Red panda conservation and climate change in Dhorpatan Hunting Reserve: Integrating community knowledge and land use change

Jhalak Paudel[1], Bijaya Dallakoti[1], Birendra Prasad Kandel[2], & Ramesh Prasad Sapkota[1,*]

[1]*Central Department of Environmental Science, Institute of Science and Technology, TU*
[2]*Dhorpatan Hunting Reserve, Department of National Parks and Wildlife Conservation, Nepal*
[*]*Corresponding Author: rsapkota@cdes.edu.np*
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Abstract

This study explores the perceptions of local people on climate change and red panda conservation in Dhorpatan Hunting Reserve (DHR), Nepal, emphasizing the integration of conservation knowledge and land-use changes. Using GIS-based land-use change analysis, climate data assessment, and socio-ecological survey, the study evaluates habitat alterations from 2017 to 2023 and their implications for red panda population. Similarly, peoples' perceptions on red panda conservation were assessed through interviews and focus group discussion in six villages within DHR. Habitat loss, decline in Nigalo (Himalayan bamboo) coverage, and increase in Nigalo flowering incidences were identified as major threats to red panda in the region. Anthropogenic disturbances, including livestock grazing, resource extraction and other human activities, further exacerbate these challenges. Findings indicate significant land-cover changes, such as reduced rangeland and snow-ice areas and increased tree cover and bare ground. Climate analysis reveals fluctuating rainfall trends across meteorological stations, with localized impacts on vegetation and habitat suitability. Results show limited awareness of conservation practices but a strong cultural connection with the species depicting the need of the community-based conservation approaches. The study underscores the importance of integrating local knowledge into conservation strategies to address threats like habitat fragmentation, climate change, and anthropogenic stressors.

Keywords: climate change, community perception, community-based conservation, habitat, red panda

Introduction

Protected areas and their buffer zones play a critical role in species conservation in the Himalayan region (Bhusal, 2014). However, only 18% of species' habitats fall within protected areas, leaving a significant portion outside these zones (DNPWC, 2022). Human activities, including resource extraction by indigenous communities residing within protected areas, further exacerbate the vulnerability of these ecosystems. Furthermore, anthropogenic stressors within protected areas further exacerbate the vulnerability of these ecosystems. The anthropogenic activities, combined with global environmental changes such as climate change, pose significant threats to biodiversity (Dawson et al., 2021; Pereira et al., 2024; Tiwari et al., 2020). Moreover, allowing certain human activities within protected areas, coupled with low conservation awareness among some of the local communities residing near outskirts create additional challenges for conservation efforts. This highlights the need for an integrated approach that balances biodiversity conservation with human livelihoods while also enhancing awareness and engagement among local communities.

Red panda *(Ailurus fulgens)*, the most elusive and unique species, is recognized for its distinct appearance and ecological significance (Yonzon, 1989). Distributed across five countries in the Himalayan region, this species is facing significant threats due to the global environmental changes, habitat competition with domesticated animals, conflicts with other wildlife, and poaching pressures. Despite their wide geographic range over the Himalayas, they are distributed unevenly and found at low density (Shrestha et al., 2020). However, because of its habitat loss and fragmentation, red panda falls under endangered category of IUCN, red list. Threats like illegal trade and demand for pet animals are now more serious threats in Nepal than in other distribution countries (Badola et al., 2020).

Global climate change further endangers red panda and their habitats (Basumatary et al., 2021). In parallel, some of the listed endangered faunal species are at a high level of threaten due to the change in climatic conditions that have impacted the vegetation of their habitats (Bista et al., 2017, Pradhan et al., 2001). Although the red panda being listed as one of the 27 protected species, its population is steadily declining due to multiple threats. These include forest fires, rotational grazing, slash-and-burn cultivation, timber and firewood collection, predation by dogs, natural die-off of Nigalo (Himalayan bamboo) species, inbreeding depression, drought, landslides, agricultural expansion, lack of awareness, and development activities (Bista et al., 2017; DNPWC & DFSC, 2018; Wei et al., 1999). In the key conservation areas such as the Kanchenjunga Conservation Area, Dhorpatan Hunting Reserve, Sagarmatha region, and Central Himalayas, major threats include livestock grazing, habitat destruction, and fragmentation, heavy reliance on forests for firewood and construction materials, and harmful local practices, such as chasing and killing panda (Acharya et al., 2018; Mahato et al., 2011; Subedi & Thapa, 2011).

