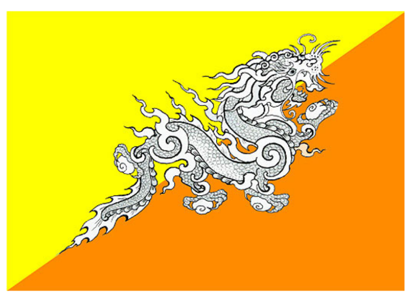
Climate Summit for a
LIVING HIMALAYAS
Bhutan 2011

Food
Water
Energy
Biodiversity

Bangladesh Bhutan India Nepal

NATIONAL ACTION PLAN

BIODIVERSITY PERSISTENCE AND CLIMATE CHANGE



BHUTAN

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CHAPTER 1: INTRODUCTION

1.1. Importance of Biodiversity

Biological diversity is vitally important for every sphere of human existence and provides us with a vast range of products and services. These are provisioning services, such as food, water, timber, fibre, genetic resources, and medicines; regulating services such as regulation of climate and, water and soil quality, and pollination; cultural services such as recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation and nutrient cycling. Biodiversity also plays a significant role in mitigating and adapting the impacts of climate change. Intact ecosystems such as forests and peat lands sequester carbon in their vegetation and soil thus supporting climate-regulating functions worldwide (Carlson *et al*, 2010, Amend & Eiβing, 2010).

Loss of biodiversity is caused by several factors such as changes in land use, over exploitation of natural resources, destruction of natural habitats, urbanization, human wildlife conflict, forest fires, hydropower development, industrial development, invasive species, etc. Climate change will further exacerbate the effects of other stressors (CBD, 2009; MEA, 2005) and is likely to become the dominant direct driver of biodiversity loss by the end of this century. Biodiversity and climate change are closely linked and each impacts upon the other. Human-induced climate change threatens biodiversity and biodiversity loss heightens the impacts of climate change on population and ecosystems (Gitay *et al*, 2002, MEA, 2005). In addition, the impacts of climate change on natural ecosystems exerts significant feedbacks to the climate system, mainly through increase in soil respiration under increased temperature and reduced capacity to act as carbon sink (Campbell et al, 2009).

1.2. Biodiversity of Bhutan

Bhutan straddles two major biogeographic realms, the Indo-Malayan and Palearctic and is part of the Eastern Himalayan region which contains parts of three global biodiversity hotspots, 60 ecoregions, 330 important Bird Areas, 53 Important Plant Areas, and a large number of wetlands and 29 Ramsar sites. (ICIMOD, 2010). Bhutan is home to a diverse array of flora and fauna including 5603 species of vascular plants, 400 lichens, 200 mammals and about 700 birds. In addition to the currently known 105 endemic plant species (Annexure 1), Bhutan also hosts a number of globally threatened species including 27 mammals (Annexure 2), and 18 birds (Annexure 3).

The country has 70.46 percent of the total area under forest cover (LCMP, 2010) and 51.32 percent, secured as protected areas and biological corridors. These serve not only as rich reservoirs of biodiversity but indirectly serve as long-term stores of carbon which mitigate the adverse impacts of climate change. The protected areas system of Bhutan is regarded as one of the most comprehensive in the world. It encompasses a continuum of representational samples of all major ecosystems found in the country, ranging from the tropical/sub-tropical grasslands and forests in the southern foothills through temperate forests in the central mountains and valleys to alpine meadows in the northern mountains (NEC, 2009). Bhutan also has an extensive network of rivers due to the high level of precipitation, numerous glaciers and glacial lakes and well-preserved forests resulting in upstream and downstream benefits such as water and other ecosystem services (BAP, 2009).

Bhutan emits approximately 1.5 million tonnes of carbon annually, and its forests absorb approximately 6.3 million tonnes, leaving it with a carbon emission of -4.7 million tonnes, distinguishing it as one of the few countries in the world with negative carbon emissions. Ironically Bhutan's status as a negative carbon emitter does not make it immune to the impacts of climate change. In fact, its location in the Himalayas renders it more vulnerable to the impacts of climate change because warming trends are higher and the impacts are magnified by the extreme changes in altitude over small distances (Shrestha & Eriksson, 2009). In addition, it has become increasingly evident that those likely to bear the greatest brunt of climate change are the world's poorest countries and in particular the poor and marginalized communities and people who depend almost exclusively on natural resources and have reduced capacity to adapt due to their vulnerable situation (Tse-ring et al, 2010). These raise concerns for the persistence of our biodiversity and the livelihood of 69 percent of our rural population who depend directly on agriculture and natural resources.

As a country that is predominantly agricultural, Bhutan is rich in agricultural diversity. About 80 species of agricultural crops are reported to occur in the country. Several crop species with unique landraces have evolved as an adaptation to the micro-environment created by altitudinal and climatic variations. For instance, there are some 350 rice varieties, 47 of maize, 24 of wheat, and 30 of barley. Several of the crop varieties represent adaptations to some of the highest agricultural lands in the world. There are also numerous wild relatives of both indigenous and introduced cereal and horticultural crops (BAP, 2009).

In livestock, although at the species level, the livestock diversity of Bhutan is not different from those commonly occurring elsewhere in the Himalayas, there are many livestock breeds with marked genetic differences and uniqueness. For example, amongst the cattle breeds, the *Nublang* is believed to have originated in Sombey geog of Haa and the horse breeds found in the country are also considered unique.

1.3. Policy environment

Bhutan is fortunate to have emerged virtually unscathed in the twenty first century in terms of its biological wealth. This is due to the far-sighted vision and leadership of our Kings and our rich tradition of living in harmony with nature throughout the centuries. In an era where economic goals and developmental needs far outweigh conservation needs, Bhutan firmly perseveres on the development philosophy of Gross National Happiness which categorically states environmental conservation as one of the four pillars of Gross National Happiness. This effectively ensures that development is never achieved at the cost of the environment.

The Constitution of the Kingdom of Bhutan mandates the maintenance of a minimum forest cover of 60 percent for perpetuity. Article 5 Section 2 of the Constitution states that the Royal Government shall "protect, conserve and improve the pristine environment and safeguard the biodiversity of the country; prevent pollution and ecological degradation; secure ecologically balanced sustainable development while promoting justifiable economic and social development; and ensure a safe and healthy environment".

As a clear vindication of the commitment of the country to preserve its rich environment, many policy documents and action plans have already been developed such as Vision 2020, National Forest Policy (1974, 2010), Forest and Nature Conservation Act of Bhutan 1995, Biodiversity Act of Bhutan 2003, Biodiversity Action Plan (2009, 2002, 1998), National Environment Strategy for Bhutan 1998, and the National Adaptation Programme of Action (NAPA 2006).

Bhutan is party to the United Nations Convention on Biological Diversity (UNCBD), United Nations Framework Convention on Climate Change (UNFCC), United Nations Convention to Combat Desertification (UNCCD), and United Nations Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Most recently, Bhutan committed to remain carbon neutral during the United Nations Climate Change Conference, COP 15 at Copenhagen. However clear policies on the issue of climate change are yet to be developed owing to the recent recognition and understanding of climate change as a real threat to biodiversity.

CHAPTER 2: CLIMATE CHANGE TRENDS

2.1. Observed changes in climate parameters

Surface air temperature

The global mean surface temperature has increased by 0.6°C (0.4-0.8°C) over the last 100 years (Gitay et al, 2002). The analyses of climate parameters of the Eastern Himalayas have shown that the Eastern Himalayan region's mean annual temperature is increasing at the rate of 0.01^{o}C/year or more (Chettri et al, 2010). Further, warming is observed and predicted to be more rapid in the high mountain areas than at lower elevations, with areas greater than 4000 m experiencing the highest warming rates (Shrestra & Devkota, 2010).

The analysis of surface air temperature data in Bhutan from 1985 to 2002 has shown a warming trend of about 0.5°C, mainly during the non-monsoon season (Tse-ring et al, 2010). Analysis of data from 2000 to 2009 from meteorological stations of the four representative eco-floristic zones of Bhutan also shows a trend of rising mean summer and winter temperature (Fig. 1). However, due to the short time-series data on temperature, it is difficult to quantify the annual rise in temperature.

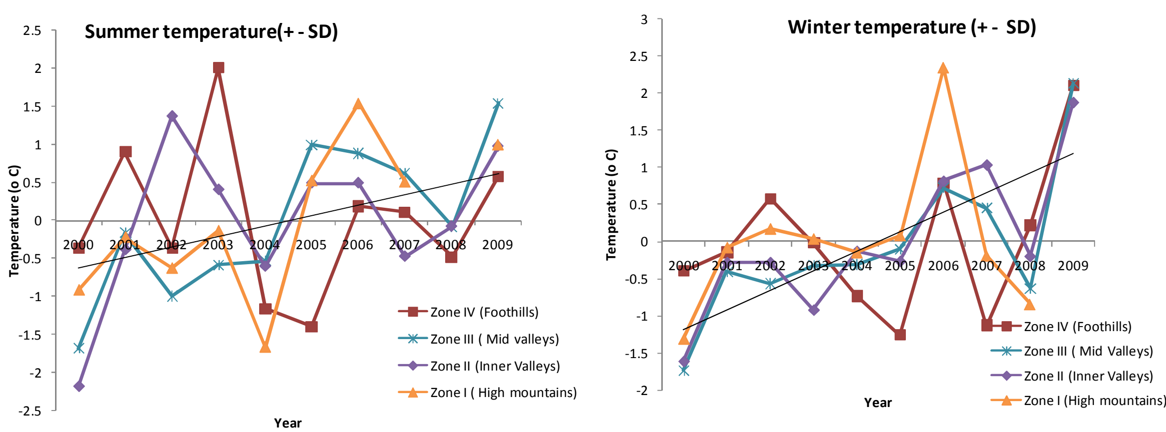

Fig. 1: Observed mean winter and summer temperature

Rainfall

Unlike temperature, no consistent spatial trends have been observed in precipitation throughout the Eastern Himalayan region. The changes in annual precipitation are quite variable, decreasing at one site and increasing at a nearby site (Tse-ring et al, 2010). In Bhutan, no comprehensive precipitation observations are available to conclude any trends. However, rainfall fluctuations are largely random with no systematic change detectable on either annual or monthly scale (Tse-ring 2003). A recent analysis of rainfall data from 2000 to 2009 across four eco-floristic zones of Bhutan shows annual fluctuations within regions without any detectable trend (Fig. 2).

