Republic of Botswana

Botswana's First Adaptation Communication to the United Nations Framework Convention on Climate Change

June 2022

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Foreword

It is with great pleasure that Botswana submits her first Adaptation Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in fulfilment of Article 7.10 of the Paris Agreement. The formulation of the AdCom has been pivotal in enhancing the profile of adaptation and increased participation of actors in Botswana which is expected to translate to strengthened adaptation action to cope with climate change impacts. The AdCom is instrumental in propelling Botswana to embark on transformational adaptation that will build resilience in its economy and society. It gives Botswana an opportunity to report its climate change adaptation progress, challenges and support needs.

It is evident that climate change adversely affects Botswana sectors of the economy and communities. Therefore, the Government of Botswana prioritises integration of adaptation into development planning as outlined in Vision 2036. The key sectors prioritised for adaptation in this AdCom are agriculture, water, health, infrastructure, and biodiversity and ecosystems.

The AdCom presents information on the national circumstances; institutional arrangements; legal and policy frameworks; climate change impacts, risks and vulnerability; and adaptation priorities and the implemented adaptation efforts. It further elaborates on barriers, challenges and gaps to planning and implementing climate change adaptation, and the support and implementation needs to deliver on adaptation priorities.

Honourable Philda Nani Kereng

Minister of Environment and Tourism

Executive Summary

The Government of Botswana submits its first Adaptation Communication (AdCom) in fulfilment of Article 7.10 of the Paris Agreement. The formulation of this AdCom allows Botswana to report its climate change adaptation progress, challenges, and financial needs for global stocktaking planned for 2023.

Botswana became a party to the United Nations Framework Convention on Climate Change (UNFCCC) on June 12, 1992, and ratified the Convention on January 27, 1994, as a non-Annex I member. As a party member, Botswana recognises the potentially disastrous and irreversible impacts of climate change on its national economy and community livelihoods. The country's vulnerability is compounded by a combination of a harsh semi-arid environment, acute water scarcity, and fragile ecosystems, which are generally degraded. Consequently, the country prioritises climate change adaptation in national development planning processes through National development plans and Vision 2036.

In the endeavour to develop an effective climate change adaptation programme, the country undertook climate change vulnerability assessments to inform the national adaptation planning processes. The vulnerability assessment paints a gloomy future for the country for a majority of sectors (agriculture, health, infrastructure, ecosystems and biodiversity, and water).

Recognising this climate change predicament, the GoB has initiated the adaptation process. The major achievements in the country's process include the development of the Botswana Climate Change Response Policy (BCCRP) of 2020. Furthermore, to create an enabling environment and facilitate a seamless adaptation process, the GoB developed the NAP Framework in 2020.

The institutional arrangement for the adaptation process includes the Ministry of Environment and Tourism, the Parliamentary Portfolio Committee (Wildlife, Tourism, Natural Resource and Climate Change), the National Committee on Climate Change (NCCC), and the District Climate Change Committees and Village Development Committees (VDC). These organs are designed to facilitate vertical integration of the adaptation process.

In terms of progress made on the implementation of adaptation projects, Botswana has made some significant progress despite a lack of sectoral national adaptation plans. Most of the adaptation projects implemented cover water, ecosystems-based and smart climate agriculture projects, and early warning systems.

Climate change adaptation is a costly investment, which will guarantee economic growth and development during climate change. The updated NDC reported a partial budget for the adaptation totalling USD 93.96 million. However, this estimate did not consider vital expenditures such as drought relief programmes (DRP), health, infrastructure, and earmarked water development projects. There is, therefore, a need to revise the adaptation budget to realistic expenditure, which could be more than the estimated updated NDC adaptation

budget of US$ 93.96 million. Furthermore, the adaptation budget will be different depending on the degree of climate change.

Various gaps and challenges have been identified that impede the adaptation process in the country, these include:

- Absence of continuation/sustainability plan for the externally funded projects.
- Lack of national and sectoral adaptation plans and implementation frameworks.
- Weak community participation in implementing adaptation measures.
- Limited financial resources to implement the identified adaptation measures.
- Weak markets for adaptation measure products.
- Lack of implementation capacity from both grassroots and implementing entities.
- Weak coordination among the implementing entities.
- Limited ability to present the adaptation measures as business opportunities to the business community.

Over the years, Botswana has prioritised economic diversification to reduce reliance on the mining sector as the main source of economic growth. There are various areas of synergies between the NAP process and the national diversification strategy such as:

- Commercialising, restructuring/rebuilding the livestock sector.
- Improving the value chain in the agricultural sector for both crops and livestock.
- Increasing investment in the agro-industry projects.
- Increasing investment in the tourist sector and biodiversity conservation.

In order to accelerate the adaptation process for the country, support is needed in the following areas:

1. Climate financing skills and competencies/climate finance.
2. Development of NAP, sectoral adaptation plans, and their implementation plans.
3. Monitoring and evaluation for climate change adaptation.
4. Institutional, technical, and human resource capacity/adaptation capacity building.
5. Strengthening the legal framework for climate change.

