Climate Change Vulnerability Assessment and Adaptation Planning

Report

Enhancing Sustainability and Climate Resilience of Forest and Agriculture Landscape and Community Livelihoods in Bhutan

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List of Acronyms

AAA	Adaptation Action Areas of RNR SAPA
BC	Biological Corridors
CCA	Climate Change Adaptation
CCAP	Climate Change Adaptation Program
CORRB	Council for RNR Research of Bhutan
CVCA	Climate Vulnerability and Capacity Analysis
DoA	Department of Agriculture
DOFPS	Department of Forests and Parks Services
FAO	Food and Agriculture Organization of the United Nations
FNCA	Forest and Nature Conservation Act
FYP	Five-Year Plan
GAIN	Global Adaptation Institute
GCCA	Global Climate Change Alliance
GEF	Global Environment Facility
GLOF	Glacial Lake Outburst Flood
GLS	Gray Leaf Spot
GNHC	Gross National Happiness Commission
HH	Household
ICIMOD	International Center for Integrated Mountain Development
INDC	Intended Nationally Determined Contribution
IPCC	Inter-governmental Panel on Climate Change
JKSNR	Jigme Khesar Strict Nature Reserve
JSWNP	Jigme Singye Wangchuck National Park
LCMP	Land Cover Mapping Project
MoAF	Ministry of Agriculture and Forests
MoWHS	Ministry of Works and Human Settlement
NEC	National Environment Commission
NECS	National Environment Commission Secretariat
NLFS	National Labor Force Survey
NRP	National Rehabilitation Programmed
PAR	Poverty Analysis Report
PPG	Project Preparation Grant
PRA	Participatory Rural Appraisal
REAP	Rural Economy Advancement Programmed
RGOB	Royal Government of Bhutan
RNR	Renewable Natural Resources
SAPA	Sector Adaptation Plan of Action
SKRA	Sector Key Result Area
SNC	Second National Communication to UNFCCC
PNP	Phrumsengla National Park
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WCP	Wangchuck Centennial Park

List of Bhutanese terms

Dungkhag	Sub-division of district
Dzong	Fortress, which normally houses district monastic body and district/local administrative offices
Dzongdag	District Administrator
Dzongkhags	District
Dzongkhags Tshogdu	District Development Council
Gewog	Administrative Block/County consisting of a number of Chiwogs
Gewog Tshogde	Block/County Development Committee
Thromde	Municipality, City or township
Chiwog	Cluster of villages or hamlets

Executive Summary

This report pertains to the assessing local level Climate change vulnerabilities and to assess local livelihoods, Existing and potential community-level adaptation responses, local capacity development needs to reduce the vulnerabilities and to establish baseline information required for GEF CCA tracking tool. The assessment is to provide baseline information to support formulation of the proposed Global Environment Facility through UNDP for a full-sized project titled ***"Enhancing sustainability and resilience of forest and agriculture landscape and community livelihoods in Bhutan."*** This pertains to three landscape areas comprising of significant areas under three parks and four biological corridors.

Prior to start of the assessment, a comprehensive review of literature compiled information on climate projection scenarios for Bhutan as well as impacts of climate and climate related hazards has been undertaken. The assessment has been done based on IPPC definitions for climate change and climate vulnerabilities considering exposure, sensitivity and adaptation capacity as principle components of climate vulnerability. Using this analytical framework, climate change vulnerability of indicators for landscape, Gewog and Chiwog levels were generated based on data obtained through field consultations in identified Chiwogs and Gewogs. Secondary data from RNR statistics has also been used.

Assessment of vulnerability based on exposure, sensitivity and adaptation capacity indices were done at Chiwog level. The Chiwog level assessment is based on information generated form actual consultation in the identified Chiwogs. The Gewog level assessment is based on average scores of the Chiwog level assessment to reflect Gewog vulnerabilities. However, at the Gewog level an additional indicator, average household income, has been added (raw data from RNR statistics, 2011/2012 and 2013) as part of the group of indicators in the Adaptation Capacity Index. The assessment at the landscape level has been made based on average score of Gewogs within a particular landscape.

Based on the analysis, climate change vulnerability maps have been prepared at the Gewog and landscape levels.

The analysis of climate vulnerability shows that landscape three, which comprises of areas within Phrumsengla National Park (PNP) and the Biological Corridor (BC4) connecting the PNP to Jigme Singye Wangchuck National Park (JSNP) is relatively the most vulnerable to climate change. It also has the highest score on Sensitivity index.

Landscape two comprises of Jigme Singye Wangchuck National Park (JSWNP) and biological corridors connecting JSWNP connecting to Jigme Dorji National Park (BC2) and the one connecting it to Wangchuck Centennial Park (BC8) is second most vulnerable. It scores the highest on exposure index and lowest on adaptive capacity.

Landscape one, comprising of Jigme Khesar Strict Nature Reserve (JKSNR) and the BC1 connecting JKSNR to Jigme Dorji National Park (JDNP), is the least vulnerable among the three landscapes. It has the highest score on adaptive capacity and lowest scores on exposure and sensitivity indices.

Maximum contribution to vulnerability at the landscape level arises from sensitivity index followed by adaptation capacity index and exposure index.

Among the landscape Gewogs, Tsento Gewog is the least vulnerable of the eighteen Gewogs included in the study. Tsamang Gewog in Monger the most vulnerable. Toepisa Gewog scores the highest on exposure index while Jaray Gewog scores the least in exposure index. Nangkor Gewog shows the highest sensitivity index and Tsento Gewog the least. Ura Gewog has the highest adaptive capacity while Athang Gewog has the lowest adaptive capacity.

Among the thirty-six Chiwogs, included in the study, Thuenmong_Tokari in Tsamang Gewog has the highest vulnerability as well as sensitivity index. Goennkha_Mendrelgang Chiwog of Teopisa has the highest exposure index and Buli of Nangkor has the highest adaptive capacity. Nyamjey_Phangdo Chiwog of Tsento has the lowest vulnerability and sensitivity index while Nangngey Chiwog of Jaray has the lowest exposure index. Lawa_Lamga Chiwog of Athang Gewog has the lowest adaptive capacity.

Policy approach to climate change at the national level do not adequately reflect linkage across sectors to take on board cross sector issues of relevance to climate change such as climate information product development and dissemination to local levels. Coordinated actions among relevant agencies need to addressed to enable building resilience through a coordinated national climate change approaches that links to local level climate change actions to national level policies and programs.

The assessment of local level adaptation measures and proposals on adaptation to climate change indicate that actions related to adaptation to climate change are fragmented and show weak coordination towards a commonly understood direction. Therefore there is need to strengthen linkages across local level sector development plans and climate change adaption interventions

Adequate level of capacity building is required at the local levels for assessment, planning and coordinated implementation of climate resilient interventions.

Based on the assessment of vulnerability component indicators, strategies and priorities along with baseline information has been generated to feed into the project preparation process. A list of baseline information aligned with the GEF tracking tool has also been provided.

1. Background

1.1 Context

In order to reduce climate change vulnerabilities and improve the sustainability of local livelihoods and biodiversity of the country, the Royal Government of Bhutan has requested support from the Global Environment Facility through UNDP for a full-sized project titled ***"Enhancing sustainability and resilience of forest and agriculture landscape and community livelihoods in Bhutan."*** The project aims to operationalize an integrated landscape-based approach to climate change adaptation and biodiversity conservation through;

- Improvement of institutional capacity at national, sub-national and local levels to manage forest and agricultural landscapes sustainably for enhanced climate resilience;
- Emplacement of governance system for biological corridors and operationalization of conservation management system in the pilot corridors; and
- Development of climate-resilient livelihood options for the local communities.

The project preparation phase of the project (January to December, 2016) includes collection of information and gathering of data needed for the project design of the approved indicative outcomes and outputs including baseline data, identification of lead implementing partner and implementation arrangements, development of indicators and targets, establishment of partnerships and commitments for co-financing.

As part of the project preparation phase a series of sub-consulting assignments has been called to facilitate the project design and formulation of the Project Document.

1.2 Scope of work and limitations

This report pertains to the assessing the following aspects at community level in the protected areas and biological corridors:

- Climate change vulnerabilities to local livelihoods, including livelihood assets/ resources;
- Existing and potential community-level adaptation responses;
- Associated local capacity development needs to reduce the vulnerabilities; and
- Baselines required for GEF CCA tracking tool

2. Methodology of the assignment

2.1 Desk Review

A review of related existing literature to climate change has been carried out to provide an understanding of the impacts of climate change and climate change scenario for Bhutan.

2.2 Climate Change Scenario in Bhutan

Bhutan is a land-locked least developed country located in the fragile mountainous landscape of the Eastern Himalayas. About 50% of the Geographical area comprises slopes greater that 50% and about 52.65 % of the land area lies above 2600 meters above mean sea level (Bhutan RNR Statistics, 2015) with elevations ranging from 100m in the South to 7570m at the Peak of Gangkar Punsum Mountain. Under the influence of climate change, mountains are likely to experience wide ranging effects on the environment, biodiversity, and socioeconomic conditions (Beniston 2003)[1]. The mountainous terrain and rapid variation in agro-ecological zone renders Bhutan vulnerable to climate change, climate variability and its impacts.

Information on climate and vulnerabilities to climate change in Bhutan is limited. The most recent official information on climate and climate vulnerabilities come from the Second National Communication (SNC) of the Kingdom of Bhutan to UNFCCC (RGOB, NEC, 2011). The SNC and various sources indicate that temperatures are increasing and are projected to increase. Annual precipitation is expected to increase with the monsoon season predicted to become wetter, while the winters will become drier (See Table 2). International sources categorized Bhutan to be vulnerable to climate change as indicated in the following table:

Table 1: Assessment of Bhutan's Exposure and Vulnerability to Climate Change

Source	Rank	Implications
German watch (2013); Climate Risk Index of 2012	143 out of 178 countries	Indicates a level of exposure and vulnerability to extreme events based on 1993-2012 (past) data of weather related events and losses. Based on past data, this indicates that its 143rd out of 178 countries that is most exposed to climate risk
Global Adaptation Institute (GAIN) index (2011)	117 out of 177 countries. (125/183 in the vulnerability & 108/179 in the readiness score)	High vulnerability score (125th most vulnerable out of 183 countries) and low readiness score (108th out 179 in terms of readiness to adapt) of requiring investments and innovations to improve climate change readiness

Source: ADB, 2014; Climate Change Country Risk Assessment, Country Partnership Strategy: Bhutan, 2014-2018.

[1] Observation from Climate Change Impacts and Vulnerability in the Eastern Himalayas, ICIMOD, 2009 (Eklabya Sharma, Nakul Chettri, Karma Tse-ring, Arun B Shrestha, Fang Jing, Pradeep Mool and Mats Eriksson)

2.2.1 Temperature Scenario

Overall temperature outlook in Bhutan is described in the SNC document as follows;

Table 2: Overall temperature outlook for Bhutan

Parameters	Simulated Changes	Source
Mean Annual Air Temperature	Increase by 0.8°C to 1.0° C in 2010 to 2039 and by 2.0 ° C to 2.4° C in 2040 to 2069	SNC, RGoB 2011
	Increase by 4.9° C from 1981 to 2100 averaged over all 17 sub-catchments for Echam A2 and Increase by 2.5° C from 1981 to 2100 averaged over all 17 sub-catchments for Echam B1	Stein Beldring & Astrid Voksø, 2011
Mean summer air temperature	Increase by 0.8° in 2010 to 2039 and by 2.8°C 2040 to 2069	SNC, RGoB 2011
Mean winter air temperature	Increase by 1.2° C in 2010 to 2039 and by 2.1°C 2040 to 2069	SNC, RGoB 2011

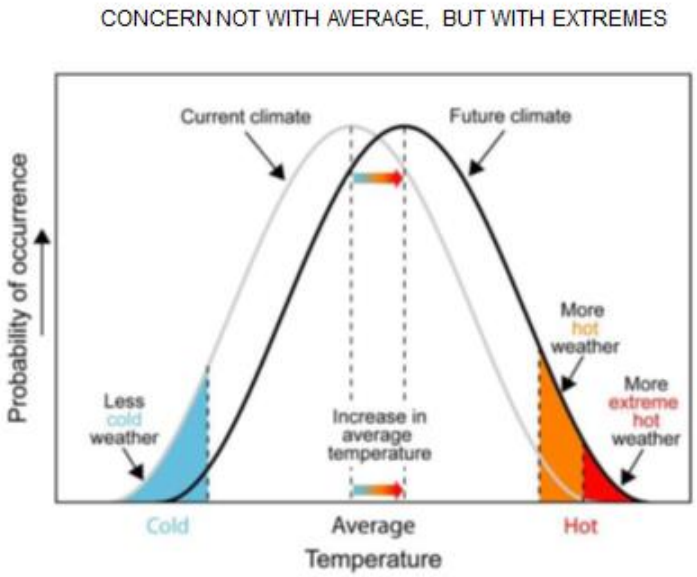
Warming is observed and predicted to be more rapid in the high mountain areas than at lower elevations, with areas higher than 4000 m experiencing the highest warming rates (Shrestra & Devkota, 2010)2. The draft inception report of the ADB project, BHU-8623, 2014 portray that the average temperatures in Bhutan will not only increase but it is more likely that there will be extreme hot temperature conditions (See figure 1)3.

In the study area, 93.2% of all participants during consultations reported that they have observed change in summer temperatures with 4.6% of the total participants reporting that they have observed decrease in summer temperatures while 95.1% reporting that they have observed increase in summer temperatures (See Annex 1). Male and female response on this has been almost similar (5.1% male participants and 4.3% female participants reported observation of decrease while 94.9% male and 95.3% females reported observation of increase in summer temperatures). On winter temperatures, 85.4% of all participants reported that they have observed temperature changes. This includes 39.8% of participants who reported observing decrease and 60.2% who reported observing increase in winter temperatures. Observation by male and female participants has been similar (51 % male participants and 32.9% female participants reported observation of decrease while 49% male and 67.1% females reported observation of increase in winter temperatures). In summary, majority of both male and female participants reported observing increase in summer as well as in winter temperatures. This aligns with the simulations in average summer and winter temperatures (See Table 2).

2 Data taken from National Action Plan, Biodiversity Persistence and Climate Change, National paper of Bhutan on biodiversity persistence and climate change at Climate Summit, 2011 (p 7)

3 Chart taken from Egis Eau & RSPN/ BhWP (BHU-8623), 2014; Adapting to Climate Change through IWRM, Draft Inception Report, October 2014 (p -15).

Figure 1: Probability of Extreme Temperatures



The Climate Change Impact and Vulnerability in the Eastern Himalayas Synthesis Report by ICIMOD projects that surface air temperature in Bhutan will increase with the greatest change in the west, gradually decreasing towards the east. The projected surface warming will be more pronounced during the pre-monsoon than during the summer monsoon season. The temperature increase will be higher in the inner valleys than in the northern and southern parts of the country. It predicts peak warming of about 3.5°C by the 2050s in Bhutan (Tse-ring et al., 2010) with higher changes in the inner valleys than in the southern and northern parts of the country.

Observations in the field as reported by several studies and surveys in Bhutan tend to agree with the above projections. In the survey for the national paper of Bhutan on biodiversity persistence and climate change, 2011, about 81.1 percent of the survey respondents (n=417 households in 16 Dzongkhags) reported increase in temperature over the last ten years.

In a sample of households in the Gewogs of Chhokhor (Bumthang), Nubi and Sephu (Wangdue) across Wangchuck Centennial Park (WCP) in 2012, 22% of the key informants reported that due to increased temperatures, they were now experiencing fewer cold days with higher minimum temperatures (Lhendup, 2012). A study done by Wangchuck Centennial Park (WCP) on Climate Change Vulnerability Assessment of WCP (WWF, 2011) report that, 89% of respondents mentioned observing increased temperatures, with fewer cold days and more warm days. Physical evidence such as the cultivation of new vegetables (those usually grown in lower altitudes), changes in plant phenology, presence of new diseases in plants and domesticated animals and the appearance of mosquitoes in Sephu and Chhokhor Gewogs have been recorded by the report.

In eastern Bhutan, a Gewog level study showed that 59.29 percent of households in Kangpara Gewog reported experiencing drought and widening difference between the maximum and minimum temperatures since 2008 (RSPN, 2012), indicating occurrence of extremes in both maximum and minimum temperatures.

Literature review as well as community consultation show that increase in temperatures have become a reality indicating evidence of increased exposure to temperatures variations at local levels.

2.2.2 Precipitation Scenario

Most studies on climate in Bhutan report fluctuations and erratic rainfall in the recent past (Climate summit, 2011; SNC, 2011). The SNC document also presents projected changes in precipitation scenario for Bhutan as follows:

Table 3: Overall Precipitation Outlook for Bhutan

Parameters	Simulated Changes	Source
Mean annual precipitation	Increase by 10% from 2010 to 2039 and by 20% in 2040 to 2069 with wetter monsoons and slightly drier winter seasons.	SNC, 2011
	Mean annual precipitation sums for 1981-2010: • above 5000 mm/yr in the southern low- lying areas • below 500 mm/yr in the northern, high-altitude parts	Stein Beldring & Astrid Voksø, 2011 (p, 31)
Monsoon mean total precipitation	Increase by ~ 350 to 450 mm/season from 1980 to 2069	SNC, 2011
Winter mean total precipitation	Decrease by ~ 5 mm/season from 1980 to 2069	SNC, 2011

A study by SERVIR[4] and the University of Oklahoma (SERVIR, 2011) in the Wangchu Basin that looked at the basin using three possible climate scenarios laid out by the IPCC as high (A2), medium (A1B), and low (B1) emissions, pointed out that while annual precipitation would be slightly higher, temperatures and runoff were likely to increase during Bhutan's rainy seasons and become even lower than present-day conditions during dryer months (January and December).

In a survey conducted in 2010, 72% of the survey respondents across all four eco-floristic zones had the opinion that the rainfall pattern had become more erratic and unreliable (Bhutan climate summit, 2011). Bhutan is expected to experience a significant overall increase in precipitation, but with an appreciable change in the spatial pattern of winter and summer monsoon precipitation, including a 20 to 30% decrease in winter precipitation, over the north-east and south-west parts of Bhutan for the 2050s (Tsering et al., 2010).

Within the survey area, 36.4% of the participants reported observation of decrease in rainfall and 63.6% reported increase in rainfall. However, 95.8% reported observing decrease in snowfall while only 4.2% reported observing increase in snowfall.

[4] SERVIR is joint development initiative of National Aeronautics and Space Administration (NASA) and United States Agency for International Development (USAID)

Past studies show that there Bhutan has been experiencing erratic pattern of rainfall. The community observations in the study area tend to align with the projections that predict increase in precipitation.

2.2.3 Impacts on Agriculture and Livestock

The Labour Force Survey Report (LFSR) reports that 58% of the total employed population is engaged in agriculture and forestry sector (LFSR, 2015). This comprise of 27.5% of employed males and 30.5% of employed females. As can be seen from the past incidences of impacts described in the following sections, agriculture and forestry sector, is very vulnerable to impacts from climate change. Furthermore, agriculture in Bhutan depends mostly on rain-fed crops.

The National paper of Bhutan on biodiversity persistence and climate change at Climate Summit, 2011 reported the following;

- 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% yield loss and loss of traditional rice varieties. 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 3,835 households covering 4,711.76 acres of maize crop threatening the household food security and existence of about 38 traditional maize varieties.
- Ahmed, M. and S. Suphachalasai (2014) categorized the paddy producing areas of Bhutan in three categories: low altitude zone (38% area coverage), mid-altitude zone (50% area coverage), and high altitude zone (12% area coverage). Accordingly, based on the current and expected maturity days for cultivating paddy, expected paddy yields are forecasted for 2030 and 2060. The study indicates that the expected yield of paddy is likely to be reduced in the low and mid altitude zones (low altitudes zones with higher level of reduction in yield), while its yield in high altitude zone is likely to be increased.
- 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, Turkism Leaf Blight (TLB) and GLS in maize, ginger rot, cardamom rot, potato blight, maize root rot and Foot and Mouth Disease in livestock.

A vulnerability study in the WCP areas in 2011, reported that there appears to be an increase in the emergence and spread of both existing vector-borne diseases and macro-parasites of animals and new diseases. Local people observed an increase in lice, flies, and ticks on livestock, and the incidence of foot and-mouth disease also has increased. In Tang Chudtod village, an invasive weed species (Taraxacum officinale) has rendered most of the livestock pastures unsuitable for grazing and for grass harvesting of hay feed for livestock during the winter.

In March 2009, avalanches killed 20 yaks in the northern part of Sephu Gewog. Local people blame the avalanches on the warming of the snow, which, at a higher temperature, cannot cling to mountains. The frequency of smaller avalanches has increased in the northern part of Chhokhor Gewog, destroying trails and depositing debris.

The agriculture and livestock sector faces the challenge of coping with reduced yields, loss of genetic resources, occurrence of pests and diseases, having to deal with unpredictable weather patterns for improved crops and livestock management.

2.2.4 Impacts on Forests and Biodiversity

Bhutan has a total forest cover of 70.46% (excluding shrubs), comprising of 62.43% broadleaf; 22.69% Mixed Conifer; 6.77% Fir; 3.98% Chirpine; 2.96% Blue pine and 1.16% Broadleaf with conifer. The Shrubs constitute 10.81% (LCMP, 2010). The climate change impact on biodiversity includes significant changes in agriculture, forestry, wildlife and land resources.

- Within the areas of WCP, community livelihoods based on pastoralism and agriculture are indicated to be affected by new diseases, pests, and parasites and by shifting phenological and seasonal changes induced by climatic changes. As a result, vulnerability at a community level, particularly among subsistence farmers, is considered to be high (Lhendup P, et al, WWF, 2011).
- A survey in 2010 indicated that the productivity of *Abies densa*, *Pinus wallichiana*, *Quercus glauca* and *Quercus griffithii* forests suffered set-backs due to periodic diebacks and insect attacks. It also 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. 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. A study in 2009 (Wangda et al.2009), found that pine die-back was strongly correlated with higher temperature and lower rainfall during the die-back incidences in the area.
- Climate Change Vulnerability Assessment of WCP in 2011 deduced a warming trend in annual temperature and high levels of variability and uncertainty in annual precipitation, which will lead to shifts in seasonal stream flow, ecosystems, and distributions of species depending on habitat shifts. The deterioration of ecosystem connectivity and the increase of habitat fragmentation are identified as major sources of vulnerability for both terrestrial and aquatic ecosystems (Lhendup P, et al, WWF, 2011).
- Forest fire is a recurrent phenomenon. Incidences have been on a decline from 44 incidences 2010-2011, 39 in 2011-2012 and 34 in 2012-2013. However, the number of forest fires increased from 34 in 2012-2013 destroying 12,175 acres of forest to 64 incidences destroying around 45,095 acres of forests during 2013-2014 (RNR Statistics, 2015). By average, the most affected Dzongkhags are Wangduephodrang, Trashigang, Monger, Lhuentse and Thimphu.

Occurrence of forest fires, loss of biodiversity, shifts in habitats, occurrence of pests and diseases and overall decline in ecosystem services of the environment are challenges that the forests and biodiversity sector confronts.

Available literature (MoAF, 2010) indicates that due to the changes in temperature and rainfall patterns, there have been visible changes in the pattern of biodiversity as indicated in the following

tables on observed changes in flowering time (see Table 4) of plant species and observed changes in population of animal species (see Table 5)

Table 4: Observed Changes in Flowering Time of Plant Species

Eco-floristic zones	Species	Flowering time (2010)	Flowering time (10-20 years ago)
High	Rhododendron spp.	March	April
Mountains	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

The above observations pertain to changes observed that could be attributed to the impact of climate change.

Table 5: Observed Changes in decrease or increase in wildlife population

Eco-floristic zones	Observed increase in species population	Observed decrease in species population
Alpine Altitude: 4000m + Mean Temp: 5.5^0 C/y Rainfall: <550 mm/yr	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: 9.90C-12.5^0 C/y Rainfall: 650-850 mm/yr	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:17.20C-18.5^0 C/y Rainfall: 850-2500 mm/yr	Macaque, wild boar, deer, laughing thrush and common crow.	Jackal, tiger, bear, musk deer, leopard, jungle fowl, hornbill, pheasant, cuckoo and vulture
Foothills Altitude: 150-1000 m Mean temp: 23.6^0 C Rainfall: 2500-5500 mm/yr.	Rabbit, wild boar, sambar, macaque, barking deer, porcupine, gaur, bear	Asian elephant, wild dog, tigers, hornbill, common crow, vulture and ring dove

The RNR Sector Adaptation Plan of Action (SAPA) document, 2013 recognizes that at present there are very limited climate resilient varieties of crops and fodder and that selection and adaptation of crop and fodder varieties resistant to biotic and abiotic stress are limited. Farmers continue to

depend on traditional varieties that are highly vulnerable to pest and disease, drought and heat stress. In the face of significant impacts on the agriculture, livestock and biodiversity sectors (as described in the preceding sections) which provides employment to 58% of labour force in Bhutan, there is compelling need for implementation of climate resilient agriculture, livestock and biodiversity management practices.

