



Human-wildlife conflicts and climate change in the Spiti Valley of the Himalayan Region

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Abstract

Purpose

This work examines the growing challenges of human–wildlife conflict in the Spiti Valley, a remote desert located in the Indian Himalayas at a high altitude. There is a focus on how climate change is at the bottom of these changes. By bringing together wisdom and the daily an experience of local people, the analysis explores not only the triggers of these conflicts but also the way they unfold, and the deep social and ecological impacts felt by the populace.

Methodology

To construct the full picture, this research combines the stories with numbers. The work consisted mainly of household surveys for quantitative insights and detailed, face-to-face interviews with farmers, herders, and local women for the qualitative inputs. Through the



process of systematic coding and analysis, the study explains the obvious patterns and the costs of living with wildlife—from yields that are lost to emotional strain—allowing us to understand how vulnerable yet resilient these local populations are.

Findings

The evidence shows that the biggest issues arise from snow leopards and Himalayan wolves preying on livestock, while wild herbivores damage crops. Climate change has made matters worse: rising temperatures and a switch from snowfall to rainfall disrupt the valley's precious water supply, hurt pasture quality, and shrink harvests. As the wildlife adapt to the shifting landscape, they come closer to villages in search of food and water. Intriguingly, there were no reports of any kind of poaching, retaliation, or human casualties in 2017 and 2022—proof of the tolerance of the locals, fostered by various compensation and insurance schemes.

Research Limitations and Implications

This study focuses on the Spiti Valley, with data from selected years, so its results may not apply to all regions of the Himalayas. Future work must aim to explore other regions and track these changes over time to help construct a broader understanding of how climate and wildlife conflicts intersect.

Practical Implications

The findings point to urgent priorities: better water management, stronger community-led solutions (like secure animal enclosures and new livelihoods), and adaptive policies that honour both the environment and local traditions.

Social Implications

Despite tough conditions, local communities show impressive resilience and adaptability. The research highlights how inclusive decision-making and fair compensation help pave the way for sustainable coexistence with wildlife in these delicate mountain areas.

Originality and Value

This chapter offers realistic perspectives on the relationship between climate change and wildlife conflict. It blends ecological and social viewpoints and adds new content for both academics and policymakers to design culturally sensitive strategies for mountain communities that are sensible and sustainable.

Keywords: Spiti Valley, Human-wildlife conflict, Climate change, Snow Leopard, Livestock

I. Introduction

Human-wildlife conflict (HWC) is a global challenge and is broadly understood as a negative interaction between humans and animals of the wild, which gives unwanted results for both, as well as the preservation of the habitats (Worldwide Fund for Nature, 2004; United States Geological Survey, 2007). Conflicts usually arise from increased competition for available natural resources, directly impacting the food security of humans, living, and the survival of wild animals of various species (Worldwide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.). In different types of landscapes,



HWC is known to be a major barrier for betterment in a sustainable manner, food security, and the broader goals for conservation of biodiversity (Worldwide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.).

The effects of human–wildlife conflict (HWC) are wide-ranging and complex. Human–wildlife conflicts bring a range of direct challenges, including the destruction of crops, lower agricultural yields, and intensified competition for grazing land and water. Predation on livestock is a frequent and painful issue, leading to both financial losses and emotional hardship for affected families. In more severe cases, these conflicts can damage essential infrastructure, increase the risk of disease transmission between wild and domestic animals, and occasionally result in human injuries or fatalities. These complicated impacts bring forth the significant difficulties faced by people living close to wilderness, shaping their daily lives and long-term wellness.(Worldwide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.). Further to these encounters can also bring in a negative mindset towards some species of animals within the communities that are affected by these conflicts. (International Fund for Animal Welfare, n.d.).

Changes in climate disturb settings and the availability of essential resources, forcing animals to either move or change their migration routes. Animals spread their areas to locate food and water. These animals hence travel to places occupied by people, increasing the chances of conflict. In sensitive places, small changes in rainfall or temperature can bring forth major migrations, bringing animals closer to farms and villages and extending the tensions between humans and animals.(International Fund for Animal Welfare, n.d.; Kent & Lustig, 2025). Such issues are more pronounced in areas that have fewer resources and at higher altitudes, like the Spiti Valley. In such locations as the Spiti Valley, even small changes in availability driven by a change in climate can quickly disrupt the balance between humans and wildlife. These shifts have immediate and tangible impacts on local communities, making global patterns of human–wildlife conflict highly relevant on the ground. Moreover, human–wildlife conflict is far more than a local issue—it poses a major threat worldwide to sustainable development, food security, and efforts to conserve biodiversity. Understanding these conflicts as part of a broader global challenge highlights the urgent need for coordinated and comprehensive plans to address them effectively. (Worldwide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.). Studying Human – Animal Interactions in Spiti Valley within this broad context shows how local issues are linked to larger environmental and social challenges. This approach moves us away from looking at these as individual and separate events and includes them as parts of a larger, connected system. Understanding them this way calls for well-coordinated solutions that address the root causes across all levels—not just temporary solutions at the local scale but strategies that consider broader ecological and societal dynamics. Mountain ecosystems, specially within the Himalayan area, display susceptibility to climate change due to their limited capacity to adapt and the lack of resources (Joshi & Negi, 1995; Beniston & Stoffel,



2014). Himalayan region is known to be a sensitive locale for climate change, with impacts arising at a very high pace (Worldwide Fund for Nature, n.d.). Changes here are expected to grow in the years ahead, which shall lead to difficult consequences with respect to food, water, energy, as well as biodiversity and loss of wildlife species in the region. (Worldwide Fund for Nature, n.d.; Frontiers in Environmental Science, n.d.). The Region is crucial for the survival of over a billion people, making the region's vulnerability to climate change a major concern. (Worldwide Fund for Nature, n.d.) Among the key threats are the retreat of glaciers, losses in biodiversity, and major changes in water resources. There is a threat to water and agriculture, which has long-term impacts on animals as well as the local populace (Frontiers in Environmental Science, n.d.).