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Acronyms

AdCom	Adaptation Communication
CbA	Community-based Approach (CbA)
CCRP	Climate Change Response Policy
CMIP5	Coupled Model Intercomparison Project Phase 5
CO_2	Carbon Dioxide
CSA	Climate Smart Agriculture
CVI	Climate Vulnerability Index
DCCC	District Climate Change Committee
DDCs	District Development Committees
DDPs	District Development Pans
DMS	Department of Meteorological Services
DRP	Drought Relief Programme
DRR	Disaster Risk Reduction
EbA	Ecosystem based Adaptation
EPP	Environmental Protection Program
GCF	Green Climate Fund
GCM	Global Circulation Models
GoB	Government of Botswana
IPCC	Intergovernmental Panel on Climate Change
LIVSIM	Livestock Simulator
M&E	Monitoring and Evaluation
NAP	National Adaptation Plan
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communication
NCCAPB	National Climate Change Action Plan for Botswana
NCCC	National Committee on Climate Change
NCCU	National Climate Change Unit
NCCSB	National Climate Change Strategy for Botswana
NDC	Nationally Determined Contribution
NDP	National Development Plan

NDRRS	National Disaster Risk Reduction Strategy
NMES	National Monitoring and Evaluation System
PCP	Parliamentary Committee Portfolios
RCM	Regional Climate Model
RCPs	Representative Concentration Pathways
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
SDG	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
W/m^2	Watts per square metre

1.0 Introduction

Climate change is unequivocal, with unprecedented impacts cutting across economic sectors and natural ecosystems (IPCC, 2021). Climate change is already at an advanced stage in Botswana, which is evident from rising temperatures accompanied by heat waves (Urich et al., 2020; GoB, 2018). Furthermore, the country is experiencing intensifying storms, heavy rainfall with hailstorms, and flooding events. The occasional above-normal precipitation increases biomass accumulation and consequently veldt fires with widespread impacts on wildlife, agriculture, and rural livelihoods (GoB, 2019). On the other extreme, the country also experiences droughts which appear to have intensified with shortened return periods (ASSAR, 2017; Urich et al. 2021). These climatic events have widespread socio-economic and ecological impacts. The socio-economic impacts of climate change are widespread and devastating, ranging from the destruction of properties (shelter), an increase in livestock mortality during the drought period, and crop production failure. As communities—particularly vulnerable rural communities—are dependent on the agricultural sector, loss of livestock and crop failure result in household income loss and increased poverty levels. At the national level, climate change results in a significant decline in gross domestic product (GDP) due to a decline in agricultural sector productivity and a decline in the construction sector as a result of acute water scarcity, among other reasons. Furthermore, climate change impacts, particularly drought, increase budget deficits as the government increases its budget for social protection and drought relief programmes.

Climate change impact and vulnerability assessments paint a gloomy future for Botswana's economy (GoB, 2020). Evidently, climate change could hinder the country's target of achieving high-income status by 2036, as outlined in Vision 2036, and attaining Agenda 2030 for sustainable development unless a pragmatic adaptation programme is implemented (GoB, 2017).

Research indicates that climate change impacts are irreversible due to the atmospheric lifespan of greenhouse gases (GHGs). Thus, even if GHGs are reduced, the atmospheric temperature rises are not expected to decrease (Solomon et al. 2009). Consequently, the role of a comprehensive and robust adaptation process to build the country's economic resiliency to climate change impacts cannot be overemphasised. A pragmatic adaptation process will guarantee continued economic growth and development under changing climates. Adaptation involves a range of approaches that build resilience to climate risks: these approaches may include policy measures, behaviour change, and engineering solutions. This is achieved by increasing adaptive capacity and reducing the sectors' sensitivity (agriculture, ecosystem and biodiversity, health, infrastructure, water) to climate change.

The UNFCCC recognizes the importance of adaptation together with mitigation as pivotal to managing climate change impacts. Subsequently, it urges its party members to develop a robust national adaptation planning process to address climate change impacts. Under Paris Agreement Article 7, paragraphs 10 and 11, party members are requested to develop and submit the AdCom to UNFCCC to increase the visibility of adaptation and its balance with

mitigation, strengthen adaptation action and support, contribute to global stocktaking, and gauge party members' national adaptation processes.

Consequently, this submission is developed in fulfilment of Article 7, paragraphs 10 and 11 of the Paris Agreement. In addition, it is developed to contribute to the country's national adaptation plan process, which is still at its infant stage but has been identified as a high priority. The AdCom is developed based on the Paris Rulebook, which set out guidelines on the development of AdComs. It is submitted as a stand-alone document to UNFCCC secretariat.