2.2.5 Impacts on socio-economic development infrastructure

Significant level of damage caused by extreme weather events such as flash floods, landslides, forest fires, windstorms, excessive rains continue to be experienced across the country as can be seen from the following table on climate related natural hazards and disasters in Bhutan

Table 6: Extreme Weather Events, Hazard and Damages

Timeline	Events	Source
1994	Major glacial lake outburst flood (GLOF) from Lugge Tsho, in Lunana area, northwestern Bhutan causing extensive damage to agricultural lands and pastures, and loss of several human lives and livestock along Pho Chhu. There are about 2,674 glacial lakes existing in the country, of which 25 were classified as potentially dangerous. Of these, the most immediate threat comes from the Raphstreng and Thor Thormi lakes in the headwaters of Puna Tsang Chhu. These lakes are adjacent to each other separated by just a moraine wall. The combined discharge of outbursts of these lakes is estimated at 53 Mm3 – three times more than 1994 Lugge Tsho GLOF.	NAP, 2014
1998-99 (Winter)	Prolonged spell of dry (snowless) weather. This exacerbated incidents of forest fires that winter, even occurring in places where fire incidences were previously not known. The year (1998-99) saw a record number of 112 forest fire incidents - the highest ever since forest fire occurrence began to be officially recorded.	NAP, 2014
2000	Unprecedented rainfall in the summer. Heavy rains triggered off unprecedented number of floods and landslides, causing loss of dozens of human lives and damage to infrastructures and natural resources.	NAP, 2014
2002	Fire incidence destroyed 25 houses leaving 26 families homeless in Haa	World Bank, 2015
2003	A landslides in 2003 threatened the Kurichu Hydropower Station	RSPN, 2012
2004	Landslides and flash floods in 2004 in 6 eastern Dzongkhags claimed 9 lives; damaged 162 houses, 664 acres of farmland, and 39 irrigation channels; lost 350 million tons of maize, 126 million tons of paddies, and 2,000 citrus trees. Transportation remained disrupted for days in the affected Dzongkhags	RSPN, 2012, World Bank, 2015
2005	5 houses in Trashi Yangtse and 7 shops in Bumthang destroyed by fire	World Bank, 2015
2006	2 deaths; 5 houses and thousands of acres of forests destroyed by fire	World Bank, 2015
July, 2008	Windstorm damaged houses and crops in the eastern region. There were also cases of roadblocks and road users being washed away or killed by falling boulders along the national highways.	RSPN, 2012

Timeline	Events	Source
	Damages to 249 households, 8 school buildings, religious structures, and 1 government office in Trashigang and damages to more than 80 acres of maize crops affecting 96 households in Monggar	World Bank, 2015
May 2009	Three days of incessant rain, in the aftermath of Cyclone Aila, left nine people dead, washed away bridges, damaged and/or destroyed government buildings, private houses, and irrigation and drinking water supply lines, blocked or washed away several highways, feeder roads and farm roads, and inundated forest plantations and agricultural fields. The DDM, MoHCA, had estimated that restoration works would cost the government more than Nu. 719 M (US$ 15.60 M).	NAP, 2014
September, 2009	Eastern part of the country was hit by a strong earthquake of magnitude 6.1, followed by several aftershocks. The earthquake claimed 12 lives and 47 injuries and damaged 4,950 rural homes, 177 schools, 45 BHUs, 29 RNR Centers, 26 Gup offices and caused massive damage to cultural assets	RSPN, 2012
2010	Flashflood and landslides damaged 2,000 acres of farmland and irrigation channels affecting nearly 4,800 households; 40 acres of pastureland and 1,000 livestock destroyed in all Dzongkhags	World Bank, 2015
2010	Windstorm damaged more than 5,000 acres of farmland affecting 432 households across the country	World Bank, 2015
2011	Windstorm damaged 2,424 houses, 81 religious structures, 57 schools, 21 health centers, and 13 government buildings in 16 Dzongkhags	World Bank, 2015
2011	Flash floods and landslides caused loss of property to 200 households Industrial estates and residential areas in Phuentsholing and Pasakha	World Bank, 2015
June, 2012	Low intensity and prolonged rainfall followed by extremely high downpour (about 170 mm in four hours) caused landslides, landslips and flooding at Damji, under Gasa Dzongkhags. This event washed away the arable fields & roads, caused siltation and completely damaged the irrigation canal networks.	NAP, 2014
April, 2015	Windstorm damaged a total of 67 Structures in Samtse, 363 Structures in Dagana, 228 structures in Chukha, 49 structure in Pema Gatshel and 2 structure in Phuntsholing Thromde comprising of rural homes, schools, RNR center, processing units, health facilities, monasteries and government service centers	UNDP
January, 2016	The hailstorm in January 9, in Sipsu and Biru, Samtse damaged more than 8,000 fruit bearing areca nut trees, more than 10,000 areca nut saplings	Kuensel

2.3 Policies, Legislation, Regulations and Programs

The following key documents provide the national policy context for initiating and pursuing climate change adaptation and mitigation programs and projects:

Bhutan 2020 outlines the country's development goals, objectives and targets with a twenty-year perspective to maximize Gross National Happiness (GNH). It enunciates Bhutan's development pursuits to be carried out within the limits of environmental sustainability and without impairing the ecological productivity and natural diversity, providing the policy context for sustainable development - implicitly encompassing a path that is resilient to and mitigates climate change.

National Environment Strategy (NES), 1998 identifies and describes the main avenues and approaches for sustainable development. The strategy is currently under review and in the absence of a separate CC policy, the revised NES will among other things focus on low-carbon and climate resilient development, addressing both climate change mitigation and adaptation aspects.

National Forest Policy, 2012 serves as the guiding policy framework for forest management and nature conservation. It recognizes the important role of sustainable forest management in CC mitigation and adaptation. The policy adopts an integrated landscape-level approach to sustainable forest management.

Bhutan Water Policy, 2003 describes the approach and context of water resources management from a multi-sectorial perspective. The policy advocates integrated water resources management to address existing and emerging water issues including those arising from climate change. It identifies priorities of allocating water for drinking and sanitation, for food production for hydropower development and for industrial purposes. The priorities for water allocation mentioned in the Water Policy do not include water for Environment in clear terms. It specifies assessment and inventory of national water resources as a special area of attention for informed water resources management.

The Water Act of Bhutan, 2011 assigns the NEC to prepare and continuously update of a National Integrated Water Resources Management Plan (NIWRMP) for the conservation, development and management of water resources. The plan shall be mainstreamed into National Policies, Plans and Programs. It also requires establishment of River Basin Committees (RBC) within a basin for the purpose of proper management of water resources within a basin and to prepare River Basin Management Plans (RBMP). The NIWRMP shall serve as a binding guideline for the preparation of River Basin Management Plans. For the purpose of proper and effective protection and management of water resources at the Dzongkhags' level, the existing Dzongkhags Environment Committee shall also function as the Dzongkhag's Water Management Committee. The act accords water use priorities such as – 1) water for drinking and sanitation; 2) water for agriculture; 3) water for energy; 4) water for industry; 5) water for tourism and recreation; and 6) water for other uses.

National Communications to the UNFCC: The Initial National Communication of Bhutan was produced in 2000 and the Second National Communication in 2011. These National Communications provide inventories of GHG emission and sequestration, describe climate change vulnerabilities, and outline a wide range of adaptation and mitigation options across various climate-sensitive development sectors.

In its Intended Nationally Determined Contributions (INDC) Bhutan has reconfirmed its target to remain carbon neutral at the COP 21 in Paris. Bhutan also committed itself to maintain a minimum of 60% of land area under forest cover. Based on the information from the NAPA process as well as vulnerability and adaptation assessment in the Second National Communication, other

plans and programs of sectors, priority adaptation actions identified in Bhutan's INDC, 2015 are as follows[5]:

- Increase resilience to the impacts of climate change on water security through Integrated Water Resource Management (IWRM) approaches;
- Promote climate resilient agriculture to contribute towards achieving food and nutrition security;
- Sustainable forest management and conservation of biodiversity to ensure sustained environmental services;
- Strengthen resilience to climate change induced hazards;
- Minimize climate related health risks;
- Climate proof transport infrastructure against landslides and flash floods, particularly for critical roads, bridges, tunnel and trails;
- Promote climate resilient livestock farming practices to contribute towards poverty alleviation and self-sufficiency;
- Enhancing climate information services for vulnerability and adaptation assessment and planning;
- Promote clean renewable and climate resilient energy generation; and
- Integrate climate resilient and low emission strategies in urban and rural settlements

National Adaptation Programme of Action (NAPA) was produced in 2006 and regarded Glacier Lake Outburst Floods as the highest priority climate induced hazard. The NAPA was reviewed and updated in 2012 to incorporate new climatic hazards such as windstorms, fire and cyclones and also to take stock of the implementation status of the priority projects.

National Strategy and Action Plan for Low Carbon Development, 2012 has been primarily prepared in support of Bhutan's commitment to remain carbon neutral development at the 15th Conference of Parties of the UNFCCC in Copenhagen in December 2009. It presents a long-term national strategy comprising of various scenarios analyzing development paths from 2005 until 2040. Concomitant to these scenarios, the action plan articulates a number of short and medium-term interventions under various development sectors to achieve sustainable economic growth through green and low-carbon growth.

National Disaster Management Act, 2013 establishes the National Disaster Management Authority at the central level chaired by the Prime Minister; formalizes the establishment of Dzongkhags Disaster Management Committee in all Dzongkhags and sub-committees at Dungkhag and Gewog levels. The implementation of the Act will necessitate a great deal of capacity development for institutions at various levels, especially of local governments, non-state actors and local communities.

Eleventh Five-Year Plan: (2013-2018) defines the overall goal of 11th FYP to achieve "self-reliance and inclusive green socio-economic development." The term "green" in the development goal is explained to mean – carbon neutral development. The plan seeks to promote carbon-neutral and environmentally sustainable development, and engenders mainstreaming of environment,

[5] Taken from Bhutan's INDC document submitted to UNFCCC at CoP21, Paris.

climate change and disaster risk reduction as crosscutting issues along with gender and poverty reduction.

For these cross cutting themes, the planning guideline specifies steps to identify vulnerabilities and options to address these vulnerabilities (GNHC, 2012). The planning guidelines prescribes a whole set of Sector Key Result Areas (SKRAs) on vulnerable groups and areas as follows and associated indicators;

- Youth Empowered (taken care under labour plan)
- Child's Right to Protection Enhanced
- Well-being of single parent strengthened
- Prevention and elimination of Gender based violence
- Differently abled people services strengthened
- Care, security and dignity of senior citizen enhanced.

In addition, it is hoped that these issues are further addressed by activities of civil society organizations such as the Youth Development Fund (leadership skills, drug rehabilitation, special education, basic skills and vocational training, advocacy research and education); the Tarayana Foundation (support the poor and disadvantaged communities by building local capacities, providing scholarships, facilitating micro-finance and housing improvements, child care and community enterprises developments); the RENEW (empowering women and girls in Bhutan, especially victims of domestic and gender based violence through counseling, shelters, legal assistance and need-based vocational training in selected skills and micro-enterprises to help transform lives); Draktsho Vocational Training Centre for Special Children and Youth (empowering disabled youth through training for their eventual integration into the mainstream population); Ability Bhutan Society (providing services and facilities to address the needs of families and individuals with multiple impairments, especially children living with mental retardation, cerebral palsy, autism and multiple disabilities); the Royal Society for Senior Citizens (enhancing human security especially amongst its old age citizens) and Lhak-Sam (promoting support system based on solidarity, networking and people's participation for addressing and taking collective action towards effective responses to HIV/ AIDS and its impact).

To have in a policy or guideline is one but to have climate change actually integrated in the plan and implemented is quite another. For instance the guidelines of 11th FYP preparations includes the following:

- In the health sector, the guidelines include SKRA on "Health resilience to climate change impact strengthened". In the actual plan this SKRA is not included. It is reflected within the program profile of Public Health Engineering Division's (PHED). Not reflecting at the level of SKRA indicates a lower priority that intended by the planning guidelines.
- In education the guideline expressed a SKRA called, "Environment & Climate change Learning Outcome of students enhanced" but in the actual plan the SKRA has been toned down as "Environment Education Enhanced in Schools".
- Traditional as well as modern Bhutanese houses do not have heat conservation materials or design. Being a cold country subjected to intense heat to through cold temperatures, climate change inclusion of appropriate heat conservation in Bhutanese housing could be a practical climate adaptation. This could also be an area for the private sector to be engaged in climate

resident activities. In housing sector the planning guidelines prescribed a SKRA called "Environment friendly and energy efficient houses/housing complex" developed. This SKRA does not reflect in the final housing sector plan.

The 11th FYP planning process intended to integrate elements of climate change in the overall development process. However, the actual plans address climate change to a lesser extent than actually intended by the planning guidelines (policy tool). It indicates a need for monitoring the compliance or implementation of mainstreaming policies and tools. Within the RNR sector, most of the planned development interventions related to climate change and the sector has made concerted efforts by formulating and implementing the a sector adaptation plan of action.

The Bhutan Poverty Assessment, 2014 identifies that crop losses due to pest and diseases, and wildlife and natural disasters like storms, earthquake and drought make the community vulnerable to poverty. The principal risk in agriculture across all the community was identified as wildlife attacking both food and cash crops. Farmers are left to harvest sometimes only the remnants of the crops. The community believes that increasing conflict is as a result of human encroachment due to deforestation, construction of roads, erecting of electricity poles and other developmental activities. Farmers have no access to compensation for the damage given the challenges in assessing the extent of the damage caused and in absence of crop insurance. It concludes that lack of irrigation, vulnerability of principal crops to pest and diseases, market inaccessibility and loss of crops to wild animals amongst others were perceived as important conditions of community wise experience with decline. The findings suggest that these common factors are often external in nature and beyond the control of the community who are less endowed with technical knowledge and expertise in immediately solving the problems by themselves. Problems of irrigation and drought show community's vulnerability and limited resilience to the forces of climate change although the country has abundant fast flowing rivers but beyond the reach of these specific communities. The cash crops' vulnerability to pests and diseases demands a better understanding of the causes and requires a long-term solution that is also acceptable to the community. Possible and immediate solutions may be; sharing of best practices, lesson learning experiences and exploring and diversifying alternative livelihood strategies.

The RNR SAPA, 2013 is a broad framework for channeling interventions and funding to enhance resilient capacity of the sector to the impacts of the climate change. It is intended to enable implementation of RNR adaptation plans for responding to changing and uncertain climatic conditions; Inform and facilitate RNR Sectorial programs working towards the integrated approaches among various programs and sub-programs; and to create awareness among the communities in understanding the changing climatic conditions and engage them effectively in the process of developing adaptation activities. The SAPA identifies seven Adaptation Action Areas (AAA) as follows:

- Food Security and Poverty Alleviation;
- Forest and Biodiversity Conservation;
- Governance and Sustainability;
- Forest and Ecosystem;
- Natural Disasters and Infrastructure;
- Research, Education & Advocacy; and

- Water Resources Use, Access and Management.

2.4 Survey Design

In line with the objectives of the assignment and to accomplish the tasks details, the field surveys at Gewog and Chiwog levels were planned. Structured questionnaires, approved by the Project Preparation Grant (PPG) team, were administered at each level from the 19th April to 22nd May, 2016 in the selected Dzongkhags, Gewogs and Chiwogs of the landscape areas.

2.4.1 Selection of Gewogs and Chiwogs for the Field Survey

Although a household level survey was proposed to be administered in the landscape area, the joint meeting of the PPG and sub-consultant held at hotel Ariya on 1st of April, 2016, agreed that an assessment at the Gewog level would suffice for the purpose of providing the required information for project formulation and that detailed surveys will have to be taken up during the project implementation to collect real-time baseline data. Therefore, a PRA at the Chiwog level has been carried out. The type of information collected at Chiwog level is presented in 3.1 to 3.3 and Annex 2.3.

In order to enable representation of the each Dzongkhags, the study included a minimum of at least one Gewog in each Dzongkhags. However, the Dzongkhags that have less than or equal to 10% of its area under the landscape have been omitted in the Gewog selection. Beyond this minimum consideration, the prioritization of Gewogs was done on the following criteria.

- Gewogs that have more than 30% of area falling within the landscape are considered for selection.
- Maximum of three Gewogs and minimum of one Gewog in each Dzongkhags, priority being accorded to the gewogs with highest proportion of area falling within the landscape.
- Where there are more than three gewogs that qualify, the Gewog with higher proportion of its area within the buffers of Protected Areas were selected.

Based on the above criteria, the survey area selected 10 Dzongkhags and 18 Gewogs of landscape area for the field survey. Within these gewogs, there are a total of 93 Chiwogs out of which 36 Chiwogs (39%) were selected. Based on the list, the Chiwogs in the selected gewogs were identified through administering random sampling method. Table 1 shows the list of Dzongkhags and the number of Chiwogs in each Gewog that were included in the field survey.

Table 7: Survey Area selection framework

Landscapes	Geographical location		% Areas under Landscape		Chiwogs	
	Dzongkhag	**Gewog**	**JKSNR**	**BC1**	**Total**	**Selection (>30%)**
Landscape 1: Jigme Khesar Strict Nature Reserve **(JKSNR)** + Biological Corridor connecting to Jigme Dorji National Park	Haa	Bji	50%	20-25%	4	2
	Haa	Sombay	40-45%		5	2
	Paro	Tsento	15-20%		5	2
	Dzongkhag	**Gewog**	**JSWNP**	**BC2 + BC8**		
Landscape 2: Jigme Singye Wangchuck National Park **(JSWNP)** + Biological Corridors connecting to Jigme Dorji National Park and Wangchuck Centennial Park	Trongsa	Korphu	100%		5	2
		Tangsibji	70-75%	10-15%	5	2
	Sarpang	Jigmechholing	55%	20%	6	2
	Wangdue	Athang	60%	15%	5	2
		Dangchhu		60%	5	2
		Phobji	30-35%	20%	5	2
	Punakha	Toepisa		50%	5	2
	Zhemgang	Trong	30%		5	2
	Dzongkhag	**Gewog**	**PNP**	**BC4**		
Landscape 3: Phrumsengla National Park **(PNP)**+ Biological Corridor to Jigme Singye Wangchuck National Park	Bumthang	Chhume	30%		5	2
		Ura	50%		5	2
	Lhuentse	Jaray	55-60%		5	2
		Metsho	55%		6	2
	Monggar	Tsamang	55%		5	2
		Saleng	40%		6	2
	Zhemgang	Nangkor	10%	45%	5	2
All	**10**	**18**			**93**	**36**

2.5 Field Survey and Data Collection

Participatory discussions as well as key informants were engaged to derive information from the targeted respondents in the selected Gewogs and Chiwogs. These exercises were guided by the structured questionnaires to assess community level climate change vulnerabilities. The following information at community level was collected through the PRA and key informants;

✓ To assess vulnerability of people, livestock, physical assets/resources to adverse effects of climate change:

- Type and extent of community assets affected by climate change;
- Extent of adoption of climate-resilient technologies/practices.

✓ To assess institutional and technical capacities for effective climate change adaptation:

[6] Rough estimates provided by the PPG team based on ocular assessment of PA/BC system map provided by WWF with Gewog boundaries and not based on any conscientious GIS-based calculations

- Sources of information on climate, early-warning and related services;
- Trainings to assess climate change assessment/planning for adaptation or technologies

✓ To assess climate change adaptation into relevant policies, plans and associated processes:

- Institutional arrangements to lead, coordinate and support the integration of climate change adaptation into relevant policies, plans and associated processes;
- National and sector-wide polices, plans and processes developed and strengthened to identify, prioritize and integrate adaptation strategies and measures;
- Local level plans and processes developed and strengthened to identify, prioritize and integrate adaptation strategies and measures;
- National and local level systems and frameworks for monitoring, reporting and review of adaptation.

The respondents at the Gewog level included the Gewogs RNR and health officials. Chiwog level PRA participants included local community household members from selected Chiwogs with representation of both men and women. Data at Gewog level on land and livestock population were taken from secondary sources.

2.6 Data compilation and Analysis

Upon completion of Survey, data compilation was done in Access Database. Relations between different tables were built in the database and linked tables were transferred to excel database. Final analysis was done in excel based on tables imported from Access database. In addition, landscape and Gewog level maps were produced to highlight vulnerabilities across space. The analysis covered community level vulnerabilities to adverse effects of climate change as described under chapter 3. The following indicators define the survey area.

Table 8: Landscape and Survey Area Coverage

Indicators	Data Unit		All LS	LS 1	LS 2	LS 3
No. of Dzongkhags in LS (Trongsa & Zhemgang appears in both LS 3 and 2, hence total is only 12	LS Total		12	2	7	5
	SA		10	2	5	4
No. of Gewogs Within LS	LS Total		37	4	22	10
	SA		18	3	8	7
No. of Chiwogs within land scape	LS Total		189	20	112	57
	SA		36	6	16	14
Estimated Population	LS Total	M	45,843	7,093	26,946	11,804
		F	42,970	5,527	25,936	11,507
		All	88,813	12,620	52,882	23,311
	SA (participants)	M	297	44	150	105
		F	189	33	97	57
		All	486	77	247	162
Estimated area (Ha)	LS Total		1,270,934	195,860	724,291	350,783
	SA		663,057	175,693	273,902	213,462

LS = Landscape; M = Male; F=Female; Ha = Hectares; SA = Survey Area

3. Conceptual Framework for Climate Change Vulnerability Assessment

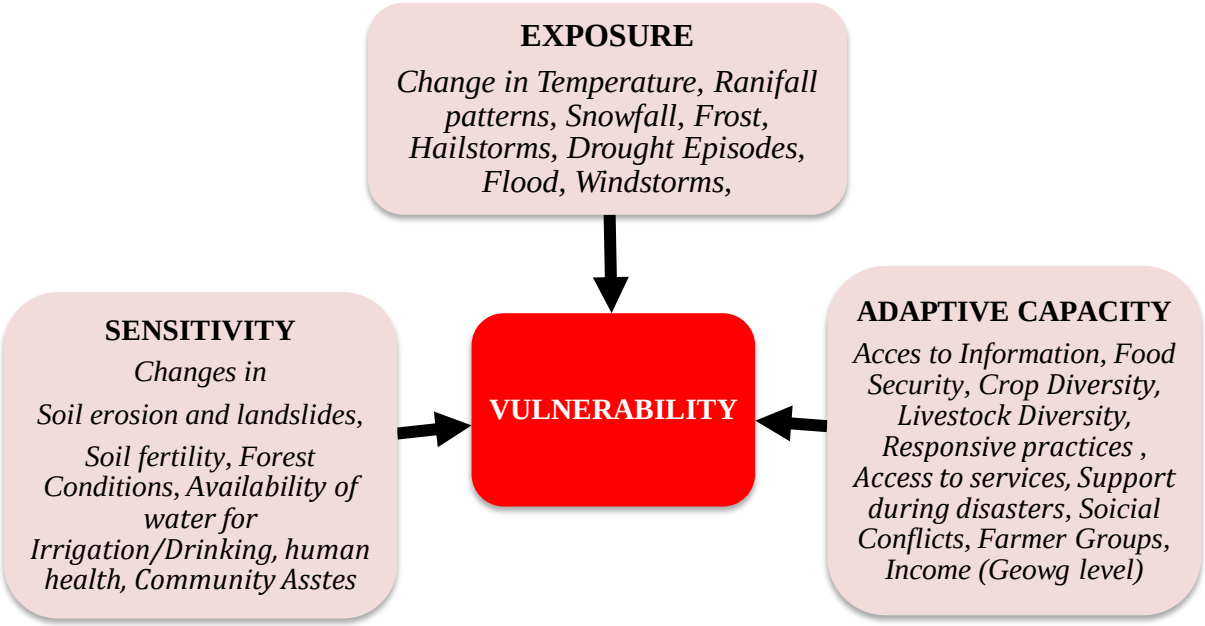
3.1 Definitions

The IPCC defines **Climate change** as "Any change in climate over time, whether due to natural variability or as a result of human activity". **Vulnerability to climate change** as "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity". It is understood as a function of exposure, sensitivity and adaptive capacity. **Exposure** is the nature and degree to which a system is exposed to significant *climatic variations*. **Sensitivity** is the *responsiveness of a system* to climatic influences based on both socio-economic and environmental conditions and **Adaptive capacity** is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. **Adaptation** is the *adjustment* in natural or human systems in response *to actual or expected climatic stimuli* or their effects, which moderates harm or exploits beneficial opportunities.

3.2 Climate Change Vulnerability Analysis Framework

Understanding vulnerability at a community level requires an integrative approach that looks at both the physical (external hazard/risk) and social dimensions (internal susceptibility/coping of different groups) of vulnerability. It is a function of exposure, sensitivity and adaptive capacity. Therefore, the conceptual framework for the vulnerability analysis is constructed as follows:

Figure 2: Climate Change Vulnerability Analysis Framework (Adopted from C4 Eco Solutions, 2012)



3.3 Vulnerability Index concept

Therefore, a vulnerability index was developed for each Gewog based on the following formula[7]:
Based on the above concept, exposure, sensitivity and adaptive capacity indices have been developed for each Chiwog (See Table 8). Using these indices, a vulnerability index for each Chiwog has been generated. The final vulnerability index has been consolidated to the Gewog and landscape levels. For the purpose of visualization, the vulnerability index has been standardized to show its scale between 0 and 1 after actual indices are calculated.