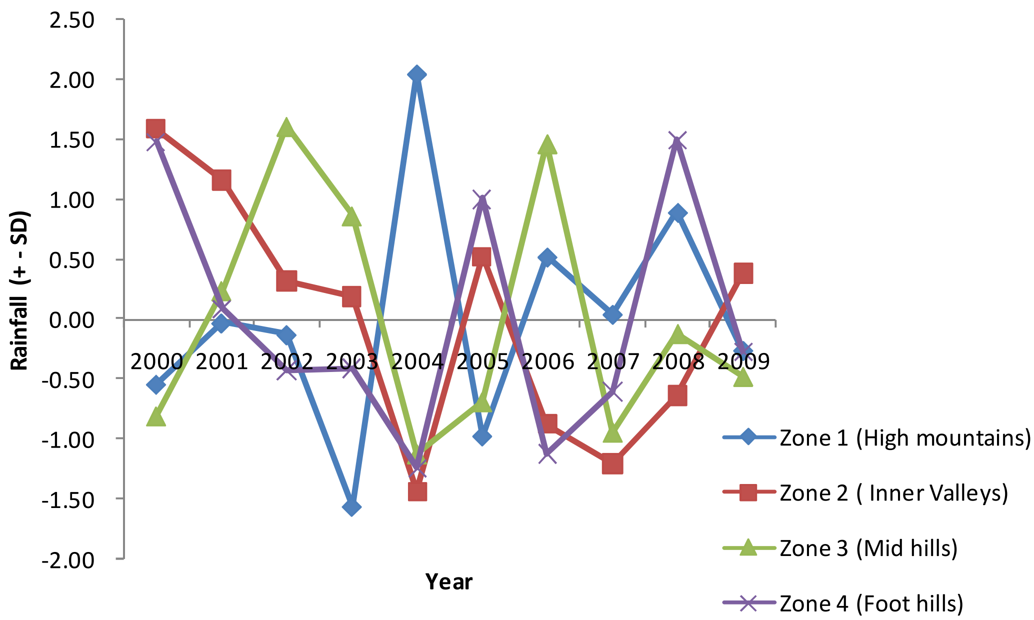

Figure 2: Rainfall trends from 2000 to 2009

Snow cover, Snow Fall pattern and Frost.

The extent of snow cover has decreased by about 10 percent on average in the Northern Hemisphere since the late 1960s (Gitay et al, 2002). Analysis of snow cover from Landsat MSS images taken from 1973 to 1979 and Landsat ETM+ images from 1999 to 2000 indicates a decrease in snow cover in the eastern Himalayas by 24.6 percent (Chettri et al, 2010).

There is no systematic record of data and observation on snow cover and snow fall to analyse and conclude any trends in Bhutan. However, people's observations on snow fall are discussed under community observation and perception on climate change.

2.2. Community observations on impacts of climate change on biodiversity

In order to record community observation and understand their perspectives on climate change and its impacts on biodiversity, a pre-structured questionnaire survey was conducted from October to November 2010 (hereafter referred to as survey 2010). The survey covered 16 Dzongkhags, 31 Geogs, 154 villages and 417 households across the country representing four broad eco-floristic zones of the country; Zone I- High mountains/Alpine (above 4000 masl), Zone II- Inner valleys (2000-4000 masl), Zone III- Mid hills (1000-2000 masl), and Zone IV- Foothills (150-1000 masl). A total of 417 respondents participated in the survey. The survey results were analyzed using SPSS version 16.

The survey 2010 showed that people's understanding on climate change and its impacts on biodiversity was poor in general. The survey also highlighted the poor preparedness of the communities on any potential impacts of climate change. However, change in physical environment such as rising temperature, changing rainfall pattern, change in frost occurrence, change in snowfall pattern, etc. were observed by a majority of the respondents (Fig. 3)

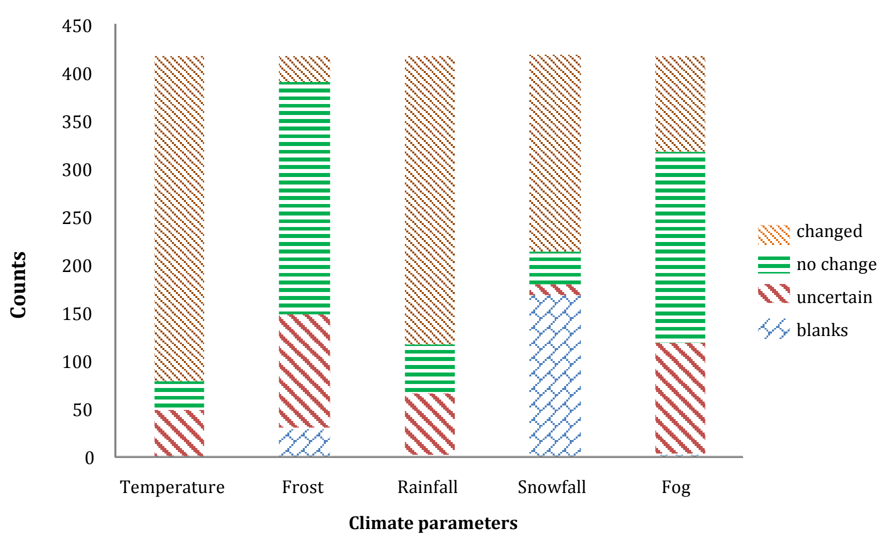

Figure 3: community perception on change in climate parameters

Temperature

Irrespective of their residency in different eco-floristic zones, 81.1 percent of the survey respondents reported increase in temperature over the last ten years. The people's observation supplements the results of the observed surface air temperature data (cf. Fig. 1 & 4). For instance, a farmer Rinchen from Thimphu, who has never heard of global warming is "adamant that climate in Thimphu has become warmer over the years" (Kuensel, 7th July, 2007).

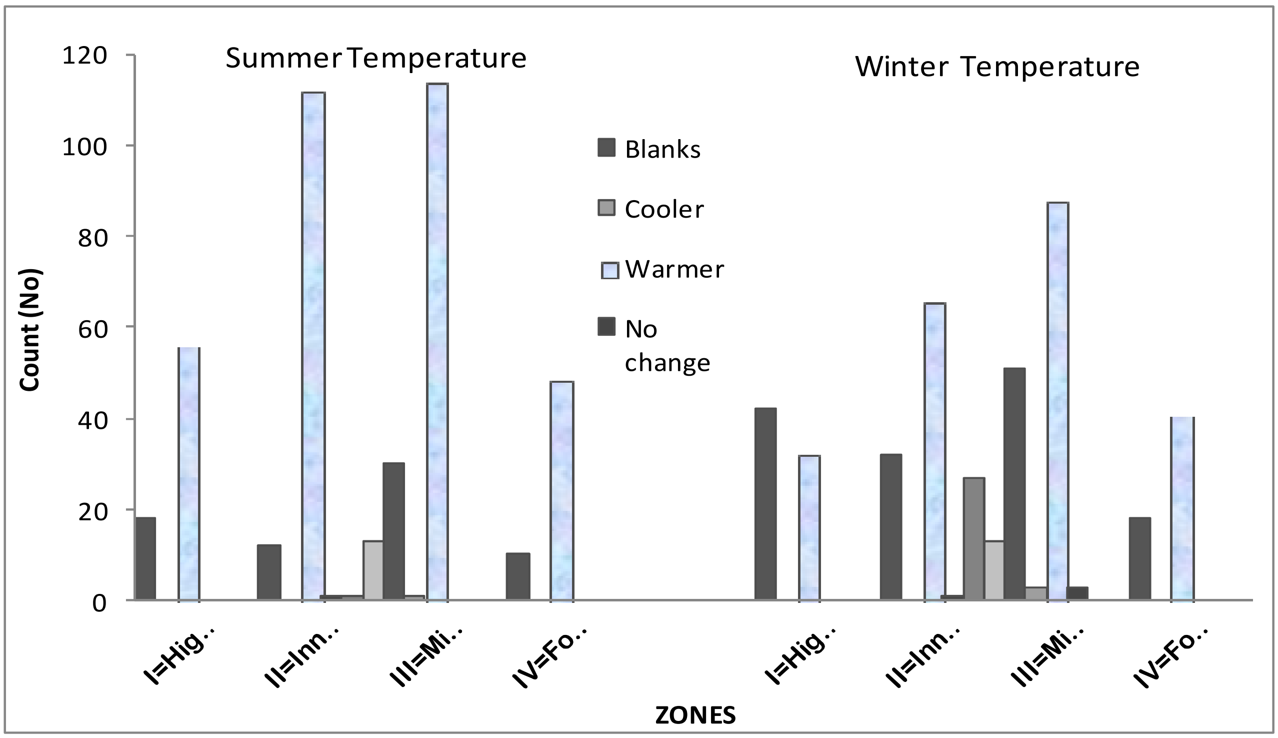

Fig.4 . Community perception on winter and summer temperature change.

Rainfall

As observed globally, 72 percent of the survey 2010 respondents across all four eco-floristic zones had the opinion that the rainfall pattern had become more erratic and unreliable. The national newspaper, Kuensel also carried various news articles reporting on the changing weather patterns. An unusually long spell of dry weather in 2007 scorched farmlands across central and eastern Bhutan with farmers delaying the preparation of the field for paddy transplantation due to the extremely dry weather (Kuensel 2nd June, 2007). Low potato yields in 2007 were also blamed on a long dry-spell in June accompanied by unceasing rains just before harvest time (Kuensel 4th August, 2007) highlighting the vulnerability of farming communities to erratic weather conditions.