Climate change in Botswana affects all sectors both directly and indirectly. Therefore, the Government of Botswana (GoB) has prioritised all the economic sectors in its adaptation processes. This includes agriculture and food security, water, human health, ecosystems and biodiversity, disaster risk management, infrastructure development, industry and manufacturing, and tourism (GoB, 2018). Thus, the production of this AdCom focused on all the priority sectors.

2.0 National Circumstances

Geography

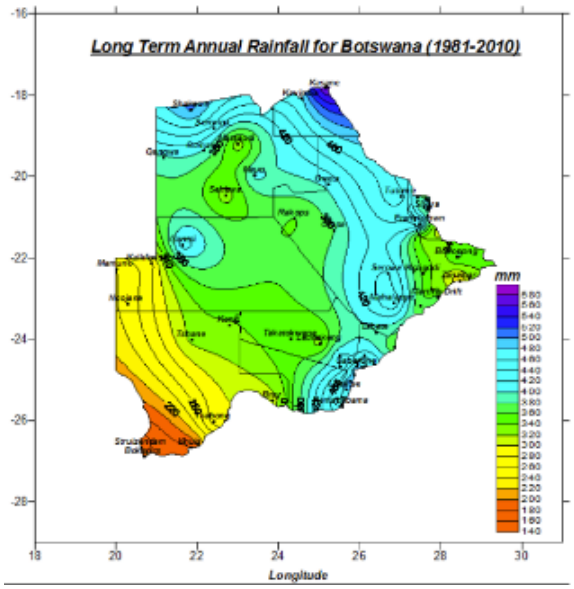
Botswana is a land-locked country, bordered by South Africa in the southern and eastern part, Zambia to the north, Zimbabwe in the northeast, and Namibia in the western part of the country. The country occupies an area of approximately 581,730 square kilometres. The country is predominantly flat, with undulating hills in the eastern part of the country. The altitude ranges from 1,000 m to 1,100 m above sea level. Botswana's largest hill is Monalanong hill in Otse, with an altitude of 1,494 m (GoB, 2010). The geomorphology of the country includes the Okavango Delta and the Sandveld and Hardveld regions. The sand veldt is known as the Kalahari sands and covers approximately 70% of the country (GoB, 2010). The predominant natural features are

- The Kalahari Desert
- The Okavango Delta in the North-western part of the country
- The Makgadikgadi salt pans (GoB, 2013).

Climate

Botswana's climate is semi-arid with a subtropical desert climate characterized by great differences in day and night temperatures and overall low humidity (GoB, 2019). Rainfall in Botswana is convective and thus localised and highly variable both spatially and temporally (Bhalotra, 1987). The rainfall season is in summer (October to March). However, the country occasionally receives winter rainfall (May-June) which accounts for 10% of the annual rainfall (GoB, 2019). Spatially, the north-eastern part of the country (Chobe district) receives the highest rainfall averaging approximately 600 mm/year while the southwestern part of the country (Kgalagadi district) receives the lowest rainfall averaging less than 250 mm/year (Figure 1).

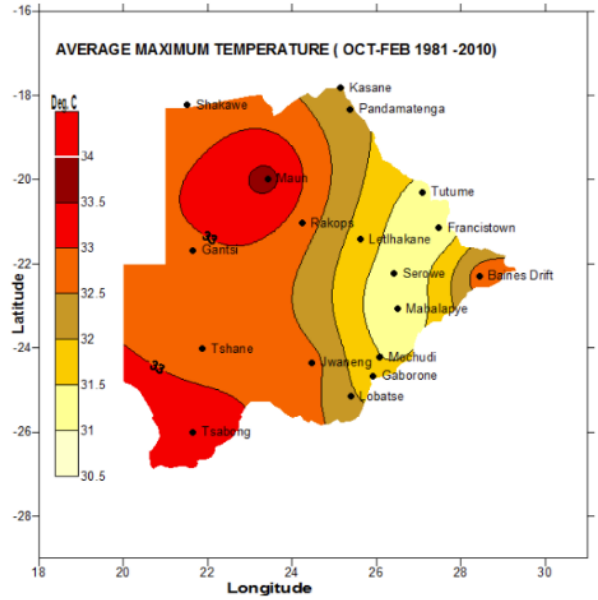
Figure 1. Botswana's annual average rainfall between 1981–2010



Source: Botswana Third National communication (GoB, 2019).

There is also a marked variability between summer and winter temperatures. The mean monthly maximum temperatures in summer months (October to February) for the past 30 years (1981–2010) range from 31˚C to 34˚C (GoB, 2019). According to the Department of Meteorological Services (DMS) records, the highest summer temperature could reach above 40˚C in Botswana. Spatially, the northwestern and western parts of the country record the highest average temperatures, as depicted in Figure 2. On the other hand, the summer mean monthly minimum temperatures ranged from 16˚C to 20.5˚C in the period 1981–2010 (GoB, 2019).