Vulnerability = (Exposure x Sensitivity) – Adaptive capacity

Whereas;

- The exposure index is expressed as the sum of the scores for 7 exposure indicators
- The sensitivity index is expressed as the sum of scores for 7 sensitivity indicators
- The adaptive capacity index is expressed as the sum of scores for 7 adaptive capacity indicators

Table 9: Vulnerability analysis indicators and scoring (Chiwogs as measurement units)

Index	**Indicator**	**Indicator Scores (For Exposure & Sensitivity - higher score means more vulnerable; For Adaptive Capacity – higher score means less vulnerable)**		
		0	**1**	**2**
Exposure	1) Changes in summer temperature	No change in summer temperature	Change in summer temperature but no impact	Chang in summer temperature and impacts
	2) Changes in winter temperature	No change in winter temperature	Change in winter temperature but no impact	Change in winter temperature and impacts
	3) Changes in rainfall patterns	No change in rainfall patterns	Change in rainfall patterns but no impact	Change in rainfall patterns and impacts
	4) Frequency of hailstorm	No change in hailstorm patterns	Change in hailstorm patterns but no impact	Change in hailstorm patterns and impacts
	5) Frequency of windstorm	No change in windstorm patterns	Change in windstorm patterns but no impact	Change in windstorm patterns and impacts
	6) Drought events	No drought events	Drought events but no impact	Drought events and impacts
	7) Flood events	No flood events	Flood events but no impact	Flood events and impacts

[7] Adapted from the formula applied by C4 Eco Solutions in establishing Baseline Information for the APP project "Supporting Integrated & Comprehensive Approaches to Climate Change Adaptation in Africa-Building a comprehensive national approach in Rwanda" & LDCF Project on "Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems & Support for Integrated Watershed Management in Flood Prone Areas", 2012.

Sensitivity	8) Changes in Soil erosion and land slides	No erosion and landslides around their Chiwog.	Soil erosion but no landslides around their Chiwog.	Soil erosion and landslides around their Chiwog.
	9) Change in Soil fertility	Increase in soil fertility	No change in soil fertility	Decrease in soil fertility
	10) Changes in forest conditions[8]	No change	Change with no negative impact	Change with negative impacts
	11) Change in availability of water for irrigation	Increase	No Change	Decrease
	12) Water for drinking	Increase	No Change	Decrease
	13) Impact on human health[9]	Decrease in waterborne diseases	No Change	Increase in waterborne diseases
	14) Impact on Community Assets[10]	No impact	Yes but only upto 4 asset categories affected	Yes - 5 and above number of asset categories affected
Adaptive Capacity	15) Access to climate Information on climate change (Average = 2 sources)	No source of information available	Information available from 1 to 2 sources	Information available from 3 or more sources
	16) Food Security (max = 3 & min = 1)	Food insecure and have only 1 means to cope	Food insecure but have 2 or more means to cope	Food Secure
	17) Crop Diversity	Decreased	No Change	Increased
	18) Livestock Diversity	Decreased	No Change	Increased
	19) Responsive practices (average = 4)	Adopting up to 2 or lesser responsive practices	Adopting up to 3-4 responsive practices	Adopting 5 or more responsive practices
	20) Access to services (Average of 4 service types in 1 Hr walking distance)	No services available within 1 hr walking distance	Up to 4 types of services available within 1 hr walking distance	More than 5 types of services within 1 hr. walking distance
	21) Support during disasters (max is 3 agencies)	No assistance	Assistance from only 1 agency	Assistance from 2 or more agencies
	22) Social conflicts (Water related)	Increased	No Change	Decreased

[8] Composite score of availability of timber/firewood/fuel wood/fodder/NWFPs/Streams/lakes, incidence of forest fire, plant diversity and wildlife diversity.

[9] Based on Composite score of occurrence of water borne diseases such typhoid, cholera, fever/common cold.

[10] Composite score of observations on damage of community assets due to climate change. Assets include agriculture land, livestock, water sources, irrigation channel, houses, farm roads, electricity lines, mobile network, bridges, monasteries and schools.

	23) Farmer Groups (average = 3 FGs)	No farmer groups in place	At lease 3 Farmer Groups in place	4 or more farmer groups in place
	26) Sources of household income (For Gewog level analysis)	Ranking in annual average HH income from agriculture, livestock, NWFPs & off-farm activities falls within 1st Quartile (lowest) of annual average HH income across survey Gewogs	Ranking in annual average HH income from agriculture, livestock, NWFPs & off-farm activities falls within 2nd and 3rd Quartiles (mid range) of annual average HH income across survey Gewogs	Ranking in annual average HH income from agriculture, livestock, NWFPs & off-farm activities falls within 4th (highest) Quartile of annual average HH income across survey Gewogs

4 Climate Change Vulnerability Assessment

Baseline for exposure, sensitivity, adaptive capacity and overall vulnerability of different landscapes, landscape Gewogs as well Chiwogs have been generated before implementation of the UNDP/GEF/LCDF project on ***"Enhancing sustainability and resilience of forest and agriculture landscape and community livelihoods in Bhutan."*** The assessment of vulnerabilities is used as a basis for identifying adaptation strategies and actions.

4.1 Vulnerability Assessment at different levels

Literature review indicates that there are many studies carried out in Bhutan that relate to climate change and climate change vulnerability. However, there is no standard method adopted to measure climate change vulnerabilities across local spaces. With increasing need to focus on integrating climate change in development approaches, there is a need to look at simple methodologies to assess climate change vulnerability at local levels. We believe that the methodological framework applied in this work can be adapted to different situations and at different levels to assess climate change vulnerability. Applying this framework, we have carried out climate change vulnerability at Chiwog, Gewog and at landscape levels.

Assessment of vulnerability based on exposure, sensitivity and adaptation capacity indices were done at Chiwog level. The Chiwog level assessment is based on information generated form actual consultation in the identified Chiwogs. The Gewog level assessment is based on average scores of the Chiwog level assessment to reflect Gewog vulnerabilities. However, at the Gewog level an additional indicator, average household income, has been added (from raw data used of RNR statistics, 2011/2012 and 2013) as part of the group of indicators in the Adaptation Capacity Index. The assessment at the landscape level has been made based on average score of Gewogs within a particular landscape.

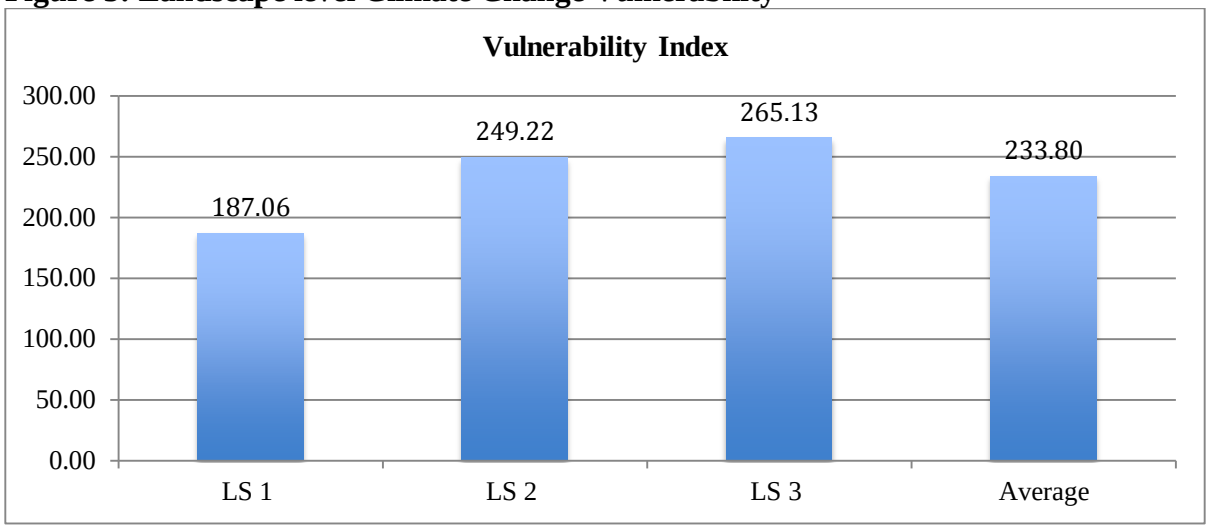
Based on the analysis, climate change vulnerability maps have been prepared at the Gewog and landscape levels. It has not been possible to prepare maps at Chiwog level for lack of GIS data at this level.

Due to high exposure and sensitivity indices together with low adaptive capacity, the overall vulnerability in all Chiwogs, Gewogs and landscape areas are high. Indices are initially constructed based on the formula presented in section 3.3 of this report. To enable better visualization of the results, the indices are presented in a scale of 0 to 1 in most cases. Maps and charts are based on standardized values.

4.1.1 Climate Change Vulnerability across Landscapes

At the landscape level, vulnerability index is highest within landscape three, which comprises of areas within (PNP) and the BC4 connecting the PNP to Jigme Singye Wangchuck National Park (JSNP). The Dzongkhags that have territories within this include Bumthang, Lhuentse, Monggar and Zhemgang. While all landscapes have almost similar score in exposure and adaptive capacity indices, landscape three has the highest score in sensitivity index, which contributes to making it the most vulnerable landscape of the three (see Figure 3 and Table 10).

Figure 3: Landscape level Climate Change Vulnerability



Landscape two comprises of (JSWNP) and biological corridors connecting JSWNP to JDNP (BC2) and the one connecting it to WCP (BC8). It has a vulnerability index lower than landscape three but higher than landscape one. It has the highest exposure capacity index and lowest adaptive capacity index. The high exposure index of landscape two is on account of it being highest hit by hailstorm hazards. Its adaptive capacity index is low due to its lesser score in terms of food security, decrease in livestock diversity, lesser number of local adaptation practices and relatively lesser access to services within 2 hr. walking distance as compared to other landscapes.

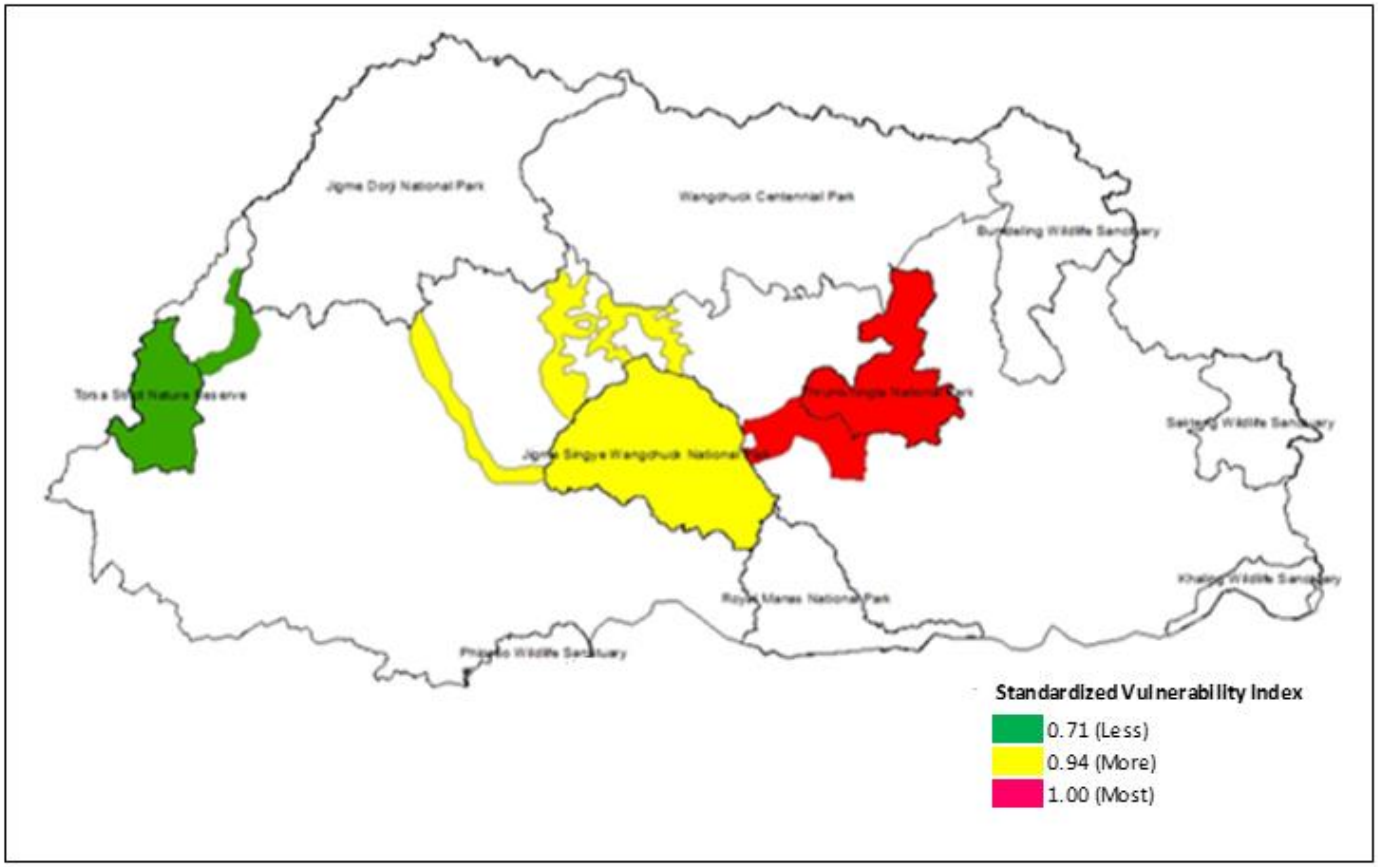
Landscape one, comprising of JKSNR and the BC1 connecting JKSNR to JDNP, is the least vulnerable among the three landscapes, mainly due to its least score in exposure as well as well sensitivity indices. It also has the highest index on adaptation capacity.

Table 10: Climate Change Vulnerability indices of landscapes

	Vulnerability Index		
Landscape	**Landscape1 (JKSNR_BC1)**	**Landscape2 (JSWNP_BC2+BC8)**	**Landscape3 (PNP_BC4)**
Exposure	8.33	9.63	9.43
Sensitivity	23.67	26.75	29.14
Adaptive	10.17	8.25	9.64
Vulnerability Index	**187.06**	**249.22**	**265.13**
Standardized index	**0.71**	**0.94**	**1.00**

Maximum contribution to vulnerability at the landscape level arises from sensitivity index. Based on the vulnerability index, a landscape level vulnerability map has been prepared (See Figure 4). The maps have been prepared based on standardized vulnerability index of the landscapes.

Figure 4: Climate Change Vulnerability Map of the three Landscape areas



4.1.2 Vulnerability across landscape Gewogs

Based on the Chiwog level vulnerability assessment, Gewog level vulnerability has been generated showing relative vulnerability to climate change across the Gewogs (See Figure 5). At the Gewog level, average scores for standardized vulnerability, exposure, sensitivity and adaptive capacity indices are 0.68, 0.75, 0.79 and 0.71 respectively.

From the standardized climate change vulnerability assessment, nine Gewogs namely Tsamang and Saleng (Monger), Toepisa (Punakha), Chhume (Bumthang), Dangchhu and Phobji (Wangdue), Nangkor and Trong (Zhemgang) and Korphu (Trongsa) have vulnerability above average across all Gewogs.

For the purpose of analysis, the Gewogs are grouped by Most, More, Less and Least Vulnerable categories. Accordingly, the landscape Gewogs in the study are categorized as follows in terms of vulnerability to climate change (See Table 11 and Figure 6).

Figure 5: Gewogs by Climate Change Vulnerability (Standardized vulnerability index)

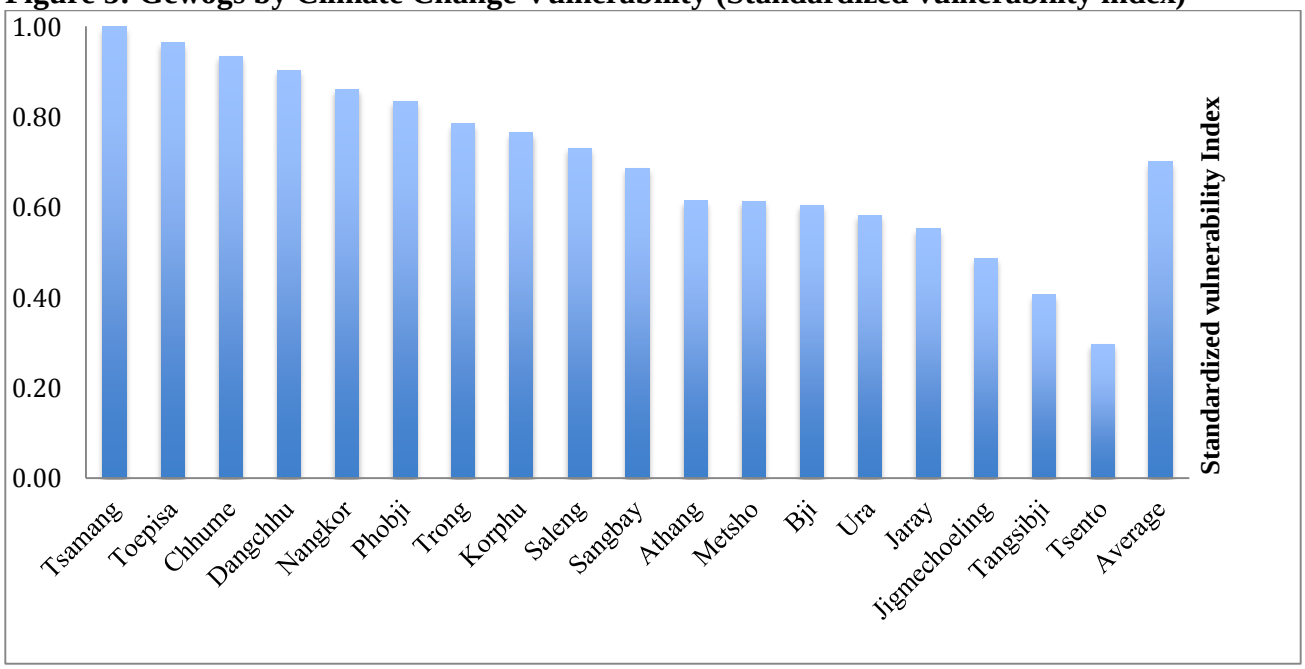
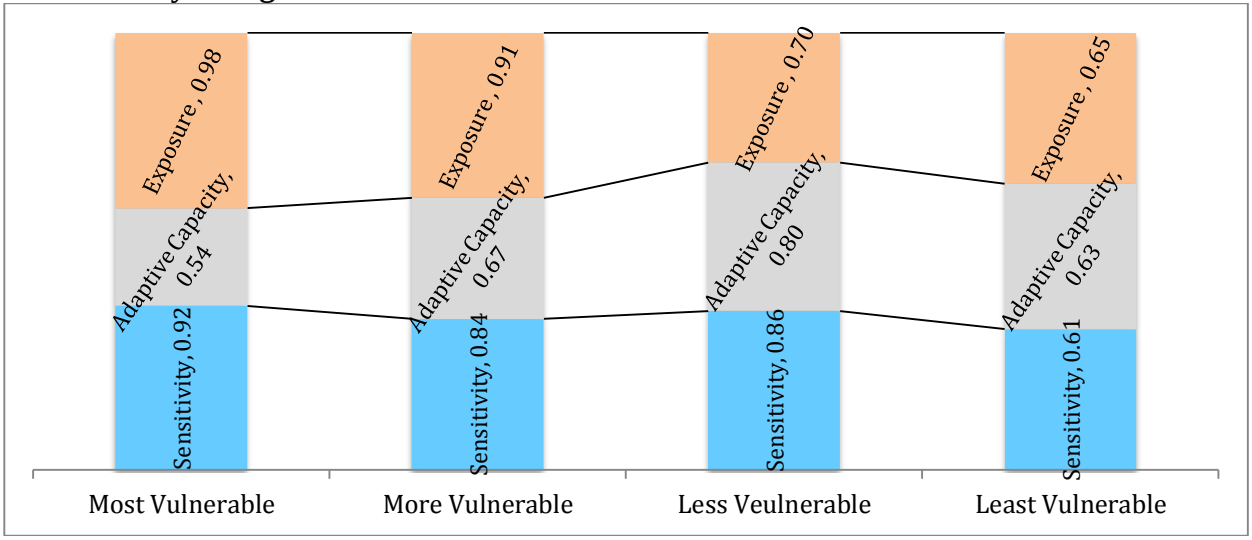


Table 11: Category of Gewogs by vulnerability

Vulnerability Categories	Gewogs/Dzongkhags
Most Vulnerable	Tsamang Gewog (Monger); Toepisa Gewog (Punakha); Chhume Gewog (Bumthang); Dangchhu Gewog (Wangdue)
More Vulnerable	Nangkor and Trong (Zhemgang); Phobji (Wangdue); Korphu (Trongsa); Saleng (Monger)
Less Vulnerable	Sangbay and Bji (Ha); Athang (Wangdue); Metsho and Jaray (Lhuentse); Ura (Bumthang
Least Vulnerable	Jigmechoeling (Sarpang); Tangsibji (Trongsa); Tsento (Paro)

Although Tsento Gewog scores lowest on adaptive capacity (standardized score of 0.46), its vulnerability is lowest due to its least low score on sensitivity index (standardized score of 0.39) low score on exposure (standardized score of 0.34) compared across all other Gewogs whereas Tsamang Gewog become the most vulnerable as it has the highest score in exposure (standardized score of 1.0), high score on sensitivity (standardized score of 0.94) and lowest score on adaptive capacity (standardized score of 0.46).

Figure 6: Contribution from different components to Vulnerability Index by Gewog Vulnerability Categories

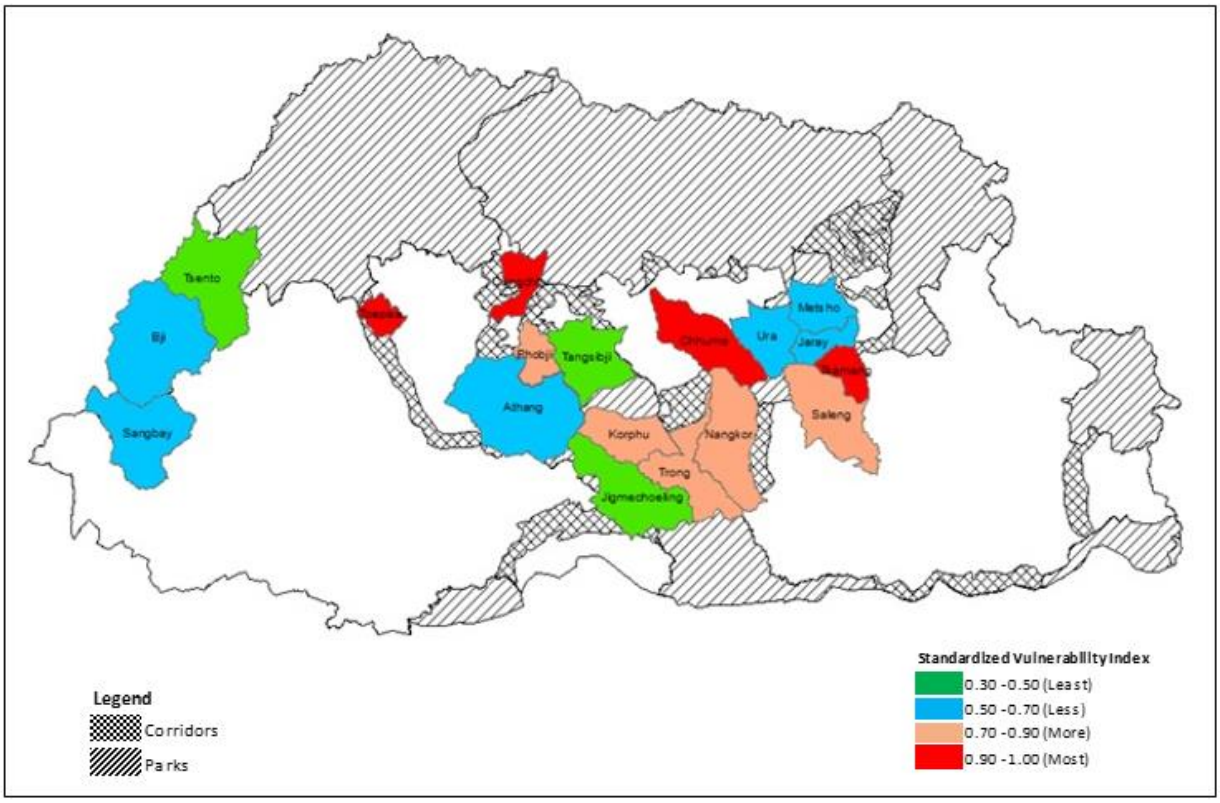


A ranking of Gewogs by climate change vulnerability is presented in table 12 and spatial distribution of vulnerability at Gewog level within the project landscapes is presented in Figure 7. The map is based on standardized vulnerability index.

Table 12: Climate Change Vulnerability indices of Gewogs

			Index				
Land-scape	**Dzongkhag**	**Gewog**	**Expo-sure**	**Sensi-tivity**	**Adaptive Capacity**	**Vulner-ability**	**Standardi-zed**
LS 3	Monger	Tsamang	11.50	31.00	6.50	350	1.00
LS 2	Punakha	Toepisa	11.50	30.00	7.50	337.5	0.96
LS 3	Bumthang	Chhume	11.00	30.50	8.50	327	0.93
LS 2	Wangdue	Dangchhu	11.00	29.50	8.00	316.5	0.90
LS 3	Zhemgang	Nangkor	9.50	33.00	12.00	301.5	0.86
LS 2	Wangdue	Phobji	11.50	26.00	7.00	292	0.83
LS 2	Zhemgang	Trong	11.00	26.00	11.50	274.5	0.78
LS 2	Trongsa	Korphu	9.50	29.00	8.00	267.5	0.76
LS 3	Monger	Saleng	11.00	24.00	8.50	255.5	0.73
LS 1	Ha	Sangbay	9.00	28.00	11.50	240.5	0.69
LS 2	Wangdue	Athang	8.50	26.00	6.00	215	0.61
LS 3	Lhuentse	Metsho	9.00	25.00	10.50	214.5	0.61
LS 1	Ha	Bji	7.50	30.00	13.50	211.5	0.60
LS 3	Bumthang	Ura	7.50	29.00	14.00	203.5	0.58
LS 3	Lhuentse	Jaray	6.50	31.50	11.50	193.25	0.55
LS 2	Sarpang	Jigmechoeling	7.50	24.00	9.50	170.5	0.49
LS 2	Trongsa	Tangsibji	6.50	23.50	10.50	142.25	0.41
LS 1	Paro	Tsento	8.50	13.00	6.50	104	0.30

Figure 7: Gewog level Climate Change Vulnerability Map within the landscape areas



4.1.3 Vulnerability across landscape Chiwogs

The average of standardized vulnerability index for Chiwogs was 0.52 on a scale of 0 to 1. The average exposure, sensitivity and adaptive capacity indices across all Chiwogs are 8.25 (in range of 5.0 to 11.0); 15.83 (in the range of 4 to 22) and 9.67 (in the range of 14) respectively. A ranking of all Chiwogs by vulnerability index is presented in Annex 2.

