Assessment of Impact of Climate Change on Biodiversity of Gandaki Province, Nepal

Provincial Government

Ministry of Industry, Tourism, Forest and Environment

Forest Research and Training Centre

Pokhara, Kaski, Gandaki Province

July, 2019

© Forest Research and Training Center, Gandaki Province, 2019

Any reproduction of this publication in full or in part should mention the title and credit FRTC, Gandaki Province.

Citation:

FRTC. 2019. Assessment of the Impact of Climate Change on Biodiversity of Gandaki Provice, Forest Research and Training Center (FRTC), Pokhara, Gandaki Province.

Contact Address:
Forest Research and Training Centre
Tel: 977 061456974
Email: frtc.gandaki@gmail.com
Website: frtc.gandaki.gov.np

ACKNOWLEDGMENTS

The overall objective of this study was to predict the potential impacts of future climate change on the biodiversity of Gandaki Province. Forest Research and Training Centre, Pokhara firstly would like to thank SMART Pvt. Ltd., Kathmandu, for their crucial role in completing this research project. FRTC would like to thank officers Mr. Basanta Sharma, Mr. Ghanendra Khanal, Mr. Govinda Thapa, Mrs. Anshu Dhakal, Rangers Mr. Rajesh Pokhrel, Ms Chungla Sherpa for their suggestions, support and coordinations during the study period. Further, special thanks goes to all the Division Forest Offices of Gandaki Province, Soil and Watershed Management offices Parbat and Tanahun, Annapurna Conservation Area Project, Manaslu Conservation Area Project and Dhorpatan Hunting Reserve, students, members of community forest user groups, local peoples, and local guides for sharing the valuable information during discussion and meetings to the study team.

Thank You.

Rajesh Malla
Director
Forest Research and Training Centre
Pokhara, Gandaki Province

ABSTRACT

Conservation of biodiversity is becoming a challenging task due to climate change, land use land cover change and anthropogenic pressures on it throughout the world. Due to more effect of climate change in Himalaya than average, the biodiversity of this region is facing the serious threat. This study was designed to explore the impact of climate change on biodiversity in Gandaki Province. Here, species occurrence points and environmental variables (bio-climatic and topographical) were used and current and future distribution of nine species (three species of threatened wildlife: common leopard (*Panthera pardus*), musk deer (*Moschus chrysogaster*), snow leopard (*Panthera uncia*); three species of high value NTFP: ban lasun/Himalayan onion (*A. wallichii*), chiraito (*Swertia chiraita*), lokta (*Daphne bholua*) and three species of major timber and fuel wood trees: chilaune (*Shima wallichi*), sal (*Shorea robusta*), utis (*Alnus nepalensis*) were predicted using Maximum Entropy (MaxEnt) model. The representative concentration pathway (RCP) 4.5 scenario was used to predict the future distribution of all nine species. Distribution of all nine species will be shrinkage remarkably in 2070 due to climate change. Except for *S. robusta* and *S. wallichi*, distribution of all species will be shifted towards the northern sides. In this study, the impact of only climatic was analyzed. The result might be different if other variables were used.Here other factors like edaphic factors, land use change, human management to conserve the species, adaptation, genetic mutation, and resistance to change were not calculated. Generally, this kind of study can be designed for large scale. Due to small area of the province, some resultsmay me inflated.

TABLE OF CONTENTS

ABSTRACT .... **ii**
ACKNOWLEDGMENTS .... **iii**
1. INTRODUCTION **1**
Background 1
Problem statement 5
Objective of the study 6
Research question 6
Research hypothesis 6
Limitation of the study 6
2. MATERIALS AND METHODS **8**
Study area 8
Data collection 10
Collection of secondary occurrence data 10
Collection of primary occurrence data 10
Environmental variables 11
Bio-climatic variables ***11***
Assessment of impacts of climate change on biodiversity 12
Accuracy assessment 14
3. RESULTS AND DISCUSSION **15**
Impact of climate change on threatened wildlife 15
Common leopard (P. pardus) 15
Musk deer (M. chrysogaster) ***16***
Snow leopard (P. uncia) 18
Impact of climate change on high value NTFP 19
Ban lasun (A. wallichii) 19
Chiraito (S. chiraita) 21
Lokta (D. bholua) ***22***
Impact of climate change on major timber and fuel woodspecies 24
Chilaune (S. wallichi) 24
Sal (S. robusta) 25
Utis (A. nepalensis) ***27***
4. CONCLUSIONS AND RECOMMENDATIONS **29**
Conclusions 29
Recommendations 29
REFERENCES **31**
Appendix **37**

LIST OF FIGURES

Figure 1: Study area (Gandaki Province)....10
Figure 2: Current distribution of common leopard (*P. pardus*)....15
Figure 3: Distribution of common leopard (*P. pardus*) in 2070....16
Figure 4: Current distribution of musk deer (*M. chrysogaster*)....17
Figure 5: Distribution of musk deer (*M. chrysogaster*) in 2070....17
Figure 6: Current distribution of snow leopard (*P. uncia*)....18
Figure 7: Distribution of snow leopard (*P. uncia*) in 2070....19
Figure 8: Current distribution of ban lasun (*A. wallichii*)....20
Figure 9: Distribution of ban lasun (*A. wallichii*) in 2070....20
Figure 10: Current distribution of chiraito (*S. chiraita*)....21
Figure 11: Distribution of chiraito (*S. chiraita*) in 2070....22
Figure 12: Current distribution of lokta (*D. bholua*)....23
Figure 13: Distribution of lokta (*D. bholua*) in 2070....23
Figure 14: Current distribution of chilaune (*S. wallichi*) forest....24
Figure 15: Distribution of pure chilaune (*S. wallichi*) forest in 2070....25
Figure 16: Current distribution of pure sal (*S. robusta*) forest....26
Figure 17: Distribution of pure sal (*S. robusta*) forest in 2070....26
Figure 18: Current distribution of utis (*A. nepalensis*)....27
Figure 19: Distribution of utis (*A. nepalensis*) in 2070....28

1.INTRODUCTION

Background

Biodiversity is a source of the important economic asset. For instance, biodiversity helps to improve the productivity of ecosystems (Wilsey & Potvin, 2000). Now a days, climate change is becoming a severe threat to biodiversity (González-Orozco et al., 2016). Often species react to climate change by shifting distribution to follow changing the environmental situation, by adapting to changing conditions in location, or, if unable to do either, by remaining in isolated pockets of the unchanged environment or, more likely, becoming extinct (Holt, 1990). Similar to climate change, the land use change is also becoming the emerging threat to conserve the biodiversity and may lead the greater species loss in tropics (Jetz, Wilcove, & Dobson, 2007). Furthermore, the global biodiversity resource has been declining continuously over the last several decades, mainly due to heavy anthropogenic pressures on it (Tittensor et al., 2014). The extinction rate of species is about 1000 times more than the likely background rate, and these rates are supposed to increase in future (Pimm et al., 2014). Agricultural activities and over-exploitation of the biological resources such as crop production and livestock farming are identified as the main causes of worldwide biodiversity loss (Maxwell, Fuller, Brooks, & Watson, 2016). Domesticated animals and habitat fragmentation are major challenges for wildlife conservation (Bentley, Catterall, & Smith, 2000; Loss, Will, & Marra, 2013). The socio-political situation of the country is directly responsible for the conservation of biological resources (Barnes et al., 2016). Less developed countries like Nepal are focusing on the production of food and management of shelter for their people. Due to the poverty (Adams et al., 2004), human-wildlife conflict (Acharya, Paudel, Neupane, & Kohl, 2016), overexploitation of biological resources and tourism pressure on protected areas (Bhattarai et al., 2017), people's dependency on forests and consequent deforestation as well as forest fragmentation (Uddin et al., 2015) Nepal is facing more difficulties for biodiversity conservation.

Carnivores and large herbivorous mammals, considering as flagship species are indicators of rich and stable biodiversity (Simberloff, 1998). For example, the presence of tiger, snow leopard (*Panthera uncia)*, and common leopard *(Panthera pardus)* is an indication of the existence of small mammals and vegetation. They are top consumers and maintaining the ecological system from high trophic level; therefore, conservation of flagship species leads to conservation of overall biodiversity in the region (Williemas, Burgess, & Rahbeck, 2000). Conservation of large mammals is more challenging due to the requirement of large habitat patches and a large number of feeding resources. Some species like giant panda do not prefer the small patches of fragmented habitats (Wang, Ye, Skidmore, & Toxopeus, 2010). Also, the human-wildlife conflict is a major conservation challenge to conserve the large mammals because of their aggressive behavior to human fatalities (Acharya et al., 2016).

This study had selected nine species based on the importance of the species and the availability of adequate species occurrence points of the modeling.

Common leopard (*Panthera pardus*)

The common leopard (*P. pardus*) is a leopard subspecies widely distributed on the Indian subcontinent. The species *P. pardus* is listed as vulnerable on the International Union for Conservation of Nature (IUCN) Red List because populations have declined following habitat loss and fragmentation, poaching for the illegal trade of skins and body parts, and persecution due to conflict situations (Stein et al., 2016). The *P. pardus* is a versatile, opportunistic hunter, and has a very broad diet. It can take large prey due to its massive skull and powerful jaw muscles. The number of *P. pardus* in the country has significantly gone down in the last few years due to shortage of food and lack of safe habitat. A report published by IUCN in 2012 showed Nepal had a total of 1,000 *P. pardus*. The report had also stated that the number of *P. pardus* was decreasing every year (Stein et al., 2016).

Musk deer (*Moschus chrysogaster*)

Musk deer (*M. chrysogaster*), small compact deer, family Cervidae (order Artiodactyla) is a solitary shy animal. The *M. chrysogaster* lives in mountainous regions from Siberia to the Himalayas. It has large ears, a very short tail, no antlers, and, unlike all other deer, a gall bladder. The *M. chrysogaster* is grayish brown, with long coarse, brittle hair, and stands 50–60 cm (20–24 inches) at the shoulder, slightly higher at the rump. The male has long upper canine teeth that project downward from the mouth as tusks and has a musk-producing organ, the musk pod, on its abdomen. The musk from that organ is valued for use in perfumes and soaps. The *M. chrysogaster* is listed as endangered in IUCN red data list and Appendix I of CITES (Convention on

International Trade in Endangered Species of Wild Fauna and Flora) (CITES, 2017; Harris, 2016).

Snow leopard (*Panthera uncia*)

The snow leopard (*P. uncia*), also known as the ounce, is a large cat native to the mountain ranges of Central and Southern Asia. It is listed as vulnerable on the IUCN Red List because the global population is estimated to number less than 10,000 mature individuals and decline about 10% until 2040. It is threatened by poaching and habitat destruction following infrastructural developments. It inhabits alpine and subalpine zones at elevations from 3,000 to 4,500 m (McCarthy, Mallon, Jackson, Zahler, & McCarthy, 2017).

Ban lasun (*Allium wallichii*)

Himalayan onion/ban lasun (*A. wallichii*) is a perennial herb with numerous purple flowers, borne in a lax rounded umbel 5-7 cm across, on top of a leafless 3-angled flowering-stem; 1-3 ft. It is a high value Non-Timber Forest Product (NTFP). Petals are broadly linear blunt, spreading in a star, at length reflexed, longer than the purple stamens and ovary. Leaves are many, spear-shaped, flat and keeled, up to 2 cm broad, often almost as long as the flowering stem. Bulb is solitary or clustered, cylindrical; tunic yellowish brown, fibrous. Himalayan onion is found in the Himalayas, from Pakistan to south west China, at altitudes of 2800-4300 m. Its bulb is used to treat asthma, bronchitis, and bleeding during cough, especially during tuberculosis. A paste of the bulb is applied to check bleeding from wounds and to treat pimples (Tiwari et al., 2014).

Chiraito (*Swertia chiraita*)

Chiraito (*S. chiraita*) has been used by Nepali locals since the old days, and this is one of the traditional medicinal herbs used by people of Nepal. This herb is mainly used for the treatment of stomach aches, constipation, excess urination, parasites cure, and malaria treatment. The *S. chiraita* is a popular medicine herb found in forests and open slopes of the Himalayan region of 1600-2500 m above sea level. The plant of *S. chiraita* is made of an ingredient called “chiratin” which is bitter in taste. The illegal harvesting of this herb is banned by the government of Nepal. The *S. chiraita* herbs are legally farmed within the community forests and subsidiary lands on eastern hilly regions of Nepal (GoN/MFSC, 2013).

Lokta (*Daphne bholua*)

Nepalese handmade lokta paper is made from the fibrous inner bark of high elevation evergreen shrubs primarily from two species of Daphne (plant) (Greek: meaning "Laurel"): *Daphne bholua* and *Daphne papyracea*, known collectively and vernacularly as lokta bushes. The *D. bholua* are found in moist regions at altitudes ranging from 6,000 to 10,000 feet. The fiber for making the paper is extracted from the bark of this plant. October signals the beginning of the *D. bholua* collection season. It is harvested like sugarcane by cutting the stem about 30 cm above the ground. Interestingly, the *D. bholua* have the special ability to regenerate and reach maturity within 4 to 5 years after the first cutting (Jackson, 1987).

Chilaune (*Schima wallichi*)

Chilaune (*S. wallichi*) is a medium evergreen tree up to 35 m tall. However, in most places, it may be seen only 40 ft high. The stem is cylindrical, branchless for up to 25 m, diameter up to 1 m, with steep buttresses rarely up to 1.8 m high; bark surface ruggedly cracked into small, thick, angular pieces, red-brown to dark grey; inner bark with skin-irritating fibers, bright red in color. Leathery leaves are elliptic-oblong in shape and look somewhat like Champa (*Michelia*) leaves. *S. wallichi* has fast growth even under infertile soil conditions. Flowering is in April-May, and fruiting is in February-March (Shaw, Roy, & Wilson, 2015). The main value of *S. wallichi* is its hard and durable timber.

Sal (*Shorea robusta*)

Sal (*S. robusta*) is a timber yielding dominant tree that occurs commonly on the plains and lower foothills of the Himalayas and is distributed both in the tropical moist and in the dry deciduous forests of India, Bangladesh, Nepal, and Bhutan (Gautam & Devoe, 2005). *S. robusta* forests naturally occur in eco-regions with a mean annual temperature ranging from 22 to 27°C and mean annual rainfall of 1,000 to 2,000 mm (Gautam & Devoe, 2005). Although *S. robusta* is listed as a “least concern” species in the IUCN Red List (Ashton, 1998), recurrent anthropogenic disturbances such as overexploitation, deforestation, and encroachment combined with climate change, are major threats to *S. robusta* forests (Kushwaha & Nandy, 2012).

Utis (*Alnus nepalensis*)

Utis (*A. nepalensis*) is large deciduous alder with silver-gray bark that reaches up to 30 m in height and 60 cm in diameter. The leaves are alternate, simple, shallowly toothed, with prominent veins parallel to each other, 7–16 cm long and 5–10 cm broad. The flowers are catkins, with the male and female flowers separate but produced on the same tree. It occurs throughout the Himalaya at 500–3000 m of elevation from Pakistan through Nepal and Bhutan to Yunnan in southwest China. It grows best on deep volcanic loamy soils, but also grows on clay, sand, and gravel (Shaw et al., 2015). It tolerates a wide variety of soil types and grows well in very wet areas. It needs plenty of moisture in the soil and prefers streamside locations, but also grows on slopes.

Problem statement

Climate change is becoming a challenging issue for biodiversity conservation. The climatic condition is directly responsible for determining the daily activities of animals and plants so their habitat may shift under climate change in the future (Holt, 1990). The habitats of wildlife will be reduced and shifted due to climate change and combined effect of climate change and land use change in future (Aryal et al., 2016; Lamsal, Kumar, Aryal, & Atreya, 2018; Panthi, 2018). Forest and freshwater wetland ecosystems of Nepal are vulnerable and likely to be impacted by climate change shortly (Lamsal, Kumar, Atreya, & Pant, 2017). Majority of Nepalese people are experiencing the drought due to climate change from the last 25 years (CBS, 2017). If conservationists do not know about the impact of climate change on biodiversity in the future, they cannot prepare strategies to tackle the future situation to conserve biodiversity. How the future climate change will affect biodiversity is also to be answered for effective conservation planning. Furthermore, conservation of Mountain biodiversity in Himalaya is becoming challenging day by day due to its more vulnerability to climate change in this region than average (IPCC, 2007).

How the future climate change will affect the current situation of biodiversity is also to be answered. The conservationists do not know about the impact of climate change on the distribution of the threatened wildlife, high-value NTFP and major timber and fuelwood species in future so they cannot think to tackle the future situation to conserve biodiversity in the region.

Objective of the study

The overall objective of this study was to predict the potential impacts of future climate change on the biodiversity of Gandaki Province, Nepal. Specific objectives of the study are as follows:

- To predict the potential impacts of future climate change on threatened wildlife (at least three wildlife among snow leopard (*P. uncia*), common leopard (*P. pardus*), red panda (*Ailurus fulgens*), Asiatic black bear (*Ursus thibetanus*), Himalayan monal/danphe (*Lophophorus impejanus*), musk deer (*M. chrysogaster*), serow (*Capricornis thar*), goral (*Naemorhedus goral*), etc.) of Gandaki Province of Nepal
- To predict the potential impacts of future climate change on high-value NTFP (at least three high-value NTFP among Chinese caterpillar fungus/yarshagumba (*Ophiocordyceps sinensis*), jatamansi (*Nardostachys grandiflora*), kutki (*Picrorhiza scrophulariiflora*), chiraito (*S. chiraita*), ban lasun (*A. wallichii*), lokta (*D. bholua*), etc.) of Gandaki Province of Nepal
- To predict the potential impacts of future climate change on major timber and fuel wood species (at least three species among sal (*S. robusta*), rani salla (*Pinus roxburghii*), gobresalla (Pinus wallichina), chilaune (*S. wallichi*), utis (*A. nepalensis*), sisau (*Dalbergia sissoo*), khayar (*Acacia catechu*), thingresalla (*Abies spectablis*), etc.) of Gandaki Province of Nepal

Research question

The research question of the study was "what is the impact of future climate change on the biodiversity of Gandaki Province, Nepal?"

Research hypothesis

The hypothesis of the study was the distribution range of threatened wildlife, high-value NTFP, and major timber and fuelwood species will be shrunk due to the impact of climate change in the future.

Limitation of the study

Biodiversity is wide ranging and normally divided into three levels: genetic diversity, species diversity and ecological/ecosystem diversity. Due to limited time and resources, the study has analyzed the impact of climate change on only nine species. If a large amount of budget was allocated, the study could explore the impact of climate change on more species. This study only explores the impact of climate change on the species level of biodiversity only. This study used 19 bioclimatic variables as environmental variables having 1 km resolution. One km resolution is quite large for this type of small study area. Climatic variables having 30 m resolution can be better for this kind of study.

2.MATERIALS AND METHODS

Study area

Nepal is situated in the central part of the Himalaya (26^{0}22’ - 30^{0}27’ N, 80^{0}04’ - 88^{0}12’ E), covering an area of 147,181 km^2 and an elevation ranges from 67 m to 8848 m. Nepal has diverse climates due to the large variation in elevation. The climate varies from the humid tropical type in the tropical lowlands in the south to alpine cold semi-desert type in the trans-Himalayan zone (Ohsawa, Shakya, & Numata, 1986). Nepal’s forest ecosystems can be categorized into 10 major groups on the basis of climatic conditions: (1) tropical, (2) subtropical broad-leaved, (3) subtropical conifer, (4) lower temperate broad-leaved, (5) lower temperate mixed broad-leaved, (6) upper temperate broadleaved, (7) upper temperate mixed broadleaved, (8) temperate coniferous, (9) subalpine, and (10) alpine scrub (Stainton, 1972). Nepal has diverse geography that ranges from permanently snow and ice covered very rugged Himalayan Mountains in the north to the tropical alluvial plains in the south. Due to variation in climate and topography, Nepal is classified into five physiographic zones (i.e., Terai, Siwalik, middle Mountain, high Mountain, and Himalaya) (Barnekow Lillesø, Shrestha, Dhakal, Nayaju, & Shrestha, 2005; Shrestha, Shrestha, Chaudhary, & Chaudhary, 2010). The average annual rainfall is around 1000 – 2000 mm, but sometimes it exceeds 3000 mm in some lower parts of the country (Ichiyanagi, Yamanaka, Murajic, & Vaidyad, 2007). Gandaki is one province out of seven provinces of Nepal. This province is situated at the center part of Nepal by covering the 11 districts: Nawalpur, Tanahun, Gorkha, Lamjung, Kaski, Syanjya, Parbat, Baglung, Myagdi, Manang, and Mustang (Figure 1). Similarly, there are only 85 local administrative bodies in the region of Pokhara, Nepal's big Pokhara municipality, 26 municipalities and 58 villages in Nepal, 18 constituencies area and 36 constituencies for the constituent assembly members for election. There is a constitutional provision of 60 members including proportional to the state assembly (MoITFE, 2018).

In the north-central part of Nepal, the Gandaki Province is spreading from Himal to Terai from north to south. The total area of this state is 21,976.34 km^2, i.e. 14.93% of the total area of Nepal. Near the border of India, the lowest part near the Gandak canal of Narayani River is at the height of 93 meters above sea level. This height went up gradually to Dhaulagiri is a huge iceberg with 8,167 meters, Manasalu 8,163 meters, and Annapurna first 8,091 meters. In this state, only the high Himalayan mountain range has fallen to the middle of the country. The valley is situated in the upper part of Manang, Mustang, and Gorkha. Apart from this, the vast majority of natural areas like earthquake, mountainous, wind, soil, environment, biological diversity, is in this province (MoITFE, 2018). This province consists of five distinct geographical regions: Himalaya, high mountains, middle mountains, Shivaliks and Terai or inner Madhes.