Red panda presence has been recorded in 24 districts and 7 protected areas with potential habitat of approximately 23,977 km^2 (DNPWC & DFSC, 2018; Panthi et al., 2019; Thapa et al., 2018) across Nepal's mid-hill regions. Some studies also indicate the presence of red panda outside protected areas and their buffer zones (Thapa et al., 2018). Despite its wide distribution, most conservation efforts are predominantly concentrated in eastern Nepal, particularly in Pachthar-Ilam-Taplejung (PIT) Corridor. Additionally, limited conservation initiatives have been carried out in the Gaurishankar Conservation Area (GCA) and Langtang National Park (LNP). In contrast, in western Nepal, where studies have identified potential red panda habitats and occurrences, there is a notable lack of conservation programs, particularly community-based initiatives. Most of the studies on red panda are focused mainly on proxy sources like fecal droppings and pugmarks (Pradhan et al., 2001; Shrestha et al., 2021; Yonzon & Hunter, 1991) as well as interviews with local stakeholders. This study aims to address this gap by exploring local conservation knowledge, understanding how communities perceive this elusive species, and assessing their awareness of habitat changes in areas with potential red panda presence. Focusing on these dimensions, the research aims to contribute to the development of targeted conservation strategies that engage local communities and promote the long-term survival of red panda in the western Nepal. This study has identified local conservation knowledge on red panda and its importance on cultural and sustaining ecosystem to ensure the species long term survival.

Materials and methods

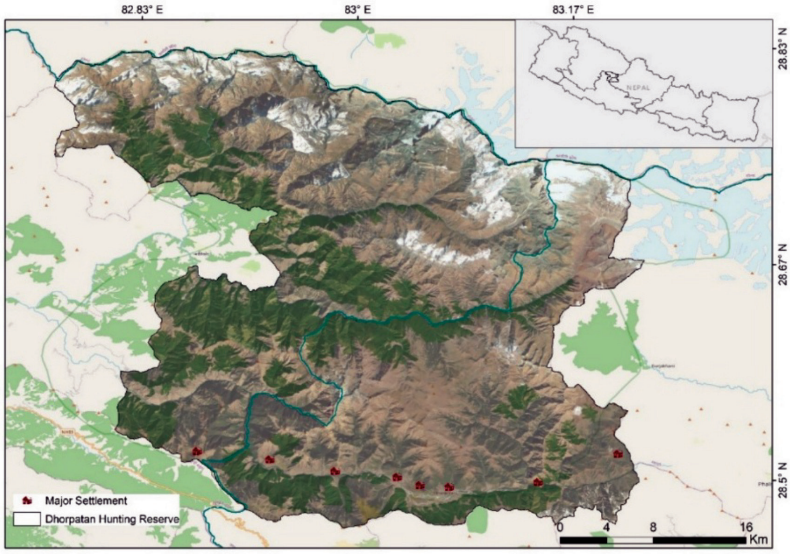
Study area

Dhorpatan Hunting Reserve (DHR) is located at 82°50' to 83°15' East longitude and 28°30' to 28°50' North latitude, along the Central Himalaya (Figure 1). The elevation of the reserve ranges from 2000 m (Taksera) to 7246 m (Putha Himal) above sea level encompassing diverse topography including valley, rangeland ridges and steep slopes (Aryal et al. 2010; DHR, 2019; Kandel, 2000). DHR is the only hunting reserve in Nepal that permit sport hunting of Blue sheep (Pseudois nayaur) and Himalayan thar (Hemitragus jemlahicus) with an area of 1325 km^2 and 539.04 km^2 area as proposed buffer zone. This reserve encompasses diverse topography and microclimates, supporting various endangered and protected faunal species. However, human access to the reserve for grazing and resource extraction presents ongoing conservation challenges (Rai, 2024). The reserve is significant for its biocultural diversity. It harbors large numbers of rare, endangered, endemic medicinal plants and animals. The reserve covers three districts- Baglung, Myagdi and East Rukum of Gandaki and Lumbini Provinces of Nepal. The study focused on community, community practices and conservation on red panda within three different blocks of DHR, which is located in the western region of Nepal.

Besides from red panda, the reserve is home to a variety of protected wildlife species, making it a significant biodiversity hotspot. Large mammalian fauna present in the area include Himalayan tahr (Hemitragus jemlahicus), musk deer (Moschus sp.), and Himalayan black bear (Ursus thibetanus) (Kandel, 2008; Karki & Thapa, 2013). DHR also has access to human for the resource use like grazing and extraction of other resources (DHR, 2019). The livelihood highly depends on high-altitude forests and rangelands, which are also used for the traditional livestock herding and collection of value medicinal plants, firewood and building materials (DHR, 2019; Sharma & Belant, 2010).