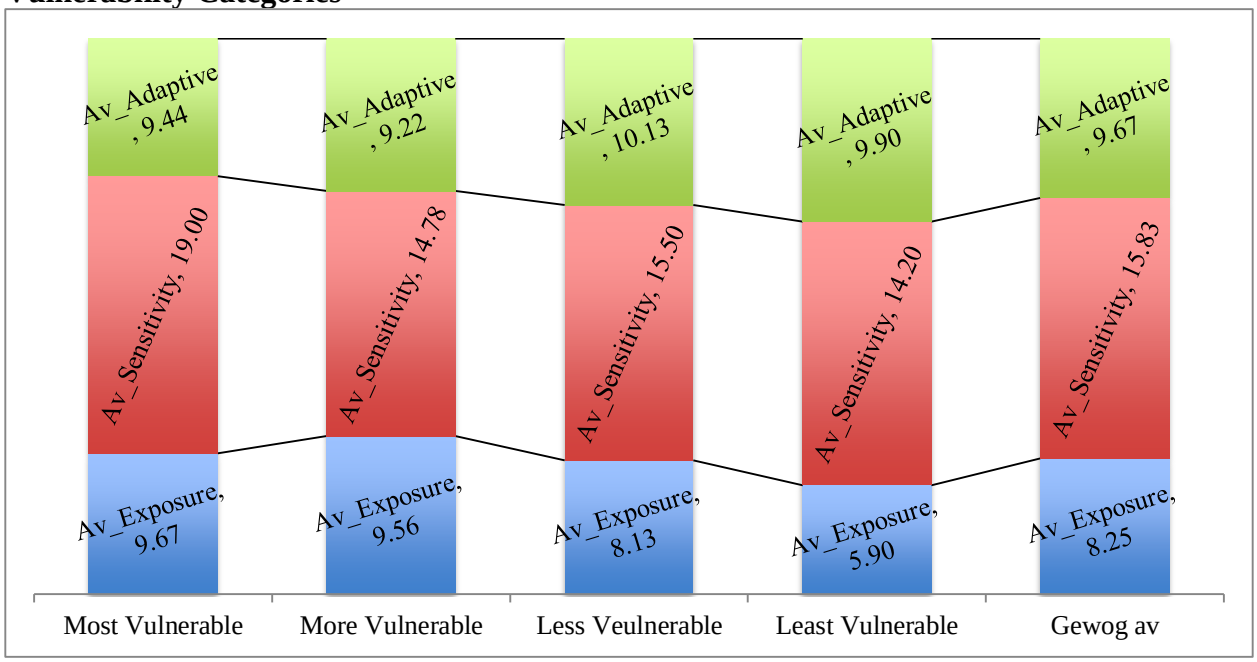
The least vulnerable Chiwog within landscape is Nyamjey_Phangdo of Tsento Gewog in Paro with a standardized vulnerability index of 0.05. Although the Chiwog has an adaptation capacity index score of 8.0, which is lower than the Chiwog average of 9.67, its standardized vulnerability index is lowest on account of the Chiwog being lowest on exposure index (5.0) and being lowest on sensitivity index (4.0).

The most vulnerable Chiwog is Thuenmong_Tokari Chiwog of Tsamang Gewog in Monggar with a standardized vulnerability index of 1.0. The Chiwog has below average adaptation capacity index (8.0) coupled with its highest exposure index (11.0) and highest sensitivity index (22.0) among all Chiwogs (See Annex 2). When categorized into quartiles of vulnerability to climate change, the Chiwogs in the survey area show that nine Chiwogs fall within the most vulnerable category; nine within the more vulnerable; eight within the less and ten in the least vulnerable categories (See Table 13 and Figure 8).

Table 13: Category of Chiwogs by vulnerability

Vulnerability Categories	Chiwogs/Gewogs
Most Vulnerable	Thuenmong_Tokari (Tsamang), Khyimdro_Nemphel (Phobji), Dhangkhar_Trong (Trong), Uesagang (Dangchu), Goenmkha_Mendrelgang (Toepisa), Domkhar and Zung-Ngae (Chhume), Korphu Maed (Korphu) and Nyakhar (Nankkor)
More Vulnerable	Dochola_Maenchhuna (Toepisa), Gongphu (Trong), Buli (Nangkor), Thridangbi (Saleng), Tokaling_Tomla (Dangchhu), Samkhar (Jigmechoeling), Damchhoe_Gangphel (Phobji), Mochhu (Sangbay) and Drangmaling_Nangkor (Tsamang)
Less Vulnerable	Ladrong (Jaray), Shingkhar (Ura), Sangbay Ama (Sangbay), Ung-gar (Metsho), Nyimzhong Toed (Korphu), Nyechhu_Shar-ri (Tsento), Yangthang (Bji) and Saling (Saleng)
Least Vulnerable	Lawa_Lamga and Rookha (Athang), Chenpa_Geychhukha (Bji), Shing-Nyer (Ura), Nangngey (Jaray), Gorsum (Metsho), Gongtsekha (Jigmechoeling), Chendenbji and Tangsibji (Tangsibji) and Nyamjey_Phangdo (Tsento)

Figure 8: Contribution from different components to Vulnerability Index by Chiwog Vulnerability Categories



4.2 Exposure Index

Exposure index has been constructed based on survey response on seven exposure indicators including Changes in summer temperature; Changes in winter temperature; Changes in rainfall patterns; Frequency of hailstorm; Frequency of windstorm; Occurrence of Drought and Flood events (See Table 9). Initially snowfall and frost were also included. However, the PPG team advised that these two indicators could introduce biases since all areas do not experience these two exposure indicators. Hence the exposure assessment is based on these seven indicators after excluding snow and frost indicators. The sum of all exposure indicator scores reflect the score of exposure index.

4.2.1 Exposure indices across landscapes

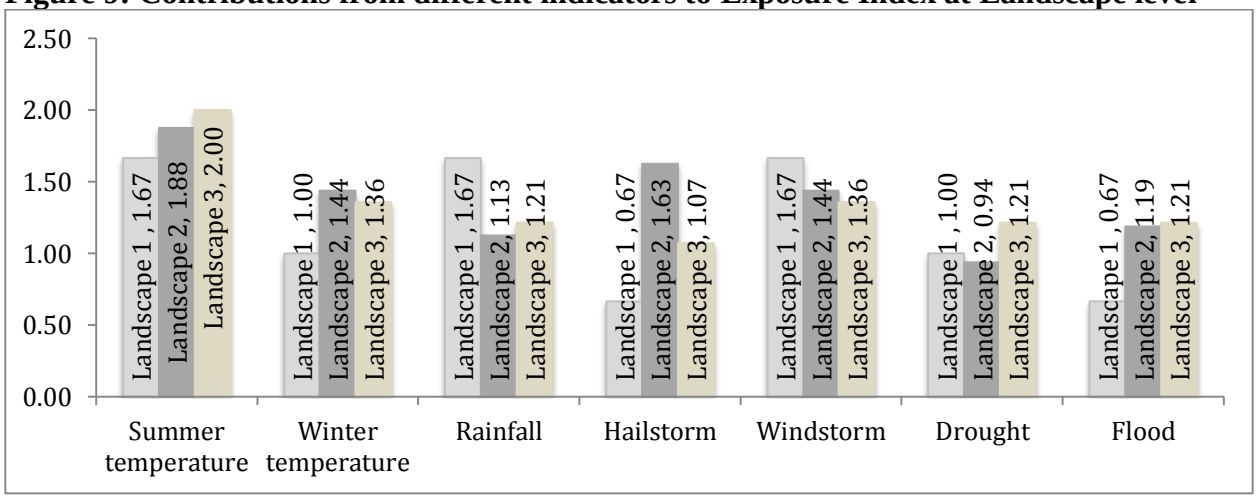
On a scale of 0 to 1, standardized score of exposure index at landscape level do not show large variations. Landscape two has the highest score of 1.0 followed by landscapes three with a exposure score of 0.98 and landscape one with the minimum score of 0.87. (See Table 14 and Figure 9). Table 14 shows the details of indicator scores that contribute to exposure indices of each landscape based on the survey data.

Table 14: Indicators of Landscape Exposure Index

	Exposure Index		
Landscape	**Landscape 1**	**Landscape 2**	**Landscape 3**
Summer temperature	1.67	1.88	2.00
Winter temperature	1.00	1.44	1.36
Rainfall	1.67	1.13	1.21
Hailstorm	0.67	1.63	1.07
Windstorm	1.67	1.44	1.36
Drought	1.00	0.94	1.21
Flood	0.67	1.19	1.21
Exposure total	8.33	9.63	9.43
Standardized index	0.87	1.00	0.98

Changes in summer temperature, windstorm and rainfall patterns, are the major factors that contribute to the score in exposure index at the landscape level. Landscape one is the most affected by changes in rainfall and windstorm while landscape two is affected the most by changes in winter temperature and hailstorm. Landscape three is the most affected by changes in summer temperature and flood (See Figure 9).

Figure 9: Contributions from different indicators to Exposure Index at Landscape level



4.2.2 Exposure Indices across landscape Gewogs

The average score of exposure index across Gewogs is 9.3 in the range of 6.5 to 11.5. Toepisa Gewog (Punakha) has the highest exposure with an exposure index score of 11.5 while Jaray Gewog (Lhuentse) has the lowest exposure an exposure index score of 6.50 (See Table 15 for details).

Table 15: Climate Change Exposure Indicator scores of Gewogs

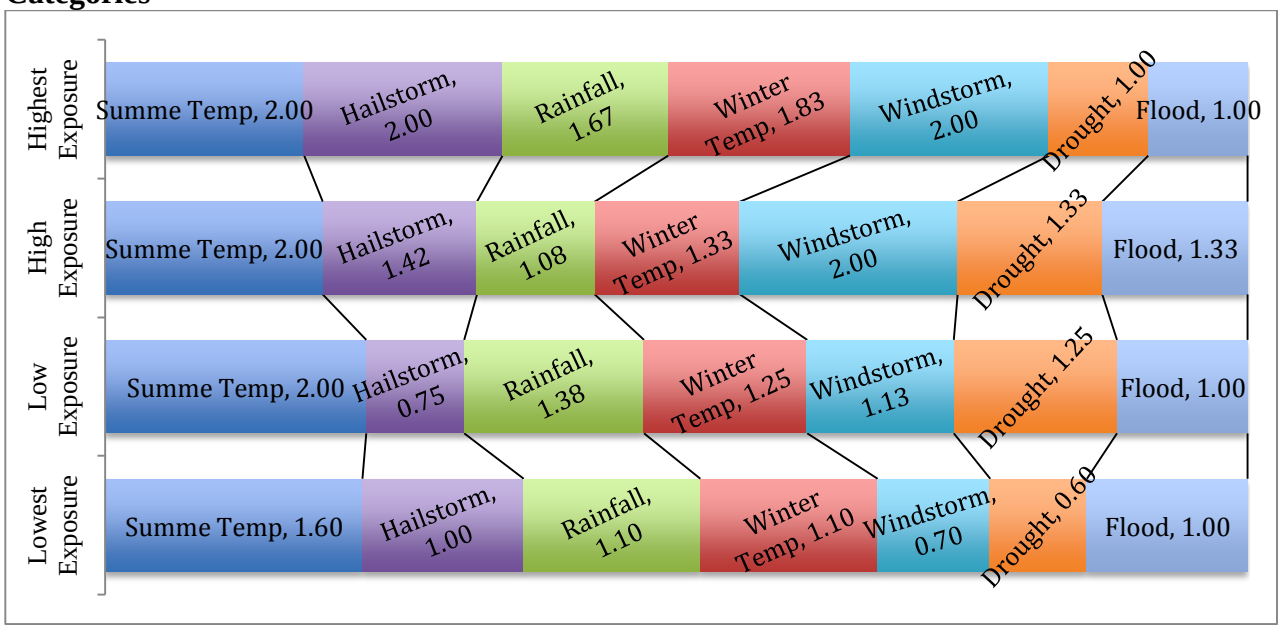
Gewog	Summer Temp	Winter Temp	Rainfall	Hailstorm	Windstorm	Drought	Flood	Exposure index
Toepisa	2.00	2.00	1.00	2.00	2.00	1.50	1.00	11.50
Phobji	2.00	2.00	2.00	2.00	2.00	0.50	1.00	11.50
Tsamang	2.00	1.50	2.00	2.00	2.00	1.00	1.00	11.50
Dangchhu	2.00	2.00	1.00	2.00	2.00	1.00	1.00	11.00
Trong	2.00	1.50	1.00	2.00	2.00	1.00	1.50	11.00
Chhume	2.00	1.50	1.00	2.00	2.00	1.50	1.00	11.00
Saleng	2.00	1.50	2.00	0.00	2.00	2.00	1.50	11.00
Korphu	2.00	1.00	0.50	1.50	2.00	1.00	1.50	9.50
Nangkor	2.00	0.50	1.00	1.00	2.00	1.50	1.50	9.50
Sangbay	2.00	0.50	2.00	0.50	2.00	1.00	1.00	9.00
Metsho	2.00	1.50	1.00	1.00	0.50	1.50	1.50	9.00
Tsento	2.00	1.50	1.50	1.00	1.00	1.00	0.50	8.50
Athang	2.00	1.50	1.00	0.50	1.00	1.50	1.00	8.50
Bji	1.00	1.00	1.50	0.50	2.00	1.00	0.50	7.50
Jigmechoeling	2.00	0.50	1.50	1.50	0.50	0.50	1.00	7.50
Ura	2.00	1.50	1.00	1.00	1.00	0.50	0.50	7.50
Tangsibji	1.00	1.00	1.00	1.50	0.00	0.50	1.50	6.50
Jaray	2.00	1.50	0.50	0.50	0.00	0.50	1.50	6.50

Table 16 presents categories of Gewogs by exposure and contribution from different indicators to exposure by Gewog exposure categories are presented in Figure 10.

Table 16: Category of Gewogs by Exposure

Exposure Categories	Gewogs/Dzongkhags
Highest Exposure	Toepisa (Punakha), Phobji (Wangdue), Tsamang (Monger)
High Exposure	Dangchhu (Wangdue), Trong & Nangkor (Zhemgang), Chhume (Bumthang), Saleng (Monger) and Korphu (Trongsa)
Low Exposure	Sangbay (Ha), Metsho (Lhuentse), Tsento (Paro) and Athang (Wangdue)
Lowest Exposure	Bji (Ha), Jigmechoeling (Sarpang), Ura (Bumthang), Tangsibji (Trongsa) and Jaray (Lhuentse)

Figure 10: Contribution from different indicators to Exposure Index by Gewog Exposure Categories



The highest contribution to exposure index comes from changes in temperature (both summer and winter), followed by changes in occurrence of windstorm and rainfall patterns. Therefore, local level appropriate adaptation interventions related to exposure to climate change would be:

- Enabling availability of climate and weather information to enhance individual innovation and risk management;
- Agriculture and livestock interventions to protect from severe impacts of temperature changes, particularly impacts of increased temperature in summer and decreased temperatures in winter.
- Agriculture and livestock interventions to protect from severe impacts of windstorms and hailstorms.
- Agriculture and livestock interventions to protect from severe impacts of drought
- Protection of community assets from floods (flood mitigation and protection activities)

4.2.3 Exposure Indices across landscape Chiwogs

The average of exposure index for Chiwogs is 8.25 in the range of 5 to 11. The exposure index among all Chiwogs is lowest in the Nangngey Chiwog of Jaray Gewog in Lhuentse with an exposure index of 5.0 and highest in Goenmkha_Mendrelgang Chiwog of Toepisa in Punakha with an exposure index of 11.

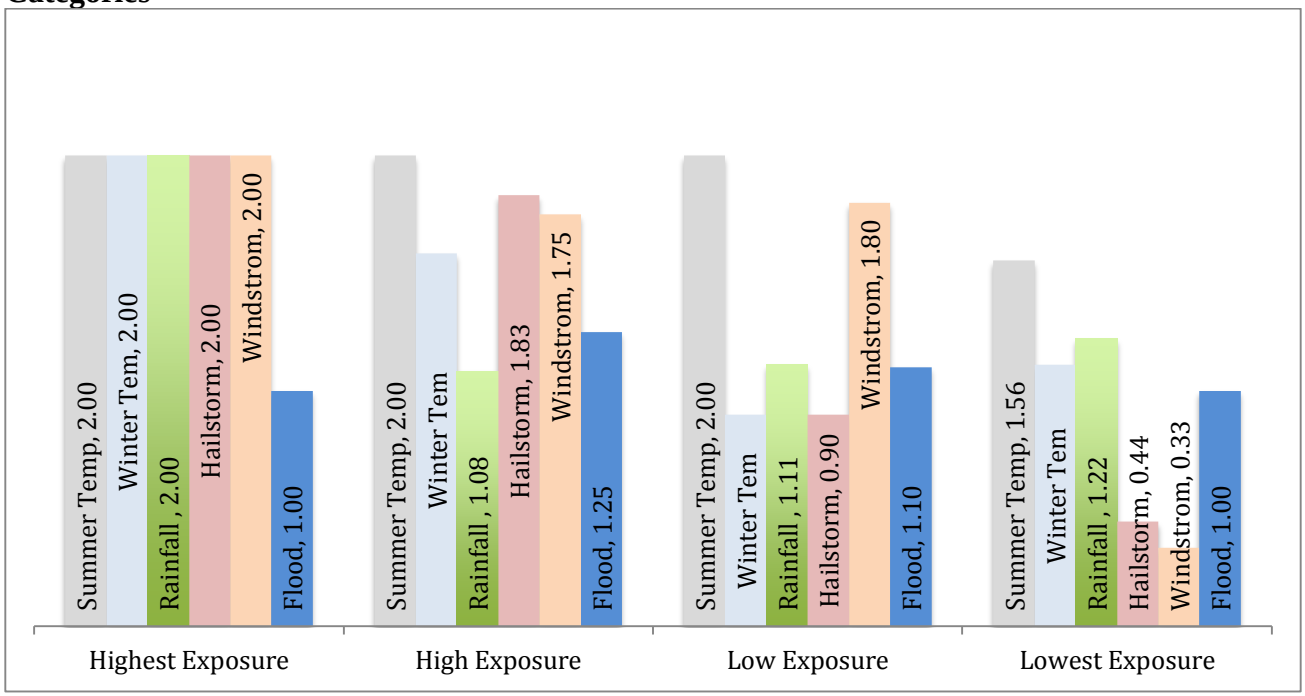
Five Chiwogs are within the highest exposure category, twelve in the high exposure category, ten in the low exposed category and nine in the lowest exposed category (See Table 17). The indicators that contribute to exposure within the Chiwogs categorized by quartile is presented in Figure 11. At the Chiwog level, as is the case at Gewog level. Highest contribution to exposure arises form

change in summer temperature, followed by change in winter temperature, occurrence of windstorms and change in rainfall patterns.

Table 17: Category of Chiwogs by Exposure

Exposure Categories	Chiwogs/Gewogs
Highest Sensitivity	Goenmkha_Mendrelgang (Toepisa), Tokaling_Tomla (Dangchhu), Damchhoe_Gangphel and Khyimdro_Nemphel (Phobji) and Thuenmong_Tokari (Tsamang)
High Sensitivity	Nyechhu_Shar-ri (Tsento), Dhangkhar_Trong and Gongphu (Trong), Domkhar and Zung-Ngae (Chhume), Thridangbi (Saleng), Drangmaling_Nangkor (Tsamang), Dochola_Maenchhuna (Toepisa), Samkhar (Jigmechoeling), Korphu Maed (Korphu), Uesagang (Dangchhu) and Ung-gar (Metsho).
Low Sensitivity	Mochhu and Sangbay Ama (Sangbay), Nyimzhong Toed (Korphu), Rookha (Athang), Shing-Nyer (Ura), Saling (Saleng), Buli and Nyakhar (Nangkor), Yangthang (Bji) and Ladrong (Jaray)
Lowest Sensitivity	Chenpa_Geychhukha (Bji), Chendenbji and Tangsibji (Tangsibji), Lawa_Lamga (Athang), Shingkhar (Ura), Gorsum (Metsho), Nyamjey_Phangdo (Tsento), Gongtsekha (Jigmechoeling) and Nangngey (Jaray)

Figure 11: Contribution from different indicators to Exposure Index by Chiwog Exposure Categories



As in the case of Gewog level, exposure at the Chiwog level is also mostly influenced by changes in summer temperature followed by occurrence of windstorms. Therefore, interventions to adapt to exposure can be similar to as described under Gewog level exposure.

4.3 Sensitivity Index

Sensitivity index has been constructed based on survey response on seven sensitivity indicators including Changes in Soil erosion and landslides, Change in Soil fertility, Changes in forest conditions, Change in availability of water for irrigation, Water for drinking, Impact on human health and Impact on Community Assets (See Table 9). The sum of all sensitivity indicator scores reflects the score of sensitivity.

4.3.1 Sensitivity indices across landscapes

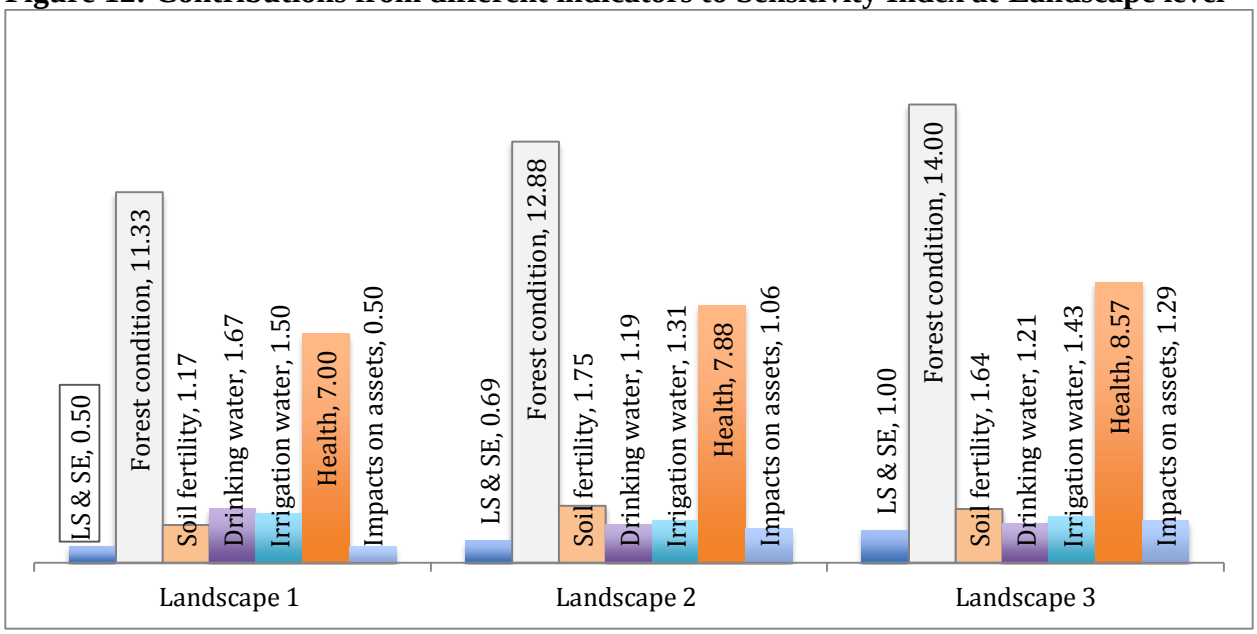
On a scale of 0 to 1, standardized score of sensitivity index at landscape level show large variations. Landscape three has the highest score of 1.0 followed by landscapes two with a exposure score of 0.92 and landscape one with the minimum score of 0.81. (See Table 18 and Figure 11). Table 18 shows the details of indicator scores that contribute to sensitivity indices of each landscape based on the survey data.

Table 18: Indicators for landscape level Sensitivity index

	Sensitivity Index		
Landscape	**Landscape 1**	**Landscape 2**	**Landscape 3**
Land Slides & Soil Erosion	0.50	0.69	1.00
Forest condition	11.33	12.88	14.00
Soil fertility	1.17	1.75	1.64
Drinking water	1.67	1.19	1.21
Irrigation water	1.50	1.31	1.43
Human health	7.00	7.88	8.57
Impacts on assets	0.50	1.06	1.29
Sensitivity total	23.67	26.75	29.14
Standardized index	0.81	0.92	1.00

Changes in forest condition and human health (water borne disease) are the major factors that contribute to the score in sensitivity index at the landscape level. Landscape Three is the most affected both by changes in forest conditions and human health followed by landscape two and three respectively.