According to the census 2068, the total number of families in this state is 5,78,21. There are 4 members of the family. Similarly, the total population of the province is 24,03,757 according to which the number of men is 10, 9080, and the number of women 13,129. Women show more 2,22,141 than the number of men. Therefore, the proportion of the gender ratio of the entire province is 83 percent. District population is the highest population in the Kaski district, and the lowest population is in Manang. Bahun, Magar, Gurung, and Visakhakarma are the leading 4 heads of the province. Apart from these Tamang, Tharu, Thakali, and Kumal are other major race of the province (MoITFE, 2018).

Around 37.1% area of the province is covered by forest. Major trees species of the province are *S. robusta,* sissoo, khair, rani salla, *S. wallichi*, katus, *A. nepalensis* , and gobre salla. The major forest management models exercised in the provinces are community forest management, collaborative forests management, and block forest management. Scientific forest management program was launched in all these forests throughout the province. Chiraito (*S. chiraita*), kutki, panchaule, lokta (*D. bholua*), ban lasun (*A. wallichii*), satuwa, atis, nirmansi are major NTFPs of province (MoITFE, 2018).

Gandaki Province is rich in protected areas. Around 45.68 % area of the Gandaki Province is covered by protected areas. Annapurna Conservation Area, Manaslu Conservation Area, some part of Dhorpatan Hunting Reserve and Chitwan National Park are in this province. Annapurna Conservation area is famous for mountain trekking and unique landscape, Dhorpatan Hunting Reserve is popular for trophy hunting of blue sheep and Himalayan tahr. Similarly, Chitwan National Park is famous for rhino and tiger, and Manaslu conservation area is famous for trekking, unique landscape, and mountain biodiversity (DNPWC, 2017; MoITFE, 2018).

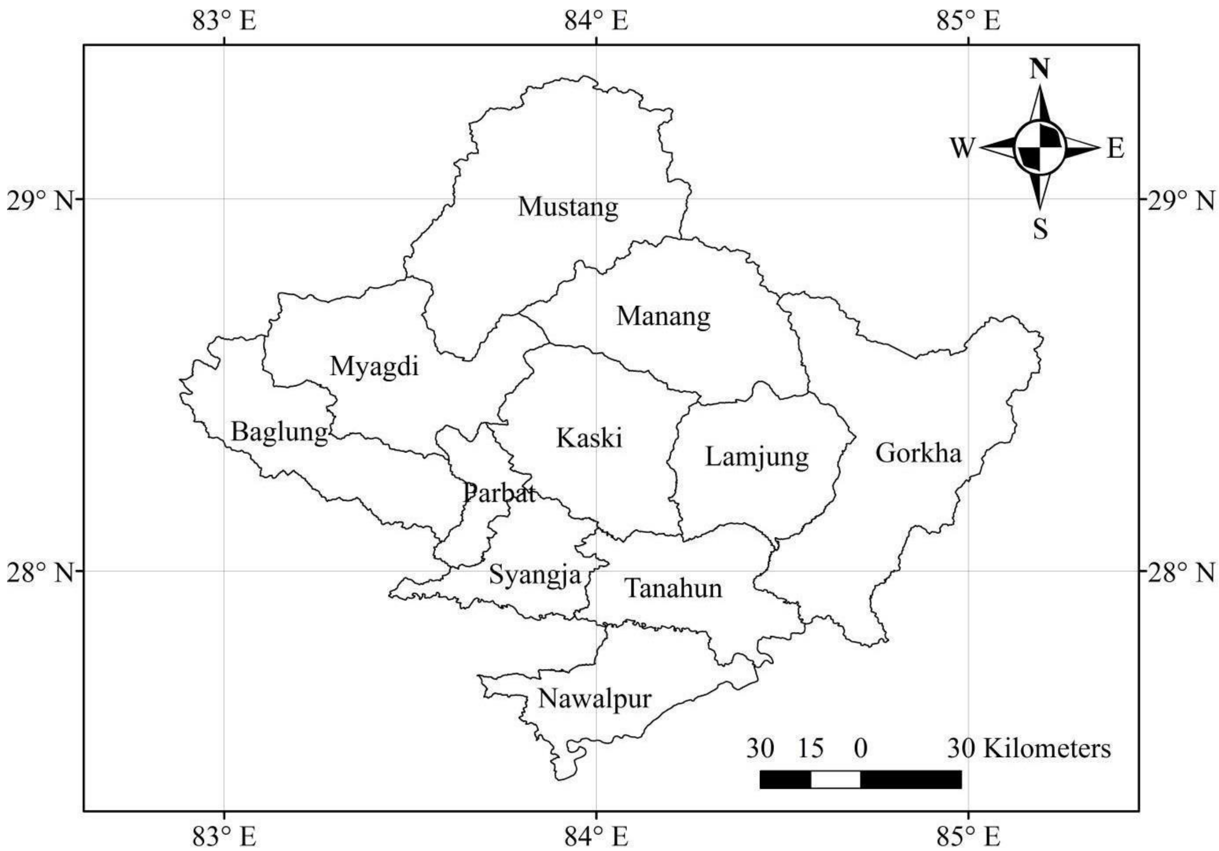

Figure 1: Study area (Gandaki Province)

Data collection

Collection of secondary occurrence data

The secondary occurrence data of all nine species observed from 2010 to 2019 were collected and compiled from published and unpublished research reports and reports of the government. All these secondary data were collected using Global Positioning System (GPS) receivers. Just before the data analysis, the secondary data were updated to include the available occurrence points from possible sources.

Collection of primary occurrence data

Based on the spatial distribution of the secondary occurrence data, several biodiversity experts and staffs of divisional forests offices were interviewed further to identify other potential habitats of these species for primary data collection. The field survey was carried out between February to June, 2019 in all 11 districts of the province. Due to the nature of the study and specifically the rugged mountainous characteristics of the field, data were collected by adopting a purposive sampling. In the field, the direct and indirect signs of these species (i.e., droppings) were recorded using a GPS. As a result, 724 presence points of species were collected and used for the study. To avoid unnecessary data, only one point was collected if there are lots of species within 1-2 kilometers distance. The data were collected carefully and adopting different assumption for different species. For wildlife and NTFP, occurrence points were collected if observer encountered with any signs of presence. For the timber species, points were collected from forest type only. For *S. wallichi*, we collected occurrence points if groups of trees (n>100) were recorded. For *A. nepalensis*, we collected GPS points if we found patches of *A. nepalensis* trees (n>500). For *S. robusta*, we collected occurrence points if we find the block of *S. robusta* forests (area>100 ha).

Environmental variables

The environmental variables were downloaded from freely available sources (Table 1) and processed in ArcGIS (ESRI, 2017) to make appropriate format (ASCII), same spatial resolution (1 km) and equal geographical extent. Some variables with vector features (i.e., point and line) were also converted into raster format having the same resolution. The environmental variables were divided into two categories, as follows.

Bio-climatic variables

In this world, every living being is sensitive to the climate. Living beings are distributed according to their suitable climatic conditions. The bio-climatic variables are biologically meaningful variables for species distribution at global-scale (Blach-Overgaard, Balslev, Dransfield, Normand, & Svenning, 2015). Nineteen bio-climatic variables were downloaded from the WorldClim database (http://worldclim.org/). The WorldClim database (version 1.4) is a set of global climate layers that derived from over 4000 weather stations between 1950 and 2000, including annual time series with annual means, seasonality, and extreme or limiting temperature and precipitation data (Hijmans, Cameron, Parra, Jones, & Jarvis, 2005). In this study, 19 bio-climatic layers with a spatial resolution of 1 km were used (Table 1).

Topographical variables

The topographical variables are major influential factors for the distribution of the animals. These variables have been widely used for species distribution modeling for 20 years (Osborne, Alonso, & Bryant, 2001). Elevation, aspect, and slope are most important topographical factors regarding the selection of habitat by living beings (Aryal et al., 2016; Lamsal et al., 2018; Shrestha & Bawa, 2014). These variables were used for the habitat modeling of the species since the beginning (Osborne et al., 2001). Digital Elevation Model (DEM) of 1 km resolution was downloaded from the USGS website (https://earthexplorer.usgs.gov/), and slope and aspect were calculated from the DEM using ArcGIS software (ESRI, 2017).

Table 1: Environmental variables used for the modeling

Data Sources	Categories	Variables	Abbreviation	Units
WorldClim	Bio-climatic (version 1.4)	Annual mean temperature	bio1	°C
		Mean diurnal range (mean of monthly (max temp – min temp))	bio2	°C
		Isothermality (BIO2/BIO7)	bio3	Dimensionless
		Temperature seasonality (standard deviation)	bio4	°C
		Max temperature of the warmest month	bio5	°C
		Min temperature of the coldest month	bio6	°C
		Temperature annual range (BIO5-BIO6)	bio7	°C
		Mean temperature of wettest quarter	bio8	°C
		Mean temperature of driest quarter	bio9	°C
		Mean temperature of warmest quarter	bio10	°C
		Mean temperature of coldest quarter	bio11	°C
		Annual precipitation	bio12	mm
		Precipitation of wettest month	bio13	mm
		Precipitation of driest month	bio14	mm
		Precipitation seasonality (coefficient of variation)	bio15	Dimensionless
		Precipitation of wettest quarter	bio16	mm
		Precipitation of driest quarter	bio17	mm
		Precipitation of warmest quarter	bio18	mm
		Precipitation of coldest quarter	bio19	mm
USGS GTOPO30	Topographic	Elevation	elevation	m
		Aspect	aspect	Degree
		Slope	slope	Degree

Assessment of impacts of climate change on biodiversity

Present and future projections of distribution of species were modeled by the MaxEnt by using the species occurrence points and environmental variables (Phillips, Anderson, & Schapire, 2006). The MaxEnt is widely used and established functionality for projecting the future distribution of the species under the climate change based on current species-environment relationships (Aguilar, Farnworth, & Winder, 2015; Aryal et al., 2016; Fuller, Morton, & Sarkar, 2008; A. C. Holt, Salkeld, Fritz, Tucker, & Gong, 2009; Pickles, Thornton, Feldman, Marques, & Murray, 2013; Rödder & Weinsheimer, 2009). The topographical variables were not changed within the simulation period (2070). Version 1.4 of bio-climatic variables (Hijmans et al., 2005) are available for the future projection also. Vegetation-related and other anthropogenic variables may be changed, but future projections of these variables are not available. Therefore, this study avoided anthropogenic variables for modeling and models were run using topographic variables and current bio-climatic variables and then projected onto the future climate.

The representative concentration pathways (RCP) 4.5 is the more realistic carbon emission scenario and provides the common platform for future climate change (Thomson et al., 2011). Therefore, RCP 4.5 of 2070 was used for the future prediction of the distribution of nine species. Model for Interdisciplinary Research on Climate (MIROC5) global climate model (GCM) was selected because it is the latest model and recommended for interdisciplinary research on climate changes (Watanabe et al., 2010).

The data acquisition, exploration, processing, modeling, and validation were done as described in the previous sections of the methodology part of this study. Finally, the percentage of loss or surplus and range shifting situation of all nine species due to climate change were identified by comparing the outputs of current and future models.

Only one occurrence point was used from one pixel of environmental variables to lessen the spatial autocorrelation. The 5,000 background points, 10 replicates, and 1000 maximum iteration were selected for the fine and reliable result (Barbet-Massin, Jiguet, Albert, & Thuiller, 2012). The maximum sum of sensitivity and specificity (MaxSSS) threshold is appropriate to convert the continuous probability map to binary map when only presence data are available from the field (Liu, White, & Newell, 2013). Therefore, this threshold was used to produce the distribution map of the nine species in Gandaki Province.

For habitat suitability modeling and distribution modeling of the species, a wide range of models (e.g., BIOCLIM, BRT, DOMAIN, GARP, GLM, and MaxEnt) has been developed to cover aspects as diverse as climate change, biogeography, biology, spatial ecology, and habitat management. These models have been used to predict the distribution of plants, and animals

(Gillespie & Walter, 2001; Guisan, Theurillat, & Kienast, 1998; Pearce & Ferrier, 2000; Phillips et al., 2006). These species distribution models are also using to predict the risk of landslides (Goetz, Guthrie, & Brenning, 2011), fires (Renard, Ṕlissier, Ramesh, & Kodandapani, 2012), accidents (Maher & Summersgill, 1996) and diseases (Murray et al., 2011). Modeling the distribution of the species is crucial to understand the spatial ecology of these species and to manage them for mutual benefit for the ecosystem and human. Due to the chance of not recording the observation at the time of the researcher's field visit, the recording of the true absence data points is a challenging task during the study. Moreover, a collection of a large number of data for rare species is also another challenge in research. Therefore, the species distribution model which needs only presence data from the field is becoming more popular among the species distribution models. In this scenario, MaxEnt needs only presence data for the modeling, and it is very popular to predict the future distribution of species (Aryal et al., 2016; Lamsal et al., 2018; Panthi, 2018; Shrestha & Bawa, 2014). Therefore, this study used MaxEnt modeling tool to identify the impact of future climate change on biodiversity in Gandaki Province, Nepal.

Accuracy assessment

Assessment of the accuracy is essential to validate the models and to understand the performance of the models. Total 50 % of the species occurrence points were allocated for the training dataset, and 50 % were used as a testing /validation dataset for all models. The models were evaluated by the two methods. One method was threshold independent, and another was threshold dependent. In threshold independent method, the area under the receiver-operator curve (AUC) of models were reported (Phillips et al., 2006; Wiley, McNyset, Peterson, Robins, & Stewart, 2003). The higher the AUC, the higher the model performance was. The AUC <0.7 denotes poor model performance, 0.7–0.9 denotes moderately useful model performance, and >0.9 denotes excellent model performance (Pearce & Ferrier, 2000). Although AUC is classical and widely used model evaluation parameter, it is criticized by some researchers (Lobo, Jiménez-valverde, & Real, 2008). Therefore, threshold dependent accuracy assessment: True Skill Statistic (TSS) was also performed for the model evaluation (Merow, Smith, & Silander, 2013). TSS was calculated for all model outputs (0-9 replications), and final TSS was averaged of all 10 replications (Jiang et al., 2014).

3.RESULTS AND DISCUSSION

Impact of climate change on threatened wildlife

Common leopard (P. pardus)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *P. pardus* by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 782.5 km^2 of the area is identified as the current distributed area of this species (**Figure 2**), but that will be 350.2 km^2 in 2070 due to climate change **(Figure 3)**. The distribution of *P. pardus* will be decreased by 44.75 % in 2070 due to climate change. The threshold 0.331 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.889 and 0.673, respectively.

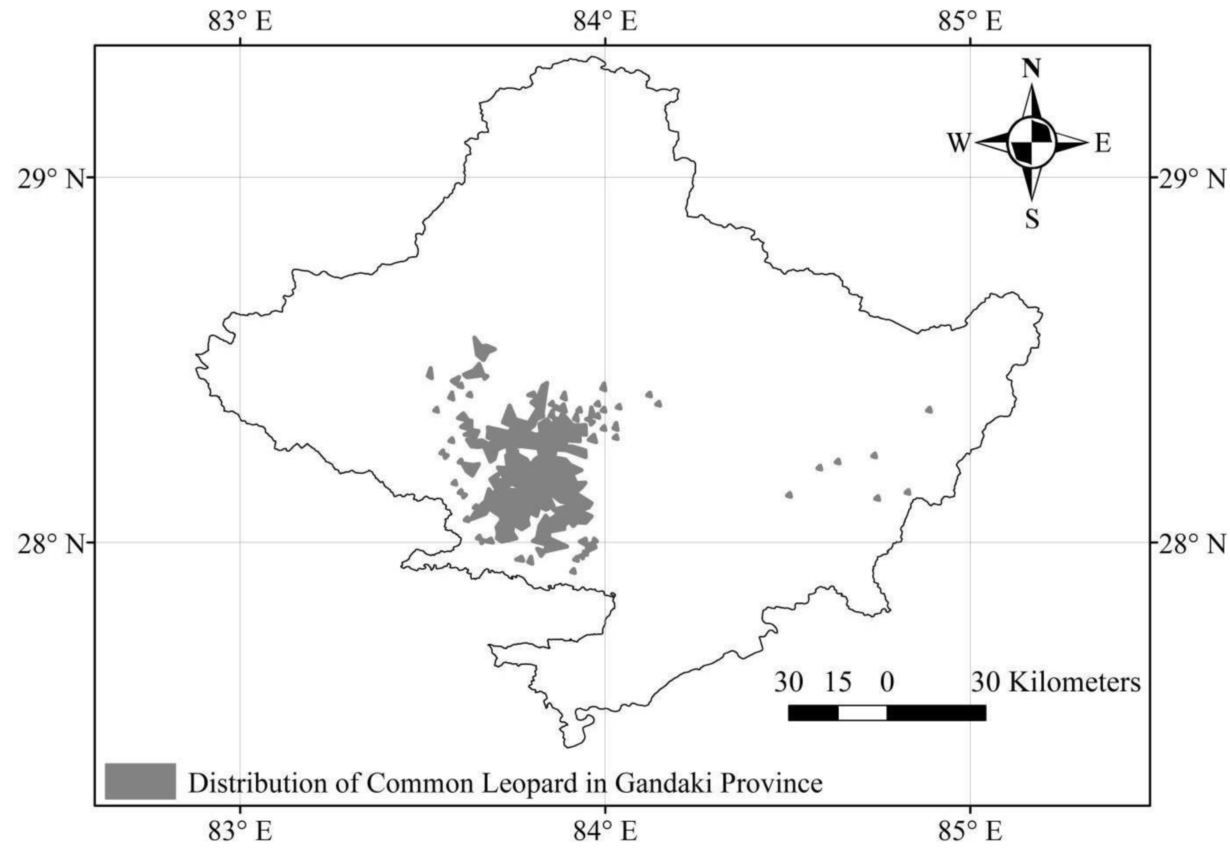

Figure 2: Current distribution of common leopard (*P. pardus*)

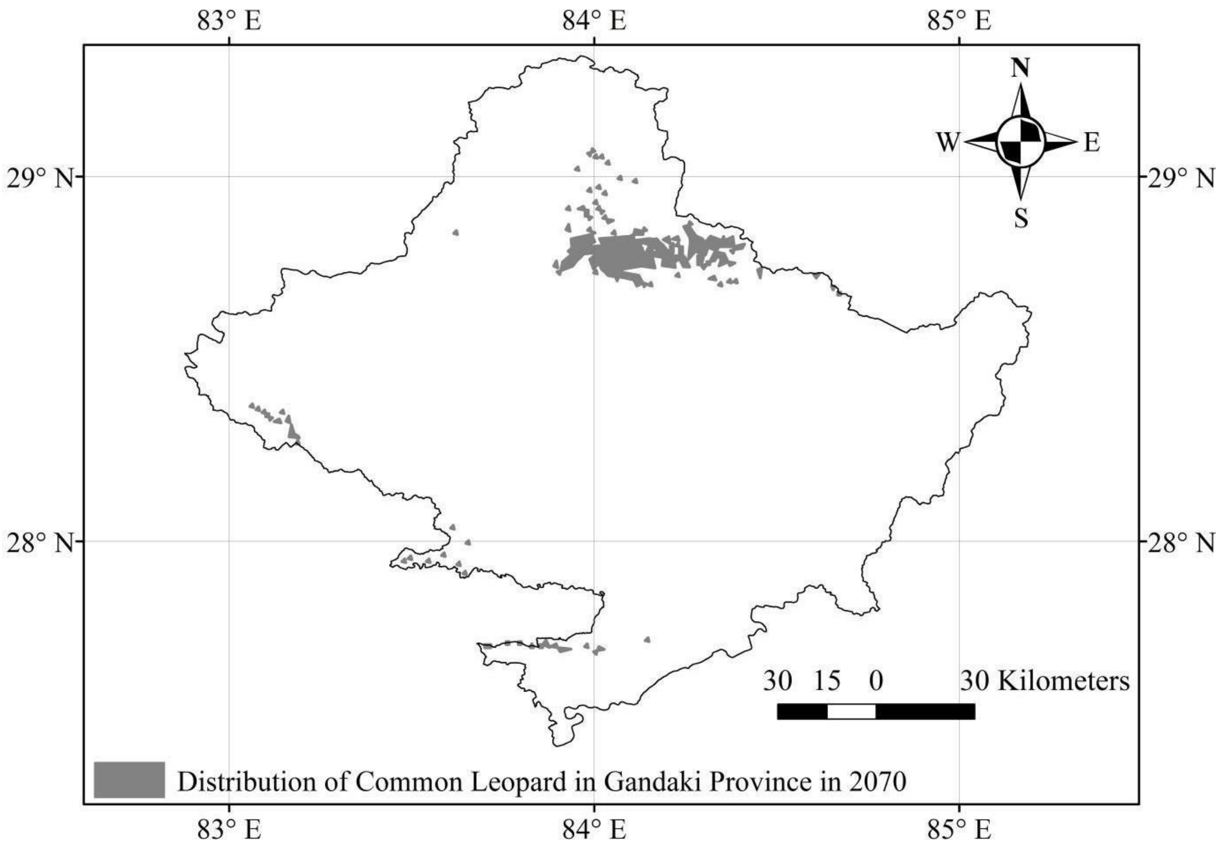

Figure 3: Distribution of common leopard (*P. pardus*) in 2070

Musk deer (*M. chrysogaster*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of musk deer by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 1,205.92 km^2 of the area is identified as the current distributed area of this species (**Figure 4**), but that will be 518.57 km^2 in 2070 due to climate change **(Figure 5)**. The distribution of *M. chrysogaster* will be decreased remarkably in 2070 due to climate change. The threshold 0.136 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.984 and 0.915, respectively.