Figure 1

Study area map showing major settlements inside the hunting reserve



Data analysis approach

The ecological and climatic factors influencing red panda conservation in the DHR, as well as the perspectives of the local population, were assessed using a combination of socio-ecological surveys, land use change detection, and climate data analysis. Historical rainfall data was obtained from the Department of Hydrology and Meteorology (DHM), Nepal, in order to investigate long-term climatic changes affecting red panda habitats. Rainfall data for the research came from eight local meteorological stations: Bobang, Gurja Khani, Dunai, Muna, Shera Gaun, Rukumkot, Baghara, and Libang Gaun. Thession polygon technique in ArcMap 10.8 were utilized to identified the spatial extent of rainfall station covering full extent of DHR. K-Nearest Neighbors (KNN) imputation method was applied in R using VIM package (Kowarik & Templ, 2016) for imputation of missing rainfall data. Information on precipitation patterns over DHR was obtained by spatial interpolation, which was used to build a rainfall map. A basis for comprehending possible climate-related habitat changes impacting red panda populations was established by this precipitation study. To assess land use and habitat change over time, satellite imagery from Sentinel-2 L2A (2017 & 2023) was downloaded via the ESRI platform (ESRI, 2025). A change detection approach was used to examine changes in land cover, forest degradation, and other landscape alterations potentially affecting red panda habitats in DHR. This GIS-based approach helped quantify recent habitat variations, indicating possible threats from human activities and environmental changes.

A semi-structured questionnaire survey was used to identify the local conservation knowledge on red panda, opinions on climate change, and human-wildlife interactions. The survey was carried out between October 2022 and April 2023 in six DHR villages: Gurjaghat, Masa, Niseldhor, Pakathar, Syalpakhe, and Sera Gaun. Herders, locals, and informants from the Hunting Reserve Office and ranger stations were among the 55 interviews chosen because of their accessibility and experience with red panda habitats. Data on subjects such perceived climate impacts, habitat changes, and red panda conservation awareness were gathered through in-person interviews using semi-structured questionnaires.

Focus group discussions (FGDs) were also held in Sera Gaun with local leaders for obtaining a wider community viewpoint on conservation concerns and cross-validate individual replies. Due to their seasonal migration from lower land to upland and other different circumstance only 55 people were surveyed. DHM rainfall trends were compared to local opinions of climate change's effects on red panda habitats. The land use change analysis was carried out using GIS-based spatial methodologies to quantify and determine habitat changes. Thematic analysis was used to discover critical trends in conservation knowledge, attitudes, and perceived risks to red panda based on questionnaire survey and focus group data. Ethical concerns were followed throughout the investigation. All participants provided prior informed consent, ensuring that their participation was voluntary. The study adhered to ethical principles for dealing with indigenous groups, respecting local knowledge and cultural sensitivity. The study's findings are likely to help community-based conservation efforts and inform future policy choices for red panda conservation within and outskirt of DHR.

Results and discussion

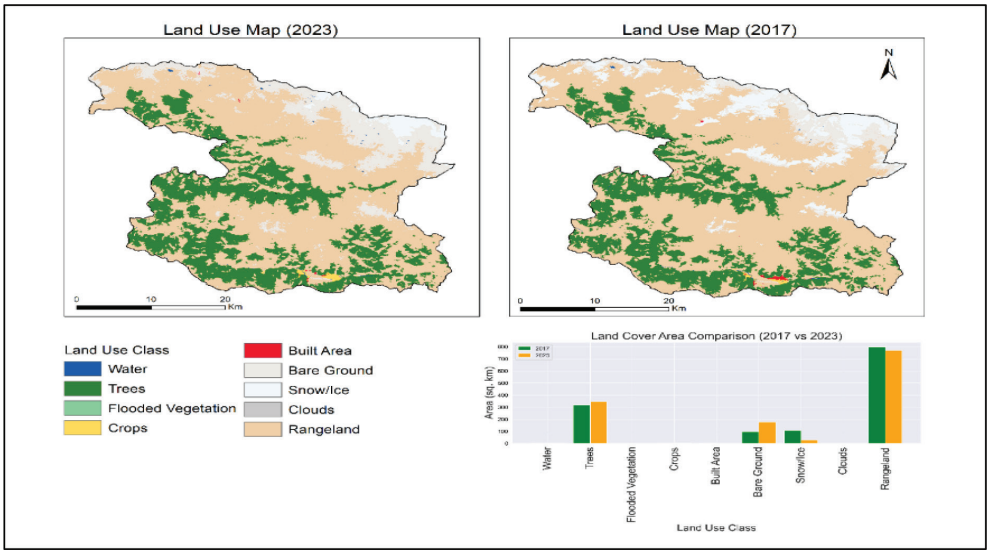
Land use change

Analysis of land use change and quantification of change in land use class are critical for understanding ecological dynamics, and anthropogenic processes in an landscape (Chettri et

