



# Climate Change Adaptation Plan of the Protected Areas of Bhutan

## 2022-2032



Ugyen Wangchuck Institute for Conservation and Environment Research  
Department of Forests and Park Services

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# **Climate Change Adaptation Plan of the Protected Areas of Bhutan 2022-2032**

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## Forward

Climate change is recognized as the global concern with its impacts felt all across in the atmosphere, oceans, cryosphere and biosphere. Scientific community have unequivocally predicted an increasing trend of temperature rise, irregular precipitation patterns and increasing climatic extreme events in the near future. It is critically important that global community come together to take serious measures to mitigate climate change and support adaptations to cope with increasing impacts of climate change. It is even more critical for the Himalayan region which is experiencing even higher rates of warming, further exacerbated by fragile mountain terrain and reliance on climate sensitive resources.

Bhutan acknowledged the global threats of climate change and pledged to remain carbon neutral at the COP15 in Copenhagen, despite being a least developed country. Bhutan's network of Protected Areas which constitute about 51% of the country's land area plays vital role in upholding national commitment to remain carbon neutral and to conserve 60% of the total area under forest cover which is an important carbon sink. The Protected Areas not only harbor rich diversity of flora and fauna but are also home to rural communities, who plays vital role in country's success of managing and conserving Protected Areas. As evident from studies, rural communities are more vulnerable to climate change due to numerous factors like high dependence climate sensitive agriculture and livestock farming, fragile mountain landscape, financial instability and remoteness.

Therefore, as envisioned in the Climate Change Policy of the Kingdom of Bhutan to build resilience to climate change, the Department of Forest and Park Services have developed an adaptation plan for the Protected Areas of Bhutan. The adaptation plan was developed after thorough community climate vulnerability assessment and adaptation priorities identified in consultation with local stakeholders for each park. The plan has multi-sector and localized adaptation priorities identified for Gewogs and Chiwogs. We must all come together to fight climate change and I urge all concerned stakeholders and agencies for their help in implementing the adaptation priorities. Through the adaptation plan, we aspire to not only conserve environment and biodiversity but also protect the life and livelihoods of the communities.

The Adaptation plan development was possible with fund support of the Bhutan for Life Project. My appreciation to Bhutan for Life Project for supporting the climate change vulnerability assessment, adaptation plan development and implementing pilot climate adaptation measures. My appreciation to the Ugyen Wangchuck Institute for Conservation and Environment Research and concerned Protected Area offices for your effort in coming up with the much needed adaptation plan.

I wish you very best for the successful implementation of the adaptation plan.

Lobzang Dorji, Director, DoFPS

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# 1 Introduction

The global mean temperature has accelerated in the last four decades, and the observed changes in the atmosphere, oceans, cryosphere and biosphere provides the evidence of a warming world (IPCC, 2021). Global surface temperature as a result of anthropogenic activity shows an increase of 0.8 °C to 1.3 °C from 1850 - 1900 to 2010 - 2019. The global mean temperature for the year 2020 was  $1.2 \pm 0.1$  °C above the 1850 - 1900 baseline indicating 2020 as one of the three warmest on record with variation in temperature anomalies across the globe (WMO, 2021). The IPCC Sixth Assessment Report (AR6) summary for policy maker (SPM) predicts earth to be 1.4 - 4.4 °C hotter than pre industrial levels by the end of the century which depends on the rapid and substantial reduction in global greenhouse gas (GHG) emissions.

The climate change impacts on natural and human systems have been observed (IPCC, 2018) and these impacts are bound to no area and regions, and are particularly significant for rural communities of the least developed countries (UN-OHRLLS, 2009), that depend on natural resources for food and other needs.

Bhutan has ~71% forest cover (DoFPS, 2016) and is globally acknowledged for being a net sequester of greenhouse gases (GHG). However, communities of the country are not spared from the negative impacts of climate change owing to its fragile mountainous ecosystem, and dependence of the country's economy on climate-sensitive sectors such as agriculture and hydropower (NEC, 2020a). The topography and the effects of climate variability has highly exposed Bhutan to diversity of hazards such as extreme weather (NCHM, 2019; NEC, 2020a) that includes flash floods, GLOF (Glacial Lake Outburst Flood), landslides, cyclone induced storm, erratic rainfall and drought affecting the lives and livelihoods of the people (NCHM, 2021). This situation is further worsened by the country's low adaptive capacity, poor economic status constrained by financial, technical and human capacity (NEC, 2020a).

Acknowledging the changing climate and its impacts, Bhutan committed to remain carbon neutral for all times and pursue an ecologically sustainable development in line with the development philosophy of Gross National Happiness. Bhutan adopted the Climate Change Policy of the Kingdom of Bhutan (NEC 2020b) which envisages to have “a prosperous, resilient and carbon neutral Bhutan where the pursuit of gross national happiness for the present and future



generation is secure under a changing climate”. Building resilience to climate change is one of the policy objective which highlights the need to periodically assess the vulnerability and adaptation needs across all sectors.

The National Adaptation Plan (NAP) process identified forests and biodiversity as one of the seven vulnerable sectors along with water, agriculture and livestock, human settlements and climate smart cities, health, energy, and climate services and disaster risk reduction sectors. Climate risk assessments were conducted for water, agriculture, forest and biodiversity, energy and health sectors to guide the national adaptation plan and priorities.

Further to secure the future of communities and conservation in the Protected Areas (PAs) networks of Bhutan under changing climate, the Bhutan for life has a project milestone to assess vulnerability of communities of the PAs of Bhutan, develop adaptation plan and support adaptation activities. Community climate change vulnerability assessment was conducted to guide the development of the adaptation plan for respective PAs.

## 2 Summary of Climate Vulnerability of the PAs of Bhutan

The vulnerability assessment was conducted for all 10 National Parks/Sanctuaries/Reserves and 4 of the 8 Biological Corridors with higher human settlements. Community exposure, sensitivity and adaptation capacity to climate change was assessed through social survey. Set of 7 indicators for *E*, 12 for *S* and 19 for *AC* were used to calculate respective index. Vulnerability index(*V*) was calculated using following function;

$$\text{Vulnerability Index (V)} = \text{Adaptive Capacity (AC)} - (\text{Exposure (E)} + \text{Sensitivity (S)})$$

The vulnerability assessment study found that landslides, flash floods, rainfall seasonality, windstorms and temperature extremes are the top contributors to exposure. Phibsoo Wildlife Sanctuary (PWS) was found to have highest exposure (Table 1) with higher percentage of households perceiving the observation of temperature extremes, increased occurrence of landslides, flash flood, seasonal droughts, and windstorms. The Jigme Khesar Strict Nature Reserve (JKSNR) has comparatively lower exposure than other PAs.

**Table 1. Index of Adaptive Capacity (AC), Exposure(E) & Sensitivity (S) of the Protected Areas.**

Protected Area Office	Adaptive Capacity	Exposure	Sensitivity
	Index	Index	Index
Phibsoo Wildlife Sanctuary(PWS)	0.5	0.44	0.33
Jigme Dorji National Park (JDNP)	0.48	0.37	0.17
Bumdeling Wildlife Sanctuary (BWS)	0.47	0.24	0.27
Biological Corridor - 4	0.6	0.32	0.27
Biological Corridor - 3	0.53	0.23	0.25
Jigme Singye Wangchuck National Park (JSWNP)	0.47	0.18	0.22
Jomotshangkha Wildlife Sanctuary (JWS)	0.65	0.25	0.28
Biological Corridor - 7	0.48	0.14	0.21
Wangchuck Centennial National Park WCNP	0.57	0.26	0.17
Phrumshingla National Park (PNP)	0.54	0.19	0.17
Biological Corridor - 8	0.48	0.17	0.12
Jigme Khesar Strict Nature Reserve (JKSNR)	0.51	0.13	0.18
Royal Manas National Park (RMNP)	0.72	0.26	0.23
Sakten Wildlife Sanctuary (SWS)	0.79	0.15	0.09

*Source: Yoezer et al. (2022)*

Issues concerning human-wildlife conflict (HWC), drinking and irrigation water availability, change in forest composition and shortage of pastureland were reported as the main

contributors to sensitivity. Among all the PAs, PWS was found to have highest sensitivity with index score of 0.33, as compared with the least sensitive Sakteng Wildlife Sanctuary (SWS) having score of 0.09 (Table 1).

The adaptive capacity was assessed through measure of 5 asset types, namely; human asset, social asset, natural asset, financial asset and physical asset. The SWS has the highest adaptive capacity (Table 1) with higher contributions from indicators such as productive member, house type, distance to nearest school, distance to nearest health facility, distance to Gewog center and savings.

Overall, PWS was found to be most vulnerable with low vulnerability index of -0.27 and SWS has the highest index of 0.56 (Figure 1). PWS had the lower adaptive capacity coupled with highest exposure and sensitivity. With lowest adaptive capacity, BWS is the second most vulnerable along with JDNP due to lower sensitivity and exposure index. SWS had the highest adaptive capacity and lowest sensitivity and third lowest exposure making it the least vulnerable, followed by RMNP. The detailed vulnerability assessment of the PAs is published as separate document titled “**Community-based Climate Change Vulnerability and Capacity Assessment of the Protected Areas of Bhutan**”.

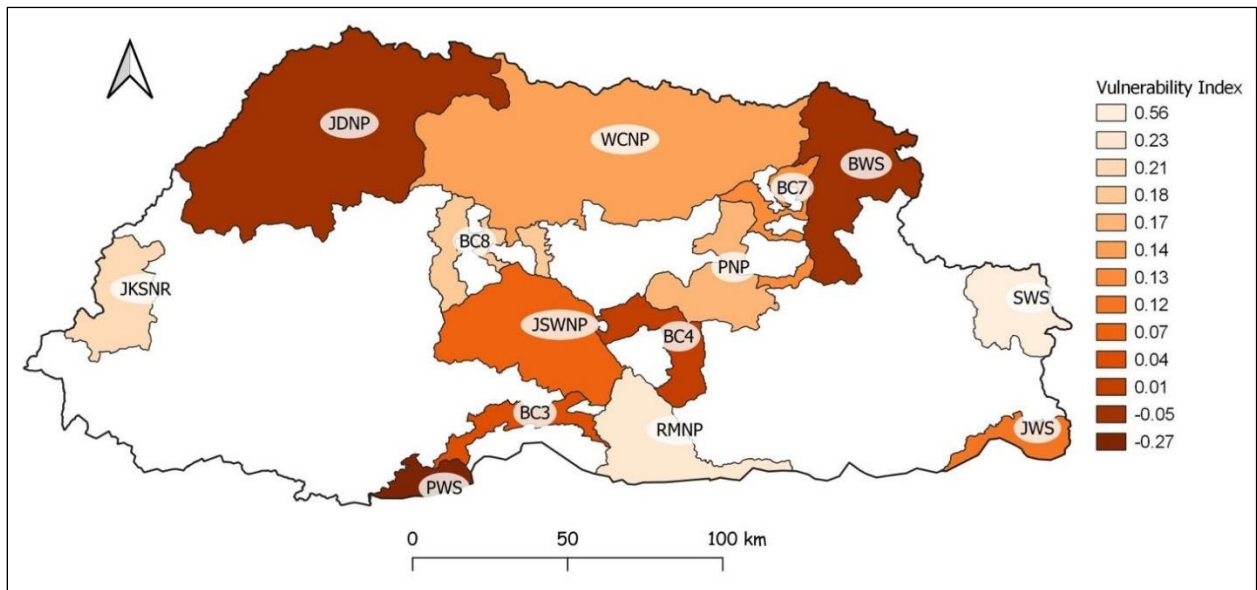


Figure 1. Vulnerability index map of Protected Areas of Bhutan

Source: Yoezer et al. (2022)

### 3 Vision of the Adaptation Plan

The adaptation plan of the PAs of Bhutan draws inspiration from the Climate Change Policy of the Kingdom of Bhutan (2020) which envisions to have “a prosperous, resilient and carbon neutral Bhutan where the pursuit of gross national happiness for the present and future generation is secure under a changing climate”. The PAs of Bhutan constitutes ~51% of the total area of the country which is crucially important in achieving national goal of conserving 60% of Bhutan’s land area under forest cover and in fulfilling national commitment to remain carbon neutral for all times to come. The PAs of Bhutan supports livelihood of ~12,000 rural households who also plays vital role in ensuring the conservation of Protected Areas.

Therefore, through the development of the adaptation plan, we envision to lower climate vulnerability and improve climate resilience of communities living in the PAs of Bhutan and secure their livelihoods through integrated promotion of sustainable climate smart livelihood practices.

## 4 Process of Protected Areas Adaptation Plan Development

The adaption plan is guided by the community climate vulnerability assessment conducted through social survey covering ~15% of the households residing or depending on PAs. The assessment identified and ranked most vulnerable PAs. Primary contributors to climate exposure and sensitivity were listed for each PA to strategize adaptation measures. Similarly, adaptive capacity of the communities was assessed and adaptation activities were prioritized to enhance their resilience. Common coping mechanisms and indigenous practices identified in the study were also considered while developing the adaptation plan. The vulnerability ranking of Gewogs and Chiwogs under respective PAs helped to develop area specific and localized adaptation actions.

The results of the vulnerability assessments were discussed with Gewog and Dzongkhag stakeholders and adaptation plan was prepared in consultation with local government leaders and relevant stakeholder including community groups. Additional resources like the Third National Communication to the UNFCCC (NEC, 2020), adaptation priorities for forests and biodiversity sector identified in the National Adaption Plan (NAP), Bhutan national human-wildlife-conflict management strategy (NCD, 2008), and PA management plan of respective offices were reviewed to prioritize adaptation actions. Consultations with local government stakeholders enable to integrate the adaptation plan with the local government development plans and priorities.

## 5 Plan Integration, Implementation and Fund Sourcing

Acknowledging the multisector impacts and cross-cutting issues of climate change, the Climate Change Policy of the Kingdom of Bhutan calls for integration of adaptation priorities with national and local development plans. Aligning the proposed adaptation priorities in the Five Year Plan (FYP) of the local government offices provides opportunity for securing fund through Royal Government of Bhutan fund allocation and ensure coordinated implementation. Since the adaptation plan is developed in consultation with the sectoral stakeholders and decision-making bodies of the local government, the prioritized adaptation activities are closely tied with local development plans and priorities.

The Adaptation plan needs to be aligned with sectoral plans and policies for better integration and implementation. For instance, adaptation plan must be synced with human-wildlife conflict management strategy of the Department of Forests and Park Services, as HWC was identified as one of the main contributors to the climate sensitivity of farming communities. Similarly, national disaster risk management strategy and programs can support adaptation priorities related to climate induced events like flash floods, landslides, windstorms etc. Importantly, the adaptation plan needs to be aligned with the PA management plan to ensure proper integration and sync climate smart prescriptions of the PA management plan with climate change adaptation priorities. This will also enable for timely review and evaluation of the adaptation plan in line with the management plan. The plan has identified potential risks as a result of implementing the adaptation actions which needs to be thoroughly reviewed to avoid possible maladaptation and adversities.

The National Adaptation Plan (NAP) have identified adaptation priorities for Bhutan which can help to channel international climate funds to support adaptation priorities through United Nations Framework Convention on Climate Change (UNFCCC) financing mechanisms. The Local Climate Adaptive Living Facility (LoCAL) program in Bhutan funded by the United Nations Capital Development Fund (UNCDF) has been supporting local governments in Bhutan to enhance community resilience and adaptive capacity for climate change and has plans to scale up the program in all 205 Gewogs. The Bhutan for Life (BFL) also has fund allocated to pilot and support adaptation priorities in the vulnerable PAs. Conservation agencies like WWF and BTFEC support climate change projects and Bhutan is in process of establishing Bhutan Climate Fund.

## 6 Climate Change Adaptation Plan of the Phibsoo Wildlife Sanctuary

### 6.1 Background

Phibsoo Wildlife Sanctuary (PWS) is the smallest wildlife sanctuary in the country. PWS was initiated in 1993 following the nationwide revision of PAs system. While the conservation efforts begun in 1999, its first management plan was approved in 2012 for the period of five years covering an area of 269 sq.km. Furthermore, with the expiration of its management plan in 2017, surveys were conducted to study the status of biodiversity and socio-economic status in the wildlife sanctuary. The management area boundary also got revised to 286.83 sq.km in 2019 with the delineation of latest national parks and biological corridor boundary. It covers two districts of the country, Sarpang to the east and Dagana to the west. The northern part of PWS shares boundary with Beteni gewog under Tsirang Dzongkhag with Biological Corridor (BC3) connecting the wildlife sanctuary on north eastern side. Its southern boundary follows Indo-Bhutan international border with Ripu-Chirang Reserved Forest and Raimona National Park.

The sanctuary has great conservation significance for Bhutan, the region and the world at large. Not only does the sanctuary protect the country's southernmost variant of sub-tropical Himalayan Forest ecosystem but is also critical source of several seasonal and perennial water bodies which contribute to the fertility of the Assam Duars. The sanctuary indisputably serves as critical habitats in protecting some of the world's most endangered wildlife species. The sanctuary also happens to be the easternmost limit of Spotted deer (*Axis axis*), Common Pea Fowl (*Pavo cristatus*) and Sal (*Shorea robusta*) bearing forests. In-fact, PWS is the place where natural stand of Sal and Spotted deer can be sighted the most. At the same time, PWS is the westernmost limits of the globally threatened Golden Langur (*Trachypithecus geei*) and the rare and valuable agar tree (*Aquillaria malaccensis*). It also provides refuge to a number of charismatic and globally threatened species including the Asian elephant (*Elephas maximus*), Bengal tiger (*Panthera tigris tigris*), Chinese Pangolin (*Mani's pentadactyla*), Rufous-necked hornbill (*Aceros nipalensis*) and White-bellied Heron (*Ardea insignis*). Besides, lush alluvial grassland provides safe refuge to the prey species of keystone species.

The policy of the Royal Government of Bhutan is to allow local communities those who are legally settled in and around the protected area to live and have right and access to the resource in line with the Forest and Nature Conservation Acts (FNCA) & rules (WCD, 2010). The

communities depend on forest for most of their basic needs such as timber, NWFP and other resources like sand, boulders and gravels for their socio-economic development. Like other PAs in Bhutan, PWS also host local communities that co-exist and have been a part of ecosystem of the sanctuary. However, unlike most of the PAs in the country, PWS has relatively low density of settlement inside the sanctuary. The socio-economic survey carried out in 2017 listed 21 villages with population of 2981, of which 35.4% dwell inside the sanctuary and 64.6% adjacent to PWS. These populations interact constantly with forest ecosystem and primarily depend on forest products such as timber, fuel wood, and grazing and NWFP collection. Around 151 households with population of 1032 that dwell in the periphery also depend on PWS for timber, fuel wood and grazing.

The dominant community in PWS is *Lhotsampas* and practice Hinduism who also worship nature. People of Nichula practice tradition of conducting local rituals called "Devi Puja and Sansari Puja". They perform these pujas at water source and forest near rivers to appease the local deities for peace and prosperity to the community. Every community in Nichula gewog has their own sites for the rituals and it is conducted on annual basis.

In order to encourage community to participate in the forest resources management and promote sustainable utilization of the resources, establishment of community forest is encouraged to the sanctuary residents under the provision of FNCA and Rules. Two community forest management groups (CFMG) were created with technical support of PWS. In total 703.96 acres of forest in multiple use zone had been designated as community forest for the community of Dangreybu and Gangtokha under Nichula gewog.

Recognizing the importance of the sustainability of the forest area and to cater the ever-increasing timber demand and other forest resources to the community outside the forest management regime, the Local Forest Management Plan (LFMP) was developed in line with the National Forest policy 2011.

Nichula watershed covering an area of 2371 ha serves as critical water source to the communities of Nichula besides being sources of various forest resources like timber and NWFPs. The watershed has more than 23 water source which supports 151 households of Nichula gewog. It sources to drinking water purposes, irrigation and water for any developmental activities in the area. However, with rise in dependence on watershed for resource extraction, developmental



activities and climate change, watershed has been impacted which requires intervention to protect for its future use.

Even though, some mitigation works like construction of drainage system along the roads were put in place by Nichula Gewog administration, other intervention measures like construction of retention walls, water tanks, flood protection works etc. has to be carried out in the watershed. The watershed management plan was developed through participatory process involving relevant stakeholders both in the field and at PWS (PWS, 2022: Integrated Watershed Management Report for Nichula Watershed in Phibsoo Wildlife Sanctuary).

Communities of PWS largely depend on agriculture, livestock and forests, which are particularly vulnerable to climate change due to its topography and remoteness. Being one of the least developed Gewog, the resources to reduce the vulnerability are very limited. As per the recent CVCA assessment result PWS is found to be the most vulnerable due to climate change, PWS is having the lowest average elevation in Bhutan with highest precipitation and extreme temperature. PWS communities experienced extreme temperature, land slide, flashflood, seasonal drought and windstorms. There is an increased threat to agriculture in general and food security in particular along with change in forest composition affecting livelihood.

## 6.2 Objective

- Enhance livelihood and adaptive capacity of the communities through adoption of appropriate adaptation measures identified through community consultation.
- Reduce impacts and incidences of climatic extreme events to minimize risk to communities.

## 6.3 Adaptation Priorities of the Phibsoo Wildlife Sanctuary

### Section 1. Priority Issues of Climate Vulnerabilities

#### 1. **Drinking water**

Due to extreme temperature & seasonal drought there is issue with water sources drying up and which is leading to poor health of the communities.

#### 2. **Irrigation water**

Due to extreme temperature and seasonal drought, there is same issue with water source drying up and not enough water for irrigating farmlands.

#### 3. **Human-wildlife conflict**

Due to increase in wildlife population, habitat loss, change in forest composition, there is increase HWC affecting farmers' livelihood.

#### 4. **Poor rural infrastructure vulnerable to extreme climate events**

Due to heavy rain and constant windstorm, the sub-standard rural infrastructures are vulnerable to damage, affecting socio-economy and threatening human life.

#### 5. **Landslide and flashflood**

Due to erratic rainfall pattern, drought and extreme temperature there is damages to farm road, water source and irrigation sources being washed away by flashflood and covered by landslide.

#### 6. **Forest composition and invasive species**

There is a change in forest composition leading to decrease in fodder species and more invasive species overtaking grasses leading to increase in HWC, less grazing area and decrease in livelihood as forest products are limited which was an alternate source of livelihood.

#### 7. **Health facilities**

Health facilities is needed in the Gewog with increase in population and possibility of increase in climate related diseases and health impacts.

## Section 2. Priority Actions to Address Vulnerabilities

Priority Issues of Climate Vulnerabilities	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Drinking Water	1. Carryout plantation and protection of water source	Local government, Water flagship programs, Agriculture sector, Forestry sector, Health sector, Environment sector, Engineering sector	Increasing water variability/scarcity	1. Yarphelling Chiwog 2. Gangtokha Chiwog 3. Damzekesa Chiwog	
	2. Find alternative water source 3. Study on eco-hydrology required to have appropriate interventions				
2. Irrigation water Source	1. Source Protection 2. Infrastructure construction for irrigation channel needed 3. Find Alternate water source	Local government, Water flagship programs, Agriculture sector, Livestock sector, Forest sector, Environment Officer, Engineering sector,	Increasing water variability/scarcity	1. Dramzekesa Chiwog 2. Gangtokha Chiwog 3. Yarphelling Chiwog 4. Dramchunang Chiwog	Possibility of floods. Even if infrastructure is provided, chances of water resources drying up.

3. Human wildlife-conflict	<ol style="list-style-type: none"> <li>1. Solar Fencing</li> <li>2. Insurance Scheme</li> <li>3. Crop and livestock compensation</li> <li>4. Quick-response Team</li> </ol>	Agriculture sector, Livestock sector, Local government, Forestry sector, Bhutan power corporation, Engineering sector, Financial institutions	Increase HW-conflict driven by climate change	All Chiwogs	
5. Poor rural infrastructure vulnerable to extreme climate change	<ol style="list-style-type: none"> <li>1. Construction approval</li> <li>2. Climate smart infrastructure</li> </ol>	Local Government Bhutan Power Corporation Engineering sector Forestry sector Land record section	Increase climate smart infrastructure.	All Chiwogs	
6. Land slide and flash flood	<ol style="list-style-type: none"> <li>1. Plantation</li> <li>2. River bank protection wall</li> <li>3. Water source protection wall from landslide</li> <li>4. Farm road need proper damages and slope stability infrastructure and technique</li> <li>5. Bio-engineering</li> <li>6. Land management</li> </ol>	Local government Agriculture sector Engineering sector Forestry sector Livestock sector Disaster management Environment sector Land sector Dzongkhag kidu office	Extreme rainfall events trigger landslide and flashflood	<ol style="list-style-type: none"> <li>1. Gangtokha Chiwog</li> <li>2. Dramchunang Chiwog</li> <li>3. Dangreyboog chiwog</li> <li>4. Yarpelling Chiwog</li> </ol>	

7. Forest composition and invasive species	1. Community Forest management 2. Control of invasive species 2. Plantation of native species	Forestry Sector Agriculture Sector Livestock sector Environment sector Non-Government Organizations	Change in forest composition and spread of invasive species induced changing climate	All Chiwogs	
8. Health Facilities	1. Health facilities needed in the Gewog	Local Government Engineering Sector Ministry of Health	Climate induced diseases.	Nichula Gewog	

<b>Section 3. Potential Roles and Responsibilities</b>			
<b>Adaptation Action</b>	<b>Lead Stakeholder</b>	<b>Collaborating Stakeholder</b>	<b>Support Needed</b>
1. Plantation and protection of water Source	Water committee	Water flagship programs office, Agriculture sector Forestry sector Health sector Environment Officer Engineering sector	Cost estimation, procurement of materials, labor cost and technical support.
2. Find alternative water Source			
3. Study on eco-hydrology required to have appropriate interventions	Forestry sector	UWICER/ Watershed Management Division	Technical support and recommendation
4. Source Protection	Irrigation channel committee	Water flagship programs office Agriculture sector Forestry sector Health sector Env. Office Engineering sector	Cost estimation, procurement of materials, labor cost and technical support.
5. Infrastructure construction for irrigation channel needed			
6. Find alternate water source			
7. Solar Fencing	Agriculture	Local government Livestock sector Agriculture sector Forestry sector Disaster sector Financial institutions	Cost estimation, procurement of materials, labor cost and technical support.
8. Insurance Scheme			
9. Crop and livestock compensation			
10. Quick-response Team			
11. Construction approval needed from LG	Local government	Land/Agri/Livestock/Engineering Sector	Cost estimation, procurement of materials, labor cost and technical support.
13. Climate smart infrastructure			
14. Plantation	Forestry Sector	Land sector Engineering,	

15. River bank protection wall	Local government	Dagana Dungkag Administration, Forestry, Agriculture and livestock sector.	Cost estimation, procurement of materials, labor cost and technical support.
16. Water source protection wall from landslide			
17. Farm road need proper damages and slope stability infrastructure and technique			
18. Bio engineering	Forestry Sector		
19. Land management	Local Government		
20. Community forest management			
21. Control of invasive species	Forestry Sector		
22. Plantation of native species			
23. Health facilities needed in the Gewog	Local government	Health Sector, Dagana Dungkag administration	Cost estimation, tender and funding support.

## Section 4. Implementation and Resourcing

<b>Adaptation Action</b>	<b>Next Step for Implementation</b>	<b>New or Existing</b>	<b>Cost (Nu. million)</b>	<b>Funding Available</b>	<b>Timeline Year (1 - 10)</b>	<b>Key Performance Indicator</b>
1. Plantation and protection of Water Source	Secure funding, forming water committee, develop watershed plan	Existing but need additional fund support	1	0.1	2	No. of water source protected and plantation in acre.
2. Find alternative water Source	Secure funding, forming water committee, developed watershed plan	new	5	0	2	New water source designated and infrastructure built.
4. Study on eco-hydrology required to have appropriate interventions	Secure funding, developed watershed plan	New	0.3	0	1	Produce technical report and recommendation
3. Infrastructure construction for irrigation channel needed	Secure funding, developed watershed plan	New and planned for the 13 <sup>th</sup> five-year plan	10	0	3	No. of source taped. Kilometer of channel built along with numbers of acre irrigated. Household benefited.
4. Solar Fencing	Secure funding, develop bylaws, future studies on effectiveness needed along with monitoring	Existing. Need additional funding for	3	0	3	No. of household benefited. Acres of farm land solar fenced. Solar electric fencing effectiveness reported.



		improved energizer				
5. Insurance Scheme	Secure funding, developed bylaws, group formation and registration to financial institutions.	new	1.5	0	3	No. of farm land/crop insured. No. of livestock insured.
6. Crop and livestock compensation	Secure funding, developed bylaws, group formation and registration to financial institutions.	new	5	0	5	Compensation committee formation and seed money deposited in bank
7. Quick-response Team	Secure funding, developed bylaws, group formation, study on animal ecology needed.	Existing	1.5	0	1	Bylaws developed. Better equipment procured along with first aid tool kit. Capacity building for members to tackle HWC.
8. Construction approval needed from LG	Visit policies and enforce rules	existing	0.5	0	1	Training and awareness on green infrastructure along with construction rules given.
9. Climate smart infrastructure	Development of new guide lines along with climate smart infrastructure	new	0.5	0	1.	Guidelines on climate smart infrastructure developed.
10. Build river bank protection wall	Secure fund tenders out the identified work along with cost estimates.	New	1	0	2	No. of wall constructed. No. of house hold benefited.

11. Build climate smart and resilient farm road need	Secure fund tenders out the identified work along with cost estimates.	existing	10	0	4	Kilometer of farm road blacktoppednwith proper drainage.
12. Land management	Secure funding, develop plan	new	0.1			
13. Community Forest management	Secure funding, develop capacity in product diversification	Existing. Need funding for new activity	0.5	0	1	No. of CF member trained on product development and marketing.
14. Control of invasive species	Secure funding, develop invasive checklist and management plan	new	0.5	0	1	Plan developed and implemented
15. Plantation of native species	Secure funding, developed checklist on native species of agroforestry and economic importance and make management plan	new	1	0	2	Plants planted per acre.
16. 1.Health facilities needed in the Gewog	Pass resolution through Gewog Tshowdue, Dzongkhag Tshogdue and get approval from MoH along with cost estimates and tender out	Existing- already planned. In need of fund support.	5	0	2	No. of People benefitted
17. Tourism development	Secure funding, develop tourism development plan and identify its potential products	new	1	0	4	Tourism business plan developed

18. Improved livestock breed introduced	Secure funding, procure improved breeds to reduce labor cost and more returns	new	0.5		5	No. of improved breed supplied and household benefited.
19. Skill development to productive age group	Secure funding and train them in life skill like electricity, carpentry and Masonry	new	0.3	0	4	No. of productive age trained and house hold benefited.
20. Capacity development on farm product development and marketing	Secure funding, conduct training on farm product development and marketing	new	0.2	0	7	No. of household benefited.
21. Farm mechanization	Improved facilities provided along with capacity building.	new	1	0	8	No. of house hold benefited.
22. Establish Yarpheing medicinal plants/ ethnobotany group	Secure funding, trained in forest medicinal product development and marketing	new	0.5	0	6	No. of household benefited.
<b>Total budget estimate for 10 years</b>			<b>49.9m</b>			

<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>	<b>Nos. of Participants</b>
20/10/2022	Consultation meeting with Nichula LG members, CF members, Agriculture and other relevant stakeholder.	Gup, Tshogpas, Gewog-Agri, Forestry, Livestock, Gewog Admin, BPC, CF members	18 (17 male, 1 Female)
21/10/2022	Nichula Range Staff – CVCA assessment report presentation on Nichula Gewog, report writing and grass root discussion to find field realities.	PWS Staff	17 (15 male, 2 Female)
<b>Consultation and Plan Preparation led by</b> Phuntsho Tobgay, Dy.CFO, tobgayp06@gmail.com Yeshe Tshering, Sr. FO, yeshit@haa.gov.bt Bal Krishna Koirala, FO, bkkoirala@moaf.gov.bt Khandu Tshomo, FO, khandut@moaf.gov.bt Karma Chedup, FR-I, karmachedup10@gmail.com			

## 7 Climate Change Adaptation Plan of the Bumdeling Wildlife Sanctuary

### 7.1 Background

The Bumdeling Wildlife Sanctuary (BWS), erstwhile known as Kulongchhu Wildlife Sanctuary was gazetted in the year 1994. The Wildlife Sanctuary was officially established in the year 1995 to protect ecological zones of the mid and high-altitude ecosystems of the eastern parts of Bhutan, to support and strengthen the important religious sites, and to cater socio-economic needs to the local people residing inside the Sanctuary. BWS has made notable achievements in terms of infrastructures development, human resources, conservation of floral and faunal diversity, enhancement of ecotourism programmes and conservation advocacies to local communities.

Geographically, the sanctuary consists mostly of rugged mountainous terrains, rocky peaks, permanent snow, small glaciers, glacial lakes, steep river valleys, and few plains. Almost 90% of the Sanctuary lies between 2500m and 5000m elevation. The sanctuary has warm temperate climate in the south, cool temperate climate in the centre and alpine in the northern part. In the lower parts of the Sanctuary, the maximum temperature ranges from 20°C to 30°C and minimum between 8°C to 15°C, while the centre region experiences maximum temperature of 15°C to 20°C with minimum temperature ranging between 3°C to 10°C. The Northern part of the Sanctuary usually remains cold with most of the time under snow cover. Maximum rainfall is received in the months of May - September. The annual rainfall ranges from 1000mm to 3500mm.

BWS caters services to three gewogs of Khoma, Sherimuhung, Bumdeling totaling up to 1,119 households with 8,782 people. However, only 217 households fall inside the park area. Major source of income for the park residents are from the sale of agricultural products (rice and vegetables such as chilli and potatoes). Non-farm activities (contract and portering, business and shops, weaving, salary, carpentry, farmhouse and sale of bamboo products, Dapa and paper products) and sale of livestock products were other sources of income for the residents of Sanctuary.

A total of 149 households were sampled in BWS for the CVCA assessment. BWS has Adaptive capacity (n = 0.47), Exposure (n = 0.24), Sensitivity (n = 0.27) and Vulnerability Index (n = -0.05). BWS also has higher percentage of household reporting the observation of temperature extremes, increased occurrence of landslides, flash flood and windstorm. BWS was found to have

second highest sensitivity among all the PAs and lowest adaptive capacity to adapt to climate change. BWS is the second most vulnerable along with JDNP due to lower sensitivity and exposure index.

## 7.2 Objective

- To enhance biodiversity conservation through adoption of climate smart interventions.
- To improve livelihood of the local communities through adoption of climate smart and disaster resilient interventions.

### 7.3 Adaptation Priorities of the Bumdeling Wildlife Sanctuary

#### Section 1. Priority Issues of Climate Vulnerabilities

##### Issues related to exposure to climate vulnerability

Extreme Temperature	Decline in crop yield, death of livestock
Rainfall Seasonality	Decline in crop yield, decline in soil quality
Windstorm	Decline in crop yield, property damage
Landslide	Decline in crop yield, Habitat degradation
Flashflood	Decline in crop yield, Damage of property
Seasonal Drought	Decline in crop yield, decrease in availability and quality of fresh water

##### Issues related to sensitivity to climate vulnerability

Human-wildlife conflict	Crop damage, property damage, decline of livestock
Drinking water	Sanitation issues, water related conflicts, decline in livestock
Irrigation water	Decline in crop yield, water related conflicts

##### Issues contributing to low adaptive capacity

Natural asset	Landholding, forest resources, water source and croptypes
Human asset	Household-head literacy, vocational skill, climate awareness
Physical asset	House type, communication medium, market, health facility, Gewog center, School
Social asset	Community group, productive member
Financial asset	Credit access, savings, off-farm contribution, livelihood diversity

## Section 2. Priority Actions to Address Vulnerabilities

Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Build covered catchment ponds for the community to support household use during dry season months.	Water, infrastructure	Increasing water variability/scarcity	Khoma, Sherimuhung & Bumdeling gewog	Flood/landslide risk if not designed properly
2. Build fences around upstream areas of catchments near springs to prevent grazing and increase water recharge through natural regeneration and/or reforestation	Water, nature-based solution	Increasing water variability/scarcity	Lhakchung & Goenpakarp in Khoma Gewog.	Might reduce grazing access, affecting livelihoods for those dependent on livestock
3. Supply of high yielding heat adaptable seeds and livestock	Climate- smart agriculture	Decline in crop yield, loss of livestock	Khoma, Sherimuhung & Bumdeling gewog	If not well researched than it may become invasive.
4. Alpine habitat management	Habitat management	Decline in grazing land and alpine habitat	Khoma and Bumdeling	Prescribed burning might lead to forest fire
5. Sustainable land management (Construction of Check dams, terracing of land, land revival)	Sustainable land management	Decline in crop yield, decline in soil quality	Khoma, Sherimuhung & Bumdeling gewog	No risk foreseen
6. Construction of retaining walls	Infrastructure	Decline in crop yield, damage to property	Hodorma in Bumdeling, Tsango in Khoma Gewog & Sherimuhung gewog	Flood/landslide risk if not designed properly



7. Plantation in landslide area	Nature based solutions	Damage to property	Bumdeling, Khoma and Sherimuhung gewog	Planting of exotic species may lead to invasive species
8. Construction of river protection walls	Infrastructure	Decline in crop yield, damage to property	Bumdeling gewog (Kangteng to Dungzam, Meidung, Gilingbu, Chenairong, Dechenphodrang)	Flood/landslide risk if not designed properly
9. Supply of pesticides, chemical fertilizers, and green house.	Climate-smart agriculture	Decline in crop yield	Bumdeling, Khoma and Sherimuhung gewog	Excess usage may lead to environmental hazards
10. Irrigation schemes to increase crop productivity and water efficiency	Water, climate-smart agriculture, infrastructure	Increased water scarcity	Sherimuhung gewog (Tsaburi, Malang, Yermi), Khoma gewog (Nylamdung & Gangla-khema), Bumdeling gewog (Zhapang, lamdra, Baytshamang, Ngalimang, Phangteng)	Construction of channels may lead to landslide
11. Maintenance of irrigation schemes to increase crop productivity and water efficiency	Water, climate-smart agriculture, infrastructure	Increased water scarcity	Sherimuhung gewog (Shiling, Martshala) and Bumdeling Gewog	Construction of channels may lead to landslide
12. Drinking water schemes and renovate old to increase water efficiency	Water, climate-smart agriculture, infrastructure	Increased water scarcity	Sherimuhung gewog (Malang, Rashu Brangsa, Gangmung, Labor, Isuchhu, Khesing Brangsa), Bumdeling gewog (Phanbu and Baytsamang), Khoma gewog (Goenpakarp, Bapdong, Likchu, Kemtshong, Drakteng, Khoma).	Construction of pipelines may lead to landslide

13. Electric fencing and chain link fence with plastic poles	Infrastructure	Decline in crop yield, damage to property	Khoma gewog (Namgong, Babtong, Pangkhar, Drakteng, Shuma, Tsango, Kemtshong), Sherimuhung gewog (Bumdedrang, Phakpagodhor, Rothpa, Soenamkhar, Muhung, Lari, Serzhong) Bumdeling gewog.	It may restrict the movement of wildlife if the fencing covers whole village and risk of short circuit.
14. Compensation scheme	Human-wildlife conflict	Damage to property	Bumdeling, Khoma and Sherimuhung gewog.	
15. Build early warning system for flooding and establish disaster risk reduction and response village committee	Disaster risk, human capacity, infrastructure	Increasingly extreme flooding, landslides and GLOF	Bumdeling, Khoma and Sherimuhung gewog	First need to do risk assessment
16. Awareness program on climate change	Educational advocacy	Educating illiterate people	Bumdeling, Khoma and Sherimuhung gewog	No risk
17. Construction of bridges	Infrastructure	Damage to property	Bumdeling gewog (Kuktorgang, Talikang and Lamdangkang)	
18. Supply of chilli drying machines, paddy thresher machine and power tillers	Machineries	Damage to property	Bumdeling, Khoma and Sherimuhung gewog	
19. Revival of degraded wildlife habitats through removal of vegetative outgrowths in the alpine areas	Sustainable land management	Reduces grazing areas for livestock and wildlife	Khoma & Bumdeling	No risk

20. Restoration of degraded natural lakes.	Water, nature-based solution	Increasing water variability/scarcity	Khoma and Shelrimuhung	No risk
21. Enrichment plantation of host and feeding plants of B. Ludlowi.	Climate-smart based solution	Decline in host plants and feeding plants	Bumdeling	No risk
22. Removal of solid waste stocks from Singye Dzong, Aja Ney and Shingphel areas to the destination.	Educational advocacy	Educating illiterate people	Bumdeling, Khoma & Sherimuhung	No risk
23. Restoration of wintering ground of BNC in Bumdeling affected by the flash floods.	Sustainable land management	Reduces feeding and roosting BNC	Bumdeling	No risk

### Section 3. Potential Roles and Responsibilities

<b>Adaptation Action</b>	<b>Lead Stakeholder</b>	<b>Collaborating Stakeholder</b>	<b>Support Needed</b>
1. Build covered catchment ponds for the community to support household use during dry season months.	Water management committee	WMD, BFL	Funding, supplies/materials, technical support for engineering analysis
2. Build fences around upstream areas of catchments near springs to prevent grazing and increase water recharge through natural regeneration and/or reforestation	Disaster management committee	SFED, FRMD, BFL	Funding, materials (seedlings), technical support for reforestation guidance
3. Supply of high yielding heat adaptable seeds and livestock	RNR	Gewog, DOL, DOA, BFL	Funding, support for seeds and livestock

4. Alpine habitat management	BWS	Gewog, BFL	Funding, Technical support from DoFPS
5. Sustainable land management (Construction of Check dams, terracing of land, land revival)	DOA	BWS, Gewog, BFL	Funding, materials, technical support from DOA
6. Construction of retaining walls	Gewog	Dzongkhag, BFL	Funding, materials, technical support for engineering analysis
7. Plantation in landslide area	Gewog	BWS, GBCL, BFL	Funding, materials, technical support from DoFPS
8. Construction of river protection walls	Gewog	Dzongkhag, BFL	Funding, materials, technical support for engineering analysis
9. Supply of pesticides, chemical fertilizers, and green house.	DOA	Gewog, BFL	Funding, materials, technical support from DOA
10. Irrigation schemes to increase crop productivity and water efficiency	DOA	Gewog, BFL	Funding, materials, technical support for engineering analysis and from DOA
11. Maintenance of irrigation schemes to increase crop productivity and water efficiency	DOA	Gewog, BFL	Funding, materials, technical support for engineering analysis and from DOA
12. Drinking water schemes and renovate old to increase water efficiency	Gewog	Dzongkhag, BFL	Funding, materials, technical support for engineering analysis
13. Electric fencing and chain link fence with plastic poles	Gewog	Dzongkhag, BFL	Funding, materials, technical support
14. Compensation scheme	BWS	Gewog, DOA, DOL, Dzongkhag, BFL	Funding
15. Build early warning system for flooding and establish disaster risk reduction and response village committee	Gewog	Dzongkhag, BFL	Funding, materials, technical support

16. Awareness program on climate change	BWS	Gewog, BFL	Funding
17. Construction of bridges	Gewog	Dzongkhag, BFL	Funding, materials, technical support for engineering analysis
18. Supply of chilli drying machines, paddy thresher machine and power tillers	Gewog	FMCL, DOA, BFL	Funding and materials
19. Revival of degraded wildlife habitats through removal of vegetative outgrowths in the alpine areas	BWS	Gewog, BFL	Funding, materials, technical support forestry sectors
20. Restoration of degraded natural lakes.	BWS	Gewog, BFL	Funding and materials
21. Enrichment plantation of host and feeding plants of B. Ludlowi	BWS	Gewog, NCD, UWICER	Funding, materials, technical support forestry sectors
22. Removal of solid waste stocks from Singye Dzong, Aja Ney and Shingphel areas to the destination.	Gewog	BWS, BFL	Funding and materials
23. Restoration of wintering ground of BNC in Bumdeling affected by the flash floods.	BWS	Gewog, BFL, Dzongkhag	Funding, materials, technical support for engineering analysis and from DOA

<b>Section 4. Implementation and Resourcing</b>						
<b>Adaptation Action</b>	<b>Next Step for Implementation</b>	<b>New or Existing</b>	<b>Cost (Nu. Million)</b>	<b>Funding Available</b>	<b>Timeline Year (1 -10)</b>	<b>Key Performance Indicator</b>
1. Build covered catchment ponds for the community to support household use during dry season months.	Secure funding, Engineering feasibility study	New	0.5m per pond	None	Year 1	No. of catchment ponds developed
2. Build fences around upstream areas of catchments near springs to prevent grazing and increase water recharge through natural regeneration and/or reforestation	Secure funding, planning meeting with lead committees and outside support	Existing, expansion	0.5m for seedlings; 0.5m for new nursery (per location)	None	Year 2-5	Acres of degraded areas reforested
3. Supply of high yielding heat adaptable seeds and livestock	Secure funding, planning meeting with communities	New	1m per gewog	None	Year 1-10	Amount of seeds and no. of livestock supplied
4. Alpine habitat management	Secure funding, consultation meeting with communities	Existing, expansion	0.5m per gewog	None	Year 2-4	Acres of area brought under habitat management
5. Sustainable land management (Construction of Check dams, terracing of land, land revival)	Secure funding, meeting with communities and identifying feasible area	New	2m per gewog	None	Year 3- 6	Acres of land brought under land management

6. Construction of retaining walls	Secure funding, consultation meeting	New	2m per gewog	None	Year 1-5	No. of retaining walls constructed
7. Plantation in landslide area	Secure funding, consultation meeting, development of nursery	New	1m per gewog	None	Year 2-6	Acres of land brought under plantation
8. Construction of river protection walls	Secure funding, consultation meeting, identifying suitable area	New	2m per gewog	None	Year 3-8	No. of protection walls constructed
9. Supply of pesticides, chemical fertilizers, and green house.	Secure funding, consultation meeting	New	1m per gewog	None	Year 1-4	Quantity of pesticides and fertilizers and no. of greenhouse supplied
10. Irrigation schemes to increase crop productivity and water efficiency	Secure funding, consultation meeting, identifying, and surveying the area	New	3m per gewog	None	Year 1-5	Length of irrigation channel constructed
11. Maintenance of irrigation schemes to increase crop productivity and water efficiency	Secure funding, consultation meeting, identifying area, and surveying	Maintenance	2m per gewog	None	Year 1-4	Length of irrigation channel renovated

12. Drinking water schemes and renovate old to increase water efficiency	Secure funding, consultation meeting, identifying area, and surveying	New and existing	4m per gewog	None	Year 2-7	Length of drinking water scheme constructed and renovated
13. Electric fencing and chain link fence with plastic poles	Secure funding, consultation meeting, identifying area, and surveying	New and existing	3m per gewog	None	Year 1-5	Length of electric fencing and chain link fence constructed and innovated
14. Compensation scheme	Secure funding, verification of wildlife kills	New	5m per gewog	None	Year 1-10	No. of HWC cases compensated
15. Build early warning system for flooding and establish disaster risk reduction and response village committee	Secure funding, consultation meeting, feasibility study	New	2m per gewog	None	Year 1-3	No. of warning system established
16. Awareness program on climate change	Secure funding, awareness program	New	0.5m per gewog	None	Year 1-2	No. of participants attended the program
17. Construction of bridges	Secure funding, consultation meeting, surveying	New	5m per gewog	None	Year 3-7	No. of bridges constructed
18. Supply of chilli drying machines, paddy thresher machine and power tillers	Secure funding, procurement of machines	New	5m per gewog	None	Year 1-5	No. of machines procured
19. Revival of degraded wildlife habitats through	Secure funding, consultation	New	1m per gewog	None	Year 7-8	Hectares revived degraded areas



removal of vegetative outgrowths in the alpine areas	meeting, feasibility study					
20. Restoration of degraded natural lakes.	Secure funding, consultation meeting, feasibility study	New	1 each per gewog	None	Year 6-7	No of lake restored
21. Enrichment plantation of host and feeding plants of B. Ludlowi.	Secure funding, procurement of equipment, stationers	New	5 per hectares	None	Year 8-9	Hectares planted host plants
22. Removal of solid waste stocks from Singye Dzong, Aja Ney and Shingphel areas to the destination.	Secure funding, consultation meeting & awareness	New	1 each per gewog	None	Year 6-10	Quantity of waste removed
23. Restoration of wintering ground of BNC in Bumdeling affected by the flash floods.	Secure funding, consultation meeting, identifying, and surveying the area	New	3m	None	Year 7-10	Area restored affected by flash flood
<b>Total budget estimate for 10 years</b>			<b>140m</b>			

<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholder</b>	<b>Nos. of Participants</b>
12/10/2022	Consultation with Khoma Gewog officials	Gewog Agriculture extension, Gewog Livestock extension, Gewog officials, CF group, NWFP group, Khoma Park Range Office officials & chiwog Tshokpas.	22 heads
14/10/2022	Consultation with Sherimuhung gewog official	Gewog Agriculture extension, Gewog Livestock extension, Gewog officials, CF group, NWFP group, Sherzhong Park Range Office officials & chiwog Tshokpas.	22 heads
17/10/2022	Consultation with Bumdeling gewog official	Gewog Agriculture extension, Gewog Livestock extension, Gewog officials, CF group, NWFP group, Dungzam Park Range Office officials & chiwog Tshokpas.	35 heads
<p><b>Consultation and Plan Preparation led by</b>            Sonam Choidup, Sr. Forest Ranger II, sonamchoidup@gmail.com            Tez Bdr. Ghalley, Forestry Officer, tbghalley@moaf.gov.bt</p>			

## 8 Climate Change Adaptation Plan of the Jigme Dorji National Park

### 8.1 Background

Jigme Dorji National Park (JDNP) is one of the oldest and largest PAs in Bhutan, second only to Royal Manas National Park (RMNP) and Wangchuck Centennial National Park (WCNP) respectively. The park covers an area of 4374.06 km<sup>2</sup> with altitude ranging from as low as 1400 m in lower south to over 7000 meters above mean sea level to its north in north-western Bhutan. Owing to its huge altitudinal range the park encompasses five major ecosystem type viz. subtropical, warm temperate, cool temperate, subarctic/cold temperate forests and rhododendron scrub (Ohsawa, 1987). The park is one of the ten protected areas in Bhutan and it is mandated to conserve ecosystems of north-western Bhutan. At the landscape level, JDNP shares boundary with WCNP to its east and connected to Jigme Khesar Strict Nature Reserve (JKSNR) and Jigme Singye Wangchuck National (JSWNP) by biological corridors.

