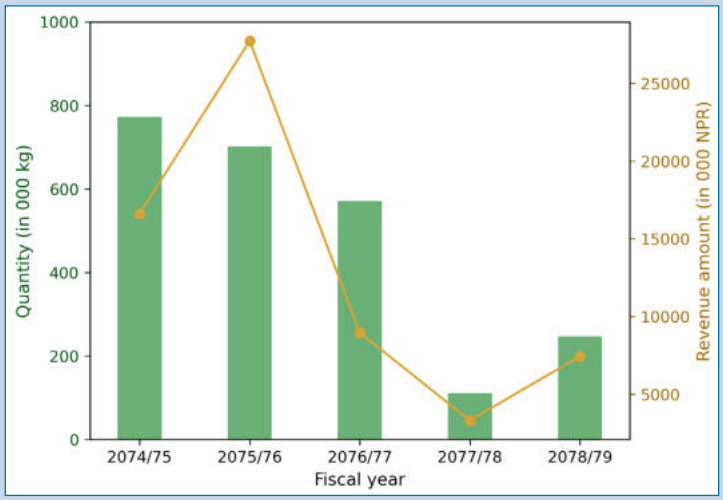

Figure 18. Quantity and revenue of Yarsagunbu collected from Karnali Province over the last five years.

While the Yarsagunbu boom has brought economic benefits to many, it has also led to challenges. Due to its high value and the heavy reliance of locals on this resource, harvesting Yarsagunbu has become a matter of life and death for many. The harvesting season often sees conflicts over pasture rights, with occasional violence. Additionally, around 10 people die every year during Yarsagunbu collection while crossing cliffs and rivers, falling in avalanches, slipping in the snow and suffering from altitude sickness (Shrestha 2019).

The mean annual harvest of this species has declined in many if not all areas across its range in the Himalaya and Tibet due to overharvesting. In addition, over harvesting and climate change pose significant threats to the natural populations of Yarsagunbu (Hopping et al. 2018). Hence, this species has been listed in the Vulnerable category by IUCN (Yang 2020). Nevertheless, other ecological impacts of intensive harvesting are evident but largely understudied. The collection process is clearly detrimental to the natural regeneration of the species, leaving no inch of habitat untouched by the end of the season. Destruction of alpine pastures, solid waste pollution, and deforestation are major ecological concerns. Soil compaction and trampling of vegetation due to the unprecedented movement of humans are common (Shrestha 2019). Rampant digging of alpine meadows has also degraded the soil. The cutting of juniper, rhododendrons, birch, and other slow-growing trees at the timberline for fuelwood and heating has led to deforestation (Shrestha and Bawa 2013). Solid waste, mostly plastic packaging from noodles, biscuits, and other dry foods, litters the pristine landscape. No studies have been conducted to assess the impact of Yarsagunbu harvesting on wild animals. A decline in its populations could have serious ecological and economic consequences for the communities of Karnali Province that depend on it.

2.3.3. Food (Vegetables, Wild Mushrooms, Edible Fruits)

Rangelands in Karnali Province also harbor 87 species of wild edible plants belonging to 30 angiosperm families, contributing to the local diet and income. The highest number of edible plants belong to the Rosaceae (11 species), Asteraceae (9 species) and Polygonaceae (9 species), followed by Fabaceae (6 species) and 4 species each in the Amaranthaceae, Araceae, Asparagaceae, Berberidaceae and Solanaceae families. Among these edible species, most of them (58 species) are used as leafy vegetables, with leaves and young shoots being consumed as vegetables. Additionally, the roots of *Arisaema jacquemontii* and the tuberous roots of *Dioscorea deltoidea* and *Dioscorea bulbifera*, and the fruits of *Solena heterophylla*, *Indigofera hebepetala*, *Leucas cephalotes*, *Solanum aculeatissimum*, *Solanum torvum* as well as the flowers of *Ricinus communis* and *Caragana brevispina* are consumed as vegetables. Fruits of 21 plant species are also edible. The seeds of *Prinsepia utilis* (Dhatelo) are used to produce essential oil, which is now traded. Additionally, two species—*Cyanthillium cinereum* and *Duhaldea cappa*—are used for making Marcha (a mixed dough inoculate used as a starter culture to produce traditional alcoholic beverages). There are seven different edible mushrooms found in the rangelands of Dolpa, Karnali (Devkota 2008).

2.3.4. Feed/Grazing Ground for Livestock

The rangelands of Karnali Province are home to more than 1,625 species of plants, with 56 species identified as palatable species for livestock. Among these, *Anaphalis sp.*, *Anaphalis triplinervis*, *Carex sp.*, *Cenchrus sp.*, *Potentilla plurijuga*, and *Potentilla spp.* are considered highly palatable. Similarly, species such as *Cortia depressa*, *Lancea tibetica*, *Bistorta sp.*, *Androsace spp.*, and *Saxifraga spp.* are considered less palatable. However, certain species in the pastures are poisonous to animals, including *Anemonastrum elongatum*, *Meconopsis horridula*, *Cymbopogon distans*, *Cymbopogon martini*, *Cymbopogon pospischilii*, and *Triglochin maritima*. Notably, *Triglochin maritima*, an aquatic herb, is also considered poisonous to livestock (Richard et al. 2000 and pers. obs.).

Livestock rearing is a cornerstone of the economy in Karnali Province, with highland communities relying on animals such as yaks, sheep, goats, and cattle for their livelihoods, while lowland communities primarily rear buffaloes, cattle, and goats. The Province's high-elevation rangelands support large populations of yaks, sheep, horses, cattle, and goats. These activities generate income through the sale of livestock products such as ghee, meat, and woolen products, while also fulfilling dietary needs with milk products and

Livestock grazing in a pasture of Dolpa
Photo: Uttam Babu Shrestha

meat. On average, farmers earn NRs. 7,000 to 8,000 per chauri per year and typically sell three to four sheep per household annually, with each sheep fetching between NRs. 20,000 to 30,000 (field survey). According to the Agriculture Census (2021), the total livestock population in Karnali Province is estimated to be over 2.16 million, with goat/chyangra (1,272,580), sheep (203,850), and cattle (658,367) comprising the majority (NSO 2021). The district-wise distribution of different livestock populations is provided in **Table 2**.

Table 2. District wise livestock population in Karnali Province.

District	Cattle	Goat/Chyangra	Sheep	Buffalo	Other Livestock*
Dailekh	100,750	210,912	3,406	37,956	103
Dolpa	23,250	51,356	20,353	284	11,585
Humla	38,714	37,244	17,694	2,321	5,837
Jajarkot	94,719	158,855	15,982	24,325	1,136
Jumla	63,113	38,417	53,895	1,773	4,272
Kalikot	63,453	59,259	13,966	18,264	1,930
Mugu	37,750	35,994	29,508	3,815	2,794
Rukum West	39,800	117,565	16,236	30,348	721
Salyan	100,811	283,519	24,936	17,589	250
Surkhet	96,009	279,460	7,874	27,442	534
Total	658,370	1,272,581	203,850	164,117	29,161

*other livestock includes yak, chauri, nak, horse, mule Data source: NSO 2021

2.3.5. Energy and Other Materials

Rangelands in Karnali Province are essential not only for grazing but also serve as a critical source of household energy for herders. These rangelands support 246 plants of woody species (shrubs, climbing shrubs, subshrubs, and woody climbers) that are potentially used by local herders as fuelwood. Among these species, Juniperus (juniper) and Berberis, along with other tree species available in the forest-rangeland ecotones, provide a reliable source of fuelwood. Additionally, animal waste, particularly yak dung, is commonly used as an energy source by herder communities in these remote areas. This bioenergy, derived from fuelwood and animal dung, is crucial for cooking, heating, and other household activities, especially in high-elevation regions where access to alternative energy sources is scarce or non-existent.

2.3.6. Water Quality and Quantity Regulation

High-elevation rangelands in Karnali Province, often covered by snow during winter, play a crucial role in water resource management for both local and downstream communities. The snow acts as a natural reservoir, gradually releasing water as it melts, ensuring a continuous supply of fresh water throughout the warmer months. These rangelands are the source of numerous springs and streams that originate from the melting snow and precipitation accumulating in these elevated areas (**Figure 19**). Additionally, lakes such as Shey Phoksundo and Rara, along with various lakes and ponds in the rangeland areas, provide a perpetual water supply to rivers and streams. Furthermore, major watersheds of the key river systems in Karnali Province are largely covered by rangelands. The vegetation in these rangelands also enhances water quality, benefiting the local environment. This water meets the needs of local herder communities and their livestock while flowing downstream to support the water supply of other communities, irrigate agricultural lands, and maintain local ecosystems.

2.3.7. Soil Formation

Rangelands help in soil conservation by providing ground cover that reduces soil erosion. In Karnali

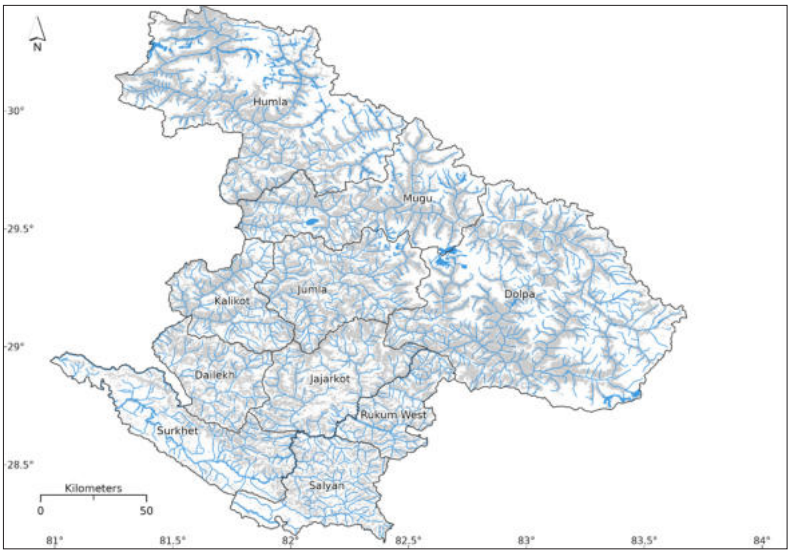

Figure 19. Major water sources (river, lakes, and ponds) in Karnali Province.

Province, rangelands are vital for both soil formation and soil erosion control, contributing significantly to the stability and sustainability of the region's ecosystems. The diverse vegetation in these rangelands, including grasses, shrubs, and other ground-covering plants, helps anchor the soil, reducing the impact of wind and water erosion. The roots of these plants bind soil particles together, preventing soil loss and maintaining the integrity of the landscape, especially in the steep and erosion-prone terrains. Additionally, the natural process of organic matter decomposition in rangelands contributes to soil formation by enriching the soil with nutrients, enhancing its fertility, and promoting the development of a healthy soil structure. This not only supports vegetation growth but also ensures the long-term productivity of the rangelands, benefiting both local agriculture and livestock grazing. The protection and sustainable management of these rangelands are therefore crucial for maintaining soil health and preventing degradation.

2.3.8. Carbon Sequestration

Although carbon sequestration by the rangelands in Karnali Province has not yet been studied, these rangelands possess substantial carbon sequestration potential, playing a critical role in mitigating climate change. A study conducted in the Himalayan rangeland in eastern Nepal showed that rangelands could store 17.3 t/ha to 28.3 t/ha soil carbon and 22.7 t/ha to 42.5 t/ha vegetation carbon (Koirala and Shang 2013). The vegetation found in these rangelands stores carbon in plant biomass and the soil. Additionally, the accumulation of organic matter from decaying plant material further enhances the soil's ability to store carbon. These processes make rangelands an essential component of the region's carbon cycle, helping to offset carbon emissions and reduce the concentration of greenhouse gases in the atmosphere.

2.3.9. Pollination

In Karnali Province, 53 out of 76 (70%) commonly cultivated crops depend on insects such as honeybees, bumblebees, and flies for pollination (Devkota et al. 2023). Although the exact number of insects and other pollinators in the rangelands of Karnali Province is not known, many of these vital pollinators inhabit the region's rangelands and forests. Rangelands are home to a diverse array of flowering plants, which attract a variety of pollinators, including bees, butterflies, birds, and other insects. The presence of these pollinators ensures the successful reproduction of many plant species in the rangelands and the adjacent agricultural fields. The pollination services provided by these insects and birds dwelling in the rangelands are crucial for the growth of crops, fruits, and vegetables in agricultural settings, thereby enhancing crop yield and productivity (Devkota et al. 2023). This interconnected relationship between rangeland vegetation and pollinators is essential for supporting the livelihoods of local communities by improving the yield and quality of crops, as well as sustaining the overall ecological balance of the region.

2.3.10. Tourism

The high-elevation rangelands contribute significantly to the scenic beauty of the region, attracting visitors for trekking and cultural tourism, which in turn supports the local economy. Twenty-seven key tourist destinations including monasteries/gompas, temples, cultural and natural landscape areas and water bodies as well as three major trekking routes in Karnali—namely the Limi Valley (Humla) Trek, Shey Phoksundo National Park, Rara Lake Trek, and Upper/Lower Dolpo Trek—pass through these rangelands (**Figure 20**). A significant portion of these routes traverses rangeland areas. The major tourist destinations include eight monasteries/gompas, seven temples, five natural and cultural landscapes, and seven water bodies (**Table 3**).

Table 3. District wise tourism destinations and routes in Karnali Province.

Monasteries and Gompas (District)	Temples (District)	Cultural/ Natural Landscapes (District)	Water Bodies (District)
Rinchenling Monastery (Humla)	Kedarnath Temple (Jumla)	Limi Valley (Humla)	
Railing Gompa (Humla)	Chhayanath Dham (Jumla)	Pugmo Village (Dolpa)	Chyachhara Waterfall (Humla)
Dolpo Shering Monastery (Dolpa)	Chimara Malika Temple (Jumla)	Rigmo Village (Dolpa)	Pachal Waterfall (Kalikot)
Samye Choeling Monastery (Dolpa)	Bala Tripurasundari Temple (Dolpa)	Nyalu Langa Pass (Humla)	Selima Daha (Mugu)
Shey Gompa (Dolpa)	Pancha Deval (Dailekh)	Sinja Valley (Jumla)	Rara Lake (Mugu)
Ribo Bhumpa Gompa (Dolpa)	Kharpunath Temple (Humla)		Phoksundo Lake (Dolpa)
Yangsher Gompa (Dolpa)	Kanaka Sundari Temple (Jumla)		Shankar Jharana (Jumla)
Samling Gompa (Dolpa)			

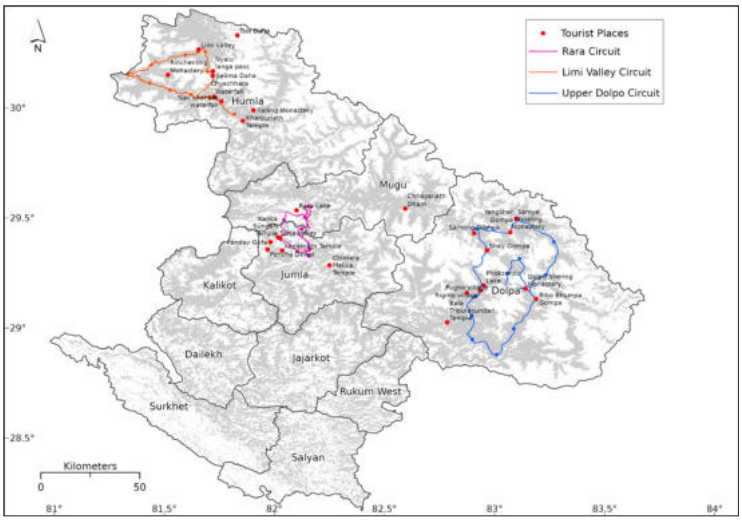

Figure 20. Major tourist destinations and routes in Karnali Province (Grey shaded area showing rangelands).

The ecotourism potential of these rangelands helps diversify livelihood options for local communities while highlighting the region's unique culture and natural heritage. These four destinations—Shey Phoksundo National Park, Rara National Park, Upper/Lower Dolpo, and Humla—collectively receive over 16,000 visitors including both Nepali and foreigners annually on average (MoCTCA 2019, 2020, 2021, 2022, 2023) (**Figure 21**). Among them, Rara National Park, particularly Rara Lake, stands out as the most popular destination, attracting over 10,000 visitors per year (DNPWC, 2019, 2020, 2021, 2022, 2023). In contrast, the Dolpo trek sees a relatively low number of visitors, making it the least visited area partly due to the lack of reliable road connectivity.

Visitor numbers have shown an increasing trend in recent years, reflecting the growing popularity of these destinations. As these trekking routes have gained popularity among domestic youth and foreign visitors in recent years, the number of

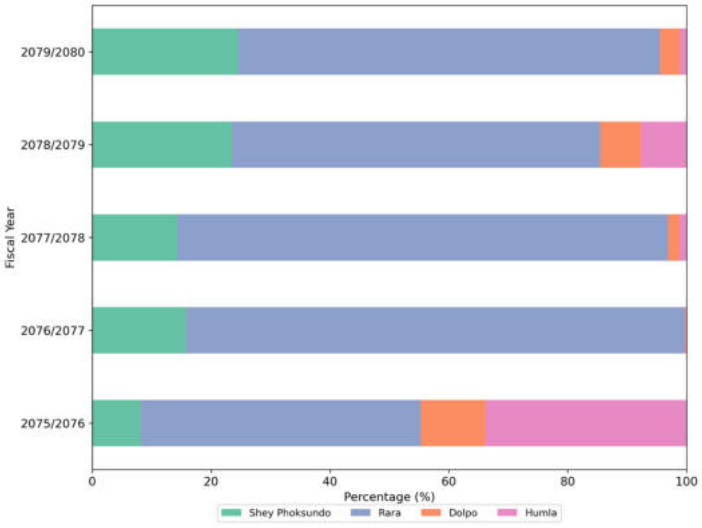

Figure 21. Percentage of tourists visiting four major trekking routes in Karnali Province. This figure is based on the total number of visitors visited these destinations from 2019-2023 based on DNPWC and MoCTCA data.

tourists will increase in the future showing huge potential for tourism in the Province. Unregulated tourism can lead to an increase in the consumption of goods, including plastics, generation of waste, and heightened demand for fuelwood, all of which may adversely impact local aquatic and terrestrial biodiversity in rangeland ecosystems.

2.3.11. Learning

The vast rangeland landscapes in Karnali Province serve as living laboratories, offering unique opportunities for scientists, researchers, and students to study a range of topics including ecological processes, species interactions, and the impacts of climate change in high-elevation environments. These rangelands are rich in biodiversity, hosting numerous species of fungi, flora and fauna, many of which are endemic or adapted to extreme conditions, making them invaluable for scientific exploration and discovery. Moreover, these ecosystems are deeply intertwined with the cultural heritage and practices of local communities, who have developed extensive indigenous knowledge over generations about sustainable land use, medicinal species, pastoral management, and adaptation to changing climates. This traditional wisdom, passed down through the ages, not only enriches scientific understanding but also provides sustainable practices that can inform modern conservation efforts. By supporting education, research, and cultural preservation, rangelands contribute significantly to the well-being and knowledge systems of people.

2.3.12. Culture and Identity

Rangelands are not just physical spaces but are also an integral part of the cultural and spiritual heritage of the people. Rangelands in Karnali Province are deeply embedded in the cultural identity and ceremonies of local communities, shaping their traditions, practices, and sense of belonging. Many areas such as Mahabu patan of Kalikot District, Limi Lapcha of Humla District (viewpoint for Mt. Kailash from Nepal side) are places where cultural narratives and spiritual beliefs are rooted, with many natural features considered sacred or symbolic. Additionally, the practice of transhumance is a tradition that has been passed down through generations. Ninety-nine percent of the Pahari and Bhotia communities living below 3000-3300m pursue one or the other form of transhumance practices (Bishop 1990), although this practice has been rapidly declining due to socio-ecological changes, such as the younger generation's lack of interest in herding and restrictions on grazing in community forests within lowland areas. Nevertheless, this movement is not only a practical response to the changing seasons but also a cultural ritual that reinforces community ties, knowledge transfer, and a deep connection to the land.

2.3.13. Transhumance Practices

Transhumance is a traditional pastoralist practice involving the seasonal movement of livestock between fixed summer and winter pastures. In many districts of Nepal, including Karnali Province, the traditional transhumance system has been practiced since ancient times (Bishop 1990). In many parts of Karnali Province, transhumance typically involves moving livestock, such as yaks/chauries, sheep, goats, horses, and cattle, to high-elevation pastures during the summer months and bringing them down to agricultural lands and forests at lower elevations during the winter. Generally, herders begin moving herds to high-elevation pastures from the months of Jestha/Ashad (May/June), although this timing varies across locations and depends on the timing of snow melting and spring rains. They return to their villages or lower valleys by Kartik (October/November) to avoid the cold winter.

Transhumance is a vital economic activity for many Himalayan communities (Aryal et al. 2014). It provides livelihoods through the sale of livestock products such as milk, meat, wool, and medicinal species collected during the seasonal migrations. The transhumance system is deeply embedded in the cultural and social fabric of Himalayan societies. It involves traditional knowledge and practices passed down through generations, contributing to the cultural heritage and identity of these communities.

This system is crucial for managing livestock in a manner that ensures optimal use of fodder resources, mitigates environmental impact, and sustains the livelihoods of pastoral communities. This movement pattern allows herders to take advantage of the lush, nutrient-rich grasses in the high-elevation meadows during the summer while avoiding the harsh winter conditions at higher elevations by moving to more sheltered and milder climates in the low-elevation regions. By rotating grazing areas, transhumance helps prevent overgrazing, allowing vegetation to recover and reducing soil erosion. Additionally, the practice of open grazing in the summer and restricting grazing activities in the winter in the

highlands helps maintain natural regeneration and the overall health of the rangeland ecosystem. Seasonal grazing patterns help preserve the biodiversity of alpine meadows and forests. The periodic absence of livestock allows plant species to regenerate and supports diverse wildlife habitats (Basnet and Chaudhary, 2017).

Box II. Transhumance Practices in Humla

Case Study: Dojam in Simkot Rural Municipality

The pastures of Dojam in Simkot Rural Municipality have been famous for sheep and goat herding for a long time. Herders from the Dojam, Simkot, and Sarkegad areas bring their livestock to these pastures. Traditionally, herders used to move to high-elevation summer pastures at the beginning of Jestha (May/June), but this year, they departed in mid-Ashad (July) due to the delayed greening of the rangeland caused by prolonged winter/spring droughts (**Figure 23**). Before departing for the pasture, the exact date of departure is fixed by the Lama, a Buddhist spiritual leader. On that day, they proceed with their herd after a ceremonial send-off in the village, including praying to the gods and eating good food, asking for blessings and wishes for good health and grass. They follow the traditional transhumance route, beginning from Tallo Sangu to Gurunggada/Rakharu (the ending point). However, the length of stay at each stop in recent years has shortened due to reduced availability of grass and water. In the winter months, sheep-goat herders and horsekeepers from the Dojam-Simkot area used to travel up to Bajhang, Surkhet, Dhangadi, and Dang districts in search of grazing land. However, this trend has significantly declined due to restrictions on open grazing by lowland community forests, resulting in a decrease in the number of herders and livestock over time.

Case Study: Limi Valley, Namkha Rural Municipality

The Limi area was once renowned for yak farming, where wealthy individuals owned thousands of sheep and hundreds of yaks, while middle-class families owned around 50 yaks and 100 sheep per household. During that time, the number of cattle was a symbol of wealth; the larger the number, the richer the household. Limi Valley's vast pastures provide grazing grounds for the residents of Limi as well as lowland communities. Buddhist spiritual leader, Lama, used to set the dates for moving to pasturelands. Herders would reach Tibet for grazing in winter, but new regulations have since restricted grazing in Tibetan rangelands, causing a significant decline in livestock farming in the three villages of Limi Valley due to the lack of winter pastures. The residents of the Dinga-Kermi (Namkha) area follow a traditional pastoral route, starting from Takur Khola and ending at Takche Khola (Limi-Lapcha). The length of stay at each stop varies from a week to several weeks, depending on the availability of grass, water resources, and the season. Typically, they begin moving upward from the end of Jestha (May/June), reach Limi-Lapcha, in the peak and return to the starting point (Takur Khola) by Aswin/Kartik (September-November) (**Figure 22, 23**).