al., 2013). Land use change analysis between 2017 and 2023 (Figure 2) of DHR shows a decrease in rangeland (797 to 770 km^2) and snow/ice (107 to 27 km^2), while bare ground (95 to 176 km^2) and tree (345-319 km^2) areas have expanded, particularly in the southern region with minor change in other land use class. The bar chart illustrates such changes, revealing an increase in tree cover and bare ground and decrease in rangeland and snow/ice cover. Similar type of result recorded by Sharma et al. 2019 in DHR with nearly 2% increase in forest area but contradict with the result of declining snow/ice cover as they calculated 0.42% increase in snow/ice cover. Similarly, correlating the major habitat of red panda, forest cover, which changes or altered in a spam of five years could significantly impact the habitat as it could possibly shift the niche and could create conflict between them or within other animals. Furthermore, in protected area for instance DHR, such change in land use and cover cause significant impact and make vulnerable to the species. Land cover change has been one of the major drivers of change leading to an alteration of critical habitats for many of the threatened species worldwide. Species with a narrow range and specialized habitats are at higher risk (Chettri et al., 2013). Similarly, heat map (Figure 3) describes the significant changes occurred in rangeland and snow/ice areas, with 37.56 km^2 of rangeland and 43.96 km^2 of snow/ice transitioning to bare land. Following bare ground conversion, Snow/ice notably converting to rangeland (31.91 km^2). Trees experienced some conversion (10.05 km^2 shifted to rangeland and 34.45 km^2 rangeland converted into tree.

Figure 2

Land use changes between 2017 and 2023 in DHR

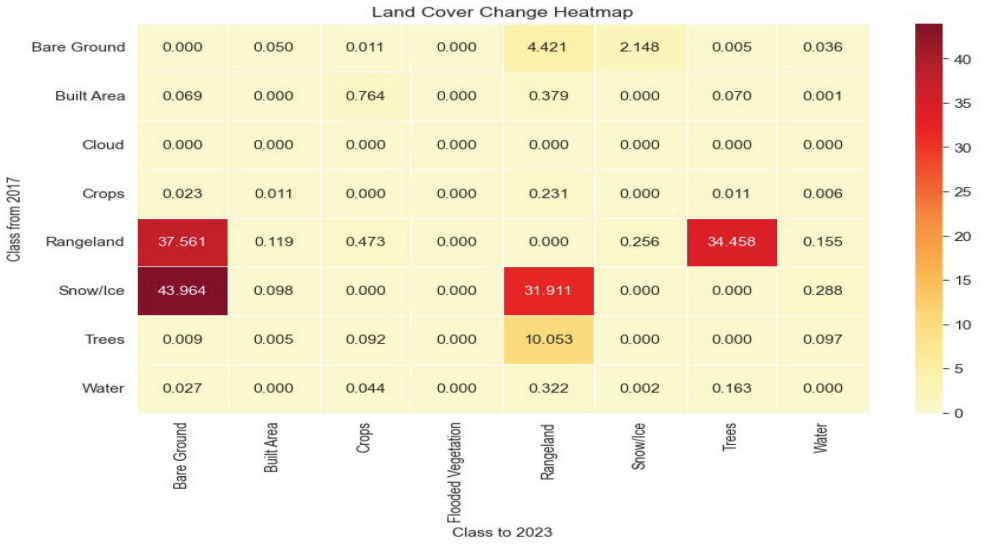


Note:

Sources - Sentinel Image-2 L2A (2017 & 2023).