The Park caters services to 10 Gewogs that includes entire Gasa and parts of Punakha, Thimphu and Paro Dzongkhags. There are 975 households with a population of 5026, majority of the population are without formal education (52.7%), of which illiteracy is higher in female population (54.6%). There is a mosaic of communities inside the park, in alpine regions; people mostly live a semi-nomadic lifestyle, herding yaks (with distinct culture) while in lower temperate regions people do subsistence farming (agriculture and livestock). The main sources of livelihood for the communities are livestock products and NWFP. In 2019, the income from livestock products was Nu. 20m. likewise the income from NWFP was 540.58m. Cordyceps alone contributes 477m (88.4%) while income from other NWFPs was close to Nu. 63 m, that is about 11.6% of the gross income (Dendup et al., 2021).

JDNP has an incredible wealth of biodiversity comprised of 1,434 species of vascular plants (with more than 200 species of medicinal plants), 50 mammals, 406 birds, 4 wild bees, 184 butterflies, 15 amphibians, 22 reptiles and 17 dragonflies and damselfly (Thinley et al., 2015; Koirala & Jamtsho, 2018, Dendup et al., 2020a; Jamtsho, 2020, Dorji et al., 2021). It is also a home to threatened species of fauna such as Alpine musk deer (*Moschus chrysogaster*), Himalayan musk deer (*M. leucogaster*), Bhutan Takin (*Budorcas taxicolor whitei*), Red panda (*Ailurus fulgens*), White-bellied heron (*Ardea insignis*), Pallas's fish eagle (*Haliaeetus leucorhynchus*), Bearded vulture (*Gypaetus barbatus*), Himalayan vulture (*Gyps himalayensis*) etc. The salient feature that

distinguishes JDNP from the rest of the PAs in Bhutan is the presence 3 out of 4 national symbols viz. the national animal - Takin (*Budorcas taxicolor whitei*), the national bird - Northern raven (*Corvus corax*), and the national tree - cypress (*Cupressus corneyana*). JDNP also has a thriving populations of the endangered Royal Bengal tiger (*Panthera tigris tigris*), Asiatic wild dogs (*Cuon alpinus*) and the vulnerable snow leopard (*Panthera uncia*) sharing their habitats. Further, it is laudable to note that we captured and confirmed the presence of Wolly Flying Squirrel (*Eupetaurus species*) (Jamtsho et al., 2022) and captured photos of the Palla's Cat (*Octocolobus manul*) and Tibetan/Himalayan Wolf (*Canis lupus chanco*) from the recent camera trap surveys. All these charismatic mammals inhabit the rugged mountains above tree line. Thus, JDNP is the conservation jewel in the eastern Himalayas, for sure.

Since four major river basins namely the Phochu, Mochu, Pachu and Wangchu originates from the snow-capped mountains of the park it is worth considering JDNP as the water tower of western Bhutan. Hydro-electricity from hydropower plants built along these river basins, downstream generates enormous revenue for the country. Higher percentage of the GDP in the country comes from hydro-electricity (NSB, 2021). JDNP is also contributes significantly to the national tourism industry, especially to nature tourism. Large number of international tourists trek through the paradisiacal alpine meadows and snow-capped mountains in the park, particularly along Jomolhari Trek and the Snowmen Trek. Prior to the pandemic, JDNP used to receive the highest number of international tourist. In 2019, JDNP received 1,266 international tourists (FRMD, 2020). The presences of majestic snow-capped mountains such as Jomolhari, Jichu Drakey, Tsherim Gang, Matsang Gang, Gangchen Tag, and Gangchen Singye (aka Table Mountain) that are internationally popular, magnificent landscapes, spectacular sceneries of serene alpine meadows adorned with fragrance of flowers, cascading rivers originating from lakes of varying colours, and lush green forests hidden in clouds and mists, harmonious herds of blue sheep grazing amongst yaks ascribe JDNP to be the centre of attraction for international tourist. With the recent Snowmen Race (*the Ultimate Race for Climate Action*), 2022 JDNP is once again brought into the spotlight of nature tourist worldwide and climate action in tandem. Further, JDNP has many culturally significant sites such as Gasa Dzong, Zabsel Goenpa, Choeten Goenpa, Tshechhu Dra, Tshephu Nye, to name few. There are also natural hot springs and mineral springs (Mennchhus) that attracts local visitors from all nooks and corners of the country.

However, JDNP cannot tolerate the looming threats of changing climate and global warming because it was found that JDNP has the lowest mean annual temperature (0.82°C) and least average precipitation (424mm) over the last 30 years. The park was also found to be the second most exposed and vulnerable to climate change. The average elevation (4313 masl) is highest in JDNP amongst all PAs in the country whereas the projected mean temperature of was 1.4°C in the next 3 decades, this aggravate the exposure of the park to climate change variables. The factors contributing to its exposure are rainfall seasonality, temperature extremes, windstorm and landslides among others (Yoezer, D. & Choden, K., 2022). Some of the communities, particularly, Lunana, Laya and Soe are exposed to glacial lake outburst flood (GLOF). The threat of climate change appears real and pervasive to human communities and natural ecosystems in Bhutan, particularly in the alpine regions. It is also suggested that Bhutan will experience a 3.5°C temperature increase by 2069, (that is about 6 decades from now) based on present trends, and the rise in average rainfall will be steady to over 500 or 600 mm annually, with unpredictable rainfall pattern and rather erratic monsoon regimes (RNR 2016). Climate change can drive the survival and vitality of flora and fauna in higher elevations to its brink given above scenarios, more so to those species that are already listed as vulnerable and endangered (snow leopard is listed as vulnerable). It is stated that for every additional degree of warming there will be unpleasant climate consequences, exponential increase in the cost of adaptation and a sudden increase in temperature will compel wildlife to struggle for survival.

The factors impacted by exposure to climate change variables include issues of drinking water in the communities, the shortage or quality deterioration of pastureland and human wildlife conflict. Crop yield and forest composition are other factors needing consideration while planning for adaptive measures. Though, the adaptive capacities of the communities appear adequate at present, particularly, in terms of financial and social aspect but the sustainability is uncertain. The fact that the highlanders are very much dependent on the non-wood forest products, as source of their livelihood (roughly 90% of highlander's income comes from sale of Cordyceps); the changing climate will have overwhelming impact on their livelihood resources.

Therefore, in order to come up with an inclusive climate change adaptation plan, JDNP went around the Dzongkhags to consult with relevant sectors who are in effect the technical experts. We also involved the Gups and Mangmis where possible as they will be the eventual clients of the adaptation plan. The interventions are presented in the tables below with budget

estimates and assigned work responsibilities. The plan stretches for a period of ten year has an estimated budget of Nu. 477.087millions, we expect that our conservation partners (donors) will support the JDNP in meeting the required budget for successful implementation of the plan.

## 8.2 Objective

The overall objective of the adaptation plan is to come up climate change adaptation interventions that will address the impending threats in terms of exposure, sensitivity and adaptive capacities of the communities residing inside the park.

The specific objectives of the plan are as follows;

- To implement eco-system based, climate smart approaches such as crop diversification, livestock breed improvement, pasture development etc. in agriculture and livestock farming
- To address the impacts of climate change with appropriate interventions (electric fence, chain link fence, coral fence, etc. for human wildlife conflict)
- To improve adaptive capacities of the communities by providing both tangible (inputs) and intangible (awareness, trainings, etc.) resources

### 8.3 Adaptation Priorities of the Jigme Dorji National Park

#### Section 1. Priority Issues of Climate Vulnerabilities

##### **Issues related to exposure to climate vulnerability**

1. Temperature extremes causing decline in crop and livestock productivity, decline forest composition, habitat loss for wildlife.
2. Rainfall seasonality causing shortage of drinking and irrigation water, soil erosion, crop failure and declining crop yield.
3. Landslides causing loss of land and properties, soil fertility loss, decline forest composition
4. Windstorm causing damages to properties (blowing of roofs), soil fertility loss, crop damage storms, etc.
5. Glacial lake outburst flood (GLOF)
6. Seasonal droughts

Breaking down the analysis further to Gewog and Chiwog level the exposure variable such as GLOF and seasonal droughts become a priority, especially GLOF in Laya-Lunana and windstorm in Soe-Lingzhi Gewogs.

##### **Issues related to Sensitivity to climate vulnerability**

1. Change in Forest composition leading to habitat loss, human wildlife conflict, phenology changes, loss/reduction of timber species.
2. Increasing wildlife population causing human-wildlife conflict such as crop and livestock depredation
3. Shrinkage of Pastureland causing decline in production of milk, decline in livestock population, pastureland conflicts
4. Drinking water shortage causing sanitation issues, health issues, water related conflict
5. Decrease in crop yield resulting in less production, famine, affect self-sufficiency, nutrition.
6. Impact on infrastructure causing financial losses, risk to lives
7. Irrigation water shortage leading to crop failure, low yield, less income, nutrition, etc

##### **Issues contributing to low adaptive capacity**

1. No market accessibility market

2. Lack of vocational skill
3. Poor literacy
4. Less community group memberships
5. Further from health facilities
6. Less alternate water source
7. Further from Gewog center
8. Low crop varieties
9. Low household landholding
10. Less diversity of forest resources
11. Lack of awareness on climate change
12. Poor condition of dwellings

The parameters such as landholding, forest types, climate change awareness and house types are prioritized even though they scored high because at Gewog and Chiwog level these needs intervention. For instance, in Khatoed Gewog, they proposed to lease SRF land to develop additional arable land while climate change awareness, people still need more awareness and exposure especially when it comes to risks associated GLOF.



Section 2. Priority Actions to Address Vulnerabilities					
Priority Climate vulnerability	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Temperature extreme	1. Protect agriculture: Use of Greenhouse	Agriculture sector	Avoid extreme weather conditions to produce fresh vegetable throughout seasons	Punakha (Goenshari, Chhubu and Toewang Gewogs)	
	2. Customized greenhouse to suit the climatic conditions in high elevations	Agriculture sector	Avoid extreme weather conditions to produce fresh vegetable throughout seasons	Thimphu (Lingzhi, Soe and Naro) Paro (Tsento)	
2. Rainfall seasonality	3. Maintenance of irrigation canal: Replace concrete irrigation canals with polythene pipes	Agriculture and engineering sector	Irrigation water shortage due to unpredictable rainfall and temperature extreme	Punakha (Goenshari, Chhubu and Toewang Gewogs)	
3. Flashflood	4. Proper drainage in the settlement, town & agriculture land	Engineering and Environment sectors	Flood, landslides & wastewater	35 Km drainages in Khatoed and Gasa area for proper drainage of waste water	
	5. Maintenance of wooden bridges	Engineering sector & JDNP	Flood	3 bridges in Doteng and 1 in Tsento	
4. Landslides	6. Land management	Agriculture sector	Landslides	Punakha (Goenshari, Chhubu and Toewang Gewogs)	

	7. Farm-road improvement (all weather)	Agriculture and engineering	Landslides and flooding	Punakha (Goenshari, Chhubu and Toewang Gewogs)	
	8. Blacktop of farm roads	Dzongkhag, Gewog & Park	Landslide (runoff from unpaved farm road)	6Km in Khatoed Gewog	
	9. Maintenance of footpaths	Engineering sector & JDNP	Landslides	2 footpaths in Doteng & 5 in Tsento	
5. GLOF	10. Flood risk awareness along GLOF risk areas	Environment sector & JDNP	GLOF	Soe and Tsento Gewogs	
	11. River bank protections along GLOF area	Environment and Engineering sectors & JDNP	GLOF, Flood	Chhubu and Toewang Gewogs in Punakha	
6. Windstorm	12. Construct concrete band to reinforce roof of houses in storm prone areas	Engineering sector	Windstorm	15 H/h on pilot basis in Soe, Naro and Lingzhi	
1. Wildlife population (human wildlife conflict)	13. Chain link fencing	Agriculture, livestock and park	Wildlife population (human wildlife conflict)	10Km in Punakha (Goenshari, Chhubu and Toewang Gewogs)	They don't fence SRF land near farmland
		Agriculture, livestock and park	Wildlife population (human wildlife conflict)	35 Km in Gasa (Khatoed and Khamaed)	They don't fence SRF land near farmland

	14. Improved livestock sheds	Livestock sector	Wildlife population (human wildlife conflict)	5 improved livestock sheds in Goenshari, Chhubu and Toewang Gewogs (on pilot basis)	
	15. Coral fencing to protect yak calves from predators	Livestock sector & JDNP	Wildlife population (human wildlife conflict)	50 h/h in Naro Gewog	
		Livestock sector & JDNP	Wildlife population (human wildlife conflict)	17 h/h in Tsento and Doteng Gewogs	
	16. Electric fence to protect solitary people from wild animals (retreat centres)	Agriculture sector & JDNP	Wildlife population (human wildlife conflict)	10 sets in Soe, Naro and Lingzhi	
	17. Electric fence to protect houses from wild animal attack	Agriculture sector & JDNP	Wildlife population (human wildlife conflict)	47 h/h (9.4Km) in Tsento and Doteng	
2. Drinking water	18. Protection of critical spring shed areas	Environment sector and JDNP	Drinking water, rainfall seasonality	Chhubu and Toewang Gewogs in Punakha	
	19. Water harvesting (herder camps with drinking water issues)	Livestock sector & JDNP	Drinking water	9 herder camps with acute drinking water problem in Tsento and Doteng Gewogs	
3. Pastureland	20. Livestock breed improvement	Livestock sector	Unproductive breeds increasing pressure on pastureland	Punakha (Goenshari, Chhubu and Toewang Gewogs)	

	21. Establish improved private pasture	Livestock sector	Pastureland	50 Acres per Gewog in Goenshari, Chhubu and Toewang Gewogs (on pilot basis)	
	22. Creation of communal grazing pasture (decongest grazing areas near settlements/alternate pasture in higher elevation)	Livestock and Land sectors	Pastureland	Khatoed Gewog Gasa	Permissible under the land lease guideline
	23. Feed and fodder development and conservation with fencing	Livestock sector	Pastureland	100 Acres in Soe, Naro and Lingzhi	
4. Forest composition	24. Construction of biogas plants	Livestock sector	Forest composition	10 households each in Goenshari, Chhubu and Toewang Gewogs	
	25. Design, manufacture and supply of Bukhari that can use dung as fuel	Livestock sector & JDNP	Forest composition	47 herders in Tsento and Doteng	
5. Crop yield	26. Crop diversity	Agriculture sector	Crop yield	Punakha (Goenshari, Chhubu and Toewang Gewogs)	
6. Irrigation	27. Smart Irrigation (covered channels for improved conveyance efficiency)	Agriculture and Engineering sectors	Irrigation	Punakha (Goenshari, Chhubu and Toewang Gewogs)	

	28. Climate smart irrigation channel (channel with pressure brakes at appropriate distance)	Agriculture sector	Irrigation	25Km in Gasa (Khatoed and Khamaed)	
Adaptive capacity (Physical asset)	29. Solar heating systems in schools and other government institutions	Education, Health sectors and JDNP	Avoid chilling winter cold	3 Schools and 3 BHUs in Soe, Naro and Lingzhi	
Adaptive capacity (Human asset)	30. Awareness & mock drill along the GLOF basin	Environment sector and JDNP	Risk of GLOF from Lunana, preparedness	Chhubu and Toewang Gewogs in Punakha	
Adaptive capacity (Human asset)	31. Research on conflicting species	JDNP, Dzongkhags and Gewogs	Crop and livestock depredation by wild animals		
Adaptive capacity (Human asset)	32. Specialized short course on forest and water to park staff		Decline in forest composition, drying up of water sources		
Adaptive capacity (Natural asset)	33. Land development & management (create arable land for production & food security) -500 acre	Agriculture, Gewog& Land sector	Landslides and loss of fertility in the farmland		Permissible under the land lease guideline

Adaptive capacity (Human asset)	34. Exposure trips/ tour to 3rd country with good CC adaptation practices (LGs and selected farmers from the CC affected sites)	Gewog, RNR-sectors & park	Lack awareness on the risk posed by different variable of CC Enhance capacity of the communities on some best management practices prevalent in other countries	Laya, Lunana, Khatoed&Khamoed	No COVID (Lockdowns)
Adaptive capacity (Natural asset)	35. Eco-demo park in Gasa (model park)	Dzongkhag, Gewog and JDNP	Enhance adaptation measures to CC (convey CC message to people visiting the model park)	Laya, Lunana, Khatoed&Khamoed	Permissible under the land lease guideline
Adaptive capacity (Physical asset)	36. Construct toilet & tea points along Zhabdrung trail (Khatoed-Lingzhi)	Dzongkhag, Gewog and JDNP	Reduction of waste and pollution	Khatoed	
Adaptive capacity (Physical asset)	37. Recycle machines (waste management)	Environment, Gewog & JDNP	Reduction of waste and pollution	Khatoed	
Adaptive capacity (Physical asset)	38. Purchase of dumper placer vehicle and bins (Waste management in the Gewogs)	Environment, Gewog & JDNP	Unmanaged waste (enhance disposal of waste to designated location)	Goenshari, Chhubu and Toewang in Punakha	
Adaptive capacity (Human asset)	39. Zero waste Bhutan App advocacy and training	Environment, Gewog, TCB, GAB, ABTO & JDNP	Unmanaged waste in high altitude areas	Soe, Naro and Lingzhi	

Adaptive capacity (Financial asset)	40. Farm house (geyser-toilet, access road)	Gewog, Park & Dzongkhag	Camping in undesignated sites and littering the areas with unmanaged waste	Khatoed & Khamoed	
Adaptive capacity (Human asset)	41. Awareness on climate change adaptation in Schools and communities	Environment sector JDNA	School children and local communities lack knowledge and awareness on CC and measures to cope from risk posed by different CC variables	Soe, Naro and Lingzhi	
Adaptive capacity (Physical asset)	42. Supply of customized roof trusses and tarpaulins to herders	Livestock sector & JDNA	Herders cut trees and poles yearly to make temporary herder camps in various location	47 herders in Tsento and Doteng	
Adaptive capacity (Physical asset)	43. Solar lighting	Livestock sector & JDNA	Electric supply not possible in herder camps, so no light, difficult life for herders	47 herders in Tsento and Doteng	
Adaptive capacity (Social asset)	44. Biking trail development from Chindukha to Dragay Phangtsho (promote eco-tourism at the same time institute responsible waste management mechanism)	Engineering sector & JDNA	Production of unmanaged waste at Dragay Phangtsho area by trekkers, no proper route and therefore no management	7Km in Doteng Gewog	

Adaptive capacity (Financial asset)	45. Business planning and media production on Dragay Phangtsho eco-trail (brochure and broadcast)	Engineering sector, TCB & JDNP	People not aware of the availability of shorter route to Dragay Phangtsho from Chindukha in Doteng	Doteng Gewog	
Adaptive capacity (Physical asset)	46. Procure bikes for Mobile AI facility in Chhubu and Toewang and for agriculture Extension Agents in 3 Gewogs	Livestock and agriculture sectors	Quick response to breed improvement (AI) and Agricultural service delivery	2 bikes for mobile AI service in Chhubu and Toewang 3 bikes for 3 agri EAs of 3 Gewogs	

<b>Section 3. Potential Roles and Responsibilities</b>			
<b>Adaptation Action</b>	<b>Lead Stakeholder</b>	<b>Collaborating Stakeholder</b>	<b>Support Needed</b>
1. Protected Agriculture: Use of Greenhouse	Agriculture sector, Punakha	FMCL, Engineering sectors, JDNP and Gewogs	Fund mobilization
2. Customized greenhouse to suit the climatic conditions in high elevations	Agriculture sectors, Thimphu and Paro	FMCL, Dzongkhag, JDNP and Gewogs	Fund mobilization
3. Maintenance of irrigation channels: Replace concrete irrigation channels with polythene pipes	Agriculture and Engineering sectors, Punakha	Dzongkhag, Gewogs and JDNP	Fund mobilization
4. Proper drainage in the settlement, town & agriculture land	Engineering and Environment sectors	Dzongkhag, Khatoed Gewog	Fund mobilization
5. Maintenance of wooden bridges	Engineering sector, Paro	Dzongkhag, JDNP	Forestry clearance and timber permit



			Fund mobilization
6. Land Management	Agriculture sector, Punakha	Dzongkhag, Regional Research Centres, Central agencies (NSSC), JDNP	Technical expertise from various discipline
7. Farm-road improvement (all weather)	Agriculture and Engineering sectors, Punakha	Dzongkhag, JDNP	Fund mobilization
8. Blacktop farm roads	Engineering sector, Gasa	Dzongkhag, Gewog, JDNP	Fund mobilization
9. Maintenance of footpaths	Engineering sector, Paro	Dzongkhag, Gewogs, JDNP	Fund mobilization
10. Flood risk awareness along GLOF risk areas	Environment sector, Thimphu	Dzongkhag, Gewogs, JDNP	Fund mobilization
11. River bank protections along GLOF area	Environment and Engineering sectors, Punakha	Dzongkhag, Gewogs, JDNP	Clearances (forestry and environment) Excavator from Dzongkhag Fund mobilization
12. Construct concrete band to reinforce roof of houses in storm prone areas	Engineering sector, Thimphu	Dzongkhag, Gewogs	Fund mobilization by the coordinating agency
13. Chain link fencing	Agriculture and Livestock sectors, Gasa and Punakha	Dzongkhag, Gewogs, JDNP	Forestry clearance Fund mobilization
14. Improved livestock sheds	Livestock sector, Punakha	Dzongkhag, Gewogs, JDNP	Subsidy on timber for construction of sheds Fund mobilization
15. Coral fencing to protect yak calves from predators	Livestock sectors, Thimphu and Paro	Gewogs and JDNP	Fund mobilization

16. Electric fence to protect solitary people from wild animals (retreat centres)	Agriculture sector, Thimphu	JDNP	Fund mobilization
17. Electric fence to protect houses from wild animal attack	Agriculture sector, Paro	Gewogs and JDNP	Fund mobilization
18. Protection of critical spring shed areas	Environment sector, Punakha	Gewogs, JDNP, WMD	Technical expertise from WMD Fund mobilization
19. Water harvesting (herder camps with drinking water issues)	Livestock sector, Paro	JDNP, Irrigation Div. under MoAF	Technical expertise from the Irrigation Div. of the MoAF Fund mobilization
20. Livestock breed improvement	Livestock sector, Punakha	Gewog, Central Programs	Fund mobilization
21. Establish improved private pasture	Livestock sector, Punakha	Gewogs, LPO, Central Programs	Seeds and technical expertise Fund mobilization
22. Creation of communal grazing pasture (decongest grazing areas near settlements/alternate pasture in higher elevation)	Khatoed Gewog, Gasa	Livestock and Land sector, Dzongkhag, JDNP	Land lease Forestry clearances Technical expertise Fund mobilization
23. Feed and fodder development and conservation with fencing	Livestock sector, Thimphu	Gewogs, LPO, Central Programs,	Seeds and technical expertise Fund mobilization
24. Construction of biogas plants	Livestock sector, Punakha	Gewogs and JDNP	Fund mobilization
25. Design, manufacture and supply of Bukhari that can use yak dung as fuel	JDNP (SPRO)	Engineering Livestock sector of Paro, FMCL	Technical expertise Fund mobilization
26. Crop diversity	Agriculture sector, Punakha	Research Centre, Bajo, Gewogs	Technical expertise Fund mobilization

27. Smart Irrigation (covered channels for improved conveyance efficiency)	Agriculture and Engineering sectors, Punakha	Environment sector, Gewogs, JDNP	Technical expertise Fund mobilization
28. Climate smart irrigation channel (channel with pressure brakes at appropriate distance)	Agriculture sector, Gasa	Engineering and Environment sectors, JDNP, Irrigation Div. under MoAF	Technical expertise Fund mobilization
29. Solar heating systems in schools and other government institutions	Education and Health sectors, Thimphu	Dzongkhag, Gewog, DRE, JDNP	Technical expertise Fund mobilization
30. Awareness & mock drill along the GLOF basin	Environment sector, Punakha	Dzongkhag, Gewogs, JDNP	Fund mobilization
31. Research on conflicting species	JDNP	UWICER, NCD, DoFPS, Dzongkhags and Gewogs	Technical expertise
32. Specialized short course on forest and water to park staff	JDNP	NCD, DoFPS	HR approval from the Department, HRD and Ministry
33. Land development & management (create arable land for production & food security) - 500 acre	Khatoed Gewog, Gasa	Land and Agriculture sectors, JDNP, NLC	Land lease Forest clearance
34. Exposure trips/ tour to 3rd country with good CC adaptation practices (LGs and selected farmers from the CC affected sites)	Gewogs, JDNP	NCD, DoFPS	HR approval from the Department, HRD and Ministry Fund mobilization
35. Eco-demo park in Gasa (model park)	Khatoed Gewog Beautification Officer and Extension Officers	Dzongkhag, JDNP	Forestry clearance and other relevant clearances Technical expertise from various fields

36. Construct toilet & tea points along Zhabdrung trail (Khatoed-Lingzhi)	Khatoed Gewog, Gasa	Dzongkhag, JDNP	Forestry clearance Fund mobilization
37. Recycle machines (waste management)	Environment sector, Gasa	Dzongkhag, Gewog, JDNP	Clearances Fund mobilization
38. Purchase of dumper placer vehicle and bins (Waste management in the Gewogs)	Environment sector, Punakha	Dzongkhag, Gewog, JDNP	Fund mobilization
39. Zero waste Bhutan App advocacy and training	Environment sector, Thimphu	Gewogs, TCB, GAB, ABTO & JDNP	General public and government's support in strict implementation of the waste act
40. Farm house (geyser-toilet, access road)	Khatoed Gewog, Gasa	Engineering sector, JDNP	Fund
41. Awareness on climate change adaptation in Schools and communities	Environment and Education sectors, Thimphu	Schools Principals, Gewogs, JDNP	Fund mobilization
42. Supply of customized roof trusses and tarpaulins to herders	JDNP (SPRO)	Paro Livestock sector, Gewogs, FMCL	Fund
43. Solar lighting	JDNP	Paro Livestock sector, Gewogs, NCD, DRE	Fund
44. Biking trail development from Chindukha to Dragay Phangtsho (promote eco-tourism at the same time institute responsible waste management mechanism)	Doteng Gewog, Paro & SFES, JDNP	Paro Engineering sector, NCD, TCB	Technical guidance from NCD and TCB Technical expertise from relevant organizations such as ABTO and GAB
45. Business planning and media production on Dragay Phangtsho eco-trail (brochure and broadcast)	JDNP, Doteng Gewog	NCD, TCB	Technical guidance from NCD and TCB Technical expertise from relevant organizations such as ABTO and GAB

46. Procure bikes for Mobile AI facility in Chhubu and Toewang and for agriculture Extension Agents in 3 Gewogs	Livestock and agriculture sectors, Punakha	JDNP	Fund
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Section 4. Implementation and Resourcing								
Adaptation Action	Next Step for Implementation	New or Existing	Cost (Nu. million)			Funding Available	Timeline Year (1-10)	Key Performance Indicator
			Unit	Rate	Total			
1. Protected Agriculture: Use of Green House (GH)	Procurement of fabricated GH equipment, Selection of progressive vegetable grower, Supply and installation of GH	New	20 sets	0.15	3	No	2	Fabricated GH procured, supplied and established
2. Customized greenhouse to suit the climatic conditions in high elevations	Design and fabricate Green House equipment, selection of progressive vegetable grower, supply and installation of GH	New	50 sets	0.15	7.5	No	1 & 2	Customized (snow resistant) GH designed and installed
3. Maintenance of open irrigation channels: Replace concrete irrigation canals with polythene pipes	Procure and supply of polythene pipes for maintenance of irrigation channels	New			60	No	2	Polythene pipes procured and supplied in affected areas

4. Proper drainage in the settlement, town & agriculture land	Develop drainage plan in Gasa Dzong and Khatoed area including both old and new town	New	35 km	0.05	1.75		9	Drainage in Gasa improved
5. Maintenance of wooden bridges	Apply for forestry clearance and timber permit, construct bridge	New	4 Nos.	0.25	1	No	1	Wooden bridges connecting the herder camps and communities maintained
6. Land Management	Strategize the land management option depending on the vulnerable of the community/ies, implement land management	New			10			Land susceptible to landslides and flooding in Chhubu, Toewang and Goenshari brought under sustainable land management practices
7. Farm-road improvement (all weather)	Fund sourcing	Existing	50 km	3.5	175	No	5	All farm roads exposed to eroding factor improved
8. Blacktop	Site selection (road prone to landslide)	New	6 km	1.8	10.8	No	6	Roads prone to landslides blacktopped

9. Maintenance of footpaths	Apply for forestry clearance, carry out maintenance	New	30 km	0.035	1.05	No	2 & 3	Footpaths maintained
10. Flood risk awareness along GLOF risk areas	Prepare material for awareness	New			0.25	No	3	Awareness conducted and reported
11. River bank protections along GLOF area	Pitching of boulders along the river bank in areas vulnerable to eroding	New			1.2	No	2	Boulder pitched along eroding the river banks
12. Construct concrete band to reinforce roof of houses in storm prone areas	Procurement and supply of materials, construction of concrete bands	New	15 HHs	0.01	0.15	No	1 & 2	Roofs of reinforced in the storm prone areas in Soe and Lingzhi
13. Chain link fencing	Procurement of materials (cement, barbed wire, mesh, angle rods), Apply for forestry clearance, Construction of chain link fences	New	45 km	1.5	67.5	No	1 to 3	Farmlands with high HWC impact in Gasa and Punakha, fenced with chain link fences, 35 and 10km respectively
14. Improved livestock sheds	Select innovative farmers, procure materials and construct sheds	New	15 HHs	0.36	5.4	No	4	Bulls bought and supplied to beneficiary communities

15. Coral Fencing (CF) to protect yak calves from predators	Procurement, transport and supply 50 CF materials for herders in Naro Gewog	New	50 sets	0.02	1	No	1 & 2	Coral fence materials supplied
	Procurement, transport and supply 17 CF materials for herders in Tsento and Doteng Gewogs		17 sets	0.02	0.34	No	1 & 2	Effectiveness of CF in protecting yak calves monitored and documented
	Procurement, transport and supply 60 CF materials for herders in Laya Gewog		60 sets	0.02	1.2	No	4	
	Procurement, transport and supply 110 CF materials for herders in Lunana Gewog		110 sets	0.02	2.2	NO	7	
16. Electric fence to protect solitary people from wild animals (retreat centres)	Procurement, transport and supply of materials	New	10 sets	0.035	0.35	No	4	
17. Electric fence to protect houses from wild animal attack	Procurement, transport and supply of materials	New	47 sets	0.1	4.7	No	2 & 3	Houses in HWC prone areas fenced with EF in Tsen
18. Protection of critical spring shed areas	Mapping of recharge areas for critical springs	New			0.3	No	1	Recharge areas of all critical spring water in Chhubu, Toewang and



								Goenshari mapped
	Design and implement nature-based solutions in the recharge areas	New			0.8	No	2 to 10	Water discharge monitored after intervention
19. Water harvesting (herder camps with drinking water issues)	Procure materials Develop water harvest wells	New	9 herders	0.1	0.9	No	1	Water collection distance reduced for 9 herders in Tsento and Doteng
20. Livestock breed improvement	Procure and supply of improved breeding bulls (Jersey and Mithun)	New	4 Nos.	0.016	0.064	No	1	Bulls bought and supplied to beneficiary communities
21. Establish improved private pasture	Procure seeds Select progressive farmers and establish pasture	New	150 acres	0.04	6	No	3	Improved private pasture established in Chhubu, Toewang and Goenshari
22. Creation of communal grazing pasture (de-congest grazing areas near settlements/alternate pasture in higher elevation)	Process land lease, Develop pasture	New	1000 acres		0.3	No	7	Pasture developed to keep scrub cattle away from settlement

23. Feed and fodder development and conservation with fencing	Procurement of Seed, seedling and fodder conservation material, Procurement of fencing materials	Existing promotion	100 acres	0.03	3	No	8 to 10	Feed and fodder developed and conserved in Soe, Naro and Lingzhi
24. Construction of biogas plants	Procure materials, construction of bio-gas plants	Existing promotion	36 Nos.	0.06	2.16	No	2 to 5	Bio-gas plants established in 36 hh in Toewang, Chhubu and Goenshari
25. Design, manufacture and supply of Bukhari that can use dung as fuel	Design and fabricate dung fuel Bukhari, transport and supply	New	47 Nos.	0.016	0.752	No	3 & 4	Bukharis procured and supplied to 47 herders
26. Crop diversity	Supply of climate resistant crop variety seeds	New			3	No	1 & 2	Seeds of climate resilient crops procured and supplied
27. Smart Irrigation (covered canal that improves conveyance efficiency)	Procurement of Irrigation equipments	New			3	No	2 to 5	Conveyance efficiency of irrigation channels improved
28. Climate smart irrigation channel (channel with pressure brakes at	Estimate and drawing, construction of channels	New	25 km	0.05	1.25	No	1 to 3	Conveyance efficiency of irrigation

appropriate distance)								channels improved
29. Solar heating systems in schools and other government institutions	Procurement of solar heating systems, Transportation and installation	New	6 sets	0.3	1.8	No	5 to 8	Heating systems supplied
30. Awareness & mock drill along the GLOF basin	Awareness & mock drills provided to the community	New	10 times	0.2	2	No	1 to 10	Awareness and mock drill conducted every year to keep people alert in risk zones
31. Research on conflicting wildlife species	Framing research questions and developing research proposal	New			0.6	No	5 & 10	The population dynamics, prey base and habitat condition of conflict species studied and documented
32. Specialized short course on forest and water to park staff	Exploring relevant courses	New	14 heads	0.26	3.64	No	4	Capacity of park staff enhanced

33. Land development & management (create arable land for production & food security) -500 acre	Process and lease Forestry clearance Land development	New	250 acres	0.01	2.5	No	1 to 3	Arable land developed and food production enhanced
34. Exposure trips/ tour to 3 <sup>rd</sup> country with good CC adaptation practices (LGs and selected farmers from the CC affected sites)	Farmer's selection. Trip organization	New	300 heads	0.15	45	No	3 & 8	Farmer's knowledge of CC enhanced
35. Eco-demo park in Gasa (model park)	Site identification Process forestry clearance and land lease Site development	New			10	No	4 to 6	Eco-park developed
36. Construct toilet & tea points along Zhabdrung trail (Khatoed-Lingzhi)	Forestry clearance Construction of work	New	7 Nos.	2	14	No	2 & 3	Sanitation and cleanliness along Zhabdrung trail ensured
37. Recycle machines (waste management)	Procure recycle machine Establish recycle plants	New			5	No	1	Reduced waste in Gasa Dzong and Khatoed Gewog area
38. Purchase of dumper placer vehicle and	Procurement of vehicle	New	1 Nos.	6	6	No	4	Waste management

bins (Waste management in the Gewogs)								improved in 3 Gewogs
	Awareness and campaign on waste management and segregation		5 times	0.2	1	No	4 to 8	Annual awareness report published
39. Zero waste Bhutan App advocacy and training	Conduct advocacy and training on the App	New			0.5	No	2	Measurable reduction in waste, people use the App
40. Farm house (geyser-toilet, access road)	Select farmers for farmhouse, materials and construction	New	20 HHs	0.25	5	No	3 & 4	Farm houses furnished for tourist to stay
41. Awareness on climate change adaptation in Schools and communities	Preparation of awareness materials and formation of interdisciplinary team of expertise (target oriented material)	New	3 Gewogs	0.15	0.45	No	1 & 6	Awareness report published
42. Supply of customized roof trusses and tarpaulins to herders	Design and fabricate roof trusses, procure, transport and supply of materials	New	47 nos	0.04	1.88	No	2 & 3	Use of timber and poles for herder camps reduced
43. Solar lighting	Procurement, transport and supply of materials	New	47 Nos.	0.008	0.376	No	1 & 2	Solar lightings supplied to 47 herders
44. Biking trail development from Chindukha to Dragay Phangtsho (promote eco-	Forestry clearance, route development	New	7 km	0.05	0.35	No	1 & 2	Eco-trail developed

tourism at the same time institute responsible waste management mechanism)								
45. Develop business plan for Dragay Phangtsho eco-trail	Meeting with community Plan write up Media production on (brochure and broadcast materials)	New			0.45	No	2 & 3	Business plan developed
46. Procure bikes for Mobile AI facility and for agriculture Extension Agents in 3 Gewogs	Procurement and supply of bikes	New	5 Nos.	0.125	0.625	No	1	Bikes procured and issued to AI technicians and Agri. EAs
<b>Total budget estimate for 10 years</b>					<b>477m</b>			

<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>	<b>Nos. of Participants</b>
14 <sup>th</sup> October 2022	Gasa, Dzongkhag	DAO, DLO, DE, Environment, Planning, Gewog Extension Officers, Gups and Mangmis	10
19 <sup>th</sup> October 2022	Punakha, Dzongkhag	DAO, DLO, DE, Environment, Planning, Gewog Extension Officers, Gups and Mangmis	13
20 <sup>th</sup> October 2022	Thimphu, Dzongkhag	DAO, DLO, DEO, Environment, Planning, Gewog Extension Officers, Gups and Mangmis	9
21 <sup>st</sup> October 2022	Paro, Dzongkhag	DAO, DLO, DE, Environment, Planning, Gewog Extension Officers, Gups and Mangmis	7
<b>Consultation and Plan Preparation led by</b> Rinzin Dorji, Sr. Forestry Officer, dorjirinzin605@gmail.com			

## 8.4 References

- Dendup, P., Dorji, R., Jamtsho, Y., Wangchuk, W., Gyeltshen, J., Tenzin, S., Tenzin, S. & Dorji, R. (2021). People and Livelihood in Jigme Dorji National Park: A Socio-Economic Survey Report. Department of Forest and Park Services, Ministry of Agriculture and Forests. Royal Government of Bhutan. Damji: Gasa.
- Dendup, P., Dorji, S., Dorji, R., Wangdi, L., Wangchuk, T., Dorji, P. & Kuenzang, P. (2020a). Birds of Jigme Dorji National Park: A photographic field guide for the park visitors. Department of Forests and Park Services, Royal Government of Bhutan.
- Dendup, P., Wangdi, L., Kuenzang, P., Jamtsho, Y., Gyeltshen, D., Rigzin, U., Jamtsho, Y., Tashi., Dorji, R., Jamtsho, Y. & Dorji, R. (2021b). Bird diversity in Jigme Dorji National Park: A Rapid Biodiversity Assessment Report. Department of Forest and Park Services, Ministry of Agriculture and Forests. Royal Government of Bhutan. Damji: Gasa.
- Dendup, P., Dorji, R., Jamtsho, Y., Wangchuk, W., Tshering, B. & Dorji, R. (2021). Conservation Management Plan of Jigme Dorji National Park for the period July 2021 – June 2031. Biodiversity Conservation in Pursuit of Gross National Happiness. Department of Forests and Park Services, Ministry of Agriculture and Forests. Damji, Gasa.
- Dorji, R., Namgay, C., Kuenzang, P., Thinley, K., Rigzin, U., Jamtsho, Y., Tashi, Dendup, P., Dorji, P. & Dorji, R. (2021). Floral diversity in Jigme Dorji National Park: A Rapid Biodiversity Assessment Report. Department of Forests and Park Services, MoAF. Royal Government of Bhutan. Damji: Gasa.
- Dorji, T., Dorji, R., Tshering, B, Jamtsho, Y. & Wangdi, L. (2021). Butterflies of Jigme Dorji National Park: A pictorial field guide. Department of Forest and Park Services, Royal Government of Bhutan.
- FRMD (2020). Forest Facts and Figures - 2019. Forest Resource Management Division. Department of Forest and Park Services. Thimphu, Bhutan.
- Jamtsho, Y., Dendup, P., Dorji, T., Dorji, R. & Dorji, R. (2021). Jigme Dorji National Park: A wild felid biodiversity hotspot in Bhutan. *CATnews*(72). pp 30-34.
- Jamtsho, Y., Dendup, P., Wangdi, L., Dorji, R. & Dorji, R. (2022). First confirmed record of a woolly flying squirrel. *Journal of Vertebrate Biology*, 71 (22007), p7.
- Koirala, B. K. & Jamtsho, Y. (2018). Faunal Diversity of Jigme Dorji National Park- A Photographic Guide. Department of Forests and Park Service, Royal Government of Bhutan.
- Ohsawa, M. (ed). (1987). Life Zone Ecology of Bhutan Himalaya. Chiba University, Yayoicho, Chiba. Japan.
- RNR. 2016. The renewable natural resources sector adaptation plan of action, 2016. RNR Climate Change Adaptation Program, Ministry of Agriculture and Forests, Royal Government of Bhutan. Pp 44.
- Yoezer, D., Choden, K., Wangdi, D., Pelzang, S., Tshering, K., Dorji, S. (2022). Community-based Climate Change Vulnerability and Capacity Assessment of the Protected Areas of Bhutan. Uygen Wangchuck Institute for Conservation and Environment Research. Bumthang, Bhutan.