Snowfall

80 percent of the survey 2010 respondents living in snow fall area had observed changes in snowfall pattern and frequency. Further, respondents had the opinion that the current snowfall depth had decreased by about 61 percent compared to the last ten years.

Frost

Despite the lack of systematic records of frost occurrence, there is no dearth of casual observations to support the change in frost occurrence and its impacts on biodiversity. A newspaper article in 2007 reported that farmers in the apple growing region of Paro in western Bhutan blamed the fruitless season on the late frost that coincided with the flowering season in March (Kuensel 4th August, 2007). This substantiates the role that frost plays in determining the growth and reproduction of plants on a seasonal scale (Inouye, 2000).

Biodiversity

In terms of biodiversity, no marked changes were reported apart from phenology and wildlife population. Figure 5 reflects local communities' overall observations and perceptions on biodiversity change in four eco-floristics zones of Bhutan (Survey 2010).

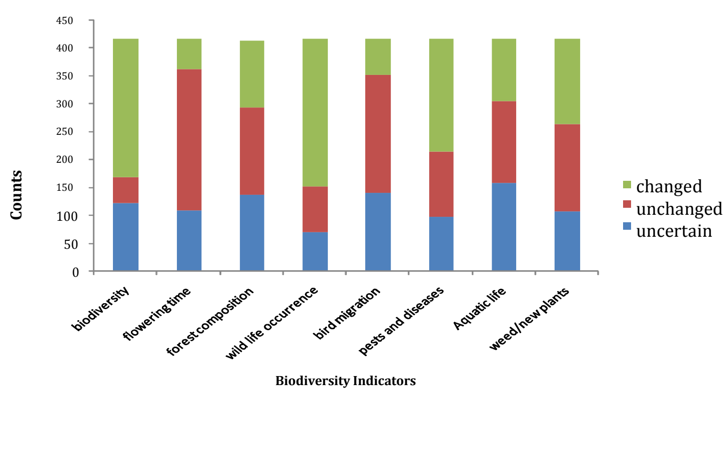

Fig.5: Community perception on biodiversity change

CHAPTER 3: OBSERVED IMPACTS AND THREATS OF CLIMATE CHANGE ON BIODIVERSITY

3.1. Disruption of ecosystem and ecosystem services

It is predicted that the resilience of many ecosystems will be threatened by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects, etc) and other global change drivers (e.g. land use change, pollution, fragmentation of natural systems, and overexploitation of resources (IPCC 2007, CBD, 2009). Modelling studies indicate significant changes in the state of some ecosystems, mainly due to rising temperature and altered precipitation regimes. It is predicted that such changes will first happen at the present boundaries between different ecosystems, such as a shift in tree line. In addition to shifting the location of ecosystems and their boundaries, climate change will alter the composition of many ecosystems leading to changes in the ecosystem functions and services (Campbell et al, 2009, Rosenzweig, et al., 2007).

In the Alpine ecosystem (above 4000 masl), the results of the survey 2010 indicate that Juniper scrub forest is increasing in area while the availability of alpine plants (eg: *Picorrhiza kuroo, Gentiana urnula and Fritillaria spp.*) are decreasing. In scrub forests, changes in management practices like fire suppression and forestry rules have led to an increase in scrub forest coverage. Locals report that the discontinuation of the use of fire in range land management regimes in the alpine region, has led to the acceleration of the incursion by woody species. It is likely that with the climate becoming warmer in future, the increasing upward movement of conifer scrub forest could result in habitat encroachment of medicinal plants such as *Picorrhiza spp., Fritillaria spp. and Rhodiola spp.*

Many alpine species are able to start their growth with the supply of snow melt water, well before the commencement of monsoon. This is important to understand from the point of view of glaciers in the country. The average rate of glacial retreat in Bhutan from 1963 to 1993 is estimated to be about 2 m/year vertically and about 7 m/year horizontally, with 8.1 percent area shrinkage in 66 selected glaciers in 30 years (Karma et al, 2003). Reports state that in the coming decades, many Himalayan glaciers will retreat, with some smaller glaciers disappearing altogether (Eriksson et al, 2009). If the glaciers disappear, the growth and life cycle of alpine plants can be disrupted because of the lack of snow melt water (Singh, Year missing).This could lead to change in species composition, structure and functioning of alpine meadows leading to the habitat alteration and disappearance of ecologically sensitive and economically important species such as *Ophiocordyceps sinensis* and plants (*Picorrhiza, Fritillaria* and *Rhodiola, etc).*

In the forest ecosystems, although there are no studies with systematic records of treeline shifts, Bluepine (*Pinus wallichiana*) encroachment into spruce/maple/birch forests is observed. The strong correlation between the upper limit of evergreen broad-leaved species and the winter temperature is also reported (Wangda & Ohsawa 2006a & b). The distribution of evergreen broad-leaved species along the altitudinal slope of dry valley mid – hills is limited by winter temperature (coldest month's mean temperature) of minus one degree celsius which coincides at 2900 masl. (Wangda & Ohsawa 2006a). With the increasing trend of winter temperature over the past ten years, according to unpublished meteorological data of the Research and Development Centre (RDC), Yusipang, there is a probability of increasing the upper limit of evergreen broad-leaved species from 2900 m (current) to higher altitudes in the near future. This could lead to the disruption of conifer forest ecosystems. Similarly, the upper limit of conifer species like *Abies, Tsuga* and *Juniperus* may shift higher or may become extinct in the process.

In the cold temperate forest ecosystem, *Abies densa* forests on the mountain tops declined in the 1980s due to moisture stress (Gratzer et al, 1997). With rising temperature, leading to increased incidences of moisture stresses, the vulnerability of this forest type is high. Concerns are similar for the montane cloud forests of Bhutan which occur around 2500 m in the inner deep dry valley slopes of Dochula-Bajo series (Wangda & Ohsawa, 2010) and around 2000 m along the mid hills of Gedu-Darla series (Wangda et al, in press). These are vulnerable to change in temperature and human disturbances which could lead to habitat loss for some important relict plant species like *Taxus, Magnolia, Tetracentron* and endangered bird species such as hornbills.

Climate change may also accelerate the damage to wetlands and fresh water ecosystems, such as lakes, marshes and rivers. Increasing temperature will cause water quality to deteriorate and have negative impacts on aquatic organisms, with the possibility of some species becoming extinct

(Campbell, 2009). Although studies on our wetlands and freshwater ecosystem are very limited, wetlands are already under threat from anthropogenic activities such as infrastructure development, resource extraction, agriculture, mega hydropower projects, urban expansion/encroachment, etc. For instance, it is feared that agriculture, continuous grazing and encroachment by bluepine and scrubs into marshy areas are altering the wetlands of Phobjikha, and thereby the habitat of the globally vulnerable black-necked cranes. In future, with the increasing effects of climate change, such wetland ecosystems could gradually disappear or become unsuitable for wintering and breeding of these birds.

3.2. Loss of species.

Many of the Earth's species are already at risk of extinction due to pressures arising from natural processes and human activities. Climate change will further exacerbate these pressures especially for threatened and vulnerable species (Gitay et al, 2002). According to the IPCC AR4, up to 30 percent of the higher plant and animal species are likely to be at an increased risk of extinction if global average temperature increase exceeds 1.5 to 2.5 degree celsius over the present temperature (Campbell et al, 2009).

Climate change will impact species mainly through changes in distribution and population status. It will also affect phenology, which in turn could affect the plant-pollinator interactions and prey-predator dynamics (Campbell et al, 2009). The risk of extinction will increase especially for those that are already at risk due to factors such as slower life history trait, limited dispersal abilities, low reproduction rate, small population size and specialist and range-restricted species, limited climatic ranges, or occurrence on low-lying islands or near mountain tops (Campbell et al, 2009, Gitay, 2002). It is also reported that endemic species are the most affected when no migration is assumed in model projections.

These predictions raise concerns for Bhutan which has about 105 endemic plants (Annexure 1) and a number of globally threatened species. The continued existence of high altitude species will be threatened due to the higher impacts of climate change in the alpine region and as land areas decrease with increasing elevation (Campbell et al, 2009). This could result in the potential loss of restricted Himalayan endemics such as the pygmy hog, Himalayan field mouse, and flying squirrel and high altitude medicinal/endemic plant species. In addition, the existence of large predators such as the tiger and the snow leopard are already threatened by shrinking or fragmented habitats making them more vulnerable to the impacts of climate change. Therefore, implementing species specific conservation programs that include securing habitats for the persistence of species at risk is an absolute priority.

While there are no systematic studies in the country on climate change impacts on species as well as species response, survey 2010 lists population change in a number of animal species (Table 1) and about 16 plant species with observed changes in flowering time (Table 2.)

Table 1: Observed changes in population of animal species (Survey 2010)

Eco-floristic zones	Observed increase in species population	Observed decrease in species population
Alpine – above 4000 masl Altitude -4000m + Mean Temp-5.5^0 C/y Rainfall <550 mm/year	tibetan fox, blue sheep, wild boar, takin and snow leopard, blood pheasant and monal pheasant	musk deer and barking deer
Inner Valleys Altitude -(2000-4000 m) Mean Temp-9.9^{0}C-12.5^{0}C /y Rainfall -650-850 mm/year	bear, wild boar and sambar, black necked crane, mynah, yellow-billed blue magpie.	barking deer, wild fox, leopard and tiger, eagle
Mid valleys Altitude -(1000-2000 m) Mean Temp-17.2^{0}C-18.5^{0}C /y Rainfall -850-2500 mm/year	macaque, wild boar, deer, laughing thrush and common crow.	jackal, tiger, bear, musk deer, leopard, jungle fowl, hornbill, pheasant, cuckoo and vulture
Foothills – 150 – 1500 masl Altitude -(150-1000 m) Mean temp- 23.6^{0}C- Rainfall-2500-5500 mm/year	rabbit, wild boar, sambar, macaque, barking deer, porcupine, gaur, bear	asian elephant, wild dog, tigers, hornbill, common crow, vulture and ring dove

Table 2: Observed changes in flowering time of different plant species (Survey 2010).