Figure 3

Heatmap showing land use change in Dhorpatan from 2023 to 2017 in km2



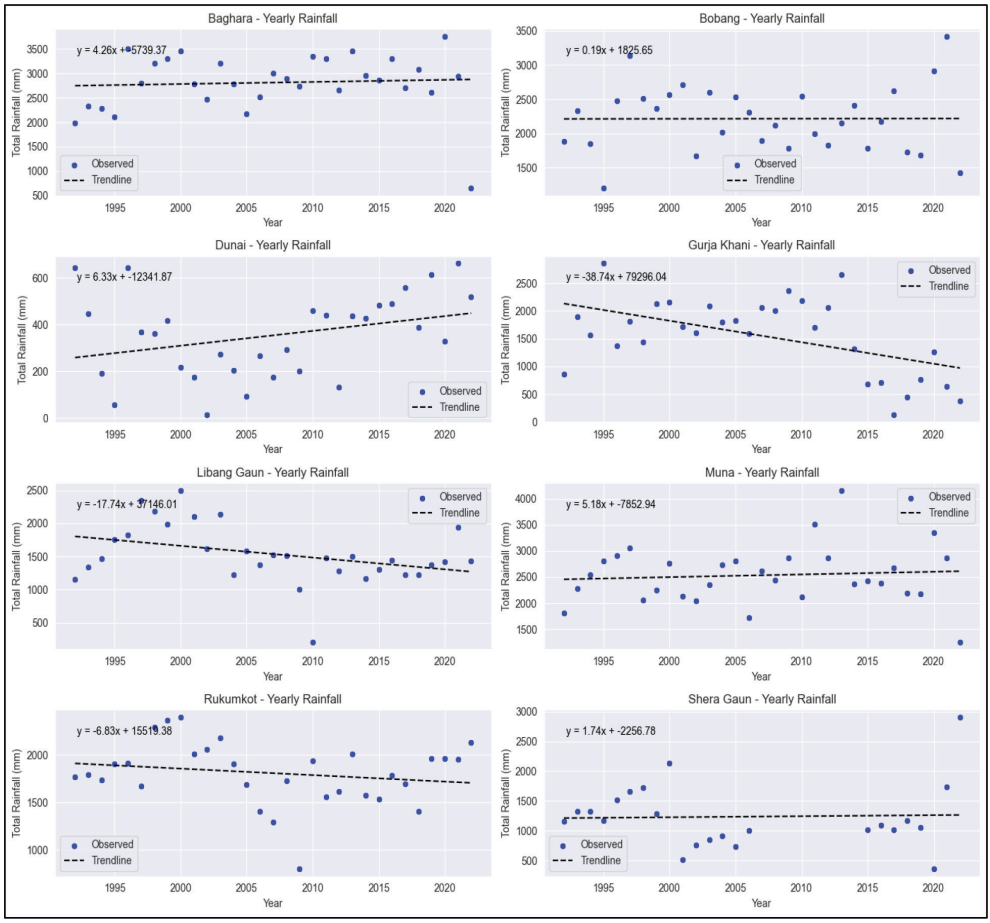
Changes in climatic variables

The climatic variable are major predictors that largely determine habitat suitability at a landscape level and are major components in the determination of vegetation composition and habitat (Thapa et al., 2018). The rainfall trends in Bhagara, Sheragaun, Dunai, and Muna showed an increasing pattern, reflected by their positive slopes. Bobang, however, showed only a negligible increase. In contrast, Gurja Khani, Libang Gaun, and Rukumkot exhibit decreasing trends, with Gurja Khani experiencing the sharpest decline (slope: -38.74). Among the increasing stations, Muna shows the strongest rise (slope: 5.18), while the remaining stations exhibit minimal fluctuations (Figure 4). Such fluctuation in the trend of rainfall might be due to rough elevation gradient and the location of the station towards windwards and leeward side. In the study by Karki et al. (2017) decreasing precipitation trends in mid-western and trans-Himalayan regions of Nepal was found, while this study shows fluctuating in each station with mixed type trends. A study by Talchabhadel et al. (2018) reported declining precipitation trends in Nepal's mid-western and trans-Himalayan regions, whereas this study reveals mixed trends across stations. The observed fluctuations of increasing spatial variability in rainfall, influenced by elevation differences and shifting monsoon patterns a finding supported by Bista et al. (2023).

Figure 5 shows an interpolated rainfall map of Nepal, indicating the highest average rainfall in the southeastern region of DHR. This pattern likely results from the monsoon's entry point, lower elevation, and the presence of valley areas such as Dhorpatan, along with high vegetation density and minimal barriers to moist air flow. In contrast, the northwestern region experiences lower rainfall, possibly due to its high elevation, mountainous terrain, and leeward positioning. Additionally, snowfall at higher altitudes-particularly in northern areas like Putha Mountain - may further contribute to reduced rainfall measurements.