Figure 12: Contributions from different indicators to Sensitivity Index at Landscape level



The high sensitivity index of landscapes arises mainly from high score on forest conditions and human health. This indicates that deterioration of forest conditions and occurrence of climate related health hazards are higher in landscape three as compared to the other two landscapes. Based on the land cover data (LCMP, 2010), proportion of Gewog area under forest cover within the survey Gewogs landscapes one, two and three are 77.1%, 90.64% and 92.66%. The sensitivity scores for the landscapes show an inverse relationship with forest cover indicating that the forest conditions in these areas are degradation and hence higher forest cover doesn't necessarily mean lower sensitivity. It indicates that the level of degradation in forest conditions is higher in areas where there is more forest coverage. Forest condition measurements include, in the order of severity, forest fire incidents, decrease in fodder availability, decrease in availability of water in streams/lakes, availability of timber/firewood, decrease in wildlife diversity, decrease in availability of NWFPs and plant diversity. Therefore, addressing aspects of forest conditions should include:

- Measures to prevent and contain forest fires and to rehabilitate forest fire affected areas;
- Enhance fodder availability through fodder development programs;
- Conservation and restoration of natural streams and lakes and technologies for efficient use of or reduction of wastage in the use of water;
- Enhance availability of timber and firewood or promote alternatives to use of timber and firewood;
- Wild life protection and measures and
- Conservation measures to enhance availability and sustainable management of NWFPs

Changes in human health condition measurements include, in the order of severity, occurrence of fever/common cold, typhoid and cholera, which are diseases, related to change in weather conditions and water/sanitation aspects. Therefore, addressing aspects of human health conditions should include activities related to related to water borne diseases such as:

- Management of outdoor water receptacles to avoid stagnant water collecting to prevent spread of mosquitoes or other vectors
- Strengthen sanitation measures and healthy living practices

4.3.2 Sensitivity Indices across landscape Gewogs

The average score on sensitivity index across Gewogs is 27.17 on in the range of 13 to 33. Nangkor Gewog (Zhemgang) has the highest sensitivity index with a sensitivity index of 33 while the Tsento Gewog (Paro) has the lowest sensitivity with a sensitivity index of 13 (See Table 19).

Table 19: Climate Change Sensitivity Score of Gewogs

Gewog	Landslides/Soil erosion	Forest condition	Soil fertility	Drinking water	Irrigation water	Health	Impact on assets	Sensitivity index
Nangkor	2	13	2	2	2	11	2	33
Jaray	1	14	2	2	2	10	2	32
Tsamang	1	16	1	1	2	9	1	31
Chhume	1	15	2	1	1	9	2	31
Bji	1	15	2	2	1	9	1	30
Toepisa	1	14	2	1	1	12	1	30
Dangchhu	0	14	2	1	1	11	1	30
Korphu	0	16	2	2	2	6	2	29
Ura	2	16	2	1	1	7	1	29
Sangbay	1	15	0	2	2	8	1	28
Athang	1	12	2	2	2	8	1	26
Phobji	1	11	2	1	1	9	1	26
Trong	2	13	2	2	2	4	2	26
Metsho	0	12	2	1	1	8	1	25
Jigmechoeling	2	11	2	2	2	6	1	24
Saleng	1	12	2	1	1	6	2	24
Tangsibji	1	12	2	1	1	7	1	24
Tsento	1	4	2	2	2	4	0	13

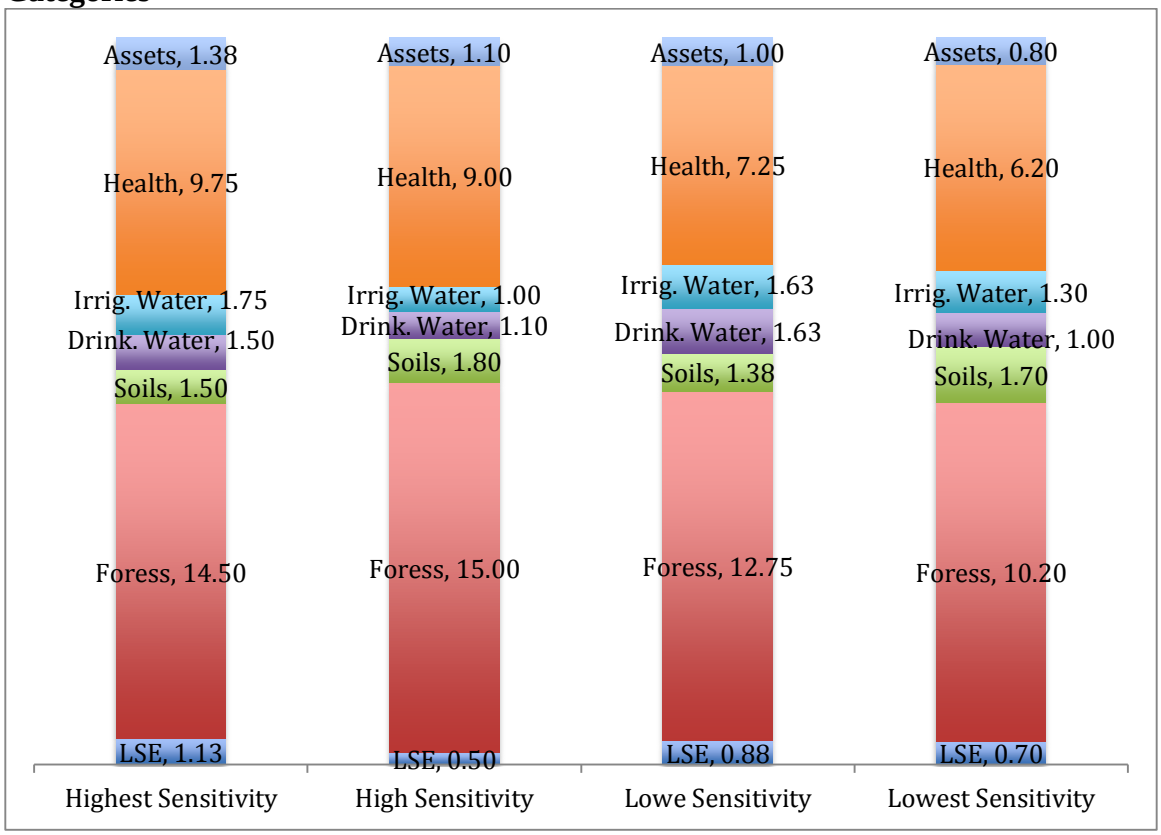
Table 20 presents categories of Gewogs by sensitivity index.

Table 20: Category of Gewogs by Sensitivity Level

Sensitivity Categories	Gewogs/Dzongkhags
Highest Sensitivity	Nangkor (Zhemgang), Jaray (Lhuentse), Tsamang (Monger) and Chhume (Bumthang)
High Sensitivity	Bji (Ha), Toepisa (Punakha), Dangchhu (Wangdue), Korphu (Zhemgang) and Ura (Bumthang)
Low Sensitivity	Sangbay (Ha), Athang and Phobji (Wangdue) and Trong (Zhemgang)
Lowest Sensitivity	Metsho (Lhuentse), Jigmechoeling (Sarpang), Saleng (Monger), Tangsibji (Trongsa) and Tsento (Paro)

The contribution of different indicators to sensitivity index by Gewog sensitivity categories is presented in Figure 13 where LSE means Landslides/Soil erosions; Irrig. Water means water for irrigation and Drink Water means drinking water.

Figure 13: Contribution from different indicators to Sensitivity Index by Gewog Sensitivity Categories



The highest contribution to the sensitivity index at the Gewog level arises from forest conditions and human health indicators, as is the case at the landscape level. Landslides and soil erosions contribute the least.

4.3.3 Sensitivity Indices across landscape Chiwogs

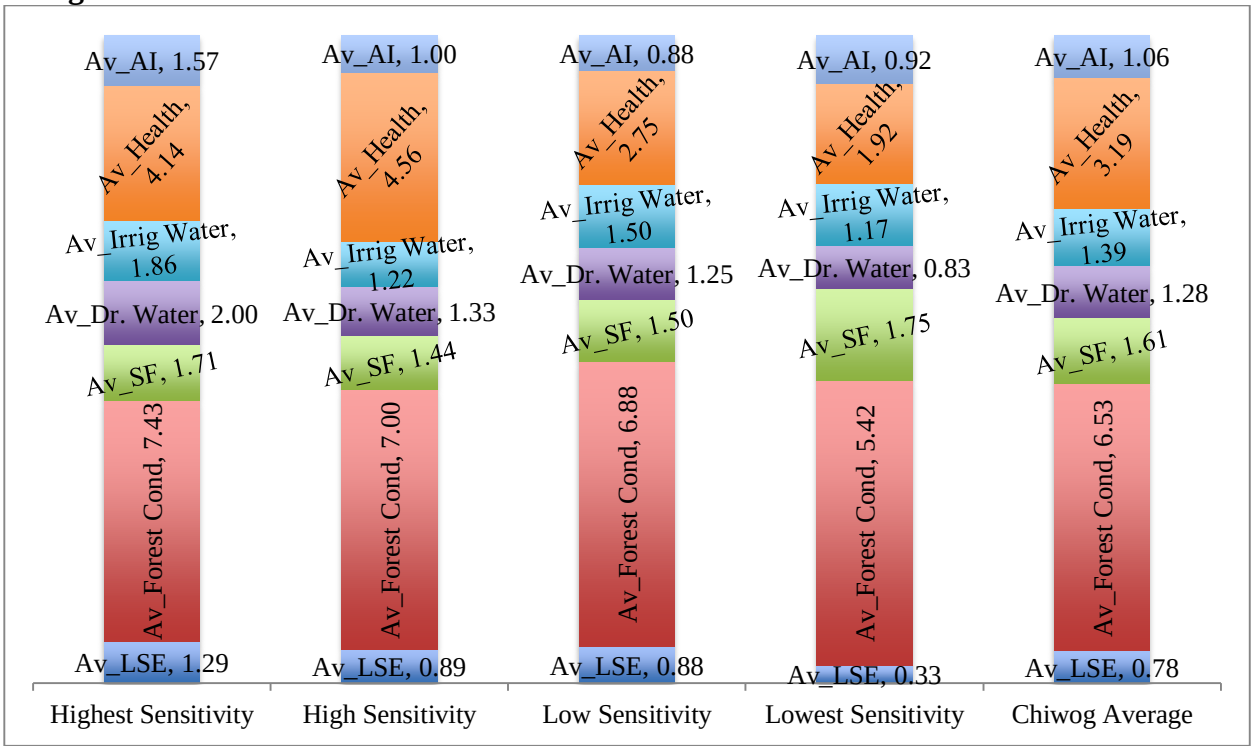
The average of sensitivity index for Chiwogs is 15.83 ranging from 4 to 22. Nyamjey_Phangdo Chiwog of Tsento Gewog in Paro has the lowest sensitivity index of 4 and Thuenmong_Tokari Chiwog of Tsamang Gewog in Monggar has the highest sensitivity index of 22. Sensitivity index (baseline) at Chiwog level is presented in Annex 4.

Table 21: Category of Chiwogs by Sensitivity level

Sensitivity Categories	Chiwogs/Gewogs
Highest Sensitivity	Thuenmong_Tokari (Tsamang), Nyakhar and Buli (Nangkor), Uesagang (Dangchhu), Korphu Maed (Korphu), Dhangkhar_Trong (Trong) and Ladrong (Buli)
High Sensitivity	Yangthang and Chenpa_Geychhukha (Bji), Khyimdro_Nemphel (Phobji), Zung-Ngae and Domkhar (Chhume), Nangngey (Jaray, Mochhu (Sangbay), Lawa_Lamga (Athang) and Shingkhar (Ura)
Low Sensitivity	Sangbay Ama (Sangbay), Dochola_Maenchhuna and Goenmkha_Mendrelgang (Toepisa), Gongtsekha and Samkhar (Jigmechoeling), Shing-Nyer (Ura), Nyimzhong Toed (Korphu) and Gongphu (Trong)
Lowest Sensitivity	Gorsum and Ung-gar (Metsho), Saling and Thridangbi (Saleng), Chendenbji and Tangsibji (Tangsibji), Rookha (Athang), Drangmaling_Nangkor (Tsamang), Nyechhu_Shar-ri and Nyamjey_Phangdo (Tsento), Tokaling_Tomla (Danghchu) and Damchhoe_Gangphel (Phobji)

Seven Chiwogs are within the highest sensitivity category, nine in the high sensitivity category, eight in the low sensitivity category and twelve in the lowest sensitivity category (See Table 21). The indicators that contribute to sensitivity within the Chiwogs categorized by quartile is presented in figure 11. At the Chiwog level highest contribution to sensitivity arises form change in forest conditions, followed by change human health, irrigation water, drinking water, soil fertility and impact on community assets.

Figure 11: Contributions from different indicators to Sensitivity Index by Chiwog Sensitivity Categories



Chiwog level response from communities on forest conditions (Table 22) shows that decrease in availability fodder is the most important indicator within the landscape Chiwogs followed by the decrease in availability of water in natural lakes and streams. The appropriate interventions, therefore, would be similar as assessed at the Gewog level.

Table 22: Community assessment of forest conditions

Forest condition index components	% of forest condition score	% of Chiwogs
Decrease in fodder availability	15.32	100.00
Decrease in availability of water in streams/lake	14.89	97.22
Decrease in availability of timber/firewood	13.62	88.89
Decrease in wildlife diversity	12.77	83.33
Decrease in availability of NWFPs	11.49	75.00
Decrease in plant diversity	11.49	75.00
Increase in forest fire incidents	10.21	66.67

Availability of drinking water: 44.44% of all Chiwogs reported observation of decrease in drinking water while 38.89% of Chiwogs reported that there has not been any change in the availability of drinking water. Incidentally, 16.67% of Chiwogs observed increase in availability of drinking water. These are areas where 67% of the Chiwogs have carried out plantation activities. At the Chiwog level 81.58% of Chiwogs reported impact on community assets from climate change and natural hazard while 13.16% of Chiwogs reported no impact. On an average 2 types of assets are destroyed by events related to climate change and natural hazards. Community assessment of other sensitivity indicators are presented in Table 23.

Table 23: Community assessment of other sensitivity indicators

	% of Chiwogs		
Other Sensitivity Indicators	**Increased**	**Decreased**	**Same**
Availability of drinking water	16.67	44.44	38.89
Availability of irrigation water	5.26	42.11	47.37
Soil Fertility	5.56	66.67	25.00
Occurrence of cholera	18.42	21.05	47.37
Occurrence of typhoid	23.68	36.42	31.58
Occurrence fever/common cold	52.63	18.42	23.68

In addition to actions proposed under the Gewog level assessment of sensitivity, Chiwog level interventions to improve sensitivity to climate change would, therefore, entail:

- Improving accessibility to drinking water (catchment protection, management drinking water schemes and promoting efficient use of water)
- Improving accessibility to irrigation water (catchment protection, management irrigation schemes, strengthening water user groups and associations, promoting efficient use of water irrigation water, climate proofing of existing and potential irrigation channels)
- Soil fertility management (SLM technologies, crop rotation, improved irrigation)

4.4 Adaptive Capacity Index

Adaptive Capacity index has been constructed based on survey response on seven indicators comprising of Access to climate Information on climate change, Food Security, Crop Diversity , Livestock Diversity Responsive practices, Access to services within 1 hour walking distance, support availed by communities during disasters (See Table 9). The sum of all adaptive capacity indicators scores reflects the score of adaptive capacity index. For visualization purpose, the adaptive capacity index at the landscape level has been presented in the scale of 0 to 1 as standardized adaptive capacity index.

4.4.1 Adaptive Capacity indices across landscapes

On a scale of 0 to 1, standardized score of adaptive capacity index show that Landscape One has the highest score of 1.0 and hence it has the highest capacity to adapt with climate change. Landscape Two has the least capacity to adapt while Landscape Three is in between (See Table 24).

Table 24: Landscape level Adaptive Capacity Index

	Adaptive Capacity Scores		
Indicators	Landscape 1	Landscape 2	Landscape 3
Sources of information on climate	1.00	1.19	1.64
Food security	2.00	1.06	1.50
Crop diversity	0.67	0.88	0.71
Livestock diversity	1.17	0.69	0.93
Local practices	1.67	1.13	1.29
Access to services	1.33	0.25	0.79
Assistance	0.50	0.88	0.86
Water's conflicts	0.50	0.88	0.86
Farmers groups	1.33	1.31	1.07
Adaptive Capacity Index	10.17	8.25	9.64
Standardized Adaptive Capacity index	1.00	0.81	0.95

In the order of importance, adaptive capacity index at the landscape level is influenced mostly by the level of Food security of the communities, the extent of climate change related local practices that are in place, accessibility to climate information and the number of supportive institutions (Farmer Groups).

Figure 12: Contributions from different indicators to Adaptive Capacity Index at landscape level

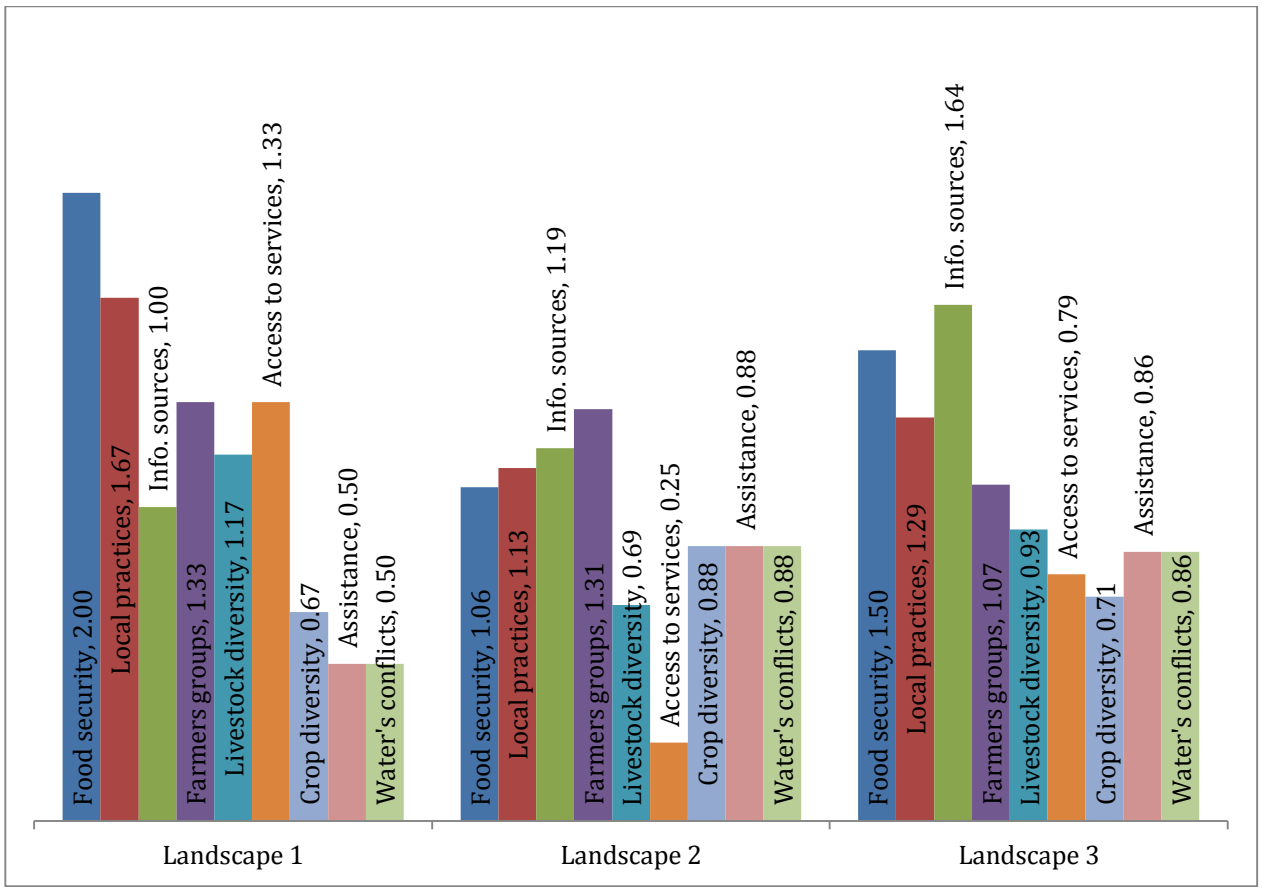


Figure 12 shows the details of indicator scores that contribute to adaptive capacity indices of each landscape based on the survey data.

4.4.2 Adaptive Capacity across landscape Gewogs

The average of adaptive capacity index across Gewogs is 9.50 in the range of 6.0 to 14.0. Ura Gewog (Bumthang) has the highest adaptive capacity with an adaptive capacity index of 14 while the Athang Gewog (Wangdue) has the lowest adaptive capacity with an adaptive capacity index of 6.0 (See Table 25).

Table 25: Adaptive Capacity indicators of Gewogs

Gewog	Info.	FS	CD	LD	Prt.	Ser.	Water Conf.	Asst.	FGs	Income	Index
Ura	2.00	2.00	1.00	0.50	2.00	0.00	1.50	1.50	1.50	2.00	14.00
Bji	1.00	2.00	1.00	2.00	2.00	2.00	0.50	0.50	1.50	1.00	13.50
Nangkor	1.50	1.50	1.00	2.00	2.00	1.50	0.50	0.50	1.50	0.00	12.00
Sangbay	2.00	2.00	1.00	1.50	1.50	2.00	0.50	0.50	0.50	0.00	11.50
Trong	2.00	0.50	2.00	2.00	1.50	0.00	1.00	1.00	1.50	0.00	11.50
Jaray	2.00	2.00	0.50	0.50	2.00	0.50	1.50	1.50	1.00	0.00	11.50
Tangsibji	1.50	2.00	1.50	0.50	1.50	0.00	1.00	1.00	1.50	0.00	10.50
Metsho	1.00	2.00	0.50	1.00	1.50	1.50	1.00	1.00	1.00	0.00	10.50
Jigmechoeling	1.50	1.00	1.00	1.00	1.50	0.00	0.50	0.50	1.50	1.00	9.50
Chhume	2.00	0.00	1.50	2.00	0.00	0.50	0.50	0.50	0.50	1.00	8.50
Saleng	2.00	2.00	0.50	0.50	0.50	0.50	0.50	0.50	1.50	0.00	8.50
Korphu	2.00	1.00	0.50	0.50	1.00	1.00	0.50	0.50	1.00	0.00	8.00
Dangchhu	1.00	1.00	0.50	0.50	1.00	0.00	1.50	1.50	1.00	0.00	8.00
Toepisa	0.50	2.00	0.00	0.00	1.50	0.00	0.50	0.50	1.50	1.00	7.50
Phobji	0.50	1.00	1.00	0.50	0.00	0.50	1.00	1.00	1.50	0.00	7.00
Tsento	0.00	2.00	0.00	0.00	1.50	0.00	0.50	0.50	2.00	0.00	6.50
Tsamang	1.00	1.00	0.00	0.00	1.00	1.00	0.50	0.50	0.50	1.00	6.50
Athang	0.50	0.00	0.50	0.50	1.00	0.50	1.00	1.00	1.00	0.00	6.00

(Info = Source of climate information; FS = Food Security; CD = Crop Diversity; DL = Livestock Diversity; Prt = Adaptive Practices; Ser = Services; Water Conf = Water related social conflicts; Asst = Assistance form agencies during climate/disaster events; Income = Annual cash income; Imdex = Adaptive Capacity Index)

Table 26 presents categories of Gewogs by different level of sensitivity index. When categorized into different levels of adaptive capacity based on adaptive capacity index quartiles, three Gewogs emerge as those with highest level of adaptive capacity, six Gewogs with high level of adaptive capacity; four with low adaptive capacity and five with the lowest level of adaptive capacity (See Table 26).