Eco-floristic zones	**Species**	**Flowering time (Current)**	**Flowering time (10-20 years ago)**
High Mountains	*Rhododendron spp.*	March	April
	Magnolia sp.	March	April
Inner valleys	*Rosa sp.*	May	June
	Juglans sp.	July	August
	Rhododendron sp.	Feb-May	Apr-June
	Populus sp.	December	January
Mid valleys	*Michelia doltsopa*	February/March	April
	Prunus sp.	March	April
	Castanopsis sp.	April	May
	Quercus sp.	January	February
Foothills	*Erythrina sp.*	August	September
	Terminalia sp.	September	October
	Bombax sp.	October	December
	Daubanga sp.	September	November
	Bauhinia sp.	August	September
	Justicia adatodha	December	January

3.3. Increased establishment of invasive species

The threat to biodiversity due to alien invasive species is considered only second to that of habitat loss. Climate change will expedite the colonization of some areas by invasive species in both terrestrial as well as fresh water ecosystems, which will have severe ramifications on native species (Campbell et al, 2009, CBD, 2009). Survey 2010 reported a significant increase in the diversity of invasive species such as *Mikania micarantha., Parthenium spp., Opuntia spp., Eupatorium ordoratum, Lantana camara, Commelina, Galinsoga* and *Phyllanthus*. Local newspapers have also carried articles on the emergence of 'foreign weeds' attributed to hotter climates by local residents (Kuensel, 7th July, 2007). Such increase of noxious invasive species may result in the decline of native species diversity in addition to lowering the production of agricultural crops through competition. This spells the need for a strong regulatory and management mechanism to control the entry and establishment of invasive species.

3.4. Increased risk of forest fire

Forest fires are considered to be one of the key threats to coniferous forests in the country with 526 incidents of forest fire, affecting over 70,000 ha of forest between 1999/2000 to 2007/2008 (BAP, 2009). While most fires in Bhutan are caused by human activity, the rising temperature and long spells of drought due to climate change are likely to increase the risk of forest fires resulting in further reduction and degradation of forest resources. Such examples include the fires in the winter of 1998/99 which was characterized by a prolonged spell of dry (snow-less) weather with forest fire incidents even in places without a known history of forest fires (BAP, 2009). However, forest fires are also an essential part of the natural process in the functioning of many ecosystems. Fire suppression in fire-adapted ecosystems or ecosystems that depend on fire often results in reduced biodiversity and increased vegetation and fuel density, often amplifying risks of catastrophic fire over time. Furthermore, the fire-ecosystem relationship is also being altered by climate change, with significant consequences for ecological processes and biodiversity. Effective biodiversity conservation therefore requires allowing fire to play their role in maintaining ecosystem functioning, without posing a threat to biodiversity or human well-being through excessive occurrence (CBD, 2009). While forest fire is considered a threat for timber production in the country, its role as a conservation tool for Bhutan's forests needs to be understood and applied under both present and future climatic conditions.

3.5. Loss of agro-biodiversity

Agricultural biodiversity plays a crucial role for adapting to altered climatic conditions through the genetic variability of crops and livestock species which can be bred to better adapt to climate change impacts. It is widely accepted that genetic diversity is important both in its own right and in determining the resilience of species to the impacts of climate change and other pressures. The introduction of modern crop varieties and breeds has led to the erosion of genetic diversity (Fowler and Mooney, 1990) with estimates that 75% of the genetic diversity of agricultural crops has been lost since the beginning of the twentieth century (FAO,1997). Now climate change poses an additional threat to agricultural biodiversity by increasing genetic erosion of landraces and threatening wild species, including crop wild relatives (Jarvis et al., 2008). On the other hand, climate change will also bring new and enhanced demand for genetic resources. National and international breeding programmes for a number of crops are already targeting new varieties with adaptations to future climatic stresses. The effort to breed for traits valued both today and in the future is likely to increase the demand and value of genetic diversity.

Bhutan’s agriculture ecosystems are diverse and fragile, and lie between 150 to 4600 masl. Farming is predominantly at a subsistence level and a majority of Bhutanese farmers continue to grow traditional crops and crop varieties. Rice and maize are the major staple crops and other commonly grown crops are wheat, barley, buckwheat, millets, oil seeds, grain legumes, orange, apple, cardamom, etc. Bhutan has over 350 traditional rice varieties grown at different agro-ecological zones starting from 150 to 2800 masl and is home to over 80 species of other crops (BAP, 2009).

The principal factors that could lead to reduced agro-biodiversity are the prevailing rise in temperature and changes in precipitation leading to increased incidence of extreme weather events (Chettri et al, 2010). This in turn could lead to low yield, higher incidences of pests and diseases, and disappearance of some species, varieties and breeds. Even as the correlation between the increase of these pests and diseases to climate change needs to be ascertained, the rice blast in 1995 caused by a fungus *Pyriculari grisea*, occurred on an epidemic scale in the high altitude warm temperate rice growing areas causing as high as 71 percent yield loss and loss of traditional rice varieties. In maize, a new maize disease Gray Leaf Spot (GLS) caused by the fungus *Cercospora zeae maydis* that was never reported in Bhutan, devastated the entire maize growing area in the east affecting about 3835 households covering 4711.76 acres of maize crop threatening the household food security and existence of about 38 traditional maize varieties (Bhutan Observer, 24th July 2010).

Resilience – the ability to revert to a stable equilibrium following 'shocks'- and 'sustainagility'- the ability to adapt by meeting needs in new ways , are the ecosystem properties that will be increasingly important for helping agriculture to maintain production in the face of climate change (FAO, 2011). Diversity of crops, breeds and diversification of management strategies are the basis of these ecosystem properties. Therefore conserving the broadest possible genetic diversity as an insurance against risks posed by climate change is a compelling argument for both *in situ* and *ex situ* agro-biodiversity conservation to prevent the loss of Bhutan's rich genetic diversity.

3.6. Increased incidences of pests and diseases

Recent moderate warming has been linked to improved forests productivity, but these gains are expected to be offset by the effects of increasing drought, fire and insect outbreaks as a result of further warming (Campbell et al, 2009). Survey 2010 results showed that the productivity of *Abies densa*, *Pinus wallichiana, Quercus glauca and Quercus griffithii* forests suffered set-backs due to periodic diebacks and insect attacks. Further the survey indicated that pests and diseases in forests and agriculture had increased over the years in general. There were outbreaks of bark beetle in spruce forests, increased incidence of mistletoe infestation, and moisture–stress related problems in blue pine forests. It is likely that with rising temperature and erratic dry and moist periods, intensity and incidences of diseases and pests will increase. In less than 16 years (1992-2008), five incidences of pine die-backs were observed (1994, 1999, 2001, 2003 & 2008) along the Paachu-Wangchu valley. The study found that pine die-back was strongly correlated with higher temperature and lower rainfall during the die-back incidences in the area (Wangda et al. 2009).

In agro-biodiversity, the survey reported a high incidence of pests such as ants in potatoes, trunk borer (in rice and wheat), and fruit fly in Citrus and diseases like Citrus greening, Turcicum Leaf Blight (TLB) and GLS in maize, ginger rot, cardamom rot, potato blight, maize root rot and Foot and Mouth Disease in livestock.

This clearly emphasizes the need to strengthen the national capacity in surveillance, identification and management of pest and diseases.

3.7. Loss of livelihood, traditional knowledge and practices ("Biocultural" loss).

The Bhutanese have always lived in harmony with nature and have used biodiversity for a myriad of purposes ranging from fuel-wood, food, fiber, shelter, medicine, household implements, and handicrafts to several other purposes. Bhutan has a rich tradition which is closely linked to biodiversity. For example, the use of *Dru Na Ngu* (nine important food crops) in offerings and rituals signifies the sacred role of biodiversity in culture and traditions. If climate and land-use change lead to losses in biodiversity, including loss of habitats, the livelihoods of local communities will be adversely affected, (Gitay et al 2002). Destruction of vegetation as a result of heavy grazing or exposure of soil could encourage the establishment of southerly weedy species under a warmer climate leading to adverse impacts on native biodiversity and local livelihoods (Gitay et al, 2002). Loss of alpine habitat from encroachment could lead to the loss of *Ophiocordyceps sinensis* and other high value medicinal plants which will have significant impacts on the livelihoods of high altitude pastoral communities.

The loss of biodiversity could also lead to the erosion of cultural practices, beliefs and traditional knowledge that will occur through the disappearance of local plant species resulting in the loss of a traditional heritage, an era, a way of life (Maffi, 2007; Singh et al, 2011). This "biocultural" loss could also act as a factor that increases poverty.

Local livelihoods are already made vulnerable by human-wildlife conflicts. It is possible that the situation will be exacerbated with climate change due to its effects on behavior and habitats of wildlife. There are already reports of change in the hibernation and movement patterns of the Himalayan black bear, leading to conflicts with farmers. The southern part of Bhutan frequently reports the destruction of crops by elephants. There is a need to study the impacts of climate change on wildlife and develop strong adaptation and coping mechanisms as well as to assess the implementation of the existing Human Wildlife Management strategy.

CHAPTER 4: CURRENT GAPS IN UNDERSTANDING AND ADDRESSING CLIMATE CHANGE IMPACTS ON BIODIVERSITY

4.1. Lack of comprehensive data and knowledge on biological diversity and climate change.

Specific areas of research in determining the impacts of climate change on biodiversity will need basic data on different ecosystems and ecosystem services as well as on species, all of which are poorly documented or have not been documented at all in the country. The existing data is confined to the higher plants, animals and birds and needs to be updated while there is little or no information on other taxonomic groups, especially the lower plants, invertebrates, herpetofauna, fungi, and microorganisms.