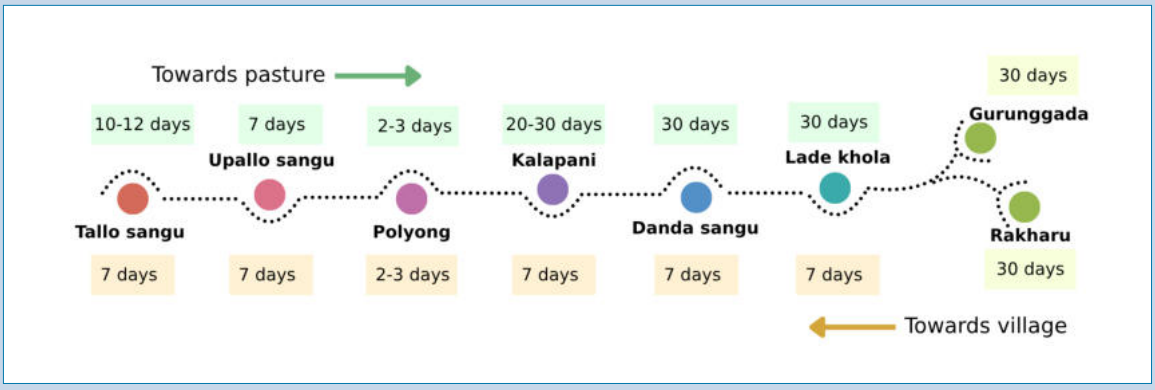

Figure 22. Transhumance route and stop points of Dojam-Simkot area in Humla.

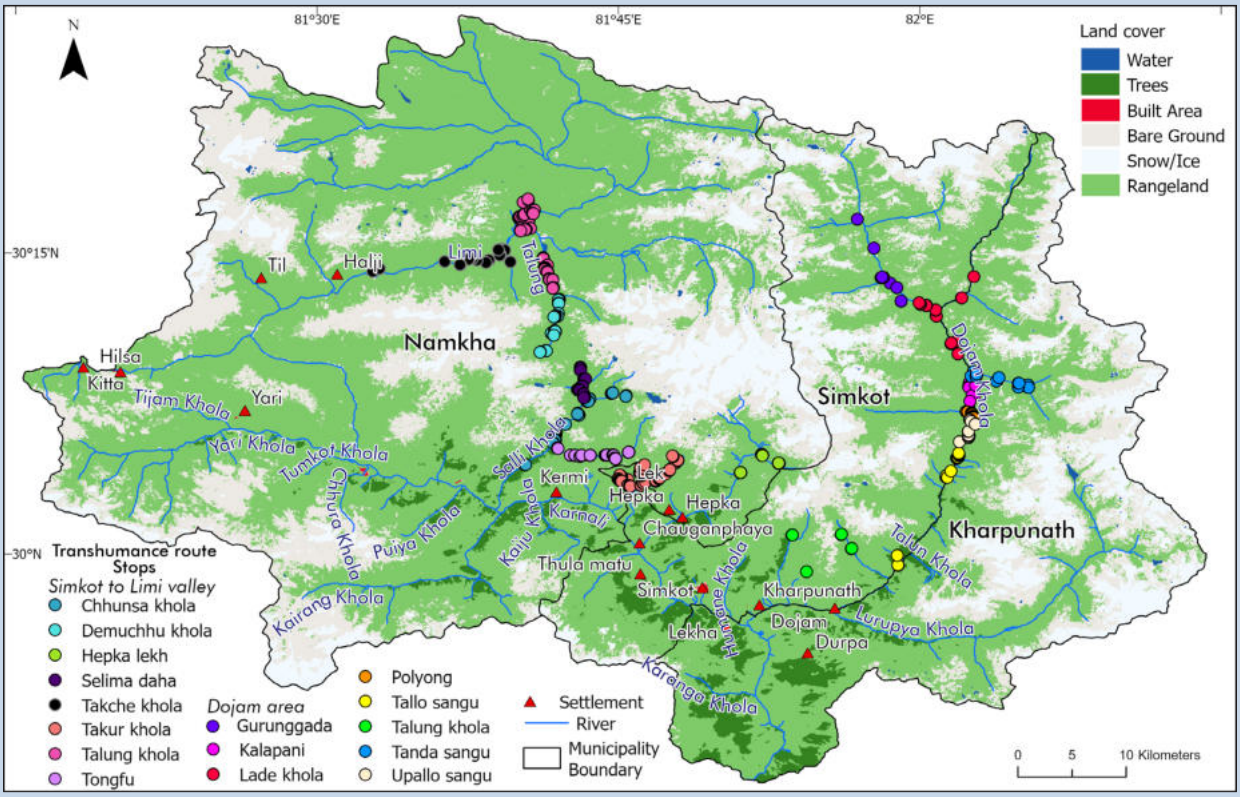

Figure 23. Transhumance routes in Humla District.

Figure 24. A transhumant herder guiding livestock (Top) and inside his shed in Limi Valley, Humla. Transhumance is a dominant pastoral practice in Karnali

Photo: Uttam Babu Shrestha

2.4. Rangeland Changes

Rangelands in Karnali Province are undergoing rapid transformations on multiple levels. Long-term satellite-derived NDVI data spanning 23 years show significant changes in rangeland vegetation and productivity. In some areas, average annual NDVI has declined, signaling reduced vegetation cover and potentially degraded ecosystem health. Conversely, other regions have experienced an increase in average annual NDVI, which may reflect improved vegetation conditions or the encroachment of shrubs and woody species. These variations in annual NDVI values are closely linked to livestock grazing patterns. Two livestock censuses (2011 and 2021) show that the total number of livestock—cattle, sheep, goats, yaks—grazing on these rangelands has increased over time. In addition to these shifts in vegetation and grazing dynamics, there is a concerning decline in the availability of key species harvested from these rangelands, including medicinal plants and other fauna dependent on rangelands (pers. comm.). The reduction in species populations indicates broader ecological stresses affecting these ecosystems, driven by both over-exploitation and changing environmental conditions.

2.4.1. Change in Rangeland Vegetation

Based on the analysis of satellite-derived NDVI data from 2000 to 2023, both positive (increased greenness) and negative (decreased greenness) trends in rangeland changes were observed across Karnali Province. However, the rangeland area with a negative slope, indicating decreased greenness, was smaller compared to those with a positive slope. In total, approximately 16,246 ha of rangelands (1.6% of the total rangeland area) showed a negative slope, while 52,559 ha (5.0% of the total rangeland area) exhibited a positive slope across the entire Province. The most significant degradation, reflected by a negative slope, was observed in Mugu District (5,360 ha), followed by Dolpa (2,739 ha) and Humla (2,689 ha) Districts, while Salyan (16 ha), Rukum West (364 ha), and Dailekh (618 ha) experienced the least degradation (**Figure 25**). Among municipalities, Chhayanath Rara (1,731 ha), Soru (1,463 ha) and Mugum Karmarong (1,424 ha) in Mugu as well as Shey Phoksundo (1,424 ha) in Dolpa, experienced the most substantial declines in rangeland area (**Figure 25**).

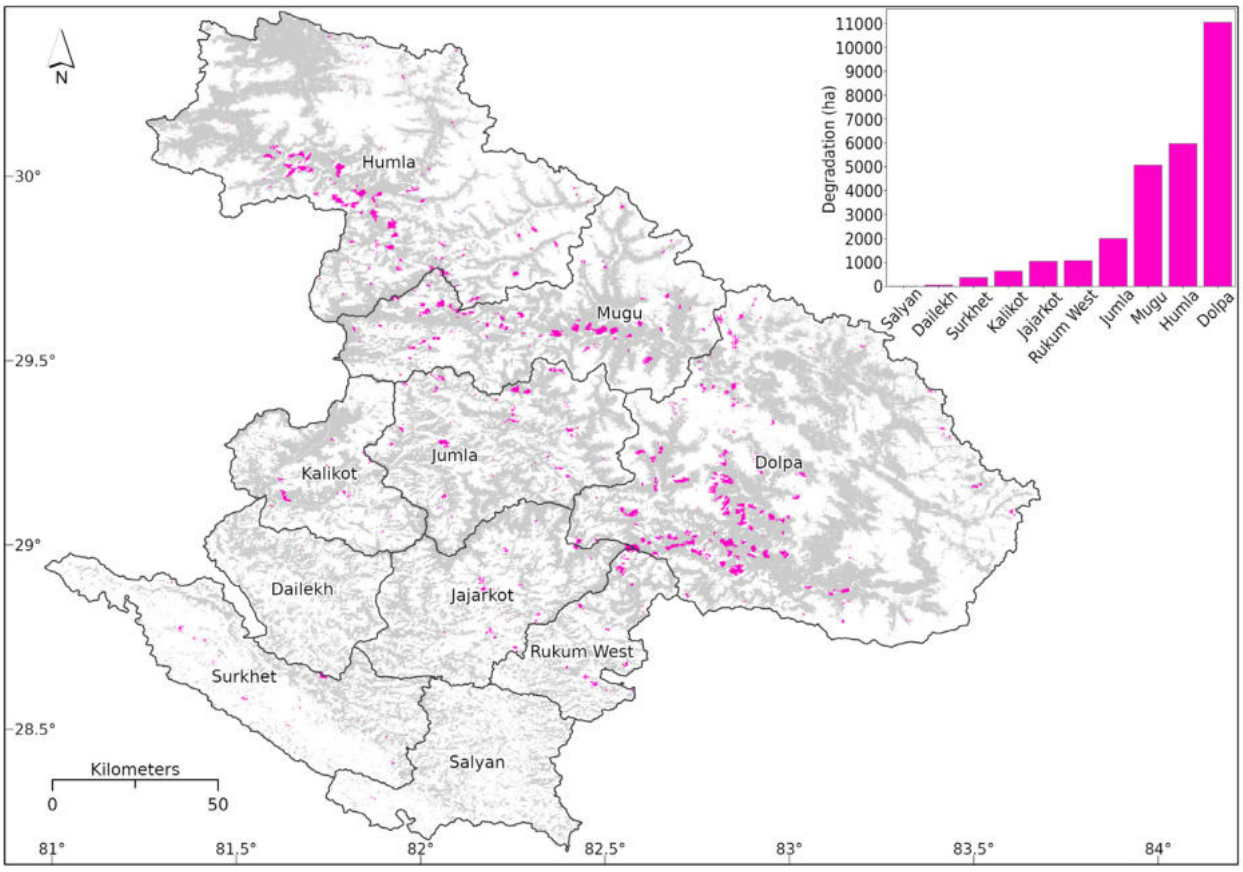

Figure 25. Map showing the areas with significant decrease of NDVI over the last 23 years.

Conversely, the largest areas of rangelands with a positive residual slope, indicating increased greenness, were found in Mugu District (10,176 ha), followed by Dolpa (10,048 ha). In contrast, Salyan (1,048 ha), Rukum West (1,723 ha), and Kalikot (2,909 ha) experienced the smallest increases in greenness (**Figure 26**). Among the municipalities, Shey Phoksundo (3,831 ha) in Dolpa, Suru (3,811 ha) and Mugum Karmarong (3,642 ha) in Mugu, Naumule (2,500 ha) in Dailekh, and Sarkegad (2,420 ha) in Humla showed the most significant increases in NDVI values in rangeland areas over the period from 2000 to 2023.

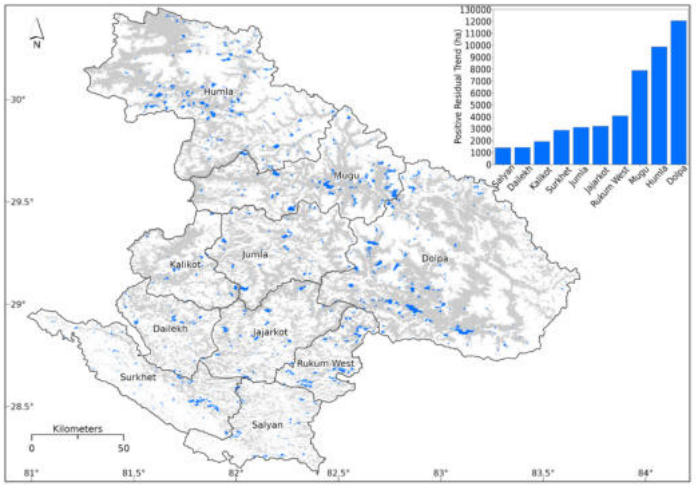

Figure 26. Map showing the areas with significant increase of NDVI over the last 23 years.

2.4.2. Change in Livestock Population

There is also variation in the change in animal populations at the municipal level. Due to the lack of long-term data for individual municipalities, data from two agricultural censuses (2011 and 2021) were compared. At the Province level, there were 724,906 cattle, 178,650 buffalo, 13,085 yaks, 224,851 sheep, and 1,007,985 goats in 2011. In 2021, there were 658,367 cattle, 164,117 buffalo, 1,272,580 goats, and 203,850 sheep. On average, the cattle population declined by 9.18%, the sheep population declined by 9.33%, and the buffalo population declined by 8.13%, while the goat population increased by 26.25% over the ten-year period.

The municipal-level changes in four major livestock populations (cattle, goat, buffalo and sheep) are shown in **Figure 27**, showing mixed trends across the municipalities. Cattle populations declined in 48 municipalities and increased in 31 municipalities. Among the municipalities with declining cattle populations, 45 experienced a decline of up to 50% over the past ten years, while a smaller number (25 municipalities) saw a similar increase of up to 50% in cattle populations.

Goat populations increased in 57 municipalities and decreased in 22. Among those with increases, 38 municipalities saw an increase of up to 50%, 11 municipalities saw increases between 50-100%, and in 8 municipalities, the goat population more than doubled.

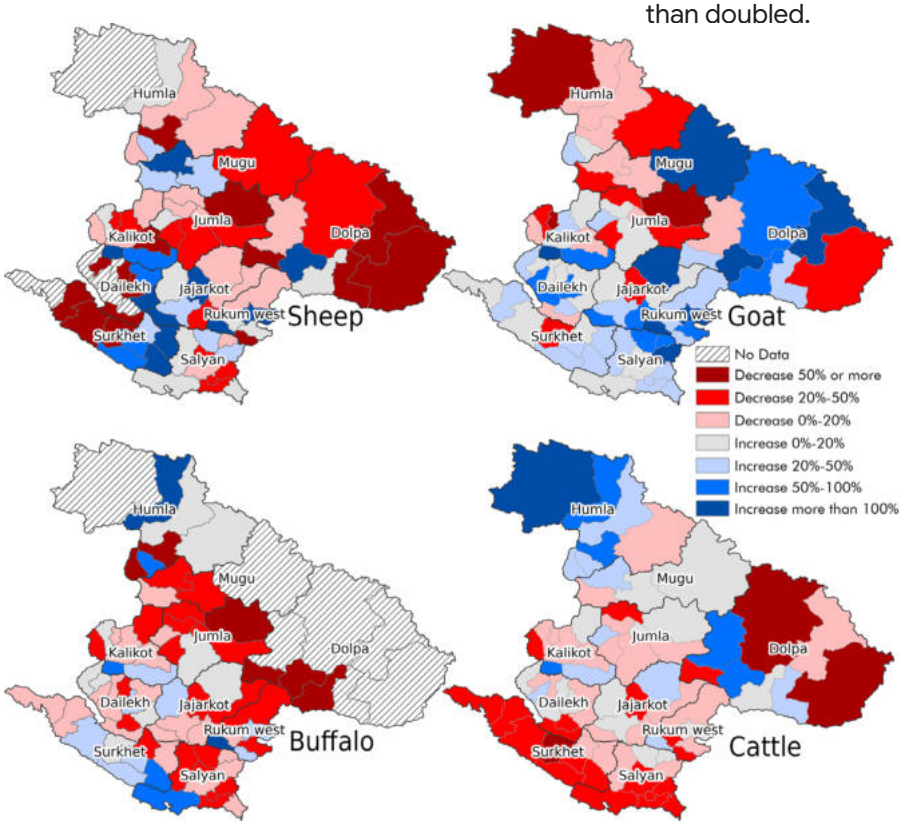

Figure 27. Municipal level change in the number of major livestock in Karnali Province.

Buffalo populations also exhibited mixed trends, with the majority of municipalities (49) experiencing declines, while 23 municipalities saw increases, and 7 municipalities had no available data. A notable decline of up to 50% was observed in 43 municipalities, while only 17 municipalities experienced a similar increase of up to 50%.

Sheep populations declined in 41 municipalities, while 31 municipalities saw an increase. A decline of up to 50% was observed in 26 municipalities, and 15 municipalities experienced a decrease of over 50%. In contrast, sheep populations more than doubled in 10 municipalities, and 17 municipalities saw increases of up to 50%.

Population data of yak/nak/chauri and horse/asses is not available at the municipal level. However, at the Province scale, yak/nak/chauri populations have decreased from 24,989 in 2012 to 19,417 in 2022 (MoALD 2023). Likewise, there was a slight increase of horse/asses' populations from 28,023 in 2012 to 31,012 in 2022 (MoALD 2023).

2.4.3. Changes in Floral and Faunal Population

There is no reliable study on the population status of flora and fauna in Karnali Province. However, IUCN Red List data provides proxies of the populations of several threatened floral and faunal species found in the rangelands in Karnali Province. Based on this data, 79 species are experiencing decreasing populations, 16 species show increasing populations, 176 species have stable populations, and the population status of 44 species is unknown (**Table 4**).

Table 4. Trends of rangeland flora and fauna found in rangelands in Karnali Province.

Trends	Group	IUCN Red list category					Total
		CR	EN	LC	NT	VU	
Decreasing	Mammals		2	2	4	4	12
	Birds	1	3	41	2	2	49
	Reptiles					1	1
	Amphibians			4	1	1	6
	Plants	1	4	2		4	11
	Total	2	9	49	7	12	79
Increasing	Mammals			1			1
	Birds			11	1	1	13
	Reptiles						
	Amphibians			1			1
	Plants			1			1
	Total			14	1	1	16
Stable	Mammals			14			14
	Birds			111			111
	Reptiles			6			6
	Amphibians			4			4
	Plants			40		1	41
	Total			175	0	1	176

Unknown	Mammals			14			14
	Birds			8			8
	Reptiles			1			1
	Amphibians						0
	Plants			21			21
	Total			44	0	0	44
CR= Critically Endangered, EN= Endangered, LC= Least Concern, NT= Near Threatened, VU= Vulnerable							

Of the 79-plant species from Karnali Province's rangelands listed on the IUCN Red List, the population of only one species, *Alternanthera sessilis* (categorized as Least Concern, LC), is increasing, while 13 species are experiencing population declines, 41 species appear stable, and 24 species have unknown population trends. Among those with decreasing populations, *Nardostachys jatamansi* is critically endangered, while four species—*Trillium govanianum*, *Cypripedium himalaicum*, *Dactylorhiza hatagirea*, and *Taxus contorta*—are endangered. Additionally, four species—*Ephedra gerardiana*, *Fritillaria cirrhosa*, *Paris polyphylla*, and *Cypripedium cordigerum*—are classified as vulnerable.

Out of the 41-mammal species assessed, the population of 12 species is declining, while only one species (*Canis aureus*) is experiencing an increase. The populations of 14 species are stable, and the status of another 14 remains unknown. Among the declining species, four (Wild Yak- *Bos mutus*, Himalayan Serow- *Capricornis thar*, Common Leopard- *Panthera pardus*, Snow Leopard- *Panthera uncia*) are classified as vulnerable, four species namely Himalayan tahr (*Hemitragus jemlahicus*), Himalayan goral (*Naemorhedus goral*), Tibetan Argali (*Ovis ammon*) and Altai Weasel (*Mustela altaica*) as near threatened (NT), two (Jungle Cat-*Felis chaus*, and Yellow-throated Marten- *Martes flavigula*) as least concern (LC), and two (Dhole-*Cuon alpinus* and Himalayan musk deer-*Moschus leucogaster*) as endangered.

For birds, the population of 49 species is decreasing, whereas only 13 species show an increase, according to IUCN Red List. The populations of 111 bird species are stable, and the status of 8 species is unknown. Among the decreasing bird populations, one species (*Sarcogyps calvus*) is critically endangered, three species (*Aquila nipalensis*, *Neophron percnopterus*, *Falco cherrug*) are endangered, 41 are classified as least concern (LC), two as near threatened (NT), and two (*Catreus wallichii*, *Gallinago nemoricola*) as vulnerable.

For herpetofauna, the population of one reptile species is decreasing, six species have stable populations, and one species has an unknown status. Among amphibians, the population of six species is declining, one species (*Duttaphrynus melanostictus*) is increasing, and the remaining four species have declining populations.

Aconitum sp., a high-altitude medicinal plant species
Photo: Uttam Babu Shrestha

Rangeland *(Guthichaur)* is increasingly covered by plastic waste, unpalatable species *(Rumex nepalensis)*
Photo: Uttam Babu Shrestha

CHAPTER 3

Drivers of Rangeland Change in Karnali Province

Introduction of Drivers of Rangeland Change

Drivers are generally defined as any natural or human-induced factors that directly or indirectly cause changes in an ecosystem (Carpenter et al. 2006). Natural direct drivers include earthquakes, lightning, and volcanic activities, and ecological succession while anthropogenic drivers encompass a wide range of human activities. Anthropogenic direct drivers, also called 'pressures' include land use change, climate change, invasive species, direct extraction, and pollution. The indirect drivers, or 'underlying causes,' indirectly affect rangelands. These include demographic factors (e.g., population, migration), economic factors (e.g., market access and demand), technological factors (e.g., use of machines and mobile devices), and governance by formal states (e.g., policies, programs). These drivers interact with community governance to influence direct drivers over time (Díaz et al. 2015; Watson et al. 2019), thereby affecting the state of ecosystems, such as rangelands. Adopting these definitions, this chapter outlines the direct and indirect anthropogenic drivers, as well as natural drivers, that change the socio-ecological components of rangelands (**Chapter II**) in Karnali Province (**Figure 28**). Like many other regions around the world, Karnali Province's rangelands are influenced by a complex interplay of natural and anthropogenic drivers that contribute to their degradation, loss of biodiversity, and conservation.

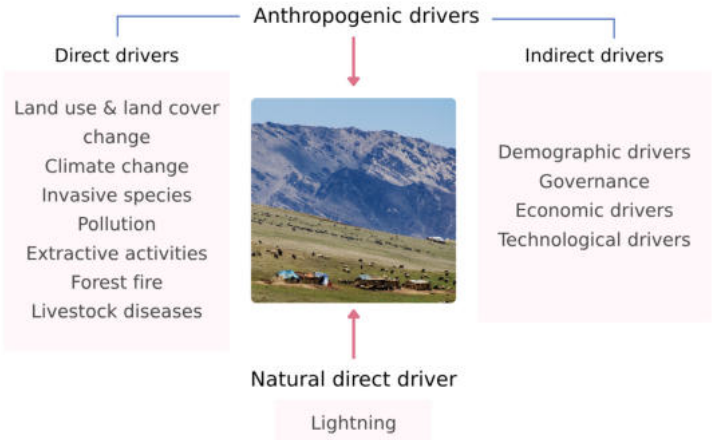

Figure 28. Anthropogenic and natural drivers of rangeland change in Karnali Province.

3.1. Anthropogenic Direct Drivers of Rangeland Change

3.1.1. Land Use and Land Cover Change

Major land use and land cover changes observed in the rangelands of Karnali Province are construction of roads and other infrastructure, encroachment of rangelands for agriculture, and pastoral abandonment. These activities

have altered the landscape condition impacting biodiversity, ecosystem function, productivity, and sustainability of rangeland ecosystems.

Road construction: Karnali Province has seen a rapid growth in the length of roads. The total road length in 2004 in the entire Karnali Province was 842 km which has increased to 1,657 km in 2023, yet the majority of the roads are earthen (DoR 2023). District-wise road length is shown in **Figure 29**, **Figure 30** shows the maximum increase in Jajarkot, followed by Dailekh, Jumla,

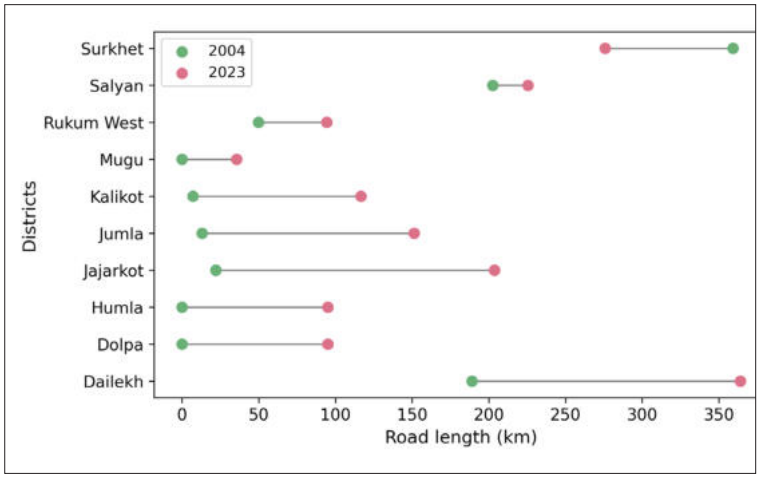

Figure 29. Change in road length across 10 districts in Karnali Province (*Road length of Surkhet has shown decreased due to the change in district boundary).

and Kalikot Districts. However, this figure does not include locally built road tracks and paths using heavy machinery. Road data extracted from the open street map shows a significant increase in road tracks. Major roads such as the Jumla-Dolpa highway, Mugu-Rara highway, and Karnali corridor in Humla pass through the rangelands. The construction of roads and other infrastructure projects in and around the rangeland areas in Karnali Province, without preventive measures for controlling slope failure, resulted in massive soil erosion and siltation problems. Haphazard building of roads is the major cause of landslides in Nepal (Petley et al. 2007), which is evident in the roads recently constructed in Karnali Province.