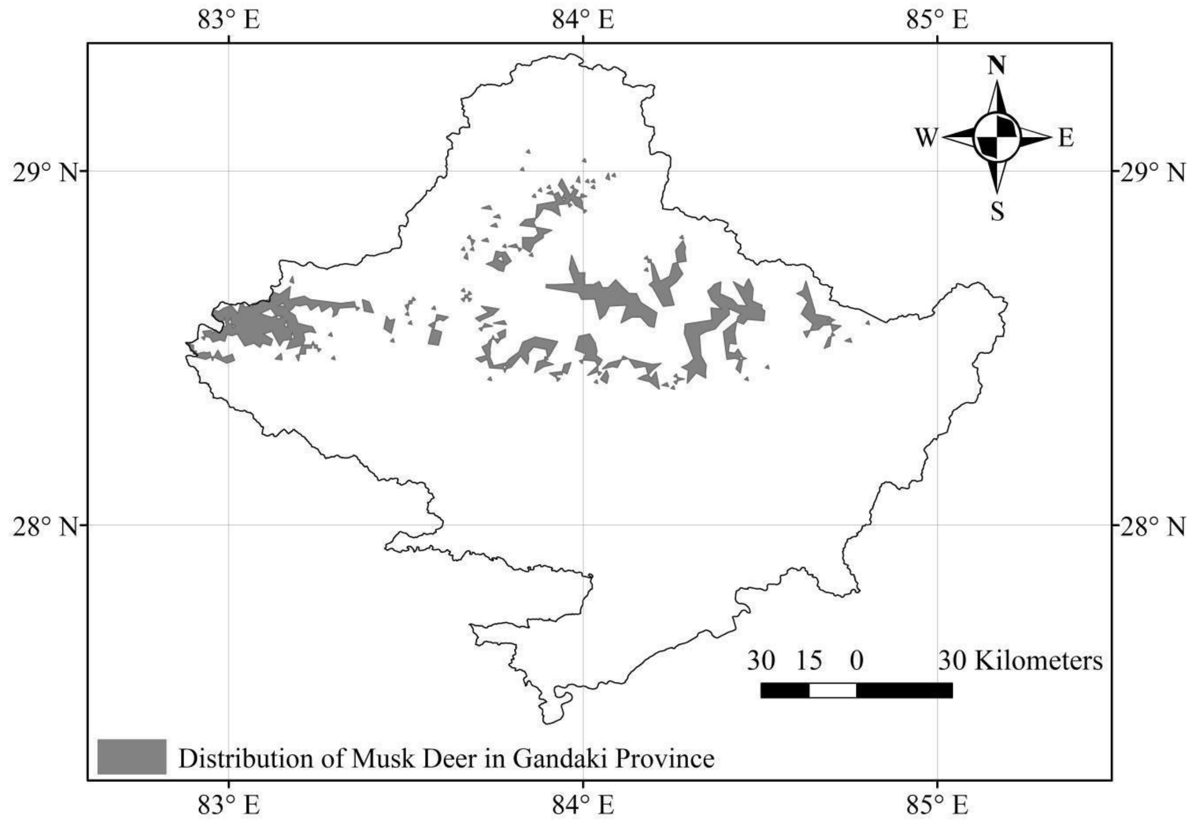

Figure 4: Current distribution of musk deer (*M. chrysogaster*)

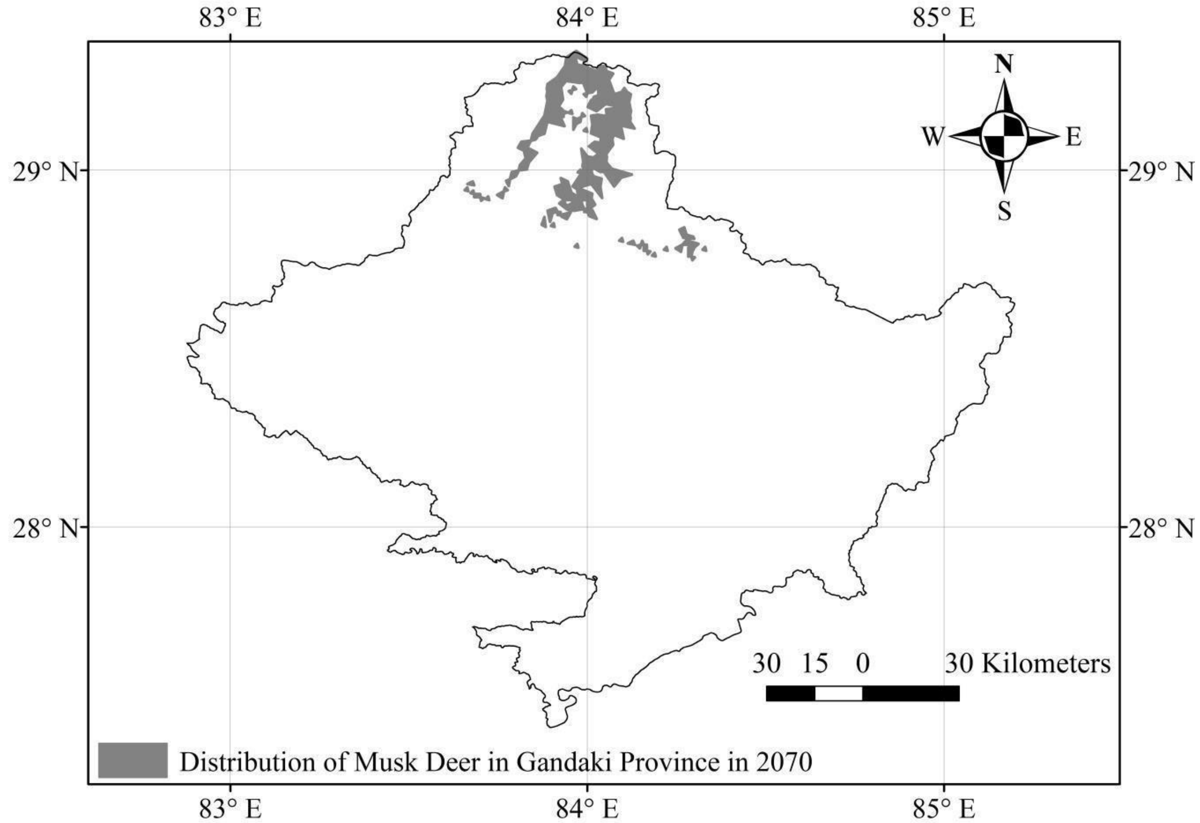

Figure 5: Distribution of musk deer (*M. chrysogaster*) in 2070

Snow leopard (*P. uncia*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *P. uncia* by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 2,591.66 km^2 of the area is identified as the current distributed area of this species (**Figure 6**), but that will be 622.43 km^2 in 2070 due to climate change **(Figure 7)**. The distribution of *P. uncia* will be decreased significantly in 2070 due to climate change. The threshold 0.244 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.909 and 0.723, respectively.

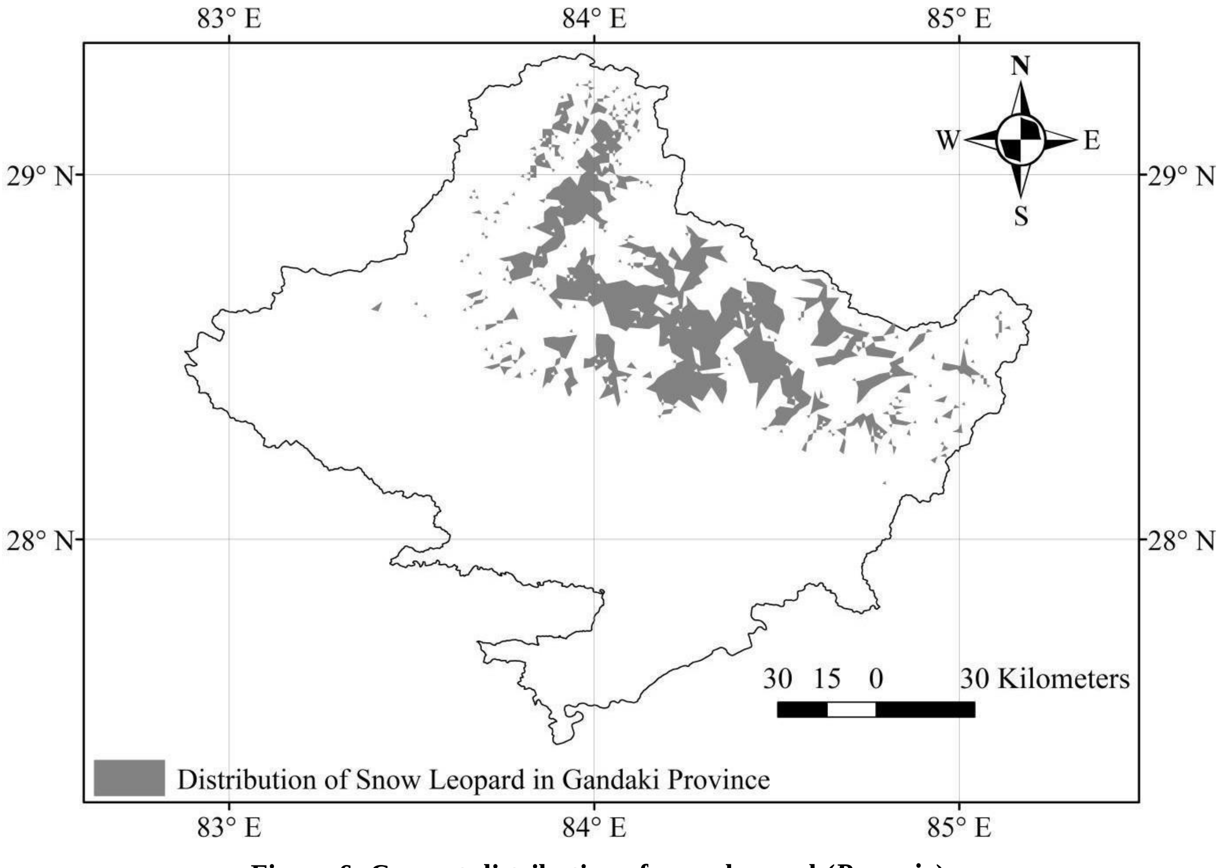

Figure 6: Current distribution of snow leopard (*P. uncia*)

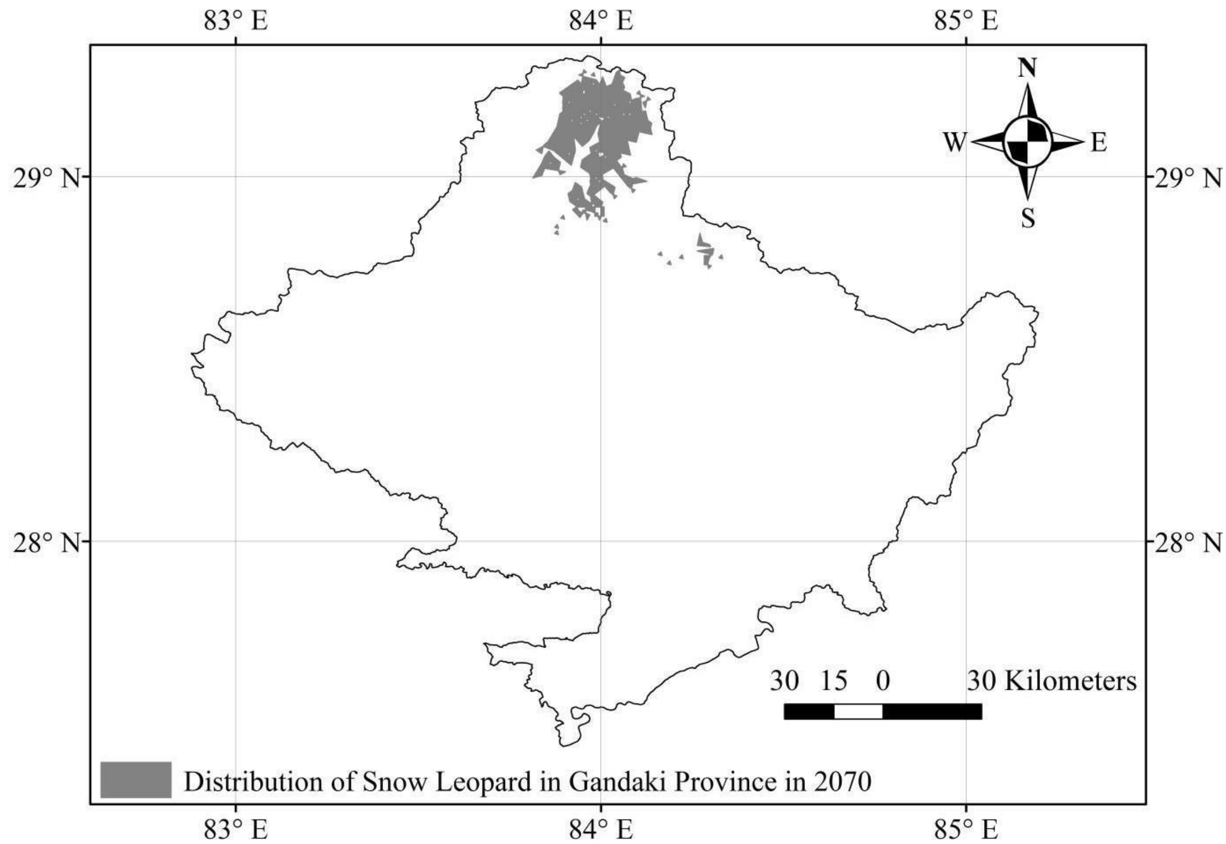

Figure 7: Distribution of snow leopard (*P. uncia*) in 2070

Impact of climate change on high value NTFP

Ban lasun (*A. wallichii*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *A. wallichii* by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 4,679.47 km^2 of the area is identified as the current distributed area of this species (**Figure 8**), but that will be 1,003.81 km^2 in 2070 due to climate change **(Figure 9)**. The distribution of *A. wallichii* will be highly decreased in 2070 due to climate change. The threshold 0.465 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.861 and 0.786, respectively.

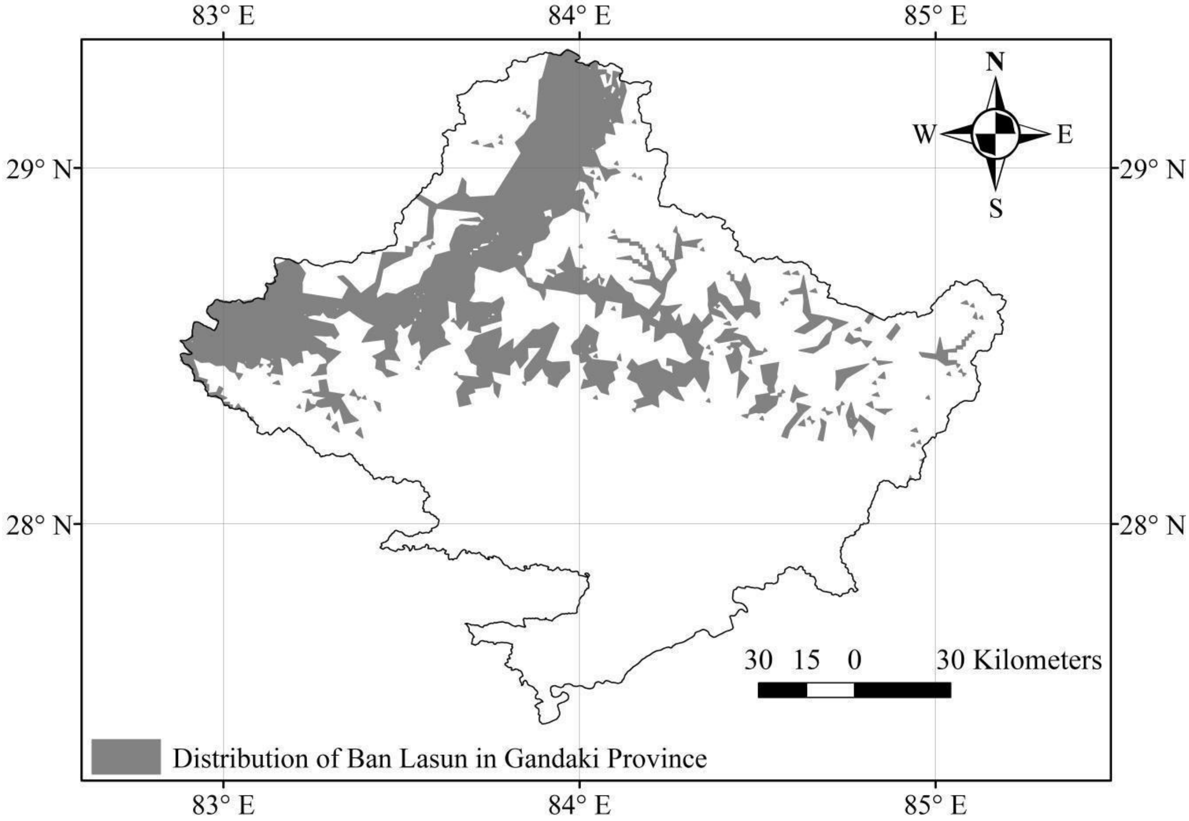

Figure 8: Current distribution of ban lasun (*A. wallichii*)

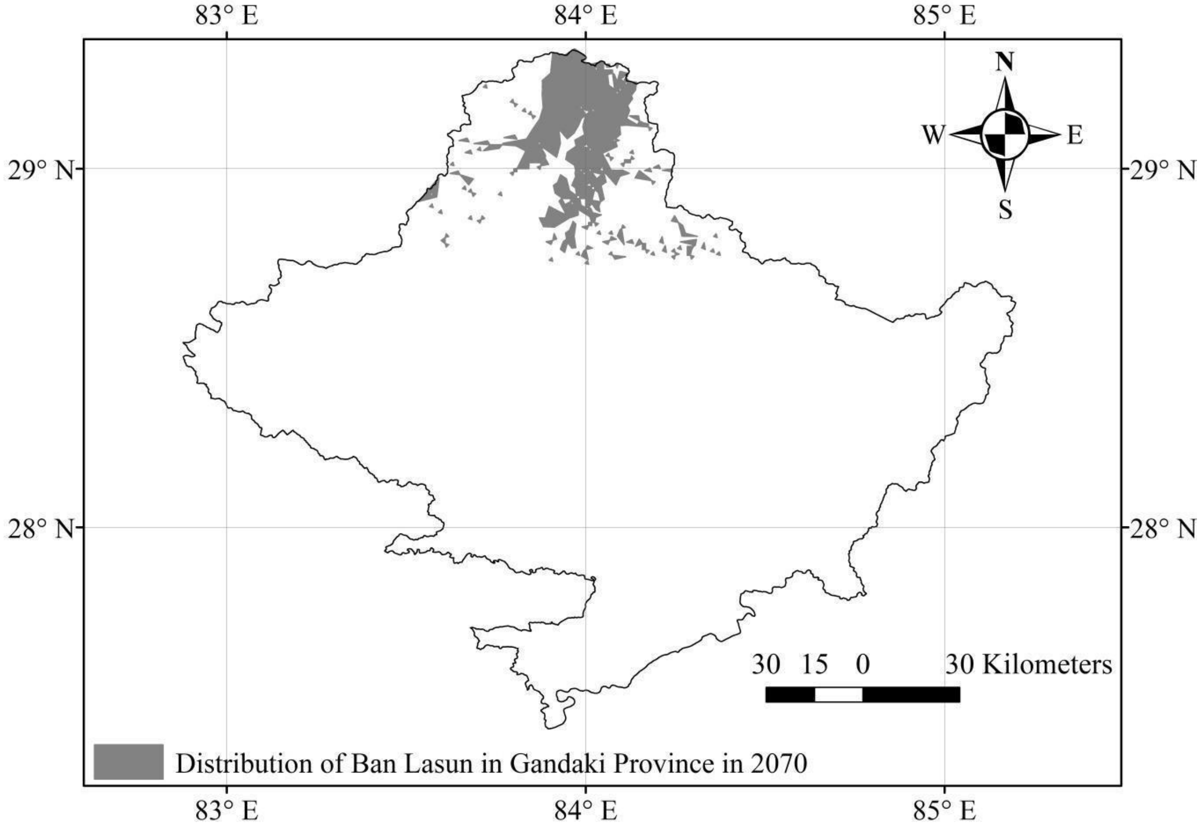

Figure 9: Distribution of ban lasun (*A. wallichii*) in 2070

Chiraito (*S. chiraita*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *S. chiraita* by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 3,848.71 km^2 of the area is identified as the current distributed area of this species (**Figure 10**), but it will be 2,554.20 km^2 in 2070 due to climate change **(Figure 11)**. The distribution of *S. chiraita* will be decreased in 2070 due to climate change. The threshold 0.477 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.679 and 0.531, respectively.