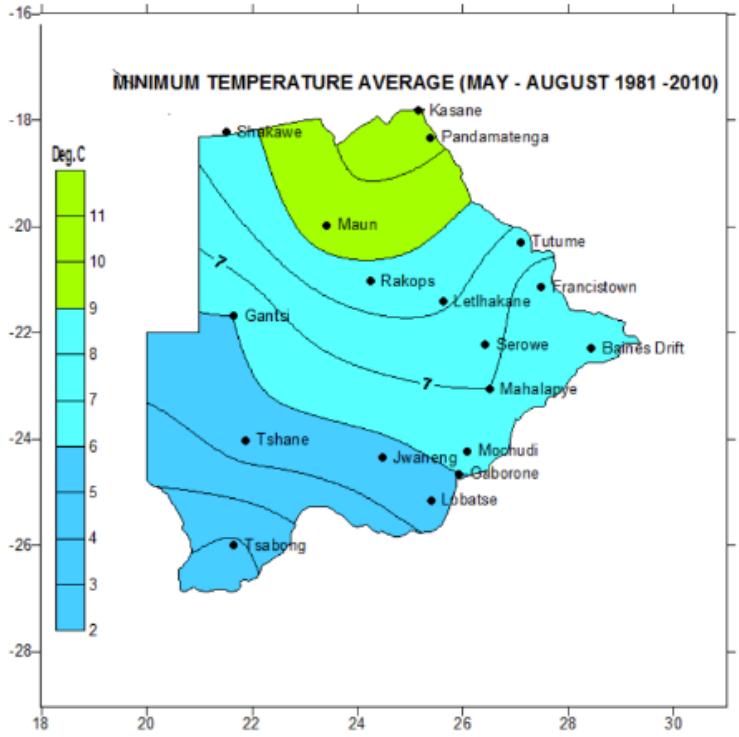
Figure 2. Mean monthly maximum temperature (1981–2010)



Source: Botswana Third National Communication (GoB, 2019).

Winter months (May to August) receive moderately lower maximum temperatures with an average of 25˚C. The average minimum temperatures for the winter months ranged from 2.8˚C to 10.6˚C in the period 1981–2010. Cold spells occasionally occur in winter, resulting in below-freezing-point temperatures, particularly in the south and eastern parts of Botswana. DMS records show that the lowest extreme minimum temperature was -15.2˚C, recorded in Tsabong on August 2, 1972. Figure 3 shows the minimum average temperature recorded between 1981 and 2010.

Figure 3. Mean monthly minimum temperature (1981–2010)



Source: Botswana Third National Communication (GoB, 2019).

The harsh semi-arid environment with acute water scarcity and fragile ecosystems which are generally degraded amplify the impacts of climate change on key economic sectors and community livelihoods. In fact, based on the harsh semi-arid environment, acute water scarcity, and fragile ecosystems, the country is already at a tipping point, where climate change could be the defining parameter to tip the scale to irreversible disastrous points for the country (Urich et al. 2021). Various studies, such as climate change vulnerability assessments and climate change and tipping points for Botswana, consistently paint a gloomy picture of the extremely harsh conditions in Botswana (GoB, 2019, Urich et al., 2021). Some of the climatic events that indicate that the country is already experiencing the impacts of climate change include the increased frequency and intensity of droughts, unprecedented heatwaves, floods and hailstorms, and pest outbreaks (GoB, 2020).

Botswana Economic Status

Botswana is an upper-middle-income country with a GDP of USD 3,962[1] million at constant 2016 prices recorded in the first quarter of 2021 (Statistics Botswana, 2021). The economy is largely driven by the public administration and defence and mining sectors specifically diamonds contributing approximately 18% and 14.2 % respectively to the GDP (Statistics Botswana, 2021). The agricultural sector, which includes forestry and fishery contributions to the GDP, is extremely low, at 1.7% (Statistics Botswana, 2021). However, it is critical to note that the revenue from diamond exports is vital for the country's economy, which supports domestic expenditure. There has been a significant increase in the non-mining GDP for the second quarter of 2021, which increased by 20.2% compared to precious years, which registered a decrease of 16% (Statistics Botswana, 2021). The forecast for the country's economy indicated that it contracted by 8.9% for the year 2020 due to COVID-19 (AEO, 2021). However, it is projected that the economy will recover to 7.5% in 2021 and 5.5% in 2022 as the COVID-19 pandemic impacts recede and global economic recovery takes effect (AEO, 2021).

Over the years, the country has concentrated its effort to diversify its economy from the mining sector specifically diamonds. The country developed its strategy for economic diversification and sustainable growth in 2008. However, the strategy has yet to bear fruit due to various challenges, which include low foreign direct investment in the country, failure to attract foreign investors, and low accessibility to credit for the private sector, among other factors.

Socio-Economic Demographics

Botswana's population is estimated at 2,346,179 based on the 2022 Population and Housing Census (Statistics Botswana, 2022). This presents a population increase of 15.9% between the years 2011 and 2022 (Statistics Botswana, 2022). On the other hand, the annual population growth rate between 2011 and 2022 is estimated at 1.4%, showing a decline from the 1.9% estimated in 2011 (Statistics Botswana, 2022).