Although landslides around the roads in Karnali Province are visible, the causal relationship between road construction as a driver of landslides has not been well understood in Karnali (**Figure 31**). But the number of landslides in Karnali Province has increased significantly in recent years and the impacts of landslides, such as human deaths, death of cattle, damage to houses and properties have also increased (**Figure 32**). The use of heavy machinery for road construction

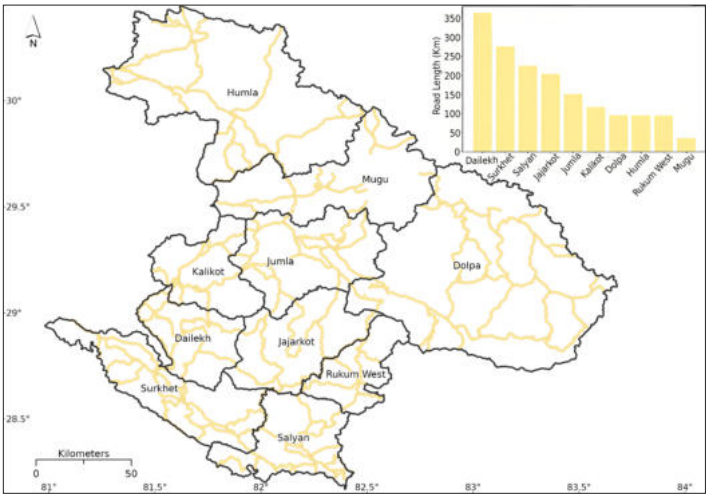

Figure 30. Road networks in Karnali Province (district wise road length is shown in bars).

also increased soil compression resulting in decreased water percolation into soil, increased runoff, and reduced nutrient uptake (Allmaras et al. 1993; Cambi et al. 2015). These changes impact rangeland by decreasing soil fertility and water retention capacity which together reduce the productivity of rangelands. The alteration of land use can impact the water cycle by reducing the infiltration of water into the soil, increasing runoff, and lowering the availability of water for vegetation (Coppock et al. 2017). This can exacerbate the effects of droughts and lead to further degradation of rangelands.

Furthermore, erosion-led loss of topsoil has reduced the vegetation cover in many areas (**Figure 31**). Although the impacts of road construction on Karnali Province's rangeland are not fully known, land use changes can cause the loss of native plant and animal species (Tsegaye et al. 2010). Fragmentation of rangelands due to roads makes it difficult for wildlife and livestock to access traditional grazing areas. This reduction in biodiversity weakens the resilience of ecosystems, making them more vulnerable to environmental changes. It also impacts the pastoral system because of the limited availability of pastoral resources (Coppock et al. 2017).

Encroachment: Along with infrastructure development, encroachment of rangelands for agriculture development is one of the major drivers of degradation. As arable land becomes scarcer, farmers are increasingly using rangelands for cultivation, leading to the conversion of these areas into croplands. This not only reduces the extent of rangelands but also disrupts the natural vegetation and soil structure, leading to soil erosion and loss of biodiversity.

Figure 31. A huge gully formation due to the road construction destroying rangelands. *Photo: Uttam Babu Shrestha*

For example, approximately 10 ha of open pasture near forests, previously under the Syanipatal Kafalbari Community Forest in Jumla, were encroached by 11 farmers who converted the community land into a private apple orchard. Although this encroachment occurred a decade ago, in May 2024, about 1,000 apple trees planted on the encroached land were removed by the community forestry user group, with assistance from the Division Forest Office (https://nagariknews.nagariknetwork.com/social-affairs/1436254-1716103601.html).

However, similar instances of encroachment, where traditional pastures have been converted into agricultural fields, have also been observed in other parts of Jumla, (Guthichaur area), Mugu (Salleri area of Rara National Park), and Dolpa (Majphal area).

Pastoral Abandonment: Youth, particularly the educated ones, are increasingly disinterested in pursuing herding as a livelihood. A reduction in grazing land productivity, greater awareness among high-elevation communities about the importance of education, the emergence of alternative occupations, and expanding employment opportunities in cities and overseas collectively threaten the continuity of traditional herding practices among younger generations (Banjade and Paudel 2008). Additionally, the diminishing social recognition and prestige associated with herding, especially when compared to opportunities in urban areas or abroad, further contributes to the decline in the number of youths engaging in herding activities (Pandey and Chetri 2005; Banjade and Paudel 2008; Tiwari et al. 2020). Migration has

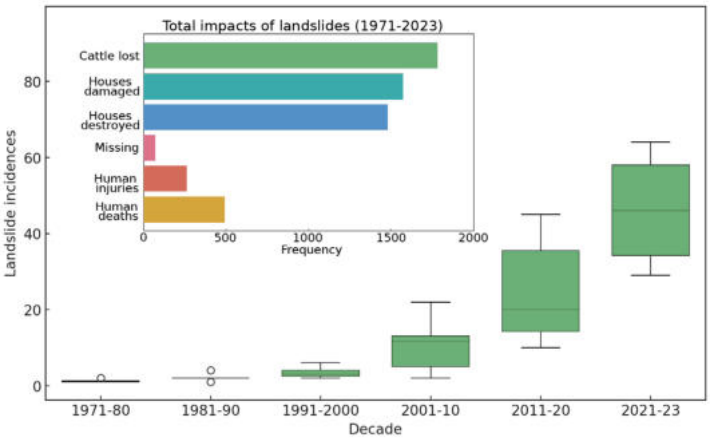

Figure 32. Decadal landslide incidences (in Box plot) and the total impacts of those landslides (in bars).

led to a population decline in the mountainous municipalities of Karnali Province, resulting in a shortage of herders (Gentle and Thwaites 2016). This shift has led to pastoral abandonment in several areas of Karnali Province, resulting in a decline in the number of herders and the abandonment of herding altogether.

In many parts of Karnali Province, shepherds and herders are leaving their traditional occupations due to socioeconomic and ecological changes. Pastoral abandonment has become a significant issue, particularly in areas where traditional pastoral practices are no longer viable. For instance, in the Namkha area of Humla, there were more than 100 herding huts 10-15 years ago, but now only around 40 remain (field survey). Both the number of herders and livestock have declined. One herder recalled that the high pastures were filled with large numbers of sheep and yaks 10-15 years ago, but

now their numbers have significantly decreased. In some areas, although the number of herders has reduced, the livestock numbers have remained the same because livestock owners hire or pay herders to manage their animals. Abandoned rangelands are often subject to ecological succession, leading to the proliferation of unpalatable species and shrubs that further degrade the rangelands and reduce productivity (Sharma et al. 2014).

3.1.2. Climate Change

Karnali Province has witnessed significant changes in average annual temperature and precipitation patterns over the period from 1950 to 2023. The Province experienced an overall change in annual average temperature, with an average increase of 0.01° Celsius/year. However, temperature changes varied across the region, with some areas seeing an increase of 0.056° Celsius/year, while others experienced a smaller increase of 0.012° Celsius/year (Figure 33 left). Among the districts, Dolpa (0.017° Celsius/year) and Rukum West (0.016° Celsius/year) recorded the largest temperature increases, while Surkhet (0.007° Celsius/year) and Dailekh (0.008° Celsius/year) saw relatively smaller increases (**Table 5**).

When comparing temperature changes with elevation, there was no consistent pattern of warming across different elevations. The most significant temperature increases were observed in regions with elevations between 2,000-3,000 m (median increase of 0.041° Celsius/year), followed by areas at 3,000-4,000 m (median increase of 0.036° Celsius/year) and 4,000-5,000 m (median increase of 0.029° Celsius/year). In contrast, regions below 1,000 m (median increase of 0.021° Celsius/year) observed the smallest temperature increases (**Figure 34 left**).

This warming trend coincides with the regions containing the largest rangeland areas in Karnali Province. Notably, the areas with elevations between 2,000-3,000 m, 3,000-4,000 m, and 4,000-5,000 m, which collectively account for 74.2% (774,634 ha) of the total rangeland in Karnali, have experienced higher rates of warming (**Figure 34 right**).

Similarly, there have been changes in annual precipitation patterns in Karnali Province, with both increasing and decreasing trends. In many parts of the Province, annual precipitation has decreased, indicating increased dryness in recent years, particularly in the low-lying areas. For example, Surkhet and Dailekh districts have experienced a decrease in annual precipitation by -5.2 mm/year and -4.8 mm/year respectively. However, Humla district has seen the lowest increase but insignificant (**Table 5**). The Limi Valley area has seen an increase in annual precipitation (**Figure 33 right**).

Table 5. Changes in annual maximum, minimum and mean temperature and annual precipitation change in 10 districts of Karnali Province from 1950-2023.

District	Maximum Temperature (°Celsius/year)	Minimum Temperature (°Celsius/year)	Mean Temperature (°Celsius/year)	Annual Precipitation (mm/year)
Dolpa	0.018	0.016	0.017	-1.21
Humla	0.014	0.017	0.016	-0.48
Jumla	0.015	0.016	0.016	-2.05
Kalikot	0.014	0.016	0.015	-3.47
Mugu	0.016	0.016	0.016	-1.61
Surkhet	0.002	0.012	0.007	-5.24
Dailekh	0.005	0.011	0.008	-4.82
Jajarkot	0.010	0.014	0.012	-2.80
Rukum West	0.013	0.019	0.016	-2.14
Salyan	0.006	0.012	0.009	-3.05

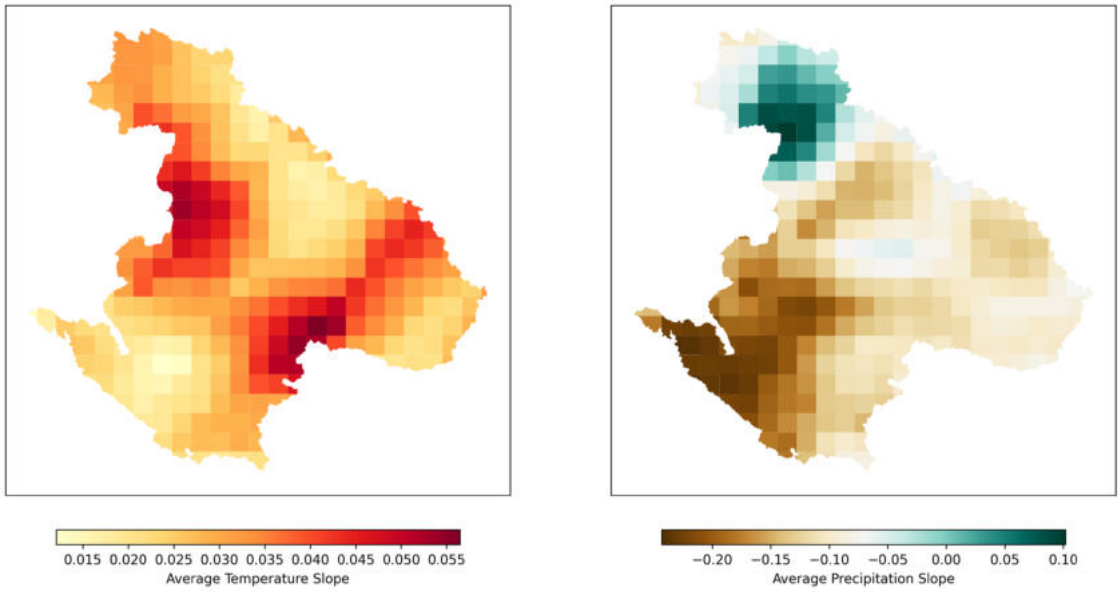

Figure 33. Change in average annual temperature (left) and total annual precipitation (right) from 1950-2023.

When analyzing precipitation changes, a consistent pattern of decreasing precipitation with increasing elevation was observed. The most significant decrease in precipitation occurred in regions with elevations below 1,000 m (-0.195 mm/year), followed by regions between 2,000-3,000 m (-0.157 mm/year). The smallest decrease in precipitation was observed in regions at elevations between 5,000-6,000 m (-0.074 mm/year), followed closely by regions at 4,000-5,000 m (-0.078 mm/ year).

A Province-level analysis of 23 major climate extreme indices related to precipitation and temperature revealed that most extreme heat indices are increasing, while precipitation indices show mixed trends (**Table 6**). For example, the indices for cold days (ID) and cold nights (FD) have significantly decreased, indicating a notable reduction in the number of cold days (-0.14, p = 0.037) and cold nights (-0.21, p = 0.007) per year, with the decline being more pronounced among frost days. Although both dry spells (CDD) and wet spells (CWD) have shown a decline, these trends are not statistically significant.

While all precipitation extreme indices (R99pTOT, R95pTOT, Rx1day, Rx5day) exhibited declining trends, only Rx5day showed a statistically significant decrease (-0.09, p = 0.0419). The

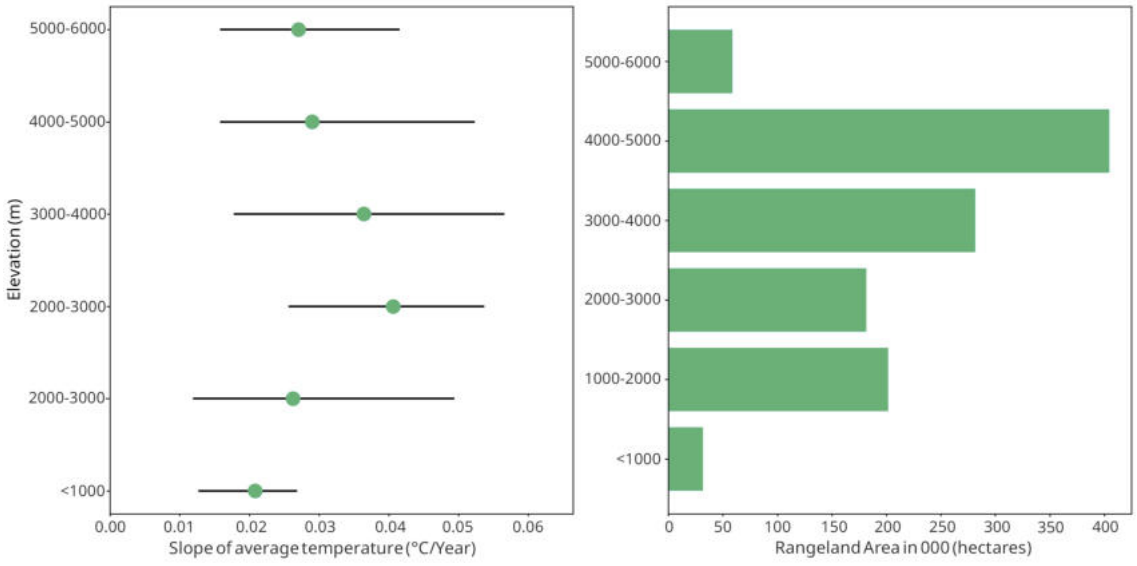

Figure 34. Slope showing the trends of temperature change across elevation gradients in Karnali Province (left) and elevation-wise rangeland distribution (right).

increase in average annual temperature has had significant impacts on temperature extreme indices, with hot extreme indices (TXx, TNx, TXn, TNn) showing a significant increase. In contrast, the cold extreme index (TX10p, percentage of cold days) showed a significant decrease (-0.11, p = 0.0005), while TX90p (percentage of warm days) and TN90p (percentage of warm nights) demonstrated significant increases. Additionally, the growing season length, as indicated by the Growing Season Length Index (GTR), has significantly increased (0.17, p = 0.03), suggesting an extended growing season.

Table 6. Change in extreme indices in Karnali Province from 1950-2023.

SN	Climate extreme indices	Unit	Slope
1	Annual count of days when daily maximum temperature is less than 0°C (ID)	Days	-0.14*
2	Annual count of days when daily minimum temperature is less than 0°C (FD)	Days	-0.21**
3	Maximum length of dry spell, maximum number of consecutive days with daily precipitation less than 1mm (CDD)	Days	-0.03
4	Maximum length of wet spell, maximum number of consecutive days with daily precipitation greater than or equal to 1mm (CWD)	Days	-0.1
5	Annual total precipitation when daily precipitation is greater than the 99th percentile (R99pTOT)	mm	-0.1
6	Annual total precipitation when daily precipitation is greater than the 95th percentile (R95pTOT)	mm	-0.83
7	Annual count of days with at least 6 consecutive days when daily maximum temperature is greater than the 90th percentile (WSDI)	Days	0.0**
8	Annual count of days with at least 6 consecutive days when daily minimum temperature is less than the 10th percentile (CSDI)	Days	-0.16**
9	Simple precipitation intensity index (SDII)	mm/day	-0.01*
10	Annual (1 Jan–31 Dec in NH) count between first span of at least 6 days with TG > 5°C and first span after 1 July of 6 days with TG < 5°C (Growing Season length, GSL)	Days	0.17*
11	Annual count of days when precipitation is greater than or equal to 10mm (R10mm)	Days	-0.08
12	Annual count of days when precipitation is greater than or equal to 20mm (R20mm)	Days	0
13	Annual total precipitation in wet days (PRCPTOT)	mm	-2.26*
14	Percentage of days when daily maximum temperature is less than the 10th percentile (TX10p)	%	-0.11**
15	Percentage of days when daily maximum temperature is greater than the 90th percentile (TX90p)	%	0.1**
16	Percentage of days when daily minimum temperature is greater than the 90th percentile (TN90p)	%	0.13**
17	Monthly maximum value of daily maximum temperature (TXx)	°C	0.01**

18	Monthly maximum value of daily minimum temperature (TNx)	°C	0.01**
19	Monthly minimum value of daily maximum temperature (TXn)	°C	0.01**
20	Monthly minimum value of daily minimum temperature (TNn)	°C	0.01**
21	Daily temperature range (DTR)	°C	0
22	Monthly maximum 1-day precipitation (Rx1day)	mm	-0.01
23	Monthly maximum consecutive 5-day precipitation (Rx5day)	mm	-0.09*
*p ≤ 0.05, ** p ≤ 0.01			

Although rangelands in Karnali Province have experienced changes in temperature and precipitation, there has been no comprehensive scientific study assessing the impacts of climate change on rangelands in Nepal, including Karnali Province. Climate change likely poses a significant threat to the rangelands of Karnali Province, with increasing temperatures, shifting precipitation patterns, and more frequent extreme weather events potentially leading to alterations in growing seasons, reduced water availability, and increased vulnerability to soil erosion. The shifting climate may also be affecting the distribution and composition of vegetation, leading to the encroachment of invasive species and shrubs and a decline of palatable forage plants. Local herders have experienced increased shrubs and non-palatable species in rangelands. While the precise impacts of climate change on Karnali Province's rangelands are not fully understood, the following paragraphs outline how rangeland ecosystems worldwide have been impacted by climate change, which may be relevant to Karnali Province as well.

Climate change is considered a major anthropogenic direct driver of rangeland change. The impact of climate change on rangelands is influenced mainly by three major climatic parameters: changes in temperature, precipitation, and atmospheric carbon dioxide levels, all of which alter the overall processes, properties, and biophysical responses of rangeland ecosystems (Hoffman and Vogel 2008; Polley et al. 2013; Mccollum et al. 2017). Climate change affects rangelands directly by altering these climatic factors and indirectly by enhancing disturbance processes such as fire, erosion, drought, invasive species, and insect outbreaks (Getabalew and Alemneh 2019).

Higher temperatures accelerate evapotranspiration, reducing soil moisture (Wan et al. 2005) and further stressing rangeland vegetation (Polley et al. 2017). Warming can cause plant species to migrate to higher elevations, altering species composition in rangelands, with drought-resistant or woody plant species becoming more dominant (Sankaran et al. 2005; Polley et al. 2013; Concilio et al. 2013). This shift can result in the loss of species adapted to cooler, higher-elevation climates and the introduction of new species that may not be suitable for the existing rangeland ecosystem (Morriën et al. 2010; Simberloff et al. 2010), thereby reducing the quality of forage available for livestock.

Changes in precipitation patterns can lead to droughts or flooding (Trenberth 2011), both of which negatively impact forage availability. Drought conditions reduce the growth of grasses (Getabalew and Alemneh 2019), leading to lower productivity and the carrying capacity of rangelands. Conversely, excessive rainfall combined with increased temperatures can cause soil erosion and degradation, further reducing the land's ability to support vegetation. Erosion, loss of soil fertility, and reduced water infiltration are common problems that reduce the land's capacity to maintain vegetation and ecosystem functions (Zuazo and Pleguezuelo 2009).

Climate change also exacerbates the spread of invasive species, which can outcompete native plants for resources. Invasive species often thrive in disturbed environments and can dominate landscapes, leading to a reduction in biodiversity and the displacement of native species (MacDougall and Turkington 2005). The encroachment of shrub species due to climate change further impacts rangelands by suppressing the growth of herbaceous species (Rundel et al. 2014), decreasing biodiversity, and reducing the carrying capacity of the rangeland (Ward 2005). This increase in invasive species poses significant challenges to livestock health and pasture productivity.

Additionally, climate change affects the hydrological cycle, leading to altered water

availability in rangelands (Trenberth 2011). Alterations in snowmelt and changes in rainfall patterns can decrease water availability for both plants and animals, further stressing rangeland ecosystems (Polley et al. 2013).

The ecological changes caused by climatic drivers carry serious economic and social costs. For example, the reduction in forage quality and availability directly impacts livestock productivity (Polley et al. 2013). This, in turn, affects the livelihoods of pastoral communities that depend on rangelands for grazing their animals, reducing their income by diminishing herd sizes (Ayele et al. 2020). Additionally, managing the impacts of climate change requires significant investment in adaptation strategies and mitigation efforts, which can be costly, especially for resource-limited regions like Karnali Province.

3.1.3. Invasive Species, Shrub and Unpalatable Species

Out of the 30 species of invasive alien plants (IAPs) reported from Nepal (Shrestha et al. 2024), 19 have already been identified in Karnali Province. Based on the modeling of climatically suitable habitats (Shrestha and Shrestha 2019), this Province may be suitable for as many as 21 IAPs (**Figure 35**). Furthermore, current surveys may not have captured all the IAP species present in Karnali Province. Even if they have, there is a high likelihood that the remaining species could soon colonize the Province.

The distribution of IAPs varies by district, with lower elevation areas such as Surkhet (17 species), Salyan (16 species), and Dailekh (15 species) reporting higher numbers of IAPs compared to higher elevation districts like Dolpa (no IAPs reported so far), Humla (2 species), and Mugu (2 species) (**Figure 36**). Habitat suitability models also indicate that lower elevation districts have maximum areas suitable for a higher number of IAPs. For instance, Surkhet, Jajarkot, and Rukum West Districts each have suitable habitats for 21 species, yet the number of IAPs reported from these districts is lower. Even in higher elevation districts, climatic suitability suggests the potential for a higher number of species, although fewer IAPs are currently reported. Although rangeland habitats are currently less impacted by IAPs, they are at risk of being affected in the future, especially as warming temperatures create more suitable conditions for these species in areas that are not currently vulnerable. Rangelands are generally more vulnerable to plant invasions than other vegetation types, such as forests (Dhakal et al. 2024). The proliferation of invasive species in rangelands is often driven by overgrazing, which creates disturbed areas more susceptible to invasion (Paneru et al. 2023). Therefore, there is a high risk of invasive species spreading in the rangelands of Karnali, even in currently undisturbed areas.