Located in North North-Eastern part of Himachal Pradesh, Spiti Valley is a distinct region in high altitude and named tly named "The middle land" as a result of its being located between Tibet and India (Wikipedia, n.d.a). Its dry climate, due to being in the rain shadow area, makes it totally dependent on snow melt for its water requirements. (Wikipedia, n.d.a; Wikipedia, n.d.b). This difficult ecosystem, having barren mountains and very scattered vegetation, is home to both humans and resilient species of animal species (Wikipedia, n.d.a; Wikipedia, n.d.b). The extreme conditions, with temperatures going down to as low as -25°C (-13°F) in winters, render inhabitants vulnerable to even subtle changes in climate and environment (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a).

This chapter examines the complex and related challenges of human-wildlife conflicts magnified by climate change in the Spiti Valley. Using a qualitative research method, the focus is on the voices and experiences of the local populace, providing detailed understanding of how they perceive, manage, and adapt to the combined environmental and social pressures they face. Additionally, the chapter reviews current efforts to reduce conflicts and offers well-supported recommendations aimed at promoting coexistence and strengthening resilience in this vital Himalayan region.

II. Spiti Valley: An Ecosystem in the Himalayan Region of India

Characteristics of the local Geography and Climatic

Study Area

Biophysical Setting

- Elevation: 3,200–6,500 m.
- Climate: mean annual temperature -1°C ; winter minima -30°C .
- Precipitation: $<170\text{ mm yr}^{-1}$; $>70\%$ falls as winter snow.
- Glaciers: ~ 750 glaciers (550 km^2) with projected 71.8% area loss by 2070 under RCP 8.5.

The Socio-economic Profile of Inhabitants of Spiti

Spiti's 13,000 residents are primarily Bodh agro-pastoralists cultivating green peas, barley and raising yak, sheep and dzomo. Tourism ($>10,000$ visitors yr^{-1}) and road connectivity have rapidly altered waste generation and stray dog populations.



Spiti Valley is a high-altitude region located within the Lahaul and Spiti district of Himachal Pradesh, India, uniquely positioned as "The middle land" between Tibet and India (Wikipedia, n.d.a; Wikipedia, n.d.b). Its average elevation spans from 2,950 to 4,100 meters (9,680–13,450 ft), with the valley floor itself averaging 4,270 meters (14,010 ft) (Wikipedia, n.d.a; Wikipedia, n.d.b). The valley is characterized by its stark, barren mountains, largely devoid of trees except for scattered stunted willows in a few villages (Wikipedia, n.d.a).

As a typical mountain desert area, Spiti lies in the monsoon rain shadow of the main Himalayan range, resulting in extremely scanty annual rainfall, averaging only about 50 mm (2.0 in) (Wikipedia, n.d.a; Wikipedia, n.d.b). Snowfall is also relatively low, typically less than 200 cm (6.6 ft) (Wikipedia, n.d.a). "This place is a land of weather extremes. From May to September, the days are comfortably warm, typically sitting around 15 degrees Celsius to 25 degrees Celsius, perfect summer weather. However, the nights are a different story, often dipping right down to 0 degrees so you really notice the chill. Then comes the long, harsh winter (October through April), where temperatures don't just get cold—they absolutely plummet, sometimes hitting -15degrees or lower." (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a). This temperature range is attributed to the region's altitude, dry conditions, and its proximity to the Himalayas (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This dry, cold desert climate makes the region sensitive to even minor climatic changes.

Crucial Human Settled locations and their livelihoods

Major villages located along the Spiti River and its surroundings include Kaza and Tabo, alongside other villages such as Losar, Kibber, Mudh, Langza, Komik, Hikim, and Sumdo (Wikipedia, n.d.a; Wikipedia, n.d.b; Holidify, n.d.). These villages are mainly reliant on agriculture and breeding animals, which form the core source of their livelihoods. As a result of the altitude and the cold desert conditions, there is a possibility of one agricultural season per year, making the success of the crop critically dependent on water availability (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a). The bred animals, including sheep, goats, and yaks, form part of the farming system and households, providing food, income, and cultural value (Wikipedia, n.d.b; Gupta & Wani, 2024). Alongside these practices, some households supplement their income through government jobs and employment in nearby towns, often as drivers, daily wage labour, and remittances received from migrants (Ogra, 2008).

An Overview of Relevant Habitats of Wild Animal Species and Protected Areas

In spite of its dry and barren land, Spiti Valley supports a large number of wild animal species which have adapted to the harsh conditions of the region (Wikipedia, n.d.b; Tethys Himalayan, n.d.). Major areas that are protected within the region include the Kibber Wildlife Sanctuary, Pin Valley National Park, and the Chandratat Wildlife Sanctuary (Wikipedia, n.d.b; Tethys Himalayan, n.d.; Spiti Wildlife Division, n.d.).