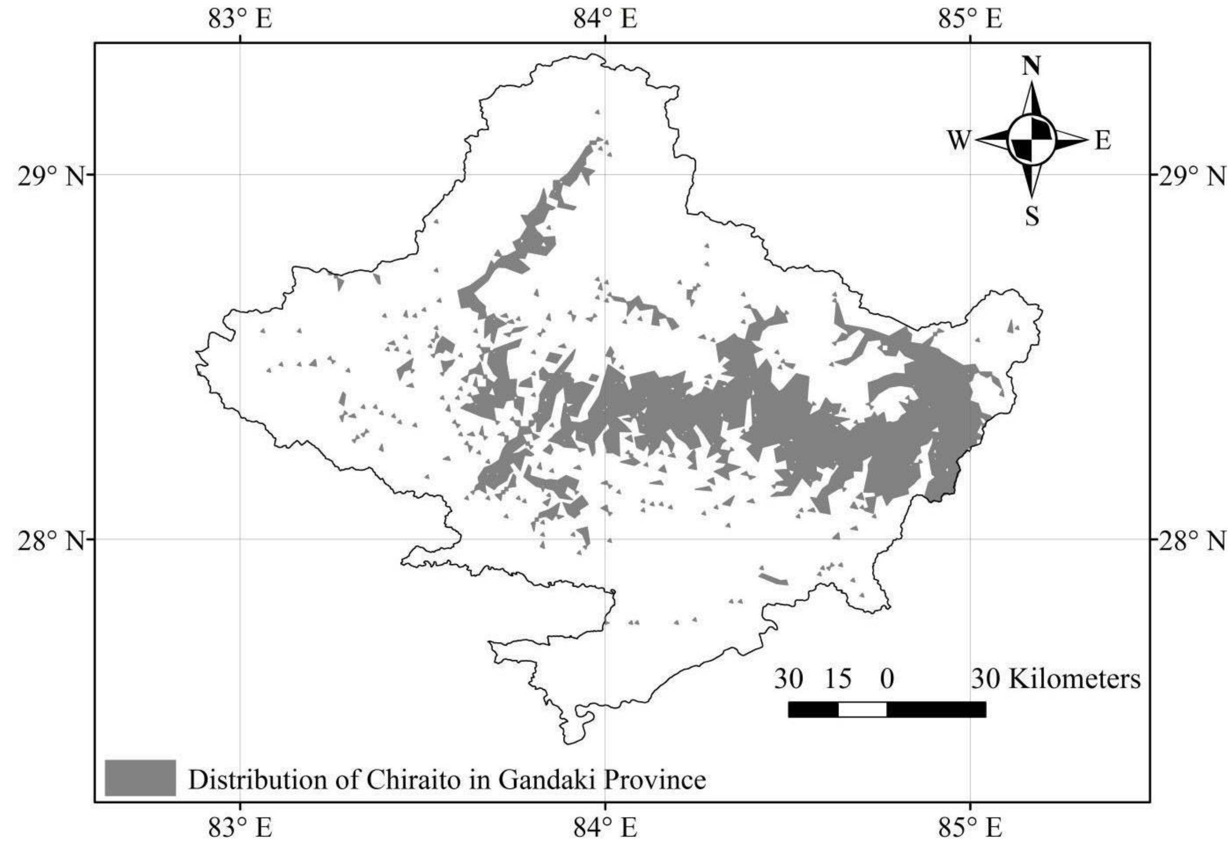

Figure 10: Current distribution of chiraito (*S. chiraita*)

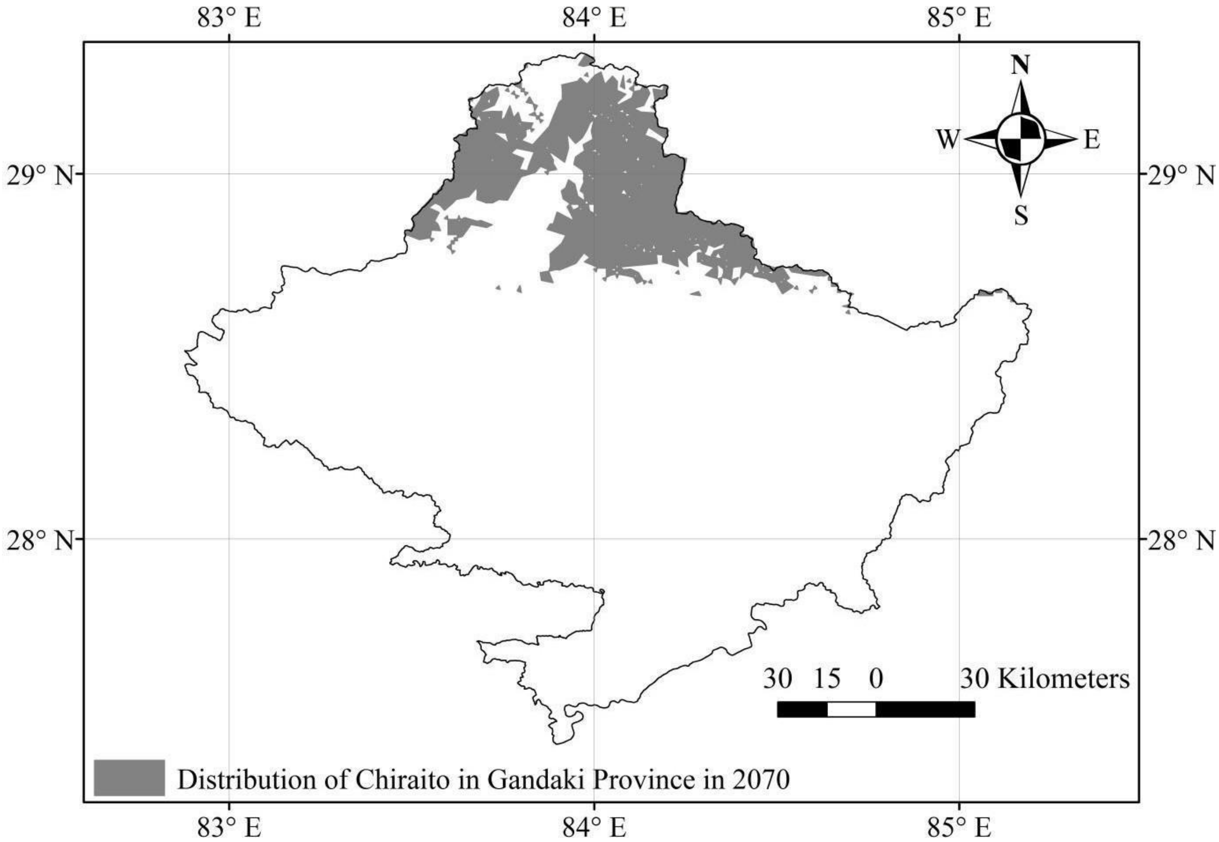

Figure 11: Distribution of chiraito (*S. chiraita*) in 2070

Lokta (*D. bholua*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *D. bholua* by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 5,601.85 km^2 of the area is identified as the current distributed area of this species (**Figure 12**), but it will be 2,207.87 km^2 in 2070 due to climate change **(Figure 13)**. The distribution of *D. bholua* will be decreased remarkably in 2070 due to climate change. The threshold 0.363 was used to convert the continuous map (habitat suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.772 and 0.650, respectively.

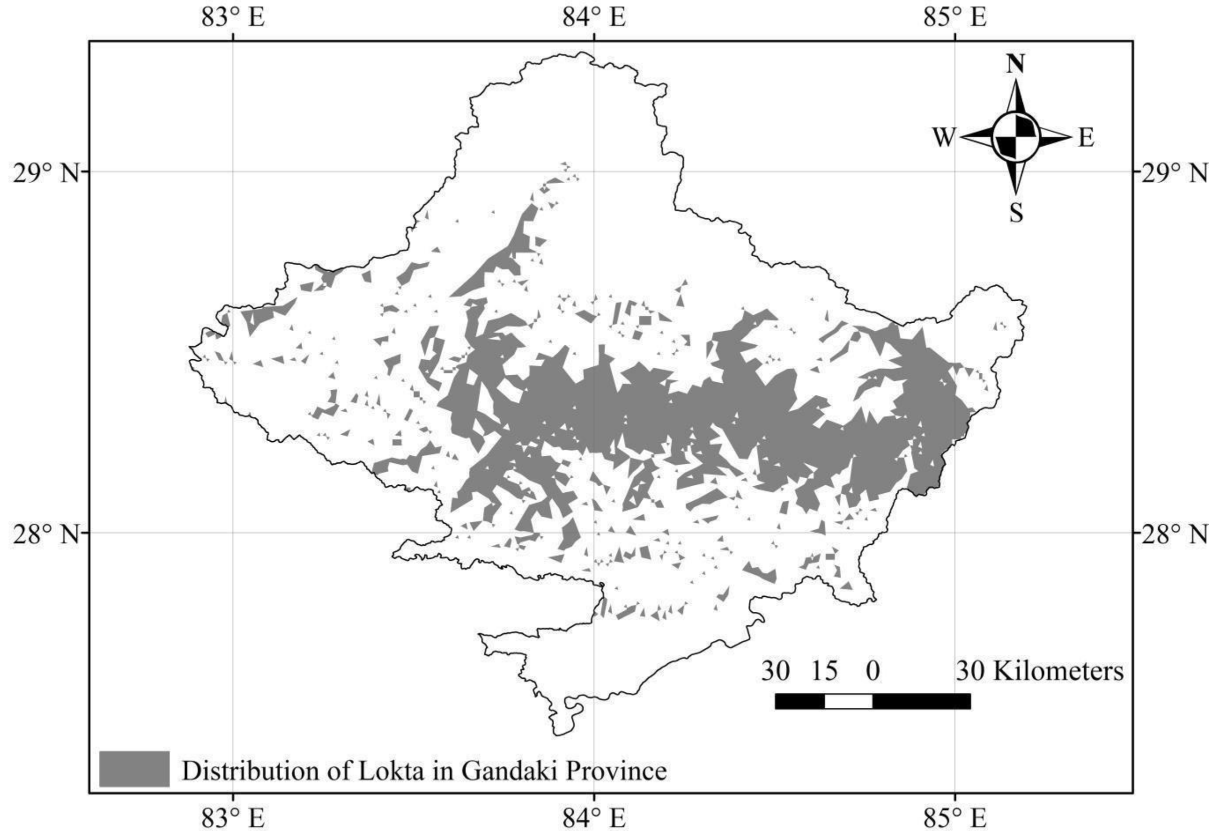

Figure 12: Current distribution of lokta (*D. bholua*)

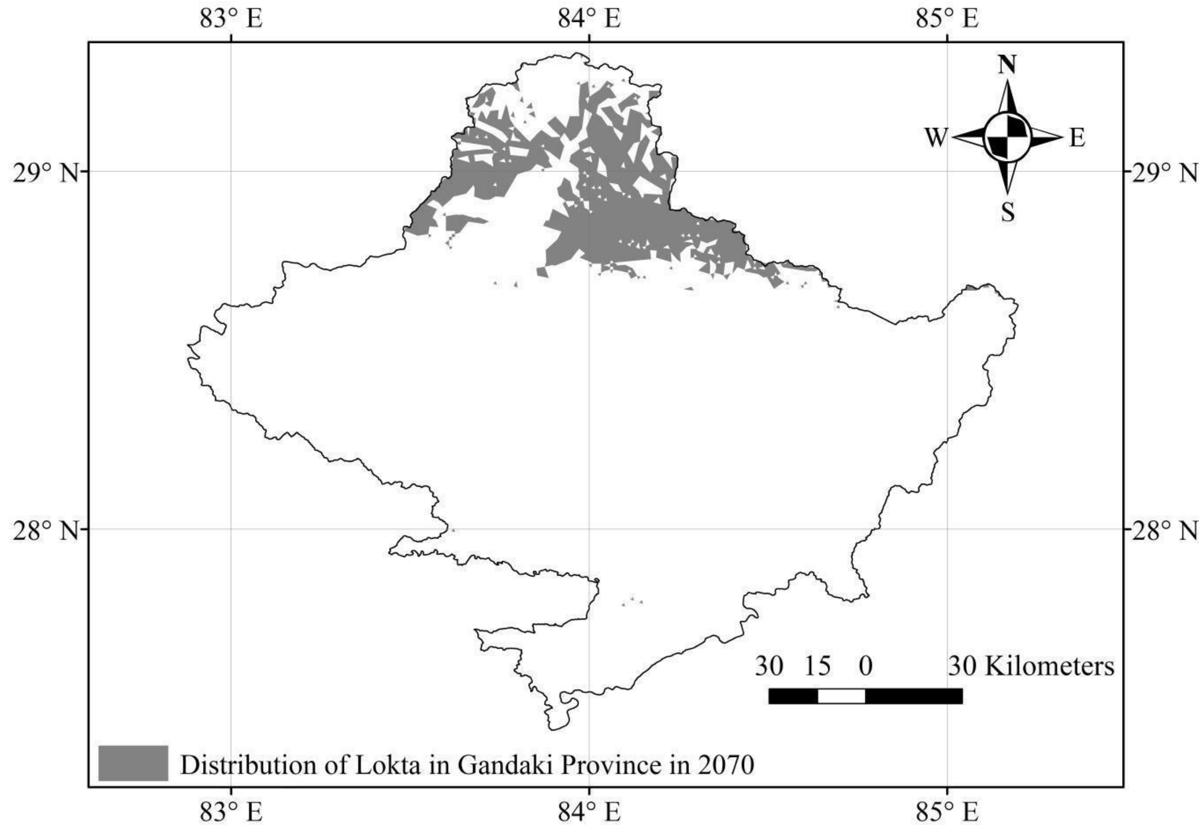

Figure 13: Distribution of lokta (*D. bholua*) in 2070

Impact of climate change on major timber and fuel woodspecies

Chilaune (*S. wallichi*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of *S. wallichi* forest by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 5,663.26 km^2 of the area is identified as a current area of pure *S. wallichi* forest (**Figure 14**), but it will be 327.42 km^2 in 2070 due to climate change **(Figure 15)**. The area of pure *S. wallichi* forest will be decreased significantly in 2070 due to climate change. The threshold 0.216 was used to convert the continuous map (suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.885 and 0.689, respectively. Unlike the animals and NTFPs, the future distribution of pure *S. wallichi* forests will move downward. It may be due to the effect of rainfall rather than temperature.

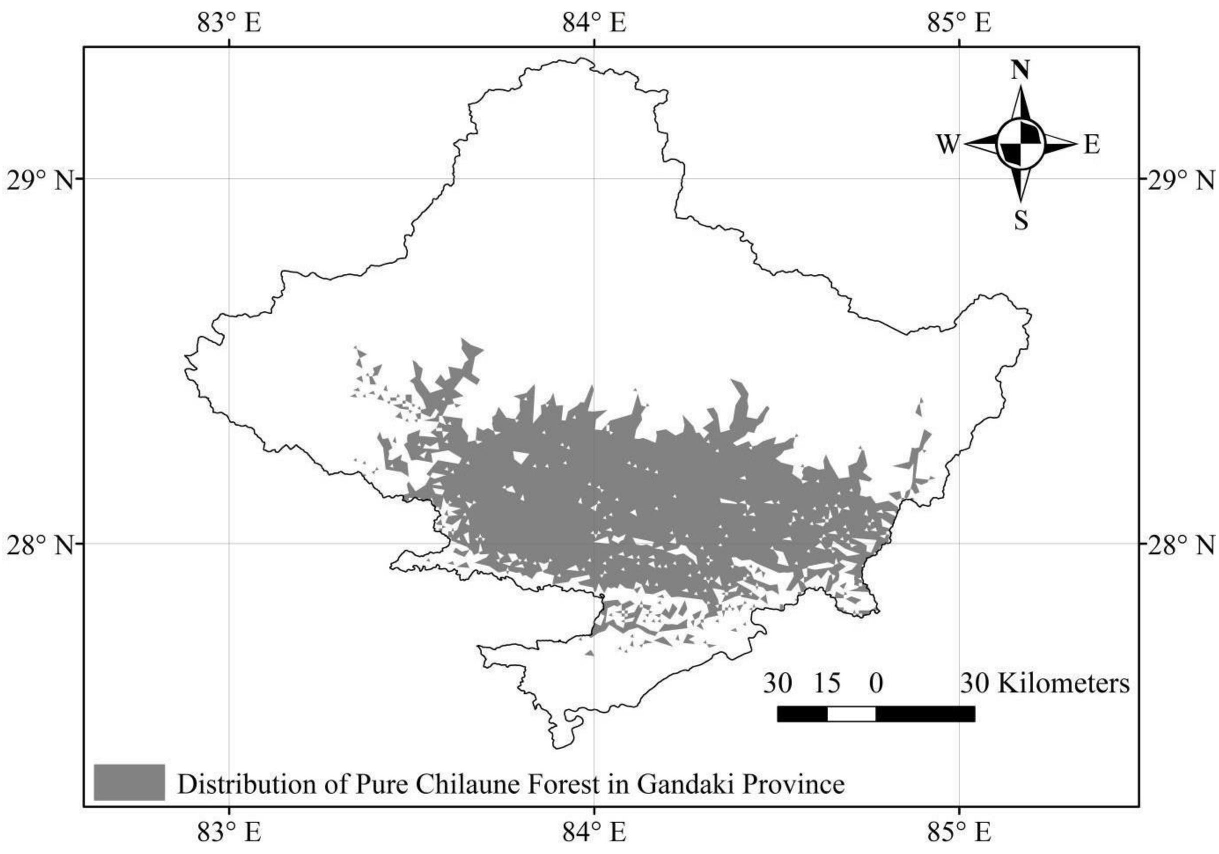

Figure 14: Current distribution of chilaune (*S. wallichi*) forest

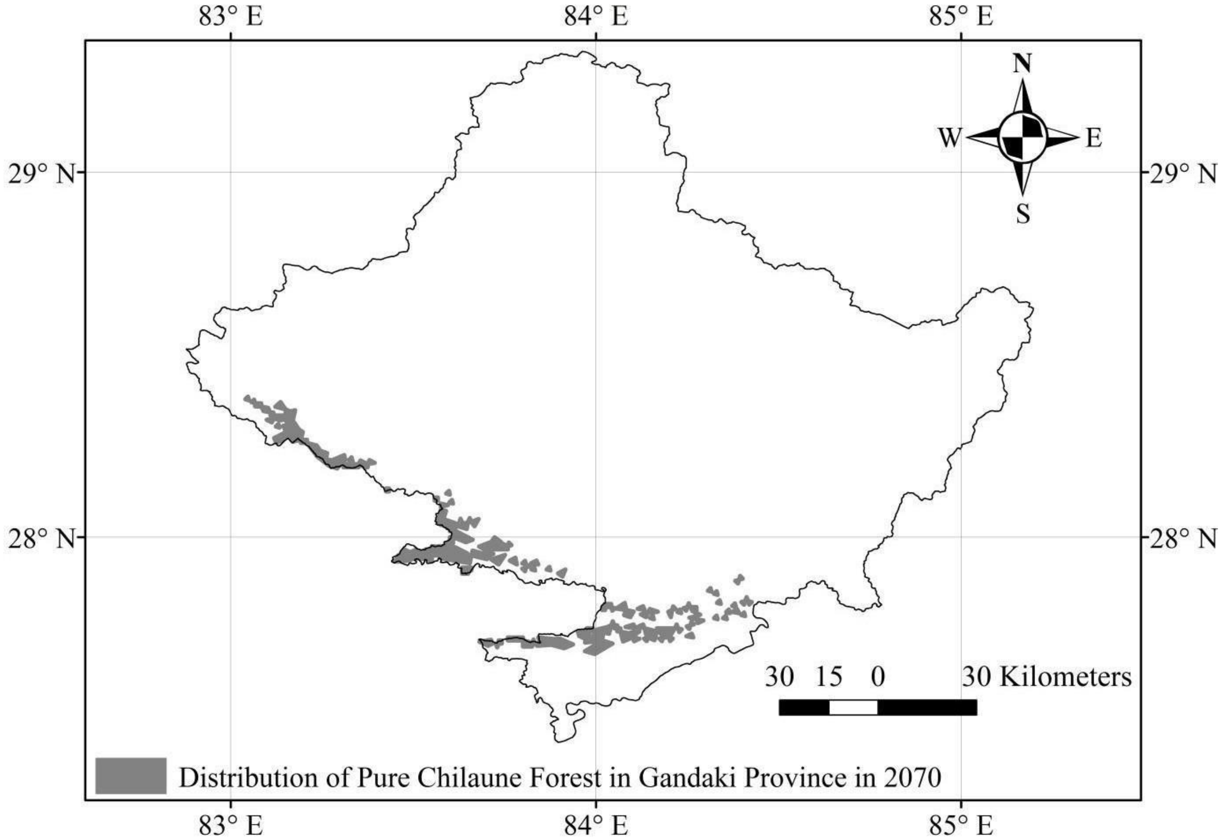

Figure 15: Distribution of pure chilaune (*S. wallichi*) forest in 2070

Sal (*S. robusta*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of pure *S. robusta* forest by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 4,208.83 km^2 of the area is identified as a current area of pure *S. robusta* forest (**Figure 16**), but it will be 212.12 km^2 in 2070 due to climate change **(Figure 17)**. The area of pure *S. robusta* forest will be decreased significantly in 2070 due to climate change. Due to climate change, other species can grow inside the *S. robusta* forest and purity of *S. robusta* forest may be lost. The threshold 0.203 was used to convert the continuous map (suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.902 and 0.774, respectively. Unlike the animals and NTFPs and similar to the *S. wallichi*, the future distribution of pure *S. robusta* forests will move downward. It also may be due to the effect of rainfall rather than temperature.