The vulnerability of species and ecosystems to the impacts of climate change is well documented outside the country. However huge gaps exist in the country in terms of knowledge on species at risk, keystone and range restricted species and the impacts of climate change on species' response. Existing studies on the composition, distribution and dynamics of forests in the country including invasive plant species, forests pests and diseases have to be greatly strengthened to protect natural ecosystems, prevent biodiversity loss and to monitor interactions with climate change. The paucity of data also extends to the number and location of lakes except for glacial lakes and the prevailing aquatic biodiversity, rendering it impossible to study the impacts of climate change on this ecosystem.

Meteorological observation data is limited to temperature and rainfall and available for less than two decades from stations that are concentrated in the mid valleys and the southern belt. Such data is inadequate to draw robust conclusions for climate change analysis and acts as a huge impediment in developing and implementing proper adaptation measures. There is an urgent need to improve the meteorological observation system and install stations across different eco-floristic zones of the country and develop capacity to carry out experimental and modeling studies to address the threats of climate change to ecosystems, biodiversity and general human wellbeing.

Therefore an urgent priority is to carry out a comprehensive inventory and catalogue the status of biological diversity in the country before they are lost forever. This will enable the formulation of effective biodiversity management plans and also the ability to determine if biodiversity changes are due to environmental degradation driven by other factors or due to climate change.

4.2. Lack of convergence of policy and practice

There are a number of policies in the country addressing the environment, forests, biodiversity, food security, etc. While the environment is considered a crucial pillar of the national development philosophy of gross national happiness, the specific concerns of climate change and its impact on the environment in general and biodiversity in particular is lacking. Nevertheless, with the reality of climate change, it has become necessary for the country to address climate change concerns through the development of coherent policies and mainstreaming the impacts of climate change on biodiversity in the sectoral plans and programs.

Bhutan's National Adaptation Programme of Action (NAPA, 2006) is the first and only document that focuses purely on urgent and immediate needs to address vulnerabilities to climate change in the country but biodiversity issues are not reflected as immediate short-term priorities. In order to ensure persistence of biological diversity, policies for climate change adaptation and mitigation have to be sound and farsighted and respect the role that diverse natural ecosystems play.

4.3. Weak linkages and coordination amongst stakeholders

There are a number of institutions working on biodiversity and related fields in the country. However, currently there is weak coordination and linkage between biodiversity stakeholders in the country as well as with donors and amongst donors.

The mandates of existing institutions working on biodiversity and climate change are isolated. For example, although National Environment Commission (NEC) houses the Climate Division, climate change is addressed from the angle of climate parameters alone, and it has neither the mandate nor the capacity to address the linkage between climate change and biodiversity.

Similarly, the mandate of the National Biodiversity Centre (NBC), the national coordinating agency on biodiversity related issues, is currently limited to biodiversity and does not have the capacity to address climate change impacts on biodiversity. Other relevant institutions and non-governmental organizations in the country also work on biodiversity and climate change but in isolation, spelling the need to revisit and realign the existing framework to ensure that all organizations work in full clarity and in synergy for effective utilization of limited resources and enhanced delivery of results.

Another important gap in addressing climate change issue and biodiversity lies in the nature of mechanisms in place. Currently any studies or activities addressing climate change impacts on biodiversity are project-based and isolated. Therefore, the lack of an institutionalized program to address climate change impacts on biodiversity is making it unsustainable and uncoordinated in addressing climate change and biodiversity issues.

This clearly emphasizes the need for institutionalizing coordination and linkage in biodiversity and climate research to strengthen the country's ability to adapt to climate change.

4.4. Lack of capacity in understanding and addressing climate change impacts on biodiversity.

There is a lack of national capacity in terms of institutional, infrastructure, human, and technical capacity across the board in dealing with climate change and its effects on biological diversity. Inadequate capacity acts as a barrier in understanding the responses of biodiversity to climate change and in implementing activities related to climate change adaptation and biodiversity conservation.

While there is a host of biodiversity experts, the existing experts lack specific technical expertise required to address biodiversity and climate change linkage. For example, lack of taxonomic capacity which is the basic necessity for knowing existing biodiversity is a huge impediment. While increased incidences of pests and diseases are observed, there is neither adequate manpower nor expertise in identification, surveillance and management of pests and diseases.

This gap is further exacerbated by the lack of adequate infrastructural facilities like laboratories. Physical climate change research capacity is also at a very embryonic stage.

In terms of climate change awareness and education, generally there is poor or no understanding on impacts of climate change on biodiversity at all levels. This can be attributed to the lack of information and limited outreach since climate change as a real threat has emerged only recently.

The specific areas that need to be addressed include research and assessment, monitoring, extension and training, and policy development. Concerted efforts must also be channeled into educating the whole country on the impacts of climate change on biodiversity. This will ensure the country's preparedness against the impacts of climate change through awareness and strengthened capacities of all the stakeholders and reduce vulnerability.

4.5. Lack of a sustained conservation financing mechanism

Currently, the overriding importance of socio-economic development and poverty eradication in the country and limited resources has also resulted in low attention for climate change and biodiversity loss. This is further compounded by the lack of sufficient donors to fund core environmental management activities leading to limited expertise and resources to carry out adaptation and mitigation activities. The current system of project-based biodiversity conservation financing has also led to unsustainable financing. Therefore, the government needs to develop strategies to adopt or sustain project initiatives on conservation and climate change. The national conservation endowment funds also need to explore new and innovative mechanisms to strengthen their fund base for sustained conservation financing.

CHAPTER 5: NATIONAL ACTION PLAN

This national action plan was developed through a series of multi-stakeholder consultative workshops with representations from national, regional and international biodiversity organizations. The goals, objectives and actions outlined in this action plan are based on the threats (observed and predicted) and gaps identified by various working groups, stakeholder meetings and survey 2010 results. Actions proposed are proactive steps to reduce the vulnerability of biodiversity and livelihoods to changing climate.

The overall goal of this action plan is to enable persistence of biodiversity to adapt to climate change, reduce vulnerability from its impacts, and promote sustainable utilization of biodiversity to engender socio-economic development of the country.

This action plan is guided by the following key goals:

1. To strengthen documentation of biological diversity and climate parameters to understand climate change impacts on biodiversity and ecosystem services.

2. To minimize impacts of climate change on biodiversity to maintain ecosystem health and continuous flow of ecosystem services.

3. To minimize impacts of other stressors of biodiversity (invasive species, fire, pest and diseases, etc.) under changing climate.

4. To enhance national capacity and resources to adapt to climate change impacts.

5. To promote effective coordination of biodiversity and climate change programs in the country.

6. To promote an enabling policy environment and mainstream biodiversity and climate change into national plans and programs.

7. To reduce the vulnerability of communities to climate change impacts.

Goal 1: To strengthen documentation of biological diversity and climate parameters to understand climate change impacts on biodiversity and ecosystem services.

Objective 1.1: To gather comprehensive data and information on biological diversity and climate parameters.

Action 1.1.1: Identify and establish subject matter specialist groups/network (including retired experts) to inventory and document the biological diversity of the country.

Action 1.1.2: Conduct comprehensive documentation of biological diversity of the country, including but not limited to vascular and non-vascular plants, fungi, birds, mammals, amphibians, invertebrates, herpetofauna, aquatic biodiversity, microbes, etc.

Action 1.1.3: Strengthen standards and mechanism for climate data collection.

Objective 1.2: To enhance understanding of climate change impacts on biodiversity and ecosystem services.

Action 1.2.1: Identify possible climate change indicator species and monitor the impacts of climate change.

Action 1.2.2: Identify those species and ecosystems at greatest risk from climate change and conduct short and long-term research and develop appropriate adaptation mechanism.

Action 1.2.3: Strengthen studies on valuation of ecosystem services best adapted to the local situation.

Action 1.2.4: Review and standardise the current forests classification systems and ecological zones.

Action 1.2.5: Institutionalize regular monitoring and status reporting of the forests cover, critical ecosystems and species at risk and impacts of climate change on biodiversity.

Goal 2: To minimize impacts of climate change on biodiversity to maintain ecosystem health and continuous flow of ecosystem services.

Objective 2.1: To strengthen the functionality of protected area systems and biological corridors under changing climate.

Action 2.1.1: Review and realign current protected areas and biological corridors and their management plans, taking into account their functionality and efficacy under changing climate.

Action 2.1.2: Fully operationalize protected areas and biological corridors to increase resilience to climate change and ensure the continued delivery of ecosystem services.

Action 2.1.3: Develop and implement sound protocol/guidelines and eco-friendly technologies for infrastructure development (smart green infrastructure) within the protected areas, biological corridors, and conservation areas to ensure their functionality and minimize the negative impacts.

Action 2.1.4: Strengthen enforcement of Environmental Impact Assessment (EIA) requirements and monitoring for infrastructure development within the Protected Areas systems and conservation areas.

Objective 2.2: To ensure sustainable management and utilization of biodiversity for adaptation to climate change.

Action 2.2.1: Review the current forest management planning and codes of practices, taking into account changing climate, biodiversity and ecosystem services.

Action 2.2.2: Strengthen participatory forestry management including community forestry, private forestry, agro-forestry, and national plantation programs.

Action 2.2.3: Implement improved timber felling and sawing techniques to minimize destruction of the surrounding vegetation and waste respectively.

Action 2.2.4: Promote and facilitate the use of efficient wood/timber treatment techniques to increase the durability of construction materials.

Action 2.2.5: Complete resource mapping of NWFPs and strengthen monitoring and status reporting mechanism.

Action 2.2.6: Develop and implement efficient technologies for harvesting, processing and marketing of NWPFs.

Action 2.2.7: Develop and diversify natural products from biological resources through bioprospecting.

Objective 2.3: To strengthen species conservation and management program to adapt to changing climate.

Action 2.3.1: Identify threatened, endemic and keystone species, and assess their population status, ranges and habitats.