Kibber Wildlife Sanctuary is the largest wildlife sanctuary in Himachal Pradesh and consists of an area of 2220.12 square km across altitudes from 3600m to 6700m (Wikipedia, n.d.b). These sanctuaries provide a crucial habitat for some special species like the elusive *Panthera uncia* (Snow Leopard), *Capra sibirica* (Himalayan Ibex), *Pseudois nayaur* (Bharal or Himalayan Blue Sheep), *Canis himalayensis* (Himalayan Wolf), Himalayan red fox, and *Moschus chrysogaster* (Himalayan Musk Deer) (Wikipedia, n.d.b; Tethys Himalayan, n.d.). The very fact that these wildlife sanctuaries are established at such locations stands testimony to the region's ecological significance and the efforts to conserve the biodiversity of the region.

The unique status of the Spiti Valley as a cold desert at high elevation, with its extreme climate and deep reliance on snowmelt for the single annual agricultural season, implies an intricate ecological and social balance within which human livelihoods and the survival of wildlife are highly entwined and extremely sensitive to even slight environmental variations. (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a). This intrinsic fragility involves the fact that climatic changes directly threaten the essential resources critical for human sustenance and wildlife survival, and cannot but heighten competition and conflict. This relationship epitomizes a pivotal interdependence wherein the well-being of human communities and that of wildlife is organically tied to the stability of the fragile mountain ecosystem.

While the establishment and presence of protected areas like Kibber Wildlife Sanctuary are important in securing wildlife habitats and conserving endangered species, their very existence within a resource-scarce environment can inadvertently lead to the concentration of wildlife populations (Wikipedia, n.d.b; Tethys Himalayan, n.d.; Spiti Wildlife Division, n.d.). The concentration, especially when combined with climate change-induced changes in the distribution of resources, may push wildlife closer to human settlements, hence potentially increasing the chances of human-wildlife conflict at the edges or even buffer zones of the protected areas.

Figure 1: Map of Spiti Valley depicting Major Human Habitats and Areas that are Protected

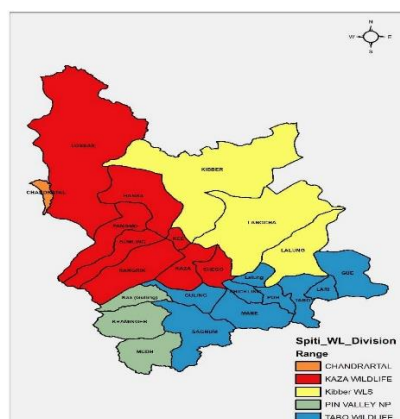




Figure 1 depicts the essential geographical context, visually showing the different regions of the valley and the wildlife.

III. Impacts of change in climate at Spiti Valley

Shifts in Climate conditions

The recent and rapid climate change, evident through distinct climatic shifts, is manifesting throughout the Himalayan region, of which the Spiti Valley is part. Scientific studies conducted in the Lahaul-Spiti district have reported clear and concerning trends by analyzing data from 1981 to 2021. (World Wide Fund for Nature, n.d.). Increasingly, the trend of monthly temperatures is observed, more pronounced in October with a p-value of 0.011 and December with a p-value of 0.05 (Joshi & Negi, 1995; Beniston & Stoffel, 2014).

Though annual and seasonal temperature trends are not statistically significant for the entire study period, these specific monthly shifts indicate a dramatic change in the region's previously cold climate. (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Temperature ranges were observed to be from -1.47°C to 7.95°C for maximum and 5.48°C to -19.2°C for minimum, while mean temperatures ranged from 6.863°C to -15.791°C from January 1981 to December 2021. (Joshi & Negi, 1995; Beniston & Stoffel, 2014). The highest consistency in temperature was observed in August (9.19% coefficient of variation) and the lowest in May (-257.89% coefficient of variation). (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This suggests a more complex, perhaps uneven, warming pattern rather than a uniform heating. The nuance here is that the climate impacts could be concentrated in those specific periods, which can still have profound ecological and socio-economic consequences-such as affecting the timing or quantity of snowmelt on which agriculture may depend, or impacting traditional winter tourism activities.

Precipitation has also recorded a significant increasing trend annually, seasonally, and monthly: p-value 0.000; winter, p-value 0.008; summer, p-value 0.003; January, p-value 0.030; April, p-value 0.032; June, p-value 0.004; July, p-value 0.027; August, p-value 0.002 (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Precipitation ranges observed over the period of research from January to December show maximums from 0 to 2.14 and minimums from 2.19 to 12.94, while the mean precipitation varies from 0.469 to 6.324 millimetres. (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Maximum uniformity in rains occurred during the month of August, with a coefficient of variation of 42.32%, while in November it was minimum at 163.54%. (163.54% coefficient of variation) (Joshi & Negi, 1995; Beniston & Stoffel, 2014). There is an observable transformation of solid precipitation to liquid precipitation, like from snowfall to rainfall, with a rise in temperatures.

Precipitation shifting from snowfall to rainfall in the Spiti Valley is a critical compounding vulnerability. (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This shift is considered a negative indicator for the region, given its geological composition of sedimentary rocks (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Even in cases where total precipitation might be increasing, the altered form means less water retention in the landscape (because of rapid



runoff on steep slopes) and an increased risk of geological hazards like mudflows, landslides, and floods-particularly in a region underlain by sedimentary rocks (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This shows that, apart from the quantity, precipitation type is also critical for the region's hydrology and stability, creating new environmental hazards and further stressing water resources for human consumption and wildlife survival.