Women constitute approximately 51% of the national population with men estimated at 49% (Statistics Botswana, 2017). The country's population is described as youthful, with 34.7% being less than 15 years old and 5% being elderly (>65 years) (Statistics Botswana, 2017). It was estimated that approximately 63.9% of the national population resided in urban areas while 36.1% lived in rural areas in 2017 (Statistics Botswana, 2017). In terms of economic opportunities, rural communities are more disadvantaged compared to urban households. The national poverty head count at the national level is estimated at 16%. Poverty is more prevalent in rural areas, estimated at 24% based on the poverty head count compared to the urban rate of 9.4% (Statistics Botswana, 2017). It is estimated that approximately 23% of the population is living under the poverty datum line, the rural settlement constituting 51% of

[1] BWP 1 = USD 0.086

the population living in poverty (Statistics Botswana, 2017). The Gini coefficient which determines equality is estimated at 0.52.

2.1 Legal and Policy Frameworks for Adaptation

Botswana became a Party to the UNFCCC on June 12, 1992, and ratified the Convention on January 27, 1994, as a non-Annex I member. Over the years, the country submitted its initial, second, and third National Communications (NC), detailing its national circumstances in respect to climate change. Furthermore, the country developed its Nationally Determined Contributions (NDC) in 2016 covering both the adaptation and mitigation actions. The country's NDC is currently being updated.

Climate change adaptation processes for the country are incorporated into various legal and policy instruments. The overarching legal framework is the Botswana Climate Change Response Policy (BCCRP) of 2021. The policy aims at guiding the country's decision-making and planning processes to achieve climate resilience, increase its adaptive capacity, and coordinate efforts to meet the UNFCCC requirements. Furthermore, it aims to strengthen the institutional arrangements by establishing a climate change unit that oversees adaptation and mitigation implementation matters.

The objective of the BCCRP is to mainstream climate change activities into development planning, promote adaptation to build a climate-resilient economy as well as mitigation of GHG emissions to embark on low carbon development pathways. Invariably, the policy emphasises the importance of enhancing both the country's adaptive capacity and its resilience to and mitigation of climate change's adverse impacts, for reducing the nation's carbon footprint. These will be achieved by mainstreaming and integrating feasible and viable adaptation and mitigation measures into existing national and sectoral development and planning processes. The policy aims at promoting various governmental departments and the private sector to identify adaptation and mitigation efforts and prepare adaptation implementation plans (GoB, 2021a).

The National Meteorological Service Act of 2014 directs the DMS to execute activities that enhance climate change adaptation. These include the implementation of the UNFCCC and its legal instruments, allowing the country to formulate, implement, and publish measures to facilitate adequate adaptation to climate change. Furthermore, DMS is tasked by the Act to provide specialised weather forecasting and climate information services, which is important for climate change adaptation.

Vision 2036 is the country's strategic planning document that outlines its long-term development goals and targets. It also outlines high-level strategic activities to achieve economic targets. Botswana's ultimate target under Vision 2036 is to achieve high-income status by 2036. Vision 2036 emphatically acknowledges the current challenges posed by climate change in its quest to achieve high-income status and calls for integrating adaptation and mitigation into development planning. The Vision thus focuses on identifying and implementing feasible and viable adaptation and mitigation measures (GoB, 2016b).

The NAP Framework was developed and adopted in 2020 as a strategic document to guide the development and coordination of national and sectoral adaptation plans. Subsequently, the NAP Framework is intended to direct the adaptation process, providing a holistic approach to mainstreaming climate change adaptation into all levels of planning for implementation at national and sub-national levels (GoB, 2020).

The NAP Framework strongly calls for robust monitoring and evaluation (M&E) of the adaptation process with indicators for tracking the country's efforts in adapting to climate change.

2.2 Climate Change Adaptation Institutional Arrangements

The climate change adaptation process in the country is evident from Vision 2036 and NDPs. It is placed under the Ministry of Environment and Tourism, under which DMS falls, which is the focal point for climate change. The BCCRP requests for the establishment of a National Climate Change Coordinating Organisational Structure, the National Climate Change Unit (NCCU), which will be the oversight body for the NAP implementation. Reporting to the NCCU will be the Parliamentary Portfolio Committee (Wildlife, Tourism, Natural Resources and Climate Change), the National Committee on Climate Change (NCCC), and line ministries/departments.

The NCCC membership constitutes line ministries/departments, non-governmental organisations (NGOs), and private sector organisations. It was established as an advisory body to coordinate Botswana's obligations under the UNFCCC. The Deputy Permanent Secretary in the Ministry of Environment and Tourism is the chairperson of the Committee. One of the critical responsibilities of the NCCC which is aligned with the adaptation process is to oversee and ensure the formulation of appropriate national responses to climate change issues.