Action 2.3.2: Implement a robust conservation and management program of species with high risk and conservation significance, in particular the Royal Bengal tiger and snow leopard.

Actions 2.3.3: Review the list of protected species under Schedule I of the Forests and Nature Conservation Act of Bhutan, 1995, considering the impacts associated with climate change.

Objective 2.4: To conserve agro-biodiversity to promote adaptation of crops and livestock to changing climatic conditions.

Action 2.4.1: Conduct genetic diversity assessment and mapping of major food crops and livestock breeds of the country.

Action 2.4.2: Conserve diverse agricultural systems and landscapes including crop wild relatives and their habitats.

Action 2.4.3: Strengthen *in-situ* conservation of traditional crops and native livestock breeds by supporting existing local farming systems and community practices, and establishment of community seed banks.

Action 2.4.4: Promote and strengthen crop diversification and integration with other farming activities.

Goal 3: To minimize impacts of other stressors of biodiversity (invasive species, fire, pest and diseases, etc.) under changing climate.

Objective 3.1: To develop and implement measures to protect natural ecosystems and agriculture production against invasive species.

Action 3.1.1*:* Update the national invasive species list and their current distribution, and prioritize high risk species.

Action 3.1.2: Develop invasive species management strategies, including threat abatement plans, taking into account the potential effects of climate change on their ecology.

Action 3.1.3: Develop guidelines and protocols and regulate the entry and introduction of alien species.

Objective 3.2: To develop and implement a comprehensive forest fire management program, taking into account the changing climatic conditions.

Action 3.2.1: Strengthen fire ecology research under different ecosystems in the light of climate change.

Action 3.2.2: Experiment fire as a management tool for those ecosystems with a history of fire as natural disturbance regime for maintenance of biodiversity (eg: High altitude rangeland).

Action 3.2.3: Strengthen national fire management program in terms of human capacity, technology, equipment, coordination, surveillance and response system, etc.

Action 3.2.4: Install fire hydrants along strategic locations (e.g. along highways in forest fire prone areas).

Action 3.2.5: Initiate and institutionalize post-fire management programs (e.g. plantation and management of appropriate species) involving communities of the locality.

Objective 3.3: To control and manage increased incidences of pests and diseases under changing climate.

Action 3.3.1: Conduct comprehensive inventory of the current pests and diseases affecting plants and animals.

Action 3.3.2: Strengthen pest and disease surveillance, control and management programs.

Goal 4: To enhance national capacity and resources to adapt to climate change impacts.

Objective 4.1: To develop sustainable conservation financing mechanisms.

Action 4.1.1: Strengthen core funds of Bhutan Trust Fund for Environmental Conservation (BTFEC) by channeling funds from external donors for climate change.

Action 4.1.2: Dedicate a financing window for climate change adaptation programs under BTFEC.

Action 4.1.3: Develop and implement national REDD-plus strategy and road map to support biodiversity conservation financing.

Action 4.1.4: Institutionalize and upscale Payment for Ecosystem Services (PES) initiatives.

Action 4.1.5: Explore collaboration with appropriate multinational biotechnology companies for bioprospecting and product development, and benefit- sharing mechanisms.

Action 4.1.6: Strengthen and institutionalize a revenue plough-back mechanism from economic activities based on natural resources to biodiversity conservation.

Objective 4.2: Strengthen infrastructural capacity to adapt to climate change impacts.

Action 4.2.1: Consolidate and upgrade the existing pest and disease laboratories to international standards to provide efficient services.

Action 4.2.2: Develop clear guidelines and infrastructure for disposal and treatment of chemical and bio-hazardous wastes from laboratories.

Action 4.2.3: Strengthen *ex-situ* conservation facilities, collections, and services, in particular gene bank facilities for conservation of recalcitrant seeds and wild relatives, and molecular characterization.

Action 4.2.4: Create facilities for voucher specimen repository of prioritized groups of biological diversity.

Action 4.2.5: Upgrade the existing national bioprospecting laboratory to an international standard.

Action 4.2.6: Establish meteorological stations of uniform standards along different eco-floristic zones of the country and a mechanism for data collection and sharing.

Objective 4.3: To enhance technical capacity to understand climate change impacts on biodiversity and design adaptation measures.

Action 4.3.1: Strengthen human resource and technical capacity in the following prioritized fields:

a) Taxonomy (both domestic and wild flora and fauna).
b) Pest and disease surveillance, identification and management.
c) Biodiversity and climate change research.
d) Vulnerability and adaptation assessments at ecosystem and community level
e) Identification, monitoring and control of invasive species.
f) Modeling and weather forecasting.
g) Biodiversity inventory and information management.
h) Genetic resources conservation.
i) Park and protected area system management.
j) Remote sensing and GIS.

Objective 4.4: To enhance public understanding and awareness on biodiversity and climate change.

Action 4.4.1: Develop and conduct systematic awareness and educational programs on biodiversity and climate change at all levels and through all forms of media and communication outreach.

Action 4.4.2: Disseminate biodiversity and climate change information through development or integration into existing biodiversity portals/websites.

Goal 5: To promote effective coordination of biodiversity and climate change programs in the country.

Objective 5.1: To strengthen institutional set up and linkage to address biodiversity and climate change issues effectively.

Action 5.1.1: Review current mandates of NEC, NBC, Wildlife Conservation Division (WCD), Research and Development Centre (RDC), Yusipang, Ugyen Wangchuck Institute of Conservation and Environment (UWICE), and Watershed Management Division (WMD) and realign where necessary for effective coordination and implementation of biodiversity conservation programs.

Action 5.1.2: Institute an annual coordination meeting amongst biodiversity stakeholders to avoid duplication of efforts, and enable effective coordination and utilization of resources.

Objective 5.2: To monitor and evaluate the implementation status of the action plans.

Action 5.2.1: Identify an institute to coordinate the implementation of the action plan among various stakeholders in the country.

Action 5.2.2: Institute national biennium reporting on the implementation of the action plan on biodiversity and climate change.

Goal 6: To promote an enabling policy environment and mainstream biodiversity and climate change into national plans and programs.

Objective 6.1 Develop enabling policy and guidelines for biodiversity and climate change

Action 6.1.1: Develop a National Climate Change Policy, coordinated by NEC.

Action 6.1.2: Incorporate criteria for policy scanning to ensure that impacts of climate change on biodiversity are factored into national policies, coordinated by Gross National Happiness Commission (GNHC).

Action 6.1.3: Develop tools and guidelines to address climate change impacts on biodiversity in national and local development plans and programs, coordinated by GNHC.

Action 6.1.4: Incorporate a provision for assessing the impacts of climate change on biodiversity in the Environment Impact Assessment procedures.

Objective 6.2: To mainstream climate change impacts on biodiversity into national plans and programs.

Action 6.2.1: Incorporate climate change impacts on biodiversity into Five Year development planning guidelines.

Action 6.2.2: Incorporate climate change and biodiversity issues in the school and university curricula.

Action 6.2.3: Integrate existing and emerging knowledge on biodiversity and climate change into biodiversity management plans and development programs to ensure climate proofing.

Goal 7: To reduce the vulnerability of local communities to climate change impacts.

Objective 7.1: To enhance the resilience of local communities to the impacts of climate change.

Action 7.1.1: Train local communities to manage local crop and livestock diversity under changing climate.

Action 7.1.2: Train local communities in the sustainable management of private/community forestry, Non Wood Forest Products (NWFPs).

Action 7.1.3: Incorporate traditional knowledge and local community perspectives in climate change adaptation and coping mechanisms.

Action 7.1.4: Make crop and livestock insurance schemes affordable, accessible and equitable.

Action 7.1.5: Explore mechanisms to ensure sustenance of the Wildlife Endowment Fund.

Action 7.1.6: Strengthen community-based nature tourism.

Table 3: National Action Log frame

Overall Goal	*To enable persistence of biodiversity to adapt to climate change, reduce vulnerability from its impacts, and promote sustainable utilization of biodiversity to engender socio-economic development of the country.*												
Goals	**Objectives**	**Outputs**	**Budget in USD**	**Time line – 2012to 2021**									
				1	2	3	4	5	6	7	8	9	10
1. To strengthen documentation of biological diversity and climate parameters to understand climate change impacts on biodiversity and ecosystem services.	**1.1: To gather comprehensive data and information on biological diversity and climate parameters.**	Subject matter specialist network established.	2000.00										
		Baseline data on prioritized biodiversity groups established.	500,000.00										
		Meteorological data collection standardized.	2000.00										
	1.2: To enhance understanding of climate change impacts on biodiversity and ecosystem services.	Key CC indicator species identified and monitored	300,000.00										
		Research on species and ecosystems at greatest risk from CC conducted	500,000.00										
		Valuation of key ecosystem services conducted	100,000.00										
		Forest classification and ecological zones standardized	100,000.00										
		National reports on forest cover, critical ecosystems and species at risk	90,000.00										
2. To minimize impacts of climate change on biodiversity to maintain ecosystem health and continuous flow of ecosystem services.	**2.1: To strengthen the functionality of protected area systems and biological corridors under changing climate.**	Protected areas reviewed for functionality and efficacy.	100,000.00										
		Protected areas and biological corridors fully operationalized.	4,000,000.00										
		Guidelines/protocols for smart green infrastructure development within PAS in place.	100,000.00										
	2.2: To ensure sustainable management and utilization of biodiversity for adaptation to climate change.	Revised forest management planning guidelines and codes of practice inclusive of biodiversity, ecosystem services and changing climate.	50,000.00										