Although studies on the impacts of invasive species on rangelands in Nepal, including Karnali, are seriously lacking, research conducted elsewhere suggests that invasive species can

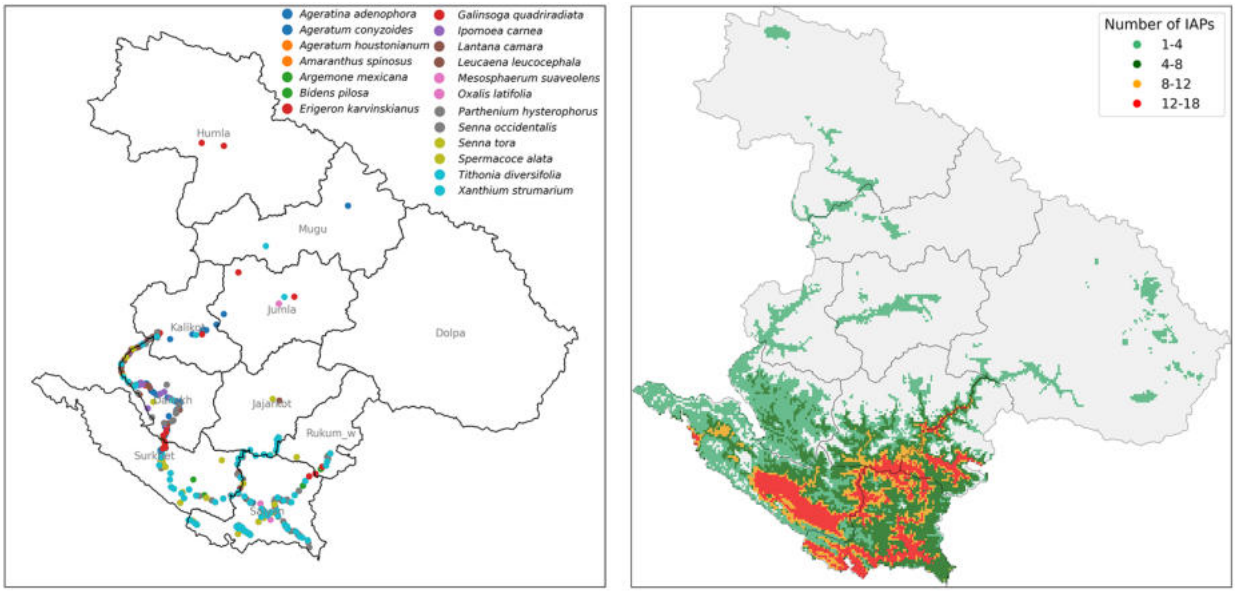

Figure 35. Occurrence and predicted distribution of invasive alien plants in Karnali Province.

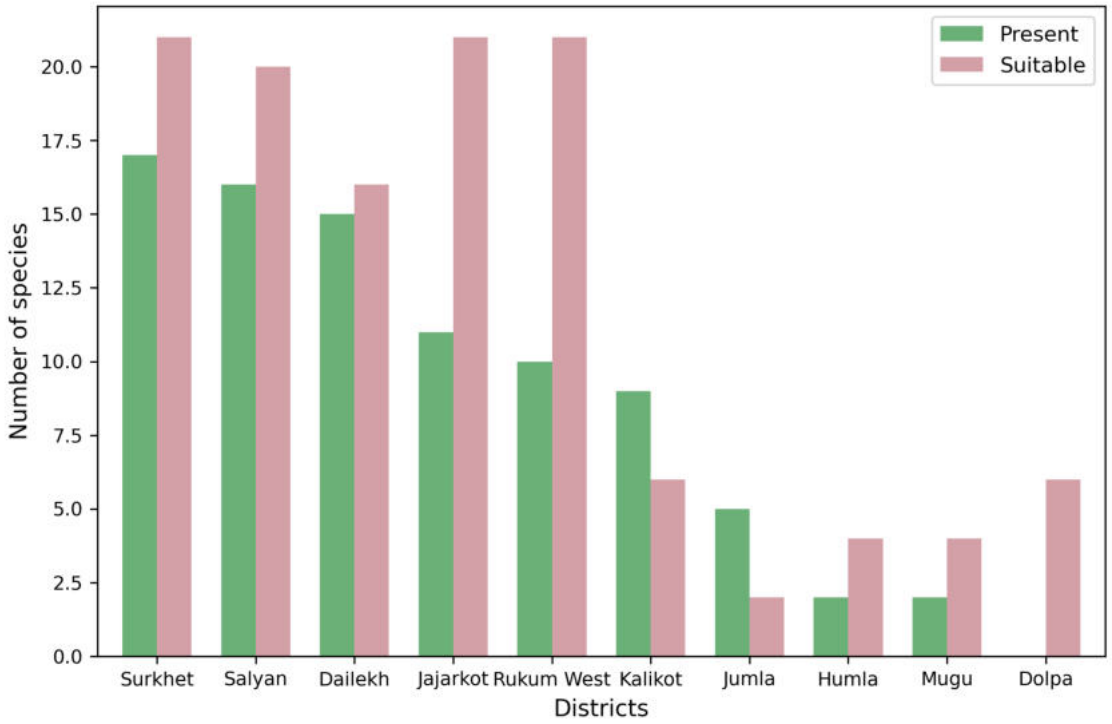

Figure 36. District wise number of invasive alien plant occurrence and presence of predicted suitable habitat.

displace native species, reduce biodiversity, and alter ecosystem functions by changing species composition, soil health and soil microbial communities, fire regimes, and nutrient cycling, leading to serious socioeconomic consequences (Timsina et al 2011; Eviner et al. 2012; Eviner and Hawkes 2012). Invasive species often outcompete native plants for resources such as sunlight, water, and nutrients, reducing the diversity of native plant species (O'Connor et al. 2014, O'Connor and van Wilgen 2020), with some native species potentially being driven to local extinction (DiTomaso et al. 2017).

Invasive species not only alter the structure of rangeland ecosystems but also their ecological functions. By changing the composition of plant communities, they can affect soil properties, hydrology, and nutrient cycling (Bais et al. 2003). Some invasive species degrade soil quality by altering its chemical composition, reducing its fertility, and disrupting soil microbial communities (Eviner et al. 2012; Jordan et al. 2008). This degradation makes it difficult for native species to re-establish, further entrenching the invasive species. Additionally, some invasive species increase the frequency and intensity of wildfire by adding more combustible material to the landscape (Brooks et al. 2004). This change in fire regimes can further harm native plant communities and promote the spread of fire-adapted invasive species. Certain invasive species also alter nutrient dynamics, often leading to the depletion of soil nutrients (DiTomaso 2000), resulting in poorer soil quality and reduced productivity over time.

Invasive plants are often less palatable to livestock than native species, decreasing the quality and quantity of available forage in rangelands (Schmelzer et al. 2014; Shrestha et al. 2019). This reduction in forage can lower the carrying capacity of rangelands, negatively impacting livestock productivity and the livelihoods of people who depend on grazing (DiTomaso 2000).

Although higher elevation rangelands in Karnali Province are currently free or less encroached by invasive plants, these rangelands are now increasingly dominated by shrubs and woody species, which have emerged as a significant problem for rangeland degradation in recent times in Nepal (Sharma et al. 2014). Many rangeland sites are witnessing an increasing abundance of *Rumex nepalensis* (locally called Halhale), a native but expansive non-palatable perennial herb species, probably due to overgrazing and other disturbances that damage rangeland vegetation (Kala and Rawat 1999; Thapa et al. 2016). In areas where grazing pressure has declined, there has been a notable increase in shrub encroachment, particularly by species that are unpalatable to livestock (field observation, **Figure 37**).

Figure 37. Shrub expansion shrinking grazing lands in Limi area, Humla. *Photo: Uttam Babu Shrestha*

The distribution, size, and density of native and non-native woody vegetation are influenced by factors such as livestock grazing (Madany and West 1983; Archer et al. 2017), climate (mainly changes in temperature and precipitation), topography, and atmospheric carbon dioxide levels (Archer et al. 2017). Woody or shrub expansion affects rangelands through three primary pathways: altering ecohydrology, modifying vegetation dynamics, and facilitating further encroachment and establishment of woody plants (Archer et al. 2017).

As woody plants, including shrubs, become more dominant, they can outcompete and reduce the diversity of understory vegetation (Hughes et al. 2006). This leads to a decline in species richness, particularly in areas where shrub cover is dense (Anadón et al. 2014). With increasing shrub cover, the diversity of herbaceous plants decreases, resulting in a more homogenous plant community dominated by shrubs (Archer et al. 2017). This shift in vegetation reduces the area available for grass, leading to the dominance of less palatable species and directly impacting the quality and quantity of forage available for livestock and wildlife. As a result, the carrying capacity of rangelands decreases, making them less productive and sustainable for grazing (Litt and Steidl 2010).

The transition from grass-dominated to shrub-dominated vegetation can also lead to changes in soil properties, such as reduced soil organic carbon (SOC) and total soil nitrogen (TSN), particularly in soils with specific textures (e.g., sandy loam) (Archer et al. 2017). This degradation further reduces land productivity and increases runoff, altering soil infiltration rates and impacting soil quality and spatial heterogeneity (Archer et al. 2017). Shrubs often have higher water-use efficiency than grasses, especially in upland areas (Bonan 2008), and their encroachment can decrease groundwater recharge (Tennesen 2008). This shift in vegetation can alter the hydrological balance of the ecosystem, potentially reducing water availability for other plants and animals and impacting the overall health of the rangeland. Additionally, increased woody species can alter fire regimes, leading to either increased fire risk due to the accumulation of woody biomass or decreased fire frequency, further promoting woody encroachment (Polley et al. 2017).

3.1.4. Pollution

Pollution in the high-elevation rangelands of Karnali Province, though currently on a smaller scale, is becoming an increasingly serious issue, especially due to the activities of NTFP collectors, the growing number of domestic tourists, and the increasing use of non-degradable materials by local communities. Small towns (e.g., Simikot, Martadi, Manma, Khalanga, Dunai) in the region are

struggling to find economically viable options for managing municipal solid waste. When herders, pilgrims, herb collectors, and tourists venture into these pristine pastures, they often bring with them food items such as noodles, biscuits, and other dry foods packaged in plastic and other non-biodegradable materials. Unfortunately, due to the lack of proper waste disposal options, and monitoring mechanisms, much of this waste is left in the rangelands, leading to a significant accumulation of solid waste.

The increase in visitor numbers in areas like Limi, Shey Phoksundo, and Rara, while beneficial for local economies, exacerbates the problem by increasing the volume of waste, including glass and plastic bottles, food packaging, and other materials that are often littered openly. Due to the absence of proper waste management facilities in these remote areas, much of this waste is either burned or simply discarded, further polluting the environment (pers. obs.). Although the per capita daily waste generated by visitors in these areas has not been studied, research conducted in the Sagarmatha National Park and Annapurna Conservation Area of Nepal showed that the daily waste generated by a visitor is comparable to the waste generation rate in some cities of Nepal (Manfredi et al. 2010; Adhikari et al. 2024). While recent years have seen significant efforts to clean up tourist routes, such as those in the Everest region of Nepal, the issue of trash generated on trekking or bus routes across the Karnali Province has largely been overlooked.

During the Yarsagunbu collection season, tens of thousands of harvesters visit high-elevation rangelands every year. In the past, Yarsa collectors used to carry homemade bread, roasted corn, and beaten rice, but these food items have been almost entirely replaced by packaged foods and drinks available in the market, which are easier to use and more affordable with Yarsa money. Although in some pastures, harvesters are urged to bury plastic packaging and bottles, in most areas, these items are simply littered around, leaving the pastures filled with plastics, abandoned clothes and shoes, torn pieces of tarpaulin, mattresses and bottles. A study conducted in Dolpa's pastures indicated that solid waste management was the second-highest sustainability concern after rotational harvesting among Yarsagunbu collectors (Shrestha and Bawa 2014). Moreover, the practice of open defecation by Yarsagunbu collectors has raised concerns about water contamination downstream, as contaminants from human waste can easily seep into water sources during the monsoon, posing health risks to both wildlife and people living downstream. Unfortunately, studies in this area are completely lacking.

Pollution, particularly from solid waste littered haphazardly, not only degrades the natural beauty of these landscapes but also threatens the delicate balance of ecosystems that support a wide range of plant and animal species. The salt in plastic packaging, for example, attracts both wild and domestic animals, and in some instances, livestock and wildlife have been known to consume the plastic (pers. comm.). Despite these growing concerns, the cumulative effects of solid waste pollution on the ecology and biodiversity of Karnali Province have yet to be explored.

3.1.5. Extractive Activities

Extractive activities such as the collection of medicinal species, grazing, hunting, and poaching are direct drivers of rangeland change. Over-extraction of resources negatively impacts biodiversity, leading to the depletion of species and degradation of soil health in rangeland ecosystems (Bai et al. 2007; Eldridge et al. 2016). For instance, moderate grazing in rangelands can enhance floral diversity by controlling dominant species or shrubs (Elias and Tischew 2016; Thapa et al. 2016), promoting grass regeneration (Grubb 1977), facilitating seed dispersal (Albert et al. 2015), and increasing community heterogeneity (Limb et al. 2018). In contrast, the high density of livestock, combined with limited grazing areas, has led to the overuse of rangelands, resulting in the loss of vegetation cover, soil erosion, and reduced land productivity.

3.1.5.1. Grazing

Overgrazing occurs when the stocking rate exceeds the rangeland's carrying capacity, resulting in negative impacts on vegetation, soil properties, and nutrient cycling (Steinfeld et al. 2006). Although rangelands are underutilized in some areas of Karnali Province, accessible rangelands are heavily overgrazed based on the local's perceptions and field observations during this study.

The long-term trends (1985-2021) of four major livestock species (Cattle, Goat, Sheep, and Buffalo) dependent on rangelands in Karnali illustrate a consistent increase in population over time (**Figure 38**). However, there is variation among the different livestock populations. Initially, Cattle and Goat

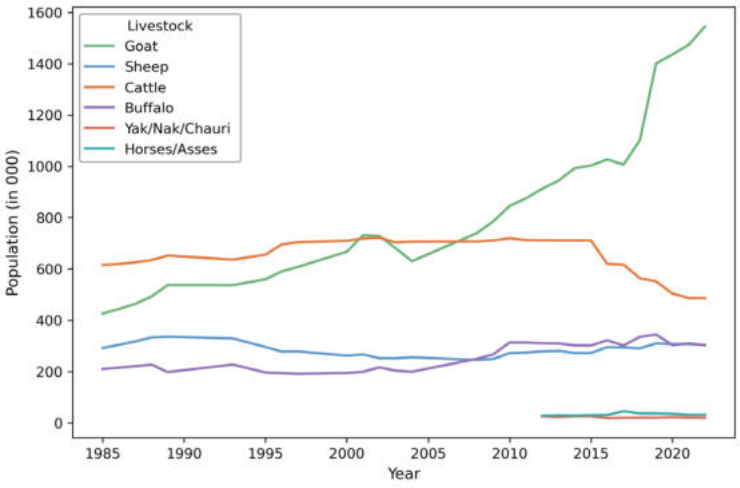

Figure 38. Population trends of livestock in Karnali Province.

populations were higher compared to Sheep and Buffalo, with Cattle showing the most significant decrease over time. While the Goat, Sheep, and Buffalo populations have increased, the Cattle population has declined. The Goat population, in particular, has seen a sharp increase, followed by a significant rise in the Buffalo population. The sharp increase of Goat population might be due to the extension of xerophytic vegetation type (Chaudhary et al. 2007).

Despite the variation in livestock populations and locations, the overall livestock population is increasing in Karnali Province. In some municipalities, this increase may have led to overgrazing, while in others, rangelands may be underutilized relative to their carrying capacity. To explore this spatial variation, we compared municipal-level livestock density (Animal Units per hectare) with the proportion of rangeland degradation. The regression analysis revealed no statistically significant correlation between livestock density and the severity of rangeland degradation (**Figure 39**). This suggests that at the broad municipal scale, raw livestock density does not act as the sole or primary driver of the observed degradation. Instead, degradation may be influenced by highly localized grazing patterns, shifting climatic factors, or historical land use that municipal-level aggregates cannot capture. Therefore, more detailed site-level studies are needed to accurately quantify stocking rates and the carrying capacities of rangelands in Karnali Province.

Over the years, overgrazing adversely affects rangelands by promoting non-palatable and expansive species such as Rumex nepalensis (Kala and Rawat 1999; Thapa et al. 2016) and removing vegetation patches through trampling (Xiao et al. 2018; Chai et al. 2019). Trampling directly harms herbaceous species by causing leaf burial, crushing, bruising plants, and reducing plant height and coverage (Tuohy et al. 2015). It can also lead to the local extinction of threatened species (Sher et al. 2010).

Livestock trampling, particularly by animals with sharp hooves, further impacts rangeland soils by increasing soil bulk density and reducing fertility (Li et al. 2017). Compaction or loosening of soil structure through trampling makes the soil more susceptible to runoff and erosion (Dunne et al.

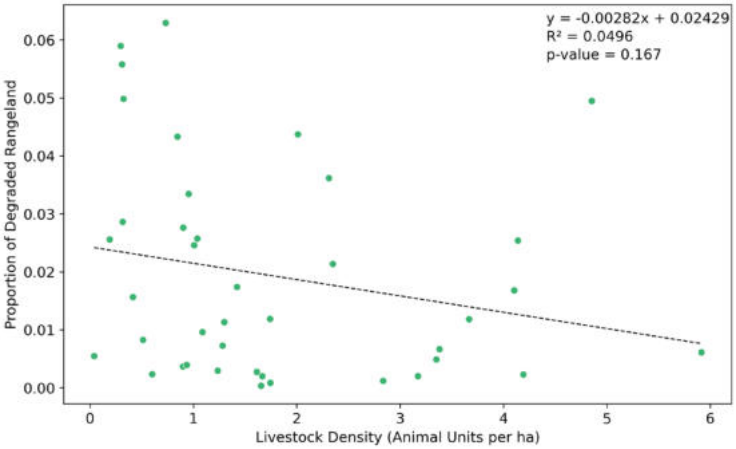

Figure 39. Relation between stocking rate and rangeland degradation (as denoted by decreased NDVI trend).

2011). Overgrazing also alters nutrient dynamics by compacting soil, detaching forage, and reducing litter biomass (Bell et al. 2011).

Furthermore, overgrazing disrupts the spatial connectivity of grass cover, which supports the formation of spatial patches that escape fire during burn events, ultimately leading to the encroachment of weedy plants (Archer et al. 2017). Excessive grazing by livestock displaces native browsers and seed predators that typically prevent the establishment of shrubs and trees and help maintain a balanced fire regime (Archer et al. 2017). This disruption further facilitates the spread of weedy plants.

3.1.5.2. Medicinal Species Harvesting

Rangelands in Karnali Province are rich in medicinal species, but the harvesting of these species has become increasingly commercialized. Many medicinal species found in these high-elevation rangelands hold significant economic value and are in high demand. Factors such as market

price, demand, and certain plant characteristics—such as the parts being collected and their life forms—make them particularly vulnerable to overharvesting. Additionally, the growth of high-elevation plants is already limited due to biophysical constraints (Vetaas and Grytnes 2002), which results in slow natural rates of population growth and recovery for these alpine species. Medicinal species that are both highly valuable and in great demand are especially prone to overharvesting and premature harvesting in Nepal (Olsen and Larsen 2003; Pyakurel et al. 2019).

Most species found in the rangelands of Karnali Province are herbaceous (perennial or annual or biennial) in nature. When roots, tubers, or entire plants of these herbaceous specie or are collected, they become highly susceptible to overharvesting compared to the non-lethal and seasonal gathering of seeds, leaves, and fruits (Lange 2006; Barron et al. 2022). Medicinal species such as *Polygonatum spp.*, *Nardostachys jatamansi*, *Bergenia ciliata*, *Neopicrorhiza scrophulariiflora*, *Valeriana jatamansi*, *Fritillaria cirrhosa*, *Paris polyphylla*, and *Ophiocordyceps sinensis*, which are found in the rangelands of Karnali, are collected in large volumes due to their high market demand and price. The collection of entire plants or their tubers/roots can be fatal to plant populations if not managed properly, leading to a sharp decline in their populations.

Although detailed population-level studies of commercially harvested species in Karnali Province are still lacking, the IUCN Red List assessment indicates that the populations of 13 medicinal species, of which 10 are traded and seven contribute to the Province's revenue, are declining (**Table 7**). Species such as *Nardostachys jatamansi*, *Paris polyphylla*, *Fritillaria cirrhosa*, and *Bergenia ciliata* are among those whose populations have decreased. Similarly, experimental studies conducted in Dolpa have shown that increased commercial harvesting reduces the recruitment and survival rates of *Nardostachys jatamansi* and *Neopicrorhiza scrophulariiflora* (Ghimire et al. 2005). Another study conducted outside of Karnali Province revealed that excessive harvesting reduces the biomass and density of *Neopicrorhiza scrophulariiflora* (Poudeyal et al. 2019).

Table 7. Traded medicinal species found in rangelands of Karnali Province.

Scientific Name	IUCN category	Traded (Y/N)	Revenue system (Y/N)
Berberis lycium Royle	LC	Traded	Yes
Arnebia benthamii (Wall. ex G.Don) I.M.Johnst.	DD	Traded	No
Nardostachys jatamansi (D.Don) DC.	CR	Traded	Yes
Ephedra gerardiana Wall. ex Klotzsch and Garcke	VU	Traded	Yes
Fritillaria cirrhosa D.Don	VU	Traded	Yes
Paris polyphylla Sm.	VU	Traded	Yes
Trillium govanianum Wall. ex D.Don	EN	Traded	No
Cypripedium cordigerum D.Don	VU		No
Cypripedium himalaicum Rolfe	EN		No
Dactylorhiza hatagirea (D.Don) Soó	EN	Banned	No
Rheum australe D.Don	DD	Traded	Yes
Bergenia ciliata (Haw.) Sternb.	LC	Traded	Yes
Taxus contorta Griffith.	EN	Traded	No
Ophiocordyceps sinensis (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora	VU	Traded	Yes

Caterpillar fungus (*Ophiocordyceps sinensis*) is another example of the decline in annual harvests due to excessive harvesting. According to an IUCN assessment, the population of this species has declined by 30% over the past 15 years, primarily due to unregulated large-scale harvesting (Yang 2020). Studies conducted in Dolpa also showed a decline in the mean annual harvest of this species (Shrestha and Bawa 2013). Furthermore, an analysis of harvesters' perceptions of resource abundance and sustainability indicates that almost all harvesters believe the availability of this fungus is decreasing and 67% consider current harvesting practices to be unsustainable (Shrestha and Bawa 2015).

3.1.5.3. Illegal Hunting, Poaching, and Wildlife Trade

Based on officially filed cases, more than 15 wildlife species, including two bird species, are illegally hunted and traded in Karnali Province (MoITFE 2023). Among these species, five— Snow Leopard (*Panthera uncia*), Himalayan Musk Deer (*Moschus chrysogaster*), Goral (*Naemorhedus goral*), Asiatic Black Bear (*Ursus thibetanus*), and Himalayan Monal (*Lophophorus impejanus*)— utilized rangelands as their primary habitats. There have been 65 reported cases of illegal hunting, poaching, and wildlife trade in Karnali Province, with the highest number of cases filed involving the snow leopard, goral, and musk deer (MoITFE 2023). All 10 districts of Karnali Province have reported instances of illegal wildlife trade. However, Salyan has the highest number of smugglers (n=33), while Surkhet has the highest number of cases filed (n=20) (**Table 8**). According to the annual reports of the Department of National Parks and Wildlife Conservation (DNPWC), between the fiscal years 2076/77 and 2079/80, Rara National Park and Shey Phoksundo National Park rescued eight and nine animals, respectively, from illegal trading.

Panchaunle (*Dactylorhiza hatagirea*), a species banned for collection, use, sale, transportation, and export.

Table 8. District wise reported smuggler involved in wildlife poaching/trade and formally filed case against them.

Districts	Smuggler	Filed cases
Dailekh	7	12
Dolpa	1	1
Humla	1	1
Jajarkot	17	9
Jumla	7	1
Kalikot	10	3
Mugu	8	7
Rukum	2	5
Salyan	33	6
Surkhet	8	20
	94	65

Data Source: MoITFE (2023)

Although the number seems smaller, illegal hunting and poaching are significant threats to the biodiversity of rangelands in Karnali Province. The illegal trade in wildlife, driven by demand for animal parts and products, has led to the decline of key species, including the Snow Leopard and Himalayan Musk Deer. These activities not only threaten wildlife populations but also disrupt the ecological balance of rangeland ecosystems.

3.1.5.4. Human-Wildlife Conflicts

Conflicts between humans and wildlife, as well as between wildlife and livestock, arise when their interactions result in physical, structural, or psychological harm. This includes wildlife damaging crops, attacking livestock, harming people, or destroying property. In response, people often engage in retaliatory killings and other harmful actions toward wildlife and their habitats. In rangeland areas, large carnivores such as black bears, snow leopards, and common leopards and small carnivores such as wild dogs, and jackals pose significant threats to livestock. Although humans and wildlife have coexisted in these regions for thousands of years, the expansion of human activities into wildlife habitats in recent years has led to more frequent conflicts. These conflicts often involve crop raiding by wildlife, predation on livestock, and competition for resources. Such human-wildlife conflicts can

result in the retaliatory killing of wildlife, further endangering vulnerable species.