Parliamentary committee portfolios (PCP) in the country are established ''for the life of Parliament with a sectoral mandate'' (Republic of Botswana, 2022). There are various PCP in the country (Republic of Botswana, 2022), and the relevant committee for climate adaptation is the Wildlife, Tourism, Natural Resources and Climate Change Committee. The members of the PCP are appointed by the National Assembly on a fact-finding mission and automatically dissolved once their task is completed. Their mandate is to provide oversight within their sectoral mandates and report their findings to the Assembly (Republic of Botswana, 2022).

At the district level, BCCRP and the NAP Framework propose the District Climate Change Committee (DCCC). Consequently, nine DCCCs will be established to oversee the district adaptation planning and implementation processes. Their task will include the development of the district climate change adaptation plans and strategies which will be mainstreamed into the district development plans (DDPs). The DCCC will report to the District Development Committees (DDCs) which were established in 1970 tasked with the DDPs and their implementation (Republic of Botswana, 1997). The structures of these committees and their terms of reference have not yet been formulated as they have been suggested by the newly adopted NAP Framework. Consequently, the DCCC could be a selected member of the DDCs

to avoid the formation of multiple committees, thus avoiding a burden due to limited capacity at the local levels.

Another important committee for the adaptation process at the grassroots level is the village development committee (VDC). Each settlement in the country has one or multiple VDCs depending on the number of wards it has. The VDCs are established under the Local Government (Village or Ward Development Committee) Regulations, 2014. Under these regulations, the committee shall constitute ten members appointed by council, consisting of chairperson, vice-chairperson, secretary, vice-secretary, treasurer, and five additional members. Furthermore, the committee will designate village or ward leadership consisting of a councillor and chief (Kgosi).

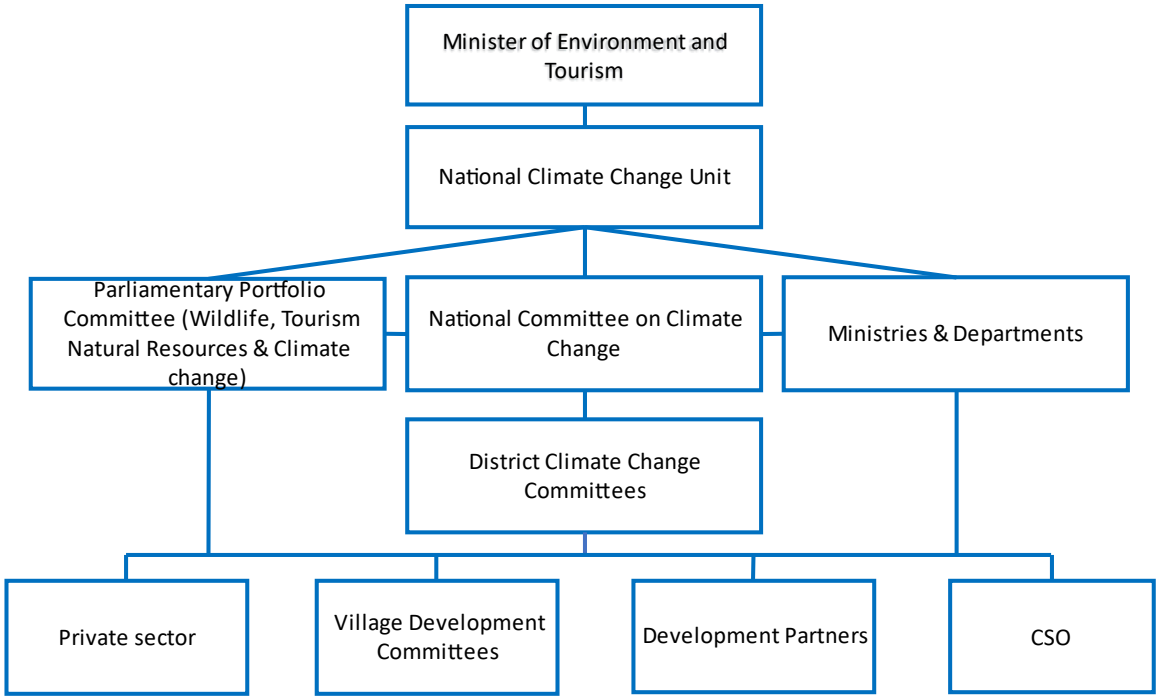
The core duties of the VDCs which are aligned to the adaptation process include:

- Coordination of national activities in collaboration with respective departments in their areas
- Develop strategic and annual plans for their community
- Mobilise the community to identify projects

The NAP Framework recommends that VDCs coordinate the development and implementation of adaptation plans and projects at the local community level. This is important since adaptation will be implemented by the communities at the grassroots. For instance, agricultural adaptation measures are implemented by both commercial and subsistence farmers. Similarly, ecosystem-based adaptation (EbA) approaches are implemented by the community that uses the ecosystems and their services for sustenance.

Figure 4 depicts the proposed institutional arrangements for the adaptation process by the NAP Framework.