		Percent of forest cover under community/private/agro-forestry/plantation programs increased.	200,000.00										
		Chainsaw users, saw millers and loggers trained and certified in improved timber harvesting and processing methods and techniques.	50,000.00										
		Environmentally friendly wood/timber treatment plants established.	1,000,000.00										
		NWFP resource status assessed and reported biennially.	100,000.00										
		Post harvest facilities for prioritized NWFPs established.	100,000.00										
		Natural products developed.	200,000.00										
	2.3: To strengthen species conservation and management program to adapt to changing climate.	Threatened, endemic and key stone species listed.	100,000.00										
		Habitat for prioritized species (tiger, snow leopard, etc) conserved and viable population maintained.	4,000,000.00										
		Revised list under schedule I of FNCA.	3000.00										
	2.4: To conserve agro-biodiversity to promote adaptation of crops and livestock to changing climatic conditions.	Genetic diversity of major crops and livestock breeds assessed.	200,000.00										
		Habitats of wild crop relatives and important agriculture landscapes protected.	100,000.00										
		Important traditional crop varieties and livestock breeds conserved *in-situ*.	1,000,000.00										
		Community seed banks established in selected areas.	75,000.00										

		Farmers' adopt diversified farming practices.	300,000.00										
3. To minimize impacts of other stressors of biodiversity (invasive species, fire, pest and diseases, etc.) under changing climate.	**3.1: To develop and implement measures to protect natural ecosystems and agriculture production against invasive species.**	Updated national invasive species list available.	50,000.00										
		Management strategies for invasive species in place.	100,000.00										
		Regulatory guidelines and protocols for entry and introduction of alien species in place.	60,000.00										
	3.2: To develop and implement a comprehensive forest fire management program, taking into account the changing climatic conditions.	Fire ecology research under different ecosystems conducted.	300,000.00										
		Fire volunteer groups trained and strengthened.	100,000.00										
		National fire management program strengthened.	300,000.00										
		Fire hydrants established.	600,000.00										
		Post fire management programs institutionalized.	150,000.00										
	3.3: To control and manage increased incidences of pests and diseases under changing climate.	List of plant and animal pest and diseases.	30,000.00										
		Management strategies for prioritized pest and diseases in place.	150,000.00										
4. To enhance national capacity and resources to adapt to climate change impacts.	**4.1: To develop sustainable conservation financing mechanisms.**	Core fund of BTFEC strengthened for Biodiversity and climate change.	All donor funds for climate change										
		A dedicated financing window under BTFEC for climate change adaptation established.	0.00										
		National REDD+ strategy plan developed and implemented.	200,000.00										
		PES up-scaled and institutionalized	100,000.00										
		Access and Benefit sharing fund strengthened through	100,000.00										

		successful collaborations in bioprospecting.	
		Revenue plough-back mechanism from economic activities based on natural resources institutionalized.	5000.00
	4.2: Strengthen infrastructural capacity to adapt to climate change impacts.	National pest and disease laboratories strengthened.	200,000.00
		Chemical and bio-hazardous waste treatment plant established/strengthened.	500,000.00
		Cryopreservation and molecular characterization facilities strengthened	300,000.00
		Facilities for voucher specimen repository of prioritized groups of biodiversity created.	200,000.00
		National Bioprospecting laboratory upgraded.	200,000.00
		Meteorological stations along different eco-floristic zones established.	200,000.00
	4.3: To enhance technical capacity to understand climate change impacts on biodiversity and design adaptation measures.	National technical capacity on biodiversity and CC strengthened (Action 4.3.1)	1,000,000.00
	4.4: To enhance public understanding and awareness on biodiversity and climate change.	Educational materials on biodiversity and climate change developed.	50,000.00
		Mass education and awareness programs at all levels conducted.	200,000.00
		Biodiversity and climate change information integrated into biodiversity portal.	100,000.00

5. To promote effective coordination of biodiversity and climate change programs in the country.	**5.1: To strengthen institutional set up and linkage to address biodiversity and climate change issues effectively.**	Institutional mandates and functions reviewed and realigned	25,000.00
		Annual coordination meetings instituted	5000.00
	5.2: To monitor and evaluate the implementation status of the action plans.	Coordination institute identified	0.00
		Biennium reports on the implementation of the action plan (s)	50,000.00
6. To promote an enabling policy environment and mainstream biodiversity and climate change into national plans and programs.	**6.1 Develop enabling policy and guidelines for biodiversity and climate change.**	Climate change policy developed	100,000.00
		Biodiversity and CC factored in policy/ policy scanning tools/planning guidelines.	50,000.00
	6.2 To mainstream climate change impacts on biodiversity into national plans and programs	Biodiversity and CC incorporated into national and local development plans, and EIA	200,000.00
		Biodiversity and climate change included in school and university curricula.	20,000.00
7. To reduce the vulnerability of communities to climate change impacts.	**7.1: To enhance the resilience of local communities to the impacts of climate change.**	Local communities trained in genetic diversity management and sustainable use of NWFPs.	300,000.00
		Local perspective and traditional knowledge on climate change assessed.	50,000.00
		Crop and livestock insurance scheme established	300,000.00 (seed money)
		Wildlife endowment fund strengthened.	300,000.00 (contribution)
		Community based nature tourism strengthened	300,000.00
			20,167,000.00

CHAPTER 6: INSTITUTIONAL ARRANGEMENTS

In order to ensure the effective coordination and implementation of biodiversity programs and to avoid duplication of efforts, the first priority will be to review and realign the existing institutional arrangements. As outlined under *Objective 5.1,* the current mandates of the NEC, NBC, UWICE and functional divisions under Department of Forests and Park Services (DoFPs) - WCD, RDC-Yusipang, and WMD needs to be revisited and realigned where necessary. A relevant institute will be mandated by the MoAF to coordinate biodiversity programs, including the national action plans and conduct annual coordination meetings amongst biodiversity stakeholders inclusive of non-governmental institutions and international non-governmental institutions as well as donors.

Further, the national focal points to various international conventions related to biodiversity conservation will be revisited in order to identify the most relevant institutions as the focal agencies for various bodies and committees. Clear procedures for nomination of country focal points will also be established. This is to ensure that national obligations and targets are met as well as to enable capacity building of appropriate institutions and to capitalize on funding opportunities.

The MoAF will be the main implementing agency for the National Action Plan on Biodiversity persistence and climate change. Relevant institutions will be mandated by MoAF to implement priority actions under the national action plan.

For sustained financing and successful implementation of the action plan, funds from external donors for climate change will be channeled into BTFEC core funds. Project proposals for prioritized actions will be developed and submitted by respective institutions to a financing window dedicated for climate change adaptation programs under BTFEC.

CHAPTER 7: REGIONAL ACTION PLAN

7.1: Rationale

Since the impacts of climate change is not limited to geographical or political boundaries, it is of paramount importance to strengthen regional collaboration in order to understand and adapt to the impacts of climate change before it is too late. This will create an enabling environment for addressing trans-boundary climate change impacts and issues as well as building regional expertise through technology transfer and information exchange. A regional stance will further strengthen national initiatives in the field of biodiversity conservation and adaptation to the impacts of climate change through targeted, regional efforts in areas such as illegal trade in wildlife, invasive alien species, creation of ecological connectivity, sharing of best practices etc.

In keeping with the spirit of regional cooperation and commitment to adapt to the impacts of climate change, the following five actions have been identified:

7.2 Action plan

Action 1: Create and manage sub-regional level landscape and ecological connectivity to adapt to climate change impacts through declaration of large contiguous landscape as sub regional protected area system, e.g: Linking Royal Manas National Park and Indian Manas.

Action 2: Institute forum for interregional coordination/collaboration in addressing the following trans-boundary climate change impacts and issues:

- Monitoring and control of invasive species, pests and diseases
- Wildlife poaching
- Technology transfer
- Sharing of best practices.
- Sharing of information and research results within the regional institutions and partner countries.

Action 3: Establish a regional Subject Matter Specialist Network.

Action 4: Establish a Himalayan seed bank to ensure agro-biodiversity conservation and food security.

Action 5: Identify a regional pest and disease laboratory to act as a regional referral laboratory.

Action 6: Explore possibilities of Payment for Ecosystem Services at the regional level.

Action 7: Streamline Hindukush Himalaya (HKH) Conservation portal with national biodiversity portals for better information sharing and coordination.

Action 8: Institute a mechanism for monitoring and evaluation of regional action plans.

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Annexure 1

List of endemic plants of Bhutan

S/N	Species	Family
1	*Allium rhabdotum* Stearn	Alliaceae
2	*Androsace hemisphaerica* Ludlow	Primulaceae
3	*Androsace ludlowiana* Handel-Mazzetti	Primulaceae
4	*Arundinella dagana* Noltie	Poaceae (Gramineae)
5	*Bhutanthera albosanguinea* Renz.	Orchidaceae
6	*Bhutanthera albovirens* Renz.	Orchidaceae
7	*Bhutanthera himalayana* Reinz.	Orchidaceae
8	*Buddleja bhutanica* Yamazaki	Buddlejaceae
9	*Bulbophyllum leopardinum* var. *tuberculatum* N. P. Balakrishnan & S. Chowdhury	Orchidaceae
10	*Ceropegia bhutanica* Hara	Asclepediaceae
11	*Ceropegia dorjei* C.E.F. Fischer	Asclepediaceae
12	*Ceropegia ludlowii* H. Huber	Asclepediaceae
13	*Ceropegia ugenii* C.E.F.Fisher	Asclepediaceae
14	*Cheirostylis sherriffii* N. Pearce & P. J. Cribb	Orchidaceae
15	*Cnidium bhutanicum* Watson	Umbelliferae (Apiaceae)
16	*Corallodiscus cooperi* (Craib) B.L.Burtt.	Gesneriaceae
17	*Corydalis aurantiaca* Ludlow	Fumariaceae
18	*Corydalis calliantha* Long	Fumariaceae
19	*Corydalis leptantha* Liden	Fumariaceae
20	*Corydalsi oxalidifolia* Ludlow	Fumariaceae
21	*Corylopsis himalayana* Griffith	Hamamelidaceae
22	*Cromapanax lobatus* Grierson	Araliaceae
23	*Cryptocarya bhutanica* Long	Lauraceae
24	*Cymbopogon bhutanicus* Noltie	Poaceae (Gramineae)
25	*Daphne ludlowii* Long & Rae	Thymelaeceae
26	*Draba sherriffii* Grierson	Cruciferae (Brassicaceae)
27	*Elatostema longicaudatum* Grierson & Long	Urticaceae
28	*Eriocaulon bhutanicum* Noltie	Eriocaulaceae