The people living in villages located at high altitudes of Spiti valley, like Komik, Kibber, and Langza, mention a faster pace of the melting of glaciers and a reduced level of snowfall in recent decades (Wikipedia, n.d.a). These perceptions are validated by findings that indicate ng that rising temperatures are indeed speeding up the glacial melt and reducing the snow cover (Joshi & Negi, 1995; Beniston & Stoffel, 2014).

Issues for Water, Agriculture and Animal Breeding

The effect of climate change in Spiti Valley has grave consequences for its water supply, agriculture, and animal breeding. Villages in Spiti rely entirely on snowmelt water from winter snows and glaciers for agricultural activities (Wikipedia, n.d.a). Thus, decreased snowfall and accelerated glacier melt directly result in worsening water shortages (Joshi & Negi, 1995; Beniston & Stoffel, 2014). While increased rainfall can be beneficial, unlike slow-releasing snowmelt, it does not last very long in the valley due to steep slopes, leading to increased water shortages, whether for drinking or irrigation (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This shrinking of important water sources directly leads to lower crop productivity and the potential to increase water conflicts within and between communities (Joshi & Negi, 1995; Beniston & Stoffel, 2014)..

Change in snow fall patterns and increased risk of crop failure as a result of changed precipitation patterns have negative consequences for Spiti's one growing season (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a). The consequences are significant loss of crop yield and quality for local people, which undermines food security and economic stability for residents (Joshi & Negi, 1995; Beniston & Stoffel, 2014). For ranching, climate change is causing pasture degradation which is a significant risk to Gaddi shepherds traditional annual animal migrations with their goats and sheep. For example, pathways for these pastoralists across rivers are being washed away or the ice bridges that once made crossings possible are disappearing forcing ranchers to find alternate routes, which are often not suitable (Wikipedia, n.d.a). Fodder for livestock is another widespread reported effect of climate change on the pastoral economy (Joshi & Negi, 1995; Beniston & Stoffel, 2014).

Studying the effect on the local ecosystems and biodiversity

In addition to direct effects specific to humans, climate change has major implications for the natural ecosystems in Spiti. Increased temperatures are resulting in permafrost thawing and changing the conditions for (local) plant and animal species (Joshi & Negi, 1995; Beniston & Stoffel, 2014). There are indications that species are either shifting their range to higher elevations, where conditions for thermal and resource availability are suitable or are facing significant obstacles to survival in their current habitats, which are becoming unsuitable



(Joshi & Negi, 1995; Beniston & Stoffel, 2014). There are also reports of invasive species being found, which could disturb ecological balance and add competition with endemic floral and faunal species (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Changes to the ecological fabric will directly impact the food base availability of those wild species, and lead them to find habitats that have resources remaining, which may take them toward human habitats, and increase the likelihood encounters between human and wildlife, and potential conflict (Kent & Lustig, 2025; International Fund for Animal Welfare, n.d.).

Table 1: Indicators of Climate Change and Trends in Lahaul-Spiti Region(1981-2021)

Parameter	Trend (1981-2021)	P-value (for significant trends)	Implications for Spiti Valley
Monthly Temperature (October)	Significant Increasing	0.011	Accelerated glacier melt, reduced snow cover.
Monthly Temperature (December)	Significant Increasing	0.05	Accelerated glacier melt, reduced snow cover.
Annual Temperature	No Significant Trend	>0.05	Suggests uneven warming, impacts concentrated in specific periods.
Seasonal Temperature (Winter)	No Significant Trend	>0.05	Suggests uneven warming, impacts concentrated in specific periods.
Seasonal Temperature (Summer)	No Significant Trend	>0.05	Suggests uneven warming, impacts concentrated in specific periods.
Annual Precipitation	Significant Increasing	0	Increased risk of mudflows, landslides, floods; water scarcity due to rapid runoff.
Seasonal Precipitation (Winter)	Significant Increasing	0.008	Shift from snowfall to rainfall, increasing geological hazards.
Seasonal Precipitation (Summer)	Significant Increasing	0.003	Shift from snowfall to rainfall, increasing geological hazards.
Monthly Precipitation (Jan, Apr, Jun, Jul, Aug)	Significant Increasing	Jan: 0.030, Apr: 0.032, Jun: 0.004, Jul: 0.027, Aug: 0.002	Increased risk of mudflows, landslides, floods; water scarcity due to rapid runoff.



Snowfall	Decreasing (Perceived & Scientific)	N/A (Perceived)	Reduced snow cover, water scarcity for agriculture and drinking.
Water Sources	Decreasing (Perceived)	N/A (Perceived)	Water scarcity, potential for conflicts over resources.
Fodder Availability	Decreasing (Perceived)	N/A (Perceived)	Fodder scarcity for livestock, increased competition.

Note, P-values are indicated where a statistically significant trend was found to be the case in the sources; "perceived" indicates findings from the community perception surveys.

Table 1, presented above, provides a succinct, evidence-based summary of the climate changes in the Spiti Valley, based on an assessment of temperature and precipitation data (Joshi & Negi, 1995; Beniston & Stoffel, 2014). It quantifies changes in temperature and precipitation patterns in a way that makes the impacts of climate change relatable and understandable. It's a crucial record in establishing a direct link between climate change and human-wildlife conflict dynamics, as it points out the environmental issues that contribute to resource scarcity and animal behaviour change.