Figure 3. Institutional arrangements for the adaptation process



Source: GoB (2020).

3.0 Climate Change Sectoral Impacts, Risks, and Vulnerability

3.1 Climate Scenarios and Extreme Events

Climate scenarios are at the heart of climate change impacts and vulnerability assessment (Hulme et al., 2018). Over the years, there have been significant innovative developments in the generation of climate scenarios to improve accuracy in vulnerability and impact assessments (USGCRP, 2017). The climate scenarios used for the Third NC on which the AdCom's vulnerability assessments are based, use the concept of Representative Concentration Pathways (RCPs). The RCPs are not emissions scenarios but are radiative forcing scenarios (USGCRP, 2017).

According to the GoB (2019), climate scenarios were constructed for precipitation and temperature for 2050 based on the RCP of 4.5 and 6.0 W/m^2. The global circulation model (GCM)/Regional climate model (RCM) ensemble was used with input from the University of Cape Town. Analysis was done for the 25th, 50th, and 75th percentiles. The variables analysed included seasonal and annual precipitation, mean, maximum, and minimum temperature, drought, extreme precipitation, runoff, and water stocks.

The seasonal and annual mean, maximum, and minimum temperatures projected an increase in temperature faster than global mean temperatures (GoB, 2019). It is projected to increase by 1.5^{o}C and 2.0^{o}C for RCP 4.5 and RCP 6.0, respectively, by 2050 (GoB, 2019). The climate scenarios indicate that by 2050, the country will experience a high average temperature of 25.9^{o}C–26.9^{o}C.

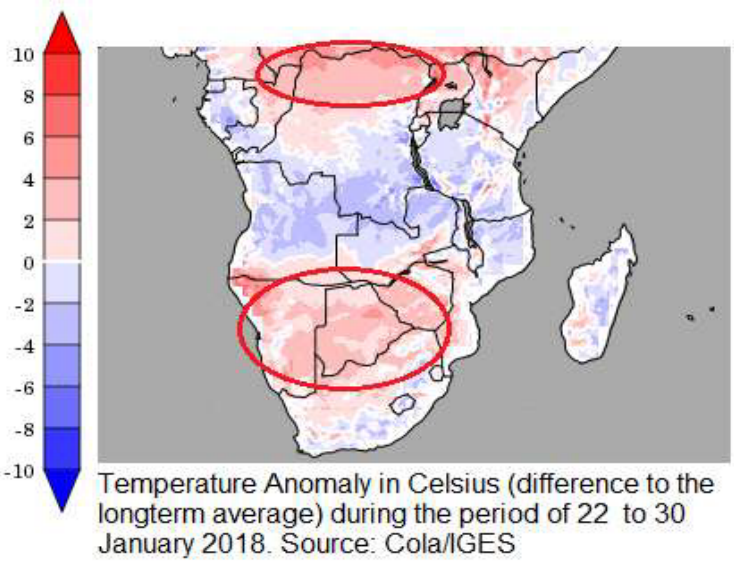
The seasonal and annual mean precipitation over Botswana showed a general decrease trend by 2050. However, the ensemble median (50th percentile) projected an increase of 1%–2% by 2050 (GoB, 2019).

The third NC further reveals that the extreme events for flooding and drought were also constructed for 2050. The probability of drought for moderate, severe, and extreme is expected to increase significantly throughout the country (GoB, 2019). For instance, throughout the country, the probability of a 7-month extreme drought will increase from a baseline probability of 1% to 6.8% for RCP 4.5 and 25% for RCP 6.0 (GoB, 2019). For a moderate 1-month drought, the probability will increase from 53% under baseline to 100% for both RCP 4.5 and 6.0 (GoB, 2019). The implication is that the drought return period will be shortened and increased in intensity.

Another extreme event that was projected is flooding based on the Average Recurrence Interval (ARI). For all the 5, 10, 50, and 100 return periods, there is a significant increase in the extreme rainfall based on 1 to 5 days rainfall events (GoB, 2019).

Botswana is often affected by periods of extremely hot weather that last for a day or more. These temperatures are usually above historical averages and are referred to as heat waves. Botswana experienced very high to extremely high temperatures during the period from January 21 to 23, 2018 (SADC-CSC, 2018). Figure 5 shows a temperature anomaly, which differs from the long-term average during January 22–30, 2018.

Figure 5. Temperature anomaly in the SADC Region during January 22–30, 2018



Sources: Cola/IGES; SADC-CSC, 2018.

Using historical simulations (1861–2005) combined with RCP8.5 that projects radiative forcing on the climate system by 2100, Nkemelang et al. (2018) projected warm spells (heat waves; WSDI) increase across the three main climatic zones in Botswana. There was a projected increase of 80 days compared to preindustrial levels at 2.0 ◦C for Region 1, and by 65 and 62 days per year for Region 2 and 3 respectively (Nkemelang et al., 2018). According to Moses (2017) an increase in TX90P and WSDI imply a significant increase in heat wave events across the country. WSDI refers to a maximum number of consecutive days per year when the daily maximum temperature is above the 90th percentile, while TX90P is the percentage of days when the daily maximum temperature is above the 90th percentile (Trouet & van Oldenborgh, 2013).