There are no reliable datasets on human-wildlife conflict (HWC) incidents outside national parks in Nepal. However, based on annual reports published by the Department of National Parks and Wildlife Conservation (DNPWC), human deaths and injuries, livestock predation, and crop raiding are the major forms of the HWC in the two national parks of Karnali (DNPWC 2021; 2022; 2023). Although human fatalities and injuries are rare, two human casualties were recorded in Rara National Park during the fiscal year 2078/79, and there was at least one incident of human injury over the past three years in Rara and one in Shey Phoksundo National Park during the fiscal year 2079/80 (DNPWC 2023).

Livestock depredation is particularly pervasive in Shey Phoksundo National Park, with an average of around 800 cases of livestock depredation reported annually (**Figure 40**). During focus group discussions, participants highlighted the issues of HWC, reporting significant losses of

Crop damage by wild animals is also a major source of conflict in the buffer zones of Rara National Park (RNP 2019). This issue is particularly problematic for villagers living near the park, as wild animals frequently raid agricultural fields, leading to substantial losses.

3.1.6. Forest Fire

Forest fires, whether natural or human-induced, pose a significant threat to rangelands in Karnali Province. Fires can destroy vegetation, degrade soil, and disrupt ecosystems, leading to long-term impacts on rangeland health. The increasing frequency and intensity of forest fires, driven by climate change and human activities, are a growing concern for rangeland management.

Annual incidences of fires and total burnt areas in rangelands were analyzed using the MODIS FIRMS (Fire Information for Resource Management System) product from 2001 to 2023 (FIRMS 2024). Fire incidencts in rangelands in Karnali have increased by 80 incidents (slope =79.6, p = 0.07) per year over the past 23 years despite annual

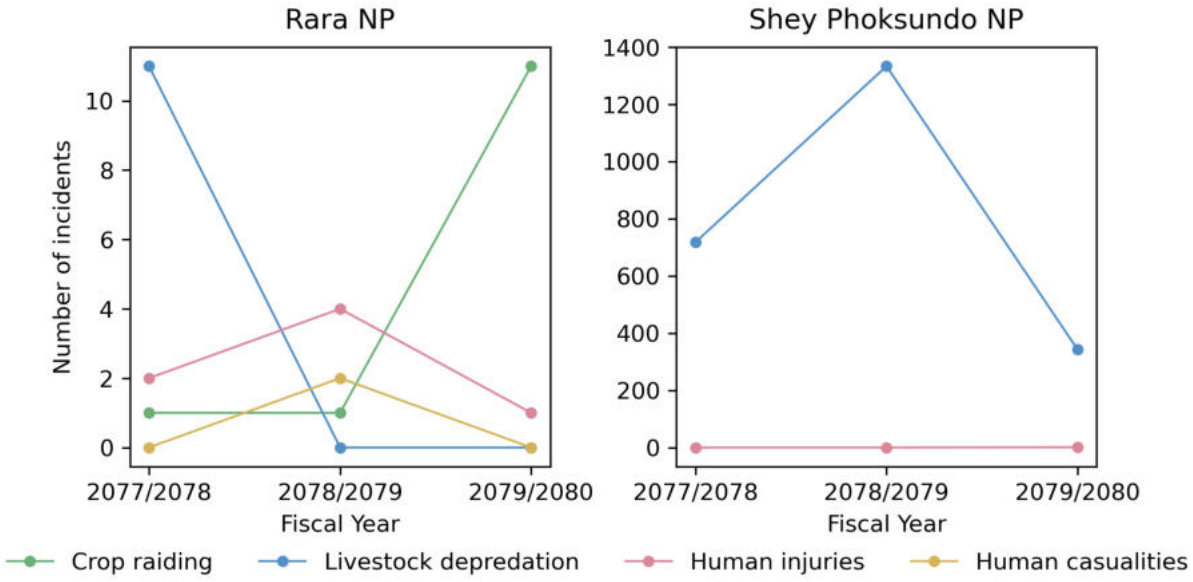

Figure 40. Incidence of human wildlife conflicts in Rara NP and Shey Phoksundo NP.

livestock due to attacks by snow leopards, wild dogs, and brown bears. Snow leopards are known to kill yak, chauri, and jhopa in subalpine and alpine meadows, while wild dogs are the main predators of sheep and goats in the rangelands. This predation causes significant economic losses for herders, exacerbating tensions between local communities and wildlife.

fluctuations **(Figure 41**). Significant spikes were observed in 2003, 2004, 2008, 2016, 2018, and particularly in 2021, which recorded the highest number of fire incidents. Conversely, years like 2002, 2006, 2010, 2017, and 2020 showed relatively fewer fire events.

There is considerable variation in fire incidents across districts. Low-elevation or warmer

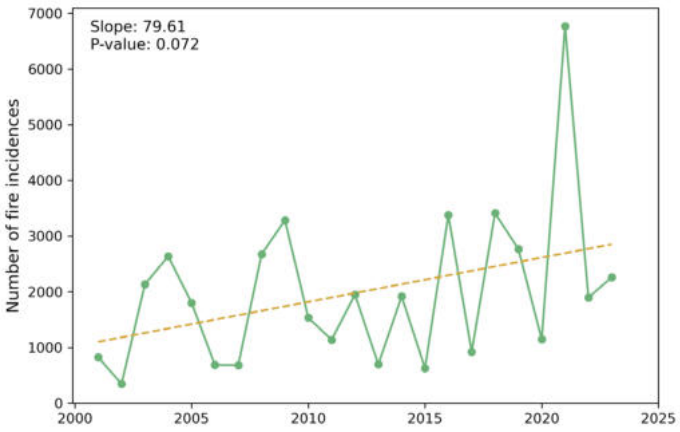

Figure 41. Number of fire incidents in Karnali Province's rangelands from 2001-2023.

districts, such as Surkhet, Salyan, and Dailekh, have experienced more frequent fires, with an average of 532 incidents per year. In contrast, colder districts like Jumla, Mugu, Kalikot, and Humla have seen fewer fire incidents. Temporal trends indicate that Surkhet, Salyan, and Jajarkot have witnessed consistent growth in annual fire incidences, with increases of 23, 16.4, and 9.5 incidents per year, respectively. Districts like Mugu, Jumla, and Humla have lower rates of increase, with 1, 4, and 4.7 incidents per year, respectively. Interestingly, Dailekh, despite having higher overall fire incidences, shows a lower rate of increase (3.7 incidents per year). The year 2021 stands out across multiple districts as having exceptionally high fire incidences, likely due to specific climatic conditions, such as drought that made the region particularly prone to fires.

The box plots (**Figure 42**) indicate that most districts exhibit a relatively wide distribution of fire incidences, suggesting year-to-year variability in fire activity. Districts like Surkhet and Salyan show a wider range of fire incidents, reflecting greater variability in fire occurrences.

In terms of burnt area, a total of 96,114 ha of rangelands in Karnali Province were burnt at least once over the past 23 years (**Figure 43**). However, there is significant spatial variation among districts. Surkhet not only has a higher number of annual fire incidents but also the largest burnt area, with 31,168 ha (32.4%) burnt at least once, followed by Salyan (19,859 ha, 20.7%) and Jajarkot (12,363 ha, 12.9%). Although Dolpa has a lower number of fire incidents, its burnt area is relatively large (12,276 ha, 12.8%). Other districts like Dailekh (5,235 ha), Humla (5,618 ha), Rukum West (3,591 ha), and Mugu (3,603 ha) show moderate levels of burnt area, suggesting smaller fires. Surprisingly, Kalikot (702 ha) and Jumla (1,700 ha) have the smallest burnt areas. The variation in burnt areas could be influenced by topography, weather patterns, or land use practices.

3.1.7. Livestock Diseases

Endemic livestock diseases such as Foot-and-Mouth Disease (FMD), Peste des Petits Ruminants (PPR), and Classical Swine Fever (CSF), along with emerging diseases like Lumpy Skin Disease, cause significant economic losses for livestock farmers in Karnali Province. The loss is further exacerbated by the lack of access to vaccination and medicine, as well as limited awareness of these vaccines. While details of other diseases are limited, Lumpy Skin Disease, first detected in Nepal in 2020 in Morang District, spread to all 77 districts of Nepal by mid-2023, resulting in the death of 48,000 cattle (Poudel 2023). The disease not only caused livestock fatalities but also led to a reduction in milk production, abortions, and infertility (Gautam et al. 2022).

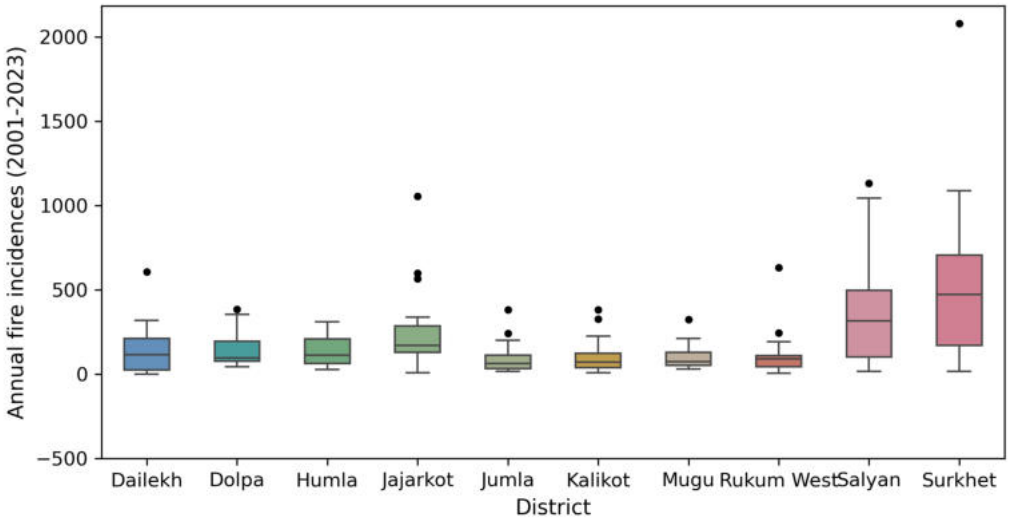

Figure 42. Distribution of annual fire incidents from 2001-2023 across 10 districts of Karnali Province.

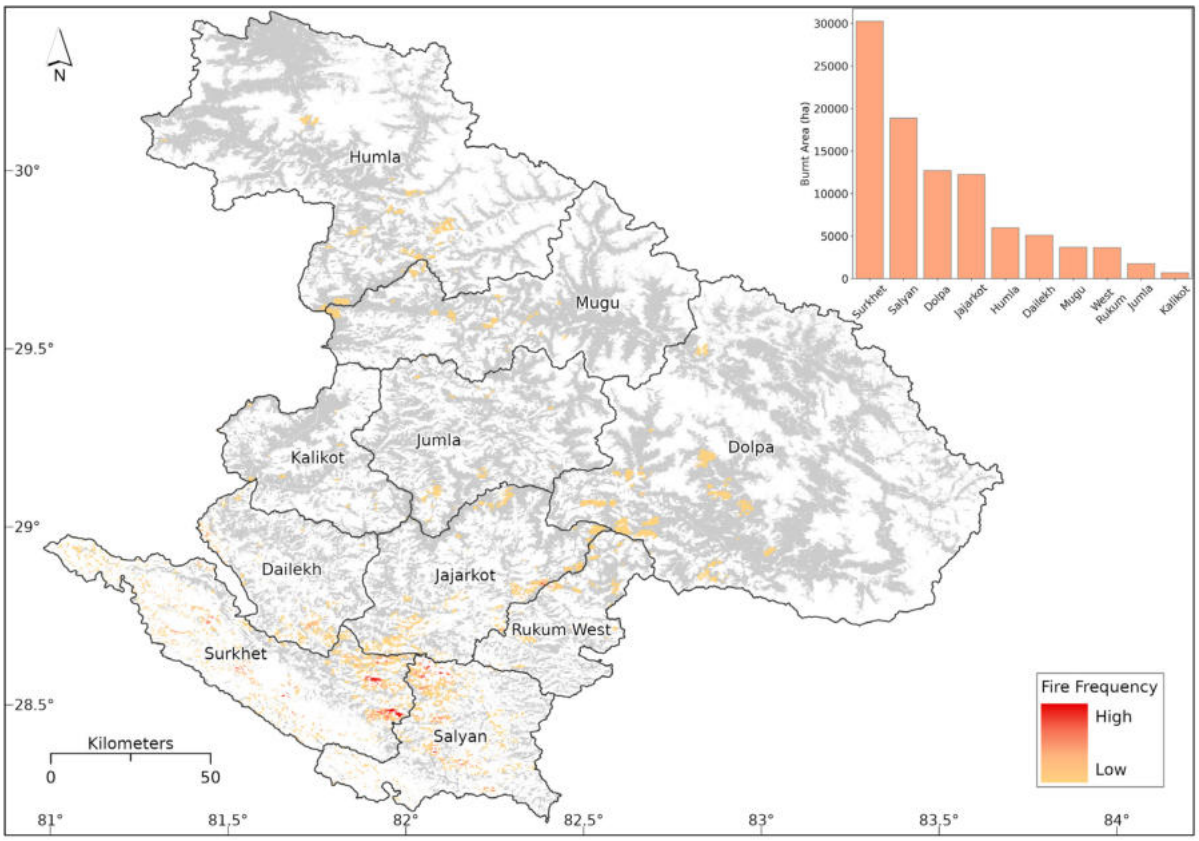

Figure 43. Total burned areas from 2001-2023 (high frequency burning means area with annually burnt) and the grey area showing rangelands.

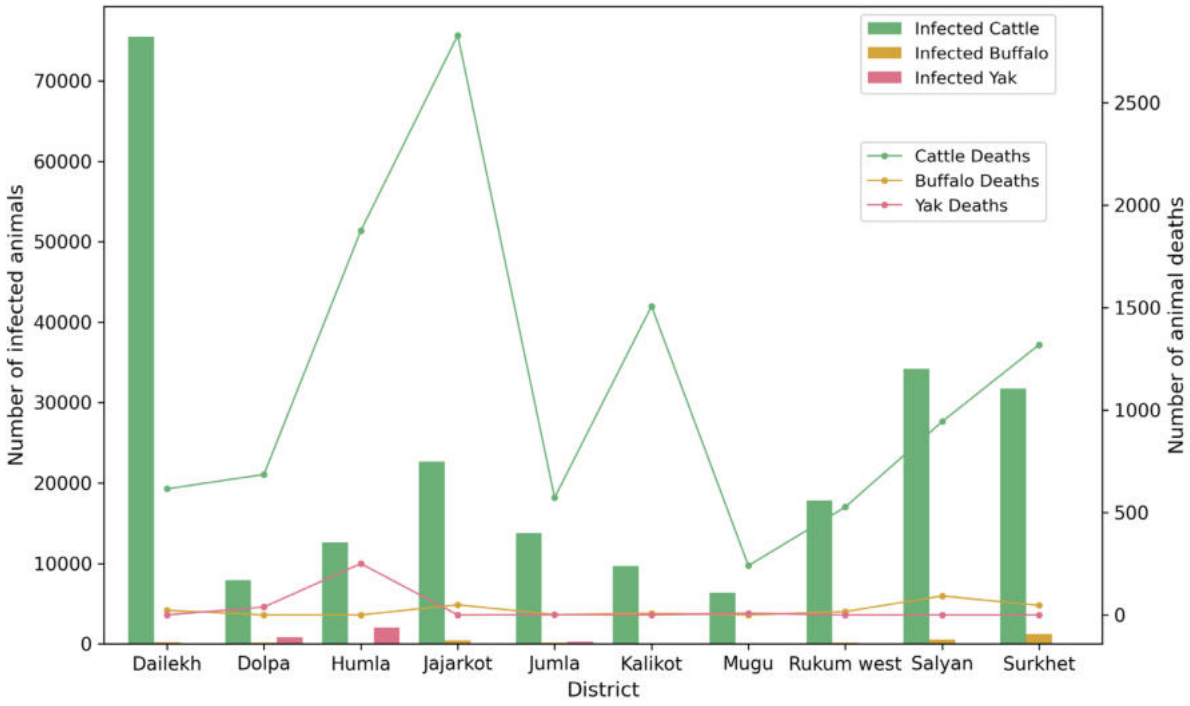

Figure 44. District wise reported number of infected and dead animals by lumpy skin disease.

In Karnali Province, Lumpy Skin Disease severely impacted livestock. According to the Ministry of Land Management, Agriculture, and Cooperatives, Karnali Province, there were 238,201 recorded cases, with cattle representing 97.5% of the cases, followed by yak (1.3%) and buffalo (1.2%). The disease claimed the lives of 11,638 animals, including 95.5% cattle, 2.6% yak, and 2% buffalo. Among the districts, Jajarkot reported the highest number of animal deaths, followed by Humla and Kalikot (**Figure 44**). The large number of animal deaths in high mountain regions like Humla created additional challenges in managing the carcasses, with entire pastures filled with the bodies of dead yaks and cattle during that time (pers. comm.).

3.2. Natural Direct Drivers

3.2.1. Lightening

Lightning is a major hazard in rangelands of Karnali Province, causing significant livestock losses and human injuries (https://cijnepal.org.np/cij-38/). In Bhadra 2076 BS, 250 sheep died in lightning in Tila RM-6 (https://dineshkhabar.com/article/13590). In Bhadra 2077, 531 sheep died in lightning in Dhadkharka, Masimsera, Patrasi RM -4 (https://www.setopati.com/social/214890). In 2078 BS, 40 sheep died in lightning in Dawalekh, Guthichaur RM -4 (https://halokhabar.com/news-details/9103/). In Asar 2079, 80 sheep died due to lightning in Bagjale, Patrasi -4 (https://ekantipur.com/pradesh-6/2022/07/02/16567672095671862.html). This year alone, 54 sheep died in Kanaka Sundari RM-2 Malikabota, Dachakharka due to lightning (https://khabarkheti.com/2024/07/15313/)

3.3. Indirect Drivers of Rangeland Change

3.3.1. Demographic Drivers

3.3.1.1. Population Changes

The population in Karnali Province has changed significantly over the past 20 years. While many mountain districts and municipalities in Nepal experienced a decline in population during this period, Karnali Province saw a notable increase, from 1,247,954 in 2001 to 1,677,225 in 2021—an increase of 34.4%. Among the districts, high-elevation areas like Jumla and Dolpa witnessed substantial population growth, with increases of 58.8% and 45.4%, respectively. However, in absolute numbers, the largest population increases were in Surkhet and Salyan (**Figure 45**). At the municipal level, Birendranagar saw the most significant change, with an additional 86,214 people over the last 20 years. Conversely, four municipalities in Karnali—Naumule (Dailekh), Chingad (Surkhet), Namkha (Humla), and Dungeshwor (Dailekh)—experienced population declines. This shift in population has impacted livelihoods, resource consumption, and management patterns across the Province.

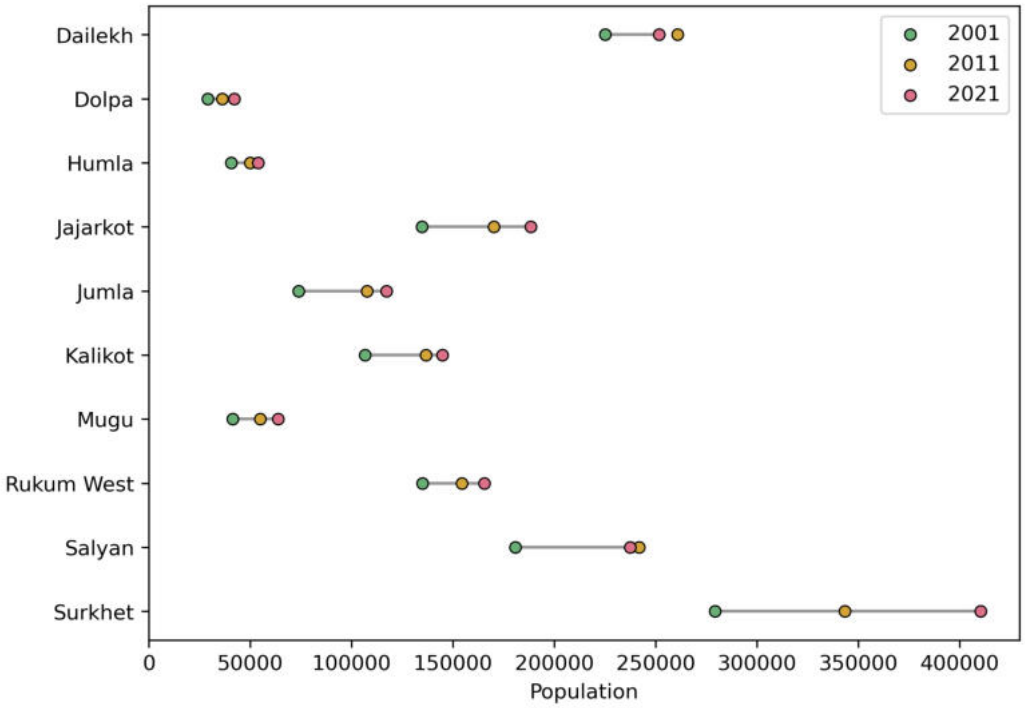

Figure 45. District wise population change from 2001, 2011 and 2021.

3.3.1.2. Migration

Although Karnali Province has a comparatively lower migration rate than other Provinces in Nepal, the trend of going overseas (beyond India) for foreign employment is steadily increasing (Table 9). From 2076/77 to 2080/81, the number of people migrating for foreign employment from Karnali Province more than doubled, rising from 31,051 in 2076/77 to 67,020 in 2080/81. This growing migration, particularly among the youth, has led to a significant shortage of labor for traditional shepherding practices. The income from shepherding is low compared to the hardships involved, making it an increasingly unattractive livelihood option.

As more individuals, especially the younger population, seek better economic opportunities abroad, fewer people remain in the mountain regions to manage and care for livestock. This labor shortage has made it difficult for pastoral communities to maintain large herds. Moreover, those who do remain in shepherding often lack the experience necessary to perform essential tasks such as herding, grazing management, and protecting livestock from predators.

The decline in available labor has also resulted in an increased workload for the remaining waged herders, often leading to overburdened individuals who struggle to manage large herds effectively. This situation can lead to reduced livestock productivity, higher rates of animal mortality, and a decline in the overall quality of pastoral care. The labor shortage and lack of experience among remaining shepherds can further degrade rangelands and negatively impact the sustainability of pastoral practices.

Table 9. District-wise migration for overseas employment.

District	2076/77	2077/78	2078/79	2079/80	2080/81
Dailekh	3336	1169	5352	11841	8984
Dolpa	167	41	262	1526	1472
Humla	136	40	226	1588	1627
Jajarkot	2469	642	3395	8932	6790
Jumla	701	335	1392	2909	2735
Kalikot	816	253	1086	2972	2547
Mugu	324	96	442	1617	1563
Rukum West	6575	2370	11794	8459	7313
Salyan	10166	3525	17074	27707	19239
Surkhet	6361	2217	11484	18094	14750
Total	31051	10688	52507	85645	67020

Source: DoL (2023)

3.3.1.3. Changing Societal Values of Livestock Holdings

Traditionally, animal husbandry was an integral part of agriculture, home-based industries, and local trade in Karnali. Livestock, second only to landholdings, was considered a vital capital investment, determining both the wealth and status of a family in the region (Bishop 1990). However, with modernization, improved connectivity to the outside world, and increasing migration, this traditional view of livestock as a symbol of wealth has shifted. Wealthy families with larger livestock holdings are often the first to migrate to urban centers like Surkhet, Nepalgunj and Kathmandu or even abroad, leaving behind those in villages with fewer livestock.

The growing abandonment of agricultural lands, along with the rise of synthetic fertilizers, has reduced the demand for livestock manure, leading to a decline in livestock holdings. Additionally, the cessation of transboundary trade with Tibetan villages has diminished the value of livestock and their products in areas such as Limi Valley and Dolpo that once relied on trade with Tibet.

As formal schooling has become more widespread in the region, children are increasingly diverted from their families' day-to-day activities, including livestock herding and shepherding during the critical periods for learning traditional knowledge and practices. Moreover, the hardships associated with herding, combined with its low economic returns, have eroded the social prestige and wealth once tied to the profession, making it a less desirable career path for educated youth. As a result, educated youth are increasingly disinterested in pursuing traditional herding practices, leading to a decline in both the number of herders and livestock in Karnali Province.