## 9 Climate Change Adaptation Plan of the Biological Corridor-4, Zhemgang Forests Division

### 9.1 Background

Bhutan has more than half of the total geographical area of the country set aside for the conservation of rare, endemic and endangered species of flora and fauna. This area constituting 51.44% are declared as PAs (National Parks, Wildlife Sanctuaries, and Strict Nature Reserve and Biological Corridors). The Biological Corridor (BC) system in Bhutan was declared in 1999 as a ‘Gift to the Earth from the People of Bhutan’ by Her Majesty Ashi Dorji Wangmo Wangchuck. The management of biological corridors is vested within the Territorial Forest Divisions (TFD).

Biological Corridors are generally defined as an area that connects one or more PAs and provides ecological connectivity between landscapes, ecosystems, and habitats. It ensures the movement of flora and fauna creating links between PAs directly or indirectly. Corridors are mainly meant to connect habitats for “effective conservation of populations, community and the maintenance of ecological processes in landscapes” (Bennett 2003).

The Biological Corridor 4 (BC4) which connects the Jigme Singye Wangchuck National Park, Royal Manas National Park and Phrumsengla National Park provides a wildlife movement corridor to several threaten wildlife species including Royal Bengal Tiger as the key species using the corridor.

The corridor recorded 26 species of mammals through camera traps. Three cubs belonging to two individual Tigris were captured in the camera trap from the corridor. The corridor recorded 305 species of birds belonging to 61 families encompassing 9 threatened and 65 migratory birds. It is also home to the critically endangered White Bellied Heron with its active nesting in the corridor. Other species record includes; 37 species of mushrooms, 38 species of ferns, 15 species of damselflies, eight species of dragonflies, 23 species of snakes, three species of frogs, 129 species of orchids, 150 species of orchids, and 36 species of moths.

The total population estimate of resident communities in BC4 is 3644, with a male to female ratio of 53:47. The household member living with the household is primarily occupied by those aged between 20 to 40 years. The construction and renovation of their residential homes encompass most of the annual expenses. The more significant portion of the land is dryland (58.97%), followed by wetland (21.96).

Communities grow ten varieties of cereal crops, and maize is the most grown cereal crop, followed by wetland rice and bitter buckwheat. In addition, local communities grow 13 varieties

of cash crops, including cardamon, ground apple, and sweet potato, at a larger scale. All the households are growing either type of vegetable among the 20 varieties of vegetables grown by the communities. The farmers in the corridor rear ten varieties of livestock; most practice tending in the agriculture field and sending them to the forest as livestock caring option. Most believe that insufficient fodder and low milk are the central problem of livestock rearing apart from human-wildlife conflict.

The climate change and its impacts are evident and vivid in the Himalayan country like Bhutan. It is vital to know the status of climate change and rightful actions are needed to make the environment and local communities resilient to its dynamism. People are experiencing climate change in diverse ways. It affects our health, ability to grow food, housing, safety and work, thus we are already vulnerable to climate impacts. Adapting to climate consequences protects people, homes, businesses, livelihoods, infrastructure and natural ecosystems. It covers current impacts and those likely in the future. Adaptation will be required everywhere, but must be prioritized now for the most vulnerable people with the fewest resources to cope with climate hazards. Therefore, to determine the status on climate change and its vulnerability towards community and environment, an assessment on Climate Vulnerability Capacity Assessment was conducted in year 2021 for selected protected areas in Bhutan and it also includes BC4.

BC4 falls within the second most exposure risk with exposure index of 0.37 with rainfall seasonality as the highest (88%) and extreme temperature with 65% as the next among the indicators. Human wildlife conflict followed by drinking and irrigation water availability are the main contributor to sensitivity in the corridor, where it ranked 2<sup>nd</sup> in the sensitivity indicator with sensitivity index of 0.28. The corridor also has the 2<sup>nd</sup> highest adaptive capacity with adaptive capacity index of 0.72. The vulnerability index of the is 0.01, which it neither most vulnerable nor safe from vulnerability because of is intact adaptive capacity.

It has seen paramount importance to have climate change adaptation action plans to reduce the effects of climate change and enhance resilience of the local communities to the impacts of climate change. Therefore, this plan presents the key climate change issues and their mitigation or reduction actions in BC4.

## 9.2 Objective

- To enhance the community resilience to climate change through prioritized climate action interventions

### 9.3 Adaptation Priorities of Biological Corridor-4, Zhamgang Forests Division

#### Section 1. Priority Climate Vulnerabilities

Rank of issues contributing to higher exposure to climate vulnerability (% of households)

1. Rainfall seasonality (85%)
2. Windstorm (53%)
3. Temperature extreme (43%)
4. Landslides (25%)
5. Seasonal droughts (17%)

Rank of issues contributing to higher sensitivity to climate vulnerability (% of households)

1. Human-Wildlife Conflict (80%)
2. Drinking water (46%)
3. Irrigation water (38%)
4. Forest composition (35%)

Rank of issues contributing to low adaptive capacity (% of households)

1. Vocational skill (3.75%)
2. Community group (10%)
3. Household literacy (21%)

## Section 2. Priority Actions to Address Vulnerabilities

Priority Climate Vulnerabilities	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Rainfall seasonality	Sensitization of public on erratic /rainfall pattern due to climate change impacts	Forestry	Increasing impact of rainfall seasonality risk	Whole area	
	Installation of weather station to get rainfall data and provide information to the community	Forestry	Increasing impact of rainfall seasonality risk	Duenmang, Nimshong, Buli and Baling	
	Encourage cut and carry feeding system for cattle	Livestock	Increasing risk of livestock mortality	Cattle owners	Cutting and looping of the trees leads to deforestation
	Encourage sedentary/confined rearing system of cattle	Livestock	Increasing risk of livestock mortality	Buli, Khikhar, Nimshong	
	Inform periodic weather forecast to public	Disaster risk reduction	Increasing impact of rainfall seasonality risk	Whole area	
	Promote traditional practices to please local deity.	Human tradition	Increasing impact of rainfall seasonality risk	Whole area	
	Support supply of climate resistant and improved agriculture seeds	Agriculture	Increasing impact of rainfall seasonality risk	Duenmang, Kamjong, Nyakhar and Tsaidang	

	Construction of concrete reservoir tank to store water to be used during lean season.	Infrastructure	Increasing risk of water scarcity	Radhi, Nimshong Zangling and Thajong	Increase flood and landslide risk if not managed properly
2. Windstorm	Plantation of trees and bamboo species around agriculture land (eg. Fodder trees, Willow)	Agriculture and forest	Increasing risk of windstorm damage	Kamjong-Duenmang, Buli, Khikhar	
	Introduction of windstorm tolerant crop varieties	Agriculture		Kamjong-Duenmang, Tali, Kikhar	
	Support of wind storm resistant house construction materials (pro-poor)	Climate smart Infrastructure,	Increased impact of windstorm impact	Kamjong-Duenmang, Radhi, Thajong, Buli	Risk of social division while selecting pro-poor household
	Sensitization and advocacy on periodic windstorm forecast to reduce the impacts and use of windstorm proof timber	Dzongkhag Disaster Management	Increased impact of windstorm impact	Whole community	
2. Extreme temperature	Sensitization and advocacy on extreme temperature events	Forestry	Increasing impact of extreme temperature impacts	Whole community	
	Protected and promote resilient agricultural practices (greenhouse, heat tolerant crop varieties, etc)	Agriculture	Increasing risk of low agriculture productivity/yield	Khikhar, Buli, Ngakhar, Tsaidang Baling	Risk of social division

					while selecting the beneficiary household
	Establishment of efficient cold chain facilities	Agriculture	Increasing risk of low marketing of the agricultural products	Strategic points of BC4 communities	
	Promote and conservation of native animal breeds to thrive extreme temperature. (Jatsham sapha and dompha)	Livestock	Increase risk of low livestock productivity	Duenmang, Nimshong, Koshala	Risk of losing local breed cattle
3. Landslides	Bio-engineering works in landslide prone areas	Nature based solution	Increasing risk of landslides	Duenmang, Koshala, Buli to Tsaidang farm road	
	Initiation of sustainable land management activities such as plantations.	Nature based solution	Increasing risk of landslides	Kamjong, Thajong, Radhi	Reduction in area of community grazing land
	Maintain proper drainage systems	Infrastructure	Increasing risk of landslides	Newly and unstable roads	
	Construction of slope retention structure	Climate smart infrastructure	Increasing risk of landslides	Duenmang, Reotala, along newly constructed farm roads	

4. Seasonal droughts	Initiate water recharge interventions (trenches, water holes, etc) for recharging of water table and springs.	Water	Increasing scarcity of water availability	Kamjong, Nimshong, Radhi	Habitat alteration due to human induced intervention
	Introduction of drought resistant crop varieties	Agriculture	Increasing risk of low productivity due to less drought resistant diversity	Duenmang, Kamjong, Radhi, Nimshong	May take longer time to bring to the field because of the long feasibility research
5. Human-Wildlife Conflict	Identify HWC hotspot area	Forestry, Agriculture, livestock	Increasing intensity of Human wildlife conflict incidences	Whole area	
	Awareness creation on HWC to the communities	Forestry	Increasing risk of HWC impacts	Whole area	
	Chain link fencing to reduce HWC	Forestry, Agriculture, livestock	Increasing risk of damage by the wild animals	Nimshong, Buli (Bumdeling area) and Baling	May reduce feeding habitat of wild animals
	Initiate HWC insurance schemes for crop and livestock	Forestry, Agriculture, livestock	Increasing risk of damage by the wild animals	Nimshong, Kikhar, Baling	

	Introduction of improved livestock breeds (AI program)	Livestock	Increased exposure of livestock to depredation by wild predators	Whole area	Risk of losing local cattle breed
	Initiation of alternative interventions such as stall feeding, rotational grazing, improvement of pastureland, etc	Forestry, Agriculture, livestock	Increased exposure of livestock to depredation by wild predators	Tsaidang and Ngakhar	
	Wildlife habitat enhancement	Forestry	Poor quality wildlife habitat	Malaya, Yangarpang and Boilera	Risk of increased poaching in the improved habitats
	Improve pasture development	Livestock	Risk of reduced and less productive pastureland	Baling, Koshala and Khikhar	Deforestation due to creating of pasturelands
	Support for high yielding cows to affected areas	Livestock	Increasing risk of low productivity and exposure to depredation by wild predators	Buli, Khikhar, Koshala and Thajong	Risk of losing local cattle breed
	Strengthen technical capacity in wildlife rescue operation	Human capacity	Reduced knowledge to response to HWC	ZFD staff & RRT at community level	
	Support electric fencing	Agriculture	Increased risk of HWC	Koshala	



6. Drinking water and source	Conservation and protection of water catchment areas	Forestry, Water	Increasing risk of water scarcity	Radhi, Baling, Kamjong, Reotala	Alteration of wildlife habitats
	Drinking water reservoir/tank construction	Forestry, Water	Increasing risk of water scarcity	Koshal-Tongtophey drinking water	
	Hydrogeological mapping of critical water source areas and intervention works.	Forestry, Water,	Increasing risk of water scarcity	BC4 whole area	
	Support Rural Water Supply Scheme	Forestry, Water,	Increasing risk of water scarcity	Tongling, Kamjong and lower Baling	
7. Irrigation water	Renovation of climate proof (resilient) irrigation scheme (Pipe & Pressure system)	Forestry, Water, Agriculture	Increasing risk of water scarcity	Pangzur & pandee	
	Irrigation water source protection by constructing retention wall	Forestry, Water, Agriculture	Increasing risk of water scarcity	Baling	
	Build irrigation channel for Koshala (3km) (60 acres) (HDPE supply)	Forestry, Water, Agriculture	Increasing risk of water scarcity	Koshala	
	Construction of irrigation channel from Rongdugang to Sibgigang paddy field	Agriculture	Increasing risk of water scarcity	Nimshong chiwog	Deforestation during construction of irrigation channel
	Promote micro-irrigation (drip, sprinkler) and rain water harvesting	Agriculture	Increasing risk of water scarcity	Radhi and Kamjong	Deforestation during construction

					of irrigation channel
8. Forest composition	Enrichments plantation in barren areas/fallow land (or pasture land development)	Nature based solution	Increasing risk of forest lost	Pangzur and Baling	Might reduce grazing area of wild herbivores and livestock grazing
	Protection of forest area through SMART patrolling	Forestry	Increasing risk of forest lost	Whole area	
9. Vocational skill	Train youth/school dropouts on vocational skills (Agriculture, horticulture, livestock farming, etc.), training on essential services (saloon, cobbling, toothpick making, incense making, baking, ice-cream making, etc)	Human capacity	Risk of low adaptive capacity to response to climate change impacts	Koshala, Baling, Buli, Khikhar	
	Train local youths on carpentry, masonry, electrical	Human capacity	Risk of low adaptive capacity to response to climate change impacts	Koshala and Baling	
	Train youths/school dropouts on nature guide (Bird watching, Butterfly watching, etc)	Human capacity, Nature based solution	Risk of low adaptive capacity to response to climate change impacts	Buli	
10. Community group	Knowledge exchange programs for communities through study tours	Human capacity	Risk of high impact exposure	Whole area	

			to climate change adverse events		
	Provide book & Record keeping training to CFMG member to enhance their capacity in CF management	Human capacity	Risk of high impact exposure to climate change adverse events	7 CFs	
	Create awareness and group formation on uses of lesser-known plant/tree species/ Promote WBIs.	Human capacity	Risk of high impact exposure to climate change adverse events	Kikhar, Ngakhar-Tsaidang, Buli & Duenmang-Kamjong chiog.	
	Promote community-based ecotourism groups (Homestays, eco-camps, natural trails, souvenir shops-Traditional)	Human capacity	Increasing risk of livelihood alternatives impacted from climate change events	Buli, Nimshong and Koshala	
	Strengthening of existing citizen-science groups of farmers and youths	Human capacity	Increasing risk of livelihood alternatives impacted from climate change events	Cattle herders of BC4 and school dropout youths	
11. Household literacy	Initiation of non-formal education (NFE) in the community	Human capacity	Risk of low adaptive capacity to response to climate change impacts	Lower and upper part of BC4	

	Conduct awareness on policy and rules related to Climate adaptation practices	Human capacity	Risk of low adaptive capacity to response to climate change impacts		
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### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
Sensitization of public on erratic /rainfall pattern due to climate change impacts	Forestry	Local government	Funding, technical support on climate change
Installation of weather station to get rainfall data and provide information to the community	Forestry	NCHM	Funding and technical support for procurement and installation of the weather station
Encourage cut and carry feeding system for cattle	Livestock	Local government, Forestry	Public support from local government
Encourage sedentary/confined rearing system of cattle	Livestock	Local government, Forestry	Coordination support from local communities
Inform periodic weather forecast to public	NCHM	Forestry	
Promote traditional practices to please local deity.	Local government		Coordination support from local communities
Support supply of climate resistant and improved agriculture seeds	Agriculture	Local government	Funding
Construction of concrete reservoir tank to store water to be used during lean season.	Agriculture	Local government, forestry, engineering section	Funding and technical support on design and work execution estimation by engineer

Plantation of trees and bamboo species around agriculture land (eg. Fodder trees, Willow)	Agriculture and forest	Local government	Funding and labour support from local communities
Introduction of windstorm tolerant crop varieties	Agriculture	Local government	Funding and coordination support from local communities
Support of wind storm resistant house construction materials (pro-poor)	Local government	Dzongkhag administration, Forestry	Funding
Sensitization and advocacy on periodic windstorm forecast to reduce the impacts and use of windstorm proof timber	Dzongkhag Disaster Management	Forestry, local government	Funding and coordination support from local communities
Sensitization and advocacy on extreme temperature events	Forestry	Forestry, local government	Funding and coordination support from local communities
Protected and promote resilient agricultural practices (greenhouse, heat tolerant crop varieties, etc)	Agriculture	Local government	Funding
Establishment of efficient cold chain facilities	Agriculture	Local government	Funding and labour support from local communities
Promote and conservation of native animal breeds to thrive extreme temperature. (Jatsham sapha and dompha)	Livestock	Local government	Funding and cost sharing support from local communities
Bio-engineering works in landslide prone areas	Forestry	Local communities, Department of Road	Funding
Initiation of sustainable land management activities	Forestry, agriculture	Local government	Funding and labour support from local communities

Maintain proper drainage systems	DoR, local government	Local government	Coordination support from local communities
Construction of slope retention structure	Forestry	Local government, DoR	Funding
Initiate water recharge interventions (trenches, water holes, etc) for recharging of water table and springs.	Forestry	Local government	Funding
Introduction of drought resistant crop varieties	Agriculture	Local government	Funding
Identify HWC hotspot area	Forestry	Local communities	Funding
Awareness creation on HWC to the communities	Forestry	Local government	Funding
Chain link fencing to reduce HWC	Agriculture	Local government, forestry, engineer	Funding and technical support from engineering
Initiate HWC insurance schemes for crop and livestock	Forestry, Agriculture, livestock	Local government	Funding
Introduction of improved livestock breeds (AI program)	Livestock	Local government	Funding
Initiation of alternative interventions such as stall feeding, rotational grazing, improvement of pastureland.	Livestock	Local government	Corporation from the local communities
Wildlife habitat enhancement	Forestry	Local government	Funding and labour support from the communities
Improve pasture development	Livestock	Local government	Funding and labour support from the communities
Support for high yielding cows to affected areas	Livestock	Funding and labour support from the communities	Funding and cost sharing support from the communities

Strengthen technical capacity in wildlife rescue operation	Forestry	Nature Conservation Division	Funding and technical support in wildlife rescue operation
Conservation and protection of water catchment areas	Forestry	Local government	Funding and coordination from local communities
Drinking water reservoir/tank construction	Health	Local government	Funding
Support electric fencing	Agriculture	Local government	Funding
Hydrogeological mapping of critical water source areas and intervention works.	Forestry	Watershed management division	Funding and technical support
Support Rural Water Supply Scheme	Dzongkhag heal sector	Local government, engineer	Funding and technical support from engineer
Renovation of climate proof (resilient) irrigation scheme (Pipe & Pressure system)	Agriculture	Forestry, local government	Funding
Irrigation water source protection by constructing retention wall	Agriculture	Forestry, local government	Funding
Construction of irrigation channel from Rongdugang to Sibgigang paddy field	Agriculture	Forestry, local government	Technical support from engineering
Build irrigation channel for Koshala (3km) (60 acres) - Existing channel maintenance. (HDPE supply)	Agriculture	Forestry, local government	
Promote micro-irrigation (drip, sprinkler) and rain water harvesting	Agriculture	Forestry, local government	Funding and technical support

Enrichments plantation in barren areas/fallow land (or pasture land development)	Forestry	Local government	Funding
Protection of forest area through SMART patrolling	Forestry	Forest Protection and Enforcement Division	Funding
Train youth/school dropouts on vocational skills (Agriculture, horticulture, livestock farming, etc.), training on essential services (saloon, cobbling, toothpick making, incense making, baking, ice-cream making, etc)	Forestry, Agriculture, livestock	Local government	Funding and technical support
Train local youths on carpentry, masonry, electrical	Local government	Dzongkha administration	Funding and technical support
Train youths/school dropouts on nature guide (Bird watching, Butterfly watching, etc)	Forestry	Local government	Funding
Knowledge exchange programs for communities through study tours	Local government	Forestry	Funding
Provide book & Record keeping training to CFMG member to enhance their capacity in CF management	Forestry	Local government	funding
Create awareness and group formation on uses of lesser-	Forestry	Wood based industries, local government	funding



known plant/tree species/ Promote WBIs.			
Promote community-based ecotourism groups (Homestays, eco-camps, natural trails, souvenir shops-Traditional)	Forestry	Local government	Funding
Strengthening of existing citizen-science groups of farmers and youths	Forestry	Livestock, local government	Funding
Initiation of non-formal education (NFE) in the community	Education	Local government	
Conduct awareness on policy and rules related to Climate adaptation practices	Dzongkhag environment	Local government	funding

#### Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New or Existing	Cost (Nu. million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			
Sensitization of public on erratic /rainfall pattern due to climate change impacts	Securing fund	New	500 HHs	0.00315	0.2	No	2	Number of participants attended the meeting
Installation of weather station to get rainfall data and provide	Discussion with NCHM for equipment availability	New	3 Nos.	0.2	0.6	No	1	Number of weather stations installed

information to the community								
Encourage cut and carry feeding system for cattle	-	Existing	-	-	-	-	1 & 7	Number of households (HHs) practicing feeding system
Encourage sedentary/confined rearing system of cattle	-	Existing	-	-	-	-	1 & 5	Number of HHs practicing confined rearing of cattle.
Inform periodic weather forecast to public	-	Existing	-	-	-	-	Whole period	Number of communities connected with television
Promote traditional practices to please local deity.	-	Existing	-	-	-	-	Whole period	Number of events conducted
Support supply of climate resistant and improved agriculture seeds	Identification of the tolerant varieties of crop	New	10 acres	50000	0.05	No	2,3,4	Acres of land cultivated with climate resilient crops
Construction of concrete reservoir tank to store water to be used during lean season.	Securing fund, , Design and cost estimation of the reservoir	New	7 Nos.	100000	0.7	No		Nos of reservoir tanks constructed

Plantation of trees and bamboo species around agriculture land (eg. Fodder trees, Willow)	Securing fund		100 Nos	5000	0.5	No	3 & 6	Numbers of seedlings planted
Introduction of windstorm tolerant crop varieties	Securing fund, Identification of wind tolerant crop varieties	New	10 acres	20000	0.2	No	2 & 8	Acres of lands cultivated with windstorm tolerant varieties
Support of wind storm resistant house construction materials (pro-poor)	Securing fund, Identification of the pro-poor households and securing fund	New	10 HHs	100000	1	No	3 & 7	Nos. of households provided with the wind storm resistant materials
Sensitization and advocacy on periodic windstorm forecast to reduce the impacts and use of windstorm proof timber	Securing fund	New	500 HHs	315	0.25	No	Alternative year	Nos. of households imparted with awareness program
Sensitization and advocacy on extreme temperature events	Securing fund	New	500 HHs	315	0.25	No	Alternative year	Nos. of households imparted with awareness program
Protected and promote resilient agricultural practices (greenhouse,	Securing fund	New	100	10000	1	No	4 & 9	Nos. of households supported with

heat tolerant crop varieties, etc)								resilient agriculture practices
Establishment of efficient cold chain facilities	Securing fund	New	5 Nos.	20000	1	No	1 & 6	Nos. of cold chain facilities established
Promote and conservation of native animal breeds to thrive extreme temperature. (Jatsham sapha and dompha)	Securing fund	New	100 Nos.	10000	1	No	6	Nos. of native animal breeds procured and supplied
Bio-engineering works in landslide prone areas	Securing fund	New	10 km	50000	0.5	No	3 & 7	Length of bio-engineering works carried out
Initiation of sustainable land management activities	Securing fund and identification of type of management activities	New	10 acres	50000	0.5	No	4	Acres of land bought under sustainable management interventions
Maintain proper drainage systems	-	Existing	50 km	-	-	Yes	Regular work	Length on proper drainage system maintained
Construction of slope retention structure	Securing fund	New and existing	5km	200000	2	No for new construction	5	Length of slope retention structure constructed

Initiate water recharge interventions (trenches, water holes, etc) for recharging of water table and springs.	Securing fund and carry out hydrogeological mapping of the area	New	15 Nos.	30000	0.45	No	6 & 7	Numbers of intervention structures constructed
Introduction of drought resistant crop varieties	Securing fund and identification of site-specific drought resistant crop varieties	New	10 acres	20000	0.2	No	2, 6, 9	Acres of land bought under the drought resistant crop varieties
Identify HWC hotspot area	Data analysis and report writing	Existing	1 report	-	0.5	-	1	Data analyzed and report produced
Awareness creation on HWC to the communities		Existing	300 HHs	315	0.5	No	6	Nos. of households imparted with awareness
Chain link fencing to reduce HWC	Design and cost estimation of the work by engineer	New	8km	500000	4	No	4	Kilometers of land supported with chain link fencing
Initiate HWC insurance schemes for crop and livestock	Securing fund	New	3 groups	500000	1.5	No	3,7, & 9	Number of insurance schemes established
Introduction of improved livestock breeds (AI program)	Securing fund	New	200 HHs		0.4	No	5 & 6	Nos. of HHs benefited from AI program

Initiation of alternative interventions such as stall feeding, rotational grazing, improvement of pastureland, etc	-	Existing	100 HHs	-	-	-	2	Nos. of HHs practicing livestock depredation proof alternatives
Wildlife habitat enhancement	Securing fund	New	7 Nos.		0.5	NO	1 & 6	Nos. of wildlife habitat management interventions carried out
Improve pasture development	Securing fund	New	20 acres	30000	0.6	No	4	Acres of pasture development activities initiated
Support for high yielding cows to affected areas	Securing fund	New	10 Nos.	50000	0.5	No	6	Nos. of high yielding cows procured and supplied to local communities
Strengthen technical capacity in wildlife rescue operation	-	Existing	10 Nos.		0.5	yes	1	Number of staff trained on wildlife rescue operation
Conservation and protection of water catchment areas	Securing fund	New	10 acres	50000	0.5	No	4	Acres of water catchment areas protected

Drinking water reservoir/tank construction	Securing fund	New	1	600000	0.6	No	6	Nos. of water reservoir tank constructed
Support electric fencing	Securing fund	New	6 km	200000	1.2	No	4	Kilometers of electric fence constructed
Hydrogeological mapping of critical water source areas and intervention works.	Securing fund	New	200 sq.km	600000	.6	No	1	Area coverage for hydrogeological mapping
Support Rural Water Supply Scheme	Securing fund	New	2 village	400000	0.8	No	4 & 9	Nos. of villages supported with RWSS
Renovation of climate proof (resilient) irrigation scheme (Pipe & Pressure system)	Securing fund and design and estimation of the cost	New	10 km	100000	1	No	8	Length of climate proof irrigation schemes renovated
Irrigation water source protection by constructing retention wall	Securing fund and design and estimation of the cost	New	20 m		1	No	3	Meters of retention wall constructed
Construction of irrigation channel from Rongdugang to Sibgigang paddy field	-	Existing	15 km		3	Yes	2	Length of irrigation channel constructed
Build irrigation channel for Koshala (3km) (60 acres) -Existing channel	Securing fund and design and	New	3 km		2	No	3	Length of irrigation

maintenance. (HDPE supply)	estimation of the cost							channel constructed
Promote micro-irrigation (drip, sprinkler) and rain water harvesting	Securing fund	New	3 Nos.	400000	1.2	No	4 & 7	Number of micro-irrigation structures constructed
Enrichments plantation in barren areas/fallow land (or pasture land development)	Securing fund	New	7 acres		0.3	No	5	Acres of enrichment plantation carried out
Protection of forest area through SMART patrolling	Securing fund	Existing	10 Nos.		0.5	Yes	Whole period	Nos. of smart patrolling conducted
Train youth/school dropouts on vocational skills (Agriculture, horticulture, livestock), training on essential services (saloon, cobbling, toothpick making, incense making, baking, ice-cream making, etc.)	Securing fund and identifying particular area specific skill for development	New	3 groups	200000	0.6	No	5	Nos. of youth group formed
Train local youths on carpentry, masonry, electrical	Securing fund	New	20 youths	50000	1	NO	7	Nos. of youth trained on carpentry, masonry and electrical



Train youths/school dropouts on nature guide (Bird watching, Butterfly watching, etc)	Securing fund	New	1	40000	0.4	No	3	Grouped formed and functional
Knowledge exchange programs for communities through study tours	Securing fund	New	40 HHs	30000	1.2	No	4&8	Nos. of HHs engaged for knowledge exchange program
Provide book & Record keeping training to CFMG member to enhance their capacity in CF management	Securing fund	New	200 HHs		0.3	No	3	Nos. of CFMG members imparted with training
Create awareness and group formation on uses of lesser-known plant/tree species/ Promote WBIs.	Securing fund	New	100 HHs		0.3	No	4	Nos. of WBI head involved group formed
Promote community-based ecotourism groups (Homestays, eco-camps, natural trails, souvenir shops-Traditional)	Securing fund	New	1 group		0.5	No	5	Number of groups formed
Strengthening of existing citizen-science groups of farmers and youths	Securing fund	Existing	10 HHs		0.4	No	1	Additional member added to the existing citizen science group

Initiation of non-formal education (NFE) in the community	Securing fund	New	50 HHs		1		Whole period	Nos. of HHs engaged in non-formal education
Conduct awareness on policy and rules related to Climate adaptation practices	Securing fund	New	500 HHs		0.4	No	3,7,9	Nos. of HHs engaged in climate awareness
<b>Total budget estimate fro 10 years</b>					<b>38m</b>			
<b>Section 5. Details of Stakeholder Consultation</b>								
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>				<b>Nos. of Participants</b>		
21/10/2022	RLDC meeting hall	Dzongkhag Sector heads (Zhemgang Dzongkhag), Range officers, Beat officers, ZFD section heads				20 (Male 16, female:4)		
23/10/2022	Langthel Gewog meeting hall	RNR staff, Gewog administration and forestry officials				12 (male:8, female:4)		
<b>Consultation and plan Preparation led by</b> Phub Dorji, Senior Forestry Officer, phubdorji@moaf.gov.bt								

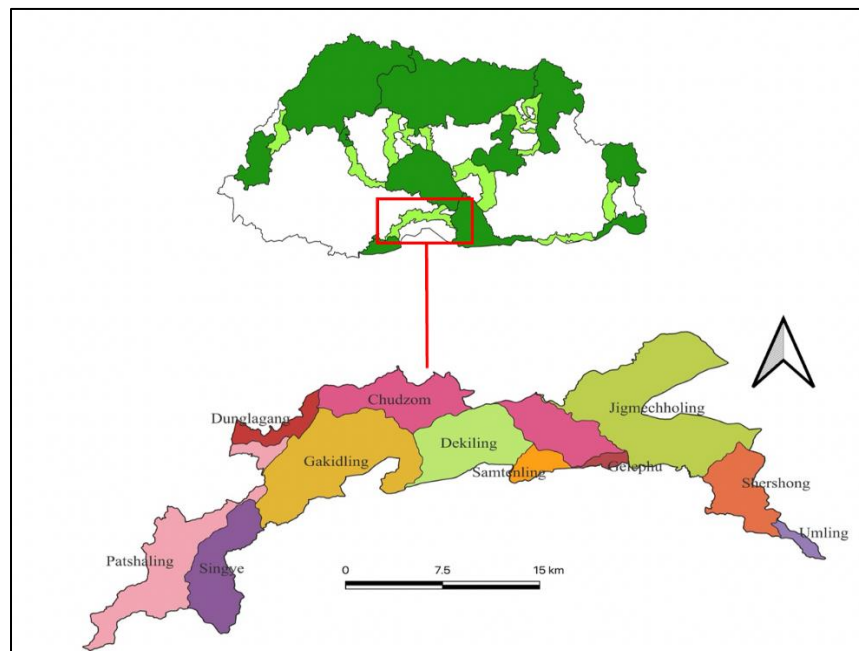
#### 9.4 References

- Bennett, Andrew F. 2003. Linkages in the Landscape : The Role of Corridors and Connectivity in Wildlife Conservation. Linkages in the Landscape : The Role of Corridors and Connectivity in Wildlife Conservation. <https://doi.org/10.2305/iucn.ch.2004.fr.1.en>.
- Dorji, P. & Raika, O. (2022). Biodiversity report. Biodiversity Status of Biological Corridor 4. Department of Forests and Park Services, Ministry of Agriculture and Forests. Royal Government of Bhutan.
- Dorji, P. & Raika, O. (2022). Socio-economic survey report. People and livelihood in Biological Corridor 4. Department of Forests and Park Services, Ministry of Agriculture and Forests. Royal Government of Bhutan.
- Zhemgang Forest Division (2023), Conservation Management Plan of Biological Corridor 4 (January 2023 to December 2032). Department of Forests and Park Services, Ministry of Agriculture and Forests, Royal Government of Bhutan, Zhemgang.

## 10 Climate Change Adaptation Plan of the Biological Corridor-3, Sarpang and Tsirang Forests Division

### 10.1 Background

Biological Corridor (BC3) has an area of 407.69 sq km with approximate length of 57.68 km and width of 27.47 km. BC3 connects Jigme Singye Wangchuck National Park, Phibsoo Wildlife Sanctuary and Royal Manas National Park. It shares an area of 6329.20 ha (63.29sqkm) with Divisional Forest Office, Tsirang which is 15.52% of the BC3 area. Rest 84.48% of BC3 area falls inside Divisional Forest Office, Sarpang. It is situated approximately between 26°04'09.43"N and 26°49'06.39"N latitudes and 90°04'05.84"E and 91°38'16.93"E longitudes. BC3 has an altitudinal range from 353masl to 2360masl. Sub-Tropical broadleaf forest is main vegetation composition of the biological corridor 3. BC3 encompasses total of 11 gewogs under Divisional Forest Office of Sarpang and Tsirang. Nine gewogs are under Sarpang and two gewogs are under Tsirang. A portion of BC3 passes through Patshaling and Dunglagang Gewog in Tsirang. There are 363 households in Patshaling Gewog with population of 2566 and 383 households in Dunglagang Gewog with population of 3433, out of which 111 households of Patshaling and 53 households of Dunglagang Gewog directly depends on forest resources within BC3.



Primary income sources for the public are from livestock and agriculture products. People residing within the vicinity of BC3 under Tsirang do subsistence farming, majority of the people earn their livelihood through vegetable farming as their area is favorable for vegetable production. Most of the household's rear livestock, poultry and cardamom plantation to earn cash income.

## 10.2 Objective

The objective of biological corridor is to provide habitat linkages for the movement of faunal and floral biodiversity to enable migration, colonization and inter breeding of plants and animals.

Specifically, the objectives of biological corridor are:

- To provides connectivity between different landscapes, ecosystems and habitats, natural or modified,
- Maintain stable, thriving and diverse populations of key species contributing toward national and global biodiversity goals;
- To allow the movement of animals in between the protected areas for maintenance of viable populations as habitat linkage connecting protected areas,
- Enhance the socio-economic wellbeing of communities in and in the vicinity of the PAs through climate-informed natural resources management.
- Help Bhutan remain carbon neutral by increasing forest and vegetative cover within the Protected Area System.
- To protect, conserve and manage habitat from fragmentation and degradation,
- **To monitor and ensure adaptive measures on climate related impact on wildlife habitats, water, and local communities.**
- Strengthening institutional capacity for effective services delivery and implementation of conservation program.

### 10.3 Adaptation Priorities of the Biological Corridor-3

#### Section 1. Priority Climate Vulnerabilities

The Divisional Forest office, Sarpang and Tsirang carried out Dzongkhag and Gewog level stakeholder consultation from 20<sup>th</sup> October 2022 onwards and discussed thoroughly on the Community Vulnerability and Capacity Assessment (CVCA) report of BC 3. The priority actions were prioritized based on the CVCA study results and stakeholder consultations.

#### Rank of issues contributing to higher exposure to climate vulnerability (% of households)

Extreme temperature	64.47
Rainfall seasonality	54.73
Windstorm	20.06
Seasonal droughts	13.47
Landslides	11.46
Flash flood	7.16

#### Rank of issues contributing to higher sensitivity to climate vulnerability (% of households)

Wildlife population and HWC	69.34
Drinking water	66.48
Irrigation water	33.24
Forest composition	25.79
Pastureland	12.61
Crop yield	6.59

#### Rank of issues contributing to low adaptive capacity (% of households)

Vocational skill	2.29
Forest resources	9.46
Alternative water source	10.89
Community group	11.17

## Section 2. Priority Actions to Address Vulnerabilities

Priority Climate Vulnerabilities	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Extreme temperature	Using of efficient technology (drip and sprinkler) to support households during dry season	Agriculture, Engineering	Increasing water scarcity for drinking and irrigation	11 gewogs	
	Carrying out afforestation in degraded and barren areas	Forestry	Landslides, erosion and increase in temperature	11 gewogs	Possibility for more Human wildlife conflict
	Installation of biogas plants (reduce firewood consumption & methane gas release)	Livestock	Deforestation	11 gewogs	
	Carrying out of waste management (segregation, install reuse/recycling plant)	Environment	More waste will lead to more burnings which will contribute towards global warming	11 gewogs	
	Conducting awareness on forest fire	Forestry	Forest fires induced by global warming	11 gewogs	
	Construction of cold storage facility	Livestock and Agriculture	Food damage and scarcity	11 gewogs	
	Identifying green zone/recreational area in Urban areas	Forestry	Reduce heat stress	Shompangkha, Gelephu, Dekiling and Samtenling gewogs	

2. Rainfall seasonality	Establishment of water harvest technology/infrastructure (reservior)	Agriculture, Engineer	Water scarcity	11 gewogs	
	Installation of weather forecast/early warning technology	Climate	Unpredictable weather	2 gewogs (one each in Sarpang and Tsirang)	
	Enhance vector surveillance to prevent pest and disease	Health	Increasing pest and disease due to extreme events	11 gewogs	
3. Windstorm	Carring out afforestation	Forestry	Landslides, erosion and increase in temperature	11 gewogs	Possibility for more Human wildlife conflict
	Installation of weather forecast/early warning technology	Climate	Unpredictable weather	2 gewogs (one each in Sarpang and Tsirang)	
4. Seasonal drought	Installation of water harvesting technology	Agriculture, Engineer	Water scarcity	11 gewogs	
	Carrying smart agriculture practices like hydroponics, green house, plastic mulching.	Agriculture Agriculture	Climate impacts on agriculture farming	11 gewogs 11 gewogs	
	Practicing precision agriculture (Accurate use of resources)/optimum use of infrastructures provided	Agriculture	Climate impacts on agriculture farming	11 gewogs	

	Institutionalization of crop insurance scheme	Agriculture	Climate impacts on agriculture farming	11 gewogs	
	Promotion of climate resilient materials (green house, mulching plastic and green net)	Agriculture	Increasing water scarcity for drinking and irrigation	11 gewogs	Green net and mulching plastic may leads to waste issue after use
5. Landslides	Carrying out plantation in degraded areas.	Forestry	Landslides, erosion and increase in temperature	11 gewogs	Possibility for more Human wildlife conflict
	Maintaining balance ecosystem (reduce hunting to maintain hervibore population)	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
	Avoiding extraction of timber/forest resources	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
	Avoiding Minning/quarrying in unstable areas.	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
	Carrying out Bio-egineering (Plantation and retaining wall)	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
	Discouraging overgrazing	Forestry	Landslides, erosion and increase in temperature	11 gewogs	



	Prevention and awareness on Forest Fire	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
	Carrying out Land management activities	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
6. Flash floods	Carrying out land management activities	Forestry	Landslides, erosion and increase in temperature	Gelephu, Samtenling and Shompangkha gewogs	
	Dredging and proper channelling of waterways	Water	Washing away of arable lands	Gelephu, Samtenling and Shompangkha gewogs	May impact aquatic ecosystem
	Constructing flood walls	Water	Washing away of arable lands	Gelephu, Samtenling and Shompangkha gewogs	May impact aquatic ecosystem
	Put in place communication system to warn on occurrence of climate induced disasters	Disaster, infrastructure	Increasing flash floods, windstorms, landslide due to extreme events	11 gewogs	
7. Wildlife population and HWC	Construction of electric/chain link fencing, trenching, formation of QRT to protect crops and settlements	Engineering, Agriculture	Crop and livestock depredation	11 gewogs	Retaliation killing. May lead to accident as animals may get trapped

	Carrying out enrichment plantation for wild animal	Forestry	Less food for wild animals in forest	Jigmecholing, Gelephu, Dekiling and Samtenling	
	Habitat restoration plantation with grass and wild fruits trees	Forestry	Crop and livestock depredation	11 gewogs	Risk of wildlife poaching and hunting
8. Drinking water	Protection of water sources	Forestry	Scarcity of water	11 gewogs	
	Construction and conservation of reservior tanks (Rain harvesting) and water ponds	Agriculture and Water	Scarcity of water	11 gewogs	
9. Irrigation	Construction and Conservation of reservior tanks (Rain harvesting) and water ponds	Agriculture and Water	Scarcity of water	11 gewogs	
10. Forest composition	Carrying out Plantation/ Afforestation/ Rehabilitation plantation/ scientific thinning and removal of invasive plant species	Forestry	Landslides, erosion and increase in temperature	11 gewogs	
11. Pastureland	Supplying and reseeding of pasture seeds and fodder seedlings	Agriculture	Degraded areas, inadequate fodders	11 gewogs	
	Live fencing (Fodder species)	Agriculture, Forestry	Degraded areas, inadequate fodders, crop and livestock depredation	11 gewogs	

12. Crop yield	Providing support for agriculture land development	Agriculture	Degraded areas, inadequate crop production	11 gewogs	
	Providing compensation for crops damaged by wildlife and natural calamities	Forrestry, Livestock	Degraded areas, inadequate fodders, crop and livestock depredation	11 gewogs	
	Supplying of highbreed seeds and seedlings	Agriculture	Degraded areas, inadequate fodders, crop and livestock depredation	11 gewogs	
	Discouraging use of pesticides, insecticides etc and encouraging organic farming	Agriculture	Degraded areas, inadequate crop production	11 gewogs	
13. Vocational skills	Enhance vocational skills of household members to cope up the climate change impact and to improve livelihood	Multisectoral	Low vocational skills to cope up changing climate change and livelihood	11 gewogs	
14. Forest resources	Plantation of timber and firewood species to increase the availability of resources to households	Forestry	Increasing scarcity of firewood, NWFPs and timber	11 gewogs	
15. Alternative water sources	Construction of borewell, dip irrigation, sewage water treatment plants and supply of water pipelines	Agriculture, water and health	Increasing water scarcity for drinking and irrigation	11 gewogs	

	Climate resilience integrated water scheme to increase crop productivity and water efficiency	climate smart agriculture, Health	Increasing water scarcity for drinking and irrigation	11 gewogs	
16. Community groups	Establish community groups such as Community Forest, livestock and agriculture related groups, water user groups	Multisectoral	Increasing scarcity of firewood, NWFPs, timber resources, vegetables, dairy products	11 gewogs	

<b>Section 3. Potential Roles and Responsibilities</b>			
<b>Adaptation Action</b>	<b>Lead Stakeholder</b>	<b>Collaborating Stakeholder</b>	<b>Support Needed</b>
Using of efficient technology (drip and sprinkler) to support households during dry season	Agriculture	LG	Funding support required purchasing raw materials and work charges.
Carrying out afforestation in degraded and barren areas	DoFPS	LG, CFMG,	Funding for seedlings, work charges, transportations
Installation of biogas plants (reduce firewood consumption & methane gas release)	Livestock	LG	Funding for raw materials, trainings required
carrying out of Waste management (segregation, install reuse/recycling plant,	MoAF	All RNR sectors, LG, Schools	Fundings for transportation of waste, working lunch, purchase of gloves etc required.