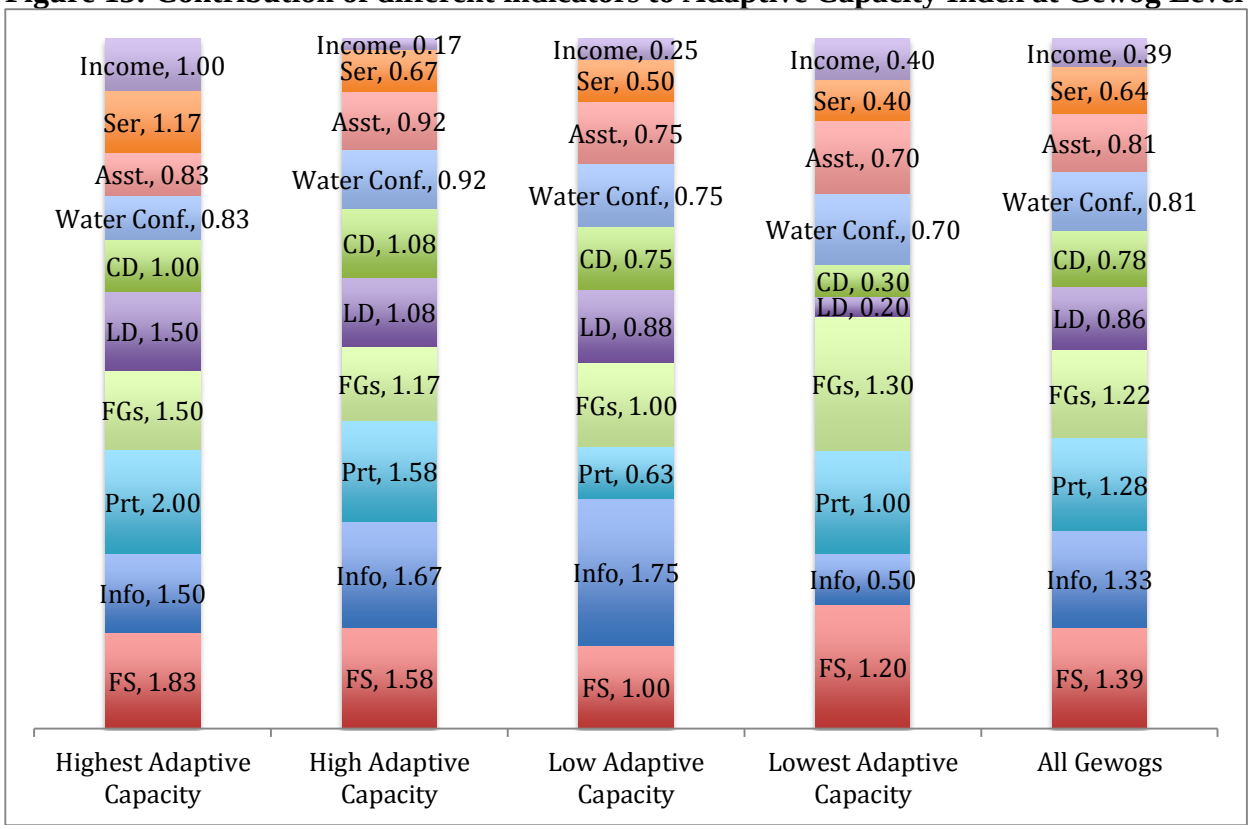
Table 26: Gewogs by level of Adaptive Capacity Index

Adaptive Capacity Categories	Gewogs/Dzongkhags
Highest Adaptive Capacity	Ura (Bumthang), Bji (Ha) and Nangkor (Zhemgang)
High Adaptive Capacity	Sangbay (Ha), Trong (Zhemgang), Jaray and Metsho (Lhuentse), Tangsibji (Tangsibji) and Jigmechoeling (Sarpang)
Low Adaptive Capacity	Chhume (Bumthang), Saleng (Monger), Korphu (Trongsa) and Dangchhu (Wangdue)
Lowest Adaptive Capacity	Toepisa (Punakha), Phobji and Athang (Wangdue), Tsento (Paro) and Tsamang (Monger)

The contribution of different indicators to adaptive capacity index show that food security is one major indicator that contribute towards adaptive capacity of communities followed by access to

climate information and implementation of responsive adaptation practices. Contribution from different indicators towards adaptive capacity index at the Gewog level is presented in figure 13.

Figure 13: Contribution of different indicators to Adaptive Capacity Index at Gewog Level



The contributions from different indicators to adaptive capacity index at the landscape and Gewog levels are similar.

4.4.3 Adaptive Capacity Indices across landscape Chiwogs

The average of adaptive capacity index for all Chiwogs is 9.67 ranging from 5.0 to 16.0. The adaptive capacity index is lowest in Lawa_Lamga Chiwog of Athang Gewog in Wangdue with an adaptive capacity index of 5.0. Buli Chiwog of Nangkor Gewog in Zhemgang has the highest standardized adaptive capacity index of 16.0. Adaptive capacity index (baseline) at Chiwog level is presented in Annex 5. Five Chiwogs fall within the category with highest quartile of adaptive capacity; eleven in the high quartile; nine in the low and ten in the lowest quartile of adaptive capacity index (See Table 27).

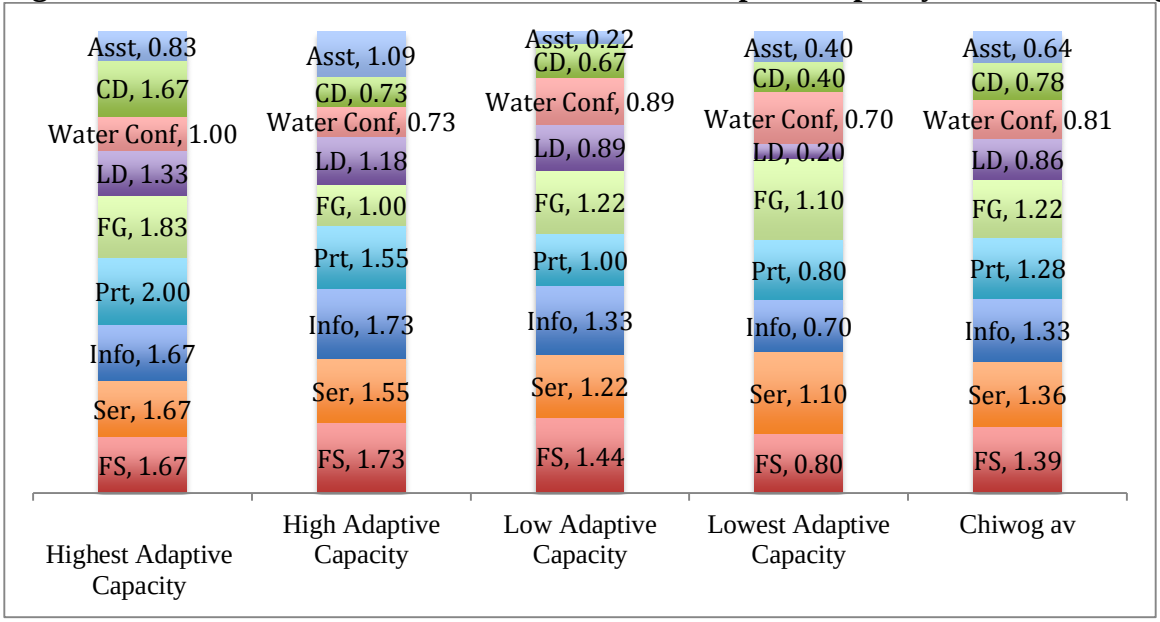
Table 27: Chiwogs by level of Adaptive Capacity Categories

Adaptive Capacity Categories	Chiwogs/Gewogs
Highest Adaptive Capacity	Buli (Nangkor), Yangthang and Chenpa_Geychhukha (Bji), Tangsibji (Tangsibji), Dhangkhar_Trong (Trong) and Shingkhar (Ura)
High Adaptive Capacity	Mochhu and Sangbay Ama (Sangbay), Korphu Maed (Korphu), Gongphu (Trong), Ladrong and Nangngey (Jaray), Shing-Nyer (Ura), Gorsum and Ung-gar (Metsho), Nyakhar (Nangkor) and Samkhar (Jigmechoeling)
Low Adaptive Capacity	Goenmkha_Mendrelgang (Toepisa), Gongtsekha (Jigmechoeling), Chendenbji (Tangsibji), Uesagang (Dangchhu), Domkhar and Zung-Ngae (Chhume), Saling and Thridangbi (Saleng) and Nyamjey_Phangdo (Tsento)
Lowest Adaptive Capacity	Nyechhu_Shar-ri (Tsento), Rookha & Lawa_Lamga (Athang), Damchhoe_Gangphel and Khyimdro_Nemphel (Phobji), Nyimzhong Toed (Korphu), Tokaling_Tomla (Dangchhu), Drangmaling_Nangkor and Thuenmong_Tokari (Tsamang) and Dochola_Maenchhuna (Toepisa)

As an average across all Chiwogs, the highest contribution to adaptive capacity arises from food security although there is difference in its importance across different categories. Major indicators that contribute to adaptive capacity, in the order of importance, are food security, availability and accessibility of services, accessibility to climate information, prevalence of local adaptation practices and existence of institutions (farmer groups).

Within the survey Chiwogs, 63.64% of all Chiwogs are not able meet their food requirements through their own production. For these Chiwogs, the most popular means of coping with their food requirements in the order of popularity are through sale of labour (54.55%), borrow or loan from neighbors and sale of livestock. Unlike at the Gewog level, access to services (such as extension, school, health facilities, etc) and access to climate information are considered more important than crop and livestock diversity (See Figure 13 and 14).

Figure 14: Contribution of different indicators to Adaptive Capacity Index at Chiwog level



Farmer groups are considered important at both the Gewog and Chiwog level assessment. The most popular type of farmers' groups in the landscape comprises of Community Forest Management Groups (CFMGs). It constitutes 28.08% of all farmer groups in the landscape comprises and are prevalent in 86.1% of all Chiwogs. The next important type of farmer groups in the Chiwogs comprise of WUAs (18.69%) of all FGs, which exist in 55.56% of all Chiwogs. The third most popular type of FGs is the livestock based FGs (14.95% of all groups) and are prevalent in 44.44% of all Chiwogs. Agriculture based groups comprise of 13.08% and are prevalent in 38.89% of all Chiwogs.

4.5 Overall Assessment

Assessment of vulnerability and its component indicators show variations at landscape, Gewog and Chiwog levels in importance of each component or their indicators as summarized in Table 28. In the table, components/ indicators are shown in order of importance (from top to bottom, top item being the most important) as revealed by the analytical result.

Table 28: Comparison of vulnerability components and indicators at different levels

	Landscape	**Gewog**	**Chiwog**
Vulnerability Index	Sensitivity index Adaptive Capacity Exposure	Sensitivity index Exposure Adaptive Capacity	Sensitivity index Adaptive Capacity Exposure
Exposure	Summer temp Windstorm Rainfall Winter temperature Hailstorm Drought Flood	Summer temp Windstorm Winter temperature Rainfall Hailstorm Flood Drought	Summer Temp Winter Temp Rainfall Hailstorm Windstorm Flood

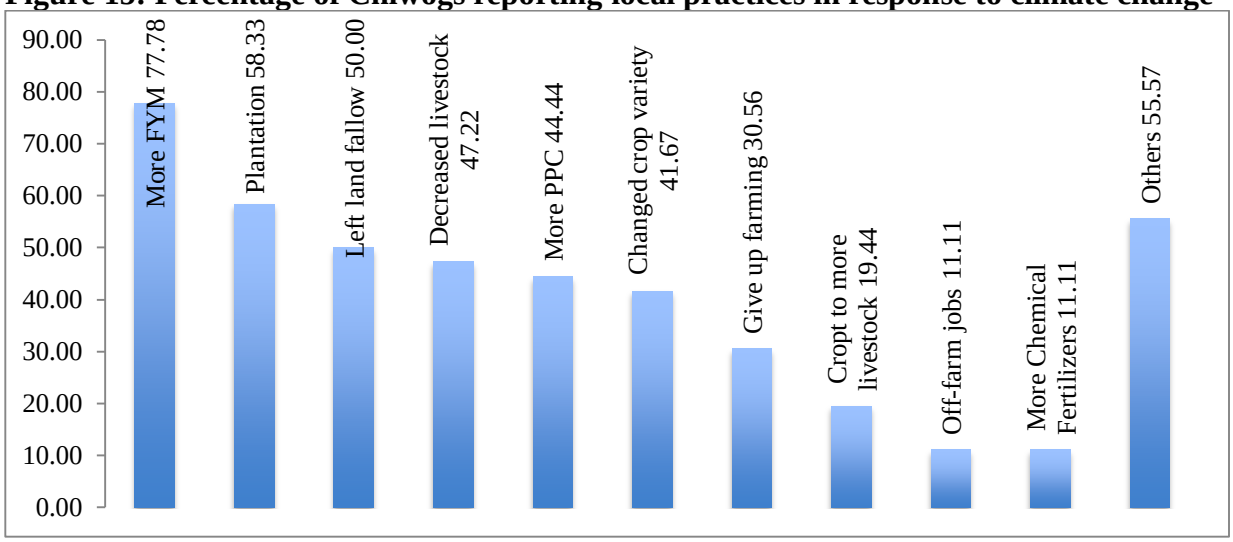
	Landscape	Gewog	Chiwog
Sensitivity	Forest condition Health Soil fertility Irrigation water Drinking water Impacts on assets Landslides /soil erosion	Forest condition Health Soil fertility Irrigation water Drinking water Impact on assets Landslides/Soil erosion	Forest condition Health Soil fertility Irrigation water Drinking water Impact on assets Landslides/Soil erosion
Adaptive Capacity	Food security Local practices Information Farmers groups Livestock diversity Access to services Crop diversity Assistance Water's conflicts	Food security Information Local practices Farmers groups Livestock diversity Water's conflicts Assistance Crop diversity Access to services Annual cash income	Food security Access to services Information Local practices Farmers groups Livestock Diversity Water's conflicts Crop Diversity Assistance

5 Climate Change Adaptations

5.1 Existing Adaptation Responses - Programs

The most popular local level climate change response at the Chiwog level include use of more farmyard manure to increase soil fertility and plantation of trees to combat land degradation as well as to manage catchment areas. However, there are incidences where community members have reported to leaving agriculture lands left fallow and choosing to give up farming as a response to impacts of climate change (See Figure 15).

Figure 15: Percentage of Chiwogs reporting local practices in response to climate change



At the Gewog level, the information from service providers show a different set of local practices that are in place as a response to climate change (See Table 29).

Table 29: Improved Adaptation Practices reported by Gewog officials

Improved Adaptation Practices	Proportion of gewogs reporting (%)
Drip irrigation	1.63
Sprinkler	4.15
Adopting zero grazing practices	16.58
Greenhouses poly tunnels	17.37
Compost making	44.87
Fodder conservation	58.49
Organic farming	65.5

The surveyed Gewogs have initiated 594 acres of winter fodder production; brought 1,651 acres of land under improved pasture and carried out climate resilient enrichment planting on 44 acres of land through the support from the RNR sector. They have carried out climate proofing on 22% of their 283.6 km of farm roads and on 46% of their 153.4 km of irrigation channels.

The most popular adaptation related actions reported by officials at the Gewog comprise of organic farming followed by fodder conservation, compost making, greenhouses and poly tunnels etc. (See table 29).

The programs at the local level in response to climate change as reported by the Chiwogs and by the Gewogs are very different in terms of thematic focus and in terms of their relationship to climate change. This reflects the wide difference in understanding of and hence their perspectives in actions needed to adapt to climate change. There is a clear need to harmonize understanding of climate issues and therefore of appropriate actions to respond and adapt to climate change through awareness and capacity building.

5.1 Existing Adaptation Responses - Policies and Programs

While array of the existing development policies and programs relate to climate change adaption at various levels, one of the most succinct policy frameworks that aims to address climate change is the RNR SAPA. The adaptation plan of action of RNR SAPA includes actions for agriculture and food security, water resources, forest and biodiversity. It includes:

A. **Under Agriculture and Food Security**

(i) Developing and promoting biotic and abiotic stress tolerant crop and fodder varieties;
(ii) Improving local breeds & traditional crops that have adapted to local climatic stress and feed resources;
(iii) Strengthening in-situ and ex-situ conservation of crop and livestock resources;
(iv) Institutionalizing surveillance and forecasting system and containment mechanism for emerging plant and animal diseases;
(v) Diversifying and integrating livestock and crop production; and
(vi) Developing and piloting climate smart RNR Program.

B. **Under Adaptation Action Plan for Water Resources**

(i) Watershed Management Planning and implementation of activities in the critical watersheds;
(ii) Conservation and use of forest and wetland ecosystem for enhancing livelihoods
(iii) Comprehensive water resources inventory; mapping, assessment of the quality and quantity of the major water sources for various uses;
(iv) Rain water harvesting to prevent water shortages during dry periods and irregularities during the monsoons; and
(v) Traditional knowledge and local perspectives in adapting to the changing climate.

C. **Under Forest and Biodiversity**

(i) Sustainable management and utilization of biodiversity;
(ii) Improving and strengthening forest fire management program
(iii) Conserving biodiversity (Plant and Animal);
(iv) Developing livelihood options and adaptation strategies for forestry and ecosystem services; and
(v) Enhancing understanding of climate change impacts on biodiversity and ecosystem services,

Such a packaged policy approach to climate change is appreciable. However, even at the policy level, as can be understood from RNR SAPA, there is no adequate reflection of linkage with other sector issues of relevance to climate change. The policy does not address the issue of climate information to local levels, which would require coordinated actions among the Department of Hydromet services, National Environment Commission, the Department of Disaster Management and the Department of Local Governance and the local Governments in addition to the agencies within the MoAF. It also remains silent on disaster management and emergency operations, energy issues, conflict management, and human health. Therefore, there is a need to address climate change and building resilience through a coordinated national climate change approach that links to local level climate change actions to national level policies and programs. Within the surveyed landscape area, the following climate related issues were reported during the survey:

Table 30: Climate Change related issues reported at Gewog Level by communities

Issues Reported	% of Survey Gewogs
Damage to farm roads due to poor drainages, landslides, erosion & floods	44.4
Drying up of water sources	33.3
Ban on retaliatory killing has increased wild boar population inflicting more damage	27.8
Conflicts in the community due to shortage of water	22.2
Soil erosion due to heavy rainfall	16.7
Reluctance of some farmers in electric fencing	11.1
No capacity in protection of critical land areas	11.1
No capacity in water management	11.1
Weak community ownership in maintenance works of farm roads	5.6
Unsuccessful plantations for land protection due to drought	5.6
Availability of NWFP is declining	5.6
Damage of water pipes	5.6

The assessment of local level adaptation measures and proposals on adaptation to climate change indicate that actions related to adaptation to climate change are fragmented and show weak coordination towards a commonly understood direction. Therefore, there is need to strengthen linkages across local level sector development plans and climate change adaption interventions. Table 30 shows the survey result on responses related to local issues to climate change. The issues pointed out related very much to local level development issues but do not indicate clear connection to climate change and reflect isolated issues that may or may not relate to climate change. Therefore, there is the need for such linkages across local level sector development plans. Likewise, national level policies and programs such as focus on renewable energy, watershed management, Environment Committees at Dzongkhag and Gewog levels, Electrical vehicles etc. do not emerge in local level discussions. Therefore, there is also need to strengthen such linkages with national level policies and programs.

The government has recognized that disaster risk management is an important entry point for stimulating livelihood adaptation. A national disaster management framework with actions and at the national, Dzongkhags, Thromde and Gewog levels is in place. Development programs increasingly recognize the need to reflect climate change issues in the their activities. Within the MoAF, the concept of Climate Smart Villages and climate smart agriculture is recognized as an intervention strategy to build resilience of communities and local production systems with strong emphasis on poverty alleviation and food security.

However, the RNR extension officials, who are the key facilitators for local actions and do not seem to have adequate awareness on climate change issues and more importantly on how to assess climate change vulnerability as well as in adaptation planning. Of all training programs to extension staff as well as to farmers in the 11th FYP local plans, there is hardly recognizable mention of training related to climate change.

Analysis of Chiwog level survey responses show that 31.71% of information on climate change is received through television, 25.61% through radio and 18.29% through friends. Only 9.76% is received through Gup offices, 8.54% is through trainings/workshops, and 2.44% through G2C centers. This indicates that there is minimal information on climate change issues made available through formal channels. Hence, there is scope for strengthening capacity of formal institutions such as the Gewog centers, associations and extension staff to be able to assess, maintain and disseminate climate related information to communities.

To enable building local capacities and abilities to address the complex, inter-sector climate change concerns, it is imperative to enable adequate understanding interpretation of climate change issues, risks and impacts based on which local level policies and programs and be initiated.

The survey has not been able to capture the level of local communities' understanding of climate change and related issues except for their observation of changes and sources of information on climate change. To enable the local communities to come up with appropriate local level policies, programs and actions there is need for sensitization on climate change, risks and impacts on local environment, livelihood options and well-being. Along the same line, consultations related to

planning climate change interventions at local levels should be accompanied with awareness and sensitization on such topics.

5.2 Recommendations on Potential Adaptation Responses

The analysis of vulnerability indicators and assessment of the indices for exposure, sensitivity and adaptive capacity within the landscape areas indicate the need for programs and capacity development along the following strategic areas and tentative activities. Detail of baselines as derived from the filed survey in selected Chiwogs and Gewogs as are presented in Annex 9 (Tracking tools aligned baselines). Priority of landscape, Gewogs based on the ranking of their vulnerability, exposure, sensitivity or adaptive capacity indices as well as their component indicators are proposed in Table 31. It is proposed that the activities that arise from the PPG workshops be aligned with the Gewogs and thematic focus that emerge from the vulnerability analysis.

Table 31: Proposed Climate Resilient Action Planning Framework for Landscapes and Community Livelihoods

Strategy (Vulnerability Index based)	**Interventions (Vulnerability Indicator based)**	**Action Areas (Based on analysis of vulnerability indicators and sub-components)**	**Priority Gewogs**
Increased resilience of ecosystem and ecosystem services (Sensitivity index or ecosystem indicators contributes the most to vulnerability index)	Improvement of Forest condition (*Forest Condition Indicator contributes the most to sensitivity index*)	Climate smart feed and fodder development, conservation, management, technologies (Decreased availability of fodder contributes the most to forest condition index at Gewog level) Upscale stall feeding Households adopting zero grazing practices = 3.27% Areas under winter fodder = 594 acres Increase households adopting Fodder conservation = 1.53%	All Gewogs with priority to Nangkor Gewog Least priority to Trong and Tangsibji
		Develop and promote biotic and abiotic stress tolerant fodder varieties	All Gewogs

Strategy (Vulnerability Index based)	Interventions (Vulnerability Indicator based)	Action Areas (Based on analysis of vulnerability indicators and sub-components)	Priority Gewogs
		Climate resilient conservation, restoration and management of natural streams and lakes (Decrease in Availability of water in streams/lakes is the second most contributing indicator to forest condition indicator) Area under Climate resilient enrichment planting = 44 acres	All Gewogs with least priority to Tsento Gewog
		Promote alternatives to use of timber and firewood (Decrease in Availability of timber/firewood is the third most contributing indicator to forest condition indicator)	All Gewogs except Tsento
		Species conservation actions (Decrease in Wildlife diversity is the 4th most contributing indicator to forest condition indicator)	Bji, Sangbay, Toepisa, Korphu, Athang, Dangchu, Phobji, Chhume, Ura, Jaray, Metsho, Saleng, Tsamang
		Climate resilient plant diversity conservation and management (Decrease in plant diversity contributes 12.8% to indicator on forest conditions)	Bji, Sangbay, Korphu, Tangsibji, Dangchhu, Phobji, Trong, Chhume, Ura, Jaray, Metsho, Saleng, Tsamang,

		Management of NWFP, Sustainable harvesting, processing and marketing of selected commercially viable NWFPs (Decrease in Availability of NWFPs contributes 12.8% to indicator on forest conditions) Annual average household's cash income from NWFPs = Nu. 6,758	Bji, Toepisa, Korphu, Tangsibji, Dangchhu, Trong, Ura, Jaray, Metsho, Saleng, Tsamang,
		Upscale measures to prevent and contain forest fires and to rehabilitate forest fire affected areas. (Increase in forest fires incidence contributes 11.3% to indicator on forest conditions)	Priority Gewogs: Bji, Sangbay, Toepisa, Korphu, Trong, Chhume, Ura, Tsamang
Increased resilience of community health, well-being and infrastructur e (Relevant Sensitivity indicators and adaptive capacity indicators related	Climate resilient drinking water and human health management (Human health and drinking water contributes 34.5% to the Sensitivity Index)	Interventions related to waterborne diseases and sanitation (Increase in water-borne diseases contributes 29.45% to sensitivity index)	Bji, Sangbay, Toepisa, Jigmechoeling, Korphu, Tangsibji, Athang, Dangchhu, Phobji, Chhume, Ura, Jaray, Metsho, Saleng, Tsamang, Nangkor
		Improve availability, access and efficient use of drinking water including catchment protection, management drinking water schemes and promoting efficient use of water, rain water harvesting, water reservoirs. (Increased shortage of drinking water contributes to 4.7% to the sensitivity index)	Bji, Sangbay, Tsento, Jigmechoeling, Korphu, Athang, Trong, Chhume, Jaray, Tsamang, Nangkor

	Climate smart soil fertility management (contributes 5.93% to sensitivity index)	Soil fertility management (SLM technologies, green manuring/cover cropping technologies, crop rotation, improved water efficient field irrigation systems, invasive species, pest and diseases, weed control and management) % of chiwogs with sustainable land management groups = 19.4%	Bji, Tsento, Toepisa, Jigmechoeling, Korphu, Tangsibji, Athang, Dangchhu, Phobji, Trong, Chhume, Ura, Jaray, Metsho, Saleng, Nangkor
	Climate resilient irrigation water management (contributes 5.11% to sensitivity index	Improve accessibility to irrigation water and efficient management of irrigation water (catchment protection, improved management irrigation schemes, strengthening water user groups and associations, promoting efficient use of irrigation water, climate proofing of existing and potential irrigation channels) % of Chiwogs with water users association = 27.8% % of HH within landscape adopting Drip irrigation = 0.11% % of HH within landscape adopting Sprinkler irrigation = 0.82 to Irrigation infrastructure in the survey gewogs = 153 km	Sangbay, Tsento, Jigmechoeling, Korphu, Athang, Trong, Jaray, Tsamang, Nangkor
Enhance climate resilient	Climate resilient food security	Upscale Climate Smart Agriculture Technology interventions to protect from	All Gewogs (All Gewogs affected by

adaptive capacity of communities	initiatives through climate smart agriculture technologies (Food Security indicator contributes the most to adaptive capacity index)	severe impacts of increased temperature in summer and decreased temperatures in winter. (Changes in temperature contribute the most to exposure index). - Develop and promote biotic and abiotic stress tolerant crop and fodder varieties	increase in summer and winter temperature)
		Strengthen infrastructures to maintain food reserve.	All Gewogs except Korphu, Saleng and Tsamang (the three Gewogs already have trials on Silos for food storage)
		Promote Green house and poly tunnels (% of HH adopting Green house and poly tunnels in the landscape Gewogs = 17.3%)	Toepisa, Dangchhu, Phobji, Trong, Chhume, Korphu, Jigmechhoeling, Tangsibji (Gewogs which experience more severe Hailstorms)
		Agriculture interventions to protect from severe impacts of windstorms and hailstorms (these could include green houses, climate information, harvest and pos harvest practices that can avoid or withstand impacts from windstorms and hailstorms)	Toepisa, Phobji, Tsamang, Drangchu, Trong, Chhume