29	*Eulophia stenopetala* Lindl.	Orchidaceae
30	*Flemingia bhutanica* Grierson	Leguminosae (Fabaceae)
31	*Gentiana wangchukii* E. Aitken & D.G.Long	Gentianaceae
32	*Gentianella griersonii* E. Aitken & D.G. Long	Gentianaceae
33	*Glochidion bhutanicum* Long	Euphorbiaceae
34	*Hedychium griersonianum* R.M.Smith	Zingiberaceae
35	*Hedyotis griffithii* Hook.f	Rubiaceae
36	*Heracleum bhutanicum* Watson	Umbelliferae (Apiaceae)
37	*Herminium pygmaeum* Renz	Orchidaceae
38	*Hetaeria pelota* N. Pearce & P. J. Cribb	Orchidaceae
39	*Hoya bhutanica* Grierson & Long	Asclepediaceae
40	*Hypericum sherriffii* Robson	Guttiferae (Clusiaceae)
41	*Isodon atroruber* Clements	Labiatae
42	*Keraymonia pinnatifolia* Watson	Umbelliferae (Apiaceae)
43	*Kickxia membranaceae* Sutton	Scrophulariaceae
44	*Kickxia papillosa* Mill	Scrophulariaceae
45	*Lobelia nubigena* Anthony	Campanulaceae
46	*Lycium armatum* Griffith	Solanaceae
47	*Meeboldia digitata* (Kljuykov) Watson	Umbelliferae (Apiaceae)
48	*Musa griersonii* Noltie	Musaceae
49	*Neopicrorhiza minima* Mill	Scrophulariaceae
50	*Onosma bhutanica* (Johnston) Grierson & Long	Boraginaceae
51	*Onosma griersonii* Mill.	Boraginaceae
52	*Ophiorrhiza longii* Wood	Rubiaceae
53	*Oreorchis sanguinea* (N. Pearce & P. J. Cribb) N. Pearce & P. J. Cribb	Orchidaceae
54	*Pedicularis dhurensis* R.R.Mill	Scrophulariaceae
55	*Pedicularis hicksii* Tsoong	Scrophulariaceae
56	*Pedicularis imbricata* Tsoong	Scrophulariaceae
57	*Pedicularis inconspicua* Tsoong	Scrophulariaceae
58	*Pedicularis longipedicellata* Tsoong. Var. *lanocalyx* R.R.Mill	Scrophulariaceae
59	*Pedicularis longipedicellata* var. *longipedicellata* Tsoong	Scrophulariaceae
60	*Pedicularis ludowiana* Tsoong	Scrophulariaceae
61	*Pedicularis melalimne* R.R.Mill	Scrophulariaceae
62	*Pedicularis microloba* R.R.Mill	Scrophulariaceae
63	*Pedicularis mucronulata* Tsoong	Scrophulariaceae
64	*Pedicularis perpusilla* Tsoong	Scrophulariaceae

65	*Pedicularis porriginosa* Tsoong	Scrophulariaceae
66	*Pedicularis sanguilimbata* R.R.Mill	Scrophulariaceae
67	*Pedicularis woodii* R.R.Mill	Scrophulariaceae
68	*Pedicularis xylopoda* Tsoong	Scrophulariaceae
69	*Persea bootanica* (Meisner) Kostermans	Lauraceae
70	*Pinus bhutanica* Grierson , D.G.Long & C.N.Page	Pinaceae
71	*Pomatocalpa bhutanicum* N. P. Balakrishnan	Orchidaceae
72	*Potentilla arbuscula* var. *unifoliata* Ludlow	Rosaceae
73	*Potentilla bhutanica* Ludlow	Rosaceae
74	*Primula chasmophila* Hutchinson	Primulaceae
75	*Primula jigmediana* W.W.Smith	Primulaceae
76	*Primula sherriffae* W.W. Smith	Primulaceae
77	*Primula umbratilis* Balfour.f. & Cooper	Primulaceae
78	*Primula xanthopa* Balfour.f.& Cooper	Primulaceae
79	*Rhodiola marginata* Grierson	Crassulaceae
80	*Rhododendron bhutanense* Long & Bowes Lyon	Ericaceae
81	*Rhododendron kesangiae* Long & Rushforth	Ericaceae
82	*Rhododendron pogonophyllum* Cowan & Davidian	Ericaceae
83	*Rubus cooperi* Long	Rosaceae
84	*Rubus sengorensis* Grierson & Long	Rosaceae
85	*Saxifraga flavida* H.Smith	Saxifragaceae
86	*Saxifraga harry-smithii* Wadhwa	Saxifragaceae
87	*Saxifraga serrula* H. Smith	Saxifragaceae
88	*Saxifraga sherriffii* H. Smith	Saxifragaceae
89	*Saxifraga thiantha* H. Smith	Saxifragaceae
90	*Saxifraga vacillans* H. Smith	Saxifragaceae
91	*Schulzia bhutanica* Watson	Umbelliferae (Apiaceae)
92	*Scrophularia cooperi* R.R. Mill.	Scrophulariaceae
93	*Scrophularia subsessilis* R.R. Mill.	Scrophulariaceae
94	*Sibbaldia byssitecta* Sojak	Rosaceae
95	*Silene julaensis* Grierson	Caryophyllaceae
96	*Stipa bhutanica* Noltie	Poaceae (Gramineae)
97	*Stipa jacquemontii* Jaub. & Spach subsp. *chuzomica* Noltie	Poaceae (Gramineae)
98	*Strobilanthes accrescens* subsp. *accrescens* J.R.I.Wood	Acanthaceae
99	*Strobilanthes accrescens* subsp. *teraoi* J.R.I.Wood	Acanthaceae
100	*Strobilanthes jennyae* J.R.I.Wood	Acanthaceae
101	*Swertia crossoloma* H.Smith	Gentianaceae

102	*Swertia grandiflora* H.Smith	Gentianaceae
103	*Torenia burrttiana R.R.Mill*	Scrophulariaceae
104	*Vanda bicolor* Griff.	Orchidaceae
105	*Viola bhutanica* Hara	Violaceae

Annexure 2

List of globally threatened mammal species found in Bhutan.

S/N	Species	Common name	Global Threat Category
1	*Sus salvanius*	Pygmy Hog	Critically Endangered
2	*Trachypithecus geei*	Golden Langur	Endangered
3	*Trachypithecus pileatus*	Capped Langur	Endangered
4	*Cuon alpinus*	Dhole/ Wild Dog	Endangered
5	*Ailurus fulgens*	Red Panda	Endangered
6	*Panthera tigris tigris*	Bengal Tiger	Endangered
7	*Uncia uncia*	Snow Leopard	Endangered
8	*Elephas maximus*	Asian Elephant	Endangered
9	*Rhinoceros unicornis*	One-horned Rhinoceros	Endangered
10	*Bubalus bubalis*	Asiatic Water Buffalo	Endangered
11	*Caprolagus hispidus*	Hispid Hare	Endangered
12	*Platanista gangetica*	Ganges River Dolphin	Endangered
13	*Macaca assamensis*	Assamese Macaque	Vulnerable
14	*Melursus ursinus*	Sloth Bear	Vulnerable
15	*Ursus thibetanus laniger*	Himalayan Black Bear	Vulnerable
16	*Moschus chrysogaster*	Himalayan Musk Deer	Vulnerable
17	*Lutrogale perspicillata*	Smooth-coated Otter	Vulnerable
18	*Prionailurus viverrinus*	Fishing Cat	Vulnerable
19	*Pardofelis marmorata*	Marbled Cat	Vulnerable
20	*Neofelis nebulosa*	Clouded Leopard	Vulnerable
21	*Catopuma temmincki*	Asiatic Golden Cat	Vulnerable
22	*Cervus duvauceli*	Swamp Deer	Vulnerable
23	*Bos gaurus*	Gaur	Vulnerable
24	*Capricornis sumatraensis*	Serow	Vulnerable
25	*Budorcas taxicolor*	Takin	Vulnerable
26	*Myotis sicarius*	Mouse-eared Bat	Vulnerable
27	*Rattus sikkimensis*	Sikkim Rat	Vulnerable

Annexure 3

Critically Endangered and Vulnerable bird list of Bhutan (courtesy-BirdLife)

S/N	Species	Common Name	Category
1	*Arborophila mandellii*	Chestnut-breasted Partridge	Vulnerable
2	*Tragopan blythii*	Blyth's Tragopan	Vulnerable
3	*Aceros nipalensis*	Rufous-necked Hornbill	Vulnerable
4	*Apus acuticauda*	Dark-rumped Swift	Vulnerable
5	*Grus nigricollis*	Black-necked Crane	Vulnerable
6	*Gallinago nemoricola*	Wood Snipe	Vulnerable
7	*Haliaeetus leucoryphus*	Pallas's Fish-eagle	Vulnerable
8	*Gyps bengalensis*	White-rumped Vulture	Critically Endangered
9	*Ardea insignis*	White-bellied Heron	Critically Endangered
10	*Sitta Formosa*	Beautiful Nuthatch	Vulnerable
11	*Prinia cinereocapilla*	Grey-crowned Prinia	Vulnerable
12	*Aythya baeri*	Baer's Pochard	Endangered
13	*Aquila clanga*	Greater Spotted Eagle	Vulnerable
14	*Aquila heliacal*	Eastern Imperial Eagle	Vulnerable
15	*Mulleripicus pulverulentus*	Great Slaty Woodpecker	Vulnerable
16	*Chlamydotis undulate*	Houbara Bustard	Vulnerable
17	*Saxicola insignis*	White-throated Bushchat	Vulnerable
18	*Sarcogyps calvus*	Red-headed Vulture	Critically Endangered