Conducting awareness on forest fire	DoFPS	LG	Awareness and training of forest fire management. Procurement of necessary equipment to fight forest fire.
Construction of cold chain facility (cold storage)	Livestock	LG	Funding for raw materials, trainings required
Identifying green zone/recreational area in Urban areas	DoFPS	Thromde, LG	Budget for training, survey, consultation and working lunch required
Establishment of water harvest technology/infrastructure (reservior)	Agriculture	LG	Funding for raw materials, trainings required, work charges, working lunch, transportation required
Installation of weather forecast/early warning technology	National Center for Hydrology and Meteorology	LG	Funding for construction of weather centre
Enhance vector surveillance to prevent pest and disease	MoH	LG	Awareness and supply of necessary medical kits
Carrying Smart agriculture practices like hydroponics, Green house, plastic mulching.	Agriculture	LG	Funding for raw materials, trainings required, work charges, working lunch, transportation required
Practicing precision agriculture (Accurate use of resources)/optimum use of infrastructures provided	Agriculture	LG	Funding for raw materials, trainings required, work charges, working lunch, transportation required
Institutionalization of crop insurance scheme	Agriculture	LG	Funding for raw materials, trainings required, work charges, working lunch, transportation required
Promotion of climate resilient materials (green house, mulching plastic and green net)	Agriculture	LG	Funding for materials, trainings, work charges, working lunch, transportation required

Maintaining balance ecosystem (reduce hunting to maintain herbivore population)	DoFPS	LG	Awareness on FNCRR and importance on conservation of fauna.
Avoiding excess extraction of timber/forest resources	DoFPS	LG, CFMG members	Training, establishment of CF, LFMP, PF
Avoiding Mining/quarrying in unstable areas.	DoFPS	LG	Awareness and consultation
Carrying out Bio-engineering (Plantation and retaining wall)	DoFPS	LG	Funding for seedlings, work charges, transportations
Discouraging overgrazing	DoFPS	LG, CFMG,	Awareness
Carrying out Land management activities	DoFPS	LG	Funding for seedlings, necessary trainings, work charges, transportations
Dredging and proper channelling of waterways	DoFPS	LG, NRDCL	Awareness and consultation
Constructing flood walls	DoFPS	LG, NRDCL	Awareness and consultation
Construction of electric/chain link fencing, trenching, formation of QRT to protect crops and settlements	DoFPS	LG and Agriculture	Funding for materials, trainings, work charges, working lunch, transportation required
Carrying out enrichment plantation for wild animal	DoFPS	LG	Funding for materials, seedlings, trainings, work charges, consultation, working lunch, transportation required
Protection of water sources	DoFPS	LG	Awareness and consultation
Supplying and reseeded of pasture seeds and fodder seedlings	Agriculture	LG	Funding for seeds, awareness required
live fencing (Fodder species)	Livestock	LG	Funding for awareness required
Providing support for agriculture land development	Agriculture	LG	Funding for materials, seedlings, trainings, work charges, consultation, working lunch, transportation required

Providing compensation for crops damaged by wildlife and natural calamities	Agriculture	LG	Funding for trainings, consultation, working lunch required
Supplying of highbred seeds and seedlings	Agriculture	LG	Funding for seeds, seedlings, awareness required
Discouraging use of pesticides, insecticides etc and encouraging organic farming	Agriculture	LG, Livestock	Funding for awareness required
Enhance vocational skills of household members to cope up the climate change impact and to improve livelihood	MoLHR	All agency	Funding for trainings
Plantation of timber and firewood species to increase the availability of resources to households	DoFPS	LG, CFMG members, GBCL	Funding for supply of seedlings
Construction of borewell, drip irrigation, sewage water treatment plants and supply of water pipelines	RWSS	LG, Municipal	Fundings for procuring water pipelines and basic items required
Climate resilience integrated water scheme to increase crop productivity and water efficiency	RWSS	LG, Municipal	Fundings for procuring water pipelines and basic items required
Establish community groups such as Community Forest, livestock and agriculture related groups, water user groups	MoAF	Forest, Agriculture, Livestock, LG	Funding to initiate or establish community groups

<b>Section 4. Implementation and Resourcing</b>						
<b>Adaptation Action</b>	<b>Next Step for Implementation</b>	<b>New or Existing</b>	<b>Cost (Nu. million)</b>	<b>Funding Available</b>	<b>Timeline Year (1 - 10)</b>	<b>Key Performance Indicator</b>
Using of efficient technology (drip and sprinkler) to support households during dry season	Public consultation, procurement	New	24.00	none	1-5	Nos of drip and sprinkles procured and supplied
Carrying out afforestation in degraded and barren areas	Site identification, procurement of seedlings, plantation	New	1.10	none	1-10	Total areas carried out with plantation
Installation of biogas plants (reduce firewood consumption & methane gas release)	Assess needs, trainings procurement and construction	New	20.00	none	1-10	200 households with biogas installed.
Carrying out of Waste management (segregation, install reuse/recycling plant,	Cleaning campaign	New	1.00	none	3-5	Cleaning campaign in 11 gewogs achieved.
Conducting awareness on forest fire	Training and purchase of equipment	New	1.10	none	1-3	Firefighting training and equipments for 11 gewogs achieved
Construction of cold chain facility (cold storage)	Training and purchase of equipment	New	30.00	none	3-8	Cold storage for 5 gewogs constructed
Identifying green zone/recreational area in Urban areas	Assess, survey	New	0.50	none	2-5	3 green zones identified
Establishment of water harvest technology/infrastructure (reservior)	Survey, identify the sites, construction	New	5.00	None	1-10	5 water reservoirs constructed



Installation of weather forecast/early warning technology	Awareness, discussion, consultation, site identification	new	30.00	none	1-10	3 meteorology stations constructed
Enhance vector surveillance to prevent pest and disease	Awareness, monitoring, survey, procurement	new	0.50	None	2-3	Awareness for 11 gewogs conducted.
Carrying Smart agriculture practices like hydroponic, Green house, plastic mulching.	Awareness, discussion, consultation, allocation	New	20.00	None	3-8	Smart agriculture for 200 HHS put into practice
Practicing precision agriculture (Accurate use of resources)/optimum use of infrastructures provided	Awareness, discussion, consultation, allocation	New	2.00	None	5-8	Smart agriculture for 50 HHs put into practice
Institutionalization of crop insurance scheme	Public consultation, bylaws preparation, formulation of chiwog level insurance committee	new	1.10	none	3-7	20 chiwogs with crop insurance by-laws formulated
Promotion of climate resilient materials (green house, mulching plastic and green net)	Public consultation, procurement	new	15.00	None	1-2	Nos of green houses, mulching plastic and green net procured and supplied
Maintaining balance ecosystem (reduce hunting to maintain hervibore population)	Awareness	New	0.50	none	1-2	Awareness on importance of flora and fauna to 11 gewogs conducted

Avoiding excess extraction of timber/forest resources	Awareness	New	0.30	none	1-2	Awareness on importance of flora to 11 gewogs conducted
Avoiding Minning/quarrying in unstable areas.	Awareness	New	0.50	none	1-2	Awareness on importance of flora to 5 gewogs conducted
Carrying out Bio-engineering (Plantation and retaining wall)	Public consultation, procurement,	New	2.00	none	3-5	Bio-engineering works carried out at Aislip and Box-cutting.
Discouraging overgrazing	Public consultation, procurement, construction	new	7.20	None	1-10	Nos of improved cattle breeds supplied and shed constructed
Carrying out Land management activities	Public consultation, training, procurement, land management activities	new	15.0	None	2-5	50 acres of landslide area managed.
Dredging and proper channelling of waterways	Public consultation, feasibility study, site identification, secure funding	new	10.00	None	1-3	5 waterways properly dredged and channeled
Constructing flood walls	Public consultation, feasibility study, site identification, secure funding	New	5.00	None	1-5	Flood walls for 3 waterways constructed
Construction of electric/chain link fencing, trenching, formation of QRT to protect crops and settlements	Public consultation, feasibility study, site identification, secure funding	New	1.50	none	2-5	Km of chain link/electric fencing constructed and QRT formed

Carrying out enrichment plantation for wild animal	Site identification and plantation	New	1.10	none	1-10	Enrichment plantation for 11 gewogs carried out
Protection of water sources	Water sources assessment, identification of relevant intervention	New	2.00	None	1-10	20 water sources protected.
Supplying and reseeded of pasture seeds and fodder seedlings	Purchase and supply	New	0.50	None	1-10	Supply of fodder seeds and seedlings to 11 gewogs achieved
live fencing (Fodder species)	Purchase and supply	New	5.50	None	1-10	Supply of fodder seedlings to 11 gewogs achieved
Providing support for agriculture land development	Public consultation, feasibility study, site identification, secure funding	New	10.00	None	3-10	Agriculture in 5 gewogs developed
Discouraging use of pesticides, insecticides etc and encouraging organic farming	Awareness	New	0.50	None	1-5	Awareness on negative impact of chemicals usage for 11 gewogs conducted
Enhance vocational skills of household members to cope up the climate change impact and to improve livelihood	Consultation, identification of vulnerable groups and youths, training and capacity building	new	0.50	None	1-3	100 youths skills development training conducted
Construction of borewell, dip irrigation, sewage water treatment plants and supply of water pipelines	Public consultation, feasibility study, site identification, secure funding	New	10.00	None	1-5	Water pipes and catchment ponds for 11 gewogs supplied/constructed

Climate resilience integrated water scheme to increase crop productivity and water efficiency	Public consultation, feasibility study, site identification, secure funding	New	5.00	None	1-5	Integrate water scheme developed
Establish community groups such as Community Forest, livestock and agriculture related groups, water user groups	Public consultation, feasibility study, site identification, secure funding	New	5.00	None	1-10	Relevant groups in 11 gewogs established
<b>Total budget estimate for 10 years</b>			<b>233m</b>			

#### Section 5. Details of Stakeholder Consultation

Date of Consultation	Consultation Meeting	Stakeholders	Nos. of Participants
20.10.2022	Dzongkhag level Consultation	Chief District Engineer, Dzongkhag Planning Officer, DLO, ADLO, DAO, ADAO, Dzongkhag Disaster focal, Dy Chief Environment Officer, Dzongkhag Health Officer, VO, LPO, Forestry focal	18
21.10.2022	Dunglagang Gewog LG and RNR Officials and CF chairman	Gup, Mngmi, GAO, Tshogpas, Agri and Livestock, CF chairman ( Norjangsa, Hatidengeni, Pemaling, Khorssaney) forestry focal	16
22.10.2022	Patshaling Gewog LG and RNR Officials and CF chairman	Gup, Mangmi, Tshogpas, AAEO, AALO, CF chairman (Yarkay, Thakorling, Kuchi, Chuzomsa, Tsakaling)	17
24.10.2022	Meeting with local government, Livestock and Agriculture officials	Gewog heads, Livestock and Agriculture supervisors	21
26.10.2022	Consultation meeting with forestry officials	Foresters	16

27.10.2022	Consultation meeting with Umling gewog	LG, CF members and health officials of Umling Gewog	22
<b>Consultation and Plan Preparation led by</b> <ol style="list-style-type: none"> <li>1. Phub Dhendup, Chief Forestry Officer (DFO, Sarpang), pdhendup@moaf.gov.bt</li> <li>2. Chhimi Dorji, Offtg CFO, (DFO, Tsirang) chhimidorji@moaf.gov.bt</li> <li>3. Tshering Dorji, Sr. FO, tsheringdorji1@moaf.gov.bt</li> <li>4. Wangdi, wangdi@moaf.gov.bt</li> <li>5. Kharananda Ghimeray, Sr Forest Ranger ghimeray@hotmail.com</li> <li>6. Kinley, Sr Forest Ranger III, kinley@moaf.gov.bt</li> <li>7. Gempa, Sr Forest Ranger I, rubjibgempa@gmail.com</li> <li>8. Tsheten Dorji, Sr Forest Ranger I, tshetendorji09@gmail.com</li> <li>9. Yeshe Phuntsho, Forest Ranger I, gasaranger@gmail.com</li> </ol>			

#### 10.4 References

- SFD & TFD (2022). Conservation Management plan for Biological Corridor-03(draft). Sarpang Forests Division & Tsirang Forests Division, DoFPS, Bhutan.
- NECS (2020). The middle path National Environment Strategy. National Environment Commission. Thimphu, Bhutan.
- NECS & UNDP (2021). Assessment of Climate Risk on Forest and Biodiversity for National Adaptation Plan (NAP) formulation process in Bhutan. National Environment Commission Secretariat and United Nations development Program-Bhutan, Thimphu, Bhutan

# 11 Climate change Adaptation plan of the Jigme Singye Wangchuck National Park

## 11.1 Background

Jigme Singye Wangchuck National Park (JSWNP) is geographically dominated by the Black Mountain Range occupying the central region of the country. Every aspect of the Park including its climate, hydrology, geology and biodiversity is influenced by the mountainous terrain that is typical of the Himalayas. Hence, it is no exception to the impacts of climate change. The majority of the inhabitants within the park have been found to be heavily dependent on agriculture, livestock and forest resources through a recent socio-economic survey conducted. Therefore, the communities within the park remain highly vulnerable to the adverse impacts of climate change. With the climate vulnerability index of 0.07, JSWNP ranks 6th out of the 14 PAs assessed during the Community based Climate Vulnerability and Capacity Assessment (CVCA) study conducted by the Ugyen Wangchuck Institute of Conservation and Environment Research (UWICER) in 2022. According to the study, climate issues such as Rainfall seasonality, Extreme Temperature, Landslides and Floods, Human-Wildlife Conflict, Water Scarcity are major contributing factors to the climate vulnerabilities of the communities living within the park. Accordingly, the Park Management has conducted multiple consultations with the stakeholders at the local levels to prioritize and devise solutions for these issues with the existing coping mechanisms used by the locals.

## 11.2 Objective

The objective of this Adaptation Plan are;

- To devise effective adaptation measures against the impacts of climate change faced by the local communities.
- To incorporate existing best practices that are in place to cope with the impacts of climate change

### 11.3 Adaptation Priorities of the Jigme Singye Wangchuck National Park

#### Section 1. Priority Issues of Climate Vulnerabilities

##### List of Priority Climate Vulnerabilities

##### 1. Human-Wildlife Conflict

Human wildlife conflict is a major issue that is faced by all the communities living within the park. It is an age-old conflict faced by the inhabitants which is observed to be increasing in occurrence due to several factors such as increasing human population resulting in greater competition between human and wild animals for the limited natural resources, habitat destruction and fragmentation due to human activities and climate change that is causing unprecedented changes in the forest composition, animal behavior and wildlife population dynamics. HWC in the form of crop damage and livestock depredation is a huge challenge to the agrarian communities as it decreases their ability to cope with the impacts of climate change rendering them more vulnerable.

##### 2. Water Scarcity

Water is an indispensable natural resource to support life and sustain the livelihood of the communities that are heavily dependent on agriculture. Despite being drained by major rivers such as the Drangme chhu and Punatshang chhu and their tributaries, the inhabitants of the Park face water shortages for both drinking and irrigation. Most of the inhabitants believe that the drying up of water sources and inadequate infrastructure for water supply are the main factors contributing to the water scarcity which is exacerbated by the climate change through erratic rainfall and extreme temperature.

##### 3. Landslides, Floods and Windstorms

With the changing climate and unprecedented weather patterns, natural hazards such as landslides and floods are increasing in occurrence throughout the Park. As a result, the communities residing within the park face risk to human life and destruction to properties, infrastructures and agricultural fields. Inhabitants of Wangling and Kella in Langthel and Tangsibji Gewogs of Trongsa, Berti in Trong gewog of Zhemgang live under the constant fear of flash floods. Similarly, occurrences of landslides in Korphu Gewog in Trongsa, cause major inconveniences to the people as it causes countless road blocks during the rainy season. Moreover, Glacial lake outburst flood (GLOF) is also a significant concern for inhabitants living in Berti and Takabe villages of Trong gewog in

Zhemgang as the settlements are located at the bank of Mangde chhu river. Increasing frequency of windstorms unlike in the past are experienced by the residents of Athang Gewog in Wangdue Phodrang which also requires intervention.

#### **4. Rainfall Seasonality**

Due to erratic rainfall patterns, the farmers that mainly practice rain-fed agriculture face severe consequences as it negatively impacts the farm productivity. Unpredictable rainfall patterns are a growing concern among the communities that are solely dependent on agriculture as their main source of livelihood. The public increasingly faces shorter, longer or delayed wet seasons, which affects the agricultural productivity in terms of both quality and quantity in the Gewogs of Athang in Wangdue Phodrang and Trong in Zhemgang.

#### **5. Pest, Diseases and Invasive species**

The occurrence and outbreak of pest and diseases and spread of invasive species have been increasingly observed across the park. Pest, diseases and invasive species impact the agricultural crops and livestock animals resulting in reduced productivity endangering the livelihood of farmers. It also has negative impacts on forest composition and ecosystem health. Pests, disease and invasive species were reported as a major concern by the inhabitants of Nabji-Korphu in Trongsa and Trong gewog in Zhemgang.

#### **6. Decrease in Crop Yield**

A major portion of the population living within the park practice traditional agriculture as a source of livelihood. However, the change in climatic conditions in the form of extreme temperatures, erratic rainfall and resulting outbreak of pests and diseases have left the farmers increasingly vulnerable to the impacts of climate change. Traditional methods of agriculture and cropping are becoming more and more inefficient to cope with the increasing impacts of climate change. Hence, the farming communities of the park have expressed concerns over the failing traditional techniques in the face of climate change and requested help from the government sectors for interventions.

#### **7. Climate education and Vocational Skills**

During the stakeholder consultations, a key area for improving the adaptation to the impacts of climate change was identified as developing means for alternative income sources. Most of the communities are entirely dependent on livestock and crop production and lack alternative income sources that can serve as a safety net when farm production fails due to climate events. Therefore, it is



deemed important to support the farming communities in developing vocational skills and development of community-based enterprises in adapting to climate change.

## Section 2. Priority Actions to Address Vulnerabilities

Priority Climate Vulnerabilities	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Human-wildlife Conflict (HWC)	1. Upscale effective HWC mitigation measures (electric fencing, live fencing, chain link fencing)	Agriculture, Forestry,	Increase in crop damage by wild herbivores driven by climate change	Wangling and Phrumzur under Jangbi Chiwog of Langthel Gewog and Kella under Tangsibji Gewog. Tama village in Trong Gewog. Athang gewog and Korphu Gewog	Risk of deflecting the conflict to nearby areas without protected agriculture fields
	2. Institute compensation and insurance schemes for crop damage and livestock loss by wildlife	Financial institutions, Livestock, Agriculture	Increase in livestock depredation by wild carnivores driven by climate change	Korphu, Athang, Langthel and Trong Gewogs.	
	3. Explore crop and livestock intensification program to offset crop and livestock loss	Agriculture and livestock	Human-wildlife conflict	Trong Gewog	Depredation may still occur due to inefficient herding practices

	4. Enrichment plantation in degraded wildlife habitat	Forestry	Forest degradation & HWC	Trong Gewog	
2. Water scarcity	1. Water source protection	Water, Forestry	Drying up of water source	Korphu, Athang, Langthel and Trong Gewogs.	May prevent wildlife movement
	2. Undertake plantation at water sources	Forestry	Felling of trees at water sources	Korphu, Athang, Langthel and Trong Gewogs.	May alter the natural forest composition
	3. Maintenance of existing irrigation channels	Agriculture	Damage to irrigation channels	Nabji and Korphu	
	4. Installation of rain-water harvesting infrastructure	Water	Erratic rainfall pattern	Athang Gewog	
3. Landslides	1. Implementation of river bank protection works	Infrastructure	Landslides and unstable geology	Adha, Reeti, Taksha and Nabji	
	2. Implement bio-engineering measures at landslide prone and eroded areas	Forestry, Infrastructure	Landslides and unstable geology	Korphu Gewog and Trong Gewog	
4. Flood	1. Installation of early warning systems	Disaster management	GLOF	Along the Mangdue Chhu	

5. Windstorm	1. Plantation of trees as wind shields	Forestry, Agriculture	Strong winds, windstorms	Athand Gewog	May take up arable land that can be otherwise used for agriculture
6. Rainfall Seasonality	1. Construction of reservoir ponds	Water, Infrastructure	Shortage of water	Athang Gewog	May destabilize land and risk of flood.
7. Pest & Diseases	1. Adopt integrated pest management for effective management of pest and diseases	Agriculture	Increase in pest outbreak	Korphu, Athang, Langthel and Trong Gewogs.	
	2. Carry out regular and opportunistic inspection of disease outbreak in livestock	Livestock	Disease outbreaks in livestock	Korphu, Athang, Langthel and Trong Gewogs.	
8. Invasive species	1. Conduct studies on invasive species	Forest and Biodiversity	Uncontrolled spread of invasive species	Korphu, Athang, Langthel and Trong Gewogs.	
	2. Contain invasive species in critical wildlife habitats	Forest and Biodiversity	Uncontrolled spread of invasive species	Korphu, Athang, Langthel and Trong Gewogs.	

8. Decrease in crop yield	1. Adoption of modern cropping techniques such as crop rotation and intercropping	Agriculture, Capacity building	Depleting soil nutrients	Korphu, Athang, Langthel and Trong Gewogs.	
9. Lack of vocational skill and education	1. Training of Bamboo and cane products	Forestry, Capacity building	Dwindling income from communities dependent on forest resources	Athang Gewog	
	2. Develop conservation awareness materials (audiovisuals/signage/publications) to enhance climate change awareness	Forestry, Mass Media	Lack of awareness on impacts of climate change	JSWNP	

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
1. Upscale Effective HWC mitigation measures (electric fencing, live fencing, chain link fencing)	Local government (LG)	JSWNP, NCD, LG	Funding, Technical support
2. Institute compensation and insurance schemes for crop	DoFPS	Financial Institutions, Donors, LG	Funding, seed money, Technical support

damage and livestock loss by wildlife			
3. Explore crop and livestock intensification program to offset crop and livestock loss	DoL, DoA	Dzongkhag and LG	Funding, supplies seeds, seedling, materials and technical support
4. Enrichment plantation in degraded wildlife habitat	JSWNP	SFED, LG	Funding, supply of seedlings, technical support
5. Water source protection through fencing and plantation in degraded sites	Water management committee	JSWNP, SFED, LG	Funding, materials, technical support for reforestation guidance.
6. Maintenance of existing irrigation channels	DoA	Dzongkhag, LG	Funding, supply, technical support
7. Installation of rain-water harvesting infrastructure	Water management committee	JSWNP, Dzongkhag, LG	Funding, materials, training, technical support
8. Implementation of river bank protection works.	Dzongkhag Administration	JSWNP, LG	Funding, supplies/materials, technical support
9. Implement Bio-engineering measures at landslide prone and eroded areas	Disaster management committee	JSWNP, SFED, LG	Funding, seedling & transportation, technical support
10. Installation of early warning systems for GLOF for communities living along Mangdechu river	Disaster management	JSWNP, WMD, NCHM	Funding, supplies/materials, technical support

11. Plantation of trees as wind shields	Disaster management committee	JSWNP, SFED	Funding, supplies materials and technical support
12. Construction of reservoir ponds	Water management committee	JSWNP, LG, Dzongkhag Engineering section	Funding, supplies materials and technical support
13. Integrated pest management	DoA	LG, JSWNP	Funding, training and Technical support
14. Carry out regular and opportunistic inspection of disease outbreak in livestock	DoL	LG, Agriculture extension	Funding and technical support
15. Conduct studies on invasive species	JSWNP	NBC, FRMS	Funding and Technical support
16. Contain invasive species in critical wildlife habitats	JSWNP	NBC, FRMS, NCD	Funding and technical support
17. Adoption of modern cropping techniques such as crop rotation and intercropping	DoA	JSWNP, LG	Funding, technical support and training
18. Training of Bamboo and cane products	JSWNP	SFED, DAMC	Funding, technical support and training
19. Develop conservation awareness materials (audiovisuals/ signage/publications) to enhance climate change awareness	JSWNP	NCD, Private Media	Funding and technical support

## Section 4. Implementation and Resourcing

Adaptation Action	Next step for Implementation	New or Existing	Cost (Nu. million)			Funding Available	Timeline Year (1 -10)	Key Performance Indicator
			Unit	Rate	Total			
1. Upscale effective HWC mitigation measures (electric fencing, live fencing, chain link fencing)	Identify and map hot spots that experience excessive crop damage for intervention.	New	Length		4	None	Year 1,2,3,5,8 and 9	Length of Fencing in Km
2. Institute compensation and insurance schemes for crop damage and livestock loss by wildlife	Secure funding for seed money	New	Schemes	1	4	None	Year 1-2	No. of compensation schemes instituted
3. Explore crop and livestock intensification program to offset crop and livestock loss	Supply breeding bulls to improve quality of livestock animals and reduce herd number	New	Number	0.06	1.5	None	Year 5-6	No. of improved breed supplied
4. Enrichment plantation in degraded wildlife habitat	Identify degraded areas in Wildlife habitats that can be brought under	New	Area	0.09	0.96	None	Year 1-10	Acres of area planted

	enrichment plantation							
5. Water source protection through fencing and plantation in degraded sites	Identify critical water sources that require protection	New	Number	0.5	2	None	Year 1-3	Number of Water sources fenced
6. Maintenance of existing irrigation channels	Maintain damaged irrigation channels	New	Length		0.5	None	Year 1-3	Length of Irrigation channel maintained
7. Installation of rain-water harvesting infrastructure	Conduct suitability study and identify sites	New	Number	1	2	None	Year 2-8	No. of infrastructures constructed
8.Implementation of river bank protection works.	Construction of Gabion walls	Existing	No. of sites	0.8	4	None	Year 2-5	No. of Gabion walls constructed
9. Implement bio-engineering measures at landslide prone and eroded areas	Identification of areas and suitable species for plantation	New	Nos. of interventions	0.15	0.6	None	Year 3-5	No. of sites brought under bio-engineering
10. Installation of early warning systems for GLOF for communities living along Mangdechu river	Secure funding, technical support, feasibility study	New	Number		2	None	Year 4	No. of early warning systems instituted.



11. Plantation of trees as wind shields	Conduct feasibility study	New	number	250	1	None	Year 2-7	Number of Wind shields planted
12. Construction of reservoir ponds	Conduct feasibility study	New	No. of ponds	0.5	1	None	Year 5	Number of Reservoir ponds constructed
13. Integrated pest management	Secure funding, technical support and conduct training	New	No. of trainings	0.5	2	None	Year 3-4	Number of communities trained in IPM
14. Carry out regular and opportunistic inspection of disease outbreak in livestock	Secure funding and technical support	Existing	Number	0.25	1.25	None	Year 1-10	Number of inspections conducted
15. Conduct studies on invasive species	Secure technical support from NBC	New	Area	0.35	1.05	None	Year 2, 3 and 4	Area studied
16. Contain invasive species in critical wildlife habitats	Through the study conducted prioritize the areas that require intervention	New	Area	0.25	2.25	None	Year 1-10	Number of areas intervened
17. Adoption of modern cropping techniques such as crop rotation and intercropping	Secure funding and technical support for	New	Number of trainings	0.5	2	None	Year 2-3	Number of trainings conducted

	conducting training							
18. Training of Bamboo and cane products	Secure funding and technical support for conducting training	New	Number of trainings	0.05	1	None	Year 5-6	Number of trainings conducted
19. Develop conservation awareness materials (audiovisuals/signage/publications) to enhance climate change awareness	Secure funding and technical support	New	Number	0.15	1.5	None	Years 1-10	Number of awareness materials developed
<b>Total budget estimate fro 10 years</b>					<b>35m</b>			

<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation meeting</b>	<b>Stakeholders</b>	<b>Nos. of Participants</b>
17-18/10/2022	Consultation with local leaders & community groups of Langthel Gewog	Tshogpas, CFMG members, NWFP groups and educated farmers	28 (male)
17-18/10/2022	Consultation with Gewog officials, CF Chairman and some villagers of Korphu Gewog	Gup, Mangmi, Adm. Officer, CF chairman and some village educators	25 (23 male, 2 female)
17-18/10/2022	Consultation with Gewog official and Community groups, Athang Gewog	Gup, Mangmi, Tshokpas, Adm, Agriculture sector, Livestock sector, CF group, NWFP group and Park staffs	26 (18 male, 8 female)

17-18/10/2022	Consultation with Gewog officials and Community Forest Groups of Trong Gewog	Mangmi, Adm. Livetsock, CF Group members from Tama and Berti village Extension officer, Livestock officer, CFMG chairperson	20 (12 male, 8 female)
<p><b>Consultation and Plan Preparation led by</b></p> <ol style="list-style-type: none"> <li>1. Karma Chorten Dhendup, FO (karmachortendendup@gmail.com)</li> <li>2. Jigme Rangdrel, FO (jigmerangdrel6@gmail.com)</li> <li>3. Phuntshok, Sr. FR I (phuntshokphuntshok@gmail.com)</li> <li>4. Cheku, Sr. FR III (www.cheku.fr@gmail.com)</li> <li>5. Ngawang Tenzin, Sr. FR II (wangjigszin82@gmail.com)</li> <li>6. Wangchuk Dorji, Sr. Forester. (wangchukdorjie90@gmail.com)</li> <li>7. Rinchen Dorji, FR II (dorjirinchen30@gmail.com)</li> <li>8. Tshering, FR II (tsheringt525@gmail.com)</li> <li>9. Tashi Tenzin, Sr. Forester (tashitenzinttt@gmail.com)</li> <li>10. Kado Rinchen, FR II (kado.rinchen@gmail.com)</li> <li>11. Dhanapati Dahal, Sr. Forester (dpatidahal@gmail.com)</li> </ol>			

#### 11.4 References

- Yoezer, D., Choden, K., Wangdi, D., Pelzang, S., Tshering, K., Dorji, S. (2022). Community-based Climate Change Vulnerability and Capacity Assessment of the Protected Areas of Bhutan. Uygen Wangchuck Institute for Conservation and Environment Research. Bumthang, Bhutan.
- JSWNP. (2022). Conservation Management Plan of Jigme Singye Wangchuck National Park. Jigme Singye Wangchuck National Park. Department of Forest and Park Services.

## 12 Climate Change Adaptation Plan of the Jomotsangkha Wildlife Sanctuary

### 12.1 Background

Jomotsangkha Wildlife Sanctuary (JWS) is one of the ten protected areas in Bhutan. The Sanctuary is located in the extreme southeastern part of the country and falls under Samdrup Jongkhar Dzongkhag. It is connected to Sakteng Wildlife Sanctuary and Royal Manas National Park through biological corridors. It shares a border with two Indian states of Arunachal Pradesh and Assam to its east and south respectively. The Sanctuary covers an area of 362 sq.km encompassing the whole of Langchnphu Gewog and part of Samrang, Serthi, Pemathang and Phuntshothang Gewogs.

The Sanctuary forms an important part of the Himalayan subtropical broad-leaved forest ecosystem which is an important element in the Himalayan eco-region. It houses a wide array of the endangered wildlife species such as Royal Bengal Tiger (*Panthera tigris tigris*), Common Leopard (*Panthera pardus*), Himalayan Black Bear (*Selenarctos Ursus thibetanus*), Gaur (*Bos gaurus*), and Asiatic Wild Elephant (*Elephas maximus*).

The Sanctuary experiences tropical climate with moist-humid summers and warm-cool winters. Average annual rainfall over the last five years is 2824mm. Average maximum temperature of 27.87 C° and minimum of 16.84 C° has been experienced over the last five years within the Sanctuary. In summer park residents receive heavy, erratic and localized rainfall resulting in flash floods and swollen streams within a short duration. However, during winter it's dry, where perennial crops need supplement irrigation to save from drying and wild animals need to travel longer distances in search of drinking water.

### 12.2 Objective

1. To prepare a resilient community against adverse impact of climate change
2. To have adaptive actions for possible climate hazards in the park

## 12.3 Adaptation Priorities of Jomotsangkha Wildlife Sanctuary

### Section 1. Priority Issues of Climate Vulnerabilities

#### Rank of issues contributing to exposure to climate vulnerability

##### 1. Seasonal Rainfall

During summer the area receives heavy, erratic and localized rainfall invoking flash floods and swollen rivers within a short period of time. Other times rain does not fall on time getting delayed or falling early from the normal season. For example, in the year 2022 the rainy the season started in March and stopped only by the end of October, which coincides with paddy harvesting period

##### 2. Extreme Temperature

The elevation of JWS ranges from 133m to 2200m above sea level, where some places experience high temperatures ( $> 35^{\circ}\text{C}$ ) during sunny days in summer causing risk to overall lives of plant and animal community.

##### 3. Landslide

Geophysical feature of the Sanctuary is characterized by foothill plain and also sudden rise of topography from the Indian plain. The area is represented by Siwalik group with presence of coal, siltstone, sandstone and conglomerates. There is a presence of alluvial and colluvial flood plains resulting from slow erosion of young foothills and upstream activities. These types of geological settings in the PA trigger landslides during monsoon or sometimes even dry slides occur.

##### 4. Flash Flood

Due to erratic and heavy downpour the place observes frequent flash floods along drainage basins and settlements. Flash floods destroy crops, livestock and even pose risk to human lives.

##### 5. Seasonal drought

When the monsoon gets delayed or gets over soon, extreme temperature is experienced where seasonal crops are less productive and even livestock fatalities are caused affecting the livelihood of the residents. Seasonal drought has caused dying of Areca nut and low yield of paddy due to insufficient irrigation as a result of low precipitation.

##### 6. Wind storm

The region experience seasonal windstorm during spring and autumn which causes some damage to crops and houses.

**Rank of issues contributing to sensitivity to climate vulnerability**

1. Drinking Water
2. Wildlife population
3. Irrigation
4. Forest Composition
5. Invasive weeds
6. Pest and Diseases
7. Pastureland
8. Human Diseases

**Rank of issues contributing to low adaptive capacity**

1. Vocational skills
2. Community group
3. Alternative water sources
4. Forests resources
5. Climate change awareness
6. Land holding
7. Literacy of head of the household
8. Livelihood diversity
9. Off-farm activities
10. Credit access
11. Crop types
12. Saving and productive members
13. Distance to market
14. Distance to school
15. Distance to Gewog center
16. House type
17. Distance to health facility

Section 2. Priority Actions to Address Vulnerabilities				
Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
Cold storage and post-harvest technology	Infrastructure	High temperature	Langchenphu, Gewog Center	
Supply of hybrid seeds (cereal & vegetables) and fruit tree seedlings	Seed and seedlings	Water scarcity	11 chewogs	Possibility of losing indigenous seeds
Tree plantation	Forest	Landslide	Along Gewog farm roads, Sathpokhari water catchment, Tsophangma landslide area,	
Protected agriculture (Polyhouse)	Agriculture	Extreme temperature/heavy rain/drought	All Chiwogs	
Improved livestock shelter (dairy & poultry)	Infrastructure/Livestock	Extreme Temp/ Heavy rain	Dramzegang & Samrang	
Construction of drainage along Samrang farm road	Infrastructure/Agriculture	Drain blockage /rainfall	Samrang farm road	
Solar energy (trapping solar energy as alternative source of renewable energy)	Infrastructure & Equipment	Prolonged monsoon	All Chiwogs	
Solar fencing for human-wildlife conflict management	Infrastructure & Equipment	Rainfall	All chiwogs	
Supply of electric stove འོད་ཀྱི་ཐབས།	Equipment		All (260) households	100% coverage expensive

Land development	Agriculture & Forests	Rainfall & Drought	Langchenphu Gewog & Tokaphu	
Strengthen protection of watershed through cultural and spiritual beliefs	Culture and tradition		Tshophangma	
Bamboo & Thysanolaena Plantation	Forest	Drought	Samrang landslide area, Langchenphu, samrang gewog and Chitori and Dramzegang	HWC, may attract wildlife towards settlement
Extract river debris to mitigate changing river course and flooding	NRDCL, Forest	Heavy rainfall	Rongchuthang, Jangsa, Chukarpo, stream above Samrang BHU	Loss of biodiversity and change of river course
River bank embankment	Infrastructure, Disaster	Heavy rainfall	Chitori, Rongchuthang, Jangsa, Jomochu, Samrang river and Diklai	Damage caused to embankment infrastructure every monsoon due to heavy rainfall
Irrigation	infrastructure	erratic rainfall	All Chiwog (7km) Langchenphu gewog	
Rainwater harvest (surface collection)	infrastructure	Drought	All villages	Insufficient for longer period
Integrated farming (fishery and goat rearing)	infrastructure/breeds	Drought/heavy rain	10HHs (Langchenphu)	adverse impact to environment if free grazing is practiced
Dry land irrigation	infrastructure & equipment	Excessive Heat	Langchenphu Gewog and Minjiwoong	Nutrient leaching may occur if proper land management not practiced



Dip irrigation	Agriculture & Gewog	Extreme Temp	Dramzegang & Samrang	Expensive and cannot cover large area
Construction of reservoir tank	Infrastructure & Gewog	extreme temp	Mena Dara	

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
1. Cold storage and post-harvest Technology	Agriculture extension & Gewog Administration	MoF/Dzongkhag/Dungkhag/National Post Harvest Centre	Financial/technical/materials
2. Supply of Hybrid seeds (cereal & vegetables) and fruit tree seedlings	Agriculture extension & Gewog Administration	National seed center/private seed supplier	Financial/materials
3. Tree Plantation	JWS	Green Bhutan Corporation limited & Gewog Administration	Technical/Financial sanction
4. Protected agriculture (Polyhouse)	Agriculture extension	Gewog administration	Technical/financial & material
5. Improved livestock shelter (dairy & poultry)	Livestock extension	Gewog administration	Financial and technical
6. Construction of drainage along Samrang Farm road	Gewog administration	Engineering	Financial and technical
7. Solar energy (trapping solar energy as alternative source of renewable energy)	Gewog administration	Department of Energy	Financial/technical and material
8. Solar fencing for human-wildlife conflict management	Agriculture/Gewog administration	JWS	Financial

9. Supply of electric stove རྒྱུ་ཐབས།	Gewog administration		Financial
10. Land Management	Agriculture extension	Gewog administration	Financial/technical
11. Land Development	Agriculture extension	Gewog administration/CMU	Financial/technical/machinery
12. Strengthen protection of watershed through cultural and spiritual beliefs	Gewog administration	Dzongkhag administration/MoHCA	Financial
13. Bamboo & thysanolaena Plantation	Gewog administration	JWS	Financial
14. Extract river debris to mitigate changing river course	NRDCL	Gewog administration/Forest	Financial and technical
15. River bank embankment	Gewog administration	JWS/Dungkhag administration	Financial and technical
16. Irrigation	Agriculture extension	Gewog/Dungkhag administration	Financial/technical
17. Rain water harvest (Surface collection)	Gewog administration	JWS/Dungkhag administration	Financial/technical
18. Integrated Farming (fishery and goat rearing)	Livestock extension	Gewog administration/DoL	Financial/technical
19. Dry land Irrigation	Agriculture extension	Gewog/Dungkhag administration	Financial/technical
20. Dip irrigation	Agriculture extension	Gewog administration	financial/technical
21. Construction of reservoir tank	Gewog administration	Dungkhag and community contractor	Financial/technical

<b>Section 4. Implementation and Resourcing</b>						
<b>Adaptation Action</b>	<b>Next Step for Implementation</b>	<b>New or Existing</b>	<b>Cost (Nu. million)</b>	<b>Funding Available</b>	<b>Timeline Year (1 - 10)</b>	<b>Key Performance Indicator</b>
1. Cold storage and post-harvest technology	Secure funds & drawings	New	3.5	Not secured	2023-2025	Nos. of technology developed
2. Supply of hybrid seeds (cereal & vegetables) and fruit tree seedlings	Procurement of seeds and seedlings	New	1	Not secured	2023-2027	Quantity of seeds and seedling supplied
3. Tree plantation	Technical sanction	New	1.33	Not secured	2023-2026	Area rehabilitated through plantation
4. Protected agriculture (Polyhouse)	procurement of polyhouse materials	New	5.85	Not secured	2023-2027	Nos. of Greenhouse established
5. Improved livestock shelter (dairy & poultry)	procurement/Drawing and estimates for the shelters	New	1.8	Not secured	2024	30 sheds constructed
6. Construction of drainage along Samrang Farm road	Cost estimates with drawing	Existing	5	Not secured	2023-2024	5km drainage completed
7. Solar energy (trapping solar energy as alternative source of renewable energy)	feasibility and technical sanction	New	8.4	Not secured	2023-2025	Coverage of solar energy
8. Solar fencing for human-wildlife conflict management	procurement of equipment	existing	1.5	Not secured	2023-2025	Length of old fencing maintained and

						HWC incidence reduced
9. Supply of electric stove རྒྱུ་ལྷན་གྱི་ཐབས་	Procurement	New	0.282	Not secured	2023	Percent of reduction in usage of firewood/LPG
10. Land management (LM)	Financial sanction & sites identified	New/existing	1	Not secured	2023-2027	100 acres of agricultural land brought under LM
11. Land development	Financial sanction & sites identified	New	1	Not secured	2023-2027	200 acres of agricultural land terraced
12. Strengthen protection of watershed through cultural and spiritual beliefs	Estimate, design and approval	New	1	Not secured	2027	Spiritual monument constructed
13. Bamboo spp. & Thysanolaena spp. plantation	Financial sanction	New	2.3	Not secured	2024-2025	10 acres and 1.8 km of plantation carried out
14. Extract river debris to mitigate changing river course	Planning and award of work	new (above Samrang BHU, Jangsa, Rongchuthang, Old (Chukarpo)	6.4	Not secured	2023-2025	Properties and settlement along the rivers protected
15. River bank embankment	Drawing and estimates	Existing (Jomochu, Chukarpo, Jangsa,	14.5	Not secured	2023-2027	6.8 km embankment completed securing

		Rongchuthang, Samrang & Diklai				settlement & farmlands
16. Irrigation	Drawing and estimates	Existing (Langchenphu)	7	Not secured	2025	Area irrigated
17. Rain water harvest (Surface collection)	Drawing and estimates	New	1	Not secured	2025	Nos. of scheme established
18. Integrated farming (fishery and goat rearing)	Drawing and estimates	New	5	Not secured	2024- 2025	Nos. of integrated farms established
19. Dry land irrigation	Drawing and estimates	New	10	Not secured	2023- 2027	Area covered
20. Dip irrigation	Procurement	New	1	Not secured	2025	Area covered
21. Construction of reservoir tank	Drawing and estimates	New	1.5	Not secured	2026	Nos. of reservoirs established
<b>Total budget estimate for 10 years</b>			<b>80m</b>			

<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>	<b>Nos. of Participants</b>
20.10.2022	Consultation with Gewog officials (GT & RNR) and CFMG chairpersons of Serthi and Langchenphu Gewog	Gup, Mangmi, ADM, Tshokpa(s)Gewog Agriculture Extension Officer, Gewog livestock officer, CFMG chairperson, Forestry staff from Minjiwoong Beat office(Sethi) and Jomo Range office(Langchenphu)	18 (Male:12, Female: 6)
21.10.2022	Consultation with Gewog officials (GT & RNR) and BLD, Health and CC of Samrang and Pemathang Gewog	Gup, Mangmi, ADM, Tshokpa(s), Staff of BLDCL, HA, CC and Literate elderly people of Samrang and Pemathang Gewog	16 (Male: 11, Female:5)
<b>Consultation and Plan Preparation led by</b> <ol style="list-style-type: none"> <li>1. Ugyen Tshring, CFO, ugyentshering3@moaf.gov.bt</li> <li>2. Lekey Chaida, Sr. FO, lchaida@moaf.gov.bt</li> <li>3. Damber Kumar Ghemiray, FO, dkghemiray@moaf.gov.bt</li> </ol>			

### 13 Climate Change Adaptation Plan of the Biological Corridor-7, Mongar Forests Division

The Biological Corridor (BC-7) is one among eight biological corridors in the country that is located in the eastern part of the country and falls within the administrative jurisdiction of Lhuentse and Mongar Dzongkhag. It covers Gangzur, Khoma, Metsho, Menbi, Minjay and Tsenkhar Gewogs under Lhuentse and Tsakaling and Tsamang Gewogs Mongar Dzongkhag. With an area of 419.66 km<sup>2</sup>, it connects Wangchuck Centennial National Park (WCNP) in northwest, Phrumsengla National Park (PNP) in southwest and west with two strands and Bumdeling Wildlife Sanctuary (NWS) in northeast.

BC-7 has numerous streams and tributaries draining into Kurichhu. The 15.26 km of Kurichhu that is assessed as degraded catchment runs through BC-7 forming indispensable migratory routes to avifauna and other lesser known aquatic lives. It is joined by 43.48 km of streams and other 1,296.68 km of rivulets and tributaries. The globally threatened Pallas’s fish eagle, River lapwing and Black-necked Crane feeds and roost along these river stretches.