Figure 4

Annual rainfall trend of nearest 8 stations of DHR

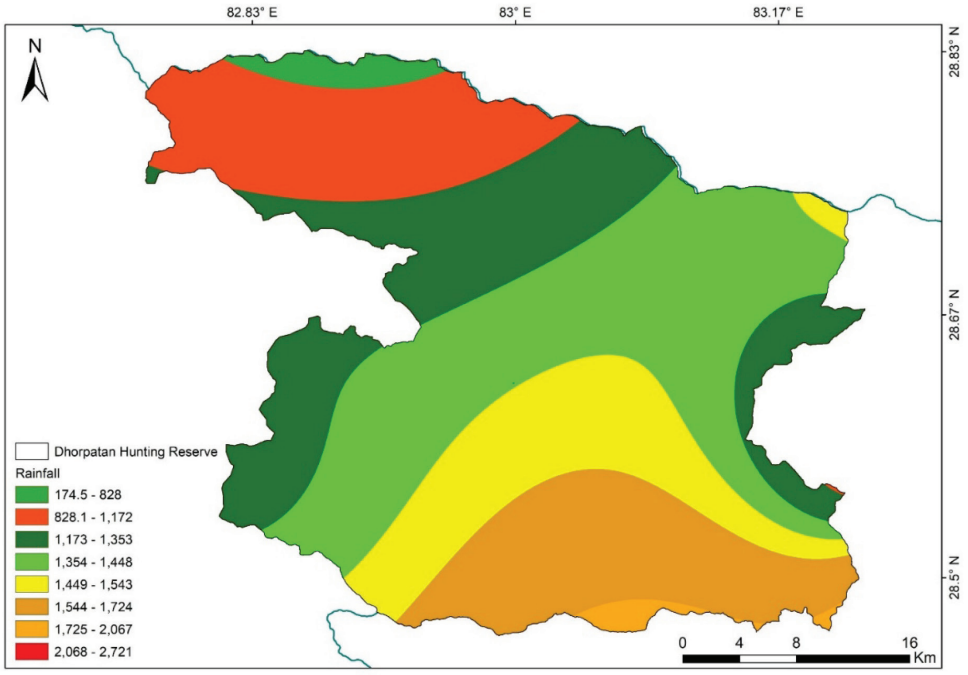


Note:

This figure shows the average annual rainfall trend from the eight nearest rainfall stations around DHR.

Figure 5

Interpolating rainfall over DHR



Note:

Interpolation map of DHR using the average annual rainfall data from the eight nearest stations.

People's conservation knowledge towards red panda and climate change

The level of awareness and conservation knowledge and its ecological significance was found to be low among the villagers. Summer huts made by herdsmen to keep their livestock were scattered in every block which showed that animal husbandry was the main livelihood option for the local people in and around DHR, such process causing a severe threat to wild animal habitats by consumption and destruction of its food. Red panda is a very shy animal due to which livestock might be creating disturbance in their mating activities. During field survey extensive evidence of livestock effects on vegetation included overgrazing and trampling of Nigalo stands was also observed. Due to their seasonal migration from lower land to upland and other different circumstance only 55 people were surveyed. 76% of respondent have heard about red panda but only 52.72% know about distribution and its habitat. Among them, most of the respondents frequently visited the forest (~24%) (Figure 6). 56% of respondents have not seen red panda (Figure 6) Among the people who have observed red panda, most of them observed red panda between 2 to 3 years ago (16%), followed by less than 1 year ago (14%) at DHR (Figure 7).