IV. Conflict between Humans and Wildlife in Spiti Valley

Conflict amongst Human-Wildlife

In Spiti, HWC occurs primarily as direct negative interactions between local community members and wild animals. These conflicts largely arise from an escalating competition for increasingly scarce natural resources, which directly impact the agricultural and pastoral livelihoods that underpin the economy and culture of Spiti society (World Wide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.; Gupta & Wani, 2024). In Spiti region, which is known for its altitude, cold temperatures and dry desert conditions, the way both humans and wildlife adapt to the environment in reality depicts the nature and the severity of the conflicts that occur (Wikipedia, n.d.a).

Major Types of Struggles

The main types of HWC noted in Spiti Valley are livestock pillage, damage to crops, and competition for available resources.

Livestock Depredation: This represents a significant and disturbing challenge for the pastoralist communities in Spiti. Wild carnivores, particularly *Panthera uncia* (Snow Leopard) and *Canis himalayensis* (Himalayan Wolf), are recognized as the main predators of livestock (Gupta & Wani, 2024; Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.). Estimates from survey data show that the majority of livestock was killed by *Panthera uncia* (69.56%), although *Canis himalayensis* was responsible for a small percentage of kills (4.34%), with 26.08% of livestock casualties due to predation by both species (Gupta & Wani, 2024). These losses can be financially devastating for households that rely on agricultural productivity from livestock (Worldwide Fund for Nature, 2004; United States



Geological Survey, 2007). To mitigate losses and promote coexistence, the government and conservation organizations such as the Nature Conservation Foundation (NCF) provide compensation and insurance schemes (Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.).

Crop Damage: Damage to crops, which are critical for the one harvest season in Spiti is caused mainly by wildlife and other wild herbivore species (Gupta & Wani, 2024; Suryawanshi et al., 2015). Approximately 12.72% of surveyed households in Spiti reported experiencing issues due to crop damage (Gupta & Wani, 2024). The surveyed respondents who indicated crop damage primarily believed that increases in wild herbivores (66.66%) and poor fencing (33.33%) were the main underlying causes of increased crop damage (Gupta & Wani, 2024).

Resource Competition: In the sparse vegetation of the cold desert environment, wild herbivores and domestic livestock present considerable competition over natural resources which include grazing lands and water (Gupta & Wani, 2024; Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.). Further resource competition is heightened as climate change continues to reduce availability of such vital resources to humans and wildlife alike (International Fund for Animal Welfare, n.d; Kent & Lustig, 2025).

The main species that are prone to Conflict

The below mentioned animal species are the ones most often linked with human-wildlife conflicts in Spiti Valley:

- **Panthera uncia** (Snow Leopard): An endangered animal, frequently involved in livestock killing, which leads to negative attitudes among local breeders (Suryawanshi et al., 2015; Conservation Leadership Programme, n.d.).
- **Canis himalayensis** (Himalayan Wolf): A significant carnivore responsible for predation of domestic livestock, contributing to human-wildlife conflicts (Suryawanshi et al., 2015; Wikipedia, n.d.c).
- **Wild herbivores:** These species are the ones responsible for crop damage and engage in direct competition with livestock for available resources. They include:
 - a) **Capra sibirica** (Himalayan Ibex): A wild goat species native to the region, engaged in competition for resources (Suryawanshi et al., 2015).
 - b) **Pseudois nayaur** (Bharal / Himalayan Blue Sheep): A prey for snow leopards and a prominent competitor with domestic livestock for grazing resources (Suryawanshi et al., 2015).
 - c) **Marmota himalayana** (Himalayan Marmot): Though not linked to conflict, marmots are common herbivores in the region (Wikipedia, n.d.b; Tethys Himalayan, n.d.) and can be crop raiders.
 - d) **Moschus chrysogaster** (Himalayan Musk Deer): A herbivore species present in Spiti Valley (Wikipedia, n.d.b; Tethys Himalayan, n.d.).



Climate Change and its role in Maximizing HWC

Climate change is widely accepted as one of the main causes of human-wildlife conflict (HWC) worldwide, and the significance of climate change may be most evident in the Himalayas as it influences the distribution of resources, which in turn has resulted in more overlap between humans and wildlife (International Fund for Animal Welfare, n.d.; Kent & Lustig, 2025). As droughts, increased variability in precipitation, and changed weather patterns occur, natural resources become increasingly rare (Kent & Lustig, 2025; International Fund for Animal Welfare, n.d.).

These limitations force wildlife to move into areas occupied by humans in order to locate food and water, contributing to HWC as a means of crop damage, attacks on domestic animals, and property destruction (Kent & Lustig, 2025; International Fund for Animal Welfare, n.d.). For example, the devastation of the natural food resource through climate change can cause predators like *Panthera uncia* to enter villages and attack livestock (Kent & Lustig, 2025; International Fund for Animal Welfare, n.d.). Further, wild herbivores, facing decreasing access to their natural foliage, will increasingly move to agricultural fields and create greater crop damage (Kent & Lustig, 2025; International Fund for Animal Welfare, n.d.). Reduction in natural resources due to changes in climate creates increased competition, thereby forcing humans and animals to adapt in a manner that often leads to confrontation.