There are four major forest types in BC-7 classified as broadleaf, chirpine, fir and mixed conifer forest. The one third of the BC area falls under broadleaf forest. The chirpine and fir forest has least coverage in the BC area. The other land cover type includes shrub and meadows and landslide and built up areas has least coverage in the BC area.



Figure. Boundary of BC-7 showing the jurisdictions of Gewogs falling under it. The BC boundary connects with Bumdeling Wildlife Sanctuary in the east, Wangchuck Centennial National Park in the northwest and Phrushingla National Park in the southwest.

The floristic compositions consist of 307 plant species belonging to 103 families from which 104 tree species, 47 shrub species, 144 herb species including one endemic species. As of date, 276 species of birds have been documented out of which 1 is endangered, 3 are vulnerable and 6 are near threatened as per the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species. The camera trap studies and field surveys have revealed the presence of 28 species of mammals belonging to 11 families and 4 orders. Of these, 3 are endangered, 8 are Vulnerable, and 5 are Near Threatened and 12 are Least Concerned as per IUCN.

A total of 193 households reside within the BC area and around 727 households that reside around BC area also uses BC for natural resource extractions particularly timber, firewood and non-wood forest products. Agriculture and livestock farming forms the mainstay of the livelihood of the farmers residing in and around the biological corridor. As of now tourism is the least income generating activity in BC area. As human populations expand, the resources like water and land are becoming scarcer and incidences of crop damage, livestock predation and conflict is growing annually. Due to the expansion of agriculture and other anthropogenic pressures including development of infrastructures through intensive garnering of natural resources, habitat fragmentation and degradation has also become a pressing issue. Crop damage and livestock predation is one of the prominent issues faced by the people living in the BC area. Results from Bhutan Monitoring Effectiveness Tracking Tools, social and ecological survey identified five significant threats such as forest fire, grazing, farm road construction, electrical transmission line and illegal harvesting of timbers in BC-7. The natural disasters such as landslides, erosions and frequent road blocks are also posing serious problems to the lives of people. There is also rise in water problem in the Gangzur area leading to conflicts with upstream and downstream users.

### 13.1 Objective

- To ensure adaptive forest management to maintain the rich biodiversity
- To ensure the adaptive climate friendly socio-economic wellbeing of the community
- To strengthen community institutions to help them provide social safety nets and develop new coping mechanisms to adapt to climate change



## 13.2 Adaptation Priorities of Biological Corridor-7, Mongar Forests Division

### Section 1. Priority Climate Vulnerabilities

#### Rank of issues contributing to higher exposure to climate vulnerability

1. Extreme temperature causing decline in crop yield
2. Rainfall seasonality causing decline in crop yield and outbreak of pest and diseases
3. Windstorm causing destruction of crops and fruit trees
4. Invasive weeds
5. Landslides leading to reduced arable land

#### Rank of issues contributing to higher sensitivity to climate vulnerability

1. Increased wildlife population causing Human-wildlife conflict
2. Depleting drinking water availability causing poor health and sanitation
3. Pastureland shortage causing low livestock yield
4. Change in forest composition leading to growth of invasive plants, and pest and disease
5. Irrigation water shortage impacting agriculture yield

#### Rank of issues contributing to low adaptive capacity (% of households)

1. Forest Resources (0.71)
2. Alternative water source (16.43)
3. Distance to Gewog Center (16.43)
4. Vocational skills (17)
5. Distance to market (29)
6. Climate awareness (36.42)
7. Distance to School (36.42)
8. Communication medium (37)
9. Crop types (37)
10. Livelihood diversity (38.57)
11. Land holding (40.71)

**Following are the priority vulnerabilities identified**

1. Erratic rainfall and drying up water sources
2. Human Wildlife Conflict
3. Floods and Erosions
4. Pest and disease outbreak

**Section 2. Priority Actions to Address Vulnerabilities**

<b>Priority Vulnerabilities</b>	<b>Climate</b>	<b>Adaptation Action</b>	<b>Sector</b>	<b>Climate Hazard</b>	<b>Area</b>	<b>Potential Trade-Off</b>
1. Drying up of water sources and erratic rainfall		a). Improve planning, designing and implementation of climate resilient irrigation infrastructures and system b). Improved resilience of irrigation infrastructure c). Replace existing open irrigation with piped irrigation d). Micro irrigation like drip and sprinkler e). Strengthen Water User Associations (WUAs) f). Metrological information system till grassroots level g). Follow existing cultural practices	Gewog with technical support by agriculture sector	Drying up of water sources and erratic rainfall due to climate change	Minjay, Maenbi, Tsengkhar and Gangzur gewogs	May affect the biodiversity from source to end

2. Human Wildlife Conflict	<ul style="list-style-type: none"> <li>a). Establish chain link fencing instead of electric fencing</li> <li>b). Live fencing</li> <li>c). Follow existing cultural practices</li> <li>d). Institute crop insurance and compensation schemes</li> <li>e). Promotion of deterrents (vegetables, human hair)</li> <li>f). Initiate and promote insurance of livestock against wildlife depredation and extreme climate condition</li> <li>g). Reduced vulnerability of livestock farmers against losses from climate change impacts</li> </ul>	Forestry, Agriculture, Livestock, Dzongkhag & Gewog Administrations	Human-wildlife conflict triggered by climate change	Khoma, Minjay, Maenbi, Tsengkhar, Ganglapong and Gangzur gewogs	
3. Flash floods and Erosions	<ul style="list-style-type: none"> <li>a). Pursue an integrated landscape approach for sustainable soil and land management for agriculture</li> <li>b). Explore, develop and promote climate resilient crop varieties and climate smart technologies to improve sustainable production systems</li> </ul>	Dzongkhag & Gewog	Erratic and intense rainfall	All BC-07 area	May trigger more erosions if not designed properly
4. Pest and disease outbreak	<ul style="list-style-type: none"> <li>a). Develop pest and diseases forecasting system</li> <li>b). Inventory/improve and promote climate resilient</li> </ul>	Agriculture & Dzongkhag & Gewog	Pest and diseases outbreak	All BC-07 area	

	<p>indigenous varieties to adapt to climate change impacts</p> <p>c). Prevent and control the increasing pest and diseases and invasive alien species</p> <p>d). Identify and map areas prone to pests and diseases, and initiate periodic monitoring and surveillance</p>		triggered by climate change		
5. Drinking water scarcity	<p>a). Planting of trees at the water sources</p> <p>b). Awareness programs for efficient water use</p> <p>c). Explore and improve water treatment and supply network systems with proper management mechanisms</p> <p>e). Strengthen institutional capacity for water management</p>	Environment, Dzongkhag and Gewog	Drought	Tawsing Goenpa Lathpoe village and Tsengkhar Gewog	Possibility of reduce flow due to plant water uptake.
6. Flooding/GLOF	<p>a). Construction of gabion walls.</p> <p>b). Maintaining proper drainage and improvement of the farm roads</p> <p>c). Protect and develop pasture land</p>	Engineering sector, Environment, Livestock sector	Flooding and GLOF. Growth of invasive species	Shawa, Khomagang, Dengchung and Khoma Jalamzur & Tawsing goenpa	

7. Minimized risk of forest fire	a). Develop and implement fire management strategies and plans. b). Enhanced awareness on forest fire management c). Develop awareness program material and carry out awareness	Dzongkhag & Gewog Administration and Forest Department	Drought and raising temperature	Minjay and Tsengkhar Gewog	
8. Key important biodiversity conserved, and climate resilience value habitats	Documenting the traditional and ecological knowledge to establish baseline environmental information	NEC, DoFPS & Dzongkhag		Whole BC area	
9. Promote people-centric biodiversity conservation and improve rural economy through Access and Benefit Sharing (ABS) Programs	a) Enhancing the use of local knowledge and beliefs for the conservation of biodiversity and Forest b) Raising awareness on the use and importance of indigenous knowledge	NEC, DoFPS & Dzongkhag		Whole BC area	

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
1. Climate resilient and efficient irrigation system a). Replace existing open irrigation with piped irrigation	Gewog Administration	Dzongkhag and DoFPS	Fund and technical support

<ul style="list-style-type: none"> <li>b). Micro irrigation like drip and sprinkler</li> <li>c). Strengthen WUAs</li> <li>d). Metrological information system till grass root level</li> <li>e). Follow existing cultural practices</li> </ul>			
<p>Human-wildlife Conflict: Crop depredation</p> <ul style="list-style-type: none"> <li>a). Establish Chain link fencing and live fencing instead of solar/electric fencing.</li> <li>b). Follow existing cultural practices</li> <li>c). Institute crop compensation scheme</li> <li>d). Promotion of deterrents</li> <li>e). Initiate and promote insurance of livestock against wildlife depredation and extreme climate conditions</li> </ul>	Livestock, Agriculture & Gewog administration	Dzongkhag, Community and DoFPS	Fund and technical support
<p>Flash floods &amp; Erosion</p> <ul style="list-style-type: none"> <li>a). Pursue an integrated landscape approach for sustainable soil and land management for agriculture</li> <li>b). Explore, develop and promote climate resilient crop varieties and climate smart technologies to improve sustainable production systems</li> </ul>	Agriculture & Dzongkhag	Gewog and Community	Fund and Technical support
<p>Pest and disease outbreak</p> <ul style="list-style-type: none"> <li>a). Develop pest and diseases forecasting system</li> <li>b). Inventory/improve and promote climate resilient indigenous varieties to adapt to climate change impacts</li> </ul>	NEC, DoA & Dzongkhag	Gewog & Community	Fund and Technical support

<p>c). Prevent and control the increasing pest and diseases and invasive alien species</p> <p>d). Identify and map areas prone to pests and diseases, and initiate periodic monitoring and surveillance</p>			
<p>Flooding/GLOF:</p> <p>a). Construction of gabion wall</p> <p>b). Maintaining proper drainage and improvement of the farm roads</p> <p>c). Protect and develop pasture land</p>	<p>Engineering sector</p> <p>Livestock Sector</p>	<p>Community people, gewog and Dzongkhag Administration</p>	<p>Funding assistance and technical specialist</p> <p>Supply of machineries</p>
<p>Scarcity and drying of water source</p> <p>a). Planting of trees at the water sources</p> <p>b). Awareness programs for efficient water use</p> <p>c). Explore and improve water treatment and supply network systems with proper management mechanisms</p> <p>d). Strengthen institutional capacity for water management</p>	<p>DoFPS &amp; Dzongkhag, Health &amp; DES</p>	<p>Gewog Administration &amp; Community</p>	<p>Fund and technical support</p>
<p>Forest Fire</p> <p>a). Develop and implement fire management strategies and plans</p> <p>b). Enhanced awareness on forest fire management</p>	<p>Dzongkhag &amp; DoFPS</p>	<p>Gewog &amp; Community</p>	<p>Financial &amp; Technical support</p>

## Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New or Existing	Cost Estimate (Nu. in million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			
1. Piped irrigation and efficient micro irrigation and strengthening WUAs	Replace open irrigation with piped irrigation and efficient micro irrigation and strengthen WUAs	Existing & New	Nos.	1.0	2.0	None	5years	1.Nos. of piped irrigation channel constructed
Human-wildlife Conflict a). Establish Chain link fencing & Live fencing instead of EFS b). Follow existing cultural practices c). Institute crop compensation scheme d). Promotion of deterrents e). Initiate and promote insurance of livestock against wildlife depredation and extreme climate conditions	Prioritize chain link fencing and live fencing instead of solar/electric fencing, Institute crop compensation schemes and promote deterrents  Institute livestock depredation schemes	New	Nos.	1.0	5.0	None	10 years	2.Nos. of Chain link fencing constructed  One scheme in placed in each gewog
Flash floods & Erosion a). Pursue an integrated landscape approach for		Existing & New	Area	2*7	14	None	5-10 years	Acres of arable land under SLM



sustainable soil and land management for agriculture  b). Explore, develop and promote climate resilient crop varieties and climate smart technologies to improve sustainable production systems	a). Carry out SLM in the critical areas identified  b) Carry out research and come up with the climate resilient crops							
Pest and disease outbreak a). Develop pest and diseases forecasting system b). Inventory/improve and promote climate resilient indigenous varieties to adapt to climate change impacts	a). Identify and map areas prone to pests and diseases, and initiate periodic monitoring and surveillance b). Prevent and control the increasing pest and diseases and Invasive Alien Species	New		1*5	5	None	5-10 years	System developed
Flooding/GLOF: a). Construction of Gabion wall  b). Maintain proper drainage and	a). Conduct feasibility study and carry out the construction b). Identify the risk area and carry out the drain construction and improvement work	New  New  New		10*4  2.5* 2	40  5  3	None  None  None	3-5 yrs  1-2 yrs  3-5years	Infrastructure developed  Acres of land conserved

improvement of the farm roads c). Protect and develop pasture land	c). Identify the area and carryout the work			1.0*3				
Scarcity and drying of water source a). Planting of trees at the water sources b). Awareness programs for efficient water use c). Explore and improve water treatment and supply network systems with proper management mechanism d). Strengthen institutional capacity for water management	a). Increase area of plantation  b). Train the community on efficient water use c). Enhance the water supply network & improve water treatment d). Give awareness & training to WUA	Existing & New		1.0  0.5	5.0  1.0  5.0  1.0	None	5-10 years	Area of land planted.  Nos. of people made aware.  Improved water supplied.  Nos. of WUAs trained.
Minimize the Forest Fire risk a) Develop and implement fire management strategies and plans. b)Enhanced awareness on forest fire management	a). Revise Dzongkhag & Gewog Forest Fire Management plan b) Develop awareness program material and carry out awareness	Existing & New  Existing & New		0.5  0.5*4	1  2.0	None  None	3-5 years  3-8 years	Nos. of people made aware on Fire Management. Equipment supplied and training conducted.

Key important biodiversity conserved, and climate resilience value habitats	Documenting the traditional ecological knowledge to establish baseline environmental information	New		0.75	1.5	None	5-7 years	Report produced and number of community benefited
Promote people-centric biodiversity conservation and improve rural economy through Access and Benefit Sharing (ABS) Programs	a). Enhancing the use of local knowledge and beliefs for the conservation b). Raising awareness on the use and importance of indigenous knowledge c). Strengthening the good practices (Ridam, Tsan & Lu areas and Risungpas)	New		0.5	1.0	None	5-8 years	Report produced and number of community benefited.
<b>Total budget estimate for 10 years</b>					<b>101m</b>			
<b>Section 5. Details of Stakeholder Consultation</b>								
<b>Date of Consultation</b>	<b>Consultation Meeting</b>		<b>Stakeholders</b>			<b>Nos. of Participants</b>		
12-13 October 2022	Consultation with Dzongkhag Officials, Gups and Community Groups		Dzo. Livestock, Agriculture, Environment, Planning, Gups & CFMG members			7 female 15 males		
<b>Consultation and Plan Preparation led by</b> Norbu Wangdi, Principal Forestry Officer, Mongar Forests Division								

### 13.3 References

- Yoezer, D., Choden, K., Wangdi, D., Pelzang, S., Tshering, K., Dorji, S. (2022). Community-based Climate Change Vulnerability and Capacity Assessment of the Protected Areas of Bhutan. Uygen Wangchuck Institute for Conservation and Environment Research. Bumthang, Bhutan.
- Mongar Forest Division (2022). Biological Corridor 07 draft Management plan.
- NECS and UNDP (2021). Assessment of climate risks on forests and biodiversity for national adaptation plan (NAP) formulation process in Bhutan. Thimphu, Bhutan
- NCD (2008). Bhutan national human-wildlife conflict management strategy. Nature Conservation Division, Department of Forests and Park Services, Thimphu, Bhutan

# 14 Climate Change Adaptation Plan of the Wangchuck Centennial National Park

## 14.1 Background

Designated across the northern-central part of the country, Wangchuck Centennial National Park (WCNP) spans over an area of 4914 sq.km across the five districts covering nine gewogs. From the sub-tropical low-lying valleys to the high snowcapped mountain peaks, the altitude ranges from 1200-7500m with the vegetation types of the warm broadleaf forest to the alpine meadows. Almost 85% of the park remains under snow cover for about four months.

Due to huge variation in its altitudinal range, the park experiences difference in the climatic conditions at different altitude. Most of the northern portion receives snowfall round the year. During summer and monsoon, the park receives continuous rain for several days, which swells the streams and rivers, thus carrying huge load of forest debris. Sometimes, it brings sudden flash floods and landslides. The park has 367 glacial lakes, which are source of our freshwater ecosystems that is indispensable for all life forms.

Most of the human settlements are in the lower valleys of the park, except for highlanders who practice transhumance. Over 746 households with total population of 6640 people resides inside the park and around 70 households with around 660 people resides at the outer edge of the park. Yak herding communities represent about 8% of the total household inside park.

Subsistence farming and rearing of livestock are the main source of livelihoods for the communities across the park. However, with the legalization of the Cordyceps collection, the Cordyceps sale has become one of the cash rich businesses for the yak herders and other eligible collectors (people of Sephu, Nubi, Chokhor and Tang). Only 0.16% of park is under cultivation by the farmers.

Human-wildlife conflict is one of the main problems faced by the communities across the park. Different communities face different types of the human-wildlife conflict (HWC) incidences as different wildlife are responsible for the damage.

43% of the park land is under forest cover, thus the wildlife and communities share same landscape wherein there is competition for the space and resources that lead to undesirable encounters; human –wildlife conflicts. Having the forest cover around the settlement further augments HWC. The crop raids, livestock depredation, property damage and attack on humans are some of the negative impacts by the wildlife, causing variable effects on life and livelihoods. In terms of crop raids, the wild boar is the main pest. The Himalayan black bear is mostly associated with property damage as it often ransacks herder's hut looking for the foods. Dhole, tiger, snow leopard and common leopard are responsible for the livestock depredation.

As per the Community-Based Climate Vulnerability and Capacity Assessment (CVCA) report of the Protected Areas of Bhutan by UWICER, the temperature extremes events, rainfall seasonality and landslides are top three catastrophic climate event perceived by the local communities of the park over the time. With sudden increase in temperature over the recent times, communities indicated that there is outbreak of new pest and diseases attacking their crops. Rainfall seasonality shift is another thing that the communities have been experiencing and they are fearful about its wrathful impacts on their crops and farming activities. Moreover, with incessant high intensity rainfall, the frequency of sudden flashfloods and landslides have increased.

In September 2022 a sudden flashflood in Jasabi village, Kurtoed gewog has washed away two traditional houses and partially damaged four other houses. The flash flood killed five elderly people and injured a couple. Moreover, the flood damaged seven acres of paddy fields, other crops and stocked grains. Eleven cattle of four families were washed away by the flood. The flood also damaged the drinking water sources and irrigation channels/pipelines of the entire village.

Impacts like HWC, shortage of pastureland and insufficient drinking water were reported to be the main contributors for the sensitivity indicator. Electric fencing, solar fencing, stone walls, crop guarding and scare crows are some of the existing crop guarding methods in the park. However, CVCA report indicates that electric fencing is not that effective, thus the communities propose to have chain-link fencing.

With global warming effects, the shrubs and scrubs have been encroaching into the grassland thus turning the alpine meadows into shrub land. The shrinkage and degradation of the pastureland has led to selling of yaks and in some case giving up the herding practice. There are cases of conflict/ communal feud over the pastureland amongst the herding communities. Thus, need to initiate and support rangeland improvement works to encourage the herding communities and to uplift their livelihood from enhanced livestock productivity.

Regarding the adaptive capacity, the CVCA report indicated in having higher financial assets and social assets in the park. Higher financial assets are result of the income generated from the lucrative Cordyceps (*Ophiocordyceps sinensis*) business and the sale of highly priced high altitude medicinal plants. The higher financial assets imply only to the communities of Chokhor, Sephu and Dangchu gewogs, whose communities collects Cordyceps yearly. However, with the climate change, the question remains on the sustainability of the Cordyceps as the most of collectors indicated that there is gradual decline in the Cordyceps growing areas.

The climate change mitigation and adaptation actions become indispensable for our vulnerable communities and their livelihoods. With the proper adaptation action plan in place, we could subside the adverse impacts from the climate change induced hazards in the communities.

## 14.2 Objective

- To reduce human wildlife conflicts in the park through appropriate adaptation actions to reduce climate sensitivity and enhance adaptive capacity.
- To uplift livelihood of highland communities by developing livestock forage resources.
- To promote climate smart/organic farming practices through integration of indigenous technique and modern technologies
- To upscale the capacity of the communities to sustainably manage forest resources by promoting participatory forest resource management in the park.

### 14.3 Adaptation Priorities of the Wangchuck Centennial National Park

#### Section 1. Priority Climate Vulnerabilities

**1. Increased human wildlife conflict, resulting in crop and livestock depredation, property damage and attacks on human.**

Human-wildlife conflict (HWC) is one of the major issues that affects the lives and livelihoods of the communities residing in the park. With increased in the wildlife population, the HWC incidences is on the rise in the farming communities. Crop damages, livestock depredation, property damages and attacks on human are some of the negative interactions between the human and wildlife. Wildlife like wild boar, barking deer, sambar, porcupine and some rodent species often raids and damages the crops. The carnivores like tiger, common leopard, asiatic black bear, snow leopard, dhole and tibetan wolf usually attacks and kills the livestock inflicting huge losses to the farming communities. Despite the rampant cases of the HWC incidences, people have been tolerant so far and they did not resort in retaliatory killings of conflicting wildlife. However, chances are there that people may resort in retaliatory killing out of sheer resentment. With climate change and its adverse impacts, wildlife and human interaction may be intensified that would lead to loss of life and livelihoods of the marginalized communities. For that, proper mitigation measures like installation of chain-link fence to guard the crops and corrals to protect the baby animals especially the yak calves from the attacks by the wildlife needs to be implemented and unscaled in the park. In worst HWC scenario, the park would look into the strategies like wildlife population regulation through sport hunting and translocation programs.

**2. Shrinkage and deterioration of pastureland is endangering livelihood of livestock farming communities of the park.**

Fodder resources in park vary with climate, season and farming system. Alpine meadows, low land grasslands, forest, improved pastureland, fodder trees and crop residues are some of fodders for the livestock. For yak herding communities' alpine grassland form the main grazing ground for the yaks. With the upward shift of alpine vegetation, the alpine grasslands are turning into shrub land, as the shrubs and unpalatable forbs are encroaching into the grassland. With this climate induced natural phenomena, the alpine grasslands are getting reduced in its size, thus decreasing the livestock productivity. Since, the yak-herding communities depend primarily on the yak rearing, alpine meadows/rangeland development need to be instituted for the betterment of these people's livelihood. For cattle in the lower valleys, the forest, natural grassland and crop residues form the main fodder. Due to shortage or insufficient pastureland in the nearly settlements, people often let their cattle freely graze in the forest, which leads to depredation by the carnivores. Moreover, during winter season, livestock productivity decreases, as the feed availability is scarce. Livestock feed storage practices like hay making and silage needs to be encouraged in the communities so that they can feed their livestock in the dry season.



**3. Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are affecting agricultural crop yield.**

Rainfall seasonality is impacting crop yield by affecting crop health and growth. Erratic rainfall is causing drought during growing season and heavy rain is reported to damage crops during harvest. Elevated temperature is endangering the viability of indigenous crop variety and livestock breed. The army worm infestation which is phenomenon of warmer climatic zones was reported from Sephu and Chokhor Gewog.

**4. Incidences of flashflood and landslides are further marginalizing rural communities of park.**

WCNP is located in the region of the eastern Himalayas, making it very susceptible to natural calamities brought on by heavy rains during the peak monsoon season. Each year, high intensity rainfall-induced flash floods and landslides poses great threat to human lives, sweep away arable agricultural land, properties, and other infrastructure. This often causes severe damage to existing farm roads and there are cases of mud slides especially in Chokhor and Tang gewog, Bumthang.

**5. Windstorm is causing damage to crops and functional infrastructures.**

Windstorms endanger rural livelihood which is already plagued by poverty. Losing home to climate induced disaster may further marginalize rural community and drive rural urban migration and fallowing of agricultural lands.

**6. Loss of natural resource to forest fire and pest and disease.**

Climate change could lead to the frequent forest fires as climate change results in increased duration of dry seasons, drying of the forest fuel loads and drought, which could make our forest susceptible to the forest fires. Moreover, the warmer temperature and drought would favor the outbreak of the new pest and diseases in the forest. These incidences would lead to the mass destruction of the forest resources of the nearby communities, which would ultimately affect the community's livelihoods. Since, the rural community's livelihood depends on the forest, the protection of the forest from pest and diseases through upscaling the forest surveillance programs and formation of forest fire fighting groups in the communities.

**7. Drying up of water source as a result of temperature extremes and rainfall seasonality.**

Bhutan's topographical and climatic features combine to form a diverse watershed with wide range of ecosystems and biodiversity that support human well-being. According to water source classification studies conducted in 2018 and 2021, most of Bhutan's watersheds are

in good condition due to stringent environmental policies and practices, but few watersheds are deteriorating mainly due to human population growth and developmental activities.

Drying of water sources has become one of the major issues in some settlement under WCNP especially during dry season which is causing both drinking water and irrigation water shortage. Water source drying up is reported during dry season across the park. There are issues of water quality deterioration mainly due to unmanaged waste and free grazing of cattle which would cause negative impact on human health.

## Section 2. Priority Actions to Address Vulnerabilities

Priority Climate Vulnerabilities	Adaptation Action	Sectors	Climate Hazards	Area	Potential Tradeoff
Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Install chain-link fencing in combination with electric fence	Infrastructures	Human wildlife conflict driven by climate change	Across park	Interruption of wildlife movement
	Demonstrate corral (iron cage) as alternative measure to address HWC in designated highland herds.	Infrastructure		Highland herding communities	
Shrinkage and deterioration of pastureland is endangering livelihood of livestock farming communities of the park.	Pastureland Development Programs – High altitude rangeland and lowland grass land	Livestock	Invasive species, rainfall seasonality, and temperature extremes	Tang, Chokhor and Sephu	Introduced grass species becoming invasive & Loss of biodiversity

Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Support infrastructure for stall feeding	Infrastructure, Livestock	Climate variability	Kurtoed, Ney and Mangdiphu	None
Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Institute compensation scheme through group formation and insurance for livestock depredation for snow leopard.	Livestock	Climate variability	Sephu and Chokhor	
Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Construct pedestrian steel truss bridges for enhanced highland livelihood and mobility	Infrastructure, Ecotourism	Climate variability	Snowman race trek route	
Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Upscale secure ration storage facility for highlanders	Infrastructure	Climate variability	Highland herding communities	

Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are affecting agricultural crop yield	Accelerate agriculture land development and farm mechanization program	Climate smart agriculture, Water	Rainfall seasonality, Temperature Extremes, Seasonal Drought	Ney Zhisar and Kurtoed	Soil erosion if not executed properly & Loss of traditional agriculture practices
Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are affecting agricultural crop yield	Promote protected production system through supply of naturally ventilated greenhouse (Accessories)	Climate smart agriculture, Infrastructure, Water	Rainfall seasonality, Temperature Extremes	Across park	Loss of traditional agricultural practices
Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are affecting agricultural crop yield	Promote dry land irrigation through integration of efficient irrigation technology.	Water, Climate smart agriculture	Temperature extremes and rainfall seasonality	Across park	
Shrinkage and deterioration of pastureland is endangering livelihood of livestock farming communities of the park.	Demonstrate silage facilities to supplement traditional fodder storage practice.	Infrastructure	Rainfall seasonality, Temperature extremes	Across park	
Loss of natural resource to forest fire and pest and disease	Encourage community based natural resources management through formation of CFMG and NWFP groups	Human Capacity, Natural resources	Climate variability	Across park	

Shrinkage and deterioration of pastureland is endangering livelihood of livestock farming communities of the park.	Promote pasture development in private registered land through supply of fodder grass seeds	Livestock	Climate variability	Sephu, Tang and Chokhor	Reduction of agriculture lands
Shrinkage and deterioration of pastureland is endangering livelihood of livestock farming communities of the park.	Initiate land lease to develop and expand pastureland near settlements for potential farmer groups.	Livestock, Forestry	Rainfall seasonality	Across park	Decline in other forest resource and Landslides & flashflood
Drying up of water source as a result of temperature extremes and rainfall seasonality	Improve water provisioning and storage facilities to improve water conveyance efficiency	Water, Infrastructure	Rainfall seasonality and Temperature extremes	Across park	
Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are affecting agricultural crop yield	Promote and upscale integrated pest management practices using locally available materials	Climate smart agriculture	Temperature elevation, Rainfall seasonality, pest and diseases	Across park	
Erratic rainfall, extreme temperature, and outbreak of new pest and diseases are	Promote integrated soil fertility management practices (Vermi-compost/Bio-char/Crop rotation)	Climate smart agriculture, Forest Sanitation, Water	Temperature elevation and Rainfall seasonality	Chokhor Gewog	

affecting agricultural crop yield					
Windstorm is causing damage to crops and functional infrastructures.	Promote fodder and fruit trees as wind break around the agricultural land	Climate smart agriculture, Agroforestry, Horticulture	Windstorm	Ney and Kurtoed	Might trigger HWC
Increased human wildlife conflict, resulting in crop depredation, livestock depredation, property damage and attacks on human.	Sport hunting of wild pig	Nature based, Ecotourism	HWC driven by climate change	Tang	Imbalanced food-chain system in the ecosystem
Drying up of water source as a result of temperature extremes and rainfall seasonality	Protection and restoration of water source and water course through plantation and fencing.	Water, Nature based	Rainfall seasonality and Temperature extremes	Kurtoed and Dangchu (Godraang-Taasa)	
Windstorm is causing damage to crops and functional infrastructures.	Promote climate resilient infrastructures through regulatory control during construction in windstorm prone areas	Infrastructure	Windstorm	Ney and Kurtoed	
Flashflood and landsides are further marginalizing rural communities of Park	Promote bioengineering practices for disaster prone/affected areas.	Water, Nature based	Heavy rainfall	Kurtoed (Jasabi and Taabi)	
Erratic rainfall, extreme temperature, and outbreak of new pest	Step up sensitization on prevention and control of invasive species	Climate smart agriculture	Temperature elevation and	Across park	

and diseases are affecting agricultural crop yield			rainfall seasonality		
Section 3. Potential Roles and Responsibilities					
Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed		
Install chain-link fencing in combination with electric fence	Gewog Administration/Dzongkhag Administration	WCNP/DoFPS, BFL, and ARDCs	Funding, materials and technical support.		
Demonstrate corral (iron cage) as alternative measure to address HWC in designated highland herds	Gewog Administration and WCNP/DoFPS	Dzongkhag Administration and BFL	Funding, materials and technical support		
Pastureland Development Programs – High altitude rangeland and lowland grass land	WCNP/DoFPS	Gewog Administration, Dzongkhag Administration, NRDCAN, NH-RDC, UWICER and BFL	Funding, supplies and technical support		
Support infrastructure for stall feeding	Gewog Administration	WCNP, BFL, Dzongkhag and Administration	Funding, materials and technical support		
Institute compensation scheme through group formation and insurance for livestock depredation.	WCNP/DoFPS	Gewog Administration, Dzongkhag Administration, UWICER, BFL and NCD	Funding, administrative support and technical support		
Construct pedestrian steel truss bridges for	Gewog Administration/Dzongkhag Administration	BFL, SMR Secretariat and TCB	Funding, materials and technical support		

enhanced highland livelihood and mobility			
Upscale secure ration storage facility for highlanders	Gewog Administration and WCNP/DoFPS	Dzongkhag Administration and BFL	Funding, materials and technical support
Accelerate agriculture land development and farm mechanization program	Gewog Administration	Dzongkhag Administration, CMU, ARDCs and BFL	Funding, machineries and technical support
Promote protected production system through supply of naturally ventilated greenhouse (Accessories)	Gewog Administration and WCNP/DoFPS	Dzongkhag Administration, ARDCs and BFL	Funding, materials and technical support
Promote dry land irrigation through integration of efficient irrigation technology.	Gewog Administration	Dzongkhag Administration, WCNP/DoFPS, ARDCs and BFL	Funding, materials and technical support
Demonstrate silage facilities to supplement traditional fodder storage practice.	Gewog Administration	Dzongkhag Administration, NRDCAN, and BFL	Funding, materials, and technical support
Encourage community based natural resources management through formation of CFMG and NWFP groups	WCNP/DoFPS	Dzongkhag/Gewog Administration, UWICER and BFL	Funding and technical support



Promote pasture development in private registered land through supply of fodder grass seeds	Gewog Administration	Dzongkhag Administration, WCNP/DoFPS, NRDCAN and BFL	Funding, supplies and technical support
Initiate land lease to develop and expand pastureland near settlements for potential farmer groups in collaboration relevant stakeholders.	Dzongkhag Administration	Gewog Administration, NRDCAN, WCNP/DoFPS and BFL	Funding, administrative support and technical support
Improve water provisioning and storage facilities to improve water conveyance efficiency	Gewog Administration	Dzongkhag Administration, WCNP/DoFPS and BFL	Funding, materials and technical support
Promote and upscale integrated pest management practices using locally available materials	Dzongkhag Administration	Gewog Administration, ARDCs, WCNP/DoFPS and BFL	Funding, supplies and technical support
Promote integrated soil fertility management practices (Vermi-compost/Crop rotation/Bio-char)	Gewog Administration	Dzongkhag Administration, WCNP/DoFPS and BFL	Funding and technical support
Promote fodder and fruit trees as wind	WCNP/DoFPS	Dzongkhag/Gewog Administration, ARDCs and BFL	Funding and technical support

break around the agricultural land			
Sport hunting of wild pig	WCNP/DoFPS	Dzongkhag Administration, TCB, BFL, UWICER and NCD	Funding, administrative and technical support
Protection and restoration of water source and water course through plantation and fencing.	WCNP/DoFPS	Dzongkhag/Gewog Administration, UWICER and BFL	Funding and technical support
Promote climate resilient infrastructures through regulatory control during construction in windstorm prone areas	Dzongkhag Disaster Response Office	Dzongkhag Administration, Gewog Administration, NCHM and BFL	Funding, materials and technical support
Promote bioengineering practices for disaster prone/affected areas.	WCNP/DoFPS	Dzongkhag/Gewog Administration, ARDCs and BFL	Funding and technical support
Step up sensitization on prevention and control of invasive species	Dzongkhag Administration	WCNP/DoFPS, ARDCs and BFL	Funding and technical support

#### Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New or Existing	Cost Estimate (Nu in million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			

Install chain-link fencing in combination with electric fence	Assessment and hotspot mapping	New	Km	1.8	36	No	Year 2-10	Total kilometers of chain link fence installed (20 Km)
Demonstrate corral (iron cage) as alternative measure to address HWC in designated highland herds	Design and drawing and detailed cost estimate	New	Number	0.25	1.25	No	Year 2-10	Number of corrals constructed (5)
Pastureland Development Programs – High altitude rangeland and lowland grass land	Consultation	Existing	Number	0.06	3.6	No	Year 1-10	Number of herders benefitted (60)
Support infrastructure for stall feeding	Stakeholder consultation	New	Number	0.05	2.5	No	Year 1-10	Number of households benefitted (50)
Institute compensation scheme through group formation and insurance for livestock depredation by snow leopard.	Group formation (Consultation and By-laws)	New	Number	1.15	2.3	No	Year 2	Number of groups formed (2 group)
Construct pedestrian steel truss bridges for enhanced highland livelihood and mobility	Design and drawing and detailed cost estimate	New	Number	2	6	No	Year 1-5	Number of bridges constructed (3 bridges)

Upscale secure ration storage facility for highlanders	Design and drawing and detailed cost estimate	Existing	Number	0.1	2	No	Year 1- 5	Number of storage hut constructed (20 numbers)
Accelerate agriculture land development and farm mechanization program	Stakeholder consultation	Existing	Acres	0.2	4	No	Year 1-10	Total acres of land developed (20 acres)
Promote protected production system through supply of naturally ventilated greenhouse (Accessories)	Procurement of greenhouse materials and stakeholder consultation to identify marginalized households	Existing	Number	0.13	13	No	Year 1-10	Numbers of naturally ventilated greenhouse supplied (100 numbers of greenhouses)
Promote dry land irrigation through integration of efficient irrigation technology.	Stakeholder consultation to identify marginalized households	New	Set	0.02	2	No	Year 1-5	Number of irrigation sets supplied (100 sets)
Demonstrate silage facilities to supplement traditional fodder storage practice.	Stakeholder consultation	New	Number	0.015	0.5	No	Year 2-5	Number of silage facilities constructed (35 numbers)
Encourage community based natural resources management through	Identify target species	Existing	Number	0.06	0.12	No	Year 1-10	Number of community groups and management plan

formation of CFMG and NWFP groups								developed (2 Groups)
Promote pasture development in private registered land through supply of fodder grass seeds	Stakeholder consultation	Existing	Acre	0.003	0.15	No	Year 1-10	Total acres of pasture Developed (50 acres)
Initiate land lease to develop and expand pastureland near settlements for potential farmer groups in collaboration relevant stakeholders.	Group formation and land lease registration	New	Number	0.5	2.5	No	Year 1 -10	Number of groups formed (5)
Improve water provisioning and storage facilities to improve water conveyance efficiency	Design and drawing and detailed cost estimate	Existing	Number	0.25	2.5	No	Year 1-10	Number of communities benefitted (5 communities)
Promote and upscale integrated pest management practices using locally available materials	Training	New	Number	0.05	0.7	No	Year 1-10	Number of trainings provided (14 times)
Promote integrated soil fertility management practices (Vermi-compost/Crop rotation/Bio-char)	Detailed project feasibility study	New	Number	0.5	1	No	Year 7	Number of bio-char/Vermi-compost facilities established (2 numbers)

Promote fodder and fruit trees as wind break around the agricultural land	Consult beneficiaries and arrange seedlings	New	Number	0.02	1	No	Year 2-10	Number of households benefitted (50 households)
Sport hunting of wild pig	Develop plan/guideline	New	Plan	0.2	0.2	No	Year 3	Plan/guideline developed (1 guideline)
Protection and restoration of water source and water course through plantation and fencing	Detailed assessment and consultation	Existing	Number	0.1	1	No	Year 1 - 10	Number of water source/course restoration work carried out (10 critical water sources)
Promote climate resilient infrastructures through regulatory control during construction in windstorm prone areas	Stakeholder consultation	New	Number	0.05	0.05	NA	Year 1-10	Number of villages brought under construction regulatory control
Promote bioengineering practices for disaster prone/affected areas.	Identify landslide/flood prone areas	New	Number	0.2	1	No	Year 1-10	Total decimals of land rehabilitated (5 sites)
Step up sensitization on prevention and control of invasive species	Sensitization	New	Number	0.02	0.28	No	Year 1-10	Number of sensitizations conducted (14 times)
<b>Total budget estimate for 10 years</b>					<b>84m</b>			

## Section 5. Details of Stakeholder Consultation

Date of Consultation	Consultation Meeting	Stakeholders	Nos. of Participants
19/10/2022	Consultation with Dangchu Gewog officials	Gewog Officials (Gup, Mangmi, GAO & Supporting staff), Gewog Livestock Sector, Gewog Agriculture Sector, Tshogpas	8 (8 Male. 0 Female)
20/10/2022	Consultation meeting with Kurtoed Gewog officials	Gewog Livestock Sector, Gewog Agriculture Sector, Health Assistant, Tshogpas and CF executives	10 (9 Male. 1 Female)
21/10/2022	Consultation meeting with Tang Gewog officials	Gewog Officials (Gup & GAO), Gewog Livestock Sector, Gewog Agriculture Sector, Tshogpas, CF executives and Forest Beat Office	14 (11 Male. 3 Female)
21/10/2022	Consultation meeting with Gangzur Gewog officials and relevant Dzongkhag officials	Dzongkhag Environment Sector, Dzongkhag Planning Sector, Gewog Officials (Gup, Mangmi, GAO, and Livestock Extension Office), NWFP executive members and Tshogpa	9 (8 Male. 1 Female)
21/10/2022	Consultation meeting with Nubi Gewog officials	Gewog Officials (Gup, GAO, CC In charge), Gewog Livestock Sector, Gewog Agriculture Sector, Health Assistant and Tshogpas	15 (8 Male. 7 Female)
24/10/2022	Consultation meeting with Sephu Gewog officials	Gewog Officials (Mangmi, GAO, CC In charge), Gewog Livestock Sector, Gewog Agriculture Sector, Tshogpas and Park Range Officials.	14 (13 Male. 1 Female)
26/10/2022	Consultation meeting with Chokhor Gewog officials and relevant Dzongkhag officials	Dzongkhag Agriculture Sector, Dzongkhag Livestock Sector, Dzongkhag Planning Sector, Gewog Officials (Mangmi, GAO, and Livestock Extension Office), and Tshogpas	11 (10 Male. 1 Female)
<b>Consultation and Plan Preparation led by</b> <ol style="list-style-type: none"> <li>1. Kinley Dorji, Forestry Officer (Kinleydorji1@moaf.gov.bt)</li> <li>2. Karma Wangdi, Forestry Officer (Karmawangdi1@moaf.gov.bt)</li> <li>3. Dorji Wangchuk, FR-I (wangchuk.d2013@gmail.com)</li> <li>4. Tilak B. Ghalley, FR-II (tilakghalley@gmail.com)</li> </ol>			

## 15 Climate Change Adaptation Plan of the Phrumsengla National Park

### 15.1 Background

Phrumsengla National Park (PNP) was declared a National Park in 1993 as Thrumshingla National Park (TNP). The park was fully operationalized in the year 2000 and was renamed as Phrumsengla National Park in 2014, covering an area of 906.6 km<sup>2</sup>. It is located in the central part of Bhutan between the geographical coordinates of 27.2831° latitude and 90.9778° longitude. The park is connected to Jigme Singye Wangchuck National Park (JSWNP), Royal Manas National Park (RMNP), Bumdeling Wildlife Sanctuary (BWS) and Wangchuck Centennial National Park (WCNP) through a string of biological corridors.

The landscape of PNP stretches from sup-tropical zone to alpine meadow with elevation range from 900 m in the south and 4500 m in the north. The park is vital for conservation of the last remaining growth of old Eastern Himalayan Silver fir forest. Moreover, the maximum area of PNP comprises Fir Forest. Wide range of elevation, diverse vegetation coverage and heterogeneous geomorphology attributes to harbor rich diversity of flora and fauna. The PNP is a significant depository of floral diversity, about 161 species of trees, 274 species of shrubs and 316 species of herbs are found in PNP. More than 154 species have been identified with medicinal value and 21 species as endemic to Bhutan. More than 70 species of mammals, about 365 species of birds and about 169 species of butterflies are recorded in the park. There are 3 species of amphibians, 12 species of reptiles and 4 species of lizards. Several globally significant species found in PNP are: Tiger (*Panthera tigris*), Red panda (*Ailurus fulgens*), Musk deer (*Moschus chrysogaster*), Takin (*Budorcas taxicolor*), Rufous-necked hornbill (*Aceros nipalensis*) and Beautiful nuthatch (*Sitta Formosa*).

Administratively PNP covers four districts, ten Gewogs and 32 villages viz., Chumey, Ura and Tang Gewogs under Bumthang Dzongkhag, Saleng and Tsamang Gewogs under Mongar Dzongkhag, Jaray, Metsho and Gangzur Gewogs of Lhuentse Dzongkhag and Nangkhor Gewog under Zhemgang Dzongkhag. There are about 6000 inhabitants from 1,165 households within the park area.



The park emphasis on conserving and protecting wild floral diversity specifically on old growth fir forest and cool temperate broadleaved forest. Also prioritize protecting wild fauna diversity with special emphasis on key species as Tiger, red panda and musk deer. The numerous research and species assessments have been conducted in the part which play a vital role if species-based management plans have to be developed. As a part of National survey, the park has also conducted National Tiger survey and National Forest Inventory.

The park also gives importance in promoting ecotourism, basically emphasizing on the richness of bird diversity, as the park is well known to have stunning old trekking routes and one of the best bird watching spots in Asia. Collaborating with Trans Bhutan Trail (TBT) the park has maintained the old trekking route to keep it vibrant. Poaching poses a threat to survival of those wild animals having high trade value in black market. Wild animals which face immediate poaching impact are Tiger, musk deer, pheasants and Satuwu etc. The park has executed regular anti-poaching patrolling in identified and suspected habitats to minimize the poaching. Illegal felling is the important factor contributing to forest degradation in the park. To curb the illegal harvesting of timber, sudden and uninformed patrolling is being conducted. Besides one forest checkpoint has been installed at Gegdong zam to inspect illegal timber transactions.