Figure 6

Visit rate of respondents to the forests

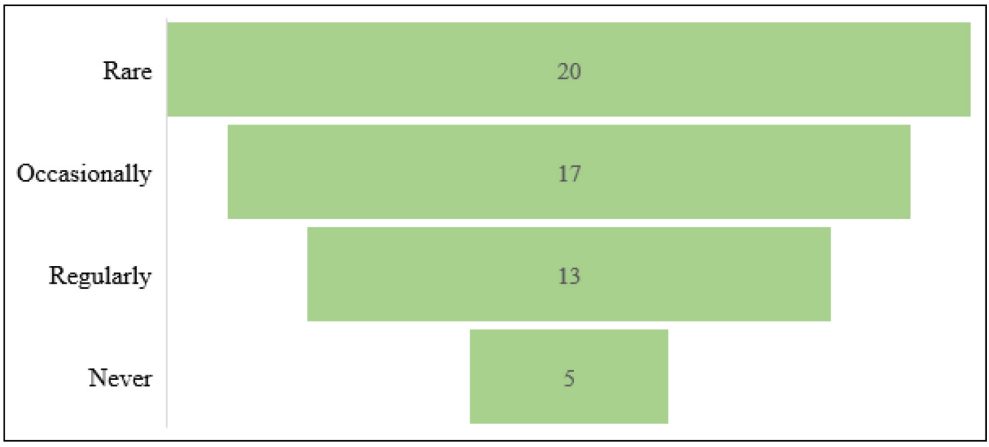
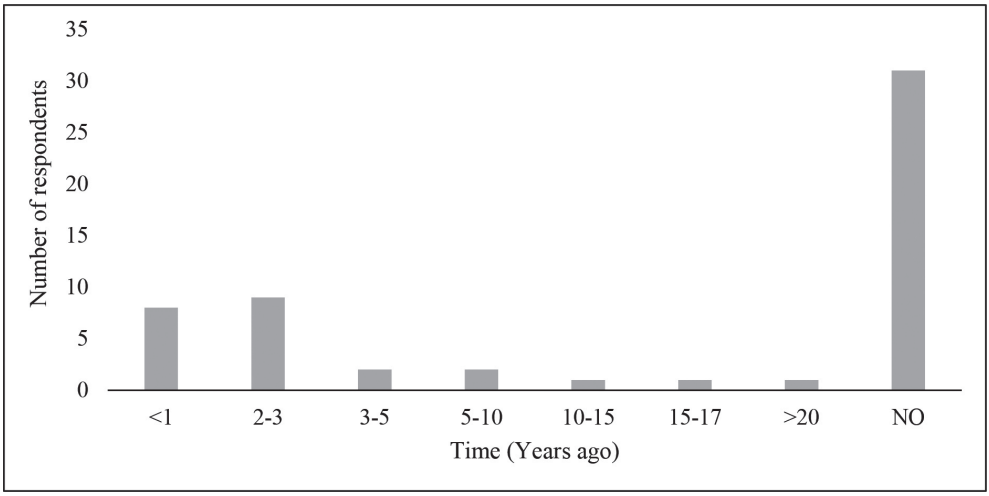


Figure 7

Respondents who have seen red panda in and around forests



Similarly, most of the respondent do not know about the status of the number, whether it is increasing or decreasing (56%), while 30% respondent responds reported they are increasing, and 3% respondent communicated that red panda numbers are stable (Figure 8). Additionally, 43% of respondent thought red panda is important for conservation. All the respondent responds as it is important who knows red panda. Different threats identified from survey are: hunting for meat, hunting for cultural values, conflict with domesticated dog, grazing domesticated animal, other wildlife and changing climate. 41% of respondent responded their habitat is decreasing while 29% respondents responded that they do not know about the status of its habitat. Most of the respondents' responded an increase in temperature (58%) and rainfall (40%) pattern while decrease in snowfall (47%) (Figure 9).

Figure 8

People perception about the number of red panda

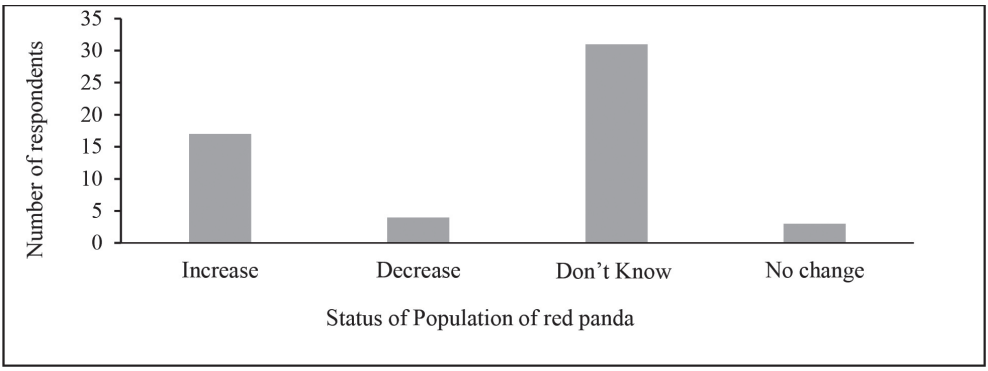
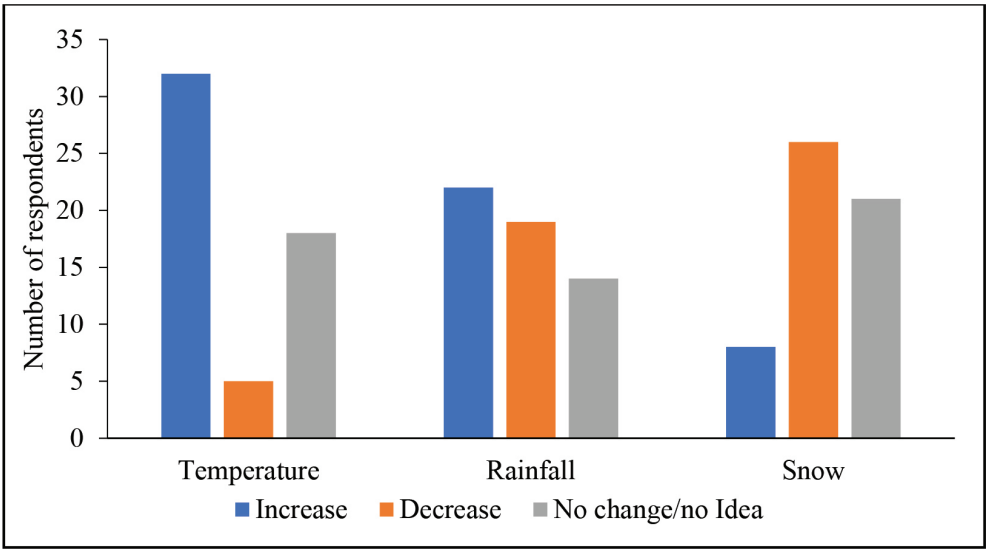