3.3.1.4. Increasing Feminization of Pastoralism

In Karnali Province, the migration of men to overseas including India for seasonal work has led to the feminization of agriculture and pastoralism, placing a heavier burden on women who remain behind to manage households, agriculture and livestock. This shift has profound implications for both the pastoral system and the women who are now at the forefront of these activities.

The Province has a significant gender gap in education, access to property, technology and income-earning opportunities (NSO 2021, UN 2021). Like other parts of the Himalaya (Verma and Khadka 2016), pastoralism in the Karnali region, is deeply gendered and dominated by male with men typically owning and controlling the livestock a key indicator of wealth. Despite the role of women in caring for animals and managing day-to-day activities, women rarely have ownership rights or decision-making power in grazing management and decisions related to livestock (pers. obs.). This imbalance is exacerbated by customary practices and cultural norms that prioritize men in the control and use of livestock and other natural resources.

For example, in these high mountain rangelands, women are responsible for collecting fodder and forage, as well as tending to farmyard manure. They also play a central role in milking yaks and cows, processing dairy products, and cleaning animal sheds. However, activities such as herding yaks, consulting veterinary services, trading livestock, and making major agricultural decisions are typically regarded as men's roles. Due to the cultural taboos, such as the belief that pastures are sacred and should not be visited by menstruating women, women are often restricted from going to certain pastures alone. Hence most of the transhumance herding is done by male.

In the context of medicinal species collection particularly Yarsagunbu both men and women may gather these resources, but the bargaining, selling, and financial decision-making are generally controlled by men. However, other medicinal species are collected predominantly by male herders.

The shift towards women taking on more responsibilities in pastoralism due to male migration is significant, but it comes with challenges. Women who have traditionally been engaged mostly in household chores are less familiar with pastoral tasks such as livestock health and herd management (pers. obs.). This knowledge deficit, combined with the already heavy burden of household chores and agricultural duties, places immense pressure on women. This results in abandonment of pastoral practices, reducing the size of herds.

3.3.1.5. Loss of Traditional Knowledge

The erosion of traditional customary practices related to rangeland management is a major concern in Karnali Province. The loss of traditional knowledge is often closely tied to the abandonment of traditional local practices. As younger generations move away from pastoralism and adopt modern lifestyles, valuable knowledge about sustainable rangeland management is being lost. This includes expertise in seasonal grazing patterns, knowledge of palatable or unpalatable and medicinal herbs, rotational grazing, and the use of fire for rangeland management.

This situation is further exacerbated by the lack of recognition and integration of this traditional knowledge in formal policies and practices. Traditional rangeland management systems, which have effectively sustained these ecosystems for centuries, are increasingly being undermined by modern policies that fail to consider local knowledge and practices. The erosion of customary rights and the imposition of top-down management approaches have alienated local communities, diminishing their capacity to manage rangelands sustainably.

3.3.1.6. Weak Infrastructure

Most high-elevation rangelands in Karnali Province are located in remote areas with steep terrain, making accessibility a significant challenge. The poor condition of trails and bridges, combined with limited basic facilities such as drinking water and medical care, makes pastoralism particularly difficult. Mobile phone networks in these areas are unreliable, which discourages youth from participating in transhumance pastoralism.

The challenges are further compounded by a high prevalence of parasitic infestations among yaks, with health services not easily accessible to farmers and herders (Paudel and Parajuli 2016). There is limited access to government veterinary services, credit facilities, and cold storage/chilling centers, all of which hinder the productivity of the livestock sector and the commercial potential of pastoralism (Pande 2010). The inherent inaccessibility of these pastures also extends to the lack of public services and technical support, further marginalizing and isolating local herders (Dong et al. 2009). This combination of physical inaccessibility and inadequate support services creates substantial barriers to the sustainability and viability of pastoralism in the region in the changing context.

3.3.2. Governance

3.3.2.1. Policy and Implementation

The governance of rangelands in Karnali Province is often hindered by the lack of rangeland-focused policies, weak institutional frameworks, and inadequate enforcement of existing sectoral policies and regulations related to rangeland management. The absence of clear land tenure systems and conflicting provisions between customary practices, statutory laws and new policies has impacted access, management and ownership of rangeland ecosystems (Acharya and Baral 2017). For instance, although the Government of Nepal promulgated the National Rangeland Policy in 2012, this policy did not align with the newly implemented federal system in the country. The policy was put forward by the federal Ministry of Agriculture and Livestock Development. The federal structure adopted after 2015 introduced changes in roles, responsibilities, and implementation mechanisms across central, provincial, and local government levels. For example, the recent Forest Act (2019) mandated provincial governments to take responsibility for the conservation, management, and utilization of forests and their resources. The forest act (Chapter 1, Article 2(Tha)) considered 'area partly and fully covered by shrubs and trees' under the definition of 'forest area'. Based on the Forest Act (2019), land ownership of the rangelands as public land controlled by the government and the authority responsible for managing the rangeland is de facto fall under the authority of the Division Forest Office. Therefore, in many instances, rangelands in Karnali were also managed by community forest user groups (CFUGs). That has created conflicts between CFUGs that provision regrading restriction and traditional herders on grazing access and rights. Similarly, the provisions in the National Rangeland Policy and Forest Act (2019) are also misaligned with those in the Chapter 3 (Article 11, Ada(8)) of the Local Government Operational Act (2017), which grants local governments the primary mandate to implement programs on 'local rangeland development and management' and run program related to livestock farming and livestock diseases related activities to improve the livelihoods of pastoral communities within their municipalities (Tiwari et al. 2020). This misalignment between national policies and the practical responsibilities of federal and local governments represents a significant gap in rangeland management in Karnali Province.

Agriculture extension programs, intended to provide advisory services and technical support to livestock farmers, have also been far from satisfactory. This was evident during the mass vaccination campaign for livestock amidst the Lumpy Skin Disease epidemic, where efforts were insufficient to meet the needs of the affected communities.

Despite policy ambiguities at the national and federal levels and insufficient support at the local level, the Ministry of Land Management, Agriculture, and Cooperatives in Karnali Province, along with the Ministry of Industry, Tourism, Forest, and Environment (MoITFE), have recently initiated rangeland-specific programs. For example, the Directorate of Livestock Development, under the Ministry of Land Management, Agriculture, and

Cooperatives, launched the herding allowance program in 2078/79. This program provides a herding allowance of NPR 1,500 per month to herders to encourage the herding profession. In the last fiscal year (2079/80), NPR 6,873,000 was distributed to 440 farmers across four districts (Humla, Mugu, Jumla, and Dolpa) under this program. However, many local representatives and stakeholders remain unaware of this initiative, and its long-term effectiveness is still uncertain. Additionally, the incentives under this herding allowance are provided to farmers primarily based on the number of livestock holdings rather than on outcomes or sustainable practices. These cash-driven initiatives raise concerns about their long-term benefits for rangeland health, as they may encourage overstocking and further degradation rather than promoting sustainable management. Consequently, the potential benefits of these programs for rangeland conservation and sustainable pastoralism remain questionable.

The provincial government's annual policies and programs have included initiatives such as promoting the commercialization of livestock, linking the livestock sector to markets, the Medicinal Herb Development Program, Livestock Insurance Schemes, and the High Land Pasture Conservation Program. Despite these efforts, the implementation and effectiveness of these high-level programs remain weak. Moreover, poor intersectoral coordination among stakeholders further impedes the effective execution of these initiatives.

The lack of recognition of customary institutions, coupled with ambiguity in statutory policies, has significantly undermined the effectiveness of government programs and institutions in managing rangelands. Governance structures have struggled to successfully integrate traditional knowledge and practices into formal legislative frameworks, leading to a disconnect between policy and practice. This ambiguity in rights and governance has created confusion and inefficiencies, particularly in the management and conservation of rangelands in Karnali Province.

3.3.2.2. Community Forestry and Grazing Rights

Access to grazing lands and other rangeland resources in Karnali Province has become increasingly restricted due to land tenure issues, legal constraints, and the establishment and expansion of protected areas. These restrictions have created significant challenges for pastoral communities that rely on these resources for their livelihoods. The lack of access to traditional grazing areas has increased pressure on the remaining rangelands, contributing to overgrazing and degradation.

In many parts of Karnali Province, various conflicts have emerged, including disputes between herders and CFUGs, conflicts between transhumant herders and farmers, and disagreements among herders over pasture access and benefit-sharing. A major source of conflict between herders and CFUGs arises from the restrictions or heavy taxes imposed on traditional herding practices. Since the enactment of the Forest Act (1993) and Forest Regulations (1996), which failed to recognize the customary practices of herders, traditional pastoralists have faced significant limitations in accessing forest resources (Banjade and Paudel 2008; Bhusal et al. 2018). The Community Forestry Program did not adequately recognize the rights of pastoralists, who previously had free access to forests before the program's introduction.

In recent years, CFUGs have either prohibited livestock grazing or charged high fees (NPR 5-10/animal). In many pastures of Jumla and Mugu, transhumant herders are required to pay both official and unofficial levies, such as money or animals, to local authorities like municipalities and wards, further complicating their access to resources (pers. comm.). Herders from Humla and Jumla who once took their herds to Surkhet during the winter have nearly abandoned doing so due to restrictions on traditional migration routes. Each year, herders struggle to secure tenure over resources they have used for generations, yet they receive little support from forest and livestock offices. Consequently, they are harassed, humiliated, and indirectly forced to abandon or reduce their traditional occupations, resulting in a decline in herding numbers.

3.3.2.3. Protected Areas and Resource Rights

The establishment of two national parks (Rara NP and Shey Phoksundo NP) in Karnali Province did not adequately consider traditional practices like transhumance pastoralism, leading to conflicts over the use and management of high-elevation rangelands. Free-roaming livestock in some critical habitats, such as the grasslands surrounding the Rara Lake remains a significant management challenge for the park authorities. Despite the allocation of grazing rights within the mountainous parks through the Mountainous National Park Regulations (1979), conflicts between protected area authorities and local herding communities remain evident. Protected areas often view grazing as a major threat to endangered animals (RNP 2019). As a result, some herders are struggling to

maintain their livelihoods, while others have been forced to abandon pastoral practices altogether.

3.3.2.4. Sino-Nepal Agreement and Trans-border Herding

For centuries, local herders from Nepal and Tibet have practiced cross-border transhumance herding in the northern transboundary regions of the Nepal-China border. Herders in Karnali Province, particularly those from Dolpa, Humla, and Mugu, traditionally take their herds to Tibet during the winter, while Tibetan herders bring their livestock to the Nepal side during the summer. However, recent developments have increasingly restricted the access of transhumance herders across the Sino-Nepal border due to the closure of borders to Tibet.

The disruption of the centuries-old annual movement of Nepali herds began following the Chinese takeover of Tibet in 1959, which led to negotiations over rangeland availability for both Nepali and Tibetan herds (Banjade and Paudel 2008). The closure of the Nepal-China border in the 1960s, formalized by the 1961 Sino-Nepal Boundary Treaty ('Treaty of Peace and Friendship') and the 1963 Border Protocol signed on January 23, 1963. In 1975, China imposed restrictions on the entry and trade of Nepali livestock and goods (Pasakhala et al. 2021). Nevertheless, until the 1980s, the restriction was not stringent and access to winter pastures within Tibet was not immediately cut off (Saxer 2013). In 1983, the governments of Nepal and China signed a bilateral agreement to halt animal migration between the two countries by April 1988 (Banjade and Paudel 2008). Another letter of exchange related to transbordary pasturing was signed between the two countries in 1999. These subsequent agreements between China and Nepal resulted in the loss of access to some seasonal pastures across the international borders posing significant challenges for local herders of Mugu, Dolpa and Humla regions. They have been compelled to reduce their livestock structure, relying more intensively on limited forage resources or searching for new pastures. Reports indicate that the cessation of transbordary animal movement has contributed to the degradation of pastoral areas and their environments (Banjade and Paudel 2008). Additionally, it has forced the opening of new grazing areas in Nepal that were previously less accessible, leading to overgrazing (Joshi 2000; Ning et al. 2016;).

3.3.3. Economic Drivers

A wide variety of rangeland products, including meat, dairy products, wool, and medicinal species, are traded legally both nationally and internationally. In addition, illegal wildlife poaching and the trade of wildlife, though on a smaller scale, are also practiced. The growing demand and market price for wild species have led to more extensive and often unsustainable harvesting to meet demand and maximize economic returns. Thus, economic drivers such as increased market demand, higher prices for medicinal species, and improved access to markets for other rangeland products have negatively impacted rangeland sustainability.

To meet global demand, local populations of herbaceous plant species are being overharvested or harvested prematurely, resulting in the decline of medicinal herb populations. Despite the positive contribution of medicinal plant trade to local livelihoods and the provincial economy, many local harvesters in Karnali perceive that numerous herbs have become increasingly rare due to excessive harvesting. This aligns with global trends, where wild species trade has caused a 61.6% decline in species abundance (Morton et al. 2021). The situation in Karnali Province may be similar or even worse due to a lack of standard harvesting guidelines for wild species, weak monitoring and a lack of regulation and enforcement of existing laws. However, there is no credible research on how trade has driven the overexploitation of medicinal species, nor is it clear whether current practices are unsustainable. Nevertheless, the ecological costs of medicinal species such as Yarsagunbu harvesting are likely significant (Shrestha and Bawa 2014).

Additionally, with increased road access, goats and sheep from Karnali Province are now traded outside albeit on a smaller scale. This increasing market access and growing demand for meat in the local markets have led to increased livestock intensification in some regions. However, it remains unclear how market-driven livestock intensification is contributing to rangeland degradation. In some areas, market forces, such as the increased demand for apples and walnuts, have also encouraged locals to convert traditional grazing lands into fruit orchards, further reducing the area available for grazing and biodiversity conservation. Additionally, declined in Yarsagunbu has forced harvesters to collect Setak chini (*Polygonatum verticillatum*)—a new species of medicinal herbs which was previously nonexistent in trade in Karnali Province (pers. comm.).

3.3.4. Technological Drivers

Technological changes have played both positive and negative roles in rangeland sustainability. Although many village areas in Karnali Province

remain disconnected from modern farming technologies, some city areas and regions near roads have begun using tractors for plowing and adopting improved crop varieties and animal breeds. Despite these advancements, traditional practices, such as using local breeds and manure, remain prevalent in many areas.

The use of heavy machinery in road construction has led to the fragmentation of rangelands and increased soil erosion. Advances in the cultivation techniques of certain medicinal species and their promotion may have supported local livelihoods and contributed to the sustainable use of wild medicinal species. For example, the cultivation of medicinal plants in some areas has started to boost income, but it remains uncertain how small-scale production can contribute to the conservation of wild species. Additionally, even though Cordyceps militaris, a caterpillar fungus, is being produced on a large scale as a substitute for the highly prized and in-demand *Ophiocordyceps sinensis* (Chen et al., 2018), wild harvesting of later remains prevalent.

Advances in science have also underscored the negative impacts of pesticide use, leading the provincial government to promote organic agriculture, which is beneficial for both health and environmental reasons.

With wider access to mobile phones, local harvesters and farmers are now able to connect more easily with traders to sell medicinal species and livestock products. While this increased connectivity has the potential to boost their income and bargaining power, it also raises concerns about the overexploitation of species, as the ease of market access could lead to intensified harvesting practices.

Ruppatan, Dolpa. *Photo: Uttam Babu Shrestha*

Pedicularis sp.—a common plant in Rangelands
Photo: Uttam Babu Shrestha

Herders milking chauri in Maure Lekh, located along the Jumla–Dolpa border. *Photo: Uttam Babu Shrestha*

CHAPTER 4

Sustainable Rangeland Management:

Opportunities, Historical Efforts, Achievements, Challenges, Gaps and Lesson Learned

This chapters outlines the opportunities, historical efforts, achievements, challenges and gaps in sustainable rangeland management in Nepal including Karnali Province.

4.1. Opportunities

Rangelands in Karnali Province have ecological, economical, and social importance. Ecologically, these vast landscapes support a rich diversity of fungi, flora and fauna, including several endemic, threatened, and flagship species, and play a crucial role in maintaining regional biodiversity. They act as significant carbon sinks, contributing to climate change mitigation, and support essential ecosystem services such as water quality and quantity maintenance, soil erosion control, and nutrient cycling. Economically, rangelands are the backbone of the agro-pastoral livelihoods in Karnali, providing grazing grounds for livestock, which are a primary source of income and sustenance for local communities. The rangelands also support the collection of high-value medicinal species, ecotourism activities, and other green enterprises, contributing to the Province's overall economic development. Socially, rangelands hold deep cultural significance for the indigenous and local communities, who have depended on these lands for generations, preserving traditional knowledge, skills, practices, as well as lifestyles that are intricately linked to the management and sustainable use of rangeland resources. Thus, the sustainable use and management of rangelands in the Province provide promising opportunities for livelihood development, biodiversity conservation, climate change adaptation and mitigation, ecotourism development, research initiatives, and knowledge generation.

4.1.1. Livelihood Development

The remoteness, low productivity of lands, and the majority of land being unsuitable for agriculture have left Karnali Province with limited opportunities. However, the vast geographic area of Karnali covered by rangelands, home to numerous species of medicinal values, including the highly prized Yarsagunbu, and a place for livestock grazing, offers significant potential. Rangelands in Karnali Province provides a foundation for developing sustainable livelihoods through the commercialization of the livestock sector and NTFPs. With sustainable use and management, these resources can be harnessed

to improve the income levels of local communities while maintaining the ecological balance.

4.1.2. Ecotourism Development

The unique landscapes, biodiversity, and cultural heritage of Karnali's rangelands offer substantial opportunities for ecotourism development. Innovative rangeland-based ecotourism packages, such as Yarsagunbu tourism, Goth stays, and Yak festivals, alongside traditional activities like hiking, trekking, and sightseeing, pilgrimage can generate revenue, create jobs, and promote conservation efforts. In addition to the established trekking routes, several beautiful and unexplored routes, and destinations (e.g., Shankar Jharana, Patarasi Himal, Sky Lake, Jagdulla Lake, Byashi, Rekhi, Choputtha Lake, Chuna Daha, and Sun Daha) in the rangelands of Karnali Province hold untapped ecotourism potential.

4.1.3. Value Chain Development

Compared to the eastern part of Nepal, market access and value chains for rangeland products in Karnali are underdeveloped. However, there is significant potential to enhance value chains for livestock products such as goat/Chyangra/sheep meat, dairy (cheese, ghee), sheep and yak wool, and high-value medicinal species. By improving market access, establishing processing facilities at the local level, and promoting the branding of rangeland products, local producers can capture greater economic benefits from their goods. The rangeland products (e.g., meat, handcrafted woolen products as souvenirs, cheese, essential oils, and herbal teas) can be linked with ecotourism by selling rangeland products to tourists.

4.1.4. Biodiversity Conservation

Karnali's rangelands, with their rich and unique biodiversity, present a significant opportunity for conservation initiatives. The establishment of two protected areas (Rara NP and Shey Phoksundo NP), a substantial portion of which is covered by rangelands and wetlands of global importance (Ramsar sites: Rara Lake and Shey Phoksundo Lake) further enhances this potential. The cultural practices and lifestyles intertwined with this rich and unique biodiversity offer an excellent opportunity to integrate conservation efforts with sustainable management practices. Protecting these ecosystems can contribute to global biodiversity goals, enhance ecosystem services, and support local livelihoods.

4.1.5. Watershed Management

Rangelands, particularly high alpine grasslands, serve as primary watersheds, regulating water flow, soil moisture retention, and groundwater recharge for both local and downstream communities in Karnali Province. Unsustainable land use practices, including overgrazing and road construction, along with climate change impacts, have led to increasing surface runoff, soil erosion, and degradation of rangeland vegetation. Restoring degraded rangelands through native grass plantation, controlled grazing, and erosion control measures can enhance soil stability and water retention capacity. Promoting nature-based solutions, such as check dams, counter trenches, and infiltration ponds, to enhance water recharge and reduce surface runoff is essential. These watershed management activities can be linked to livelihood-based initiatives as well as biodiversity conservation and climate change adaptation efforts.

4.1.6. Climate Change Adaptation and Mitigation

Rangelands in Karnali have the potential to contribute significantly to climate change adaptation and mitigation efforts. By implementing resilient rangeland management practices, including the restoration of degraded rangelands and sustainable grazing practices, these areas can help sequester carbon, regulate regional hydrology by enhancing water quality and quantity, and strengthen the resilience of local communities to climate impacts.

4.1.7. Cultural Heritage and Knowledge Preservation

The socio-cultural aspects of rangelands are deeply intertwined with the culture and traditional knowledge of local communities. By integrating indigenous practices (e.g., Amchi medicine, transhumance pastoralism) with modern management techniques, there is an opportunity to preserve and promote these cultural assets and, practices of indigenous communities while enhancing rangeland sustainability.

4.1.8. Research and Knowledge Generation

Many aspects of rangelands in Karnali are understudied, and traditional knowledge and local

practices remain largely undocumented. This creates significant opportunities for researchers, students, and academics to explore and generate new knowledge related to high-elevation rangeland ecosystems, biodiversity, climate impacts, and sustainable management practices.

4.1.9. Policy Innovation

The initiation of Karnali Province to develop and implement the Rangeland Management Strategy and Action Plan, is the first of its kind at the provincial level in Nepal. Successful implementation of this pioneering strategy will not only drive further policy innovation across other sectors but also inspire other Provinces and the federal government to create and implement their own localized rangeland management strategies and action plans. Moreover, the insights and outcomes from this initiative will provide critical input for the formulation of a new National Rangeland Policy and management strategy, shaping the future of rangeland conservation and sustainable use in Nepal.

4.2. Historical Efforts

Nepal's government has made some efforts in the management of rangelands by developing both sectoral and cross-sectoral policies and programs that incorporate the diverse aspects of rangeland ecosystems, biodiversity, and livestock. Recognizing the critical role that rangelands play in supporting livelihoods, preserving biodiversity, and maintaining ecological balance, the government has considered rangeland management as a key strategy of biodiversity conservation in the National Biodiversity Strategy and Action Plan (2014-2020). Sectoral policies, such as those focused on livestock development, protected area management, community and leasehold forestry, NTFPs promotion climate change adaptation, wetland conservation and biodiversity conservation, have been complemented by cross-sectoral initiatives that promote sustainable grazing practices, restoration of degraded lands, sustainable use of medicinal species, and the conservation of rangeland habitats within protected areas. A historical time line of the key events concerning rangelands management is provided in **Figure 46**. Time line of key events relevant to rangelands management in Nepal.

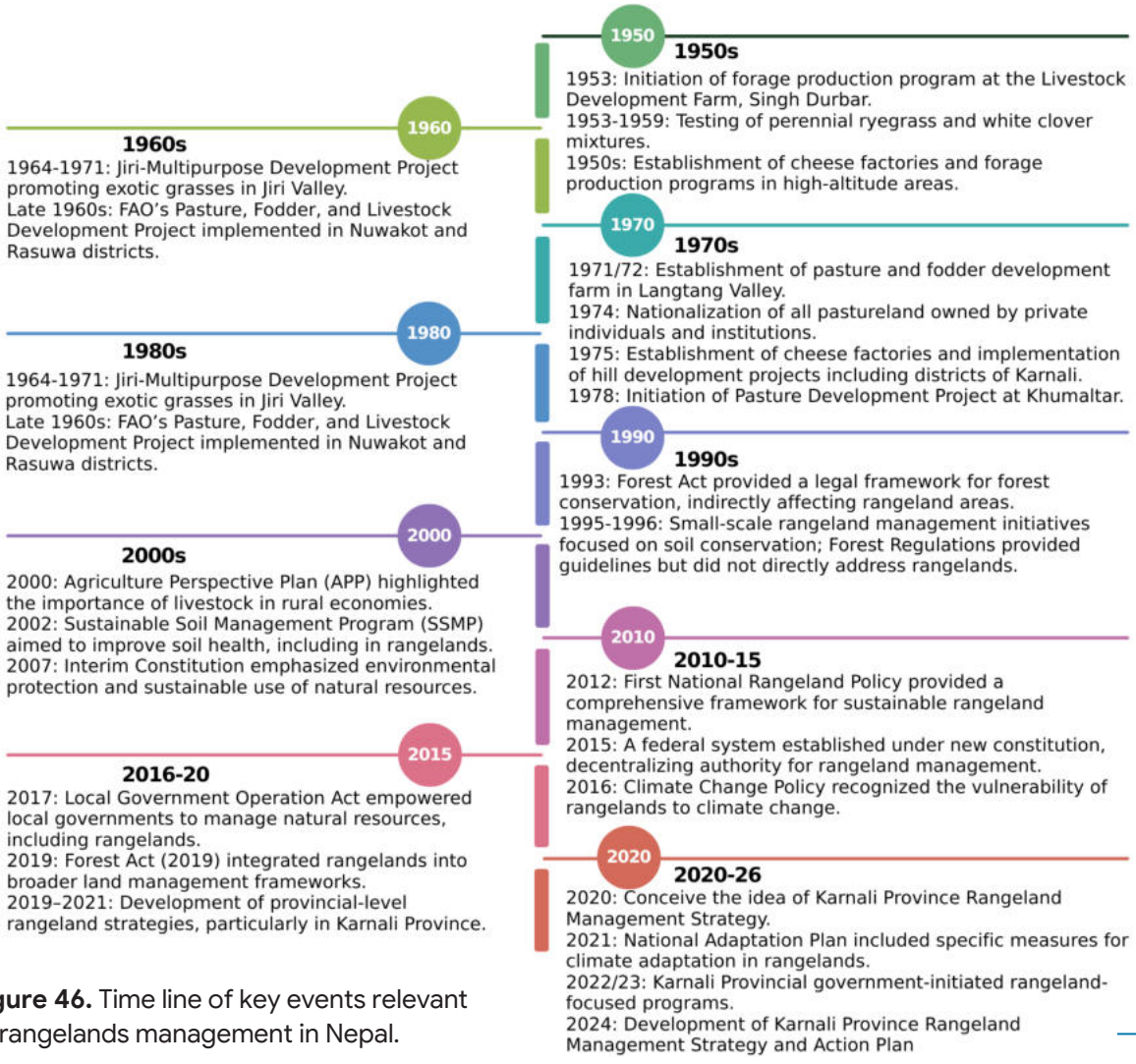

Figure 46. Time line of key events relevant to rangelands management in Nepal.