The park has prioritized management plans especially on flora and fauna conservation. Understanding flora and fauna composition in the landscape is necessary to streamline the successful conservation program. So, one of the important conservation plans of PNP is to enhance understanding of landscape, species composition and abundance in the park. About 6000 people of 10 Gewogs residing in and around the park depend on natural resources from different management zones. As a result, more forest encroachment and dependent on nearby natural resources including NWFPs is a threat to conservation of landscape. Thus, the park has a plan to empower local communities to ensure sustainable management and utilization of natural resources. With increase in demand and utilization of natural resources, encroachment of wildlife habitat and increasing developmental activities have accelerated the Human wildlife conflicts (HWC) in the park. Among the various activities implemented by the park, solar-electric fencing was one major activity implemented by the park to address the HWC. A total stretch of more than 60 kms of solar-electric fencing was carried out in 6 Gewogs covering an area of more than 500 acres. To ensure effective service delivery, the park head office has three range offices at Ura Bumthang,

Lingmethang Mongar and Phawan Lhuentse. In addition, two sub range offices at Sengor & Tsamang Under Mongar and Zangkar sub-range office under Lhuentse Dzongkhag.

The study on Community based climate vulnerability and capacity assessment (CVCA) was conducted in Protected area network of Bhutan with the aim to develop climate change adaptation plan and implement adaptation plan. The study surveyed 176 (15%) households out of 1165 households in the PNP. Extreme temperature, rainfall seasonality and windstorm are the top three contributors among other indicators of exposure while the GLOF was the least contributor. Likewise, human wildlife conflict, pastureland and drinking water were the important factors to sensitivity. For the adaptive capacity social assets was the highest contributor and natural assets was the least contributor in the PNP. Overall, the vulnerability index of PNP was 0.17 which is moderately vulnerable among other parks. Breaking down at Gewog level, the Metsho gewog under Lhuentse Dzongkhag with vulnerability index of -0.37 was most vulnerable and the Saling Gewog with vulnerable index 0.39 is the least vulnerable. At the Chewog level, Zongmaed of Metsho Gewog under Lhuentse Dzongkhag with vulnerability index of -0.53 was found most vulnerable and Ganglapong of Tsamang Gewog under Mongar Dzongkhag with vulnerability index 0.68 was the least vulnerable.

## 15.2 Objective

- To implement the climate adaptation intervention to maximize the socio-ecological benefits
- To minimize the human wildlife conflict to improve livelihood and enhance conservation
- To raise timely awareness on climate change

### 15.3 Adaptation Priorities of the Phrumsengla National Park

#### Section 1. Priority Climate Vulnerabilities

Priority List:

1. Flash flood: Resulting blockage of motor-able road, damaging crops and cultivation land besides threat to human life.
2. Human wildlife conflict: Crop and livestock depredation and posing threaten human life.
3. Crop yield: Extreme temperature resulting decrease in annual crop yield.
4. Pest and diseases: Result in crop yield reduction.
5. Invasive plants: Competes with main crop, resulting decrease in fertility of soil and crop products.
6. Water sources: Drying of water source, resulting in water scarcity.
7. Irrigation water: Drying of water sources, hampering timely cultivation.
8. Market facility: Extreme temperature resulting faster rot of vegetables.
9. Climate awareness: No timely awareness resulting delay in mitigating the issue.
- 10: Vocational skills: No opportunity to address waste problem. No alternative to reuse the waste whereby left with option to burn wastes which adds greenhouse gases directly.
11. Pastureland: Decline in pasture land increases the forest cover which leads to increase in wildlife encroachment to nearby human settlement.

#### Section 2. Priority Actions to Address Vulnerabilities

Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Flash flood: a. Construct retention wall and proper drainage system along the farm road and flash flood prone areas	a. Disaster risk reduction, nature-based solution	a. Change in rainfall pattern causing more flash flood	a. Construction of retention wall and proper drainage system at Jaray gewog, Ura, Saling Gewogs	a. It can be more damaging if not properly constructed
b. Bamboo cultivation on flash flood prone area	b. water, nature-based solution	b. Increasing flash flood	b. Bamboo cultivation at Jaray Gewog	b. It may cause diversion of surface runoff to other

<p>c. Need of crop damaged compensation scheme</p> <p>d. Rehabilitate the damaged crop field</p>	<p>c. Agriculture</p> <p>d. Agriculture, disaster risk management</p>	<p>c. Crop yield reduction</p> <p>d. Increasing crop yield reduction</p>	<p>c. Crop damaged compensation and rehabilitation of damaged crop field at Ura Gewog</p>	<p>site resulting more damages</p>
<p>2. Human wildlife conflict:</p> <p>a. Need of Chain linked fencing.</p> <p>b. Insurance scheme for crop and livestock depredation</p> <p>c. Construct fabricated green house with irrigation item.</p> <p>d. Need of solar/electric fencing for individual household</p> <p>e. Sanitization to public on protection of wild fruits</p>	<p>Agriculture infrastructure solution and human capacity focused</p>	<p>Increasing human wildlife conflict</p>	<p>a. Need of chain linked fencing at Jaray gewog, Ura, Metsho, Saling and Tsamang Gewog</p> <p>b. Insurance scheme at Jaray and Tsamang Gewog</p> <p>c. Fabricated green house at Jaray Gewog</p> <p>d. Individual solar/electric fencing at Ura Gewog</p> <p>e. Sanitization at Tsamang and Saling Gewog</p>	<p>Might be financial waste if not constructed with durable materials and studied sustainability of the insurance scheme.</p>
<p>3. Crop yield:</p> <p>a. Supply of high yield and diseases resistance seeds.</p>	<p>a. Agriculture, nature-based solution</p>	<p>a. Reduction of crop productivity</p>	<p>a. Supply of high yield and diseases resistance seeds at Jaray gewog, Ura, Saling</p>	<p>a. Might be invasive if not researched before supplying of seeds</p>

<p>b. Slope land management.</p> <p>c. Technical support to develop compost or natural fertilizer</p> <p>d. Supply of greenhouse to cultivate protected local vegetable</p>	<p>b. Agriculture, infrastructure-based solution</p> <p>c. Agriculture, nature-based solution</p> <p>d. Agriculture, infrastructure-based solution</p>	<p>b. Increasing landslide and flash food in steep slope</p> <p>c. Increasing infertile soils due to soil erosion.</p> <p>d. extinction of local vegetable due to climate variability</p>	<p>b. Slope land management at Jaray Gewog</p> <p>c. Technical support to develop natural fertilizer at Ura and Jaray Gewog</p> <p>d. Green house to cultivate protected vegetables at Metsho Gewog</p>	<p>b. May increase soil erosion if the retention walls are not constructed</p> <p>c. May invite new pest to the locality</p> <p>d. Local vegetable may not be climate resistance all time</p>
<p>4. Pest and diseases:</p> <p>a. Create awareness on latest pest and diseases to timely address the issue</p> <p>b. Conduct research and supply researched based organic pesticides and weedicides</p>	<p>Agriculture, nature-based solution and human capacity focused</p>	<p>Deteriorating the crop production</p>	<p>a. Awareness to Jaray, Ura, Metsho, Saling, and Tsamang Gewog</p> <p>b. Supply researched based organic pesticides and weedicides to Saling Gewog</p>	<p>Application of pesticides and weedicides may also kill the important weeds and insects</p>
<p>5. Invasive plants:</p> <p>a. Need of latest equipment to make the invasive plant as natural compost.</p> <p>b. Pesticides to eradicate the invasive plants at Gewog level</p>	<p>Agriculture, nature-based solution</p>	<p>Overtaking survival of local crops</p>	<p>a. Latest equipment to Jaray gewog</p> <p>b. Pesticides to eradicate invasive plants at Gewog level at Saling Gewog</p>	<p>Pesticides may also eradicate other important local weeds</p>

<p>6. Water sources:</p> <p>a. Fencing existing water catchment and develop more capacity water tank.</p> <p>b. Need to conduct research to keep the water sources sustainable</p> <p>c. Plantation surrounding the water sources</p> <p>d. Conduct assessment to allocate alternative water sources</p>	<p>Water, nature base and infrastructure solution</p>	<p>Increasing water scarcity</p>	<p>Jaray gewog, Ura, Metsho, Saling and Tsamang</p>	<p>Fencing water catchment may reduce water source for wild animals resulting shifting of wild animals nearby villages. Plantation surrounding water sources may become direct waters used and cause drying of water sources.</p>
<p>7. Irrigation water:</p> <p>a. Need proper irrigation channel</p> <p>b. Need reserve water tank</p> <p>c. Dry land irrigation for crop cultivation</p>	<p>Water, Agriculture and nature-based solution</p>	<p>Shrinkage of water sources causing water scarcity</p>	<p>Jaray, Metsho and Tsamang Gewog</p>	<p>Improper construction of irrigation channel may cause flash flood</p>
<p>8. Market facility:</p> <p>a. Need of latest dryer to dry agriculture products</p> <p>b. Storage to store crop products and shade to sell the products</p>	<p>Agriculture, infrastructure-based solution</p>	<p>Extreme temperature causing fast rot of crop and vegetable products</p>	<p>a. Latest dryer to Jaray gewog b. Storage and shade to sell the agriculture products at Metsho Gewog</p>	
<p>9. Climate awareness:</p> <p>a. Timely awareness on climate change at Chewog level.</p>	<p>Nature based solution and human capacity focused</p>	<p>Increase in climate variability</p>	<p>Jaray gewog, Ura, Metsho, Saling and Tsamang</p>	<p>Waste management may be another problem if waste from the waste</p>

b. Construct waste segregation shed at Chewog level				segregation shed not managed properly.
10. Vocational skills: Establish skills development center to develop products and enhance skills using waste produced at local level.	Human capacity focused solution	Waste contributing more greenhouse gas leading sever climate change	Jaray Gewog	If no market to trade the products it may be waste of resources
11. Pasture land: a. Develop grazing area in registered land. b. Improve existing pasture land for those harboring more cattle	Agriculture, nature-based solution	Increasing forest cover resulting reduction of grazing areas	Jaray gewog, Ura and Tsamang	If people lose interest in raring livestock, then it may become resources waste.

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
<b>1. Flash flood:</b> a. Develop retention wall and proper drainage system along the farm road. b. Bamboo cultivation on flash flood porn area c. Need of crop damaged compensation scheme	Gewog administration	Dzongkhag engineer, Dzongkhag agriculture sector, public and concern agencies	a. Budgetary support to build retention wall and proper drainage system in required places. b. Budgetary support to cultivate native or survival bamboo and resources person. c. Need of seed money to develop crop damaged compensation scheme. d. Machinery and financial support to rehabilitate the damaged crop field.

d. Rehabilitate the damaged crop field			
<p><b>2. Human wildlife conflict:</b></p> <p>a. Need of Chain linked fencing.  b. Insurance scheme for crop and livestock depredation  c. Construct fabricated greenhouse with irrigation item.  d. Need of solar/electric fencing for individual household  e. Sanitization to public on protection of wild fruits</p>	Gewog administration	Dzongkhag administration, Dzongkhag engineer, Gewog agriculture extension, DoFPS and public	<p>a. Need of material support including: chain link, fencing post, cement and transportation charge. While stone and labor support from public.  b. Need of seed money to start insurance scheme in the community.  c. Financial support to construct fabricated green house with irrigation items.  d. Solar/ electric fencing material support and resources person to install fencing in intended manner.  e. Need of technical person to do sanitize general public on importance of protecting wild fruits to minimize the HWC.</p>
<p><b>3. Crop yield:</b></p> <p>a. Supply of high yield and diseases resistance seeds.  b. Slope land management.  c. Develop compost or natural fertilizer  d. Supply of greenhouse to cultivate protected local vegetable</p>	Gewog administration	Department of Agriculture and general public	<p>a. Supply of highbred and diseases resistance seed on time.  b. Machinery support to do slope land management and technical person to guide the work.  c. Need support of available equipment and resources person to develop natural compost  d. Financial support to construct greenhouse to cultivate local protected vegetable</p>
<p><b>3. Pest and diseases:</b></p> <p>a. Create awareness on latest pest and diseases to timely address the issue</p>	Gewog administration	Gewog agriculture extension and general public	<p>a. Financial support to conduct awareness and to procure material. And technical backstop form concerned agencies.  b. Financial support to conduct research and purchase organic pesticides and weedicides</p>



b. Conduct research and supply researched based organic pesticides and weedicides			
<b>4. Invasive plants:</b> a. Need of latest equipment to make the invasive plant as natural compost. b. Pesticides to eradicate the invasive plants at Gewog level	Gewog administration	Gewog agriculture extension and general public	a. Supply of machinery to make compost and financial support to construct shade to install the composting machine and store compost. b. Supply of pesticides and sprayers to spray pesticides
<b>5. Water sources:</b> a. Fencing existing water catchment and develop more capacity water tank. b. Need to conduct research to keep the water sources sustainable c. Plantation surrounding the water sources d. Conduct assessment to allocate alternative water sources	Gewog administration	DoFPS and public	a. Supply of fencing materials and construction material to build water reserve tank and also technical person to guide the work. b. Need water expert to conduct research to enhance water sources sustainability and financial support to carry out the research. c. Need seedling that thrives in proposed locality d. Require resources person to assess the enduring water sources.
<b>7. Irrigation water:</b> a. Need proper irrigation channel b. Need reserve water tank c. Dry land irrigation for crop cultivation	Gewog administration	Dzongkhag engineer, public and concern agencies	a. Budgetary support to construct proper irrigation channel and technical assistant. b. Financial support to built water reserve tank at suitable site and also the technical person to assist the technical work especially engineering work. c. Financial support and expert to construct dry land irrigation

<p><b>8. Market facility:</b>  a. Need of latest dryer to dry agriculture products  b. Storage to store crop products and shade to sell the products</p>	<p>Gewog agriculture extension</p>	<p>Dzongkhag agriculture sector, gewog administration</p>	<p>a. Need of latest solar dryer and capacity development to process the drying products.  b. Financial support to construct crop product storage and shade to sell products.</p>
<p><b>9. Climate awareness:</b>  a. Timely awareness on climate change at Chewog level  b. Construct waste segregation shed at Chewog level</p>	<p>Dzongkhag environment</p>	<p>Gewog administration and other concern agencies</p>	<p>a. Financial support to conduct awareness with resources person to create awareness  b. Monetary support to construct the waste segregation shed at Chewog level.</p>
<p><b>10. Vocational skills:</b>  a. Establish skills development center to develop products and enhance skills using waste produced at local level.</p>	<p>Dzongkhag environment sector</p>	<p>Gewog administration and other concern agencies</p>	<p>Budgetary support to install shed and buy technology material  And resources person to teach skills.</p>
<p><b>11. Pasture land:</b>  a. Develop grazing area in registered land.  b. Improve existing pasture land for those harboring more cattle</p>	<p>Gewog Livestock extension</p>	<p>Gewog administration and DoFPS</p>	<p>a. Financial support to create pastureland and fodder tree plantation in registered land.  b. Financial support to improve existing pasture land</p>

Section 4. Implementation and Resourcing						
Adaptation Action	Next Step for Implementation	New or Existing	Cost (Nu. Million )	Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
<b>1. Flash flood:</b> a. Construct retention wall and proper drainage system along the farm road and flash flood prone areas b. Bamboo cultivation on flash flood prone area c. Need of crop damaged compensation scheme d. Rehabilitate the damaged crop field	a. Securing fund, engineering and assessing flash flood prone sites	a. Existing need to expend it	a. 1	a. No funding source available	Year 1-2	a. Length of retention wall and drainage constructed.
	b. Securing fund, feasibility study	b. New	b. 0.4	b. None		b. Total area cultivated with bamboo seedling.
	c. Securing seed money, and consulting with lead committee and concern agency.	c. New	c. 0.2	c. None		c. Number of insurance compensation group created.
	d. Securing financial support and machinery support and outside support	d. New	d. 1	d. None		d. Area of land rehabilitated.
<b>2. Human wildlife conflict:</b> a. Need of Chain linked fencing.	a. Securing funding source, feasibility assessment, engineering	a. New	a. 20	No funding source available	Year 2-4	a. Number of chewogs provided with chain linked fencing

<p>b. Insurance scheme for crop and livestock depredation</p> <p>c. Construct fabricated green house with irrigation item.</p> <p>d. Need of solar/electric fencing for individual household</p> <p>e. Sanitization to public on protection of wild fruits</p>	<p>b. Securing seed money and other support</p> <p>c. Obtaining financial sources, consulting with concern agencies</p> <p>d. Securing Funding and outsider support</p> <p>e. Seeking help from concern agency and financial support</p>	<p>b. New</p> <p>c. New</p> <p>d. Existing</p> <p>e. New</p>	<p>b. 0.5</p> <p>c. 1.6</p> <p>d. .9</p> <p>0.2</p>			<p>b. Number of insurance scheme created</p> <p>c. Number of greenhouse constructed</p> <p>d. Number of household provided with solar/electric fencing</p> <p>e. Number of chewogs sanitized</p>
<p><b>3. Crop yield:</b></p> <p>a. Supply of high yield and diseases resistance seeds.</p> <p>b. Slope land management.</p> <p>c. Technical support to develop compost or natural fertilizer</p>	<p>a. Training from Agriculture department to rightly sow seeds</p> <p>b. Securing fund, machinery support and technical back stop.</p> <p>c. Practical input from Agriculture department and securing latest equipment to</p>	<p>a. Existing but need to intensify it</p> <p>b. Existing but need to cover more chewogs</p> <p>c. New</p>	<p>a. 0.6</p> <p>b. 3</p> <p>c. 0.7</p>	<p>No funding sources</p> <p>None</p> <p>None</p>		<p>a. Number of farmers trained</p> <p>b. Hectares of land managed.</p> <p>c. Number of farmers trained</p>

d. Supply of greenhouse to cultivate protected local vegetable	product mass natural compost d. Securing fund to purchase greenhouse materials and training	d. Existing but not for vegetables	d. 1	None	Year 3-5	d. Number of greenhouse constructed and number of villagers trained.
<b>4. Pest and diseases:</b> a. Create awareness on latest pest and diseases to timely address the issue b. Conduct research and supply researched based organic pesticides and weedicides	a. Securing fund to create awareness  b. Securing fund to conduct research and procure organic pesticides	a. New  b. New	a. 0.2  b. 1	No funding available	Year 4-5	a. Number of Chewogs made aware.  b. Number of Gewogs provided with researched based organic pesticides and weedicides.
<b>5. Invasive plants:</b> a. Need of latest equipment to make the invasive plant as natural compost. b. Pesticides to eradicate the invasive plants at Gewog level	Finding financial source to conduct training and procuring necessary equipment	New	2	No funding available	Year 4-5	Quantity of compost made from invasive plants and acres of areas made free of invasive plants.
<b>6. Water sources:</b> a. Fencing existing water catchment and develop more capacity water tank.  b. Need to conduct research to keep the water sources sustainable	a. Securing budgetary support to procure materials for fencing and tank construction. b. Securing fund to conduct research,	a. Existing but need to expand	a. 2		Year 6-8	a. Number of water sources fenced and water tank built.

c. Plantation surrounding the water sources d. Conduct assessment to allocate alternative water sources	plantation and assessing alternative water sources. Training to manage water sources	New	3	No funding available		Number of alternative water sources managed based on research.
<b>7. Irrigation water:</b> a. Need proper irrigation channel b. Need reserve water tank c. Dry land irrigation for crop cultivation	Securing fund, engineering and feasibility study	New	4	None	Year 7-9	Length of irrigation channel constructed; number of water tank built
<b>8. Market facility:</b> a. Need of latest dryer to dry agriculture products b. Storage to store crop products and shade to sell the products	Securing fund to buy dryer and construct storage of crop products	New	1	No funding available	Year 7-8	Number of dryers purchased and number of storages constructed.
<b>9. Climate awareness:</b> a. Timely awareness on climate change at Chewog level b. Construct waste segregation shed at Chewog level	a. Funding sources and resource person to create awareness b. Securing funding	New b. New	a. 0.3 b. 0.5	No funding available	Year 8	a. Number of Chewogs made aware of climate changes. b. Number of waste segregation shed constructed.
<b>10. Vocational skills:</b> a. Establish skills development center to develop products and enhance skills using waste produced at local level.	Securing funding, resources person to train	New	0.7	No funding available	Year 9	Number of skill center developed.

<b>11. Pasture land:</b> a. Develop grazing area in registered land. b. Improve existing pasture land for those harboring more cattle	Securing funding sources	New	1	No funding available	Year 10	Acres of grazing area develop on registered land and number of existing pasturelands improved.
<b>Total budget estimate for 10 years</b>			<b>47m</b>			
<b>Section 5. Details of Stakeholder Consultations</b>						
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>			<b>Nos. of Participants</b>	
14 <sup>th</sup> October, 2022	Consultation with Gewog administration, CF chairperson and Forestry focal	Ura gewog administration, CFs chairperson, Range staff			12 (9 male and 3 female)	
17 <sup>th</sup> October, 2022	Consultation with Gewog administration	Jaray gewog administration, CFs chairperson, Range staff, Gewog Agriculture extension and Livestock extension.			15 (12 male and 3 female)	
18 <sup>th</sup> October, 2022	Consultation with Gewog administration, Gewog RNR focal, CF chairperson and Forestry focal	Metsho Gewog Local Government members, Gewog Agriculture and Livestock extension, CF chairperson and Forestry focal.			11 (9 male and 2 female)	
19 <sup>th</sup> October, 2022	Consultation with Gewog administration, Gewog RNR focal and Forestry focal	Saling Gewog Local Government members, Gewog Agriculture and Livestock extension and Forestry focal.			10 (5 female and 5 male)	
21 <sup>st</sup> October, 2022	Consultation with Gewog admin, Gewog RNR focal, CF chairperson and Forestry focal	Tsamang Gewog Local Government members, Gewog Agriculture and Livestock extension, CF chairperson and Forestry focal.			13 (11 male and 2 female)	
<b>Consultation and Plan Preparation led by</b>						
<ol style="list-style-type: none"> <li>1. Yonten Norbu, Chief Forestry Officer, yontenorbu@moaf.gov.bt</li> <li>2. Tenzin Rabgay, Forestry Officer, tenzinr@moaf.gov.bt</li> <li>3. Bala Ram Mafchan, Forestry officer, brmafchan@moaf.gov.bt</li> </ol>						

## 16 Climate Change Adaptation Plan of the Biological corridor-8, Bumthang Forests Division

### 16.1 Background

Biological corridors were first established in the year 1999 to provide landscape connectivity among various protected area, so that it ensures meta-population conservation, promote gene flow and allow wide-ranging species to adapt climate change. It was declared as “Gift to the Earth by the people of Bhutan” by Her Majesty the Queen mother Ashi Dorji Wangmo Wangchuck.

Biological corridors across the conservation landscape are expected to support flora and fauna movement, including dispersal movement and shift of species across the geographical area in response to climate change. Due to the climate change and habitat fragmentation, a need to manage plants and wildlife beyond National Park and wildlife Sanctuary has become significant. Hence the biological corridors became integral part of protected area system of Bhutan and about 3011 Km<sup>2</sup> of the country’s total geographical area was delineated into eight biological corridors spreading across the country.

Biological corridor-8 (BC8) with an area of 558.6 Km<sup>2</sup> is the largest among eight biological corridors and support several flora and fauna due to the wide altitudinal range and forest type. It was delineated primarily for the conservation of tiger, red panda, blue sheep, musk deer and takin. BC8 being located in the central part of Bhutan, it plays significant ecological function for Bhutan Biological Conservation Complex (B2C2). It connects Wangchuck Centennial National Park (WCNP) in the north and Jigme Singye Wangchuck National Park (JSWNP) in the South which share its southeastern boundary with Royal Manas National Park (RMNP) in the tropics, therefore, is expected to facilitate the movement of fauna and shift or dispersal of flora in response to changing pattern of climate.

Besides ecological benefit to wildlife, BC8 also provides space and it is a source of forest resources for more than 7928 people residing in and around it from Wangdue and Trongsa Dzongkhags. Given a maximum area (469.10 km<sup>2</sup>) under Wangdue Phodrang Dzongkhag, it hosts Phobji, Gangtey, Bjena, Dangchu, Sephu, Kazhi and Athang Gewogs. While 108.80 km<sup>2</sup> under Trongsa Dzongkhag is a home for people of Tangsibji and Nubi Gewogs. There are 423 households



in and around the BC8 under Trongsa Dzongkhag, and 466 households in and around the BC8 under Wangduephodrang Dzongkhag with agriculture and livestock farming practices as the main source of livelihood.

However, in face of climate change, a greater number of communities are exposed to the risk of climate change effect making them vulnerable which ultimately causes huge impact to their livelihood and sustenance. People dwelling in and around BC8 are also not an exception. Majority of people dwelling in and around BC8 have reported decline or loss of crop yield and livestock productivity due to human-wildlife conflict. According to the local people, crop destructions are caused by wild boar, deer, bird and monkey whereas, livestock depredation is mainly caused by tiger, leopard and wolves. According to the report of Nature Conservation Division, in Bhutan, human wildlife conflict is one of the major challenge due to the large population of mega-fauna living in close proximity to the rural communities. As per the study, the climate change leads to rapid change in natural resource available which increases co-occurrence and competition among wildlife and human being. Bhutan as an agrarian-based society, almost 80% of the population directly depend on crop and or livestock production for their livelihood (NCD, 2008) and crop destruction and livestock predation by wildlife directly threaten the ability of people to secure sustainable livelihood.

Moreover, water shortage is also the one of the main problems faced by the people residing in and around BC. According to the report of National Adaptation Plan (NAP) in Bhutan, though Bhutan has high per capita water availability, accessibility remain as a major issue as settlement and farm lands are mostly located on hilltops and upper slope of mountain and on the other hand water resources flow through the bottom of valley. Water shortage for irrigation as well as for drinking purpose leads to inadequate sanitation, decline crop yield and livestock productivity. Beside water shortage and Human-wildlife conflict, local communities in and around BC8 have also reported pasture land shrinkage, untimely hailstone, frost, rainfall and outbreak of crop pest and disease due to climate change.

## 16.2 Objectives

- To identify community-based climate change vulnerabilities, coping mechanism and adaptation capacity to draw key point for intervention to make their livelihood sustainable.
- To provide baseline information and guidance in implementing activities proposed by the local communities of BC8 in 10-year time frame.

## 16.3 Adaptation Priorities of the Biological Corridor-8, Bumthang Forests Division

### Section 1. Priority Climate Vulnerabilities

#### List of Priority Climate Vulnerabilities

#### **1. Increasing water source venerability for both irrigation and drinking purpose**

Water source which is being used by the local community of Nubi gewog for drinking as well as for irrigation is located near highway and in flood prone area making it vulnerable. Moreover, local leaders and people of both Nubi and Sephu have noticed the water source getting dried up. Fencing water source using barbed wire and carry out plantation were the adaption action they have suggested during the consultation.

Additionally, people of Kazhi Gewog are also facing water shortage for both irrigational and drinking purposes. Severe irrigation water shortage is present in Lengbi Chiwog. Nyisho Gewog too faces the same problem. Gewog administration, Gewog agriculture sector and Chiwog Tshokpa reported the growth of uncontrollable weeds and diseases in the paddy due to irrigation water shortage. Chiwog Tshokpa of Gangjab had also reported that two households in their chiwog have left the place due to water shortage construction of reservoir tank and rain water harvesting is the adaptation action they have suggested during the consultation.

#### **2. Decline or loss of crop yield due to the seasonal drought**

Prolonged period of abnormally low rainfall is leading to decline or loss of crop yield in Nubi Gewog as well as for Tangsibji Gewog. The crop that used to grow in the past is not growing well and or their yield had drastically reduced at the present moment. Promotion of drought resistance crop and maintaining reservoir tank to store water to be used during the drought are adaptation action they have suggested during the consultation.

#### **3. Increasing human-wildlife conflict leading to livestock depredation, crop loss and possess danger to local people**

Crop destruction by deer, bird, wild boar, monkey and livestock depredation by tiger, leopard and wolve is the major problem faced by the local communities in Tangsibji Gewog. Local officials also reported that very recently, even the wild boar had started attacking cattle in their locality. Moreover, Tshangkha Central School being located nearby forest area, wild boars are also found roaming in and around campus which possess risk to the students.

In Sephu Gewog, monkey and tiger are the most conflicting animal. Local communities have reported decline or loss of crop and livestock productivity. During the consultation, they suggested installing repellent devices and tiger toy that make noises when

monkey approaches the field, providing insurance to the owner who have lost livestock and conducting research on installing electric fencing using different wire that doesn't get rusted easily.

In Kazhi, Nyisho and Gangtey Gewog, wild pig and monkey are the main conflicting animal that causes crop destruction and tiger, leopard and wolf cause livestock predation.

#### **4. Decline or loss of crop yield due to heavy rainfall and pest and disease**

In the recent year, people of Sephu have notice low crop production as well as less demand from market especially for cabbage due to heavy rainfall and pest and diseases. Since cabbage is one of the main cash grown by the local people, the people have incurred huge loss. To combat this issue, they suggest the use of hybrid seed, biochemical and terracing. In Gangtey Gewog, people face crop yield due to pest and diseases and they suggest use of environment friendly pesticides and conducting case study.

#### **5. Shrinking of pasture land and fodder shortage**

People of Beadrog under Kazhi Gewog used to shift their yaks to lower elevation only in the last week of November. However, this year they were forced to shift their yaks to lower elevation in early October itself. According to them, there is reduction in pasture land area. Moreover, people of Gantey Gewog are also seeing reduction in number of yak and local cattle due to reduction in pasture land and fodder.

#### **6. Loss of crop to untimely hailstone, frost and rainfall**

People of Gangtey Gewog are experiencing untimely hailstone, frost and rainfall which leads to decline or loss of crop yield. To combat this problem, Gewog Agriculture sector suggested conducting public advocacy and promotion of crop insurance.

Section 2. Priority Actions to Address Vulnerabilities					
Priority Climate Vulnerabilities	Adaptation Action	Sector	Climate Hazard	Area	Potential Trade-Off
1. Increasing water source vulnerability for both irrigation and drinking purpose	Fencing water source using barbed wire and carry out plantation	Water, Infrastructure	Increasing water vulnerability	Semji (Mobjee Aring), Nubi gewog (600 mtrs)	Fencing and plantation may not gurantee increased water yield.
				Business community and Bumi Chiwog of Sephu Gewog	Nil
	Construction of irrigation channel.  Renovation of rural water supply source.	Engineer, Water	Increasing water vulnerability	Lengbi under Kazhi  Kazhi Gewog	Nil
2. Decline or loss of crop yield due to the drought	Reservoir construction. Rain water harvesting. Water source protection.	Agriculture and Forestry sector	Increasing water vulnerability	Phadikha and Daku Chiwog under Nyisho Gewog	Nil
	Promotion of drought resistant crops or maintain	Agriculture, Infrastructure,	Prolonged seasonal drought	Pang, Nubi gewog (30/40 acres)	Nil

	reservoir tank to reserve water for irrigation during drought.	Nation Seed Center			
3. Increasing human-wildlife conflict (HWC) leading to livestock depredation, crop loss and possess danger to local people	1. Installation of traps, repellent devices or buzzer as a mitigating measure for monkeys, birds and wild boars.	DoFPSs, Livestock sector, Dzongkhag education sector	Rapid changes in natural resources availability that leads to increased co-occurrence and competition among wildlife and human being	1. All Chiwog under Tangsibji gewog	Risk of increasing electronic waste after repellent devices gets damaged
	2. Fencing the school campus and livestock grazing area using chain link and barbed wire to prevent livestock predation and to reduce risk of wildlife attacking students.	DoFPSs, Livestock sector, Dzongkhag education sector		2. Tshangkha Central School (18 acre)	Nil
	Livestock compensation.	Bhutan Tiger Center, Livestock sector		Gele-Kinzaling under Nyisho Gewog	
	Installation of chain linked fencing.	Agriculture, Forestry and livestock sector		Kazhi, Komathrang Chegib Lengbi under Kazhi Gewog	Nil

				Gele-Kinzaling under Nyisho Gewog	
	Minimize the number of predators through relocating.	Forestry sector		Beadrog under Kazhi Gewog	Create problem in other place where the animal has been relocated
	Use tiger toy with battery system that make noise to chase away monkey. Conduct research on installing electric fencing using different wire that doesn't get rusted easily.	DoFPS, Livestock and agriculture sector		Butsa and Rukubji Chiwog under Sephu	
	Insurance system to compensate livestock loss by tiger predation				
	Promote group formation on HWC management.	Agriculture Sector/NPPC/ Range Office/ Gewog Administration/		Gangteng, Gorgoen, Jangchen_Koombu, Tapaiteng_Uesa and Yaekorwog Chewog.	Nil

		Dzongkhag Agriculture Office			
4. Decline or loss of crop yield due to heavy rainfall and pest and disease	Use of biochemical to combat crop pest and disease.  Land terracing and use hybrid seed to reduce loss of crop yield due to heavy rainfall.	Gewog Agriculture sector	Occurrence of heavy rainfall and pest and diseases	Sephu Gewog	Loss of soil fertility due to land terracing
5. Crop yield reduction due to pest and disease outbreak	Promote high yielding varieties, use of environment friendly pesticide and conduct case study.	ARDC & NPPC, Gewog, Dzongkhag Agriculture	Crop pest and disease outbreak	Gangteng, Gorgoen, Jangchen_Koombu, Tapaiteng_Uesa and Yaekorwog Chewog.	Nil
6. Shrinking of pasture land and fodder shortage	Pasture development, fencing, breed improvement.	Gewog Livestock sector	Reduction of pasture land	Beadrog under Kazhi Gewog	Nil
	Supply of improve breeds of cattle. supply of improve breed bulls. Establishment of Artificial Insemination at Gewog.	Gewog Livestock sector, NDDC, NRCAN	Reduction of pasture land and fodder	Gangtey Gewog	Nil



	Subsidies for high landers. Supply of seeds and fodder conservation equipment.				
7. Loss of crop to untimely hailstone, frost and rainfall	Advocacy & promotion of crop insurance	RICBL, Gewog, Dzongkhag Agriculture Office	Unpredictable weather pattern	Interested farmer under Gantey Gewog	Nil

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
1. Fencing water source using barbed wire and carry out plantation	Water management committee	WMD, BFL	Technical support, barbed wire materials, and saplings for plantation
2. Promotion of drought resistant crops or maintain reservoir tank to reserve water for irrigation during drought	Gewog agriculture sector and Water management committee	Agriculture Research and Development center	Technical support, Sipulain sheet and cement for rain water harvest Sintex, Drought resistance seeds
3. Installation of traps, repellent devices or buzzer as a mitigating measure for monkeys, birds and wild boars. 4. Fencing the school campus and livestock grazing area	Gewog, Dzongkhag education sector	DoFPSs, Agriculture and Livestock sector	Funding, materials (barbed wire, chain link fence, repellent device), technical support

<p>using chain link and barbed wire to prevent livestock predation and to reduce risk of wildlife attacking students.</p> <p>5. Use tiger toy with battery system that make noise to chase away monkey.</p> <p>6. Conduct research on installing electric fencing using different wire that doesn't get rusted easily.</p> <p>7. Insurance system to compensate livestock loss by tiger predation.</p>			
<p>8. Use of biochemical to combat crop pest and disease.</p> <p>9. Land terracing and use hybrid seed to reduce loss of crop yield due to heavy rainfall.</p>	Beneficiary, Gewog Agriculture sector	Agriculture Research and Development center	Funding, technical support, machine
<p>10. Installation of chain linked fencing.</p>	Gewog Administration (Gup,Mangmi,GAO and concern Extention officer)	Research and Development Center, Yusipang, Bhutan Tiger Center	Fund (material and transportation)
<p>11. Pasture development, fencing, breed improvement.</p>	Gewog Livestock sector	Regional Livestock Development Center	Fund (material and transportation)

12. New construction of irrigation channel.	Water management Committee	Gewog Administration (Gup, Mangmi, GAO, Engineer and Dzongkhag Agriculture sector) and Farmer	Fund (materials, labor charge and transportation)
13. Renovation of rural water supply source.			
14. Reservoir construction.	Water management Committee	Gewog, DAO, Forestry, Engineer, RNR	Funding (material cost and transportation) Technical support
15. Rain water harvesting.	Water management Committee	Gewog, DAO, Forestry, Engineer, RNR	Funding (material cost and transportation) Technical support
16. Livestock compensation.	Gewog Livestock Sector	Bhutan Tiger Center	Compensation
17. Promote group formation on HWC management.	Agriculture Sector and local government	Tshokpa, Dzongkhag Agriculture Office ARDC/NPPC/NSSC/NSC/DoA	Technical backstopping, Funding support.
18. Promote high yielding varieties, use of environment friendly pesticide and conduct case study.	Agriculture sector	Gewog, Tshogpas, Dzongkhag Agriculture Office, National Seed Centre.	Funding and technical backstopping for case studies and procurement of environment friendly pesticide.
19. Advocacy & promotion of crop insurance.	Agriculture Sector, local government	Tshogpas, Dzongkhag Agriculture Office ARDC, NPPC, NSSC, NSC, DoA	Technical backstopping, Funding support.

20. Supply of improve breeds of cattle. supply of improve breed bulls. Establishment of Artificial Insemination at Gewog. Subsidies for high landers. Supply of seeds and fodder conservation equipment.	Gewog livestock sector	NDDC, NRCAN	Technical backstopping, Funding support.
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Section 4. Implementation and Resourcing								
Adaptation Action	Next Step for Implementation	New or Existing	Cost Estimate (Nu in million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			
1. Fencing water source using barbed wire and carry out plantation	Involvement of local people, seek funding and technical support	Existing	1.Roll (Barbed wire) 2. Number (Sapling)	0.007	2.5	Nil	1 <sup>st</sup> to 5 <sup>th</sup> year	Number of water source protected
2. Promotion of drought resistant crops or maintain reservoir tank to reserve water for irrigation during drought	Public awareness and seek funding	New	Packet (seed)  Packet (Cement)	0.00005/-  0.00004/-	0.5/-  0.0004/-	Nil	2 <sup>nd</sup> year	Acre of unproductive land due to drought reduced

3. Installation of traps, repellent devices or buzzer as a mitigating measure for monkeys, birds and wild boars	Seek funding, public advocacy on how to handle the device	New	Number (repellent device)	0.005/-	0.5/-	Nil	1 <sup>st</sup> year	Number of repellent devices installed.
4. Fencing the school campus and livestock grazing area using chain link and barbed wire to prevent livestock predation and to reduce risk of wildlife attacking students	Seek funding source	New	Length in km (Chain linked fence. Roll (barbed wire)	0.55/- 0.007/-	50/- 0.07/-	Nil	1 <sup>st</sup> year	Length of chain link and barbed wire installed
5. Use tiger toy with battery system that make noise to chase away monkey	Seek funding and technical support	New	Number (Tiger toy)	0.02/-	2/-	Nil	3 <sup>rd</sup> year	Number of tiger toy used
6. Conduct research on installing electric fencing using different wire that	Seek funding, assign research team	New	Year	0.1/-	0.1/-	Nil	1 <sup>st</sup> year	Research conducted

doesn't get rusted easily								
7. Insurance system to compensate livestock loss by tiger predation	Public advocacy	Existing	Number (insurance)	0.1/-	3/-	Nil	1 <sup>st</sup> year	Number of livestock with insurance increased
8. Use of biochemical to combat crop pest and disease.	Public advocacy	Existing	Bottle (Biochemical)	0.0004/-	0.04/-	Nil	3 <sup>rd</sup> year	Crop pest and diseases reduced
9. Land terracing and use hybrid seed to reduce loss of crop yield due to heavy rainfall	Interested local people consultation, planning	New	Hour (machine hiring)	0.0035/-	1.26/-	Nil	1 <sup>st</sup> year	Number of terracing made
10. Installation of Chain linked fencing	Consultation meeting	New	Length (KM)	0.5/-	27.5/-	Nil	1 <sup>st</sup> to 3 <sup>rd</sup> year	Number of chains linked fence installed
11. Pasture development, fencing, breed improvement	Consultation meeting	New	Acres	1/-	3/-	Nil	3 <sup>rd</sup> year	Number of pasture land developed and fenced. Number of improved breeds supplied

12. New construction of irrigation channel.	Seek funding, consultation meeting with local people	New	Length	0.9/-	9.1/-	Nil	2 <sup>nd</sup> and 4 <sup>th</sup> year	Availability of water for irrigation as well as for drinking purposes increased
13. Renovation of rural water supply source								
14. Reservoir construction	Seek funding, public consultation	New	Number	2.5/-	5/-	Nil	1 <sup>st</sup> year	Reservoir tank constructed
15. Rain water harvesting	Seek funding, public consultation	New	Household number	0.01/-	1/-	Nil	2 <sup>nd</sup> year	Number of rain water harvesting station installed
16. Promote group formation on HWC management.	Seek funding	New	Number	0.4/-	2/-	Nil	1 <sup>st</sup> to 10 <sup>th</sup> year	Number of groups formed
17. Promote high yielding varieties, use of environment friendly pesticide and conduct case study	Seek funding	New	NA	0.4/-	2/-	Nil	2 <sup>nd</sup> to 10 <sup>th</sup> year	Crop yield increased
18. Advocacy & promotion of crop insurance	Seek funding	New	NA	0.2/-	1/-	Nil	1 <sup>st</sup> to 10 <sup>th</sup> year	Public aware and crop insured

19. Supply of improve breeds of cattle. supply of improve breed bulls. Establishment of Artificial Insemination at Gewog. Subsidies for high landers. Supply of seeds and fodder conservation equipment	Seek funding, technical advice	New	NA	–	5/-	Nil	1 <sup>st</sup> to 10 <sup>th</sup> year	Improved breed bull and cattle supplied. Artificial insemination established. Subsidies provided. Seed and fodder conservation equipment supplied
<b>Total budget estimate for 10 years</b>					<b>115m</b>			



<b>Section 5. Details of Stakeholder Consultation</b>			
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>	<b>Nos. of Participants</b>
20/10/2022	Consultation with Nubi Gewog officials and few local people	Gup, gewog agricultural sector, Gewog Administrative officer, Chiwog Tshokpa, Gewog Forestry sector	15 (7 Female and 8 male)
21/10/2022	Consultation with Tangsibji Gewog officials and few local people	Mangmi, Gewog Administrative officer, Chiwog Tshokpa, local people, ESC, school teacher, official from livestock, agriculture and forestry sector,	16 (9 male, 7 female)
22/10/2022	Consultation with Sephu Gewog officials and few local people	Gewog Administrative officer, Health worker, Official from agriculture sector, Local people, business man	11 (3 male, 8 female)
23/10/2022	Consultation with Kazhi Gewog officials and few local people	GAO, Gewog agriculture and livestock officer, health assistant, Tshokpa, Local people, teacher	13 (10 male, 3 female)
24/10/2022	Consultation with Nisho Gewog officials and few local people	Gup, GAO, Tshokpa, Gewog agriculture and livestock officer, Health Assistant, Mangmi, teacher	18 (13 male, 5 female)
25/10/2022	Consultation with Gangtey Gewog officials and local people	Gup, GAO, Tshokpa, Gewog agriculture and livestock officer, Mangmi	13(12 male, 1 female)
<b>Consultation and Plan Preparation led by</b>			
<ol style="list-style-type: none"> <li>1. Pankey Dukpa, Chief Forestry Officer, pandukpa@gmail.com</li> <li>2. Sonam Gyeltshen, Deputy Chief Forestry Officer, sonamg@moaf.gov.bt</li> <li>3. Pema Choden, Forestry Officer, pemachoden@moaf.gov.bt</li> </ol>			

#### 16.4 References

- NCD (2008). Bhutan National Human-Wildlife Conflict Management Strategy. Nature Conservation Division. Department of Forest and Park Services. Ministry of Agriculture and Forest.
- NSB (2018): Statistical year Book of Bhutan. National Statistic Bureau, Royal Government of Bhutan, Thimphu

# 17 Climate Change Adaptation Plan of the Jigme Khesar Strict Nature Reserve

## 17.1 Background

Jigme Khesar Strict Nature Reserve (JKSNR), previously known as Toorsa Strict Nature, is the lone strict nature reserve in the country and was declared in the year 1993 and operationalized in 2010. It is located to the north-west of the country, south-east of the Chumbi valley approximately between latitude 27°12' to 27°32' & longitude 88°53' to 89°09' in the Eastern Himalayas thereby spanning over an area of 784.225 km<sup>2</sup>. It covers two Dzongkhags of Haa and Samtse in western and south-western Bhutan.

It shares international borders with the Indian state of Sikkim to the west (Pangolakha Wildlife Sanctuary) and forms a contiguous natural habitat of pristine alpine meadows with the Tibetan Autonomous Region of China to the north. It is connected to Jigme Dorji National Park (JDNP) to its north-east part of the JKSNR-JDNP Biological Corridor 1. The nature reserve is almost entirely inside Haa dzongkhag and slightly within Samtse dzongkhag; and is home to number of important flora and fauna including the elusive *Panthera uncia*, *Panthera tigris tigris*, *Budorcas taxicolor whitei*, *Ailurus fulgens*, *Moschus chrysogaster*, *Bos gaurus*, etc.