Figure 9

People perception on change in temperature, rainfall and snowfall



Results from the survey on climate and the habitat of red panda, along with the data on rainfall from DHM, reveals clear insight and understanding about the climate change on DHR. Changes in rainfall pattern suggest that, the changes in climatic pattern have likely to change in the structure of vegetation and distribution in the area (Joshi et al., 2019) and potential impact on red panda's habitat and overall ecosystem. As a response to the observed changes in rainfall pattern, red panda might potentially adapt by relocating to higher elevations where vegetation structure is changed. This movement could impact on their food availability as search and depends on new resources to adapt with the changing environment. Further the migration can also be correlate with the change in the forest area. Most of the respondent in this study feel annual rainfall is increasing whereas the number of snowing days, and annual snowfall are decreasing in red panda habitat. Climate is a key ecological factor determining species range distribution thus, the anticipated suitable habitat shift

(latitude and/or elevation) in response to climate change. Climate-related variables offers basic information about suitable habitat for the species and are key ecological factors determinant of species occurrence (Feng et al., 2022). Climatic variable has a significant influence over the growth rates of bamboo coverage (Reid et al., 1991), a dietary staple for red panda (Zhang et al., 2009; Pradhan et al., 2001). Hence, the changes in precipitation might affect adversely like changes in plant competition and growth patterns, plant-animal interactions, and productivity.

Furthermore, transhuman movement during red panda breeding season i.e., May and August poses threats to red panda (Jnawali et al., 2011) as red panda are highly sensitive during breeding. During survey, extensive evidence of livestock effects on vegetation included overgrazing and trampling of Nigalo stands was observed. Also, livestock shelter near the red panda prime habitat also indicates the threats due to livestock grazing pressure, human movement. As observed pelts of red panda in shamans back shows the culturally importance of red panda with its threats of extension. which is also mentioned by Glatston & Gebauer, (2022) as the Northern Magar tribe in Western Nepal, specifically their Ramma or Shamans, incorporate the skin and fur of red panda into their ceremonial attire. During risky rituals performed for healing purposes, the shamans carry the red panda's body on their backs. Similar people beliefs are held by the neighboring Bhuji Khola of Baglung District. During the survey with shamans, it is estimated that there are about 80 shamans in surrounding area of DHR including Baglung and Rukum East Districts. Most of them have the pelts of red panda. Which also poses threats to red panda. Habitat degradation, declining Nigalo coverage, increase incidences of Nigalo flowering, along with illegal hunting by the shepherds and killing by domesticated dog was found as major threats to red panda in DHR.

Furthermore, there is feeble community-based conservation programs and local conservation knowledge assessments in DHR, despite its huge potential as a red panda habitat. This gap requires for comprehensive studies in under-explored regions like DHR, focusing on how local people thought about the red panda and its occurrence and impact of anthropogenic disturbance and other climate related impact is limited. This study suggests to implement community-based conservation programs and promote alternative livelihood options to conserve red panda. Furthermore, it is advised to monitor the population dynamics, distribution, home range, movement pattern and their causal factors, and various multiscale problems associated with conservation of red panda in different areas.

Conclusion

The study identified several threats to red panda in the study area, including habitat loss, decrease in Nigalo (Himalaya bamboo) coverage, and increase in the incidences of Nigalo flowering. Additionally, anthropogenic disturbances such as livestock grazing and direct human disturbances in the habitat were identified as serious threats to their existence. Furthermore, the study revealed an overall decreasing trend in average annual rainfall, which could also potentially impact red panda habitat. The study provides insights pertaining to the distribution, preferred habitat characteristics, and threats faced by red panda in DHR.

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