Table 10. List of sectoral policies relevant to rangelands.

Policy Document	Major Concerns Related to Rangelands
National Park and Wildlife Protection Act (1973)	Restricts cattle grazing in protected areas but allows historical grazing practices under strict conditions, leading to conflicts between PA authorities and herders.
Mountainous National Park Regulations (1979)	Permits sustainable grazing, timber collection, and herb harvesting in high-elevation national parks including Rara NP, supporting rangeland use for livelihoods.
Herbs and Non-Timber Forest Products (NTFPs) Development Policy (2004)	Emphasizes sustainable use and commercialization of NTFPs, including those found in rangeland affecting rangelands by promoting ex-situ cultivation of marketable herbs on agricultural lands. But did not recognize the role of rangelands in providing several species of valuable NTFPs
Agriculture Biodiversity Policy (2006)	Recognizes the importance of conserving genetic resources for grazing lands and promotes the role of traditional knowledge in rangeland management. It establishes intellectual property rights on indigenous and local food and agricultural genetic resources and indigenous practices.
National Rangeland Policy (2012)	Focuses on improving rangeland status and productivity, biodiversity conservation, and sustainable intensification through industrial enterprise based on rangelands addressing challenges like overgrazing and cl imate change.
National Wetland Policy (2013)	Lacks explicit inclusion of rangelands in wetland management, missing the integration of watersheds which are mainly fall in rangelands in conservation efforts.
Agriculture Development Strategy (2015-2035)	Focuses on implementation of research and extension for sustainable forestry through developing an extension package on best forestry practices to reduce forest threats including grazing management, sustainable forest management and improved agricultural practices
Local Government Operation Act (2017)	Assigns local governments the responsibility for managing rangeland-related activities, including livestock farming and invasive species and disease control, surveys of medicinal herbs.
National Land Policy (2019)	Supports the conservation of grazing lands by preventing their conversion to non-agricultural uses but lacks clarity on rangeland boundary placing rangelands and natural grazing areas within forest areas.
National Climate Change Policy (2019)	Does not explicitly address rangelands, overlooking their role in food security and climate resilience for high-elevation communities although provision of building climate resilience of livestock sector was mentioned.
National Agroforestry Policy (2019)	Suggests the potential use of 'barren and marginal lands' for agroforestry, implicitly including rangelands, but lacks explicit prescriptions for the implementation of agroforestry practice in rangelands.
National Forest Policy (2019)	Links rangeland biodiversity to NTFP (including Yarsagunbu, Jatamansi, Padamchal, Chiraito, Atis, Bisha, Laghupatra) development but focuses primarily on forests, with little attention to rangelands and conflicts between CFUGs and transhumance herders.
Forest Act (2020)	Recognizes rangelands within forest definitions but does not clarify the impact of forest management on traditional grazing practices.
National Biodiversity Strategy and Action Plan (2014-2020)	Highlights rangeland degradation drivers and calls for integrated management, emphasizing the need for institutional support for rangelands.
National Dairy Development Policy (2021)	Supports livestock productivity and the management of high-elevation rangelands, promoting coordinated efforts for sustainable rangeland use.
Second Nationally Determined Contribution (2022)	Promises to update the Rangeland Policy and develop sustainable rangeland management plans by 2025.
Protected Area Management Strategy 2022-2030 (2022)	Addresses habitat degradation and invasive species in rangelands, aiming to improve and expand these ecosystems within protected areas.

In Karnali Province, the MoITFE has launched an alpine pasture conservation program ('Lekh Tatha Kharka Samrakchan Karyakram') for the fiscal year 2080/81. The program's main objectives are the sustainable management of alpine rangelands including grazing pastures. Under this initiative, the Division Forest Office in Dolpa has formed three rangeland user groups along with the preliminary surveys of pastures. In Jajarkot, restoration activities were carried out, including the seeding of clover grass in the pastures of Barekot Rural Municipality. In West Rukum, awareness programs were conducted, while in Mugu, efforts focused on promoting medicinal herbs and their processing.

The Directorate of Livestock Development, under the Ministry of Land Management, Agriculture, and Cooperatives (MoLMAC), also initiated the herding allowance program in 2078/79 to provide incentives for entrepreneurial herders. This program provides a herding allowance of NPR 1,500 per month to herders to encourage the herding profession. In the last fiscal year (2079/80), NPR 6,873,000 was distributed to 440 farmers across four districts (Humla, Mugu, Jumla, and Dolpa) under this program.

4.3. Achievements

The Government of Nepal has made some progress in the management and conservation of rangelands historically, although significant challenges remain. Key achievements include:

4.3.1. Policy Development

The formulation of the National Rangeland Policy in 2012 was a significant step forward. This policy provided a comprehensive framework for the sustainable management of rangelands, recognizing the importance of rangelands for biodiversity conservation, livestock management, and the livelihoods of pastoral communities. However, the Policy was not implemented due to the shift toward a federal system of governance following the new political developments in the country.

4.3.2. Integration into National Strategies

Rangelands have been integrated into broader national strategies, such as the Nepal Biodiversity Strategy (2000); National Biodiversity Strategy and Action Plan (2014-2020) and the Forestry Sector Strategy (2016-2025) and Protected Area Management Strategy (2022-2030). These strategies highlight the ecological importance of rangelands and set goals for their conservation and sustainable use. Protected Area Management Strategy (2022-2030) specifically addresses challenges like habitat degradation, invasive species, and the impacts of climate change on rangelands.

4.3.3. Landscape Level Strategies

Two important landscape-level strategies were developed, and projects were initiated by the GoN. The first, Kailash Sacred Landscape Conservation and Development Initiative was implemented in collaboration with ICIMOD and Tribhuvan University in Karnali Province. The second is the identification and development of the Western Mountain Landscape Program by the Department of Forests, MoFE (GoN 2018). These landscape level programs aim to conserve ecosystems including rangelands.

4.3.4. Community Involvement

While the Community Forestry Program has triggered conflicts between CFUGs and transhumance herders and shepherds in many areas, handing over forest including rangeland management to local communities under the community forestry program has, in many instances, played a positive role in forest regeneration, control of poaching, and regulation of NTFPs harvesting. This approach has also empowered local communities and integrated traditional knowledge and practices into rangeland management practices.

4.3.5. Awareness, Capacity Building and Research

Although the process has been slow and the outcomes are limited, some efforts have been made to build capacity at the local and provincial levels, particularly within the context of the new federal structure, regarding the importance of rangelands. Rangelands are increasingly gaining attention in research and knowledge documentation among researchers, students, and academics. Nevertheless, this area still requires further investment and focus.

4.4. Challenges of Pastoralism

Based on the key informant interviews with herders, nine major challenges were identified. Among them, the lack of good fodder in rangelands (n = 75), lack of veterinary services (n = 63), shortage of human resources for pastoral practices (n = 58),

and livestock disease and health problems (n = 57) are significant concerns. Predation by wild animals (n = 54) and insufficient water resources (n = 53) were also highlighted as major hurdles. Market access and fluctuating prices for livestock and their products (n = 40) present further challenges. Additionally, social attitudes toward pastoralism are not positive, with pastoralists reporting a lack of respect from society. As a result, changing social attitudes towards herders (n = 39) is crucial for retaining the next generation in pastoral practices. Lastly, limited access to credit or financing (n = 33) hampers the ability of farmers to effectively manage their livestock and rangelands.

4.5. Gaps

Despite these limited achievements, there are ongoing challenges and gaps in policy, implementation, funding, knowledge production and institutional capacity.

4.5.1. Policy and Legislative

Despite the development of the National Rangeland Policy (2012), implementation has been inconsistent and insufficient. The lack of corresponding legislation and acts, particularly following Nepal's transition to a federal system, has hindered effective policy execution. Despite limited achievements, there are ongoing challenges and gaps in policy and institutional capacity, knowledge production, and fund mobilization. Even when sectoral policies and regulations related to rangeland exist, enforcement is often weak, leading to overgrazing, unregulated harvesting, and encroachment on rangelands

4.5.2. Institutional Arrangement

Despite the uniqueness of rangelands, there is no dedicated institution for rangeland management in Nepal. Rangelands are often viewed as a subsection of forests when it comes to ecosystem and biodiversity components, while livestock development falls under agriculture. This has resulted in overlapping and unclear mandates between two ministries at the federal level, which has translated to the provincial level, exacerbating coordination problems among government agencies.

4.5.3. Resource and Capacity

Local and provincial institutions often lack the technical skills, infrastructure, and resources needed for effective rangeland management. This includes detailed maps of rangeland status, levels of degradation, stocking rates, dynamics, species conservation hotspots, and zoning information for NTFPs required for sustainable use and management.

There is a general lack of awareness among local communities about sustainable rangeland management practices and the impacts of climate change on these ecosystems. Government staff are not well-equipped with cutting-edge technology useful for monitoring rangeland degradation. Local communities struggle to diversify livelihoods, partly due to their limited capacity to access markets, develop value chains, and produce competitive products.

4.5.4. Knowledge

At the national level, there is no agreed-upon information or definition of the extent of rangelands in Nepal. There is an immediate need for updated data on rangeland conditions and dynamics. Furthermore, the flora, fauna, and other wild species found in rangelands are not adequately documented. The extent of invasive species on rangelands is not well understood, leading to inadequate management strategies. Additionally, there is a lack of integration and acknowledgment of Traditional Ecological Knowledge (TEK) and indigenous practices, despite their potential contributions to sustainability. With the burgeoning challenges posed by climate change, rangelands are particularly vulnerable, and adaptive management practices in the rangeland sector are not yet sufficiently developed or implemented.

4.5.5. Finance

There is a lack of dedicated funding for rangeland management, with existing financial resources often being insufficient and not strategically allocated. Financial incentives for sustainable rangeland management and practices are either absent or poorly implemented, reducing the motivation for local communities to engage in sustainable practices.

A woman weaving *Radi Pakhi,* a traditional handmade woolen blanket produced from sheep's wool.
Photo: Uttam Babu Shrestha

Limi Valley, Humla *Photo: Uttam Babu Shrestha*

CHAPTER 5

Vision, Mission, Guiding Principles and Strategy for Rangeland Management

Vision

By 2036, Rangelands in Karnali Province will be conserved, restored and sustainably used for the prosperity of Karnali Province

Mission

By 2036, implement strategies and actions to maintain ecological integrity, promote sustainable use of rangelands, ensuring continue provision of ecosystem services to the prosperity and well-being of people. To achieve this, rangeland ecosystems are sustainably managed and restored, biodiversity, soil and water resources are conserved, invasive species and wildfire are effectively managed, sustainable commercialization and livestock and medicinal plants are ensured and the benefits generated from these activities are shared fairly and equitably; adequate financial resources are provided, collaboration and capacities are enhanced, policies are effectively implemented, and decisions are made on evidence produced by robust research.

Goal

To enhance the ecological, economic, and socio-cultural values of rangelands in Karnali Province by promoting sustainable practices, improving rangeland productivity, conserving biodiversity, and supporting the livelihoods of local communities.

Guiding Principles

- **Sustainability**: Maintain the long-term health and resilience of rangeland ecosystems safeguarding their ability to provide essential ecosystem services for future generations.
- **Community Empowerment**: Involve local communities in decision-making processes, recognizing and incorporating traditional knowledge, skills, and practices.
- **Maximizing Multiple Benefits:** Harness the multiple benefits of rangelands encompassing economic, ecological, and socio-cultural opportunities to enhance their multifunctionality.

- **Inclusiveness and Equitable**: Guarantee that strategies and actions benefit all stakeholders including marginalized groups, women, Dalits, and indigenous communities ensuring fairness and equity.
- **Adaptive Management**: Promote flexibility and responsiveness in management practices and decisions to adapt to changing environmental and socioeconomic conditions.
- **Collaboration and Synergy**: Foster collaboration and coordination among government agencies, non-governmental organizations, local communities, and international agencies to enhance the effectiveness of sustainable rangeland management efforts.
- **Integration**: Adopt management practices based on scientific evidence and knowledge while respecting and incorporating traditional knowledge and customary practices.
- **Ecosystem-Based Approach:** Ensure rangeland management actions are focused on nature-based solutions to sustain ecosystem services and mitigate-climate risks.

Strategies and Actions

Strategy 1: Integrated rangeland governance, planning, and data systems

Objective: To establish an integrated, science-based governance framework and rangeland information system that strengthens planning, clarify tenure and use rights, and enables inclusive, evidence-based decision-making by local communities and government institutions.

Actions

1.1. Harmonize policy and align institutions: Review and harmonize existing policies, laws, and regulations related to rangeland management across agriculture, forestry, environment, livestock, and land administration sectors. This includes the alignment of grazing management with the National Forest Integrated Strategic Plan 2081–2100 BS. This will clarify land tenure, grazing rights, and management responsibilities, and ensure alignment of the Rangeland Management Strategy and Action Plan with provincial and national policy frameworks.

1.2. Develop an integrated rangeland information system: Establish a comprehensive, GIS-based rangeland information system covering all major rangelands and pastures. This system will include spatial and attribute data on pastoral practices, vegetation condition, rangeland productivity, biodiversity values, seasonal migration routes, grazing zones, seasonal camps, water sources, and climate-related risks to support planning, monitoring and investment decisions.

1.3. Strengthen local institutions: Form, strengthen, and operationalize Community Rangeland Management Committees with inclusive representation of women, pastoralists, indigenous groups, and other marginalized users. These committees will be supported to develop and formalize locally appropriate grazing rules, access and use rights, conflict-resolution mechanisms, and benefit-sharing arrangements, aligned with municipal and provincial rangeland management plans.

Strategy 2: Sustainable grazing and livestock management

Objective: To optimize grazing intensity in line with the ecological carrying capacity of rangelands to prevent degradation, support vegetation recovery, and sustain long-term forage productivity.

Actions

2.1. Assess rangeland carrying capacity: Conduct systematic rangeland assessments combining vegetation surveys, forage biomass estimation, and livestock population data to determine site-specific carrying capacity and sustainable stocking density thresholds for major rangelands and pastures.

2.2. Implement adaptive grazing management: Design, pilot, and scale rotational and seasonal grazing practices that distribute grazing pressure spatially and temporally. Establish annual pasture health monitoring protocols using field indicators (e.g., forage biomass, ground cover, species composition) and community-based observations and adjust stocking rates, grazing duration, and pasture access rules based on the grazing pressure and actual forage biomass recovery potential.

2.3. Strengthen veterinary and extensive services: Establish mobile veterinary services and train community animal health workers to improve vaccination coverage, winter fodder management, and shed management in remote rangeland areas. Institutionalize incentive mechanisms to support basic safety and mobility equipment for high-altitude herders.

Strategy 3: Ecosystem restoration and biodiversity conservation in rangeland

Objective: To restore degraded rangelands, improve soil and water health, conserve biodiversity, and enhance ecosystem resilience using nature-based solutions and traditional and indigenous practices.

Actions

3.1. Restore degraded rangelands: Identify and prioritize severely degraded rangelands through ecological assessment and community validation and restore them through reseeding with drought-resistanance, palatable native grasses and shrubs, combined with post-restoration grazing protection measures.

3.2. Control soil and land degradation: Stabilize erosion-prone rangelands through nature-based solutions such as contour trenches, vegetative strips, check dams, bamboo crib walls, and conservation ponds, particularly in landslide- and erosion-affected areas.

3.3. Restore water sources, wetlands, and riparian zones: Map, rehabilitate, and maintain rangeland water sources (ponds, springs, small reservoirs), and restore degraded wetlands and riparian zones through re-vegetation, erosion control, hydrological restoration, and community-led water-sharing agreements.

3.4. Manage invasive, shrub, and unpalatable species: Conduct systematic mapping and risk assessment of invasive, shrub, and unpalatable species, implement species-specific control and eradication measures, and reseed treated areas with native palatable species through active community engagement.

3.5. Conserve critical biodiversity and habitats: Identify and protect biodiversity-rich rangelands, critical habitats, and wildlife corridors by establishing community-led conservation zones, restoring degraded habitat patches, implementing species-specific conservation actions, and promoting community-based biodiversity monitoring.

3.6. Integrate rangeland management within protected areas: Integrate rangeland management into protected area and buffer zone plans by designating regulated grazing zones, restoring rangeland patches critical for wildlife movement, establishing co-management agreements, and monitoring livestock–wildlife interactions to reduce conflict.

3.7. Manage wildfire risk and recovery: Conduct rangeland wildfire risk assessments and establish fire management zones in high-risk areas; introduce technically supervised controlled burning; strengthen early detection and local response capacity; and restore fire-affected rangelands through reseeding, erosion control, and soil stabilization measures.

Strategy 4. Sustainable rangeland-based livelihoods and bio-economy

Objective: To enhance the profitability of rangeland-based products while reducing environmental pressure value addition, income diversification, and incentive-based conservation.

Actions

4.1. Promote sustainable harvesting of NTFPs: Conduct baseline assessments of commercially important NTFPs, develop and enforce sustainable harvesting guidelines (quotas, timing, rotational zones), strengthen community user groups, and integrate traditional knowledge into NTFP governance and monitoring systems.

4.2. Develop rangeland-based enterprises: Establish community-level processing units for NTFPs, wool, dairy, and meat, promote certification and branding, strengthen cooperative models, and facilitate direct market linkages to increase local value retention and income.

4.3. Initiate rangeland-based ecotourism: Identify and map ecotourism potential sites; prepare and implement rangeland-based ecotourism plans such as goth stay, Yarsagunbu or mushroom tourism, develop eco-friendly infrastructure (trails, campsites, eco-lodges) to increase access, and train local communities as guides and service providers.

4.4. Promote green enterprises: Support green enterprises linked to rangeland resources (wool products, dairy, handicrafts, medicinal plants); promote low-impact production systems, enhance their market access.

4.5. Pilot payment for ecosystem services (PES) and incentive mechanisms: Pilot PES schemes that compensate upstream communities for water regulation, biodiversity conservation, and carbon-related services; establish benefit-sharing mechanisms, and link upstream rangeland stewardship with downstream beneficiaries.

Strategy 5: Capacity development, coordination, awareness

Objective: To develop institutional capacity, coordination, knowledge dissemination, and multi-level governance for effective and adaptive rangeland management

Actions

5.1. Build institutional and human capacity: Provide targeted training of government staff, extension workers, forestry and livestock technicians, and community leaders on rangeland governance, monitoring, restoration, conflict management, climate risks, and adaptive management.

5.2. Strengthen coordination, learning, and communication: Establish a provincial–local rangeland knowledge coordination platform to compile, translate, and disseminate research outputs, traditional knowledge, monitoring results, and best practices through manuals, guidelines, policy briefs, and learning events.

5.3. Promote research and innovation: Support research and monitoring using advanced tools such as remote sensing, drones, to assess rangeland condition, grazing dynamics, climate impacts and restoration effectiveness.

5.3. Establish intergovernmental and transboundary coordination mechanisms: Establish a Provincial Rangeland Management Committee (PRMC) to harmonize policies and bylaws, ensure budget allocation, integrate climate risk into planning, and engage federal authorities to initiate dialogue on transboundary grazing issues affecting northern Karnali particularly in Mugu, Dolpa and Humla districts.

Limi Lapcha (4,900 m), a high-altitude spiritual gateway offering views of Mount Kailash from Nepal
Photo: Uttam Babu Shrestha

Implementation Plan

Table 11. Implementation plan including activities, indicators, responsible agencies and estimated budget.

Activities	Indicators	Responsible Agencies	Year (Amount in NRs. Lakh (00,000)										
			I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Strategy 1: Integrated rangeland governance, planning, and data systems			13.5	21	24	6	6	2.5	2.5	0	2.5	0	78
1.1 Policy harmonization and institutional alignment	By Year 2, policy harmonization and alignment of federal/provincial/local policies, laws and acts completed clarifying tenure and grazing rights	MoITFE, MoLMAC, Office of Chief Minister and Council of Minister Karnali Province		10	10								20
1.2 Integrated rangeland information system	By Year 3, GIS database covering ≥90% of major rangelands operationalized	MoITFE, external donors including ICIMOD	5	5	5								15
	By Year 6, database updated at least once every 2 years		2.5		2.5			2.5	2.5		2.5		13
	At least 5 planning decisions annually informed by GIS outputs		1	1	1	1	1						5
1.3 Community Rangeland Management Committees	By Year 5, at least 50 CRMCs formed covering ≥80% priority rangelands	DFOs, Local Governments, CFUGs, LRMCs, NGOs	5	5	5	5	5						25
	≥40% representation of women and marginalized groups												
	≥70% CRMCs enforcing grazing rules annually												
Strategy 2: Sustainable grazing and livestock management			52.5	42.5	53	53	53	43	43	43	43	43	465
2.1 Carrying capacity assessment	By Year 6, carrying capacity assessed for ≥80% major rangelands	MoLMAC, Research Institutions, ICIMOD	10		10		10						30
	Stocking density thresholds formally endorsed by local governments and implemented by CRMCs												
2.2 Adaptive grazing management	By Year 6, ≥60% assessed rangelands under adaptative grazing management	MoLMAC, Local Govts, CRMCs				10							10

	≥20% increase in forage biomass in managed pastures by Year 10												
2.3 Veterinary and extension services	≥70% livestock vaccinated annually in serviced areas	MoLMAC, MoALD, Local Govts, Veterinary hospital and livestock service office	30	30	30	30	30	30	30	30	30	30	300
	≥20% reduction in livestock mortality by Year 5												
	≥30 mobile clinic visits (3 per district)/year		10	10	10	10	10	10	10	10	10	10	100
	20 training programs for herders/year		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	25
Strategy 3: Ecosystem restoration and biodiversity conservation in rangeland			137.5	145	148	135	138	135	133	133	133	133	1366
3.1 Rangeland restoration and reseeding	By Year 5, ≥5,000 ha restored and by Year 10, ≥10,000 ha restored	DFOs, Local Govts, Communities, ICIMOD, Donors	10	10	10	10	10	10	10	10	10	10	100
	≥70% survival of reseeded species after 3 years		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	25
3.2 Soil and water conservation structures	≥25% reduction in active erosion sites by Year 10 (Bioengineering)	DFOs, Local Govts, District Soil Conservation Offices (DSCO), ICIMOD, Donors	50	50	50	50	50	50	50	50	50	50	500
	≥1,000 conservation structures installed by year 10												
3.3 Wetland and water source restoration	≥150 water points/wetlands restored and maintained by Year 10	DFOs, Local Govts, District Soil Conservation Offices	30	30	30	30	30	30	30	30	30	30	300
3.4 Invasive and shrub species management	By Year 3, invasive spps mapping for ≥70% priority rangelands	DFOs, CFUGs, LRMCs, Local Govts		10	10								20
	≥40% reduction in invasive cover in the selected pastures by Year 6	DFOs, CRMCs	2	2	2	2	2	2					12
3.5 Critical biodiversity and habitat conservation	≥10 community conservation zones established and no net loss of biodiversity by year 10	DFOs, PA Authorities	10	10	10	10	10	10	10	10	10	10	100