		Promote organic/Natural farming (HHs practicing compost making = 44.87%)	Tsento, Toepisa, Korphu, Tangsibji, Athang, Dangchhu, Phobji, Trong, Chhume, Ura, Jaray, Metsho (Gewogs that use more plant protection chemicals)
		Enhancing crop diversity -Improving traditional crop varieties that have adapted to local climatic stress	Toepisa, Jigmechoeling, Tangsibji, Dangchhu, Phobji, Jaray, Metsho, Saleng, Tsamang, Nangkor. (Gewogs reporting decrease in crop diversity)
		Promote income generating activities and increase annual average household cash income (average annual HH cash income = Nu.57,035) Annual average HH cash income through livestock - Nu. 24,167) Annual average HH cash income through horticulture = Nu. 13,052	Nangkor, Sangbay, Trong, Jaray, Tangsibji, Metsho,, Saleng, Korphu, Dangchu, Phobji, Tsento, Athang
		Promote technologies and management practices to increase production of staple foods and vegetables. Promote technologies and management practices to	Priority Gewogs: Athang, Chhume, Trong, Tsamang, Phobji, Dangchu, Korphu, Jigmechhoeling

		increase production of staple foods and vegetables. (Chiwogs that are able to meet their year-round food requirement through own production = 63.6%)	
	Climate resilient food security initiatives through climate smart livestock technologies (Food Security indicator contributes the most to adaptive capacity index)	Upscale Climate Smart Livestock Technology interventions to protect from severe impacts of increased temperature in summer and decreased temperatures in winter. (Changes in temperature contribute the most to exposure index). Enhancing livestock diversity -Improving local breeds that have adapted to local climatic stress and feed resources Upscale supply of improved breeds of livestock	Toepisa, Jigmechoeling, Tangsibji, Dangchhu, Phobji, Jaray, Metsho, Saleng, Tsamang, Nangkor (Gewogs reporting decrease in livestock diversity)
		Promotion of manure management and utilization e.g. bio gas (% of Gewogs using biogas = 19%	Bji, Sangbay, Tsento, Toepisa, Jigmechoeling, Korphu, Athang, Dangchhu, Phobji, Chhume, Ura (Other Gewogs already practice Biogas or compost making initiatives)

Enhance climate resilient adaptive capacity of Institutions	Coherent and inclusive Policy	Cross sector climate action framework at national and local levels (Integration of climate perspective in development planning are not the same across sectors and at different levels)	All
	Increased Awareness	Climate and Climate change awareness and Sensitization in all Gewogs (Understanding of climate issues are different at different levels) Developing and piloting climate smart RNR programs	All
	Capacity Development	Training of officials on local level Climate Change vulnerability assessment framework	All
		Training of local level officials and local Government members on Local level Climate resilient planning framework	All
		Training of Climate Smart technologies to communities (Sustainable land management, water management, etc)	All
	Institutional Arrangements	Strengthening Gewog Environment Committees to coordinate cross sector climate resilient planning	All

	Improve Climate Information	Improve coordination of Climate Information management and dissemination Enable availability of area specific climate and weather information to enhance individual innovation and risk management at local levels. Establish and strengthen formal channels for local weather and climate information dissemination (Chiwogs receiving information from formal channels = 22.2%) Strengthen surveillance and forecasting system and containment mechanism for emerging plant and animal diseases.	Priority Gewogs: Toepisa, Phobji, Athang Bji, Metsho, Dangchu,. Tsamang,
	Strengthen Farmers groups	Upscale and strengthen institution of farmers groups for targeted products and services (average number of farmer groups per Chiwog = 2)	Priority Gewogs: Sangbay, Chhume, Tsamang.
		Develop safety nets (example: Crop insurance and credit facilities) to cope with extreme climatic events	Priority Gewogs: Bji, Nangkor, Sangbay, Jigmechhoeling, Chhume, Saleng, Korphu, Toepisa, Tsento, Tsamang

	Assistance during the time of climate events and disasters	Develop immediate response mechanisms and strengthen local level disaster management and preparedness	All Gewogs
		Enhance community level conflict management through strengthened capacity for planning and management of community infrastructure such as roads and water conveyance.	Priority Gewog: Nangkor, Sangbay, Jigmechhoeling, Chhume, Saleng, Korphu, Toepisa, Tsento, Tsamang
	Improve community Asset management	Protection of community assets from floods (flood mitigation and protection activities) Climate proofing of farm roads done = 22.2% of farms roads.	Priority Gewogs: Korphu, Nangkor, Jaray, Chhume, Trong, Saleng

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Annex 1: Community Assessment of changes in climatic factors

Total Participants	M	F	M+F
	187	299	486

Climate factors	Observed change			Observed Decrease			Observed Increase		
	Male	Female	M+F	Male	Female	M+F	Male	Female	M+F
Summer temperature	176	277	453	9	12	21	167	264	431
Winter temperature	157	258	415	80	85	165	77	173	250
Rainfall Patterns	155	246	401	63	83	146	92	163	255
Snowfall	87	197	284	86	186	272	1	11	12
Frost Patterns	47	110	157	46	99	145	1	11	12
Hailstorm Events	138	208	346	43	48	91	95	160	255
Windstorm Events	149	249	398	7	5	12	142	244	386

Climate factors	Observed change (%)			Decreased (%)			Increased (%)		
	Male	Female	M+F	Male	Female	M+F	Male	Female	M+F
Summer temperature	94.1	92.6	93.2	5.1	4.3	4.6	94.9	95.3	95.1
Winter temperature	84.0	86.3	85.4	51.0	32.9	39.8	49.0	67.1	60.2
Rainfall Patterns	82.9	82.3	82.5	40.6	33.7	36.4	59.4	66.3	63.6
Snowfall	46.5	65.9	58.4	98.9	94.4	95.8	1.1	5.6	4.2
Frost Patterns	25.1	36.8	32.3	97.9	90.0	92.4	2.1	10.0	7.6
Hailstorm Events	73.8	69.6	71.2	31.2	23.1	26.3	68.8	76.9	73.7
Windstorm Events	79.7	83.3	81.9	4.7	2.0	3.0	95.3	98.0	97.0

Annex 2: Standardized baseline indicators for climate change vulnerability at Chiwog level

		Index Values				Standardized Index
Gewog	**Chiwog**	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**Vulnerability**	**Vulnerability**
Tsamang	Thuenmong_Tokari	11.00	22.00	6.00	236.00	1.00
Phobji	Khyimdro_Nemphel	11.00	18.00	7.00	191.00	0.81
Trong	Dhangkhar_Trong	10.00	19.00	13.00	177.00	0.75
Dangchhu	Uesagang	9.00	20.00	9.00	171.00	0.72
Toepisa	Goenmkha_Mendrelgang	11.00	16.00	9.00	167.00	0.71
Chhume	Domkhar	10.00	17.00	9.00	161.00	0.68
Korphu	Korphu Maed	9.00	19.00	12.00	159.00	0.67
Chhume	Zung-Ngae	9.00	18.00	9.00	153.00	0.65
Nangkor	Nyakhar	7.00	22.00	11.00	143.00	0.61
Toepisa	Dochola_Maenchhuna	9.00	16.00	5.00	139.00	0.59
Trong	Gongphu	10.00	15.00	12.00	138.00	0.58
Nangkor	Buli	8.00	19.00	16.00	136.00	0.58
Saleng	Thridangbi	10.00	14.00	9.00	131.00	0.56
Dangchhu	Tokaling_Tomla	11.00	12.00	6.00	126.00	0.53
Jigmechoeling	Samkhar	9.00	15.00	10.00	125.00	0.53
Phobji	Damchhoe_Gangphel	11.00	12.00	7.00	125.00	0.53
Sangbay	Mochhu	8.00	17.00	12.00	124.00	0.53
Tsamang	Drangmaling_Nangkor	10.00	13.00	6.00	124.00	0.53
Jaray	Ladrong	7.00	19.00	12.00	121.00	0.51
Ura	Shingkhar	8.00	16.00	11.00	117.00	0.50
Sangbay	Sangbay Ama	8.00	16.00	12.00	116.00	0.49
Metsho	Ung-gar	9.00	14.00	10.00	116.00	0.49
Korphu	Nyimzhong Toed	8.00	15.00	6.00	114.00	0.48
Tsento	Nyechhu_Shar-ri	10.00	12.00	7.00	113.00	0.48
Bji	Yangthang	7.00	18.00	14.00	112.00	0.47
Saleng	Saling	8.00	14.00	9.00	103.00	0.44
Athang	Lawa_Lamga	6.00	17.00	5.00	97.00	0.41
Athang	Rookha	8.00	13.00	7.00	97.00	0.41
Bji	Chenpa_Geychhukha	6.00	17.00	13.00	89.00	0.38
Ura	Shing-Nyer	6.00	17.00	13.00	89.00	0.38
Jaray	Nangngey	5.00	18.00	11.00	79.00	0.33
Metsho	Gorsum	6.00	14.00	11.00	73.00	0.31
Jigmechoeling	Gongtsekha	5.00	16.00	9.00	71.00	0.30
Tangsibji	Chendenbji	6.00	13.00	9.00	69.00	0.29
Tangsibji	Tangsibji	6.00	13.00	13.00	65.00	0.28
Tsento	Nyamjey_Phangdo	5.00	4.00	8.00	12.00	0.05

Annex 3: Baseline indicators for climate change Exposure index at Chiwog level

Gewog	Chiwog	Indicator scores						
		Summer Temp	Winter Tem	Rainfall	Hailstorm	Windstorm	Flood	Exposure index
Toepisa	Goenmkha_Mendrelgang	2.00	2.00	2.00	2.00	2.00	1.00	11.00
Dangchhu	Tokaling_Tomla	2.00	2.00	2.00	2.00	2.00	1.00	11.00
Phobji	Damchhoe_Gangphel	2.00	2.00	2.00	2.00	2.00	1.00	11.00
Phobji	Khyimdro_Nemphel	2.00	2.00	2.00	2.00	2.00	1.00	11.00
Tsamang	Thuenmong_Tokari	2.00	2.00	2.00	2.00	2.00	1.00	11.00
Tsento	Nyechhu_Shar-ri	2.00	2.00	2.00	2.00	2.00	0.00	10.00
Trong	Dhangkhar_Trong	2.00	1.00	1.00	2.00	2.00	2.00	10.00
Trong	Gongphu	2.00	2.00	1.00	2.00	2.00	1.00	10.00
Chhume	Domkhar	2.00	1.00	2.00	2.00	2.00	1.00	10.00
Saleng	Thridangbi	2.00	2.00	2.00	0.00	2.00	2.00	10.00
Tsamang	Drangmaling_Nangkor	2.00	1.00	2.00	2.00	2.00	1.00	10.00
Toepisa	Dochola_Maenchhuna	2.00	2.00	0.00	2.00	2.00	1.00	9.00
Jigmechoeling	Samkhar	2.00	1.00	2.00	2.00	1.00	1.00	9.00
Korphu	Korphu Maed	2.00	1.00	0.00	2.00	2.00	2.00	9.00
Dangchhu	Uesagang	2.00	2.00	0.00	2.00	2.00	1.00	9.00
Chhume	Zung-Ngae	2.00	2.00	0.00	2.00	2.00	1.00	9.00
Metsho	Ung-gar	2.00	2.00	1.00	2.00	0.00	2.00	9.00
Sangbay	Mochhu	2.00	1.00	2.00	0.00	2.00	1.00	8.00
Sangbay	Sangbay Ama	2.00	0.00	2.00	1.00	2.00	1.00	8.00
Korphu	Nyimzhong Toed	2.00	1.00	1.00	1.00	2.00	1.00	8.00
Athang	Rookha	2.00	1.00	1.00	1.00	2.00	1.00	8.00
Ura	Shing-Nyer	2.00	2.00	0.00	2.00	2.00	0.00	8.00
Saleng	Saling	2.00	1.00	2.00	0.00	2.00	1.00	8.00
Nangkor	Buli	2.00	0.00	1.00	2.00	2.00	1.00	8.00
Bji	Yangthang	2.00	0.00	1.00	1.00	2.00	1.00	7.00
Jaray	Ladrong	2.00	2.00	0.00	1.00	0.00	2.00	7.00
Nangkor	Nyakhar	2.00	1.00		0.00	2.00	2.00	7.00
Bji	Chenpa_Geychhukha	0.00	2.00	2.00	0.00	2.00	0.00	6.00
Tangsibji	Chendenbji	2.00	1.00	0.00	1.00	0.00	2.00	6.00
Tangsibji	Tangsibji	0.00	1.00	2.00	2.00	0.00	1.00	6.00
Athang	Lawa_Lamga	2.00	2.00	1.00	0.00	0.00	1.00	6.00
Ura	Shingkhar	2.00	1.00	2.00	0.00	0.00	1.00	6.00
Metsho	Gorsum	2.00	1.00	1.00	0.00	1.00	1.00	6.00
Tsento	Nyamjey_Phangdo	2.00	1.00	1.00	0.00	0.00	1.00	5.00
Jigmechoeling	Gongtsekha	2.00	0.00	1.00	1.00	0.00	1.00	5.00
Jaray	Nangngey	2.00	1.00	1.00	0.00	0.00	1.00	5.00

Annex 4: Baseline indicators for climate change Sensitivity index at Chiwog level

Gewog	Chiwog	Indicator Score							
		Landslides & soil erosion	Forest	Soil	Drinking water	Irrigation water	Health	Impacts on assets	Sensitivity Index
Tsamang	Thuenmong_Tokari	2	8	1	2	2	6	1	22
Nangkor	Nyakhar	2	8	1	2	2	5	2	22
Dangchhu	Uesagang	0	8	2	2	1	6	1	20
Korphu	Korphu Maed	0	8	2	2	2	3	2	19
Trong	Dhangkhar_Trong	2	7	2	2	2	2	2	19
Jaray	Ladrong	1	8	2	2	2	2	2	19
Nangkor	Buli	2	5	2	2	2	5	1	19
Bji	Yangthang	1	7	2	2	1	4	1	18
Phobji	Khyimdro_Nemphel	2	5	2	1	1	6	1	18
Chhume	Zung-Ngae	2	7	2	2	1	3	1	18
Jaray	Nangngey	0	6	1	2	2	6	1	18
Bji	Chenpa_Geychhukha	0	8	2	1	1	4	1	17
Sangbay	Mochhu	1	7	0	2	2	5	0	17
Athang	Lawa_Lamga	1	7	1	1	1	5	1	17
Chhume	Domkhar	0	8	2	0	1	4	2	17
Ura	Shingkhar	1	8	1	1	1	4	1	17
Sangbay	Sangbay Ama	0	8	0	2	2	3	1	16
Toepisa	Dochola_Maenchhuna	0	7	2	0	0	6	1	16
Toepisa	Goenmkha_Mendrelgang	1	7	2	1	1	4	0	16
Jigmechoeling	Gongtsekha	2	6	2	1	2	3	0	16
Ura	Shing-Nyer	2	8	2	1	1	1	1	16
Jigmechoeling	Samkhar	1	5	1	2	2	3	1	15
Korphu	Nyimzhong Toed	0	8	1	1	2	1	2	15
Trong	Gongphu	1	6	2	2	2	1	1	15
Metsho	Gorsum	0	6	2	1	1	3	1	14
Metsho	Ung-gar	0	6	2	1	1	3	1	14
Saleng	Saling	0	6	2	1	1	3	1	14
Saleng	Thridangbi	2	6	2	0	1	1	2	14
Tangsibji	Chendenbji	1	6	1	0	1	3	1	13
Tangsibji	Tangsibji	0	6	2	1	1	2	1	13
Athang	Rookha	0	5	2	2	2	1	1	13
Tsamang	Drangmaling_Nangkor	0	8	1	0	2	1	1	13
Tsento	Nyechhu_Shar-ri	1	3	2	2	2	2	0	12
Dangchhu	Tokaling_Tomla	0	6	2	0	0	3	1	12
Phobji	Damchhoe_Gangphel	0	6	2	1	1	1	1	12
Tsento	Nyamjey_Phangdo	0	1	1	1	1	0	0	4

Annex 5: Baseline indicators for climate change Adaptive Capacity index at Chiwog level

Gewog	Chiwog	Adaptive Capacity Indicator score									
		Info-sources	Food security	Crop diversity	Livestock diversity	Practices	Access to services	Agencies providing assistance	Water related social conflicts	Farmers groups or institutions	Index
Nangkor	Buli	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	2.0	16.0
Bji	Yangthang	1.0	2.0	1.0	2.0	2.0	2.0	2.0	0.0	2.0	14.0
Bji	Chenpa_Geychhukha	1.0	2.0	1.0	2.0	2.0	1.0	2.0	1.0	1.0	13.0
Tangsibji	Tangsibji	2.0	2.0	2.0	0.0	2.0	2.0	0.0	1.0	2.0	13.0
Trong	Dhangkhar_Trong	2.0	0.0	2.0	2.0	2.0	2.0	0.0	1.0	2.0	13.0
Ura	Shingkhar	2.0	2.0	2.0	0.0	2.0	1.0	0.0	2.0	2.0	13.0
Sangbay	Mochhu	2.0	2.0	1.0	2.0	1.0	0.0	2.0	1.0	1.0	12.0
Sangbay	Sangbay Ama	2.0	2.0	1.0	1.0	2.0	2.0	2.0	0.0	0.0	12.0
Korphu	Korphu Maed	2.0	2.0	1.0	1.0	1.0	2.0	2.0	0.0	1.0	12.0
Trong	Gongphu	2.0	1.0	2.0	2.0	1.0	2.0	0.0	1.0	1.0	12.0
Jaray	Ladrong	2.0	2.0	1.0	1.0	2.0	1.0	1.0	1.0	1.0	12.0
Ura	Shing-Nyer	2.0	2.0	0.0	1.0	2.0	2.0	0.0	1.0	1.0	11.0
Jaray	Nangngey	2.0	2.0	0.0	0.0	2.0	2.0	0.0	2.0	1.0	11.0
Metsho	Gorsum	1.0	2.0	0.0	1.0	2.0	1.0	2.0	1.0	1.0	11.0
Nangkor	Nyakhar	1.0	1.0	0.0	2.0	2.0	2.0	2.0	0.0	1.0	11.0
Jigmechoeling	Samkhar	2.0	1.0	1.0	1.0	1.0	2.0	0.0	0.0	2.0	10.0
Metsho	Ung-gar	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0
Toepisa	Goenmkha_Mendrelgang	1.0	2.0	0.0	0.0	2.0	1.0	0.0	1.0	2.0	9.0
Jigmechoeling	Gongtsekha	1.0	1.0	1.0	1.0	2.0	1.0	0.0	1.0	1.0	9.0
Tangsibji	Chendenbji	1.0	2.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	9.0
Dangchhu	Uesagang	1.0	2.0	0.0	1.0	1.0	1.0	0.0	2.0	1.0	9.0
Chhume	Domkhar	2.0	0.0	1.0	2.0	0.0	2.0	0.0	1.0	1.0	9.0
Chhume	Zung-Ngae	2.0	0.0	2.0	2.0	0.0	2.0	1.0	0.0	0.0	9.0
Saleng	Saling	2.0	2.0	1.0	1.0	0.0	1.0	0.0	1.0	1.0	9.0
Saleng	Thridangbi	2.0	2.0	0.0	0.0	1.0	1.0	1.0	0.0	2.0	9.0
Tsento	Nyamjey_Phangdo	0.0	2.0	0.0	0.0	2.0	1.0	0.0	1.0	2.0	8.0
Tsento	Nyechhu_Shar-ri	0.0	2.0	0.0	0.0	1.0	2.0	0.0	0.0	2.0	7.0
Athang	Rookha	1.0	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	7.0
Phobji	Damchhoe_Gangphel	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	7.0
Phobji	Khyimdro_Nemphel	0.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	2.0	7.0
Korphu	Nyimzhong Toed	2.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	6.0
Dangchhu	Tokaling_Tomla	1.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	6.0
Tsamang	Drangmaling_Nangkor	1.0	2.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	6.0
Tsamang	Thuenmong_Tokari	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	6.0
Toepisa	Dochola_Maenchhuna	0.0	2.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	5.0
Athang	Lawa_Lamga	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	5.0

(Info = Source of climate information; FS = Food Security; CD = Crop Diversity; DL = Livestock Diversity; Prt = Adaptive Practices; Ser = Services; Water Conf = Water related social conflicts; Asst = Assistance form agencies during climate/disaster events; Income = Annual cash income; Imdex = Adaptive Capacity Index)

Annex 6: List of people consulted during the field survey and consultations

A. Chiwog level

Landscape	Dzongkhag	Gewog	Chiwog	Participants	
				Men	Women
Landscape 1 (JKSNR+BC1)	Ha	Bji	Chenpa_Geychhukha	4	10
			Yangthang	5	9
		Sangbay	Mochhu	7	7
			Sangbay Ama	6	8
	Paro	Tsento	Nyamjey_Phangdo	4	6
			Nyechhu_Shar-ri	7	4
Landscape 2 (JSWNP+BC2+BC8)	Punakha	Toepisa	Dochola_Maenchhuna	5	5
			Goenmkha_Mendrelgang	4	6
	Sarpang	Jigmechoeling	Gongtsekha	8	7
			Samkhar	5	4
	Trongsa	Korphu	Korphu Maed	6	1
			Nyimzhong Toed	4	6
		Tangsibji	Chendenbji	4	3
			Tangsibji	5	0
	Wangdue	Athang	Lawa_Lamga	4	9
			Rookha	14	9
		Dangchhu	Tokaling_Tomla	5	5
			Uesagang	3	7
		Phobji	Damchhoe_Gangphel	2	9
			Khyimdro_Nemphel	22	63
	Zhemgang	Trong	Dhangkhar_Trong	6	9
			Gongphu	0	7
Landscape 3 (PNP+BC4)	Bumthang	Chhume	Domkhar	6	6
			Zung-Ngae	1	11
		Ura	Shingkhar	1	10
			Shing-Nyer	9	19
	Lhuentse	Jaray	Ladrong	2	6
			Nangngey	5	3
		Metsho	Gorsum	7	5
			Ung-gar	5	6
	Monger	Saleng	Saling	3	6
			Thridangbi	3	7
		Tsamang	Drangmaling_Nangkor	5	5
			Thuenmong_Tokari	5	4
	Zhemgang	Nangkor	Buli	3	9
			Nyakhar	2	8

B. Gewog level

Landscape	Dzongkhag	Gewog	Gup /Mangmi /GAO	Livestock Sector	Agriculture Sector	Forestry Sector
Landscape 1 (JKSNR+BC1)	Haa	Bji	√	√	√	√
		Sombay	√	√	√	√
	Paro	Tsento	√	√	X	√
Landscape 2 (JSWNP+BC2 +BC8)	Punakha	Toepisa	√	X	X	X
	Sarpang	Jigmichhoeling	√	√	√	√
	Trongsa	Korphu	√	√	√	√
		Tangsibji	√	√	√	√
	Wangdue	Athang	√	X	X	X
		Dangchhu	√	X	X	X
		Phobji	√	√	X	X
	Zhemgang	Trong	√	√	√	√
Landscape 3 (PNP+BC4)	Bumthang	Chhume	√	√	√	√
		Ura	√	√	√	√
	Lhuentse	Jaray	√	√	√	√
		Metsho	√	√	√	√
	Monggar	Saleng	√	√	√	√
		Tsamang	X	X	√	X
	Zhemgang	Nangkor	√	√	√	√

X = Not available at the center during the time of visit

C. Other Institutions/Individuals

Names	Agency
Mr. Phub Sangey, Survey & Data Processing Division	National Statistics Bureau (NSB)
Ms. Deki Wangmo, GIS Officer	World Wildlife Fund (WWF)
Ms. Sonam Wangmo, ICT Officer	Election Commission of Bhutan (ECB)
Dr. Tshering Tempa	Ugyen Wangchuck Institute for Conservation and Environment (UWICE)
Mr. Tobgay Sonam, Consultant	Jordhen Advisors