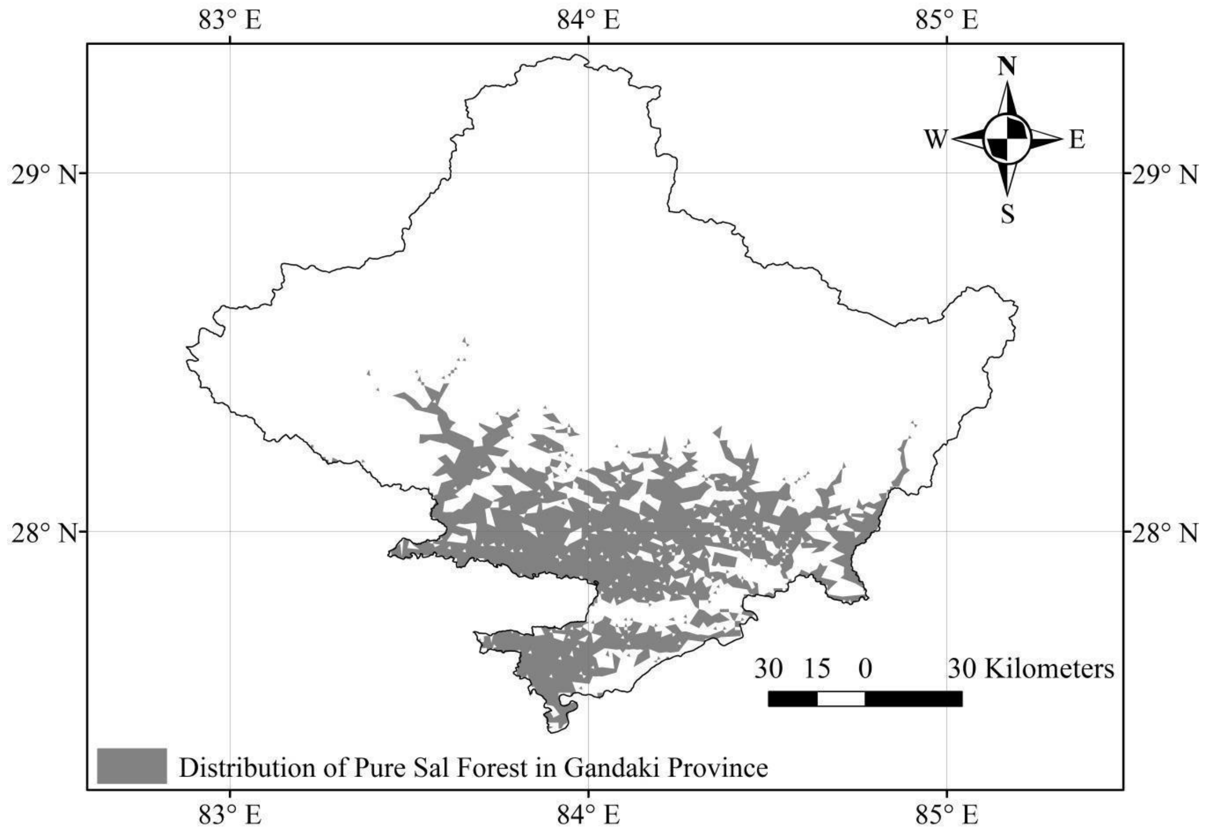

Figure 16: Current distribution of pure sal (*S. robusta*) forest

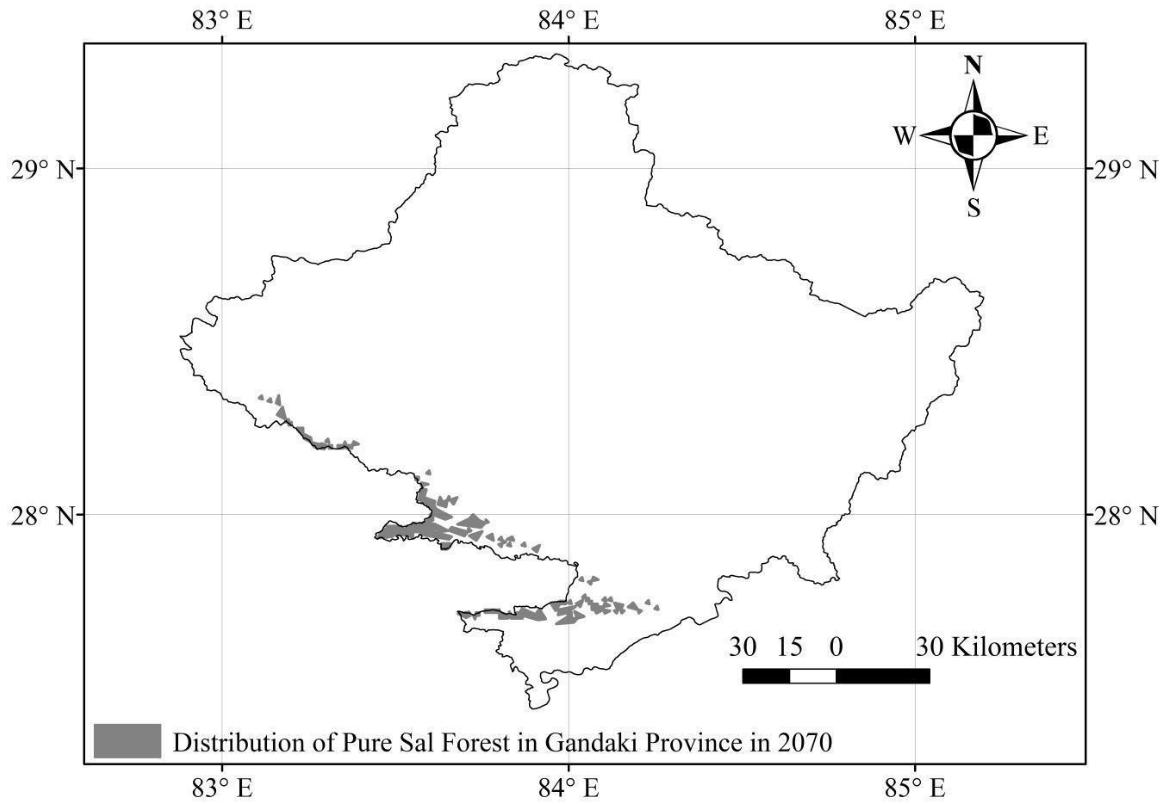

Figure 17: Distribution of pure sal (*S. robusta*) forest in 2070

Utis (*A. nepalensis*)

The MaxEnt model was run to find the current and future (2070) distribution /suitable habitat of pure *A. nepalensis* forest by using 19 bio-climatic (version 1.4) and topographical variables (elevation, aspect, slope). A total of 2,951.93 km^2 of the area is identified as a current area of pure *A. nepalensis* forest (**Figure 18**), but it will be 284.18 km^2 in 2070 due to climate change **(Figure 19)**. The area of pure *A. nepalensis* forest will be decreased significantly in 2070 due to climate change. Due to climate change, other species can grow inside the *A. nepalensis* forest and purity of *A. nepalensis* forest may be lost. The threshold 0.199 was used to convert the continuous map (suitability) to a binary map (suitable/unsuitable). The AUC and TSS of the model are 0.934 and 0.807, respectively.

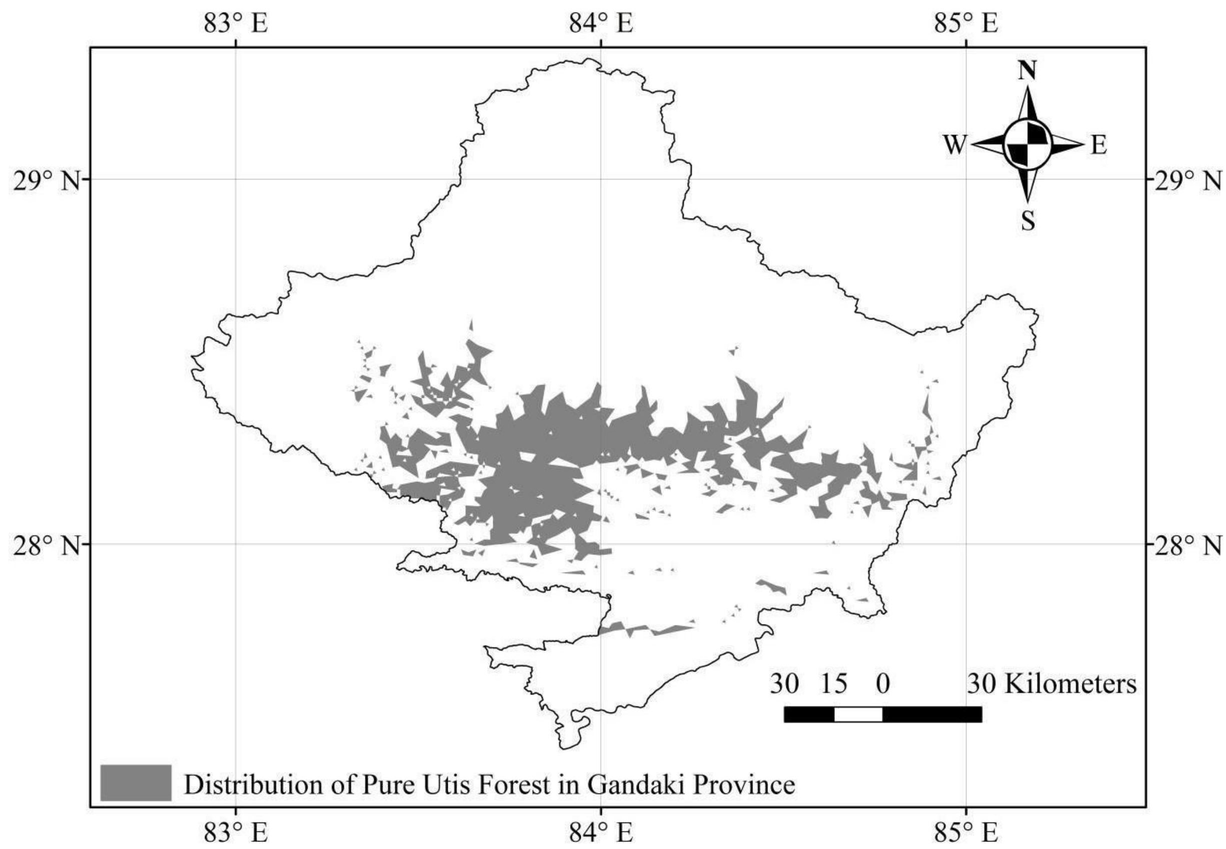

Figure 18: Current distribution of utis (*A. nepalensis*)

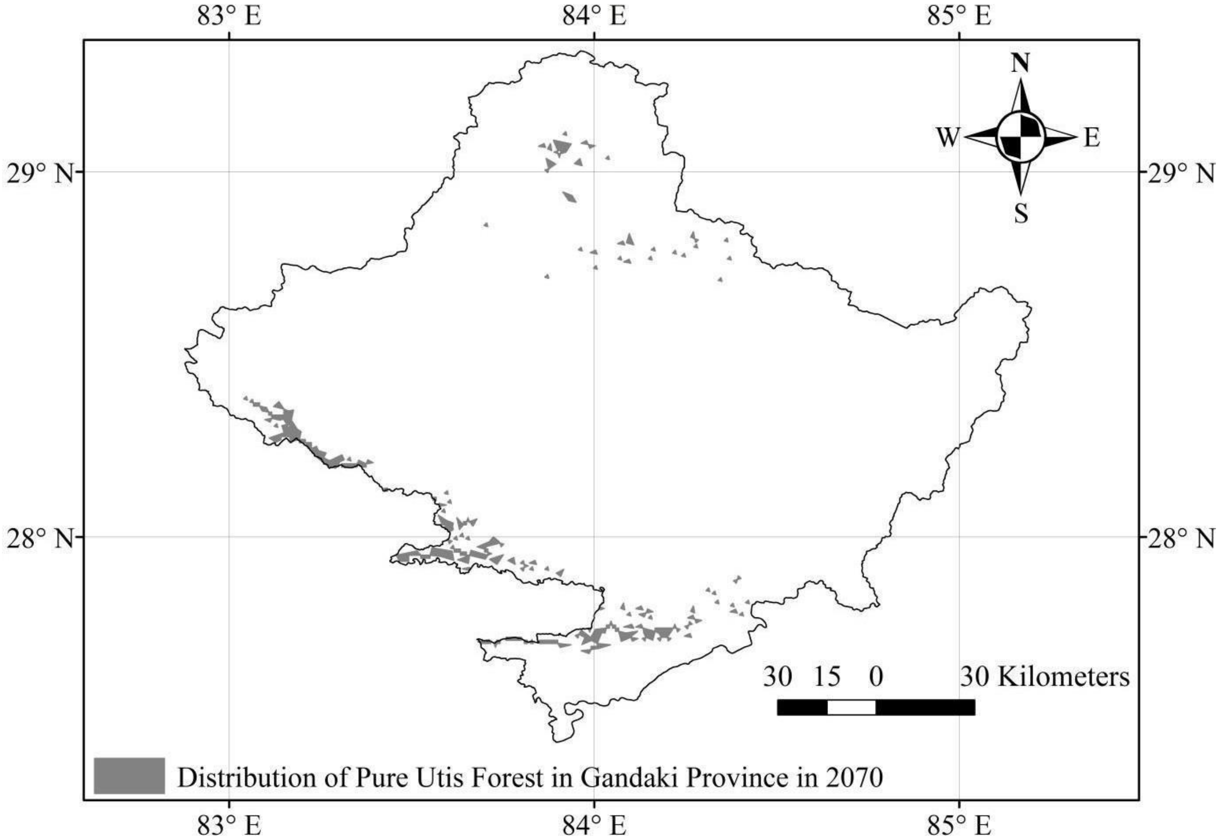

Figure 19: Distribution of utis (*A. nepalensis*) in 2070

4.CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The distribution of threatened wildlife will be decreased remarkably due to impact of climate change in 2070. The current distribution of the *P. pardus* is concentrated around the middle part of the province and that will be shifted towards the northern sides of province. Similarly, the current distribution *M. chrysogaster* and *P. uncia* are stretched east to west at middle to northern side of the province. The future distribution of these animals will be shifted to further northern side of the province. These species might be temperature sensitive therefore they will move upward with rise in temperature.

Similarly, the distribution of the high value NTFP will be decreased due to impact of climate change in 2070. The current distributions of *A. wallichii S. chiraita D. bholua* are stretched at middle part of the province. The distribution of these species will be shifted towards northern side of the province. Similar to the threatened wildlife the high value NTFP may also vulnerable to temperature and move upward with increase in temperature.

The distribution of the major timber and fuel wood species will highly be shrunk in 2070 due to the impact of climate change. Unlike to threatened wildlife and high value NTFP, *S. robusta* and *S. wallichi* will be shifted towards the southern sides of the province. Probably these species may be precipitation sensitive and temperature resilient. The distribution of *A. nepalensis* will be shifted towards the northern and southern sides but not at middle part of the province. Probably they don't care with rise in temperature within the certain limit but they may move towards the suitable precipitation range.

Overall, the impacts of climate change lead to loss of biodiversity due to habitat shift and shrinkage. Threatened fauna and high value NTFP are less climate resilient compared to timber and fuel wood species.

Recommendations

The study analyzed the only impact of climatic change. The result might be different if other variables used. For example, if anthropogenic and vegetation related variables were used, the current distribution of species can be different. Here other factors like edaphic factors, land use change, human management to conserve the species and adaptation, genetic mutation, and resistance to change were not calculated. Generally, this kind of study can be designed for large scale. Due to a small area of the province, some estimates may be inflated. For next, the current distribution of species should be modeled to identify the biodiversity hotspots throughout the province. National level studies are also recommended by co-coordinating with another province for better and reliable results. Moreover, further research on species resilience to climate change may further mainstream ecosystem-based adaptation and landscape-level conservation in the province. The factors affecting the distribution of species also need to be identified. The identified habitat of species should be conserved and managed as an intervention to mitigate the impact of climate change on biodiversity. The policymakers should introduce legislation and plans to tackle the serious impact of climate change. Preparation and implementation of Provincial Adaptation Program of Action (PAPA) to climate change is recommended to conserve the biodiversity. The state agencies, community, academia, and cross-cutting agencies in private sectors should coordinate to implement the programs for climate change impact mitigation and adaptation.

REFERENCES

Acharya, K. P., Paudel, P. K., Neupane, P. R., & Kohl, M. (2016). Human-wildlife conflicts in Nepal: Patterns of human fatalities and injuries caused by large mammals. *PLoS ONE*, *11*, e0161717. https://doi.org/10.1371/journal.pone.0161717

Adams, W. M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., & Hutton, et al. (2004). Biodiversity conservation and the eradication of poverty. *Science, 306*(5699), 1146–1149. https://doi.org/10.1126/science.1097920

Aguilar, G. D., Farnworth, M. J., & Winder, L. (2015). Mapping the stray domestic cat (Felis catus) population in New Zealand: Species distribution modelling with a climate change scenario and implications for protected areas. *Applied Geography*, *63*, 146–154. https://doi.org/10.1016/j.apgeog.2015.06.019

Aryal, A., Shrestha, U. B., Ji, W., Ale, S. B., Shrestha, S., Ingty, T., … Raubenheimer, D. (2016). Predicting the distributions of predator (snow leopard) and prey (blue sheep) under climate change in the Himalaya. *Ecology and Evolution*, *6*(12), 4065–4075. https://doi.org/10.1002/ece3.2196

Ashton, A. (1998). Shorea robusta. *The IUCN Red List of Threatened Species*, e.T32097A9675160. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T32097A9675160.en Copyright:

Barbet-Massin, M., Jiguet, F., Albert, C. H., & Thuiller, W. (2012). Selecting pseudo-absences for species distribution models: how, where and how many? *Methods in Ecology and Evolution*, *3*, 327–338. https://doi.org/10.1111/j.2041-210X.2011.00172.x

Barnekow Lillesø, J. P., Shrestha, T. B., Dhakal, L. P., Nayaju, R. P., & Shrestha, R. (2005). *The map of potential vegetation of Nepal: a forestry/agro-ecological/biodiversity classification system.* Hørsholm: Center for Skov, Landskab og Planlægning/Københavns Universitet. (Development and Environment; No. 2/2005).

Barnes, M. D., Craigie, I. D., Harrison, L. B., Geldmann, J., Collen, B., Whitmee, S., … Woodley, S. (2016). Wildlife population trends in protected areas predicted by national socio-economic metrics and body size. *Nature Communications*, *7*, 1–9. https://doi.org/10.1038/ncomms12747

Bentley, J. M., Catterall, C. P., & Smith, G. C. (2000). Effects of fragmentation of Araucarian vine forest on small mammal communities. *Conservation Biology*, *14*(4), 1075–1087. https://doi.org/10.1046/j.1523-1739.2000.98531.x

Bhattarai, B. R., Wright, W., Poudel, B. S., Aryal, A., Yadav, B. P., & Wagle, R. (2017). Shifting paradigms for Nepal’s protected areas: history, challenges and relationships. *Journal of Mountain Science*, *14*(5), 964–979. https://doi.org/10.1007/s11629-016-3980-9

Blach-Overgaard, A., Balslev, H., Dransfield, J., Normand, S., & Svenning, J. C. (2015). Global-change vulnerability of a key plant resource, the African palms. *Scientific Reports*, *5*, 12611. https://doi.org/10.1038/srep12611

CBS. (2017). *National Climate Change Impact Survey 2016. A Statistical Report*. Central Bureau of Statistics, Kathmandu, Nepal. Retrieved from cbs.gov.np

CITES. (2017). *Appendices I, II and III. Convention on international trade in endangered species of wild fauna and flora*. Retrieved from https://cites.org/eng/app/appendices.php

DNPWC. (2017). *Protected areas of Nepal*. Department of national parks and wildlife conservation, Kathmandu, Nepal. Retrieved from https://drive.google.com/file/d/0B_AvMj98dT2hbXlqR0ZKVldLaXM/view

ESRI. (2017). *ArcGIS Desktop: Release 10.5. Environmental systems research Redlands, California, USA*. Retrieved from https://www.arcgis.com/features/index.html

Fuller, T., Morton, D. P., & Sarkar, S. (2008). Incorporating uncertainty about species’ potential distributions under climate change into the selection of conservation areas with a case study from the Arctic coastal plain of Alaska. *Biological Conservation*, *141*(6), 1547–1559. https://doi.org/10.1016/j.biocon.2008.03.021

Gautam, K. H., & Devoe, N. N. (2005). Ecological and anthropogenic niches of sal (Shorea robusta Gaertn. f.) forest and prospects for multiple-product forest management - A review. *Forestry*, *79*(1), 81–101.

Gillespie, T. W., & Walter, H. (2001). Distribution of bird species richness at a regional scale in tropical dry forest of central America. *Journal of Biogeography*, *28*, 651–662. https://doi.org/10.1046/j.1365-2699.2001.00575.x

Goetz, J. N., Guthrie, R. H., & Brenning, A. (2011). Integrating physical and empirical landslide susceptibility models using generalized additive models. *Geomorphology*, *129*, 376–386. https://doi.org/10.1016/j.geomorph.2011.03.001

Gon/MFSC. (2013). *Value chain desinging of Chiraito of Panchase protected forest area.*

González-Orozco, C. E., Pollock, L. J., Thornhill, A. H., Mishler, B. D., Knerr, N., Laffan, S. W., … Gruber, B. (2016). Phylogenetic approaches reveal biodiversity threats under climate change. *Nature Climate Change*, *6*, 1110–1114. https://doi.org/10.1038/nclimate3126

Guisan, A., Theurillat, J.-P., & Kienast, F. (1998). Predicting the potential distribution of plant species in an alpine environment. *Journal of Vegetation Science*, *9*, 65–74.

https://doi.org/10.2307/3237224

Harris, A. (2016). Moschus chrysogaster , Alpine Musk Deer. *The IUCN Red List of Threatened Species*, e.T13895A61977139. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T13895A61977139.en

Hijmans, R. J., Cameron, S. E., Parra, J. L., Jones, P. G., & Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, *25*(15), 1965–1978. https://doi.org/10.1002/joc.1276

Holt, A. C., Salkeld, D. J., Fritz, C. L., Tucker, J. R., & Gong, P. (2009). Spatial analysis of plague in California : niche modeling predictions of the current distribution and potential response to climate change. *Internationl Journal of Health Geographics*, *14*, 1–14. https://doi.org/10.1186/1476-072X-8-38

Holt, R. D. (1990). The microevolutionary consequences of climate change. *Trends in Ecology and Evolution*, *5*(9), 311–315. https://doi.org/10.1016/0169-5347(90)90088-U

Ichiyanagi, K., Yamanaka, M. D., Murajic, Y., & Vaidyad, B. K. (2007). Precipitation in Nepal between 1987 and 1996. *International Journal of Climatology*, *27*, 1753–1762. https://doi.org/10.1002/joc

IPCC. (2007). *Climate change 2007: The physical science basis*. (S. Solomon, D. Qin, M. Manning, M. Marquis, K. Averyt, M. M. B. Tignor, … Z. Chen, Eds.). New York: Cambridge university press. https://doi.org/10.1038/446727a

Jackson, J. K. (1987). *Manual of Afforestation in Nepal. 2nd edition*. Kathmandu, Nepal: Forest Research and Survey Centre.