It is the only PA in Bhutan without any permanent human settlements, except for a few migratory yak-herding communities. The nature reserve protects the eastern most variant of the central temperate forests in the country ranging from broadleaf forests to alpine meadows in the north. Being virtually uninhabited, the nature reserve has one of the most pristine temperate and alpine ecosystems. Considered to be the conservation jewel in the Eastern Himalayas featured with astounding biodiversity composed of many globally endangered, rare and endemic species of fauna and flora including high value medicinal plants, spectacular sceneries and a unique culture endowed with many critical watersheds for two major rivers of Bhutan Amo Chhu and Haa Chhu-Wang Chhu (Conservation Management Plan of JKSNR, 2021-2031).

The significance of JKSNR is not only for Bhutan, but also for the entire Hindu-Kush Himalayan region (HKH), which is a significant reservoir of biodiversity, composed of extraordinarily varied eco-systems, assemblage of species of global importance, rich genetic diversity; and the only protected area in Bhutan making its connectivity with the Kanchenjunga

trans-boundary conservation landscape. It is also linked to a part of the Sacred Himalayan Landscape (SHL) of Eastern Himalayas, also known as Snow Leopard Landscape, which covers a conservation area of 39,021 square kilometers, of which about 73.5% falls in Nepal, 24.4% in Sikkim and Darjeeling of India, and the remaining 2.1% in Bhutan.

JKSNR consists of pristine mixed-conifer forests interspersed with grasslands and alpine meadows and has the strongest representation of the pristine temperate and alpine ecosystems in the country. It is also known to have the highest endemism in the country. Geographically, the northern parts of JKSNR consists mostly of rugged mountain terrain, rocky peaks, and screes, harboring numerous sacred alpine lakes and few plains. The southern parts are scoured steeply by streams and rivers forming narrow valleys. Alluvial and colluvial formation are apparent in the narrow valleys of the nature reserve, which consist of soil, silt, clay, sand and gravels brought by the action of the soil and water erosion (Conservation Management Plan of JKSNR, 2021-2031).

The Climate Change Adaptation Plan for JKSNR has been prepared by consulting with the local communities, gewog administrations and other relevant stakeholders. Increased Human-Wildlife Conflict, shortage of drinking water, extreme temperature, shortage of pastureland and occurrence of frequent landslides are some of the priority vulnerabilities identified. In order to address those vulnerabilities, adaptation action was developed.

## 17.2 Objective

- To prioritize the climate change adaptation strategies in identified communities
- To enhance the community's resilience to climate Change
- To enhance the livelihood of the communities residing in the periphery of the reserve area.

### 17.3 Adaptation Priorities of the Jigme Khesar Strict Nature Reserve

#### Section 1. Priority Climate Vulnerabilities

**1. Increased Human-Wildlife Conflict (HWC) thereby resulting in crop and livestock depredation.**

As per the social survey and consultation conducted with the local communities, the population of conflicting species has increased thus resulting in increased HWC and eventually leading to crop and livestock loss. The competition for the limited natural resources between wild animals and human increase because of the increasing population and degradation of the wildlife habitat.

**2. Extreme temperature that leads to decrease in crop yield and livestock production and increased death of livestock.**

As per the result of social survey and consultation, extreme rise and fall in temperature has been observed which has led to decrease in crop yield and livestock production and increased death of livestock. The temperature extreme cause by the climate change are affecting the communities and its changing at rapid pace which makes is hard to cope with it.

**3. Shortage of drinking water**

As per the social survey, an acute shortage of drinking water has been faced by the community (mainly by the local community of Sangbay and Gakiling Gewog). The shortages of drinking water shortage is because of the degradation of the catchment area and the destruction of the recharge point for water.

**4. Shortage of pastureland**

Since some communities solely depend on livestock and therefore the pasture is an important part of livestock rearing. Due to invasion by invasive weeds (such as Rumex sp, Rhododendron sp. Ageratina Adenophora, etc) into the pastureland, the drastic decrease in grazing land has occurred.

**5. Increased landslide thereby leading to road blockage, damage to cultivated land and water source.**

Due to erratic rainfall pattern, occurrence of landslides mainly in the lower part of the park area has been observed for past few years.

<b>Section 2. Priority Actions to Address Vulnerabilities</b>				
<b>Adaptation Action</b>	<b>Sector</b>	<b>Climate Hazard</b>	<b>Area</b>	<b>Potential Trade-Off</b>
1. Electric fencing around the cultivated land to minimize the conflict	Dzongkhag and Gewog Administration	Poverty and food scarcity	Bji, Gakiling and Sangbay, Haa, and Kachhen Kuchen, Milamthang Thangzosa under Tendruk gewog, Chhugoo Phendeygang and Chongzhu Tshachu village under Norgaygang gewog, Samtse.	Electric shock hazard to people and livestock.
2. Enrichment plantation in degraded wildlife habitat	Forestry	Forest degradation & HWC	Bji, Sangbay Range, Chhugoo, Chongzhu, Kachhen, Milamthang Thangzosa	
3. Institute compensation and insurance scheme for crop damage and livestock loss to wildlife	Financial institutions, Livestock, Agriculture	Increase in livestock depredation by wild carnivores	Park Ranges (Bji, Sangbay, Gakiling)	
4. Intensification of livestock and crops	Livestock and agriculture sector	Poverty and food scarcity	Bjee, Sangbay and Gakiling gewog.	May result in introduction of invasive plants and livestock diseases.
5. Portable coral fencing	Dzongkhag and Gewog Administration	Retaliatory killing of keystone species	Bjee gewog	Electric shock hazard to people and livestock.

6. Cultivation of climate resistant crops	Agriculture sector	Introduction of invasive plants	Whole Reserve area	Decrease in productivity.
7. Diversification of breed (Yak)	Livestock sector	Survival challenges due to increase in warming	Bjee gewog	Loss of native species
8. Rainwater harvesting	Dzongkhag engineering sector	Shortage of drinking and agricultural water	Gakiling gewog	
9. Integrated watershed management	Dzongkhag administration (Engineer and environment sector) and JKSNR	Shortage of drinking and agricultural water	Thangthokha , Gakiling Gewog	Decreased pasture land and community forests (CF)
10. Springshed management	Dzongkhag administration (Engineer and environment sector) and JKSNR	Shortage of drinking and agricultural water	Thangthokha , Gakiling Gewog	Decreased pasture land
11. Alpine grassland management	Forestry sector	Decreased pasture land	Bjee gewog	Loss of endemic species and introduction of invasive plants.
12. Growing of fodder trees and grasses	Livestock sector	Shortage of pasture land	Lower part of Park area	Introduction of invasive plants and trees
13. Soil land management, Bio engineering work	Agriculture and forestry sectors	Land degradation	Whole Reserve area	

(SLM)		thereby leading to loss of arable land		
Section 3. Potential Roles and Responsibilities				
Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed	
1. Electric fencing around the cultivated land to minimize the conflict	Dzongkhag and Gewog administration	Agriculture and Forestry sectors	Technical backstopping, funding and materials.	
2. Enrichment plantation in Degraded wildlife habitat	DoFPS	SFED, Gewog administration	Technical backstopping, funding and materials.	
3. Institute compensation and insurance scheme for crop damage and livestock loss to wildlife	DoFPS	Financial Institutions, LG	Funding for seed money, Technical support	
4. Intensification of livestock and crops	Livestock and Agriculture sector	Dzongkhag and Gewog Administration	Technical backstopping, funding, seeds and supply livestock breeds	
5. Portable coral fencing	Dzongkhag and Gewog Administration	Forestry Sector	Technical backstopping, funding and materials.	
6. Cultivation of climate resistant crops	Agriculture sector	Dzongkhag administration	Technical backstopping, funding and materials.	
7. Diversification of breed (Yak)	Livestock sector	Dzongkhag administration	Technical backstopping, funding and supply of livestock breeds.	
8. Rain water harvesting	Dzongkhag and Gewog administration	Dzongkhag engineering sector	Technical backstopping, funding and materials.	
9. Integrated water-shed management	Dzongkhag and Gewog administration	DoFPS	Technical backstopping, funding and materials.	



10. Spring shed management	Dzongkhag and Gewog administration	DoFPS	Technical backstopping, funding and materials.
11. Alpine grassland management	DoFPS	Livestock sector	Technical backstopping, funding and materials.
12. Growing of fodder trees and grasses	Livestock sector	DoFPS	Technical backstopping, funding and seedlings.
13. Soil land management (SLM)	Agriculture and Forestry Sectors	Dzongkhag and Gewog administration	Technical backstopping, funding and materials.

#### Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New or Existing	Cost (Nu. Million)	Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
1. Electric fencing around the cultivated land to minimize the conflict	Procurement of funds and materials followed by training staffs and local communities	Existing and expansion	0.8	None	Year 1	Area of land fenced and HWC minimized
2. Enrichment plantation in Degraded wildlife habitat	Identify degraded areas in Wildlife habitats that can be brought under enrichment plantation	New	0.3	None	3-4 year	Acres of area planted
3. Institute compensation and insurance scheme for crop damage and livestock loss to wildlife	Secure funding for seed money	new	3	none	1-2 year	No. of compensation schemes instituted
4. Intensification of livestock and crops	Secure fund, train local communities and	New	0.6	None	Year 1 & 2	Crop yield and livestock

	procurement of seeds and breeds of livestock					production increased
5. Portable coral fencing	Secure fund, train local communities and procurement of materials	Existing and expansion	0.5	None	Year 2	Livestock depredation minimized
6. Cultivation of climate resistant crops	Secure funds, carry out pilot activity, procurement of materials	New	0.4	None	Year 2 & 4	New variety and high yielding crop introduced
7. Diversification of breed (Yak)	Secure funds, carry out pilot activity and	New	0.7	None	Year 4 & 5	Breed (Yak) diversified
8. Rain water harvesting	Secure funds and train staffs and carry out the activity	New	0.6	None	Year 5	Water shortage addressed
9. Integrated water-shed management	Secure fund, consultation with local communities and identification of watershed	New	0.5	None	Year 5 & 6	Watershed identified and managed
10. Spring shed management	Secure fund, consultation with local communities and identification of spring shed	New	0.5	None	Year 6 & 7	Spring shed identified, and managed
11. Alpine grassland management	Fund procurement, train staff and carry out activity	Existing and expansion	0.3	None	Year 7	Alpine grassland managed and pastureland developed
12. Growing of fodder trees and grasses	Secure fund, consult experts and carry out activity	New	0.4	None	Year 8 & 9	Fodder trees and grasses made available

13. Soil land management (SLM)	Secure fund, consult local communities, train staffs and people and carry out activity	New	0.5	None	Year 10	Soil land management enhanced
<b>Total budget estimate for 10 years</b>			<b>9m</b>			
<b>Section 5. Details of Stakeholder Consultation</b>						
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>			<b>Nos. of Participants</b>	
14 <sup>th</sup> October 2022	Consultation meeting	Sangbay Gewog Administration and Executive member of the Community Groups			50 Heads	
15 <sup>th</sup> October 2022	Consultation meeting	Gakiling Gewog Administration and Executive member of the community Groups			51 Heads	
17 <sup>th</sup> October 2022	Consultation meeting	Bji Gewog Administration and Executive member of the community Groups			34 Heads	
18 <sup>th</sup> October 2022	Virtual consultation Meeting	Gewog Administration of Tendruk and Norgaygang Gewog under Samtse Dazongkha			14 Heads	
<b>Consultation and Plan Preparation led by</b> Sangay Wangchuk, Forestry Ranger I Sonam Yoenten, Forestry Officer Akey Dorji, Principal Forestry Officer						

## 17.4 Reference

- JKSNR. 2021. Conservation Management Plan (2021-2031). Jigme Khesar Strict Nature Reserve. Department of Forests & Park Services, Ministry of Agriculture & Forests, Royal Government of Bhutan.
- Tshering, D., & Sithey, G. (2008). Climate change and human health in Bhutan.  
<https://doi.org/10.1093/ajae/aar006>
- Tshering, K., Sharma, E., Chettri, N., & Shrestha, A. (2011). Climate change impact and vulnerability in the eastern Himalayas – Synthesis Report (K. Tshering, E. Sharma, N. Chettri, & A. Shrestha, Eds.). ICIMOD.  
[https://www.preventionweb.net/files/14744\\_climatechangevulnerabilityofmountai.pdf](https://www.preventionweb.net/files/14744_climatechangevulnerabilityofmountai.pdf)

## 18 Climate Change Adaptation Plan of the Royal Manas National Park

### 18.1 Background

Bhutan situated in the southern slopes of eastern Himalayas with perennial snow-capped mountain having 935 glaciers and 2674 glacial lakes is often referred as water reservoir of Asia (UWICER, 2018). However, in the recent times climate change has been increasingly affecting the Himalayan glaciers causing devastating floods. Also, Bhutan's fragile ecosystem is vulnerable to climate change and the impacts such as altitudinal species migration, flash floods, monsoon patterns, increasing human-wildlife conflict (HWC) and pest and diseases are already being felt.

Located on Himalayan landscape with vulnerable ecosystems, Bhutan has committed 51.44% of its landscape under protected area system. Establishment of protected areas is the ecosystem-based climate mitigation approach. Better managed, better connected, well financed and governed protected areas are found to be both key to mitigation and adaptation to climate change (CBD, 2022). In other words, protected areas are considered to be breathing lungs on the landscape.

Royal Manas National Park (RMNP) situated in south central of Bhutan is one of the 10 PAs in the country. The park has wide range of climatic zones. The altitudinal gradient of park ranged from 70-2714masl, with major landscape in south foothills plains. As all the river systems of Bhutan ultimately drains into the mighty Brahmaputra, India, the foothill plains and communities depending on south river basins are more vulnerable for flashfloods, landslides and other erratic impacts of climate change.

The communities with total of 1389 households with estimated population of 11755 people are residing within and in vicinity to the park areas. The community-based climate vulnerability and capacity assessment (CVCA) survey was done on 226 households sampled using Yamane (1967) method. Survey was done based on exposure (7 indicators), sensitivity (12 indicators) and adaptive capacity (19 indicators) of the communities. The climate vulnerabilities are prioritized based on scoring of indicators under exposure (E), sensitivity (S) and adaptive capacity (AC). Higher scoring is prioritized for exposure and sensitivity, whereas lower scorings are prioritized for adaptive capacity which indicates high vulnerability. The vulnerability index is computed with formula  $V = AC - (E + S)$ .

Therefore, based on the prioritized climate vulnerabilities, the consultation was carried out at Dzongkhag level; Sarpang & Zhemgang Dzongkhags and at Dungkhag level; Nganglam Dungkhag, which falls under park jurisdiction. During consultation, some additional vulnerabilities recommended by participants were discussed, vulnerabilities were reprioritized and the adaptation plans for all the prioritized vulnerabilities were developed and prescribed in this plan.

## 18.2 Objective

- Community people are aware about climate change, coping mechanism and adopt climate resilient life style
- Climate resilient infrastructures are established in the communities
- Natural ecosystems; wild flora and fauna are conserved, protected and managed to mitigate and adapt with climate change

## 18.3 Adaptation Priorities of the Royal Manas National Park

### Section 1. Priority Climate Vulnerabilities

#### List of Priority Climate Vulnerabilities

##### Exposure

1. Rainfall seasonality
2. Temperature extreme
3. Windstorm
4. Flashflood
5. Landslides
6. Seasonal droughts

##### Sensitivity

1. Human-Wildlife Conflict
2. Drinking water and source
3. Irrigation water
4. Crop types and yield
5. Forest coverage & composition
6. Pasture land
7. Pest and diseases
8. Invasive weeds
9. Human diseases

##### Adaptive capacity

1. Vocational skill
2. Livelihood diversity
3. Climate Change awareness

<b>Section 2. Priority Actions to Address Vulnerabilities</b>					
<b>Priority Climate Vulnerabilities</b>	<b>Adaptation Action</b>	<b>Sector</b>	<b>Climate Hazard</b>	<b>Area</b>	<b>Potential Trade-Off</b>
1. Rainfall seasonality	a. Install metrological station at community level (Local)	Hydrology & Metrology	Reduce crop production	Gomphu, Manas & Taraythang	
	b. Inform people about rainfall seasonality based on metrological data (of around 10 years) a week before (for alertness)	Hydrology & Metrology	Reduce crop production	RMNP	
	c. Inform people about rainfall seasonality around a year before based on metrological data (of around 5 years) to change cropping season and type	Hydrology & Metrology	Reduce crop production	RMNP	
	d. Afforest degraded land to maintain hydrological cycle and/to reduce run off during heavy rain	Forestry	Reduce crop production	Umling, Taraythang, Phangkhar, Trong	Might alter ecosystem function of locality
	e. Perform traditional & cultural practices to please local deity	Home and Culture	Reduce crop production	RMNP	
	f. Rainwater harvest (water reservoir tank) facility	Water	Reduce crop production	Umling, Taraythang, Phangkhar, Trong, Norbugang	Damage of tank can cause flashfloods
	g. Construct channel to drain out stagnated water (during heavy rainfall) which are risk to house and agriculture land	Water & Engineering	Reduce crop production	Tashithang, Umling	Might affect land at drain outlets



2. Temperature extreme	a. Protect forest, reduce deforestation (install high energy biogas) and carry out afforestation (with strict monitoring) in degraded lands	Forestry	Affect vegetation & crop yields	Norbugang, Taraythang, Umling, Phangkhar	
	b. Install weather forecast station at community level and inform people about temperature extremity based on metrological data	Metrology	Affect vegetation & crop yields	Gomphu, Manas & Taraythang	
	c. Inform & encourage people to have extreme temperature resilience housing materials (roofing, etc.) & technology (Folkerts, et al., 2022)	Disaster & Engineering	Affect vegetation & crop yields	RMNP	
	d. Establish cold storage facilities at community	Engineering	Affect vegetation & crop yields	Umling, Norbugang, Trong	Underutilization of facility if expensive for farmers
3. Windstorm	a. Inform (based on metrological data) and encourage people to have windstorm resilience housing materials with modern technology and architect	Metrology & Engineering	Damages properties and crops	RMNP	
	b. Plant trees, fruit trees, bamboo & fodder (or net fencing) around agriculture field as wind break	Forestry	Damages properties and crops	RMNP	Might introduce non-native species
4. Flashflood	a. Construct retaining wall or river bank protection walls/river training works (spurs, check dam, gabion, etc.) & crib wall along farm roads	Engineering	Damages properties	Phangkhar, Umling (Chubarthang), Trong	Might impact aquatic species

	b. Divert river/streams causing flashfloods (based on feasibility), water trail management (proper channeling, dredging, etc.)	Water & Engineering	Damages properties & risk life	RMNP	Might impact downstream community and aquatic biodiversity
	c. Plant tree or bamboo species adapting to flood plains (bio-engineering works)	Forestry	Damages properties & risk life	Manas, Umling, Taraythang, Norbugang	Might introduce non-native species
5. Landslides	a. Plant trees (landslides pioneering species such as fodder species, etc.) or carry out bio-engineering works	Forestry	Damages properties & risk life	Umling, Taraythang, Norbugang	Might introduce non-native species
	b. Establish proper drainage (properly sized channels & overflow) system in surrounding or along newly constructed areas such as along new farm roads	Engineering	Damages properties & risk life	Phangkhar, Trong, Umling & Taraythang	Might impact ecosystem in the locality
	c. Construct supporting walls at landslide areas	Engineering	Damages properties & risk life	RMNP	Might impact ecosystem in the locality
	d. Enforce strictly on excessive timber extraction, mining, quarrying, over grazing, forest fire, etc.	Forestry	Damages properties & risk life	RMNP	
	e. Manage land (construction of wall, check dam, etc.) at landslide areas	Engineering	Damages properties & risk life	RMNP	Might impact ecosystem in the locality

6. Seasonal droughts	a. Enforce laws strictly on shifting cultivation, excessive grazing, deforestation, etc.	Forestry	Damages crops and forests	RMNP	
	b. Enforce on indiscriminate felling of fodder trees & other vegetations from restricted areas such as water sources, grazing lands, catchment areas, etc.	Forestry & Agriculture	Damages crops and forests	Umling & Taraythang, Norbugang, Phangkhar	
	c. Plant trees or bring barren areas under agriculture farming (reduce exposed soil surface)	Forestry	Damages crops and forests	Phangkhar, Trong, Umling	Might introduce non-native species
	d. Perform traditional & cultural practices to please local deity and revive water sources	Home & Culture	Damages crops and forests	RMNP	
	e. Establish water harvest technology and reservoir	Water	Damages crops and forests	Norbugang, Umling & Trong	Damage and outburst of reservoir can be disastrous
	f. Implement smart agriculture practices (hydroponic, green house, mulching, etc.	Agriculture	Damages crops and forests	Norbugang, Taraythang,	
7. Human-Wildlife Conflict	a. Identify HWC hotspot and understand distribution patterns & trend	Forestry	Damages crops, affects livelihood	RMNP	
	b. Study ecology of problematic species and causes of crops & livestock depredation	Forestry	Damages crops, affects livelihood	RMNP	

	c. Support HWC mitigation techniques such as electric fencing (concrete base, high power & lightning resistant energizer & GI wire), chain link fencing, barbed wires (durable which requires less maintenance), construct trenches (at animal entry points) & walls, etc.	Forestry & Agriculture	Damages crops, affects livelihood	RMNP	Ownership & Sustainability is questionable.
	d. Explore for locally available HWC mitigation materials at affordable price to encourage communities for self-maintenance	Forestry & Agriculture	Damages crops, affects livelihood	RMNP	
	e. Capacity building on operation and maintaining of existing electric fencing for community people	Forestry & Agriculture	Damages crops, affects livelihood	RMNP	
	f. Establish or strengthen Rapid Response Team (RRT) or Quick Response Team (QRT)	Forestry & Agriculture	Damages crops, affects livelihood	RMNP	Lose community bond with non-member of RRT
	g. Institutionalize/upscale existing compensation or insurance scheme for crops and livestock affected by wild animals (RMNP, 2022) with by-laws in place	Forestry, Agriculture & Livestock	Damages crops, affects livelihood	RMNP	
	h. Strengthen community-based conservation works, to increase community stewardship (form user groups with by-laws in place for strict monitoring)	Agriculture & Livestock	Damages crops, affects livelihood	RMNP	

	i. Manage or restore wildlife habitats	Forestry	Damages crops, affects livelihood	RMNP	Might disturb natural habitat
	j. Maintain traditional trails of wild animals without disturbances	Forestry	Damages crops, affects livelihood	RMNP	Might compromise development
	k. Land substitution/relocate/resettle for people in forest fringes where HWC incidences are high (as per law of the kingdom)	National Land Commission & Forestry	Damages crops, affects livelihood	Norbugang, Trong, Phangkhar, Taraythang, Jigmecholing	
	l. Encourage continuous farming through land development and avoid fallow land	National Land Commission	Damages crops, affects livelihood	RMNP	
8. Drinking water and source (shortage)	a. Identify recharge areas, carry out mapping, assessment & spring revival interventions	Water	Risk livelihood (farming) and life	Taraythang, Umling, Norbugang, Phangkhar, Trong	
	b. Implement appropriate interventions for degraded watershed areas or water sources (restrict tree felling)	Water	Risk livelihood (farming) and life	Taraythang, Umling, Norbugang	Might disturb natural ecosystem
	c. Enrich catchment area with plantation (native tree species and suitable tree species based on site)	Water & Forestry	Risk livelihood (farming) and life	RMNP	Might disturb ecosystem
	d. Fencing of recharge area and water sources	Water	Risk livelihood	Phangkhar, Umling, Taraythang	Might restrict

			(farming) and life		natural process
e.	Encourage traditional & cultural practices to please local deity and revive water sources (in consultation with native & old age inhabitants)	Home and Culture	Risk livelihood (farming) and life	RMNP	
f.	Construct water reservoir or storage tank at community (common property resource bank) and household level	Water	Risk livelihood (farming) and life	RMNP	Damage and outburst of reservoir can be disastrous
g.	Land substitution to private land owners in watershed or recharge areas	National Land Commission	Risk livelihood (farming) and life	RMNP	
h.	Establish rainwater harvest system	Water	Risk livelihood (farming) and life	Umling, Taraythang & Norbugang	
i.	Support community with water pump technology based on the feasibility	Water	Risk livelihood (farming) and life	Phangkhar (Panabe & Zangbe)	
j.	Study the feasibility of implementing PES (Payment for Ecosystem Services)	Water & Environment	Risk livelihood (farming) and life	Umling	People might question their right for resources

9. Irrigation water	a. Maintain existing irrigation channel	Agriculture	Affects farming and crop yield	RMNP	Agriculture land pollution
	b. Construct smart irrigation and climate resilient irrigation channel	Agriculture	Affects farming and crop yield	Norbugang, Phangkhar, Umling & Taraythang	
	c. Establish rainwater harvest system	Water & Agriculture	Affects farming and crop yield	Wagaling & Shilingtoe	
	d. Increase community stewardship for irrigation infrastructures (considering upstream & downstream users) through by-laws in place	Agriculture	Affects farming and crop yield	RMNP	
	e. Support community with water pump technology based on the feasibility	Water	Affects farming and crop yield	Phangkhar, Umling	
10. Crop yield and types	a. Impart capacity development training on climate resilience agriculture practices, farming system, crop rotation, mixed cropping (nutrient management such as leguminous plantation), land management (terracing), etc.	Agriculture	Reduce agricultural production	RMNP	
	b. Provide high yielding or resistant (pest, diseases, extreme environment, etc.) crop seeds	Agriculture	Reduce agricultural production	RMNP	Loss of native species
	c. Establish seed bank (with storage facility) at community level (collect high yielding	Agriculture	Reduce agricultural production	RMNP	

	native crops seeds and distribute to the communities (Millison, 2018)				
	d. Support community with latest agriculture farming technology (hydroponic, green house, soil nutrient management, integrated plant, machineries, etc.)	Agriculture	Reduce agricultural production	RMNP	
	e. Strengthen integrated farming system	Agriculture	Reduce agricultural production	RMNP	
11. Forest coverage & composition	a. Conserve and protect natural forests from exploitation	Forestry	Exploitation of natural resources (forests ecosystem)	RMNP	
	b. Carry out afforestation, enrichment plantation and compensatory plantation in disturbed areas	Forestry	Exploitation of natural resources (forests ecosystem)	RMNP	Introduction of non-native species
	c. Carry out periodic monitoring of vegetations	Forestry	Exploitation of natural resources (forests ecosystem)	RMNP	
	d. Review and strengthen existing CF management to meet the community needs from CFs without disturbing other SRF land	Forestry	Exploitation of natural resources (forests ecosystem)	RMNP	



	e. Encourage private forest development (and introduce private enterprise development)	Forestry	Exploitation of natural resources (forests ecosystem)	RMNP	
	f. Provide alternatives to firewood such as bio-gas, electric appliances, etc. to community & institutions (such as schools, monasteries & others where firewood consumption is high).	Forestry & Livestock	Exploitation of natural resources (forests ecosystem)	RMNP	
12. Pasture land	a. Identify grazing areas (SRF) & lease out to community people for grazing	Forestry	Damages forests by excessive grazing	RMNP	Area exploitation
	b. Identify barren land for fodder plantation and lease out to the community (public partnership for fodder seed production)	Agriculture & Livestock	Damages forests by excessive grazing	RMNP	Area exploitation
	c. Provide high breed cattle & goats to community to reduce number of low yielding local breeds	Livestock	Damages forests by excessive grazing	RMNP (Umling, Taraythang for goat)	Loss of native species
	d. Supply palatable fodder seeds and feed formulation (locally available) to community	Livestock	Damages forests by excessive grazing	RMNP	Introduction of non-native species
	e. Encourage pasture land management within private land (with fencing support)	Livestock	Damages forests by	RMNP	

			excessive grazing		
	f. Introduce fodder production technology (such as hydroponic, silage, etc.) during lean fodder season to reduce grazing pressure on SRF land	Livestock	Damages forests by excessive grazing	Norbugang, Phangkhar, Taraythang & Umling	
13. Pest and diseases (crop)	a. Periodic monitoring of pest and diseases	Agriculture	Damages crops	RMNP	
	b. Study on emerging pest & disease and find out appropriate control measures	Agriculture	Damages crops	RMNP	
	c. Emphasis on eco-friendly (biological) and traditional (isolation, usage of ashes, etc.) control methods	Agriculture	Damages crops	RMNP	
	d. Supply resistant (pest & diseases) variety seeds	Agriculture	Damages crops	RMNP	Introduction of non-native species
	e. Impart capacity development training & awareness regarding pest and diseases control measures to the community people	Agriculture	Damages crops	RMNP	
14. Invasive weeds	a. Inventory of general invasive species & design appropriate measures to prevent its spread	Agriculture & Forestry	Reduces crop yields	RMNP	
	b. Study and implement feasible and eco-friendly invasive weeds control measures	Agriculture & Forestry	Reduces crop yields	RMNP	
	c. Conduct advocacy, awareness, campaign on invasive weeds control measures	Agriculture & Forestry	Reduces crop yields	RMNP	
15. Human diseases	a. Advocate community people on hygiene, health tip, healthy life style, dietary habits,	Health	Affects health and	RMNP	

	communicable & non-communicable diseases, zoonotic diseases, etc.		risk human life		
	b. Establish open physical exercise stations at strategic locations	Health	Affects health and risk human life	RMNP	
	c. Establish proper waste management system (dumping site, segregation, enforcement & monitoring, zero-waste app usage, etc.) in the community	Environment	Affects health and risk human life	RMNP	Pollution at dumping sites
	d. Establish waste management system in the Gewog similar to urban areas (infrastructures, recycling facilities, human resources, etc.)	Environment	Affects health and risk human life	RMNP	
16. Lack of vocational skills	a. Train and build capacity of local youths & school drop outs on vocational skills.	Engineering	Limited income source	RMNP	
	b. Support formation of youth groups having technical or vocational skills and encourage entrepreneurship	Engineering & commerce	Limited income source	RMNP	
17. Lack of livelihood diversity opportunity	a. Promote community-based ecotourism programs by developing products & facilities (such as river rafting, etc.)	Tourism	Limited income source	RMNP (rafting in Phangkhar)	
	b. Train on vocational skills	Engineering	Limited income source	RMNP	
	c. Commercialization of local products & skills through entrepreneurships	Commerce	Limited income source	RMNP	

	d. Support land management for agriculture farming or livestock expansion	Agriculture	Limited income source	RMNP	Exploitation of local ecosystem
18. Lack of awareness on climate change	a. Conduct education, awareness, consultation & trainings related to climate change to local communities through involving multiple sectors and target groups.	Environment	Awareness on climate change	RMNP	

<b>Section 3. Potential Roles and Responsibilities</b>			
<b>Adaptation Action</b>	<b>Lead Stakeholder</b>	<b>Collaborating Stakeholder</b>	<b>Support Needed</b>
Install metrological station at community level (Local)	NCHM	Dzongkhag & Gewog	Identify area and monitoring
Inform people about rainfall seasonality based on metrological data (of around 10 years) a week before (for alertness)	NCHM	Dzongkhag & Gewog, Media	To inform people
Inform people about rainfall seasonality around a year before based on metrological data (of around 5 years) to Change cropping season and type	NCHM	Dzongkhag & Gewog, Media	To inform and educate people
Afforest degraded land to maintain hydrological cycle and/to reduce run off during heavy rain	DoFPS	Dzongkhag & Gewog	Identify area and educate people
Perform traditional & cultural practices to please local deity	Home and Culture	Dzongkhag & Gewog	To initiate the program
Rainwater harvest (water reservoir tank) facility	Department of Water	Dzongkhag & Gewog	Establishment
Construct channel to drain out stagnated water (during heavy rainfall) which risk to house and agriculture land	Department of Water	Dzongkhag & Gewog	Construction

Protect forest, reduce deforestation (install high energy biogas) and carry out afforestation (with strict monitoring) in degraded lands	DoFPS	Dzongkhag & Gewog	Identifying area and informing people
Install weather forecast station at community level and inform people about temperature extremity based on metrological data	NCHM	Dzongkhag & Gewog, Media	Identifying area and informing people
Inform & encourage people to have extreme temperature resilience housing materials (roofing, etc.) & technology (Folkerts, et al., 2022)	Disaster Management Division and Dzongkhag Adm.	Gewog Adm.	Inform and educate people
Establish cold storage facilities at community	Department of Agriculture	Dzongkhag & Gewog	Establishment
Inform (based on metrological data) and encourage people to have windstorm resilience housing materials with modern technology and architect	NCHM	Dzongkhag & Gewog Adm., Media	Inform and educate
Plant trees, fruit trees, bamboo & fodder (or net fencing) around agriculture field as wind break	Department of Agriculture	Dzongkhag & Gewog	Identify area, educate people, initiate program
Construct retaining wall or river bank protection walls/river training works (spurs, check dam, gabion, etc.) & crib wall along farm roads	Dzongkhag Adm.	Gewog Adm.	Carry out of construction works
Divert river/streams causing flashfloods (based on feasibility), water trail management (proper channeling, dredging, etc.)	Dzongkhag Adm.	Gewog Adm.	Identify area, carry feasibility study and inform people
Plant tree or bamboo species adapting to flood plains (bio-engineering works)	DoFPS	Dzongkhag and Gewog Adm.	Informing people
Plant trees (landslides pioneering species such as fodder species, etc.) or carry out bio-engineering works	DoFPS	Dzongkhag and Gewog Adm.	Informing and educating people

Establish proper drainage (properly sized channels & overflow) system in surrounding or along newly constructed areas such as along new farm roads	DoR, Dzongkhag Adm.	Gewog Adm.	Site identification and reporting
Construct supporting walls at landslide areas	Dzongkhag Adm.	Gewog Adm.	Site identification and awarding work to community contractors
Enforce strictly on excessive timber extraction, mining, quarrying, over grazing, forest fire, etc.	DoFPS	Dzongkhag & Gewog Adm.	Monitoring
Manage land (construction of wall, check dam, etc.) at landslide areas	Dzongkhag and Disaster Management Division	Gewog Adm.	Construction
Enforce laws strictly on shifting cultivation, excessive grazing, deforestation, etc.	DoFPS	Dzongkhag & Gewog Adm.	Monitoring
Enforce on indiscriminate felling of fodder trees & other vegetations from restricted areas such as water sources, grazing lands, catchment areas, etc.	DoFPS	Dzongkhag and Gewog Adm.	Monitoring and reporting
Plant trees or bring barren areas under agriculture farming (reduce exposed soil surface)	Department of Agriculture	Dzongkhag and Gewog Adm. & DoFPS	Site identification
Perform traditional & cultural practices to please local deity and revive water sources	Home and Culture	Gewog adm.	Intimate people
Establish water harvest technology and reservoir	Department of Agriculture	Dzongkhag and Gewog Adm.	Construction and work awarding
Implement smart agriculture practices (hydroponic, green house, mulching, etc.)	Department of Agriculture	Dzongkhag and Gewog Adm.	Informing people
Identify HWC hotspot and understand distribution patterns & trend	DoFPS	Dzongkhag and Gewog Adm.	Monitoring and reporting
Study ecology of problematic species and causes of crops & livestock depredation	DoFPS	Dzongkhag and Gewog Adm.	Monitoring and reporting

Support HWC mitigation techniques such as electric fencing (concrete base, high power & lightning resistant energizer & GI wire), chain link fencing, barbed wires (durable which requires less maintenance), construct trenches (at animal entry points) & walls, etc.	DoFPS	Dzongkhag and Gewog Adm.	Monitoring and reporting
Explore for locally available HWC mitigation materials at affordable price to encourage communities for self-maintenance	DoFPS	Dzongkhag and Gewog Adm.	Informing people
Capacity building on operation and maintaining of existing electric fencing for community people	DoFPS	Dzongkhag and Gewog Adm.	Informing and educating people
Establish or strengthen Rapid Response Team (RRT) or Quick Response Team (QRT)	DoFPS	Dzongkhag and Gewog Adm.	To initiate, inform people and forming groups
Institutionalize/upscale existing compensation or insurance scheme for crops and livestock affected by wild animals (RMNP, 2022) with by-laws in place	DoFPS, DoA & DoL	Dzongkhag and Gewog Adm.	Gathering and educating people
Strengthen community-based conservation works, to increase community stewardship (form user groups with by-laws in place for strict monitoring)	DoFPS	Dzongkhag and Gewog Adm.	Informing, educating people
Manage or restore wildlife habitats	DoFPS	Dzongkhag and Gewog Adm.	Educating people
Maintain traditional trails of wild animals without disturbances	DoFPS	Dzongkhag and Gewog Adm.	Educating people
Land substitution/relocate/resettle for people in forest fringes where HWC incidences are high (as per law of the kingdom)	NLC, DoFPS	Dzongkhag and Gewog Adm.	Area identification, monitoring and recommending
Encourage continuous farming through land development and avoid fallow land	Department of Agriculture	Dzongkhag and Gewog Adm.	Educating and facilitating

Identify recharge areas, carry out mapping, assessment & spring revival interventions	Department of Water	Gewog Adm	Informing, educating and gathering people
Implement appropriate interventions for degraded watershed areas or water sources (restrict tree felling)	Department of Water	Dzongkhag and Gewog Adm	Educating people
Enrich catchment area with plantation (native tree species and suitable tree species based on site)	Department of Water, DoFPS	Dzongkhag and Gewog Adm	Gathering people
Fencing of recharge area and water sources	Department of Water, DoFPS	Dzongkhag and Gewog Adm	Inform and gathering people or labour force
Encourage traditional & cultural practices to please local deity and revive water sources (in consultation with native & old age inhabitants)	Home and Culture	Dzongkhag and Gewog Adm.	Informing and gathering people
Construct water reservoir or storage tank at community (common property resource bank) and household level	Department of Water	Dzongkhag and Gewog Adm.	Construction
Land substitution to private land owners in watershed or recharge areas	NCL, DoFPS	Dzongkhag and Gewog Adm.	Monitoring and recommending
Establish rain water harvest system	Department of Water	Dzongkhag and Gewog Adm.	Construction
Support community with water pump technology based on the feasibility	DoA, Department of Water	Dzongkhag and Gewog Adm.	Site identification and monitoring
Study the feasibility of implementing PES (Payment for Ecosystem Services)	DoFPS, Department of Water	Dzongkhag and Gewog Adm.	Educating people
Maintain existing irrigation channel	DoA	Dzongkhag and Gewog Adm.	Maintenance
Construct smart irrigation and climate resilient irrigation channel	DoA	Dzongkhag and Gewog Adm.	Monitoring and recommending



Establish rain water harvest system	DoA, Department of Water	Dzongkhag and Gewog Adm.	Educating people
Increase community stewardship for irrigation infrastructures (considering upstream & downstream users) through by-laws in place	DoA, Department of Water	Dzongkhag and Gewog Adm.	Educating people and fixing accountability
Support community with water pump technology based on the feasibility	DoA, Department of Water	Dzongkhag and Gewog Adm.	Study site feasibility, monitoring and reporting
Impart capacity development training on climate resilience agriculture practices, farming system, crop rotation, mixed cropping (nutrient management such as leguminous plantation), land management (terracing), etc.	Dzongkhag Administration	Gewog Adm.	Educating and coordinating program
Provide high yielding or resistant (pest, diseases, extreme environment, etc.) crop seeds	DoA	Dzongkhag and Gewog Adm.	Monitoring
Establish seed bank (with storage facility) at community level (collect high yielding native crops seeds and distribute to the communities (Millison, 2018))	DoA	Dzongkhag and Gewog Adm.	Study feasibility and recommend
Support community with latest agriculture farming technology (hydroponic, green house, soil nutrient management, integrated plant, machineries, etc.)	DoA	Dzongkhag and Gewog Adm.	Educate people, monitoring
Strengthen integrated farming system	DoA	Dzongkhag and Gewog Adm.	Coordinating program
Conserve and protect natural forests from exploitation	DoFPS	Dzongkhag and Gewog Adm.	Monitoring and reporting
Carry out afforestation, enrichment plantation and compensatory plantation in disturbed areas	DoFPS	Dzongkhag and Gewog Adm.	Identify site and recommend
Carry out periodic monitoring of vegetations	DoFPS	Dzongkhag and Gewog Adm.	Monitoring

Review and strengthen existing CF management to meet the community needs from CFs without disturbing other SRF land	DoFPS	Dzongkhag and Gewog Adm.	Coordinate program
Encourage private forest development (and introduce private enterprise development)	DoFPS	Dzongkhag and Gewog Adm.	Educate people and explore marketing
Provide alternatives to firewood such as bio-gas, electric appliances, etc. to community & institutions (such as schools, monasteries & others where firewood consumption is high).	DoFPS, DoL	Dzongkhag and Gewog Adm.	Coordinate program
Identify grazing areas (SRF) & lease out to community people for grazing	DoFPS	Dzongkhag and Gewog Adm.	Identify site and recommend
Identify barren land for fodder plantation and lease out to the community (public partnership for fodder seed production)	DoFPS, DoL	Dzongkhag and Gewog Adm.	Identify site and recommend
Provide high breed cattle & goats to community to reduce number of low yielding local breeds	DoL	Dzongkhag and Gewog Adm.	Identify feasibility, needs and recommend
Supply palatable fodder seeds and feed formulation (locally available) to community	DoL	Dzongkhag and Gewog Adm.	Coordinate program implementation
Encourage pasture land management within private land (with fencing support)	DoL	Dzongkhag and Gewog Adm.	Educate people
Introduce fodder production technology (such as hydroponic, silage, etc.) during lean fodder season to reduce grazing pressure on SRF land	DoL	Dzongkhag and Gewog Adm.	Educate people about the program
Periodic monitoring of pest and diseases	DoA	Dzongkhag and Gewog Adm.	Inform people
Study on emerging pest & disease and find out appropriate control measures	DoA	Dzongkhag and Gewog Adm.	Monitoring

Emphasis on eco-friendly (biological) and traditional (isolation, usage of ashes, etc.) control methods	DoA	Dzongkhag and Gewog Adm.	Educate people
Supply resistant (pest & diseases) variety seeds	DoA	Dzongkhag and Gewog Adm.	Educate people and coordinate program
Impart capacity development training & awareness regarding pest and diseases control measures to the community people	DoA	Dzongkhag and Gewog Adm.	Coordinate program
Inventory of general invasive species & design appropriate measures to prevent its spread	DoFPS	Dzongkhag and Gewog Adm.	Educate people and coordinate program
Study and implement feasible and eco-friendly invasive weeds control measures	DoFPS	Dzongkhag and Gewog Adm.	Educate people and coordinate program
Conduct advocacy, awareness, campaign on invasive weeds control measures	DoFPS	Dzongkhag and Gewog Adm.	Educate people and coordinate program
Advocate community people on hygiene, health tip, healthy life style, dietary habits, communicable & non-communicable diseases, zoonotic diseases, etc.	MoH	Dzongkhag and Gewog Adm.	Coordinate program
Establish open physical exercise stations at strategic locations	MoH	Dzongkhag and Gewog Adm.	Establish stations
Establish proper waste management system (dumping site, segregation, enforcement & monitoring, zero-waste app usage, etc.) in the community	NEC	Dzongkhag, Thromde and Gewog Adm.	Monitoring, enforcement and reporting
Establish waste management system in the Gewog similar to urban areas (infrastructures, recycling facilities, human resources, etc.)	NEC, Dzongkhag Adm.	Gewog Adm.	Monitoring, enforcement and reporting
Train and build capacity of local youths & school drop outs on vocational skills.	RUB, Dzongkhag Adm.	Gewog Adm.	Coordinate program

Support formation of youth groups having technical or vocational skills and encourage entrepreneurship	Dzongkhag Administration	Gewog Adm.	Educate people
Promote community-based ecotourism programs by developing products & facilities (such as river rafting, etc.)	TCB	Dzongkhag & Gewog Adm.	Educate people and coordinate program
Train on vocational skills	RUB, MoE	Dzongkhag & Gewog Adm.	Coordinate program
Commercialization of local products & skills through entrepreneurships	Dzongkhag Administration	Gewog Adm.	Educate people
Support land management for agriculture farming or livestock expansion	DoA, DoL	Dzongkhag Administration, Gewog Adm.	Educate and inform people
Conduct education, awareness, consultation & trainings related to climate change to local communities through involving multiple sectors and target groups	Dzongkhag Administration	Gewog Adm.	Coordinate program

#### Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New or Existing	Cost (Nu. million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			
Install metrological station at community level (Local)	Instruction procurement	New	3	0.5	1.5	No	1	Station installed
Inform people about rainfall seasonality based on metrological data (of around 10 years) a week before (for alertness)	Communication with media houses	New	1	0.3	0.3	No	2	People informed