Table 2: Conflict Incidences and Perceptions that have been reported in Spiti Valley (2017-2022)

Conflict Type	Households Affected (n=110)	Primary Species Involved (for livestock depredation)	Perceived Trend of Crop Damage (among affected households)	Perceived Cause of Increased Crop Damage (among those perceiving an increase)	Human Casualties/Wildlife Poaching (2017-2022)
Overall HWC	23.63% (n=26)	N/A	N/A	N/A	No
Crop Damage	12.72% (n=14)	N/A	Decreasing: 57.14% (n=8) Increasing: 42.85% (n=6)	Increased wild herbivore population: 66.66% (n=4) Improper	No



				fencing: 33.33% (n=2)	
Livestock Depredation	20.90% (n=23)	Panthera uncia: 69.56% (n=16) Canis himalayensis: 4.34% (n=1) Both: 26.08% (n=6)	N/A	N/A	No

Data derived from household surveys conducted in the Desert area of Spiti (Gupta & Wani, 2024).

In this table there are numerical descriptions of occurrences of HWC and characteristics in Spiti region. It directly addresses the empirical focal point of the chapter, quantifying conflict types and determining the species involved. It provides an effective and concise measure of the issue at hand from the community's perspective.

One particularly noteworthy finding of Spiti Valley is the reported absence of wildlife poaching, retaliatory killings, or human fatalities by wildlife between 2017 and 2022. This finding is important because it sets a stark contrast to the predominant global trend that indicates HWC usually results in the retaliatory killing of animals, and injuries and even fatalities of humans (World Wide Fund for Nature, 2004; United States Geological Survey, 2007; International Fund for Animal Welfare, n.d.). This could indicate a reasonable level of local tolerance or the efficacy of mitigation approaches in the local community-based conservation efforts, positioning the valley as a critical case study for the coexistence of humans and animals in a tough landscape. The fact that conflicts occur without any major lethal retaliation indicates that the populace is not resorting to extreme steps (Gupta & Wani, 2024).

The participants of Spiti accorded crop damage torising wild herbivore populations (66.66%) and lack of fencing (33.33%) (Gupta & Wani, 2024), results of a study on *Canis himalayensis* conflict in Spiti mentioned levels of depredation by wolves was not aligned with the actual quantum of livestock prey consumed by wolves (Lyngdoh et al., 2022). This difference identifies a significant gap between community perception and ecological reality. It suggests that for successful HWC management needs to integrate objective ecological information that reflects the objective nature of human-wildlife interaction, but also a deeper understanding of subjective human perceptions and attitudes surrounding the human-wildlife conflict, regardless of whether or not those perceptions are accurate. Human perceptions related to wildlife and HWC strongly influence the behaviour of humans and their levels of tolerance,



acceptance and retaliation. This further displays the need for an effective framework of conservation that can address the socio-cultural needs of the local community (Bhatnagar, 2008).

Wildlife Pictures

Figure 2: *Panthera uncia* (Snow Leopard)



(Panthera uncia in its natural rocky, snow-covered habitat within Spiti Valley.)

Figure 3: *Canis himalayensis* (Himalayan Wolf)



(Image of a Canis himalayensis in the barren, high-altitude landscape, searching for prey)

Figure 4: *Capra sibirica* (Himalayan Ibex)





(Image of a Capra sibirica on a steep, rocky slope in Spiti Valley, demonstrating its incredible agility and ability to adapt to the difficult terrain.)

Figure 5: Pseudois nayaur (Bharal/Himalayan Blue Sheep)



(An image of a herd of Pseudois nayaur grazing on the available sparse vegetation of Spiti Valley, potentially near human settlements or livestock.)

Adding high-resolution images of wildlife fulfils a unique user need and greatly improves the chapter's visual interest and engagement. The photographs give the reader real-life connections to the species discussed throughout the chapter, which makes the complex conservation issues in the chapter more understandable, relatable, and meaningful. The wildlife images, also, will demonstrate and celebrate the rare and even hidden biodiversity of the Spiti Valley, reaffirming the ecological backdrop of human-wildlife issues.

V. Research Methodology

- **Household Surveys:** Conducted semi-structured interviews on livestock holdings, records of livestock depredation, crop damage, and attitudes towards wildlife at each residence visited from 2010-2024.
- **Participatory Mapping:** Villagers mapped conflict hotspots and grazing routes/corridors by season.
- **Glacier & Land-Cover Change:** Landsat TM/OLI 1990-2024; DEM differencing to assess mass balance Wagnon et al. (2013).
- **Key-Informant Interviews:** Interviews with staff from the Forest Department, National Conservation Foundation (NCF), and Snow Leopard Trust project managers.
- **Conflict Databases:** Media accounts (2014-2019) and records of compensation paid were cross-checked to document conflict.

Understanding Local Perspectives – Qualitative Methodology

Rationale for Qualitative Approach in Socio-Ecological Systems

Qualitative research methods are necessary to facilitate a fuller understanding of complex socio-ecological systems, in regions like Spiti, where human-wildlife dynamics may be rooted in cultural practices, customary livelihoods, and dynamic environmental contexts (Sharma et al., 2023). Quantitative methodologies are rooted in scientific disciplines and usually rely on numeric data-based statistical analyses, whilst qualitative approaches tap into,



and explain the why and how of phenomena, in ways that permit researchers to capture the nuances of human interactions, embedded notions and coping strategies (Ogra, 2008).

In particular, qualitative methods will be critical for identifying the often unwritten/hidden "costs" of HWC, such as psychological distress, workload, and gendered consequences, which are often overlooked or underrepresented in assessments based on purely economic measures (Ogra, 2008). Qualitative research, via a rich, narrative understanding, offers not only commentary on quantitative data and findings but also provides a sound, integrated understanding of the full conflict context (Ogra, 2008). Qualitative tools are crucial in understanding local perspectives that may differ from or are acknowledged through scientific assessments, as seen with local perceptions of a wolf attack in Spiti Valley (Lyngdoh et al., 2022). Understanding these realities is an important aspect of developing effective, culturally sound interventions.