Jetz, W., Wilcove, D. S., & Dobson, A. P. (2007). Projected impacts of climate and land-use change on the global diversity of birds. *PLoS Biology*, *5*(6), e157. https://doi.org/10.1371/journal.pbio.0050157

Jiang, Y., Wang, T., De Bie, C. A. J. M., Skidmore, A. K., Liu, X., Song, S., … Shao, X. (2014). Satellite-derived vegetation indices contribute significantly to the prediction of epiphyllous liverworts. *Ecological Indicators*, *38*, 72–80. https://doi.org/10.1016/j.ecolind.2013.10.024

Kushwaha, S. P. S., & Nandy, S. (2012). Species diversity and community structure in sal (Shorea robusta) forests of two different rainfall regimes in West Bengal, India. *Biodiversity and Conservation*, *21*(5), 1215–1228. https://doi.org/10.1007/s10531-012-0264-8

Lamsal, P., Kumar, L., Aryal, A., & Atreya, K. (2018). Future climate and habitat distribution of Himalayan Musk Deer (Moschus chrysogaster). *Ecological Informatics*, *44*(2017), 101–108. https://doi.org/10.1016/j.ecoinf.2018.02.004

Lamsal, P., Kumar, L., Atreya, K., & Pant, K. P. (2017). Vulnerability and impacts of climate change on forest and freshwater wetland ecosystems in Nepal: A review. *Ambio*, *46*, 915–930. https://doi.org/10.1007/s13280-017-0923-9

Liu, C., White, M., & Newell, G. (2013). Selecting thresholds for the prediction of species occurrence with presence-only data. *Journal of Biogeography*, *40*, 778–789. https://doi.org/10.1111/jbi.12058

Lobo, J. M., Jiménez-valverde, A., & Real, R. (2008). AUC: a misleading measure of the performance of predictive distribution models. *Global Ecology and Biogeography*, *17*, 145–151. https://doi.org/10.1111/j.1466-8238.2007.00358.x

Loss, S. R., Will, T., & Marra, P. P. (2013). The impact of free-ranging domestic cats on wildlife of the United States. *Nature Communications*, *4*(1396), 1–7. https://doi.org/10.1038/ncomms2380

Maher, M. J., & Summersgill, I. (1996). A comprehensive methodology for the fitting of predictive accident models. *Accident Analysis and Prevention*, *28*(3), 281–296. https://doi.org/10.1016/0001-4575(95)00059-3

Maxwell, S. L., Fuller, R. A., Brooks, T. M., & Watson, J. E. M. (2016). Biodiversity: The ravages of guns, nets and bulldozers. *Nature*, *536*, 143–145. https://doi.org/10.1038/536143a

McCarthy, T., Mallon, D., Jackson, R., Zahler, P., & McCarthy, K. (2017). *Panthera uncia*. *The IUCN Red List of Threatened Species*. https://doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en

Merow, C., Smith, M. J., & Silander, J. A. (2013). A practical guide to MaxEnt for modeling species' distributions: What it does, and why inputs and settings matter. *Ecography*, *36*(10), 1058–1069. https://doi.org/10.1111/j.1600-0587.2013.07872.x

MoITFE. (2018). *Status paper*. Ministry of Industry, Tourism, Forest and Environment, Gandaki Province, Pokhara.

Murray, K. A., Retallick, R. W. R., Puschendorf, R., Skerratt, L. F., Rosauer, D., McCallum, H. I., … VanDerWal, J. (2011). Assessing spatial patterns of disease risk to biodiversity: Implications for the management of the amphibian pathogen, Batrachochytrium dendrobatidis. *Journal of Applied Ecology*, *48*, 163–173. https://doi.org/10.1111/j.1365-2664.2010.01890.x

Ohsawa, M., Shakya, P. R., & Numata, M. (1986). Distribution and succession of west Himalayan forest types on the eastern part of the Nepal Himalaya. *Mountain Research & Development*, *6*(2), 143–157. https://doi.org/10.2307/3673268

Osborne, P. E., Alonso, J. C., & Bryant, R. G. (2001). Modelling landscape-scale habitat use using GIS and remote sensing: A case study with great bustards. *Journal of Applied Ecology*, *38*, 458–

471. https://doi.org/10.1046/j.1365-2664.2001.00604.x

Panthi, S. (2018). *Predicting current and future habitat suitability for red pandas in Nepal*. MSc thesis. University of Twente,faculty of geoinformation and earth observation, Enschede, Netherlands.

Pearce, J., & Ferrier, S. (2000). Evaluating the predictive performance of habitat models developed using logistic regression. *Ecological Modelling*, *133*, 225–245. https://doi.org/10.1016/S0304-3800(00)00322-7

Phillips, S. J., Anderson, R. P., & Schapire, R. E. (2006). Maximum entropy modelling of species geographic distributions. *Ecological Modelling*, *190*, 231–259. https://doi.org/10.1016/j.ecolmodel.2005.03.026

Pickles, R. S. A., Thornton, D., Feldman, R., Marques, A., & Murray, D. L. (2013). Predicting shifts in parasite distribution with climate change: A multitrophic level approach. *Global Change Biology*, *19*(9), 2645–2654. https://doi.org/10.1111/gcb.12255

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., … Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science*, *344*(6187), 1246752. https://doi.org/10.1126/science.1246752

Renard, Q., lissier, R., Ramesh, B. R., & Kodandapani, N. (2012). Environmental susceptibility model for predicting forest fire occurrence in the Western Ghats of India. *International Journal of Wildland Fire*, *21*, 368–379. https://doi.org/10.1071/WF10109

Rödder, D., & Weinsheimer, F. (2009). Will future anthropogenic climate change increase the potential distribution of the alien invasive Cuban treefrog (Anura: Hylidae)? *Journal of Natural History*, *43*(19–20), 1207–1217. https://doi.org/10.1080/00222930902783752

Shaw, K., Roy, S., & Wilson, B. (2015). Alnus nepalensis. *The IUCN Red List of Threatened Species*, e.T194649A2355690. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2014-3.RLTS.T194649A2355690.en Copyright:

Shrestha, U. B., & Bawa, K. S. (2014). Impact of climate change on potential distribution of Chinese caterpillar fungus (Ophiocordyceps sinensis) in Nepal Himalaya. *PLoS ONE*, *9*(9), e106405. https://doi.org/10.1371/journal.pone.0106405

Shrestha, U. B., Shrestha, S., Chaudhary, P., & Chaudhary, R. P. (2010). How representative is the protected areas system of Nepal? *Mountain Research and Development*, *30*(3), 282–294. https://doi.org/10.1659/MRD-JOURNAL-D-10-00019.1

Simberloff, D. (1998). Flagships, umbrellas, and keystones: Is single-species management passe in the landscape era? *Biological Conservation*, *83*(3), 247–257. https://doi.org/10.1016/S0006-3207(97)00081-5

Stein, A. B., Athreya, V., Gerngross, P., Balme, G., Henschel, P., Karanth, U., … Ghoddousi, A. (2016). Errata version. *The IUCN Red List of Threatened Species*, *8235*, e.T15954A102421779. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2016- 1.RLTS.T15954A50659089.en [see

Thomson, A. M., Calvin, K. V., Smith, S. J., Kyle, G. P., Volke, A., Patel, P., … Edmonds, J. A. (2011). RCP4.5: A pathway for stabilization of radiative forcing by 2100. *Climatic Change*, *109*(1), 77–94. https://doi.org/10.1007/s10584-011-0151-4

Tittensor, D. P., Walpole, M., Hill, S. L. L., Boyce, D. G., Britten, G. L., Burgess, N. D., … Cheung, W. W. L. (2014). A mid-term analysis of progress toward international biodiversity targets. *Science*, *346*(6206), 241–244. https://doi.org/10.1126/science.1257484

Tiwari, U., Adams, S. J., Begum, S. N., Krishnamurthy, K. V, Ravikumar, K., & Padma, V. (2014). Pharmacognostic studies on two Himalayan species of traditional medicinal value : Allium wallichii and Allium stracheyi. *Notulae Scientia Biologicae*, *6*(2), 149–154. https://doi.org/10.15835/nsb.6.2.9308

Uddin, K., Chaudhary, S., Chettri, N., Kotru, R., Murthy, M., Chaudhary, R. P., … Gautam, S. K. (2015). The changing land cover and fragmenting forest on the roof of the world: A case study in Nepal's Kailash sacred landscape. *Landscape and Urban Planning*, *141*, 1–10. https://doi.org/10.1016/j.landurbplan.2015.04.003

Wang, T., Ye, X., Skidmore, A. K., & Toxopeus, A. G. (2010). Characterizing the spatial distribution of giant pandas (Ailuropoda melanoleuca) in fragmented forest landscapes. *Journal of Biogeography*, *37*(5), 865–878. https://doi.org/10.1111/j.1365-2699.2009.02259.x

Watanabe, M., Suzuki, T., O'Ishi, R., Komuro, Y., Watanabe, S., Emori, S., … Kimoto, M. (2010). Improved climate simulation by MIROC5: Mean states, variability, and climate sensitivity. *Journal of Climate*, *23*, 6312–6335. https://doi.org/10.1175/2010JCLI3679.1

Wiley, E. O., McNyset, K. M., Peterson, A. T., Robins, C. R., & Stewart, A. M. (2003). Niche modeling and geographic range predictions in the marine environment using a machine-learning algorithm. *Oceanography*, *16*(3), 120–127. https://doi.org/http://dx.doi.org/10.5670/oceanog.2003.42

Williemas, P., Burgess, N., & Rahbeck, C. (2000). Flagship species, ecological complementary and conserving the diversity of mammals and bird in sub-Sahara Africa. *Animal Conservation*, *3*, 249–260.

Wilsey, B. J. B., & Potvin, C. (2000). Biodiversity and ecosystem functioning: Importance of species evenness in an old field. *Ecology*, *81*(4), 887–892. https://doi.org/10.1890/0012-9658(2000)081[0887:BAEFIO]2.0.CO;2

Appendix

I. Details of accuracy assessment of nine species

Common leopard (*P. pardus*)

Replicates	Threshold	AUC	TSS
0	0.460	0.829	0.613
1	0.510	0.909	0.704
2	0.180	0.908	0.733
3	0.050	0.818	0.473
4	0.410	0.910	0.697
5	0.350	0.917	0.648
6	0.340	0.858	0.648
7	0.460	0.927	0.790
8	0.210	0.936	0.768
9	0.340	0.881	0.651
Average	0.331	0.889	0.673
Std	0.145	0.041	0.090

Musk deer (*Moschus chrysogaster*)

Replicates	Threshold	AUC	TSS
0	0.110	0.984	0.728
1	0.110	0.989	0.939
2	0.180	0.984	0.959
3	0.110	0.971	0.860
4	0.130	0.985	0.944
5	0.210	0.986	0.966
6	0.130	0.986	0.940
7	0.180	0.988	0.950
8	0.080	0.982	0.919
9	0.120	0.981	0.946
Average	0.136	0.984	0.915
Std	0.041	0.005	0.072

Snow leopard (*P. uncia*)

Replicates	Threshold	AUC	TSS
0	0.440	0.899	0.678
1	0.350	0.877	0.601
2	0.120	0.933	0.768
3	0.310	0.953	0.878

4	0.420	0.909	0.742
5	0.160	0.913	0.696
6	0.120	0.897	0.694
7	0.220	0.894	0.670
8	0.120	0.897	0.747
9	0.180	0.918	0.760
Average	0.244	0.909	0.723
Std	0.126	0.022	0.074

Ban lasun (*A. wallichii*)

Replicates	Threshold	AUC	TSS
0	0.550	0.893	0.871
1	0.240	0.718	0.684
2	0.340	0.828	0.641
3	0.560	0.916	0.864
4	0.500	0.872	0.783
5	0.550	0.905	0.857
6	0.570	0.907	0.881
7	0.550	0.913	0.852
8	0.410	0.827	0.733
9	0.380	0.827	0.695
Average	0.465	0.861	0.786
Std	0.115	0.062	0.091

Chiraito (*S. chiraita*)

Replicates	Threshold	AUC	TSS
0	0.540	0.838	0.797
1	0.580	0.548	0.424
2	0.540	0.838	0.797
3	0.640	0.529	0.440
4	0.160	0.444	0.232
5	0.730	0.696	0.482
6	0.450	0.802	0.617
7	0.490	0.795	0.667
8	0.190	0.496	0.240
9	0.450	0.802	0.617
Average	0.477	0.679	0.531
Std	0.181	0.157	0.203

Lokta (*D. bholua*)

Replicates	Threshold	AUC	TSS
0	0.570	0.902	0.873
1	0.210	0.700	0.504
2	0.480	0.862	0.826

3	0.230	0.631	0.353
4	0.530	0.872	0.849
5	0.260	0.721	0.564
6	0.320	0.739	0.697
7	0.230	0.631	0.353
8	0.390	0.828	0.757
9	0.410	0.829	0.728
Average	0.363	0.772	0.650
Std	0.133	0.100	0.196

Chilaune (*S. wallichi*)

Replicates	Threshold	AUC	TSS
0	0.370	0.906	0.755
1	0.190	0.886	0.716
2	0.310	0.900	0.699
3	0.090	0.870	0.667
4	0.210	0.856	0.603
5	0.170	0.893	0.690
6	0.300	0.883	0.701
7	0.140	0.879	0.699
8	0.260	0.895	0.697
9	0.120	0.883	0.659
Average	0.216	0.885	0.689
Std	0.091	0.015	0.040

Sal (*S. robusta*)

Replicates	Threshold	AUC	TSS
0	0.070	0.860	0.699
1	0.210	0.906	0.822
2	0.100	0.910	0.728
3	0.390	0.932	0.813
4	0.170	0.878	0.709
5	0.310	0.921	0.777
6	0.340	0.919	0.714
7	0.230	0.901	0.834
8	0.020	0.888	0.834
9	0.190	0.907	0.815
Average	0.203	0.902	0.774
Std	0.120	0.022	0.056

Utis (*A. nepalensis*)

Replicates	Threshold	AUC	TSS
0	0.120	0.926	0.822
1	0.380	0.963	0.847
2	0.080	0.926	0.791

3	0.240	0.917	0.773
4	0.300	0.955	0.881
5	0.040	0.916	0.685
6	0.290	0.958	0.885
7	0.200	0.913	0.768
8	0.070	0.913	0.742
9	0.270	0.953	0.880
Average	0.199	0.934	0.807
Std	0.116	0.021	0.067

II. Data used for modeling

S.N.	Species	X	Y
1	Ban lasun (*A. wallichii*)	83.18998	28.55548
2	Ban lasun (*A. wallichii*)	83.20606	28.55229
3	Ban lasun (*A. wallichii*)	83.20679	28.55185
4	Ban lasun (*A. wallichii*)	82.93751	28.53490
5	Ban lasun (*A. wallichii*)	82.93498	28.54590
6	Ban lasun (*A. wallichii*)	84.35396	28.57075
7	Ban lasun (*A. wallichii*)	84.46121	28.52190
8	Ban lasun (*A. wallichii*)	84.47712	28.51094
9	Ban lasun (*A. wallichii*)	84.46752	28.65118
10	Ban lasun (*A. wallichii*)	84.46863	28.65855
11	Ban lasun (*A. wallichii*)	84.46934	28.66158
12	Ban lasun (*A. wallichii*)	84.46928	28.66167
13	Ban lasun (*A. wallichii*)	84.47009	28.66493
14	Chilaune (*S. wallichi*)	83.64411	28.31783
15	Chilaune (*S. wallichi*)	83.82722	28.23325
16	Chilaune (*S. wallichi*)	84.02359	27.92290
17	Chilaune (*S. wallichi*)	84.07788	27.91868
18	Chilaune (*S. wallichi*)	84.08696	27.91763
19	Chilaune (*S. wallichi*)	84.08696	27.91763
20	Chilaune (*S. wallichi*)	83.97147	27.89306
21	Chilaune (*S. wallichi*)	84.04013	27.90945
22	Chilaune (*S. wallichi*)	84.11002	28.16296
23	Chilaune (*S. wallichi*)	84.11662	28.16654
24	Chilaune (*S. wallichi*)	84.36656	28.01332
25	Chilaune (*S. wallichi*)	84.36913	28.00727
26	Chilaune (*S. wallichi*)	84.38068	27.99693
27	Chilaune (*S. wallichi*)	83.89998	28.24270
28	Chilaune (*S. wallichi*)	83.85497	28.23742
29	Chilaune (*S. wallichi*)	83.85789	28.23175
30	Chilaune (*S. wallichi*)	83.76675	28.20734
31	Chilaune (*S. wallichi*)	83.72668	28.22337
32	Chilaune (*S. wallichi*)	83.88789	28.27542
33	Chilaune (*S. wallichi*)	83.93979	28.25097
34	Chilaune (*S. wallichi*)	84.56291	27.96974
35	Chilaune (*S. wallichi*)	84.58558	28.03976
36	Chilaune (*S. wallichi*)	84.58689	28.05236
37	Chilaune (*S. wallichi*)	84.57809	28.07713
38	Chilaune (*S. wallichi*)	84.59145	28.07951
39	Chilaune (*S. wallichi*)	84.58294	28.09153
40	Chilaune (*S. wallichi*)	84.58163	28.09266

41	Chilaune (*S. wallichi*)	84.58455	28.10290
42	Chilaune (*S. wallichi*)	84.60802	28.10231
43	Chilaune (*S. wallichi*)	84.41232	27.97330
44	Chilaune (*S. wallichi*)	84.42394	27.98339
45	Chilaune (*S. wallichi*)	84.43880	28.10089
46	Chilaune (*S. wallichi*)	84.43158	28.17175
47	Chilaune (*S. wallichi*)	84.42768	28.18135
48	Chilaune (*S. wallichi*)	84.34799	28.23239
49	Chilaune (*S. wallichi*)	84.34842	28.24153
50	Chilaune (*S. wallichi*)	84.34870	28.24271
51	Chilaune (*S. wallichi*)	84.35117	28.24356
52	Chilaune (*S. wallichi*)	84.52122	28.10337
53	Chilaune (*S. wallichi*)	84.52468	28.10537
54	Chilaune (*S. wallichi*)	84.52272	28.10300
55	Chilaune (*S. wallichi*)	84.48673	28.09428
56	Chilaune (*S. wallichi*)	84.10781	28.02402
57	Chilaune (*S. wallichi*)	84.11947	27.93358
58	Chilaune (*S. wallichi*)	84.10797	27.76424
59	Chilaune (*S. wallichi*)	84.05863	28.23628
60	Chilaune (*S. wallichi*)	84.06832	28.26033
61	Chilaune (*S. wallichi*)	84.07022	28.26647
62	Chilaune (*S. wallichi*)	84.07107	28.26864
63	Chilaune (*S. wallichi*)	83.77670	28.19351
64	Chilaune (*S. wallichi*)	83.84445	28.17051
65	Chilaune (*S. wallichi*)	83.83756	28.16100
66	Chilaune (*S. wallichi*)	83.88287	28.15306
67	Chilaune (*S. wallichi*)	83.80499	28.17652
68	Chilaune (*S. wallichi*)	83.80378	28.17438
69	Chilaune (*S. wallichi*)	83.84381	28.17546
70	Chilaune (*S. wallichi*)	83.83815	28.17227
71	Chilaune (*S. wallichi*)	83.89711	28.17451
72	Chilaune (*S. wallichi*)	83.89776	28.17468
73	Chilaune (*S. wallichi*)	83.80019	28.16234
74	Chilaune (*S. wallichi*)	83.79428	28.19829
75	Chilaune (*S. wallichi*)	83.79879	28.20583
76	Chilaune (*S. wallichi*)	83.82777	28.16024
77	Chilaune (*S. wallichi*)	83.88193	28.18245
78	Chilaune (*S. wallichi*)	83.87901	28.18048
79	Chilaune (*S. wallichi*)	83.78731	28.19753
80	Chilaune (*S. wallichi*)	83.78625	28.19896
81	Chilaune (*S. wallichi*)	83.43421	28.21788
82	Chilaune (*S. wallichi*)	83.46265	28.38835