Inform people about rainfall seasonality around a year before based on metrological data (of around 5 years) to Change cropping season and type	Communication with media houses	New	1	0.3	0.3	No	2	People informed
Afforest degraded land to maintain hydrological cycle and/to reduce run off during heavy rain	Area identification	New	4	0.2	0.8	No	2	Plantation done
Perform traditional & cultural practices to please local deity	Consult public	Existing	7	0.1	0.7	No	1	Traditional practices performed
Rainwater harvest (water reservoir tank) facility	Area identification	New	3	3.0	9.0	No	3	Rain water harvest system & tank constructed
Construct channel to drain out stagnated water (during heavy rainfall) which risk to house and agriculture land	Channel alignment at site	New	1	2.0	2.0	No	4	Channel constructed
Protect forest, reduce deforestation (install high energy biogas) and carry out afforestation (with strict monitoring) in degraded lands	Site identification	Existing	2	1.0	2.0	No	3	Plantation done. Biogas installed
Install weather forecast station at community level and inform people about temperature extremity based on metrological data	Instrument procurement	New	3	0.5	1.5	No	2	Station established
Inform & encourage people to have extreme temperature resilience	Educate community	New	5	0.1	0.5	No	5	People are aware about

housing materials (roofing, etc.) & technology (Folkerts, et al., 2022)								temperature resilience
Establish cold storage facilities at community	Site feasibility study	New	3	3.0	9	No	7	Cold storage facility established
Inform (based on metrological data) and encourage people to have windstorm resilience housing materials with modern technology and architect	Educate community	New	5	0.1	0.5	No	5	people are aware about temperature resilience
Plant trees, fruit trees, bamboo & fodder (or net fencing) around agriculture field as wind break	Site feasibility study	Existing	10	0.05	0.5	No	3	Wind break established
Construct retaining wall or river bank protection walls/river training works (spurs, check dam, gabion, etc.) & crib wall along farm roads	Site identification	New	5	2.0	10.0	No	2	Retaining walls constructed
Divert river/streams causing flashfloods (based on feasibility), water trail management (proper channeling, dredging, etc.)	Identify feasible site	New	2	1.0	2.0	No	3	Flooding rivers diverted
Plant tree or bamboo species adapting to flood plains (bio-engineering works)	Feasibility study	New	4	0.1	0.4	No	1	Plantation done
Plant trees (landslides pioneering species such as fodder species, etc.) or carry out bio-engineering works	Site study	New	4	0.1	0.4	No	1	Plantation done

Establish proper drainage (properly sized channels & overflow) system in surrounding or along newly constructed areas such as along new farm roads	Site feasibility study and site identification	New	3	2.0	6.0	No	2	Drainage system established
Construct supporting walls at landslide areas	Site identification	New	5	2.0	10.0	No	2	Walls constructed
Enforce strictly on excessive timber extraction, mining, quarrying, over grazing, forest fire, etc.	Site monitoring	Existing	1	1.6	1.6	BFL	1	Monitoring & enforcement done
Manage land (construction of wall, check dam, etc.) at landslide areas	Identify site	New	3	2.0	6.0	No	2	Walls constructed
Enforce laws strictly on shifting cultivation, excessive grazing, deforestation, etc.	Site monitoring	Existing	1	1.6	1.6	BFL	1	Monitoring & enforcement done
Enforce on indiscriminate felling of fodder trees & other vegetations from restricted areas such as water sources, grazing lands, catchment areas, etc.	Site monitoring	Existing	1	1.6	1.6	BFL	1	Monitoring & enforcement done
Plant trees or bring barren areas under agriculture farming (reduce exposed soil surface)	Site identification	New	2	0.1	0.2	No	2	Plantation done
Perform traditional & cultural practices to please local deity and revive water sources	Consult public	Existing	7	0.1	0.7	No	1	Traditional practices performed
Establish water harvest technology and reservoir	Identify site	New	3	2.0	6.0	No	3	Reservoir constructed

Implement smart agriculture practices (hydroponic, green house, mulching, etc.	Consult people	New	5	0.2	1.0	No	2	Smart agriculture practices implemented
Identify HWC hotspot and understand distribution patterns & trend	Consult public, analyze data from SMART	Existing	1	0.3	0.3	BFL	1	HWC hotspot identified
Study ecology of problematic species and causes of crops & livestock depredation	Identify problematic species	New	5	0.5	2.5	No	2	Studies done
Support HWC mitigation techniques such as electric fencing (concrete base, high power & lightening resistant energizer & GI wire), chain link fencing, barbed wires (durable which requires less maintenance), construct trenches (at animal entry points) & walls, etc.	Consult Gewogs, identify site	Existing	7	5.0	35.0	No	1	Mitigation techniques (various) implemented
Explore for locally available HWC mitigation materials at affordable price to encourage communities for self-maintenance	Explore local market, educate people	New	7	0.05	0.35	No	2	People are informed
Capacity building on operation and maintaining of existing electric fencing for community people	Consult community	New	7	0.2	1.3	No	3	Community people know to operate and maintain
Establish or strengthen Rapid Response Team (RRT) or Quick Response Team (QRT)	Consult people	Existing	7	0.2	1.3	No	1	RRT and QRT group formed or strengthened



Institutionalize/upscale existing compensation or insurance scheme for crops and livestock affected by wild animals (RMNP, 2022) with by-laws in place	Consult people	New	7	1.0	7.0	No	1	Insurance scheme established
Strengthen community-based conservation works, to increase community stewardship (form user groups with by-laws in place for strict monitoring)	Consult people	New	7	0.2	1.3	No	1	User groups formed and bylaws in place
Manage or restore wildlife habitats	Site feasibility study	Existing	3	0.8	2.4	BFL	1	Wildlife habitat managed
Maintain traditional trails of wild animals without disturbances	Identify trails & consult people	New	5	0.1	0.5	No	2	Wildlife trails maintained
Land substitution/relocate/resettle for people in forest fringes where HWC incidences are high (as per law of the kingdom)	HWC hotspot identified and inspect site	New	4	0.05	0.2	No	2	Land substitution given
Encourage continuous farming through land development and avoid fallow land	Consult communities	New	6	0.5	3.0	No	1	Farming facilities provided
Identify recharge areas, carry out mapping, assessment & spring revival interventions	Site assessment	New	2	0.5	1.0	No	2	Recharge areas assessed
Implement appropriate interventions for degraded watershed areas or water sources (restrict tree felling)	Assess and identify degraded watershed	New	2	0.5	1.0	No	2	Interventions implemented at degraded watershed

Enrich catchment area with plantation (native tree species and suitable tree species based on site)	Assess catchment areas	New	3	0.1	0.3	No	3	Enrichment plantation done
Fencing of recharge area and water sources	Identify & assess water sources	New	4	0.2	0.8	No	2	Water sources fenced
Encourage traditional & cultural practices to please local deity and revive water sources (in consultation with native & old age inhabitants)	Consult public	Existing	7	0.1	0.7	No	1	Traditional practices performed
Construct water reservoir or storage tank at community (common property resource bank) and household level	Consult people	New	3	3.0	9.0	No	3	Reservoir tank constructed
Land substitution to private land owners in watershed or recharge areas	Consult people		4	0.05	0.2	No	2	Land substitution given
Establish rain water harvest system	Consult people & identify site	New	3	2.0	6.0	No	3	Rain water harvest system established
Support community with water pump technology based on the feasibility	Study site feasibility	New	2	1.0	2.0	No	2	Water pumped technology installed
Study the feasibility of implementing PES (Payment for Ecosystem Services)	Consult communities	New	1	0.2	0.2	No	9	PES scheme adopted
Maintain existing irrigation channel	Inspect existing channels	New	5	2.0	10.0	No	5	Irrigation channels maintained

Construct smart irrigation and climate resilient irrigation channel	Identify site	New	3	2.5	7.5	No	7	Smart channels constructed
Establish rain water harvest system	Consult people & identify site	New	3	2.0	6.0	No	3	Rain water harvest system established
Increase community stewardship for irrigation infrastructures (considering upstream & downstream users) with by-laws in place	Consult people	New	3	0.1	0.3	No	4	Irrigation infrastructures are taken care and by-laws in place
Support community with water pump technology based on the feasibility	Study site feasibility	New	2	1.0	2.0	No	2	Water pumped technology installed
Impart capacity development training on climate resilience agriculture practices, farming system, crop rotation, mixed cropping (nutrient management such as leguminous plantation), land management (terracing), etc.	Plan capacity development programs	New	3	1.5	4.5	No	4	Community trained on various climate resilient farming practices
Provide high yielding or resistant (pest, diseases, extreme environment, etc.) crop seeds	Explore availability	New	7	0.2	1.4	No	1	High yielding crop seeds distributed
Establish seed bank (with storage facility) at community level (collect high yielding native crops seeds and distribute to the communities (Millison, 2018)	Study site feasibility	New	2	2.0	4.0	No	5	Seed bank established

Support community with latest agriculture farming technology (hydroponic, green house, soil nutrient management, integrated plant, machineries, etc.)	Consult communities & study feasibility	New	7	3.0	21.0	No	6	Modern farming technologies issued or established
Strengthen integrated farming system	Study feasibility	New	5	0.5	2.5	No	7	IFS strengthened
Conserve and protect natural forests from exploitation	Monitoring	Existing	1	2.0	2.0	RGoB & BFL	1	Forest not exploited
Carry out afforestation, enrichment plantation and compensatory plantation in disturbed areas	Identify site	New	1	1.0	1.0	No	9	Plantation carried out in disturbed areas
Carry out periodic monitoring of vegetations	Monitoring	Existing (NFI)	1	3.0	3.0	BFL	4	Forest status reported
Review and strengthen existing CF management to meet the community needs from CFs without disturbing other SRF land	Consult CFMG members	Existing	19	0.2	3.8	BFL	10	CF management plans revised
Encourage private forest development (and introduce wood enterprise development)	Consult people	New	2	3.0	6.0	No	10	Private forest & woo enterprise developed.
Provide alternatives to firewood such as bio-gas, electric appliances, etc. to community & institutions (such as schools, monasteries & others where firewood consumption is high).	Study feasibility	New	10	0.5	5.0	No	8	Alternatives for firewood provided

Identify grazing areas (SRF) & lease out to community people for grazing	Consult community	New	6	0.2	1.2	No	5	Grazing land for respective households are identified
Identify barren land for fodder plantation and lease out to the community (public partnership for fodder seed production)	Consult community	New	6	0.5	3.0	No	5	Barren land adopted for fodder & fodder seed production
Provide high breed cattle & goats to community to reduce number of low yielding local breeds	Study feasibility	New	7	0.5	3.5	No	9	High breed cattle & goat are issued
Supply palatable fodder seeds and feed formulation (locally available) to community	Consult community	New	10	0.3	3.0	No	2	Palatable fodder seed supplied
Encourage pasture land management within private land (with fencing support)	Consult people	New	10	0.1	1.0	No	5	Private pasture land developed
Introduce fodder production technology (such as hydroponic, silage, etc.) during lean fodder season to reduce grazing pressure on SRF land	Consult people	New	3	0.5	1.5	No	8	Fodder production technologies introduced
Periodic monitoring of pest and diseases	Site monitoring	New	1	0.5	0.5	No	3	Pest & diseases monitored
Study on emerging pest & disease and find out appropriate control measures	Site monitoring	New	1	1.0	1.0	No	3	Control measures adopted
Emphasis on eco-friendly (biological) and traditional	Consult community	New	1	0.8	0.8	No	4	Eco-friendly control

(isolation, usage of ashes, etc.) control methods								measures adopted
Supply resistant (pest & diseases) variety seeds	Study site feasibility	New	1	2.0	2.0	No	5	Resistant seed supplied
Impart capacity development training & awareness regarding pest and diseases control measures to the community people	Consult people	New	7	0.5	3.5	No	5	Community people trained on pest & disease control
Inventory of general invasive species & design appropriate measures to prevent its spread	Study site feasibility	New	1	1.0	1.0	No	8	Inventory study of invasive species done
Study and implement feasible and eco-friendly invasive weeds control measures	Study site feasibility	New	1	2.5	2.5	No	9	Invasive control measures adopted
Conduct advocacy, awareness, campaign on invasive weeds control measures	Consult people	New	1	0.2	0.2	No	9	Advocacy given
Advocate community people on hygiene, health tip, healthy life style, dietary habits, communicable & non-communicable diseases, zoonotic diseases, etc.	Consult community	New	3	0.2	0.6	No	1	Public advocacy program conducted
Establish open physical exercise stations at strategic locations	Study site feasibility	New	4	3.0	12.0	No	3	Physical exercise station established
Establish proper waste management system (dumping site, segregation, enforcement & monitoring, zero-	Consult community	Existing	3	1.0	3.0	No	4	Waste dumping site & segregation

waste app usage, etc.) in the community								facilities established
Establish waste management system in the Gewog similar to urban areas (infrastructures, recycling facilities, human resources, etc.)	Communicate with Dzongkhag and Thromde administration	New	3	2.0	6.0	No	6	Waste management infrastructure established at Gewog level
Train and build capacity of local youths & school drop outs on vocational skills.	Consult youths & drop outs	New	7	0.4	2.8	No	9	Youth trained on vocational skills
Support formation of youth groups having technical or vocational skills and encourage entrepreneurship	Consult vocational skill elite groups	New	2	1.5	3.0	No	10	Entrepreneurship of vocational skills started
Promote community-based ecotourism programs by developing products & facilities (such as river rafting, etc.)	Study site feasibility	New	4	2.0	8.0	No	3	Ecotourism products developed
Train on vocational skills	Consult youths & drop outs	New	7	0.4	2.8	No	9	Youth trained on vocational skills
Commercialization of local products & skills through entrepreneurships	Study feasibility & consult community	New	2	3.0	6.0	No	9	Local products commercialized
Support land management for agriculture farming or livestock expansion	Study site feasibility	New	3	2.0	6.0	No	10	Farm land managed

Conduct education, awareness, consultation & trainings related to climate change to local communities through involving multiple sectors and target groups	Consult community	New	5	0.3	1.5	No	1	Advocacy programs on CC conducted
<b>Total budget estimate for 10 years</b>					<b>309m</b>			
<b>Section 5. Details of Stakeholder Consultation</b>								
<b>Date of Consultation</b>	<b>Consultation Meeting</b>	<b>Stakeholders</b>				<b>Nos. of Participants</b>		
20/10/2022	Nganglam Dungkhag, Pemagatshel	Dasho Dungpa, sector heads, officials from RNR offices, forestry & community representatives				45 (40 males, 5 females)		
21/10/2022	Zhemgang Dzongkhag	Sector heads, RNR officials, LG officials and forestry				20 (16 males, 4 females)		
26/10/2022	Taraythang Gewog, Sarpang	Officials from Local government, RNR, Health, Education, forestry and community representatives				31 (26 males, 5 females)		
27/10/2022	Umling Gewog, Sarpang	Officials from Local government, RNR, CFs, Health, Education, forestry and community representatives				30 (22 males, 8 females)		
<b>Consultation and Plan Preparation led by</b> Karma Gyeltshen, Forestry Officer, RMNP								



## 18.4 References

- CBD. (2022). Convention on Biological Diversity. Retrieved from Protected Areas; an overview: <https://www.cbd.int/protected/overview/>
- Folkerts, M. A., Brode, P., Botzen, W. W., Martinius, M. L., Gerrett, N., Harmsen, C. N., & Daanen, H. A. (2022, March). Long Term Adaptation to Heat Stress: Shifts in the Minimum Mortality Temperature in the Netherlands. *Frontier in Physiology*, 11(225), 1-7. doi:doi.org/10.3389/fphys.2020.00225
- Millison, A. (2018, April). Oregon State University. Retrieved from Permaculture Design: Tools for Climate Resilience: <https://open.oregonstate.edu/education/permaculturedesign/>
- RMNP. (2022). Conservation Management Plan (Draft). Thimphu: Department of Forests and Park Services. Ministry of Agriculture and Forests; Royal Government of Bhutan.
- UWICER. (2018). 50 Years of Environmental Journey in Bhutan; Water and Climate Scenario (1968-2017) (Vol. 2). Lamai Goempa, Bumthang: UWICER Press.

## 19 Climate Change Adaptation Plan of the Sakteng Wildlife Sanctuary

### 19.1 Background

Sakteng Wildlife Sanctuary (SWS) established in 2003 represents easternmost temperate and alpine ecosystem of Bhutan. SWS is the only PA with highest Rhododendron species (41 species) in the country (SWS, 2019). SWS is home to 858 plant species, 39 mammals, 5 reptiles, 3 amphibians, 2 fishes and 104 butterflies (SWS, 2019; SWS, 2020). The sanctuary host numbers of globally threatened and endangered species like the Royal Bengal tiger (*Panthera tigris*), Red Panda (*Ailurus fulgens*), Musk deer (*Moschus sp.*), Capped Langur (*Trachypithecus pileatu*) to be named few (SWS, 2019). Despite the flora and fauna, the sanctuary is also a home to closely 5000 semi-nomads commonly known as “Brokpas”.

SWS at large can be classified into three climatic zones; sub-tropical zone, temperate zone and alpine Meadows (SWS, 2019). Like everywhere in the world, climate change is real and impacts of the climate change are felt by the people residing in the sanctuary. Climate change has resulted in changing the terrestrial, freshwater and ocean ecosystem and it adversely affected people with water and food security (IPCC, 2022). Climate Vulnerability and Capacity Assessment was conducted in protected areas of Bhutan including biological corridors (BC) in February 2022 to assess the climate vulnerability and capacity of the community in adaptation to the climate change.

SWS has reported extreme temperature (79%), shift in rainfall seasonality (34%) and Landslides (12%) as top three climate exposure and drinking water, pasture land and human wildlife conflict topped in sensitivity category. SWS was found to be low in terms of community group and alternative water sources in adaptive capacity. SWS with higher adaptive capacity with low exposure and sensitivity was found to be least vulnerable with vulnerability index of 0.56 compared to Phibso Wildlife Sanctuary with vulnerability index of -0.27 (Yoezer, et al., 2022). The indicators such as productive member, house type, distance to nearest school, distance to nearest Basic Health Unit (BHU) and distance to nearest gewog center (GC) attributed to least vulnerability index for SWS (Yoezer, et al., 2022).

Clustered settlement in Merak and Sakteng was obvious that these indicators will contribute for low vulnerability index for SWS with higher adaptive capacity since all

indispensable institutions like BHU are located just near the settlement however 85% of population depends of livestock farming (SWS, 2019) and they migrate with cattle from pasture to pasture in the forest. Therefore, the impact of climate change is most likely to be felt by the people residing in SWS. This climate change adaptation plan was focused on mitigating and adapting with the climate hazards identified both by the CVCA report and consultation meeting with the relevant stakeholders and community representatives.

## 19.2 Objective

- Build community climate resilience through enhancing community livelihood to cope with climate change impacts
- Reduce climatic hazards to minimize climatic risk to communities.
- Promote environment and biodiversity conservation to mitigate climate change
- Educate communities on climate smart livelihood practices

## 19.3 Adaptation Priorities of the Sakteng Wildlife Sanctuary

### Section 1. Priority Climate Vulnerabilities

#### List of Priority Climate Vulnerabilities

**1. Extreme weather events, change in water cycle, change in forest composition & unregulated grazing resulting in water scarcity in dry months.**

The problem in decreasing water volume especially during dry season was reported from both Merak and Sakteng gewog by Climate Vulnerability and Capacity Assessment (CVCA) study as well by community during consultation. Merak gewog has reported during consultation workshop that due to less flow of water force, the water in the water pipe gets blocked due to ice formation. Merak gewog has tapped water from 17 small sources and distributed to the villages which still fails to supply reliable water during dry season.

**2. Shift in rainfall seasonality, resulting in water shortage in rainwater dependent pastureland (highland pastureland) and resulting in crop pest and diseases.**

Many pasture land does not have reliable water sources and they depend on rain water where shift in rainfall seasonality has challenged their livelihood. Since 85% of HH in SWS depends on livestock farming (SWS, 2019), shift in rainfall seasonality has been one of the main issues and the cases of crop pest and diseases due to shift in rainfall seasonality was reported especially from lower settlements of SWS where they practice subsistence farming for their livelihood. It was reported that due to shift in rainfall seasonality their crop has been damaged by pest and diseases for 3 consecutive years.

**3. Landslides, invasive weed and unpalatable tree species resulting in reduced pasture land**

85% (567 HH) of people residing in SWS depends on livestock farming (SWS, 2019). The insufficient pasture land caused by landslides, invasive weeds and unpalatable tree species was reported during consultation workshop as well by CVCA result. The issue of insufficient pastureland was also reported in SWS management plan.

**4. Increased human wildlife conflict resulting in crop raiding and livestock depredation.**

Increased in HWC was reported during CVCA adaptation plan consultation workshop by both the gewogs (Merak and Sakteng). The crop raiding by wildlife was mostly reported from Joenkhar and thrakthri under Sakteng gewog, 95.5 % of HH confirmed the occurrence of crop raiding by wildlife (Tobgay, et al., 2019) where livestock depredation was reported from Merak and Sakteng.

**5. Water and soil pollution resulting in unhygienic and human diseases.**

The solid waste problem resulting in water and soil pollution was reported during CVCA adaptation plan consultation workshop by both the gewogs (Merak and Sakteng). The culture forbidding the waste burning was the main issue for the community of Merak and Sakteng.

**6. High demand on natural resources and change in forest composition resulting in shortage of quality timber species.**

Due to growing population and households, the increased in timber collection time and flagpoles were reported from both the gewogs. Merak gewog reported during consultation workshop that the place where they used to find abundant of Juniper and Fir trees before are no more now, this can be attribute to excessive demand on timber or change in forest composition due to climate change. The loss in fir forest was predicted to be high in Merak with 2.5% (Wangdi, et al., 2019).

**7. Increased in firewood consumption leads in over harvesting thereby reducing carbon sink.**

The extreme weather events in winter were reported to have increased in firewood consumption. The yearly firewood demand was predicted to be 5798 truckload per year (SWS, 2019), though demand supply curve showed to be positive (SWS, 2019) but likely of firewood shortage was reported in consultation workshop due to continued growth in population and households.

**8. Increase in windstorm pattern, resulting in crop damage**

Increased in windstorm affecting the crop production especially maize was reported in consultation workshop by people of Joenkhar and Thrakthri under Sakteng gewog. For last 3 consecutive years, community has reported to have experienced increased in frequency of windstorm and affected the maize production.

**9. Flash floods and landslide affecting community.**

The possibility of flash floods and landslides affecting community was reported from both the gewogs (Merak and Sakteng) during consultation as communities are located within the periphery of the several small streams whose volume gets swelled especially during monsoon season. If the swelling of streams keeps growing its pace the risk of washing away of the settlements and public infrastructure like roads are very high if appropriate interventions are not taken now.

**10. Increased pest and diseases resulting in forest degradation.**

The increased in forest pest and diseases was reported especially from Merak gewog during consultation. The hectares of rhododendron sp. were reported to be affected by forest pest and diseases at sheyteymey under Merak gewog which is likely to spread to larger area if left un-intervened.

**Section 2. Priority Actions to Address Vulnerabilities**

<b>Priority Climate Vulnerabilities</b>	<b>Adaptation Action</b>	<b>Sector</b>	<b>Climate Hazard</b>	<b>Area</b>	<b>Potential Trade-Off</b>
1. Extreme weather events, change in water cycle, change in forest composition & unregulated grazing resulting in water scarcity in dry months.	1. Conduct geohydrology mapping in degraded water sources to find the recharge area and implement appropriate intervention at recharge area	Forest/ Water	Decreased water discharge at water sources	All drinking water sources of SWS	
	2. Regulate grazing	Forest	Decreased water discharge at water sources	Grazing land in the vicinity of drinking water source	
	3. Identify the perennial huge volume stream and build water reserved tank.	Forest/ Water	Increasing water variabilities at water sources.	Merak & Sakteng	Risk of flooding if not designed and built properly.
	4. Strengthen the existing water user group by building the capacity and by identifying appropriate agency for implementing the by-laws	Water	Increasing water variabilities at water sources.	Merak & Sakteng	

	5. Insulate water pipe during winter & establish underground water pipe system	Water	Extreme weathers attributes in ice formation in water pipes	Merak & Sakteng	
2. Shift in rainfall seasonality, resulting in water shortage in rainwater dependent pastureland (highland pastureland) and resulting in crop pest and diseases.	6. Rain water harvesting	Water	Shift in rainfall seasonality leading to water shortages at highland pastureland.	All highland pastureland	
	7. Develop water holes where livestock/wildlife can feed during dry season	Water	Shift in rainfall seasonality leading to water shortages at highland pastureland.	All highland pastureland	
	8. Issuing of Portable water tank	Water	Shift in rainfall seasonality leading to water shortages at highland pastureland.	All highland pastureland	
	9. Initiate practice of mixed cropping	Agriculture	Pest and diseases due to shift in rainfall seasonality	Thrakthri, Joenkhar, Khshateng & Kheliphu	
	10. Initiate low volume, high yield crop varieties	Agriculture	Pest and diseases due to shift in rainfall seasonality	Thrakthri, Joenkhar, Khshateng & Kheliphu	
3. Landslides, invasive weed and unpalatable tree species resulting in reduced pasture land	11. Rehabilitation and restoration of degraded land by constructing check dams and bioengineering	Forest	Reduced pasturelands due to land slides	Critically landslide affected pasturelands.	
	12. Restoration of alpine and low land grass land	Forest	Reduced pasture land due to invasive weeds and unpalatable tree species	All highland and lowland pastures	

	13. Conduct grazing carrying capacity study	Forest	Degraded pasturelands due to over grazing	All highland and lowland pastures	
	14. Initiate Silvo-pasture in degraded pastureland on pilot basis to offset the fodder shortages	Forest/ Livetsock	Degraded pasture land	Degraded pasture land based on findings from carrying capacity study	
	15. Initiate silages preparation program	Livestock	Reduced pastureland	Joenkhar, Thrakthri, Khashateng and Kehliphu	
	16. Reduction of un-productive livestock (need further intensive discussion with general public and religious bodies)	Livestock	Reduced pastureland	Merak and Sakteng	
4. Increased human wildlife conflict resulting in crop raiding and livestock depredation.	17. Installation of chain link fencing to minimize crop raiding	Agriculture/ Forest	Increased crop raiding due to increased wildlife population	Thrakthri, Joenkhar, Khashateng & Kehliphu	
	18. Initiate crop insurance system	Agriculture/ Forest	Increased crop raiding due to increased wildlife population	Thrakthri, Joenkhar, Khashateng & Kehliphu	
	19. Habitat improvement	Forest	Increased crop raiding due to increased wildlife population	Thrakthri, Joenkhar, Khashateng & Kehliphu	
	20. Conduct ecological study on problematic livestock depredation wildlife species (Wild dog).	Wildlife	Increased livestock depredation due to increase in wildlife population	All pastures, Highland and lowland	



	21. Conduct wildlife depredation hotspot mapping study	Wildlife	Increased livestock depredation due to increase in wildlife population	All pastures, Highland and lowland	
	22. Initiate livestock insurance system	Livestock	Increased livestock depredation due to increase in wildlife population	Merak and Sakteng gewog	
	23. Encourage to guarding and tethering of livestock	Livestock	Increased livestock depredation due to increase in wildlife population	All pasturelands	
	24. Supply of corral fencing to mitigate livestock depredation	Livestock	Increased livestock depredation due to increase in wildlife population	All pasture lands	
5. Water and soil pollution resulting in unhygienic and human diseases.	25. Initiating waste pick-up by vehicles in the gewogs at least once a month.	Environment	Increased in solid waste	Merak and Sakteng gewog	
	26. Awareness on waste management	Environment	Increased in solid waste	Youths and schools in and adjoining of SWS.	
	27. Procure waste crushing machine and initiate entrepreneurship	Environment	Increased in solid waste	Youths of Merak and Sakteng	
	28. Construction of waste dumping yards	Environment	Increased in solid waste	Sakteng and Merak	
6. High demand on natural	29. Enhance natural regeneration	Forest	Reduced quality timber species	Merak and Sakteng	

resources and shift in forest composition resulting in shortage of quality timber species.	30.Encourage less preferred timber species usage by training community on timber seasoning techniques	Forest	Reduced quality timber species	Joenkhar,Thrakthri, Khashateng & Kheliphu	
	31.Construction of fabricated prayer flag at strategic locations	Forest	Reduced quality timber species	Merak and Sakteng	
	32.Establishment of permanent biodiversity station to monitor climate change impact on forest and other natural resources	Forest	Changed in forest composition leading to timber scarcity	Merak and Sakteng	
	33. Improved timber harvesting technology.	Forest	Reduced quality timber species	Merak and Sakteng	
7.Increased in firewood consumption leads in reduced carbon sink	34.Encourage use of electrical heaters for heating and cooking	Energy	Increased demand in firewood leading in reduced carbon sink	Merak and Sakteng	
	35.Initiate establishment of bio-briquettes from saw dust, waste wood and dung	Energy	Increased demand in firewood leading in reduced carbon sink	Merak & Sakteng	
	36.Initiate solar heating system	Energy	Increased demand in firewood leading in reduced carbon sink	Merak & Sakteng	
8.Increase in windstorm pattern, resulting in crop damage	37.Explore and implement climate resilient crop varieties	Agriculture	Increased in windstorm frequency	Joenkhar, Thrakthrii, Khashateng& Kheliphu	
	38.Initiate wind barrier plantation	Forest	Increased in windstorm frequency	Joenkhar, Thrakthrii, Khashateng& Kheliphu	
9.Flash floods and landslide	39.River training work (River and stream flowing near settlement)	Water	Increased volume of streams near	Merak & Sakteng	

affecting community.			settlement in monsoon.		
	40.Management of upstream forest	Forest	Increased volume of streams near settlement in monsoon.	Merak & Sakteng	
10.Increased pest and diseases resulting in forest degradation.	41.Early detection of pest and diseases.	Forest	Increased forest pest and diseases	Merak & Sakteng	
	42.Encourage debarking of felled pine tress	Forest	Increased forest pest and diseases	Joenkhar,Thrakthri, Kheliphu & Khashateng	

### Section 3. Potential Roles and Responsibilities

Adaptation Action	Lead Stakeholder	Collaborating Stakeholder	Support Needed
1.Conduct geohydrology mapping in degraded water sources to find the recharge area and implement appropriate intervention at recharge area	SWS	WMD/ UWICER	Fund and Technical support
2. Regulate grazing	SWS	LG/Herders	Fund support
3.Identify the perennial huge volume stream and building water reserved tank.	Dzongkhag	LG	Fund and Technical support
4.Strengthen the existing water user group by building the capacity and by identifying appropriate agency for implementing the by-laws	SWS	LG/water user groups	Fund and Technical support

5. Insulate waterpipe during winter. Deep underground water pipe system	SWS	LG	Fund and Technical support
6. Rain water harvesting	SWS	LG	Fund and Technical support
7. develop water holes where livestock/wildlife can feed during dry season	SWS	LG	Fund and Technical support
8. Issuing of Portable water tank	SWS	LG	Fund support
9. Initiate practice of mixed cropping	DoA	SWS	Fund and Technical support
10. Initiate low volume high yield crop varieties	DoA	SWS	Fund and Technical support
11. Rehabilitation and restoration of degraded land with constructing check dams and bioengineering	SWS	LG	Fund and Technical support
12. Restoration of alpine and low land grass land	SWS	Herders	Fund support
13. Conduct grazing carrying capacity study	SWS	UWICER/NCD	Fund and Technical support
14. Initiate Silvo-pasture in degraded pastureland on pilot basis to offset the fodder shortages	SWS	DoA/SFED/DoL	Fund and Technical support
15. Initiate silages preparation program	DoL	SWS	Fund and Technical support
16. Reduction of un-productive livestock (need further intensive discussion with general public and religious bodies)	DoL	LG	Technical support
17. Installation of chain link fencing to minimize crop raiding	SWS	LG	Fund and Technical support
18. Initiate crop insurance system	SWS	LG/Insurance agency	Fund and Technical support
19. Habitat improvement	SWS	LG	Fund Support

20. Conduct ecological study on problematic livestock depredation wildlife species (Wild dog).	SWS	UWICER/NCD	Fund and Technical support
21. Conduct wildlife depredation hotspot mapping study	SWS	NCD/UWICER	Fund and Technical support
22. Initiate livestock insurance system	SWS	LG/Insurance agency	Fund and Technical support
23. Encourage to Guarding and tethering of livestock	DoL	SWS/LG	Fund support
24. Supply of corral fencing to mitigate livestock depredation	SWS	NCD/herders	Fund and Technical support
25. Initiating waste pick-up by vehicles in the gewogs at least once a month.	LG	SWS	Fund support
26. Awareness on waste management	SWS	LG	Fund support
27. Procure waste crushing machine and initiate entrepreneurship	SWS	Dzongkhag/LG	Fund and Technical support
28. Construction of waste dumping yards	Dzongkhag	LG	Fund support
29. Enhance natural regeneration	SWS	SFED/FRMD	Fund and Technical support
30. Encourage less preferred timber species usage by training community on timber seasoning techniques	SWS	SFED/FRMD	Fund and Technical support
31. Construction of fabricated prayer flag at strategic locations	SWS	LG	Fund support
32. Establishment of permanent biodiversity station to monitor climate change on forest and other natural resources	SWS	UWICER	Fund and technical support
33. Improved timber harvesting technology.	FRMD	SWS/LG	Fund support

34.Encourage use of electrical heaters for heating and cooking	SWS	LG	Fund support
35.Initiate establishment of bio-briquettes from saw dust, waste wood and dung	SWS	LG	Fund and Technical support
36.Initiate solar heating system	SWS	NCD/LG	Fund and Technical support
37.Explore and implement climate resilient crop varieties	DoA	SWS	Fund and Technical support
38.Initiate wind barrier plantation	SWS	SFED/LG	Fund and Technical support
39.River training work (River and stream flowing near settlement)	LG	SWS	Fund and Technical support
40.Management of upstream forest	SWS	LG/herders	Fund and Technical support
41.Early detection of pest and diseases.	SWS	FPED/herders	Fund support
42.Encourage debarking of felled pine tress	SWS	LG	Fund support

#### Section 4. Implementation and Resourcing

Adaptation Action	Next Step for Implementation	New/ Existing	Cost (Nu. million)			Funding Available	Timeline Year (1 - 10)	Key Performance Indicator
			Unit	Rate	Total			
1.Conduct geohydrology mapping in degraded water sources to find the recharge area and implement appropriate intervention at recharge area	Secure funding	New	No. of study & intervention (10)	0.5	1.00	None	1 & 2	No. of study conducted and recharge area intervened

2. Regulate grazing	Secure funding	New	Area (5 hector per year)	0.15	1.5	None	Annually	Area brought under regulated grazing
3. Identify the perennial huge volume stream and building water reserved tank.	Secure funding	New	No. of water reserved tank (2)	1.5	3.00	None	2 & 3	No. of reserved tank build and water sources identified
4. Strengthen the existing water user group by building the capacity and by identifying appropriate agency for implementing the by-laws	Secure funding	New	No. of group (4)	0.1	0.4	None	1	No. of water user group strengthened
5. Insulate waterpipe during winter. Deep underground water pipe system	Secure funding	New	No. of institution (10)	0.1	1.00	None	1 & 2	No. of institution's water pipe insulated
6. Rain water harvesting (cost sharing)	Secure funding	New	No. of herders (40)	0.02	0.8	None	1	No. of rain water harvesting technology provided
7. develop water holes where livestock/wildlife can feed during dry season	Secure funding	New	No. of water hole (5 per year)	0.15	1.5	None	Annually	No. of water hole developed
8. Issuing of Portable water tank (cost sharing)	Secure funding	New	No. of herders (20 per year)	0.5	5.00	None	Annually	No. of portable water tank provided

9. Initiate practice of mixed cropping	Secure funding	New	No, of villages (4)	0.1	0.4	None	5	No. of villages brought under mixed cropping practice
10. Initiate low volume high yield crop varieties	Secure funding	New	No, of villages (4)	0.2	0.8	None	3	No. of villages brought under low volume high yield farming
11. Rehabilitation and restoration of degraded land with constructing check dams and bioengineering	Secure funding	New	Area, (1 hector per year)	0.5	5.0	None	Annually	No. of area brought under rehabilitation
12. Restoration of alpine and low land grass land	Secure funding	Existing	Area (10 hector per year)	0.1	1.00	None	Annually	No. of alpine and low land pasture restored
13. Conduct grazing carrying capacity study	Secure funding	New	No. of site (6)	0.5	3.00	None	1 & 2	Grazing carrying capacity study conducted
14. Initiate Silvo-pasture in degraded pastureland on pilot basis to offset the fodder shortages	Secure funding	New	Area (1 hector per year)	0.15	1.5	None	Annually	No. of pasture land brought under silvo-pasture practice
15. Initiate silages preparation program (cost sharing)	Secure funding	New	No. of HH (10 per year)	0.5	5	None	Annually	No. of silages prepared
16. Reduction of un-productive livestock (need	Seek technical and Suggestions	New					10	No. of un-productive



further intensive discussion with general public and religious bodies)	from general public							livestock reduced
17.Installation of chain link fencing to minimize crop raiding (cost sharing)	Secure funding	New	Km (5km per year)	25.00	75.00	None	3, 4, 5 & 6	Area brought under chain linked fencing
18.Initiate crop insurance system	Secure funding	New	No. of groups (4)	0.1	0.4	None	1	Crop insurance system initiated
19.Habitat improvement	Secure funding	New	Area (1 hector per year)	0.15	1.5	None	Annually	Area brought under improved habitat
20.Conduct ecological study on problematic livestock depredation wildlife species (Wild dog).	Secure funding	New	No. of study (5)	0.5	0.5	None	3	No. of study conducted
21.Conduct livestock depredation hotspot mapping study	Secure funding	New	No. of study (1)	0.15	0.15	None	1	Livestok depredation hotspot designated
22.Initiate livestock insurance system	Secure funding	New	No. of groups (10)	0.1	1.00	None	5	Livestock Insurance system initiated
23.Encourage to Guarding and tethering of livestock	Secure funding	New	No. of village (4)	0.05	0.2	None	7	No. of advocacy conducted
24.Supply of corral fencing to mitigate livestock depredation	Secure funding	New	No. of fence per year (10)	0.5	5.00	None	Annually	No. of corral fence provided

25. Initiating waste pick-up by vehicles in the gewogs at least once a month.	Secure funding	New	No. of truckloads per month (5)	0.05	0.6	None	Annually	No. of waste pick-up program initiated
26. Awareness on waste management	Secure funding	New	No. of awareness (3)	0.1	0.3	None	1	No. of awareness created
27. Procure waste crushing machine and initiate entrepreneurship	Secure funding	New	No. of machines (2)	1.00	2.00	None	6 & 7	No. of waste machine provided and entrepreneurship initiated
28. Construction of waste dumping yards	Secure funding	New	No. of dumping yards (2)	1.00	2.00	None	1	No. of waste yard constructed
29. Enhance natural regeneration	Secure funding	New	Area (5 acre)	0.05	0.25	None	1	No. of area enhanced for natural regeneration
30. Encourage less preferred timber species usage by training community on timber seasoning techniques	Secure funding	New	No. of trainings (4)	0.1	0.4	None	10	No. of community trained on timber seasoning techniques
31. Construction of fabricated prayer flag at strategic locations	Secure funding	New	No. of sites (10)	0.2	2.00	None	1	No. of fabricated prayer flag constructed

32.Establishment of permanent biodiversity grids to monitor climate change on forest and other natural resources	Secure funding	New	No. of sites (3)	0.2	0.6	None	1	No. of permanent biodiversity plot designated
33. Improved timber harvesting technology. (Cost sharing)	Secure funding	New	No. of technology (2)	0.5	1.00	None	8	No. of improved timber harvesting technology issued
34.Encourage use of electrical heaters for heating and cooking (cost sharing)	Secure funding	New	No. of HH (800)	0.01	8.00	None	10	No. of electric heater provided
35.Initiate establishment of bio-briquettes from saw dust, waste wood and dung (cost sharing)	Secure funding	New	No. of manufacturing unit (2)	1.00	2.00	None	8	No. manufacture established
36.Initiate solar heating system (cost sharing)	Secure funding	New	No. of HH (600)	0.05	30.00	None	9	No. of HH installed with solar heating system
37.Explore and implement climate resilient crop varieties	Secure funding	New	No. of village (4)	0.05	0.35	None	6	Climate resilient crop varieties supplied
38.Initiate wind barrier plantation	Secure funding	New	No. of seedlings (200)	0.1	0.1	None	5	No. of seedlings planted

39.River training work (River and stream flowing near settlement)	Secure funding	New	No. of streams (6)	2.00	12.00	None	10	No. of rivers/streams trained
40.Management of upstream forest	Secure funding	New	No. Chiwogs (10)	0.05	0.5	None	9	No. of upstream forest managed
41.Early detection of pest and diseases.	Secure funding	New	No. of visit (4per year)	0.4	4.00	None	Annually	No. of places visited
42.Encourage debarking of felled pine tress	Secure funding	New	No of advocacy (4)	0.07	0.28	None	1	Debarking system initiated
<b>Total budget estimate for 10 years</b>					<b>181m</b>			

#### Section 5. Details of Stakeholder Consultation

Date of Consultation	Consultation Meeting	Stakeholders	Nos. of Participants
14/10/2022	Merak Gewog	Merak Gewog administration	8
		NWFP group	15
		Village representatives	15
		Park Range office	4
19/10/2022	Head Office SWS	SWS	12
26/10/2022	Sakteng Gewog	Sakteng Gewog Administration	2
		Livestock Group	15
		Village Representatives	20
		Park Range Office	3

### **Consultation and Plan Preparation led by**

1. Sonam Jamtsho, Sr. Forester
2. Dorji, Sr. Forest Ranger I
3. Kesang Dorji, Sr. Forest Ranger
4. Wangchuk Dorji, Chief Forestry Officer

### **19.4 References**

- IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability.
- NCD. (2008). Bhutan national human-wildlife conflict management strategy. Nature Conservation Division. Thimphu, Bhutan.
- SWS. (2019). Conservation Management Plan of Sakteng Wildlife Sanctuary.
- SWS. (2020). Butterflies, Sakteng Wildlife Sanctuary.
- Wangdi, T., Tongay, S., Dorjee, K., Dorji, K., Yangdon, N., & Wangyel, S. (2019). Report on Building Socio-ecological Resilience: An Adaptation to Progressive Climate Change in Sakteng Wildlife Sanctuary. Department of Forests & Park Services, Ministry of Agriculture and Forests, Bhutan.
- Yoezer, D., Choden, K., Wangdi, D., Pelzang, S., Tshering, K., & Dorji, S. (2022). Community-based climate change vulnerability and capacity assessment of the Protected Areas of Bhutan. Ugyen Wangchuck Institute for Conservation and Environment Research.

## 20 Additional References

- DoFPS. (2016). National Forest Inventory: Stocktaking nation's forest resources. Volume I. Department of Forest and Park Services. Thimphu, Bhutan
- IPCC. (2021). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), *Climate Change 2021: The Physical Science Basis. Contribution of working group I to the sixth assessment report of the Intergovernmental Panel on Climate Change* (pp. 3–32). Cambridge University Press. <https://doi.org/10.1017/9781009157896.001>
- NCD (2008). Bhutan national human-wildlife conflict management strategy. Nature Conservation Division, Department of Forests and Park Services, Thimphu, Bhutan
- NCHM. (2019). Analysis of historical climate and climate projection for Bhutan. National Centre for Hydrology and Meteorology. [www.nchm.gov.bt](http://www.nchm.gov.bt)
- NCHM. (2021). Bhutan State of the Climate 2020. National Centre for Hydrology and Meteorology. [www.nchm.gov.bt](http://www.nchm.gov.bt)
- NEC. (2020a). Third National Communication to the UNFCCC. National Environment Commission. Royal Government of Bhutan.
- NEC. (2020b). Climate Change Policy of the Kingdom of Bhutan. National Environment Commission. Royal Government of Bhutan.
- NECS and UNDP (2021). Assessment of climate risks on forests and biodiversity for national adaptation plan (NAP) formulation process in Bhutan. Thimphu, Bhutan
- UN-OHRLLS. (2009). Impact of climate change on the development prospects of the Least Developed Countries and Small Island Developing States. Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States. [https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/the\\_impact\\_of\\_cc\\_on\\_ldcs\\_and\\_sids\\_for\\_web.pdf](https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/the_impact_of_cc_on_ldcs_and_sids_for_web.pdf)
- WMO. (2021). State of the Global Climate 2020. World Meteorological Organization. ISBN 978-92-63-11264-4. [https://library.wmo.int/doc\\_num.php?explnum\\_id=10618](https://library.wmo.int/doc_num.php?explnum_id=10618)
- Yoezer, D., Choden, K., Wangdi, D., Pelzang, S., Tshering, K., Dorji, S. (2022). Community-based Climate Change Vulnerability and Capacity Assessment of the Protected Areas of Bhutan. Ugyen Wangchuck Institute for Conservation and Environment Research. Bumthang, Bhutan.