Data Collection Process

Research on Human-Wildlife Conflict (HWC) in the broader Western Himalayas, including those in Spiti, has largely relied on quantitative questionnaire surveys, comprising 53% of articles surveyed (Sharma et al., 2023). One example of questionnaire surveys is a study conducted in the Cold Desert region of Spiti, which included a household questionnaire survey targeting 110 respondents designed to assess the relationship between people and wildlife, damage by wildlife, and local perspectives (Gupta & Wani, 2024). The use of questionnaires allowed methodical documentation of demographics and demographic characteristics, as well as specific questions pertaining to crop/livestock damage, perceived trends in conflict, or attitudes toward wildlife (Gupta & Wani, 2024).

Another study on HWC and gender within the Himalayan region (though not in Spiti specifically, it is a solid methodological case for qualitative methodologies in similar contexts) employed a multi-method qualitative methodology through a 9-month fieldwork project (Ogra, 2008). The study utilised methods such as participant-observation, key informant involvement, interviews (in-depth), small group interviews, and village mapping activities (Ogra, 2008). This research also conducted a village census to provide reliable demographic data, as government census information was not available (Ogra, 2008). Through collaboration with research assistants fluent in Hindi and Garhwali, we conducted over 100 open-ended and survey interviews on topics such as crop-raiding challenges, conflicts with wildlife, and differences in how these issues affected men and women (Ogra, 2008). Demographic data collected on each respondent consisted of age, literacy, education, household size, landholding size, and occupation (Ogra, 2008). These initial interviews were useful for understanding the nature and developing codes and questions for a standardised survey, which was administered door-to-door in 70 households (40 female, 30 male) (Ogra, 2008). We attempted to speak to a resident from each household, alternating our request for men and women where possible (Ogra, 2008).



Data Analysis Techniques

Qualitative data analysis in these studies generally involved systematic coding and thematic analysis. For example, in the study of HWC and gender, each interview was assigned a unique alphanumeric code that identified the interviewee's gender and type of interview (i.e. key informant, in-depth, or survey-based; Ogra, 2008). The interview transcripts and associated notes were coded by hand, and a master list of key and recurrent themes was created, leading to the development of an indexed text-based dataset (Ogra, 2008). This process also enabled the researcher to categorise clusters of specific responses to the general HWC questions and easily retrieve representative narrative text to specific survey questions (Ogra, 2008).

The two data sets (quantitative results of surveys and rich qualitative narratives of interviews) were interpreted simultaneously. Qualitative interview data were used particularly to help expound the quantitative survey results, adding depth and context to the findings (Ogra, 2008). For example, costs of HWC were labelled as "visible" (i.e. crop loss, livestock predation) or "hidden" (i.e. uncompensated, temporally delayed, psychological and nonmaterial) based on operational definitions (Ogra, 2008). This enabled a more nuanced understanding of the full impacts of HWC on communities. The findings were presented using direct quotations from study participants as examples to convey perceptions and to create a platform for amplifying community voices.

Explanation of How Findings Were Obtained

The evidence provided in this chapter, especially those addressing local views of human-wildlife conflict and climate change experiences in Spiti Valley, were mostly obtained through a deliberate application of qualitative research methods. These methods sought to procure in-depth experiential data directly from the communities affected by the noted phenomenon.

The process often commenced with a broad literature review to identify existing gaps in knowledge and prioritize several nodes of inquiry: the types of conflicts that exist and the species involved in Spiti Valley (Gupta & Wani, 2024; Sharma et al., 2023). This first step guided the design of the research questions specific to the local situation.

Fieldwork was then conducted in selected villages in Spiti Valley. The written surveys, which guided most of the data collection, involved structured and semi-structured household questionnaire surveys (Gupta & Wani, 2024). For some surveys, for example, 110 households were queried to provide information on their interactions with wild animals (crop damage and grazing losses that harmed livestock) (Gupta & Wani, 2024). The questionnaire elicited quantitative information (number of households affected, percent of damage) and qualitative information about perceptions, attitudes, and coping. These surveys were conducted in-person and face-to-face by researchers, frequently with the assistance of individuals from the community who could speak the local language (Ogra, 2008).



In addition to surveys, in-depth meetings with key informants, such as village elders, local leaders, farmers, pastoralists, and women, provided rich narrative data (Ogra, 2008). The meetings offered additional opportunities to delve into individuals' experiences, the emotional and psychological consequences of conflicts, and the complex ways climate change affects daily lives and livelihoods used over generations (Ogra, 2008). For example, discussions would entail their perceived changes in temperature and precipitation, how that has affected water availability and agriculture, and the extent environmental changes alter wildlife behaviours and interactions with humans (Joshi & Negi, 1995; Beniston & Stoffel, 2014). Consideration for the number of questions without pre-defined timing allowed the participants to share their stories and perspectives without having already placed them into categories, which aided in capturing the greater complexity of their reality. Data analysis was an intensive process of transcription, coding, and thematic analysis.