83	Chilaune (*S. wallichi*)	83.45608	28.39282
84	Chilaune (*S. wallichi*)	83.66655	28.17703
85	Chilaune (*S. wallichi*)	83.60197	28.32615
86	Chilaune (*S. wallichi*)	83.59862	28.38312
87	Chilaune (*S. wallichi*)	83.74101	28.17210
88	Chilaune (*S. wallichi*)	83.67046	28.16433
89	Chilaune (*S. wallichi*)	83.58751	28.07579
90	Chilaune (*S. wallichi*)	83.69539	28.26262
91	Chilaune (*S. wallichi*)	83.65418	28.16055
92	Chilaune (*S. wallichi*)	83.80400	28.05856
93	Chilaune (*S. wallichi*)	83.86160	28.07711
94	Chilaune (*S. wallichi*)	83.86848	28.06377
95	Chilaune (*S. wallichi*)	83.77717	28.08370
96	Chilaune (*S. wallichi*)	84.57763	28.13369
97	Chilaune (*S. wallichi*)	84.30260	28.08349
98	Chilaune (*S. wallichi*)	84.30555	28.08445
99	Chilaune (*S. wallichi*)	84.30711	28.08382
100	Chilaune (*S. wallichi*)	84.30751	28.08287
101	Chilaune (*S. wallichi*)	84.39166	28.08184
102	Chilaune (*S. wallichi*)	84.31937	27.94216
103	Chilaune (*S. wallichi*)	84.32178	27.94398
104	Chilaune (*S. wallichi*)	84.32516	27.94374
105	Chilaune (*S. wallichi*)	84.28519	27.89746
106	Chilaune (*S. wallichi*)	84.18162	27.90208
107	Chilaune (*S. wallichi*)	84.23115	28.10455
108	Chilaune (*S. wallichi*)	84.22629	28.11806
109	Chilaune (*S. wallichi*)	84.25961	28.25239
110	Chilaune (*S. wallichi*)	84.25612	28.25682
111	Chilaune (*S. wallichi*)	84.26081	28.27071
112	Chilaune (*S. wallichi*)	84.26551	28.27027
113	Chilaune (*S. wallichi*)	84.26594	28.26942
114	Chilaune (*S. wallichi*)	84.07990	28.20250
115	Chilaune (*S. wallichi*)	84.11805	28.16760
116	Chilaune (*S. wallichi*)	84.10682	28.15794
117	Chilaune (*S. wallichi*)	84.10634	28.15596
118	Chilaune (*S. wallichi*)	83.76452	28.20893
119	Chilaune (*S. wallichi*)	83.96490	28.24647
120	Chilaune (*S. wallichi*)	83.97410	28.24508
121	Chilaune (*S. wallichi*)	84.41519	28.18886
122	Chilaune (*S. wallichi*)	84.33773	28.23899
123	Chilaune (*S. wallichi*)	84.31791	28.24254
124	Chiraito (*S. chiraita*)	83.78927	28.23327

125	Chiraito (*S. chiraita*)	83.79083	28.23060
126	Chiraito (*S. chiraita*)	83.61733	28.36251
127	Chiraito (*S. chiraita*)	83.64778	28.34852
128	Chiraito (*S. chiraita*)	84.41468	28.57839
129	Chiraito (*S. chiraita*)	84.41084	28.57360
130	Chiraito (*S. chiraita*)	84.41765	28.58940
131	Chiraito (*S. chiraita*)	84.36721	28.58767
132	Chiraito (*S. chiraita*)	84.41666	28.58029
133	Chiraito (*S. chiraita*)	84.41468	28.57839
134	Chiraito (*S. chiraita*)	84.41192	28.57526
135	Common leopard (*P. pardus*)	84.02602	27.92235
136	Common leopard (*P. pardus*)	84.05997	27.84808
137	Common leopard (*P. pardus*)	84.08226	28.20166
138	Common leopard (*P. pardus*)	83.79653	28.22918
139	Common leopard (*P. pardus*)	83.79083	28.23060
140	Common leopard (*P. pardus*)	83.79313	28.22832
141	Common leopard (*P. pardus*)	83.79320	28.22595
142	Common leopard (*P. pardus*)	83.79590	28.22210
143	Common leopard (*P. pardus*)	84.34842	28.24153
144	Common leopard (*P. pardus*)	84.52204	28.10948
145	Common leopard (*P. pardus*)	84.51845	28.11412
146	Common leopard (*P. pardus*)	84.31298	28.26294
147	Common leopard (*P. pardus*)	83.80369	28.22178
148	Common leopard (*P. pardus*)	83.80018	28.22713
149	Common leopard (*P. pardus*)	83.79650	28.22923
150	Common leopard (*P. pardus*)	84.17971	27.76727
151	Common leopard (*P. pardus*)	83.85235	28.14201
152	Common leopard (*P. pardus*)	83.83472	28.15082
153	Common leopard (*P. pardus*)	83.83764	28.15546
154	Common leopard (*P. pardus*)	83.83830	28.15797
155	Common leopard (*P. pardus*)	83.83756	28.16100
156	Common leopard (*P. pardus*)	83.83121	28.18099
157	Common leopard (*P. pardus*)	83.82972	28.18802
158	Common leopard (*P. pardus*)	83.80640	28.18953
159	Common leopard (*P. pardus*)	83.77628	28.18936
160	Common leopard (*P. pardus*)	83.77670	28.19351
161	Common leopard (*P. pardus*)	83.77210	28.18597
162	Common leopard (*P. pardus*)	83.77809	28.17507
163	Common leopard (*P. pardus*)	83.80499	28.17652
164	Common leopard (*P. pardus*)	83.80378	28.17438
165	Common leopard (*P. pardus*)	83.84381	28.17546
166	Common leopard (*P. pardus*)	83.84445	28.17051

167	Common leopard (*P. pardus*)	83.83815	28.17227
168	Common leopard (*P. pardus*)	83.89711	28.17451
169	Common leopard (*P. pardus*)	83.89776	28.17468
170	Common leopard (*P. pardus*)	83.80019	28.16234
171	Common leopard (*P. pardus*)	83.80030	28.16245
172	Common leopard (*P. pardus*)	83.79428	28.19829
173	Common leopard (*P. pardus*)	83.79364	28.19803
174	Common leopard (*P. pardus*)	83.79879	28.20583
175	Common leopard (*P. pardus*)	83.82893	28.15968
176	Common leopard (*P. pardus*)	83.88193	28.18245
177	Common leopard (*P. pardus*)	83.87901	28.18048
178	Common leopard (*P. pardus*)	83.78731	28.19753
179	Common leopard (*P. pardus*)	83.78625	28.19896
180	Common leopard (*P. pardus*)	83.86890	28.17505
181	Common leopard (*P. pardus*)	83.86665	28.17489
182	Common leopard (*P. pardus*)	83.77670	28.17007
183	Common leopard (*P. pardus*)	83.77235	28.17232
184	Common leopard (*P. pardus*)	83.76847	28.16808
185	Common leopard (*P. pardus*)	83.76725	28.16654
186	Common leopard (*P. pardus*)	83.76683	28.16627
187	Common leopard (*P. pardus*)	83.77399	28.16573
188	Common leopard (*P. pardus*)	83.77354	28.16701
189	Common leopard (*P. pardus*)	83.78180	28.16447
190	Common leopard (*P. pardus*)	83.79545	28.16211
191	Common leopard (*P. pardus*)	83.79470	28.15987
192	Common leopard (*P. pardus*)	83.44870	2.88977
193	Common leopard (*P. pardus*)	83.77809	28.17507
194	Common leopard (*P. pardus*)	83.77721	28.17569
195	Common leopard (*P. pardus*)	83.77755	28.17720
196	Common leopard (*P. pardus*)	83.77010	28.17859
197	Common leopard (*P. pardus*)	83.76937	28.18272
198	Common leopard (*P. pardus*)	83.77059	28.18325
199	Common leopard (*P. pardus*)	83.76785	28.18204
200	Common leopard (*P. pardus*)	83.77210	28.18597
201	Common leopard (*P. pardus*)	83.78242	28.19161
202	Common leopard (*P. pardus*)	83.78492	28.18117
203	Common leopard (*P. pardus*)	83.84431	28.13261
204	Common leopard (*P. pardus*)	83.84396	28.13170
205	Common leopard (*P. pardus*)	83.84801	28.12852
206	Common leopard (*P. pardus*)	83.84081	28.12934
207	Common leopard (*P. pardus*)	83.83860	28.13285
208	Common leopard (*P. pardus*)	83.82539	28.13481

209	Common leopard (*P. pardus*)	83.82455	28.13548
210	Common leopard (*P. pardus*)	83.82774	28.13616
211	Common leopard (*P. pardus*)	83.79257	28.17753
212	Common leopard (*P. pardus*)	83.79257	28.17753
213	Common leopard (*P. pardus*)	83.80058	28.26604
214	Common leopard (*P. pardus*)	83.80260	28.17403
215	Common leopard (*P. pardus*)	83.80524	28.17321
216	Common leopard (*P. pardus*)	83.80625	28.17333
217	Common leopard (*P. pardus*)	83.86029	28.15445
218	Common leopard (*P. pardus*)	83.85234	28.15725
219	Common leopard (*P. pardus*)	83.84588	28.16098
220	Common leopard (*P. pardus*)	83.81062	28.17389
221	Common leopard (*P. pardus*)	83.81044	28.17012
222	Common leopard (*P. pardus*)	83.81151	28.16617
223	Common leopard (*P. pardus*)	83.81693	28.15820
224	Common leopard (*P. pardus*)	83.81700	28.15702
225	Common leopard (*P. pardus*)	83.81745	28.15662
226	Common leopard (*P. pardus*)	83.81859	28.15934
227	Common leopard (*P. pardus*)	83.82977	28.15826
228	Common leopard (*P. pardus*)	83.83024	28.15825
229	Common leopard (*P. pardus*)	83.83073	28.15914
230	Common leopard (*P. pardus*)	83.83524	28.14966
231	Common leopard (*P. pardus*)	83.82910	28.18887
232	Common leopard (*P. pardus*)	83.82952	28.18999
233	Common leopard (*P. pardus*)	83.82920	28.18685
234	Common leopard (*P. pardus*)	83.82625	28.18012
235	Common leopard (*P. pardus*)	83.82430	28.18227
236	Common leopard (*P. pardus*)	83.82358	28.18428
237	Common leopard (*P. pardus*)	83.81936	28.18614
238	Common leopard (*P. pardus*)	83.80188	28.19062
239	Common leopard (*P. pardus*)	83.80163	28.19033
240	Common leopard (*P. pardus*)	83.80139	28.19045
241	Common leopard (*P. pardus*)	83.80114	28.19079
242	Common leopard (*P. pardus*)	83.80081	28.19085
243	Common leopard (*P. pardus*)	83.79854	28.19233
244	Common leopard (*P. pardus*)	83.79885	28.19260
245	Common leopard (*P. pardus*)	83.80612	28.20114
246	Common leopard (*P. pardus*)	83.79993	28.19981
247	Common leopard (*P. pardus*)	83.79877	28.19804
248	Common leopard (*P. pardus*)	83.80017	28.18621
249	Common leopard (*P. pardus*)	83.79898	28.18466
250	Common leopard (*P. pardus*)	83.80003	28.18205

251	Common leopard (*P. pardus*)	83.79443	28.19254
252	Common leopard (*P. pardus*)	83.79438	28.19286
253	Common leopard (*P. pardus*)	83.79402	28.19196
254	Common leopard (*P. pardus*)	83.78964	28.19730
255	Common leopard (*P. pardus*)	83.77845	28.19509
256	Common leopard (*P. pardus*)	83.78765	28.19594
257	Common leopard (*P. pardus*)	83.78576	28.18671
258	Common leopard (*P. pardus*)	83.78717	28.18190
259	Common leopard (*P. pardus*)	83.88364	28.16091
260	Common leopard (*P. pardus*)	83.88168	28.15243
261	Common leopard (*P. pardus*)	83.15668	28.34012
262	Common leopard (*P. pardus*)	82.98697	28.41509
263	Common leopard (*P. pardus*)	83.62228	28.17987
264	Common leopard (*P. pardus*)	83.61101	28.18487
265	Common leopard (*P. pardus*)	83.36506	28.52694
266	Common leopard (*P. pardus*)	83.85670	28.45675
267	Common leopard (*P. pardus*)	84.50012	28.05711
268	Common leopard (*P. pardus*)	84.44269	28.52603
269	Common leopard (*P. pardus*)	84.46121	28.52190
270	Common leopard (*P. pardus*)	84.45856	28.52303
271	Common leopard (*P. pardus*)	84.41073	28.57242
272	Common leopard (*P. pardus*)	84.41083	28.57302
273	Common leopard (*P. pardus*)	84.47409	28.66557
274	Lokta (*D. bholua*)	83.78927	28.23327
275	Lokta (*D. bholua*)	83.79083	28.23060
276	Lokta (*D. bholua*)	83.79313	28.22832
277	Lokta (*D. bholua*)	83.79320	28.22595
278	Lokta (*D. bholua*)	83.81178	28.21740
279	Lokta (*D. bholua*)	83.31924	28.29354
280	Lokta (*D. bholua*)	83.65897	28.31837
281	Lokta (*D. bholua*)	84.38582	28.54675
282	Lokta (*D. bholua*)	84.40474	28.55469
283	Lokta (*D. bholua*)	84.42129	28.59463
284	Lokta (*D. bholua*)	84.42576	28.59598
285	Lokta (*D. bholua*)	84.41029	28.57448
286	Lokta (*D. bholua*)	84.38582	28.54675
287	Lokta (*D. bholua*)	84.41666	28.58029
288	Lokta (*D. bholua*)	84.40474	28.55469
289	Lokta (*D. bholua*)	84.42129	28.59463
290	Lokta (*D. bholua*)	84.42576	28.59598
291	Lokta (*D. bholua*)	84.41029	28.57448
292	Lokta (*D. bholua*)	83.80369	28.22178

293	Musk deer (*M. chrysogaster*)	84.10232	28.65026
294	Musk deer (*M. chrysogaster*)	84.10310	28.65061
295	Musk deer (*M. chrysogaster*)	84.10509	28.65232
296	Musk deer (*M. chrysogaster*)	84.10646	28.65332
297	Musk deer (*M. chrysogaster*)	84.10845	28.65373
298	Musk deer (*M. chrysogaster*)	84.10884	28.65440
299	Musk deer (*M. chrysogaster*)	84.10646	28.65620
300	Musk deer (*M. chrysogaster*)	84.10607	28.65659
301	Musk deer (*M. chrysogaster*)	84.10537	28.65590
302	Musk deer (*M. chrysogaster*)	84.10464	28.65308
303	Musk deer (*M. chrysogaster*)	84.10373	28.65177
304	Musk deer (*M. chrysogaster*)	84.10519	28.64685
305	Musk deer (*M. chrysogaster*)	84.10511	28.64488
306	Musk deer (*M. chrysogaster*)	84.10557	28.64426
307	Musk deer (*M. chrysogaster*)	84.10730	28.64482
308	Musk deer (*M. chrysogaster*)	84.10985	28.64283
309	Musk deer (*M. chrysogaster*)	84.11154	28.64166
310	Musk deer (*M. chrysogaster*)	84.11190	28.64189
311	Musk deer (*M. chrysogaster*)	84.11268	28.64222
312	Musk deer (*M. chrysogaster*)	84.11621	28.64125
313	Musk deer (*M. chrysogaster*)	84.11699	28.64336
314	Musk deer (*M. chrysogaster*)	84.11807	28.64242
315	Musk deer (*M. chrysogaster*)	84.11992	28.64264
316	Musk deer (*M. chrysogaster*)	84.12215	28.64407
317	Musk deer (*M. chrysogaster*)	84.12295	28.64201
318	Musk deer (*M. chrysogaster*)	84.12602	28.64240
319	Musk deer (*M. chrysogaster*)	84.13153	28.64495
320	Musk deer (*M. chrysogaster*)	84.13752	28.64372
321	Musk deer (*M. chrysogaster*)	84.13674	28.64570
322	Musk deer (*M. chrysogaster*)	84.13893	28.64710
323	Musk deer (*M. chrysogaster*)	84.13955	28.64647
324	Musk deer (*M. chrysogaster*)	84.13983	28.64682
325	Musk deer (*M. chrysogaster*)	84.14036	28.64664
326	Musk deer (*M. chrysogaster*)	84.14031	28.64708
327	Musk deer (*M. chrysogaster*)	84.14033	28.64739
328	Musk deer (*M. chrysogaster*)	84.14020	28.64786
329	Musk deer (*M. chrysogaster*)	84.14023	28.64813
330	Musk deer (*M. chrysogaster*)	84.14046	28.64820
331	Musk deer (*M. chrysogaster*)	84.14080	28.64827
332	Musk deer (*M. chrysogaster*)	84.14054	28.64849
333	Musk deer (*M. chrysogaster*)	84.14017	28.64876
334	Musk deer (*M. chrysogaster*)	84.13801	28.63889

335	Musk deer (*M. chrysogaster*)	84.13721	28.63871
336	Musk deer (*M. chrysogaster*)	84.13764	28.63777
337	Musk deer (*M. chrysogaster*)	84.14540	28.63658
338	Musk deer (*M. chrysogaster*)	84.13679	28.63576
339	Musk deer (*M. chrysogaster*)	84.13604	28.63453
340	Musk deer (*M. chrysogaster*)	84.13610	28.63117
341	Musk deer (*M. chrysogaster*)	84.13772	28.62733
342	Musk deer (*M. chrysogaster*)	84.14017	28.62561
343	Musk deer (*M. chrysogaster*)	84.14234	28.62305
344	Musk deer (*M. chrysogaster*)	84.14606	28.62164
345	Musk deer (*M. chrysogaster*)	84.14856	28.61923
346	Musk deer (*M. chrysogaster*)	84.47163	28.61104
347	Musk deer (*M. chrysogaster*)	84.47294	28.61054
348	Musk deer (*M. chrysogaster*)	84.47245	28.61168
349	Musk deer (*M. chrysogaster*)	84.47253	28.61390
350	Musk deer (*M. chrysogaster*)	84.47268	28.61465
351	Musk deer (*M. chrysogaster*)	84.47039	28.61551
352	Musk deer (*M. chrysogaster*)	84.47287	28.61681
353	Musk deer (*M. chrysogaster*)	84.47370	28.61807
354	Musk deer (*M. chrysogaster*)	84.46485	28.62124
355	Musk deer (*M. chrysogaster*)	84.47342	28.62443
356	Musk deer (*M. chrysogaster*)	84.46849	28.64831
357	Musk deer (*M. chrysogaster*)	84.46782	28.65041
358	Musk deer (*M. chrysogaster*)	84.46716	28.65117
359	Musk deer (*M. chrysogaster*)	84.46668	28.65239
360	Musk deer (*M. chrysogaster*)	84.46687	28.65514
361	Musk deer (*M. chrysogaster*)	84.46767	28.65592
362	Musk deer (*M. chrysogaster*)	84.47258	28.62615
363	Musk deer (*M. chrysogaster*)	84.47015	28.62339
364	Musk deer (*M. chrysogaster*)	84.47055	28.62222
365	Musk deer (*M. chrysogaster*)	84.47025	28.62047
366	Musk deer (*M. chrysogaster*)	84.14318	28.60280
367	Musk deer (*M. chrysogaster*)	84.14224	28.60295
368	Musk deer (*M. chrysogaster*)	84.14149	28.60244
369	Musk deer (*M. chrysogaster*)	84.14064	28.60242
370	Musk deer (*M. chrysogaster*)	84.13966	28.60240
371	Musk deer (*M. chrysogaster*)	84.14318	28.60248
372	Musk deer (*M. chrysogaster*)	84.14121	28.60244
373	Musk deer (*M. chrysogaster*)	84.14032	28.60242
374	Musk deer (*M. chrysogaster*)	84.13930	28.60240
375	Musk deer (*M. chrysogaster*)	84.17775	28.59559
376	Musk deer (*M. chrysogaster*)	84.18508	28.59538

377	Musk deer (*M. chrysogaster*)	84.18503	28.59627
378	Musk deer (*M. chrysogaster*)	84.18409	28.59675
379	Musk deer (*M. chrysogaster*)	84.18577	28.59874
380	Musk deer (*M. chrysogaster*)	84.18516	28.59943
381	Musk deer (*M. chrysogaster*)	84.10344	28.62262
382	Musk deer (*M. chrysogaster*)	84.10365	28.62381
383	Musk deer (*M. chrysogaster*)	84.10080	28.62434
384	Musk deer (*M. chrysogaster*)	84.09986	28.62431
385	Musk deer (*M. chrysogaster*)	84.09976	28.62426
386	Musk deer (*M. chrysogaster*)	84.09776	28.62515
387	Musk deer (*M. chrysogaster*)	84.09808	28.63012
388	Musk deer (*M. chrysogaster*)	84.09529	28.62986
389	Musk deer (*M. chrysogaster*)	84.15008	28.63843
390	Musk deer (*M. chrysogaster*)	84.14959	28.63771
391	Musk deer (*M. chrysogaster*)	84.14906	28.63625
392	Musk deer (*M. chrysogaster*)	84.14363	28.63361
393	Musk deer (*M. chrysogaster*)	84.14366	28.63409
394	Musk deer (*M. chrysogaster*)	84.14461	28.63461
395	Musk deer (*M. chrysogaster*)	89.99164	28.67990
396	Musk deer (*M. chrysogaster*)	89.99121	28.68021
397	Musk deer (*M. chrysogaster*)	89.99321	28.67980
398	Musk deer (*M. chrysogaster*)	84.35267	28.56946
399	Musk deer (*M. chrysogaster*)	84.35149	28.56873
400	Musk deer (*M. chrysogaster*)	83.18904	28.56009
401	Musk deer (*M. chrysogaster*)	83.18482	28.56021
402	Musk deer (*M. chrysogaster*)	83.18390	28.55786
403	Musk deer (*M. chrysogaster*)	83.18530	28.55737
404	Musk deer (*M. chrysogaster*)	83.18639	28.55697
405	Musk deer (*M. chrysogaster*)	83.18750	28.55627
406	Musk deer (*M. chrysogaster*)	83.18990	28.55561
407	Musk deer (*M. chrysogaster*)	83.18998	28.55548
408	Musk deer (*M. chrysogaster*)	83.18981	28.55544
409	Musk deer (*M. chrysogaster*)	83.19009	28.55592
410	Musk deer (*M. chrysogaster*)	83.19051	28.55593
411	Musk deer (*M. chrysogaster*)	83.18344	28.55787
412	Musk deer (*M. chrysogaster*)	83.19127	28.55440
413	Musk deer (*M. chrysogaster*)	83.20410	28.55314
414	Musk deer (*M. chrysogaster*)	83.20601	28.55232
415	Musk deer (*M. chrysogaster*)	83.20606	28.55229
416	Musk deer (*M. chrysogaster*)	83.20679	28.55185
417	Musk deer (*M. chrysogaster*)	82.93751	28.53490
418	Musk deer (*M. chrysogaster*)	82.93498	28.54590