Annex 7: List of selected Chiwogs by Dzongkhags and Gewogs

Landscape	Dzongkhags	Gewog	Chiwog
Landscape3 (PNP_BC4)	Bumthang	Chhume	Zung-Ngae
Landscape3 (PNP_BC4)	Bumthang	Chhume	Domkhar
Landscape3 (PNP_BC4)	Bumthang	Ura	Shing-Nyer
Landscape3 (PNP_BC4)	Bumthang	Ura	Shingkhar
Landscape1 (JKSNR_BC1)	Ha	Bji	Chenpa_Geychhukha
Landscape1 (JKSNR_BC1)	Ha	Bji	Yangthang
Landscape1 (JKSNR_BC1)	Ha	Sangbay	Mochhu
Landscape1 (JKSNR_BC1)	Ha	Sangbay	Sangbay Ama
Landscape3 (PNP_BC4)	Lhuentse	Jaray	Yabi_Zangkhar
Landscape3 (PNP_BC4)	Lhuentse	Jaray	Ladrong
Landscape3 (PNP_BC4)	Lhuentse	Metsho	Zhongmaed
Landscape3 (PNP_BC4)	Lhuentse	Metsho	Oong-gar
Landscape3 (PNP_BC4)	Monggar	Saleng	Seng-Gor
Landscape3 (PNP_BC4)	Monggar	Saleng	Thridangbi
Landscape3 (PNP_BC4)	Monggar	Tsamang	Ganglapong Toed
Landscape3 (PNP_BC4)	Monggar	Tsamang	Baanjar
Landscape1 (JKSNR_BC1)	Paro	Tsento	Nyamjey_Phangdo
Landscape1 (JKSNR_BC1)	Paro	Tsento	Nyechhu_Shar-ri
Landscape2 (JSWNP_BC2+BC8)	Punakha	Toepisa	Goenmkha_Mendrelgang
Landscape2 (JSWNP_BC2+BC8)	Punakha	Toepisa	Dochola_Maenchhuna
Landscape2 (JSWNP_BC2+BC8)	Sarpang	Jigmechoeling	Gongtsekha
Landscape2 (JSWNP_BC2+BC8)	Sarpang	Jigmechoeling	Samkhar
Landscape2 (JSWNP_BC2+BC8)	Trongsa	Korphu	Korphu Maed
Landscape2 (JSWNP_BC2+BC8)	Trongsa	Korphu	Nyimzhong Toed
Landscape2 (JSWNP_BC2+BC8)	Trongsa	Tangsibji	Chendenbji
Landscape2 (JSWNP_BC2+BC8)	Trongsa	Tangsibji	Tangsibji
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Athang	Lomtshokha
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Athang	Rookha
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Dangchhu	Uesagang
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Dangchhu	Tokaling_Tomla
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Phobji	Khyimdro_Nemphel
Landscape2 (JSWNP_BC2+BC8)	Wangdue	Phobji	Damchhoe_Gangphel
Landscape3 (PNP_BC4)	Zhemgang	Nangkor	Buli
Landscape3 (PNP_BC4)	Zhemgang	Nangkor	Nyakhar
Landscape2 (JSWNP_BC2+BC8)	Zhemgang	Trong	Gongphu
Landscape2 (JSWNP_BC2+BC8)	Zhemgang	Trong	Dhangkhar_Trong

Annex 8: Information gathered from the Gewog Center

Date:_____Dzongkhags: _____Gewog :_____

1- Livestock program related to climate change

Parameters	(√)=Yes/(X)=No	Quantity
Initiate stall feeding (Nos. HHs)		
Biogas (Nos.)		
New fodder tree varieties (Nos. varieties)		
Technologies to cope up with shortages during lean season (silage, hay, etc) (Nos. HHs)		
Improved pasture development (acres)		
Winter fodder production (acres)		
Adopting zero grazing practices (Nos. HHs)		
Species conservation:		
• Conservation Nublang		
• Improved breed cattle		
• Local pigs		
• Improved pigs		
• Fishery		
• Local poultry		
Community capacity development on climate change and adaptability in past 1 year (Nos. training in last 1 year)		
Livestock Farmers Groups (Nos. groups)		
Farmers training on livestock health care and treatment in past 1 year (Nos. training in last 1 year)		

2. Agriculture program related to climate change

Parameters	(√)=Yes/(X)=No	Quantity
Introduction of new crops varieties that are climate resilient (specify crops)		
•		
•		
•		
Irrigated land (acres)		
Rain-fed land (acres)		
Introduction of efficient irrigation systems		
• Drip irrigation (Nos.HHs)		
• Sprinkler (Nos.HHs)		
•		
Farmers training on improved farming technologies and crop diversity in past 1 year (Nos. trainings)		
Greenhouses and poly-tunnels (Nos. HHs)		

Sustainable land management technology		
• Land terracing		
• Stone bunds/stone check dams		
• Plantation of tress on field periphery		
• Hedgerow plantation with fodder trees		
• Land management campaign in past 1 year		
Compost making (Nos. HHs)		
Organic farming (Nos. HHs)		
Demonstration on organic farming in past 1 year (Nos. demo)		
Improved post- harvest technologies		
• Silo (Nos)		
• Cold store (Nos)		
•		
Total irrigation channels (KM)		
Climate proofing irrigation channels (KM)		
Total farm road (KM)		
Climate proofing farm roads (KM)		
Agriculture Farmers Groups (Nos. Groups)		
Community seed banks (Nos)		
Indigenous crops species conservation (specify crops):		
•		
•		
•		
•		
Water management		
• Rain water harvesting for drinking and sanitation		
• Rain water harvesting for irrigation		
• Training of Water User Groups in past 1 year (Nos. trainings)		
• Other1 (specify)		
• Other2 (specify)		
• Other3 (specify)		

3. Forestry programs related to climate change (Tick=Yes and Blank=No)

Initiatives of electric fencing (acres fenced)	(√)=Yes/(X)=No	Quantity
Farmers training on HWC technologies in past 1 year (Nos. trainings)		
Water Source protection and rehabilitation (Nos. schemes)		
Climate resilient enrichment planting (acres)		
Training of NWFP Groups in past 1 year (Nos. trainings)		
Silvi-culture training of Community Forestry Groups in past 1 year (Nos.trainings)		

Forest fire management training		
Species conservation:		
Tsendenshing (Cyprus) plantation		
Other1 (specify)		
Other2 (specify)		
Other3 (specify)		

4. Medium of communication and awareness on climate change

Parameters	(√)=Yes/(X)=No
Television	
Radio	
Quiz competitions	
Meetings	
Farmers trainings	
Farmers field trips	

5. Institutional and policy

5.1: Institutions

Parameters	Existence (√)=Yes/(X)=No
Gewog level committees	
• Environment conservation committee	
• Mainstreaming Reference Group	
• Gewog Disaster Management Committee	
•	

5.2: Plans and Policies

List three priority issues related to climate change

Issues related to climate change on Community Forestry
1)
2)
3)
Issues related to climate change on Water management
1)
2)
3)
Issues related to climate change on NWFP management
1)
2)
3)
Issues related to climate change on Farm road management

1)
2)
3)
Issues related to climate change on Human-wildlife conflict management
1)
2)
3)
Issues related to climate change on Land management
1)
2)
3)
Issues related to climate change on Access to market
1)
2)
3)
Issues related to climate change on Access to inputs
1)
2)
3)
Issues related to climate change on Access to services
1)
2)
3)

Annex 9: Information related to baseline aligned with GEF tracking tools

Project identification

Project title: ***Project on Enhancing Sustainability and Climate Resilience of Forest and Agricultural Landscape and Community Livelihoods in Bhutan***
Country(ies): ***Bhutan***
GEF Agency(ies): ***LDCF/GEF/UNDP***
Executing Partner(s):
Project status at submission:

GEF project ID:
Agency project ID:
Council/ CEO Approval date:
Tool submission date:

Project Baselines					
Indicator	**Unit of measurement**	**Baseline at CEO Endorsement**			
Objective 1: Reduce the vulnerability of people, livelihoods, physical assets and natural systems to the adverse effects of climate					
Indicator 1: Number of direct beneficiaries	**Number of people *(total population in the targeted landscape)***	**88,783**			
	% Female *(female in the targeted landscape)*	**48**			
	Vulnerability assessment (Yes/No)	Yes			
Outcome 1.1: Vulnerability of physical assets and natural systems					
Indicator 2: Type and extent of assets strengthened and/or better managed to withstand the effects of climate change	***Data items***	**Quantity**		***Nos. reporting Gewogs***	***Remarks***
	Total farm road (km)	284		10	*Source: CCVA survey (April/May 2016) - Gewog officials consultation*
	Total irrigation channels (km)	153		12	
	Irrigated land (acres)	1,855		10	
	Rainfed land (acres)	6,503		8	
	Cold storage (nos)	17		3	
	Silo (nos)	10		3	
	Improved pasture development (acres)	1,651		13	
	Water source protection and rehabilitation (nos)	20		11	
	Electric fencing (km)	76		14	
	Biogas plant (nos)	125		7	
	Winter fodder production (acres)	594		10	

Outcome 1.2: Livelihoods and sources of income of vulnerable populations diversified and strengthened					
	Data items	**Quantity**		***Nos. reporting Chiwogs***	***Remarks***
Indicator 3: Sources of cash income and climate-resilient livelihood options	**Number of people** ***(total population in the targeted landscape)***	**88,783**			
	% Female ***(female in the targeted landscape)***	**48**			
	% of targeted population				
	Household's annual average cash income of 18 gewogs (Nu)	46,164			*The annual income is the average of 3 years (2011-2013). The data was sourced in from Bhutan RNR statistics publication*
	- Income from sale of cereal grains (Nu)	1,844			
	- Income from sale of horticulture crops (Nu)	11,912			
	- Income from sale of livestock products (Nu)	22,981			
	- Income from sale of non-wood forest products (Nu)	9,223			
	- Income from off-farm activities (Nu)	9,702			
	Nos. of livestock farmers groups (at community level)	28		15	*Source: CCVA survey (April/May 2016) - Community meetings in the Chiwogs*
	Nos. of agriculture Groups (at community level)	14		10	
	Nos. forestry management groups (at community level)	31		25	
	Nos. of cross-sector groups (at community level)	11		9	
	Nos. of land management groups (at community level)	7		7	
	Nos. of road user groups (at community level)	7		6	
	Nos. water user groups (at community level)	20		10	
	Data items	**Quantity**		***Nos. reporting Gewogs***	***Remarks***
	Nos. of environment conservation committee (at gewog level)	4		4	*Source: CCVA survey (April/May 2016) - Gewog officials consultation*
	Nos. disaster management committee (at gewog level)	11		11	
	Nos. of land exchange committee (at gewog level)	2		2	
Outcome 1.3: Climate-resilient technologies and practices adopted and scaled up					
	Data items	**Quantity**	***Proportion out of total households in survey gewogs***	***Nos. reporting Gewogs***	***Remarks***
Indicator 4: Extent of adoption of climate-resilient technologies/ practices	Climate resilient enrichment plantation (acres)	44		5	*Source: CCVA survey (April/May 2016) - Gewog officials consultation*
	Climate proofing farm roads (km)	63		3	
	Climate proofing irrigation channels (km)	71		2	
	Community with zero grazing practices (hhs)	336	3.27	8	
	Community practicing stall feeding (hhs)	898	8.74	10	
	Community practicing drip irrigation (hhs)	11	0.11	3	
	Community practicing sprinkler irrigation (hhs)	84	0.82	3	

	Community making compost (hhs)	909	8.85	9	
	Community practicing organic farming (hhs)	1,327	12.92	10	
	Community practicing having greenhouses poly tunnels (hhs)	352	3.43	9	
	Fodder conservation to cope with livestock feed shortage in winter (hhs)	1,185	11.53	11	
	Data items	**Quantity**		***Nos. reporting Chiwogs)***	***Remarks***
	Changed crop variety (count of chiwogs out of 36)			15	*Source: CCVA survey (April/May 2016) - Community meetings in the Chiwogs*
	Used more chemical fertilizers (count of chiwogs out of 36)			4	
	Used more FYM (count of chiwogs out of 36)			28	
	Used more PPC (count of chiwogs out of 36)			16	
	Left land fallow (count of chiwogs out of 36)			18	
	Given up farming (count of chiwogs out of 36)			11	
	Changed from crop to livestock (count of chiwogs out of 36)			7	
	Decreased livestock number (count of chiwogs out of 36)			17	
	Increased livestock number (count of chiwogs out of 36)			9	
	Tree plantation (count of chiwogs out of 36)			21	
	Insured (count of chiwogs out of 36)			11	
	Seek off-farm jobs (count of chiwogs out of 36)			4	
	Data items	**Quantity**		***Nos. reporting Gewogs***	***Remarks***
	Gewogs reporting initiation of tree plantation with fodder trees			5	*Source: CCVA survey (April/May 2016) - Gewog officials consultation*
	Gewogs reporting to have conducted land management campaign			4	
	Gewogs reporting initiation of land terracing			6	
	Gewogs reporting initiation of tree plantation on the field peripheries			3	
	Gewogs reporting initiation of building stone-bunds/stone-check-dams			3	
	Gewogs reporting to have conserving nublang			9	
	Gewogs reporting to have conserving local pigs			4	
	Gewogs reporting to have conserving local poultry birds			10	

Objective 2: Strengthen institutional and technical capacities for effective climate change adaptation					
Outcome 2.1: Increased awareness of climate change impacts, vulnerability and adaptation					
	Data items	**Quantity**		***Nos. reporting Gewogs***	
Indicator 5: Public awareness activities carried out and population reached	Demonstration on organic farming in the past 1 year (nos. demo)	2		4	*Source: CCVA survey (April/May 2016) - Gewog officials consultation*
	Farmers training on improved farming technologies/crop diversity in the past 1 year (nos. trainings)	13		7	
	Water Management-Training of Water User Groups in past 1 year (Nos_trainings)	5		3	
	Farmers training on HWC technologies in the past 1 year (nos. trainings)	7		3	
	Silvi-culture training of Community Forestry Groups in the past 1 year (nos. trainings)	10		8	
	Community capacity development on climate change and adaptability in the past 1 year (nos. trainings)	3		3	
	Farmers training on livestock health care/treatment in the past 1 year (nos. trainings)	11		10	
	Training of NWFP groups (nos. trainings)	12		7	
	Forest fire management training			10	
	Farmers field trips conducted on climate change awareness			3	
	Farmers trainings conducted on climate change awareness			9	
Outcome 2.2: Access to improved climate information and early-warning systems enhanced at regional, national, sub-national and local levels					
Indicator 6: Risk and vulnerability assessments, and other relevant scientific and technical assessments carried out and updated	Local level Climate Change Vulnerability Assessment and Adaptation Planning Survey (April/May 2016)				
Indicator 7: Number of people/ geographical area with access to improved climate information services ***(Sources of CC related information)***	***Data items***	**Quantity**		***Nos. reporting Chiwogs***	***Remarks***
	Friends (count of chiwogs out of 36)			15	*Source: CCVA survey (April/May 2016) - Community meetings in the Chiwogs*
	G2C (count of chiwogs out of 36)			2	
	Gewog office (count of chiwogs out of 36)			8	
	Newspaper (count of chiwogs out of 36)			3	
	Radio (count of chiwogs out of 36)			21	
	Trainings/workshops (count of chiwogs out of 36)			7	
	Televisions (count of chiwogs out of 36)			26	

Indicator 8: Number of people/ geographical area with access to improved, climate-related early-warning information	**number of people**				
	% female				
	% of targeted area (e.g. % of country's total area)				
Outcome 2.3: Institutional and technical capacities and human skills strengthened to identify, prioritize, implement, monitor and evaluate adaptation strategies and measures					
Indicator 9: Number of people trained to identify, prioritize, implement, monitor and evaluate adaptation strategies and measures	**number of people**				
	% female				
Indicator 10: Capacities of regional, national and sub-national institutions to identify, prioritize, implement, monitor and evaluate adaptation strategies and measures	**number of institutions**				
	score				
Objective 3: Integrate climate change adaptation into relevant policies, plans and associated processes					
Outcome 3.1: Institutional arrangements to lead, coordinate and support the integration of climate change adaptation into relevant policies, plans and associated processes established and strengthened					
Indicator 11: Institutional arrangements to lead, coordinate and support the integration of climate change adaptation into relevant policies, plans and associated processes	**number of countries**				
	score				
Outcome 3.2: Policies, plans and associated processes developed and strengthened to identify, prioritize and integrate adaptation strategies and measures					
Indicator 12: Regional, national and sector-wide policies, plans and processes developed and strengthened to identify, prioritize and integrate adaptation strategies and measures	**number of policies/ plans/ processes**				
	score				
Indicator 13: Sub-national plans and processes developed and strengthened to identify, prioritize and integrate adaptation strategies and measures	**number of plans/ processes**				
	score				
Outcome 3.3: Systems and frameworks for the continuous monitoring, reporting and review of adaptation established and strengthened					
Indicator 14: Countries with systems and frameworks for the continuous monitoring, reporting and review of adaptation	**number of countries**				
	score				
Reporting on GEF gender indicators					
Q1: Has a gender analysis been conducted during project preparation					
Q2: Does the project results framework include gender-responsive indicators, and sex-disaggregated data?					
Q3: Of the policies, plans frameworks and processes supported (see indicators 12 and 13 above), how many incorporate gender dimensions (number)					
Q4: At mid-term/ completion, does the mid-term review/ terminal evaluation assess progress and results in terms of gender equality and women's empowerment?					

Annex 10: Semi-structured questionnaire for PRAs and key informants at Chiwog level

Section 1: Demographic Information

1: Respondent information

Dzongkhags		Chiwog	
Gewog		Participants	Male: _____ Female: _____

2: Accessibility to institutions and services

Institutions and services	How long does it take to get from your Chiwog to nearest facility/services?					
	Vehicle			Walk		
	Minutes	Hours	Days	Minutes	Hours	Days
Nearest school						
Nearest hospital/health center						
Bus stop						
Paved road						
Unpaved passable road						
Unpaved impassable road						
Market center						
Bank						
RNR service center						
Post office						
Police station						
G2C center						
Gewog Adm. Office						
Dzongkhags Adm. Office						

3: Food security

Food availability and shortage	Yes		No	
	M	F	M	F
Were you able to meet all food requirements from own production during the last 12 months?				
IF No, How did your households cope with the food shortage?			M	F
• Sale of livestock				
• Sale of jewelry				
• Migrated to another place				
• Received food aid				
• Took loan to purchase food				
• Burrowed				
• Sale of labor				
• Other (specify):				
Food relief (in case of food shortage)	Yes		No	
	M	F	M	F
Did you receive any food relief in the last 5 years?				
IF Yes, which were the sources from where you received food relief?			M	F
• Government				
• NGOs				
• Extended family members				
• Relatives				
• Friends				
Other (specify):				

4: Institutional and policy

4.1: Existence of institutions

Parameters (Institutions)	Existence	IF Yes		
	(√)=Yes/(X)=No	Numbers	Executive post	
			M	F
Water user association				
Road user groups				
Land management groups				
Community forestry management groups				
NWFPs groups				
Livestock groups				
Agriculture groups				
Cross-sector farmers group				
Other1 (specify)				
Other2 (specify)				
Other3 (specify)				

4.2: Policy related issues

List three priority issues related to climate change

Parameters	Nos. of responds		Parameters	Nos. of responds	
	M	F		M	F
Community forestry management			Water management		
1)			1)		
2)			2)		
3)			3)		
NWFP management			Roads / farm road management		
1)			1)		
2)			2)		
3)			3)		
Human-wildlife conflicts management			Land management		
1)			1)		
2)			2)		
3)			3)		
Access to market			Access to inputs		
1)			1)		
2)			2)		

3)			3)		
Access to services			Other (specify)		
1)			1)		
2)			2)		
3)			3)		

5: Observation on changes and trends in <u>climatic factors</u> during the last 5 years

Climatic factors	Observed changes in the weather				Trend of the effects?							
	Yes		No		Increased		Decreased		Same		Can't say	
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
Temperature in summer												
Temperature in winter												
Rain fall												
Snow fall												
Frost												
Hailstorm												
Windstorm												

6: Occurrence of climate related <u>events</u> during the last 5 years and their impacts

Events	Have you observed this event?	Received warning before this event happened?	Monasteries	Irrigation channel	Houses	Farm road	Schools	Water catchment	Bridges	Electricity	Mobile network	Drinking water scheme	Agri. land	Livestock
	Yes = 1 No = 2	*Yes = 1 No = 2*	*Nos.*	*Nos.*	*Nos.*	*Km*	*Nos.*	*Nos.*	*Nos.*	*Nos.*	*Nos.*	*Nos.*	*Acre*	*Nos.*
Drought														
Flood														
Land slide														
Soil erosion														
Hailstorm														
Forest fire														
Earthquake														

7: Impacts of climate related events on <u>water</u> and social aspects during the last 5 years

Impacts	Has effects been observed as a result of the above events?	Trend of the effects?

	Yes		No		Increased		Decreased		Same		Can't say	
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
Availability of water for irrigation												
Availability of water for drinking												
Availability of soil moisture												
Water related social conflicts												

8: Impacts of climate related events on <u>agriculture</u> during the last 5 years

Impacts	Has effects been observed as a result of the above events?	Trend of the effects?
	1=Yes, 2=No	1=Decreased, 2=Increased, 3=Can't say
Soil fertility		
Crop diversity		
Crop productivity		
Crop damage by wildlife		
Pests/diseases on crops		
Weeds/Invasive plants		
Cases of landslide		
Cases of soil erosion		
Land holding size		
Sufficiency of food		
Change in cropping seasons		
Sowing season late by ***(nos. of weeks)***		
Sowing season earlier by ***(nos. of weeks)***		
Harvesting season late by ***(nos. of weeks)***		
Harvesting season earlier by ***(nos. of weeks)***		

9: Impacts of climate related events on <u>livestock</u> during the last 5 years

Impacts	Has effects been observed as a result of the above events?	Trend of the effects?
	1=Yes, 2=No	1=Decreased, 2=Increased, 3=Can't say
Livestock holdings		
Livestock productivity		
Livestock diversity		
Livestock health status		
Fodder availability		
Livestock attack by wildlife		
Livestock diseases		

10: Impacts of climate related on <u>forests</u> during the last 5 years

Impacts	Has effects been observed as a result of the above events?	Trend of the effects?
	1=Yes, 2=No	1=Decreased, 2=Increased, 3=Can't say
Availability of timber/firewood		
Availability of non-wood forest products		
Incidents of forest fire		
Wildlife migration		
Wildlife diversity		
Plant diversity		
Availability of streams/lakes		

11: Impacts of climate related events on <u>human health</u> during the last 5 years

Impacts	Has disease affected your Chiwog in the last 12 months?	Trend of the effects?
	1=Yes, 2=No	1=Decreased, 2=Increased, 3=Can't say
Malaria (ཚང་བའི་ནད།)		
Typhoid (ཚཱ་མཐུ་ནད།)		
Cholera (བཅའ་སྐྱག་ནད།)		
Fever/common cold (དྲོད་འབབ།)		

12: Accessibility to climate change related information

Did you receive any information related to climate change during the last 12 months? 1=Yes, 2=No: _____			
If YES, from whom or where did you get the information?			
Source of information	(√)=Yes/(X)=No	Source of information	(√)=Yes/(X)=No

Television		Gewog Adm. Office	
Radio		Friends	
Newspaper		Other1 (specify)	
G2C center		Other2 (specify)	

13: Availability of assistance during the times of natural disaster

Did you receive any assistance when your households or members last hit by natural disaster? (I=Yes, 2=No) _____			
If YES, whom or where you received assistance from?			
Source of assistance	(√)=Yes/(X)=No	Source of assistance	(√)=Yes/(X)=No
Government		Friends	
NGOs		Others (Specify):	
Relatives			

14: Compensation received from government on the loss and damage of assets due to natural hazards over the last 5 years.

Assets	(√)=Yes/(X)=No	Assets	(√)=Yes/(X)=No
Livestock (killed by tiger)		Crop destroyed by wildlife and natural calamities	
Houses burnt by fire or destroyed		Other1 (specify)	
Land washed away by landslide/floods		Other2 (specify)	

15: Expenditure incurred in carrying out climate change adaptation activities in last 12 months

Activities	Expenditure range											
	<10000		10000-20000		>20000-30000		>30000-40000		>40000-50000		>50000	
	M	F	M	F	M	F	M	F	M	F	M	F
Plantation												
Land terracing												
Building walls to protect land												
Other (specify):												
Other (specify):												
Other (specify):												

16: Local practices in response to the climate change effects during the last 5 years.

Interventions/Practices	(√)=Yes/(X)=No	**Interventions/Practices**	(√)=Yes/(X)=No
Changed crop variety		Bought insurance	
Irrigated more		Community Insurance	
Irrigated less		Planted shade trees	
Left land fallow		Found off-farm jobs	
Abandoned farming		Given up off-farm activities	

Changed from crop to livestock		Built a water harvesting scheme	
Increased number of livestock		Moved to another place	
Decreased number of livestock		Other (specify):	
Use more FYM on crops		Other (specify):	
Use more chemical fertilizers		Other (specify):	
Use more plant protection chemical		Other (specify):	

17: In your opinion, how would you rate your agreement on the current state of certain statements as compared to the situations 5 years ago? Enter code and number of respondents

Statements	Code	Statements	Code
Summers are: *(1=Hotter, 2=Warmer, 3=Same)*		**Crop failure is a sign of climate change:** *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*	
Winters are : *(1=Colder, 2=Warmer, 3=Same)*		**Cropping seasons are changing:** *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*	
Roads flood: *(1=Less heavily, 2=Heavily, 3=More heavily 4=same)*		**Water sources are being improved by climate change:** *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*	
Farmers need: *(1=Less water, 2=More water, 3=Same)*		**Climate change is making people healthier:** *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*	
Fuel wood shortage:*(1=Lesser, 2=More, 3=Same)*		**Less fresh water available for people to use:** *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*	
Use of cow dung as fuel has adverse effect on health: *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*		**This year rainy season begun:** *(1=early, 2=On time, 3=Late)*	
Women fall ill more frequently due to smoky kitchen *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*		**Amount of rainfall this year is:** *(1=Average, 2=Below average, 3=Above average)*	
Climate change is causing people to suffer more sickness? *(1=Agree, 2=Disagree, 3=Neither agree nor disagree)*			

18: Climate change adaptation/mitigation activities/interventions you would like to propose

Areas of impact	Proposed interventions	
	Male	**Female**
Pests/diseases on crops		
Irrigation water shortage		
Drinking water shortage		
Hailstorm		
Excessive rainfall		
Drought		

Landslide/flood		
Crop diversity		
Livestock diseases		
Human-wildlife conflict		
Access to climate information		
Improve capacity for vulnerability assessment and adaptation		