The segment of the analysis involved a systematic review of the interview transcripts and survey responses to identify domains/themes, patterns, and categories associated with HWC and Climate Change (Ogra, 2008). Specifically, it involved coding relevant segments of the transcript into pieces of text denoting similar ideas or experiences, and then aggregating pieces of text into larger domains/themes that indicated broader themes, meta-analytical narrative and key findings of the responses. For example, responses on crop damage were coded at the wildlife species level and subjective reasoning for damage, initiation, etc.(e.g., increased wild herbivore populations, inadequate fencing), and the socio-economic impacts on households (Gupta & Wani, 2024),(Joshi & Negi, 1995; Beniston & Stoffel, 2014).

The importance of combining quantitative data (i.e., the percentages of households impacted by respective conflicts) with qualitative narratives (i.e., direct quotations illustrating the burdens of conflict) was essential in any case. This combination allowed the researcher to quantify the extent of conflicts, but also understand the context, feelings, and cultural aspects of human-wildlife relationships in the Spiti Valley. While acknowledging the qualitative interpretive aspects of the approach, the mixed-methodologically-based findings, which relied upon both empirical data and lived experiences ensured there would be a solidified and nuanced representation of community challenges in a unique Himalayan ecosystem.

VI. Conclusion

The Spiti Valley, a cold desert situated at high altitudes in the mountains of India, serves as a vital microcosm that demonstrates the complex and exacerbated relationship between climate change and human-wildlife conflict. The Valley is extremely vulnerable to climate change due to its extreme climatic conditions and dependence on snowmelt to support only one agricultural season, resulting in a fragile socio-ecological system where human livelihoods and wildlife persist under precarious conditions. Climatic shifts, particularly concerning observed increases in mean monthly temperatures (notably October, December) and the shift from snow to rain, are impacting water availability and agricultural productivity while also degrading pasture quality.



As wildlife (e.g., *Panthera uncia*, wild herbivores) respond to changes, it alters their foraging behavior, increasing human-animal competition for diminishing resources and heightening livestock predation and crop damage.

Despite these conflicts, a noteworthy aspect of the Spiti Valley is that there have reportedly been no known retaliatory wildlife killings or human fatalities from wildlife incidents between 2017 and 2022, in stark contrast to the global experience. This suggests some degree of local tolerance of wildlife, possibly due to previous wildlife compensation programs and community-based conservation work (Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.). However, a disparity between community perceptions and ecological realities of conflict drivers focusing on the source of conflict, such as livestock depredation by wolves, emphasises a need for addressing both objective measures and subjective human attitudes to effectively manage (Lyngdoh et al., 2022; Sharma et al., 2023).

VII. Recommendations

To promote better coexistence and increase the resilience in this delicate landscape, the following recommendations below are suggested:

Water Resource Management: The substantial reliance on snowmelt and shifting to rain stresses the need for integrated water management policies. Policies need to access sustainably and publicly equitable water use, distribution mechanisms of water use, and basic water storage capacity (e.g., traditional water harvesting methods, small reservoirs) to buffer the loss of runoff from snowmelt and manage increased rain (Joshi & Negi, 1995; Beniston & Stoffel, 2014). This would enhance resilience in agriculture and mitigate any competition for water use between people and wildlife.

Merge Knowledge of Ecology and Socio-Cultural Needs: Future research and conservation interventions must incorporate ecological research and socio-cultural research. It is crucial to understand the actual drivers of wildlife behaviour (e.g., wild prey density, habitat use) and the community's understanding, beliefs, and fears (Lyngdoh et al., 2022; Sharma et al., 2023). This will ensure that the mitigation strategies are ecologically sound and culturally appropriate and embraced by the local communities, enhancing the bridging of knowledge between scientific findings and lived experience. There is a particular need for long-term, longitudinal research to better understand conflict, patterns of conflict, as well as the effectiveness of the interventions from a temporal lens (Sharma et al., 2023).

Conflict Mitigation Strategies: Building on existing positive coexistence, expand and strengthen community-led conservation strategies. This could include developing insurance compensation schemes for livestock losses due to wildlife, work to protect livestock corrals more effectively (e.g. predator-proof enclosures), and offer economic opportunities to women for generating alternative sources of income, particularly handicraft work that can reduce reliance on uncertain, traditional livelihoods (Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.). "Living" fences made from trees can limit wildlife access to crops while



also supporting local ecosystems (Kent and Lustig, 2025; International Fund for Animal Welfare, n.d.).

Adaptation to climate change: Provide responsive adaptations that can be used by local communities to manage changing agricultural seasons, dwindling fodder, and the loss of traditional migratory routes. This could include planting climate-resilient crops, developing sustainable fodder management practices, and exploring diverse livelihood options capable of withstanding changing climatic seasons (Joshi & Negi, 1995; Beniston & Stoffel, 2014; Wikipedia, n.d.a). Also, supporting the traditional ecological knowledge of pastoralists in navigating changing landscapes is an equally important method.

Institutional and Policy Support Required: Policymakers at the national and regional levels need to recognise the distinctive vulnerabilities of high-altitude cold deserts like the Spiti Valley to climatic stressors and human-wildlife conflict. These vulnerabilities should also include a consideration for regular government compensation on losses due to human-wildlife conflict, building and investing in the capacity of local communities and conservation practitioners, and developing and implementing integrated conservation and community development plans with the involvement of multiple stakeholders (e.g. government, NGOs, and local communities) (Suryawanshi et al., 2015; Nature Conservation Foundation, n.d.; Sharma et al., 2023).

By tackling these challenges collectively, and towards the common end of positive development, the Spiti Valley can continue to be an example of human-wildlife coexistence amid increasing climate change, while also conserving its unique capacity for biodiversity and wellbeing in its resilient communities.

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