419	Musk deer (*M. chrysogaster*)	82.93451	28.54951
420	Musk deer (*M. chrysogaster*)	82.93505	28.54898
421	Musk deer (*M. chrysogaster*)	82.93505	28.54899
422	Musk deer (*M. chrysogaster*)	82.93616	28.54850
423	Musk deer (*M. chrysogaster*)	82.93617	28.54687
424	Musk deer (*M. chrysogaster*)	82.93575	28.54624
425	Musk deer (*M. chrysogaster*)	82.93624	28.54761
426	Musk deer (*M. chrysogaster*)	83.99217	28.66414
427	Musk deer (*M. chrysogaster*)	84.05283	28.63972
428	Musk deer (*M. chrysogaster*)	84.00042	28.66386
429	Musk deer (*M. chrysogaster*)	84.05319	28.64111
430	Musk deer (*M. chrysogaster*)	83.98108	28.66131
431	Musk deer (*M. chrysogaster*)	83.93944	28.66978
432	Musk deer (*M. chrysogaster*)	83.93556	28.67417
433	Musk deer (*M. chrysogaster*)	83.05523	28.60030
434	Musk deer (*M. chrysogaster*)	83.04290	28.59250
435	Musk deer (*M. chrysogaster*)	83.04377	28.59202
436	Sal (*S. robusta*)	84.02602	27.92235
437	Sal (*S. robusta*)	84.07678	27.91857
438	Sal (*S. robusta*)	84.09295	27.90048
439	Sal (*S. robusta*)	84.08970	27.86983
440	Sal (*S. robusta*)	83.72668	28.22337
441	Sal (*S. robusta*)	83.74501	28.27910
442	Sal (*S. robusta*)	84.55296	27.92884
443	Sal (*S. robusta*)	84.57025	28.00402
444	Sal (*S. robusta*)	84.60264	27.96765
445	Sal (*S. robusta*)	84.41232	27.97330
446	Sal (*S. robusta*)	83.66071	28.24175
447	Sal (*S. robusta*)	84.52578	28.10756
448	Sal (*S. robusta*)	84.51845	28.11412
449	Sal (*S. robusta*)	84.51854	28.11527
450	Sal (*S. robusta*)	83.61412	28.25677
451	Sal (*S. robusta*)	84.06486	28.25410
452	Sal (*S. robusta*)	83.83764	28.15546
453	Sal (*S. robusta*)	83.83472	28.15082
454	Sal (*S. robusta*)	83.83830	28.15797
455	Sal (*S. robusta*)	83.62228	28.17987
456	Sal (*S. robusta*)	83.62724	28.18723
457	Sal (*S. robusta*)	83.63818	28.16453
458	Sal (*S. robusta*)	83.60765	28.17681
459	Sal (*S. robusta*)	83.66560	28.17185
460	Sal (*S. robusta*)	83.67577	28.16773

461	Sal (*S. robusta*)	83.67188	28.22979
462	Sal (*S. robusta*)	83.66585	28.23960
463	Sal (*S. robusta*)	83.60833	28.28003
464	Sal (*S. robusta*)	83.58735	28.34445
465	Sal (*S. robusta*)	83.64301	28.13510
466	Sal (*S. robusta*)	83.61897	28.11082
467	Sal (*S. robusta*)	83.80400	28.05856
468	Sal (*S. robusta*)	83.88637	28.02912
469	Sal (*S. robusta*)	83.91690	27.97554
470	Sal (*S. robusta*)	83.57412	27.97373
471	Sal (*S. robusta*)	83.94610	27.61222
472	Sal (*S. robusta*)	83.99178	27.59594
473	Sal (*S. robusta*)	83.76611	27.58830
474	Sal (*S. robusta*)	83.91360	27.57106
475	Sal (*S. robusta*)	83.87058	27.64285
476	Sal (*S. robusta*)	83.85793	27.64441
477	Sal (*S. robusta*)	83.91287	27.66951
478	Sal (*S. robusta*)	84.85996	28.13915
479	Sal (*S. robusta*)	84.16126	27.92492
480	Sal (*S. robusta*)	84.22552	28.11623
481	Sal (*S. robusta*)	84.02242	27.89663
482	Snow Leopard (*P. uncia*)	83.98009	28.77310
483	Snow Leopard (*P. uncia*)	83.93971	28.73891
484	Snow Leopard (*P. uncia*)	83.97782	28.73317
485	Snow Leopard (*P. uncia*)	83.98420	28.74433
486	Snow Leopard (*P. uncia*)	83.99237	28.70735
487	Snow Leopard (*P. uncia*)	83.98490	28.68005
488	Snow Leopard (*P. uncia*)	84.01315	28.64559
489	Snow Leopard (*P. uncia*)	84.03272	28.68321
490	Snow Leopard (*P. uncia*)	84.03255	28.68195
491	Snow Leopard (*P. uncia*)	83.96993	28.68722
492	Snow Leopard (*P. uncia*)	83.84324	28.70858
493	Snow Leopard (*P. uncia*)	84.14926	28.65084
494	Snow Leopard (*P. uncia*)	84.26497	28.72336
495	Snow Leopard (*P. uncia*)	84.27538	28.77725
496	Snow Leopard (*P. uncia*)	84.25184	28.77912
497	Snow Leopard (*P. uncia*)	84.26620	28.76561
498	Snow Leopard (*P. uncia*)	84.25870	28.75332
499	Snow Leopard (*P. uncia*)	83.79628	28.76733
500	Snow Leopard (*P. uncia*)	83.85362	28.79242
501	Snow Leopard (*P. uncia*)	83.87133	28.85696
502	Snow Leopard (*P. uncia*)	83.67048	28.83594

503	Snow Leopard (*P. uncia*)	83.91097	28.90243
504	Snow Leopard (*P. uncia*)	83.90075	29.28429
505	Snow Leopard (*P. uncia*)	81.93577	29.18589
506	Snow Leopard (*P. uncia*)	82.93576	29.18587
507	Snow Leopard (*P. uncia*)	82.94308	29.19378
508	Snow Leopard (*P. uncia*)	29.18588	29.18588
509	Snow Leopard (*P. uncia*)	82.94309	29.19370
510	Snow Leopard (*P. uncia*)	82.94209	29.19309
511	Snow Leopard (*P. uncia*)	82.94304	29.19325
512	Snow Leopard (*P. uncia*)	82.94308	29.19379
513	Snow Leopard (*P. uncia*)	82.86433	29.14952
514	Snow Leopard (*P. uncia*)	82.82239	29.14389
515	Snow Leopard (*P. uncia*)	82.20900	29.14466
516	Snow Leopard (*P. uncia*)	82.83379	29.14195
517	Snow Leopard (*P. uncia*)	82.82510	29.14385
518	Snow Leopard (*P. uncia*)	82.82145	29.14389
519	Snow Leopard (*P. uncia*)	82.82056	29.14295
520	Snow Leopard (*P. uncia*)	82.55200	29.64453
521	Snow Leopard (*P. uncia*)	82.87213	29.15048
522	Snow Leopard (*P. uncia*)	82.08453	29.14000
523	Snow Leopard (*P. uncia*)	82.82566	29.14281
524	Snow Leopard (*P. uncia*)	82.82394	29.14277
525	Snow Leopard (*P. uncia*)	82.82053	29.14292
526	Snow Leopard (*P. uncia*)	82.78432	29.13458
527	Snow Leopard (*P. uncia*)	82.85962	29.14433
528	Snow Leopard (*P. uncia*)	82.82513	29.14280
529	Snow Leopard (*P. uncia*)	82.82513	29.14395
530	Snow Leopard (*P. uncia*)	82.82048	29.14289
531	Snow Leopard (*P. uncia*)	83.76570	28.89792
532	Snow Leopard (*P. uncia*)	84.47161	28.66717
533	Snow Leopard (*P. uncia*)	84.47287	28.66864
534	Snow Leopard (*P. uncia*)	84.35563	28.55982
535	Snow Leopard (*P. uncia*)	84.35559	28.56140
536	Snow Leopard (*P. uncia*)	84.36246	28.58090
537	Snow Leopard (*P. uncia*)	84.45726	28.51912
538	Snow Leopard (*P. uncia*)	84.47381	28.51266
539	Snow Leopard (*P. uncia*)	84.46930	28.51577
540	Snow Leopard (*P. uncia*)	84.47899	28.50966
541	Snow Leopard (*P. uncia*)	84.47870	28.50151
542	Snow Leopard (*P. uncia*)	84.48398	28.49615
543	Snow Leopard (*P. uncia*)	84.48644	28.49358
544	Snow Leopard (*P. uncia*)	84.44855	28.52790

545	Snow Leopard (*P. uncia*)	84.47450	28.51375
546	Snow Leopard (*P. uncia*)	84.47161	28.66717
547	Snow Leopard (*P. uncia*)	84.47287	28.66864
548	Snow Leopard (*P. uncia*)	84.35511	28.57055
549	Snow Leopard (*P. uncia*)	84.35591	28.56911
550	Snow Leopard (*P. uncia*)	84.35667	28.57221
551	Snow Leopard (*P. uncia*)	84.35438	28.57201
552	Snow Leopard (*P. uncia*)	84.35459	28.56797
553	Snow Leopard (*P. uncia*)	84.35505	28.56714
554	Snow Leopard (*P. uncia*)	84.35542	28.56590
555	Snow Leopard (*P. uncia*)	84.35584	28.56421
556	Snow Leopard (*P. uncia*)	84.35441	28.56167
557	Snow Leopard (*P. uncia*)	84.35508	28.55936
558	Snow Leopard (*P. uncia*)	84.35571	28.55984
559	Snow Leopard (*P. uncia*)	84.35601	28.56311
560	Snow Leopard (*P. uncia*)	84.35681	28.56354
561	Snow Leopard (*P. uncia*)	84.35745	28.56439
562	Snow Leopard (*P. uncia*)	84.35756	28.56547
563	Snow Leopard (*P. uncia*)	84.35689	28.56739
564	Snow Leopard (*P. uncia*)	84.35971	28.57806
565	Snow Leopard (*P. uncia*)	84.36058	28.57887
566	Snow Leopard (*P. uncia*)	84.36223	28.57990
567	Snow Leopard (*P. uncia*)	84.36173	28.58070
568	Snow Leopard (*P. uncia*)	84.36175	28.58126
569	Snow Leopard (*P. uncia*)	84.36214	28.58178
570	Snow Leopard (*P. uncia*)	84.36357	28.58274
571	Snow Leopard (*P. uncia*)	84.36830	28.58521
572	Snow Leopard (*P. uncia*)	84.36726	28.58451
573	Snow Leopard (*P. uncia*)	84.42088	28.59158
574	Snow Leopard (*P. uncia*)	84.42020	28.59387
575	Snow Leopard (*P. uncia*)	84.42567	28.59619
576	Snow Leopard (*P. uncia*)	84.41562	28.58583
577	Snow Leopard (*P. uncia*)	84.41568	28.58647
578	Snow Leopard (*P. uncia*)	84.41593	28.58700
579	Snow Leopard (*P. uncia*)	84.41612	28.58733
580	Snow Leopard (*P. uncia*)	84.41845	28.58880
581	Snow Leopard (*P. uncia*)	84.41983	28.58778
582	Snow Leopard (*P. uncia*)	84.42138	28.59062
583	Snow Leopard (*P. uncia*)	84.44871	28.59728
584	Snow Leopard (*P. uncia*)	84.47180	28.62545
585	Snow Leopard (*P. uncia*)	84.35419	28.56976
586	Snow Leopard (*P. uncia*)	84.35347	28.56959

587	Snow Leopard (*P. uncia*)	84.35298	28.56954
588	Snow Leopard (*P. uncia*)	84.35270	28.56947
589	Snow Leopard (*P. uncia*)	84.35216	28.56913
590	Snow Leopard (*P. uncia*)	84.35168	28.56878
591	Snow Leopard (*P. uncia*)	84.35149	28.56873
592	Snow Leopard (*P. uncia*)	84.35096	28.56805
593	Snow Leopard (*P. uncia*)	84.35454	28.56880
594	Snow Leopard (*P. uncia*)	84.35486	28.56850
595	Snow Leopard (*P. uncia*)	84.35477	28.56910
596	Snow Leopard (*P. uncia*)	84.35611	28.57012
597	Snow Leopard (*P. uncia*)	84.35718	28.57010
598	Snow Leopard (*P. uncia*)	84.35785	28.57060
599	Snow Leopard (*P. uncia*)	84.35844	28.57196
600	Snow Leopard (*P. uncia*)	84.35919	28.57586
601	Snow Leopard (*P. uncia*)	84.35909	28.57728
602	Snow Leopard (*P. uncia*)	84.35754	28.57599
603	Snow Leopard (*P. uncia*)	84.36105	28.57852
604	Snow Leopard (*P. uncia*)	84.36189	28.57940
605	Snow Leopard (*P. uncia*)	84.36249	28.58069
606	Snow Leopard (*P. uncia*)	84.36303	28.58222
607	Snow Leopard (*P. uncia*)	84.36605	28.58310
608	Snow Leopard (*P. uncia*)	84.36767	28.58347
609	Snow Leopard (*P. uncia*)	84.35215	28.56634
610	Snow Leopard (*P. uncia*)	84.37071	28.51295
611	Snow Leopard (*P. uncia*)	84.40131	28.52167
612	Snow Leopard (*P. uncia*)	84.42501	28.52696
613	Snow Leopard (*P. uncia*)	84.42818	28.52767
614	Snow Leopard (*P. uncia*)	84.43134	28.52796
615	Snow Leopard (*P. uncia*)	84.43897	28.52795
616	Snow Leopard (*P. uncia*)	84.43854	28.52775
617	Snow Leopard (*P. uncia*)	84.45935	28.52151
618	Snow Leopard (*P. uncia*)	84.46040	28.52275
619	Snow Leopard (*P. uncia*)	84.45997	28.52319
620	Snow Leopard (*P. uncia*)	84.47526	28.49869
621	Snow Leopard (*P. uncia*)	84.48003	28.50868
622	Snow Leopard (*P. uncia*)	84.47712	28.51094
623	Snow Leopard (*P. uncia*)	84.48132	28.50580
624	Snow Leopard (*P. uncia*)	84.47775	28.49546
625	Snow Leopard (*P. uncia*)	84.47544	28.49660
626	Snow Leopard (*P. uncia*)	84.48268	28.50716
627	Snow Leopard (*P. uncia*)	84.47826	28.50295
628	Snow Leopard (*P. uncia*)	84.47480	28.50195

629	Snow Leopard (*P. uncia*)	84.47469	28.51257
630	Snow Leopard (*P. uncia*)	84.47298	28.51382
631	Snow Leopard (*P. uncia*)	84.44946	28.52656
632	Snow Leopard (*P. uncia*)	84.45067	28.52653
633	Snow Leopard (*P. uncia*)	84.39828	28.52170
634	Snow Leopard (*P. uncia*)	84.42761	28.52740
635	Snow Leopard (*P. uncia*)	84.42577	28.52745
636	Snow Leopard (*P. uncia*)	84.43800	28.52747
637	Snow Leopard (*P. uncia*)	84.42951	28.52746
638	Snow Leopard (*P. uncia*)	84.45869	28.52151
639	Snow Leopard (*P. uncia*)	84.45841	28.52061
640	Snow Leopard (*P. uncia*)	84.45761	28.52003
641	Snow Leopard (*P. uncia*)	84.45787	28.51814
642	Snow Leopard (*P. uncia*)	84.45826	28.51732
643	Snow Leopard (*P. uncia*)	84.45918	28.51870
644	Snow Leopard (*P. uncia*)	84.47183	28.51397
645	Snow Leopard (*P. uncia*)	84.47508	28.51151
646	Snow Leopard (*P. uncia*)	84.47897	28.50541
647	Snow Leopard (*P. uncia*)	84.48266	28.50587
648	Snow Leopard (*P. uncia*)	84.47983	28.50607
649	Snow Leopard (*P. uncia*)	84.48034	28.49883
650	Snow Leopard (*P. uncia*)	84.48153	28.49831
651	Snow Leopard (*P. uncia*)	84.48242	28.49742
652	Snow Leopard (*P. uncia*)	84.48311	28.49675
653	Snow Leopard (*P. uncia*)	84.48378	28.49529
654	Snow Leopard (*P. uncia*)	84.48557	28.49440
655	Snow Leopard (*P. uncia*)	84.46894	28.51561
656	Snow Leopard (*P. uncia*)	84.44883	28.52730
657	Utis (*A. nepalensis*)	84.01456	28.23788
658	Utis (*A. nepalensis*)	83.97012	28.25084
659	Utis (*A. nepalensis*)	83.92687	28.30074
660	Utis (*A. nepalensis*)	84.07955	28.20325
661	Utis (*A. nepalensis*)	84.07982	28.19553
662	Utis (*A. nepalensis*)	83.85703	28.23510
663	Utis (*A. nepalensis*)	83.82671	28. 22365
664	Utis (*A. nepalensis*)	83.81913	28.22193
665	Utis (*A. nepalensis*)	83.80978	28.21972
666	Utis (*A. nepalensis*)	83.79917	28.22279
667	Utis (*A. nepalensis*)	83.80786	28.21948
668	Utis (*A. nepalensis*)	83.76768	28.20916
669	Utis (*A. nepalensis*)	83.76517	28.20438
670	Utis (*A. nepalensis*)	83.74583	28.21780

671	Utis (*A. nepalensis*)	83.71601	28.22272
672	Utis (*A. nepalensis*)	83.71031	28.22133
673	Utis (*A. nepalensis*)	83.75239	28.28341
674	Utis (*A. nepalensis*)	83.75877	28.28782
675	Utis (*A. nepalensis*)	83.77299	28.29801
676	Utis (*A. nepalensis*)	83.78070	28.29516
677	Utis (*A. nepalensis*)	83.77820	28.30164
678	Utis (*A. nepalensis*)	83.81044	28.29742
679	Utis (*A. nepalensis*)	83.81167	28.29623
680	Utis (*A. nepalensis*)	83.81627	28.29444
681	Utis (*A. nepalensis*)	83.82508	28.29161
682	Utis (*A. nepalensis*)	83.82980	28.28487
683	Utis (*A. nepalensis*)	84.59786	28.09676
684	Utis (*A. nepalensis*)	84.60845	28.09596
685	Utis (*A. nepalensis*)	84.61262	28.09107
686	Utis (*A. nepalensis*)	84.34491	28.23194
687	Utis (*A. nepalensis*)	84.34491	28.23194
688	Utis (*A. nepalensis*)	84.33927	28.23556
689	Utis (*A. nepalensis*)	84.35063	28.24398
690	Utis (*A. nepalensis*)	84.31368	28.24798
691	Utis (*A. nepalensis*)	84.30763	28.25683
692	Utis (*A. nepalensis*)	84.30764	28.26027
693	Utis (*A. nepalensis*)	84.30952	28.26463
694	Utis (*A. nepalensis*)	84.30876	28.26954
695	Utis (*A. nepalensis*)	84.30453	28.27326
696	Utis (*A. nepalensis*)	84.30951	28.27220
697	Utis (*A. nepalensis*)	84.31144	28.27616
698	Utis (*A. nepalensis*)	83.81062	28.29817
699	Utis (*A. nepalensis*)	83.95178	28.29621
700	Utis (*A. nepalensis*)	84.11336	28.41798
701	Utis (*A. nepalensis*)	84.11194	28.36414
702	Utis (*A. nepalensis*)	84.11010	28.37603
703	Utis (*A. nepalensis*)	84.11845	28.40449
704	Utis (*A. nepalensis*)	84.11223	28.42020
705	Utis (*A. nepalensis*)	84.08369	28.34969
706	Utis (*A. nepalensis*)	84.06197	28.33106
707	Utis (*A. nepalensis*)	84.06806	28.33338
708	Utis (*A. nepalensis*)	84.07725	28.35005
709	Utis (*A. nepalensis*)	84.06885	28.28379
710	Utis (*A. nepalensis*)	84.06765	28.28642
711	Utis (*A. nepalensis*)	84.06765	28.28642
712	Utis (*A. nepalensis*)	84.06705	28.24888

713	Utis (*A. nepalensis*)	83.82972	28.18802
714	Utis (*A. nepalensis*)	83.80640	28.18953
715	Utis (*A. nepalensis*)	83.77210	28.18597
716	Utis (*A. nepalensis*)	83.77809	28.17507
717	Utis (*A. nepalensis*)	83.45797	28.26104
718	Utis (*A. nepalensis*)	83.39325	28.28615
719	Utis (*A. nepalensis*)	83.56883	28.33998
720	Utis (*A. nepalensis*)	83.51392	28.33674
721	Utis (*A. nepalensis*)	83.43660	28.38902
722	Utis (*A. nepalensis*)	83.53975	28.45401
723	Utis (*A. nepalensis*)	83.53148	28.41381
724	Utis (*A. nepalensis*)	83.81860	28.41414