3.6 Rangelands in Protected Areas (co-management)	By Year 5, grazing provisions integrated into all PA plans	DNPWC, Local Govts	3		3		3						9
	≥30% reduction in livestock–wildlife conflict cases (HWC mitigation activities)	DNPWC, Local Govts	10	10	10	10	10	10	10	10	10	10	100
3.7 Wildfire risk management and recovery	20 trained wildfire response team formed by mobilizing communities and equipped with appropriate equipment's resulted in ≥30% reduction in burned area by Year 10	DFOs, Local Govts, Security Forces, LRMCs	20	20	20	20	20	20	20	20	20	20	200
Strategy 4. Sustainable rangeland-based livelihoods and bio-economy			80	80	80	80	130	80	80	80	80	130	900
4.1 Sustainable harvesting of NTFP	≥80% traded NTFPs under approved harvesting guidelines by Year 5	DFOs, Local Govts, LRMCs, CFUGs	5	5	5	5	5	5	5	5	5	5	50
	≥50% reduction in illegal harvesting by Year 10 (Laws enforcement)		5	5	5	5	5	5	5	5	5	5	50
4.2 Rangeland-based enterprise development	≥10 functional enterprise by Year 8	Local Govts, LRMCs, Cooperatives, Agriculture and Livestock Business Promotion Training Centre (ALBPTC), Veterinary hospital and livestock service office	20	20	20	20	20	20	20	20	20	20	200
	≥30% increase in household income from value-added products												
4.3 Rangeland ecotourism development	≥10 rangeland ecotourism products operational	DNPWC, MoITFE, Tourism Dept., Local Govts	10	10	10	10	10	10	10	10	10	10	100
	≥20% income increase in participating households												

4.4 Green enterprises promotion	≥20 green enterprises supported	MoITFE, Veterinary hospital and livestock service office Local Govts, ALBPTC, SMEs	20	20	20	20	20	20	20	20	20	20	200
	≥25% reduction in biomass fuel dependency		10	10	10	10	10	10	10	10	10	10	100
4.5 PES and incentive pilots	≥2 PES schemes operational by Year 10	MoITFE, Donors					50					50	100
	≥10,000 ha under incentive-based conservation		10	10	10	10	10	10	10	10	10	10	100
Strategy 5: Capacity development, coordination, awareness			25	25	60	25	25	25	35	25	25	25	295
5.1 Institutional and human capacity building	≥1,000 individuals trained by Year 10	Provincial Training Centers, FRTC, ALBPTC	5	5	5	5	5	5	5	5	5	5	50
	≥70% trainees applying skills in field												
5.2 Knowledge coordination & communication	Provincial rangeland platform operational by Year 3	MoITFE, Universities, Research centers			25								25
	≥20 knowledge products produced		10	10	10	10	10	10	10	10	10	10	100
5.3 Research and innovation support	≥10 applied research studies completed	MoITFE, MoLMAC, Universities, Research centers	5	5	5	5	5	5	5	5	5	5	50
	≥5 policy decisions informed by research		2	2	2	2	2	2	2	2	2	2	20
5.4 Intergovernmental & transboundary coordination	PRMC functional by Year 2	MoITFE, MoLMAC, MoFE, MoALD	3	3	3	3	3	3	3	3	3	3	30
	≥1 formal transboundary dialogue initiated				10				10				20
Total			308.5	313	364	298	351	285	293	280	283	330	3104

Meconopsis betonicifolia found along the way to Limi Valley, Humla *Photo: Uttam Babu Shrestha*

CHAPTER 6

Photo: Uttam Babu Shrestha

Implementation Framework for RMSAP

For the effective implementation of the RMSAP in Karnali Province, a comprehensive implementation framework is essential. This framework defines institutional roles and coordination mechanisms, financing and resource mobilization modalities, capacity development priorities, and monitoring, evaluation, and reporting system. This chapter operationalizes the strategies outlined in previous chapters by specifying responsible institutions, implementation arrangements across governance levels, financing options, partnerships, and accountability mechanisms to ensure transparent, inclusive, and results-oriented implementation of the RMSAP.

6.1. Institutional Framework

6.1.1. Implementing Agencies

MoITFE and MoLMAC will serve as lead implementing agencies for the ecosystem, and livestock-related components respectively. Key stakeholders involved are: Division Forest Office under MoITFE, Agriculture Development Office, Animal Hospital and Animal Service Office under MoLMAC, municipalities, I/NGOs, academic institutions, civil society organizations, CFUGs, herders, agro-pastoralists, collectors of medicinal species, herb traders, and the private sectors. To ensure effective coordination at the provincial level, a Provincial Rangeland Management Committee (PRMC) is envisioned. For implementation at the local level, Local Rangeland Management Committees (LRMCs) will be established. Rangeland Users Groups (RUGs) can be formed at the municipal level.

6.1.1.1. Provincial Rangeland Management Committee (PRMC)

A dedicated provincial body, the Provincial Rangeland Management Committee (PRMC), will be established to provide technical backstopping, coordination, documentation, budget tracking, and reporting support. The Secretariat will serve as the focal point for data management, inter-ministerial coordination, and liaison with donors and research institutions. This nine member committee chaired by the Minister of MoITFE will comprise representatives of three sections

(Forest Management and Biodiversity, Science, Environment and Climate and Industry and Tourism Promotion) of the MoITFE, Directorate of Forest, the MoLMAC, the Livestock Development Directorate, the Forest Research and Training Center (FRTC), the Agriculture and Livestock Business Promotion Training Center (ALBPTC), local government representatives, community organizations, private sector stakeholders, and a multidisciplinary team of experts, including an ecologist, a sociologist, and GESI specialist. The selection of the members of the committee should be inclusion, transparent and relevant. This committee should have at least three meetings annually.

Responsibilities

- Policy development: Develop and implement comprehensive policies and strategies for sustainable rangeland management,
- Priority setting: Identify priority actions and research need in the rangeland sector, ensuring alignment with provincial and national objectives,
- Budget Allocation: Allocate and advocate for sufficient budgetary resources for rangeland management efforts, ensuring financial support for key programs and activities.
- Coordination: Facilitate coordination between government agencies, local bodies, NGOs, developmental agencies, and other stakeholders.
- Monitoring and Evaluation: Monitor and evaluate the progress of rangeland management programs, ensuring they meet established goals and objectives.
- Reporting and accountability: Prepare and submit an annual implementation report to the Provincial Cabinet.

6.1.1.2. District Level Management Committees (DLMCs)

At the district level, the existing District Forest Coordination Committee (DFCC) will conduct the following activities related to rangeland management. The chairperson the DFCC will be de facto chairperson of this committee.

Responsibilities

- Monitor and evaluate the rangeland management activities conducted within the district.
- Recommend rangeland management activities and plans to the provincial government.
- Coordinate Local Rangeland Management Committee (LRMCs).

6.1.1.3. Local Rangeland Management Committees (LRMCs)

Under the 'Thematic Committee Operation Procedure 2022,' prepared by the Ministry of Federal Affairs and General Administration, local municipalities with significant rangeland areas are encouraged to form Rangeland Management Committees. LRMCs will function as thematic committees under the municipality, with formal recognition through municipal executive decisions. This committee will have seven members and the chair person will be elected by the members of rangeland user groups.

Responsibilities

- Facilitate the implementation of rangeland management actions at the municipal level.
- Work closely with PRMC, Division Forest Office, Agriculture Development Office, Animal Hospital and Animal Service Office, to address local needs and priorities.
- Engage local communities including herders, agro-pastoralists, medicinal species collectors in decision-making processes for the sustainable use and management of rangeland resources.
- Monitor the rangeland conditions and management practices and report the findings to the PRMC and other relevant bodies.
- Develop and disseminate best practices and local technologies related to rangeland management.
- Provide capacity building training and extension services to local communities, enhancing their ability to manage rangelands sustainably.

- Develop and implement local level rangeland use and management guidelines such as sustainable grazing, medicinal species collection, and fire management.

- Ensure that a portion of the local government budget is allocated specifically for rangeland management activities

6.1.1.4. Rangeland User Groups

To facilitate local access to and sustainable management of rangelands, local herders, agro-pastoralists, transhuman herders, medicinal plant collectors, livestock-based entrepreneurs, and other rangeland users can form Rangeland User Groups (RUGs) at the local level. These groups can be registered at the Municipality upon approval from the Division Forest Office and the Animal Hospital and Animal Service Office. Rangeland Management Committees if existed at the local level can support formation of RUGs. Both offices will conduct a technical assessment to evaluate the feasibility, define the boundaries of pasturelands, identify the number of users (both local and distant users), the total livestock population, the carrying capacity of the pastures, and prepare a resource inventory of medicinal and aromatic plants with high commercial and conservation value, documentation of biodiversity and wildlife with high conservation value. Additionally, they will assess the demand and supply of rangeland products, including livestock products. This group can implement income diversification programs, including medicinal plant cultivation, value-added livestock product promotion, rangeland-based ecotourism initiatives.

Similar to Community Forestry User Groups (CFUGs), RUGs will have a formal executive committee, general members, their own fund, regular meetings, an annual general meeting, and an operational plan for the sustainable management and use of rangelands. A minimum proportion of RUG-generated revenue shall be earmarked for rangeland restoration, monitoring, and conflict management activities. Detailed guidelines outlining the formation process, roles, and responsibilities of RUGs, as well as their operational framework, will be developed by the Directorate of Forest and MoITFE aligning with the legislative and policy framework.

6.1.1.5. Academic institutions

Academic institutions in Karnali Province play a crucial role in RMSAP implementation by bridging scientific knowledge with policy and practice. Academic institutions such as Tribhuvan University, Kathmandu University, Mid-West University, Karnali Academy of Health Sciences, Agriculture and Forestry University, Far-Western University, and the Institute of Forestry can be engaged to conduct research on the ecological and socio-economic aspects of rangelands, biodiversity, climate impacts, and monitoring drivers of rangeland change. These institutions can also evaluate the effectiveness of policies and programs related to rangeland management.

Additionally, they provide technical training to government officials, local communities, and herders and develop educational programs focused on rangeland conservation and sustainable management. Academic institutions will also support the PRMC and LRMCs by translating research findings into policy briefs, decision-support tools, and adaptive management recommendations.

6.2. Funding Allocation

Adequate funding allocation and efficient mobilization for rangeland management efforts in Karnali Province are crucial to the successful implementation of the RMSAP.

In the current scenario, bits and pieces of rangeland management activities are integrated into the forestry and livestock sectors. As the Karnali Provincial Government has initiated efforts to implement a separate program focusing on rangeland, a dedicated funding mechanism will be established in the future.

Funding for RMSAP implementation will flow through a combination of provincial sectoral budgets, local government allocations, externally funded projects, and community-generated revenues. The PRMC will serve as the coordinating platform to align these funding streams, avoid duplication, and ensure strategic investment across priority rangeland landscapes.

Federal and Provincial Budgets: The Provincial Rangeland Management Committee (PRMC) should advocate for a dedicated budget line within both the provincial and federal budgets to ensure consistent annual funding for rangeland management activities. This funding should support both the ecosystem and biodiversity components led by the MoITFE, and the livestock management components overseen by the MoLMAC. The herding allowance program can

be expanded to incentivize sustainable grazing practices rather than intensification only. Alignment with federal programs will be ensured through annual joint planning and reporting mechanisms between provincial line ministries and relevant federal agencies.

Local government's contribution: Similarly, local municipalities, through the Local Rangeland Management Committees (LRMCs), should allocate a portion of their budgets specifically for rangeland management initiatives. Local municipalities can also utilize funds from national programs such as the 'High-Altitude District Development and Livelihood Program', the 'High Hill and Himali Sector Prosperity Program', and the 'Presidential Women's Livelihood Development Program'. These federal funding schemes provided to local governments can be used to implement action plans tailored to the needs of rangeland-dependent communities, diversifying their income, green enterprises and value chain development, capacity building and rangeland-based ecotourism.

International Support: Additionally, the PRMC should actively seek grants from international donors, development agencies, philanthropic institutions, and environmental organizations that focus on biodiversity conservation, environmental management, climate change mitigation, climate-resilient agriculture and livestock, and sustainable development. PRMC should also promote government and academic research institutions to seek external collaborative research grants.

Public-Private Partnerships (PPPs): Encouraging partnerships between the government and the private sector can generate additional resources. Businesses involved in ecotourism, commercial livestock, and the trade of medicinal species can be encouraged to invest in rangeland conservation efforts, offering both financial support and technical expertise.

Payments for Ecosystem Services (PES): Establishing rangeland-focused PES schemes can create a sustainable funding stream. Under such schemes, stakeholders benefiting from rangeland ecosystem services—such as water supply, carbon sequestration, and biodiversity—can provide financial compensation to local communities managing these rangelands sustainably. PES mechanisms will be piloted with clear governance arrangements, transparent benefit-sharing rules, and independent monitoring to ensure credibility and equity.

Revenue from Sustainable Enterprises: Encouraging the development of rangeland-based green enterprises, such as value-added livestock products like churpi, woolen handicrafts, ecotourism, and the cultivation of high-value medicinal species, can generate income for local communities. A portion of the revenue from these green enterprises as well as medicinal species collection and trade can be reinvested into rangeland management activities, creating a self-sustaining funding model.

6.3. Capacity Building

Capacity needs assessment and building are essential for effective implementation of the RMSAP in Karnali Province. Capacity building is needed across multiple levels, including government staff, local governments, and local communities. Capacity development under the RMSAP will follow a phased approach. Initial efforts (Years 1–3) will prioritize institutional capacity, data systems, and core technical skills. Intermediate phases (Years 4–7) will focus on community-level implementation capacity and enterprise development, while later phases (Years 8–10) will consolidate advanced skills related to monitoring, climate adaptation, and market integration. The table below (**Table 12**) provides the key areas where capacity development is necessary.

Table 12. Necessary areas for capacity development.

Government staff	Local governments	Local communities
Technical		
• Training on invasive species identification, control and management • Climate smart agriculture and livestock management techniques • Rangeland mapping and monitoring using GIS/RS, Drone	• Sustainable grazing, livestock health and pasture management • Rangeland related data collection training	• Skill development for alternative income-generating activities • Marketing and value chain management of rangeland products • Identification, control and management of invasive species • Sustainable harvesting of medicinal species
Non-technical		
• Sensitization of the RMSAP and multiple benefits of rangeland use and management • Monitoring and Evaluation training to track the progress of RMSAP activities	• Sensitization of the RMSAP and Local policy and program development	• Participatory planning and conflict management • Livestock health, water management and sanitation • Awareness about the multiple use of rangelands and the impacts of climate change • Basic financial literacy
Cross-sectoral		
• Understanding and integrating GESI into rangeland use and management • Designing, implementing and utilizing monitoring, evaluation and learning • Climate change adaptation and mitigation		

Horse grazing in Guthichaur, Jumla
Photo: Uttam Babu Shrestha

Geranium sp. commonly found in Rangelands
Photo: Uttam Babu Shrestha

Rara Lake *Photo: Uttam Babu Shrestha*

CHAPTER 7

Monitoring, Evaluation and Learning

This chapters outlines the Monitoring, Evaluation, and Learning (MEL) framework to track progress, evaluate the effectiveness of implementation, and facilitate continuous learning and adaptive management of the RMSAP.

7.1. Objectives of MEL Framework

- Track the implementation performance of the RMSAP to ensure that activities, outputs, outcomes and investments are delivered on time and within budget.
- Assess effectiveness, efficiency, and impacts of the RMSAP in improving rangeland health, conserving biodiversity, enhancing water and soil conditions, strengthening institutions, and improving livestock productivity and livelihoods.
- Strengthen learning and adaptive management by identifying successes, challenges, and good practices, and systematically integrating lessons into annual planning, policy refinement, and scale-up.

7.2. Components of the MEL Framework

There are three key interconnected components of the MEL framework: Monitoring, Evaluation, and Learning. Each component has a distinct purpose for the effective implementation of the RMSAP. **Table 13** provides an overview of the basic functions and methodologies associated with each of these components.

Table 13. Key components of MEL framework.

Monitoring	Evaluation	Learning
Define SMART (specific, measurable, achievable, relevant, and time-bound) indicators for each strategy and action in the RMSAP.	Conduct a baseline (ecology, livelihoods, institutions) assessment at the start of the RMSAP to establish ecological, socioeconomic, and institutional conditions.	Establish learning platforms such as review workshops, social media page, and online portal to share lessons and disseminate knowledge among stakeholders.
Establish routine data collection mechanisms to track the indicators, using filed-based monitoring, remote sensing, and community-based monitoring.	Conduct a mid-term evaluation (year 5) to assess progress, identify challenges, and make necessary adjustments to the actions.	Institutionalize feedback loops so monitoring/evaluation results are reflected in annual workplans, budgets, and policy.
Set timelines for reporting (quarterly/annual) to track progress and adjust as needed.	Carry out a final evaluation (year 10) to measure overall success, impacts, sustainability and scalability.	Document and disseminate case studies and success stories to highlight best practices and encourage replication in other regions.

7.3. Progress Indicators

The effectiveness of the RMSAP will be examined and evaluated using three broad progress indicators. The progress of these indicators will be examined every two year from 2026-2036. There will be a mid-term review of the RMSAP in 2030. The descriptions of these indicators are provided in **Table 14**.

Table 14. Description of progress indicators.

Indicator category	Description
Ecological Indicators	○ Change in vegetation cover/condition and rangeland productivity (e.g., ground cover %, forage biomass, NDVI trend in priority sites). ○ Status and spread of invasive species (e.g., invasive cover % and area affected). ○ Soil and land health (e.g., erosion incidence, sediment risk, soil organic carbon in pilot sites). ○ Water and wetland status (e.g., number/functionality of water points, wetland condition score). ○ Status of biodiversity and critical habitats
Socioeconomic Indicators	○ Change in income from rangeland-based livelihoods (livestock, NTFPs, tourism). ○ Adoption rates of improved practices (rotational grazing, sustainable harvesting, improved animal husbandry). ○ Enterprise growth and services (number of functional processing units/cooperatives; tourism products/packages operational). ○ Market access improvements (e.g., presence of market information system, volume of value-added products).
Institutional Indicators	○ Number and functionality of PRMC/LRMC/RUGs (meetings held, plans approved, compliance monitored). ○ Local policies/bylaws and agreements established (grazing rules, water-sharing, benefit-sharing). ○ Number of people trained, by category (staff/community/women/youth) and evidence of application. ○ Budget allocation and expenditure rate for rangeland actions and MEL.

7.4. Institutions involved in MEL

The RMSAP envision three institutions and each institution will have different role and function. The institutional arrangement for MEL framework is provided in **Table 15**.

Table 15 outlines the key institutions involved in the MEL framework and their respective roles and responsibilities in implementation, monitoring, evaluation, and learning processes for the RMSAP.

Table 15. Key institutions involved in MEL.

Institutions	Roles and Responsibilities
Provincial Rangeland Management Committee (PRMC)	○ Provides overall oversight and approves MEL standards, indicators, and reporting templates. ○ Coordinates biannual data consolidation from LRMCs, line agencies, and partners. ○ Commissions/organizes baseline, mid-term, and final evaluations. ○ Ensures MEL results inform annual provincial planning and budgeting. ○ Ensures a dedicated MEL budget line is included in RMSAP financing. ○ Publishes MEL reports and supports public transparency and dissemination.
PRMC Secretariat / Technical Unit	○ Maintains the RMSAP indicator database and GIS layers. ○ Conducts data quality checks and prepares annual synthesis reports. ○ Supports training on data collection tools and reporting
Local Rangeland Management Committees (LRMCs)	○ Lead local-level monitoring and reporting against agreed indicators. ○ Coordinate community participation and verify field data with RUGs. ○ Submit standardized reports to PRMC on agreed schedule.
Rangeland User Groups (RUGs)	○ Maintain records on grazing schedules, compliance, pasture resting zones, NTFP collection, and local investments. ○ Participate in community-based monitoring (pasture condition, invasive sightings, fire incidents). ○ Support periodic updates/renewal of local rangeland plans and ensure social accountability.
Government Agencies (MoITFE, MoLMAC, DFO, Agriculture/ Livestock Offices etc.)	○ Implement sector specific activities ○ Provide technical monitoring inputs (livestock health/vaccination coverage, restoration works, wetland interventions, compliance). ○ Align sectoral monitoring with RMSAP indicators and share datasets with PRMC.
Academic institutions/ Research partners, FRTC	○ Support baseline studies, method development, and impact evaluations. ○ Conduct applied research on effectiveness of grazing systems, restoration, invasive control, biodiversity monitoring, and climate impacts. ○ Help translate findings into practical guidance and decision-support tools.
I/NGOs and development partners	○ Support implementation of RMSAP both financially, technically

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Annex I. Municipality-wise distribution of rangeland area in Karnali Province

District	Municipality	Area (ha)
Dailekh	Naumule	8361.42
Dailekh	Aathabis	5417.9
Dailekh	Gurans	5377.74
Dailekh	Bhagawatimai	5263.13
Dailekh	Thantikandh	4732.36
Dailekh	Mahabu	4673.28
Dailekh	Dullu	4075.92
Dailekh	Narayan	3625.52
Dailekh	Bhairabi	3408.2
Dailekh	Dungeshwor	3090.57
Dailekh	Chamunda Bindrasaini	2980.28
Dolpa	Shey Phoksundo	81541.86
Dolpa	Chharka Tangsong	44939.15
Dolpa	Dolpo Buddha	33968.95
Dolpa	Thuli Bheri	24963.94
Dolpa	Jagadulla	24815.59
Dolpa	Tripurasundari	24325.94
Dolpa	Kaike	20628.76
Dolpa	Mudkechula	13732.2
Humla	Namkha	90893.27
Humla	Chankheli	31320.88
Humla	Simkot	23875.32
Humla	Kharpunath	23128.23
Humla	Sarkegad	14266.22
Humla	Adanchuli	8315.98
Humla	Tanjakot	7815.49
Jajarkot	Barekot	24255.16
Jajarkot	Tribeni Nalagad	18782.64
Jajarkot	Junichande	15763.37
Jajarkot	Chhedagad	10485.76
Jajarkot	Kuse	8510.45
Jajarkot	Bheri	6182.29
Jajarkot	Shiwalaya	4953.51
Jumla	Patrasi	30589.39
Jumla	Tatopani	24366.82
Jumla	Guthichaur	18467.07
Jumla	Kanakasundari	9607.07
Jumla	Tila	8620.38
Jumla	Sinja	6897.07
Jumla	Hima	6050.57
Jumla	Chandannath	4027.51
Kalikot	Tilagufa	10715.29
Kalikot	Mahawai	10437.25
Kalikot	Palata	10166.17
Kalikot	Pachaljharana	8957.73
Kalikot	Khandachakra	7712
Kalikot	Naraharinath	7106.47
Kalikot	Sanni Tribeni	5859.96
Kalikot	Raskot	3581.07
Kalikot	Kalika	3048.89
Mugu	Mugum Karmarong	74063.27

Mugu	Chhayanath Rara	21718.67
Mugu	Soru	17130.15
Mugu	Khatyad	13291.76
Rukum West	Aathbiskot	22339.12
Rukum West	Banfikot	7235.97
Rukum West	Sani Bheri	4917.46
Rukum West	Musikot	3799.89
Rukum West	Chaurjahari	3048.71
Rukum West	Tribeni	2647.24
Salyan	Bangad Kupinde	10258.15
Salyan	Kalimati	5024.53
Salyan	Sharada	4596.98
Salyan	Bagchaur	4484.38
Salyan	Chhatreshwori	3663.53

Salyan	Kumakhmalika	3233.45
Salyan	Kapurkot	2684.36
Salyan	Darma	2610.47
Salyan	Dhorchaur	2494.04
Salyan	Tribeni	1772.29
Surkhet	Simta	8458.1
Surkhet	Chingad	7719.62
Surkhet	Birendranagar	5564.53
Surkhet	Barahtal	5560.08
Surkhet	Gurbhakot	5069.78
Surkhet	Panchpuri	4958.09
Surkhet	Lekbeshi	4799.4
Surkhet	Chaukune	3561.06
Surkhet	Bheriganga	1623.48

Provincial consultation meeting (Surkhet)

District consultation meeting (Kalikot)

District consultation meeting (Jumla)

District consultation meeting (Mugu)

District consultation meeting (Jajarkot)

District consultation meeting (West Rukum)

District consultation meeting (Dolpa)

District consultation meeting (Humla)

Focus group discussion in Jumla

Consultation with herders (Patarasi RM, Jumla)

Vegetation sampling in Jumla

Key informant interviews in Jumla

Community consultation in Jumla

Community consultation in Jumla

Key informant interviews in Jumla

Herbarium collection

Ruppatan, Dolpa | *Photo: Uttam Babu Shrestha*

Patarasi Himal seen from Patarasi RM, Jumla | Photo: © Uttam Babu Shrestha