3.2 Sectoral Impacts, Risks, and Vulnerability Assessment

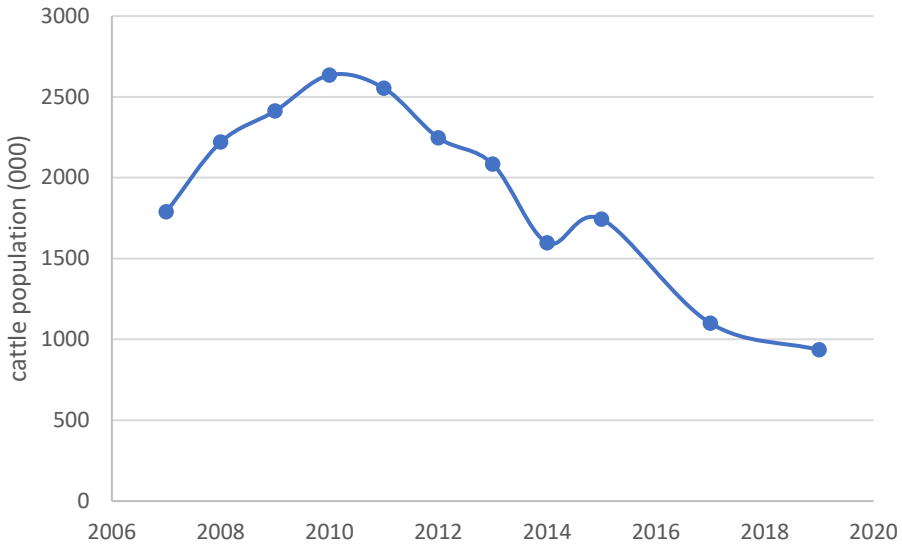
Detailed vulnerability assessments for the major sectors were undertaken in the first, second, and third NCs. However, the infrastructure vulnerability assessment was initially omitted and undertaken parallel to the AdCom development. The findings are summarised below for all the nationally prioritised key sectors

3.2.1 Agriculture

Crop production in the country is mainly rainfed; as such, it is highly exposed and sensitive to the impacts of climate change. The crop yields are a function of rainfall which is expected to decrease by 2050. Similarly, temperature plays a critical role in crop yield through soil moisture. The impacts assessment for the crop sector focused on four main crops, namely maize, sorghum, cowpeas, and pearl millet, all classified as staple foods. The vulnerability assessment for the crop sector depicted mixed results for the country (GoB, 2019). The analysis revealed that crop production under changing climates would either decrease or increase crop yields under no adaptation scenario depending on the location. For all the crops under analysis, cowpeas are the only crop that showed increased yield by 2050 throughout the country (GoB, 2019). The projected increase in yield ranged from 6 to 55% under the RCP 6.0 scenario (GoB, 2019). Except for the Gaborone region, maize yield is projected to decline by a range of 7 to 14%. Consequently, nationally it is projected that maize production will decline. Sorghum, on the other hand, is showing mixed results with three (3) regions (Central, Francistown, Southern) depicting a decline in yield, ranging from 6% to 34%, whilst two (2) regions (Gaborone and Maun) depict an increase ranging from 7% to 24% (GoB, 2019). Lastly, pearl millet which was analysed for two (2) regions (Francistown and Maun) displayed a general decline ranging from a low of 6% to a high of 16% (GoB, 2019).

The livestock sector, like crop production, is also rainfall dependent with minimal supplementary feed. The climatic event that strongly influences the livestock sector productivity is drought as depicted in Figure 6. (GoB, 2019). Drought influences the national livestock population dynamics. The livestock population depicts oscillations corresponding to the drought years. However, based on RCP 4.5 and 6.0 scenarios, birth rates are projected to be constant and increase by between 11.53% to 12.04%, respectively (GoB, 2019). Offtake is projected to decline from a baseline of 15% to 7.93% and 7.87% under the RCP 4.5 and 6.0 by 2050 (GoB, 2019). Milk production is expected to decline by 0.64% and 5.18% based on RCP 4.5 and RCP 6.0, respectively (GoB, 2019). The increased heat stress could also reduce the fertility of bulls and thus lead to a lower national calving rate (GoB, 2019).

Figure 6. Cattle population over time



Source: Statistics Botswana (2020).

It is evident from the above assessment that agricultural production in the country is likely to decline. Such a decline will have far-reaching consequences, particularly for the country's rural communities, which produce crops for home consumption and chicken feed. Home-grown chicken is a source of protein for the rural community. Thus, a lack of feed for chickens will result in a decline in the chicken population. The ultimate consequence of a decline in crop production will be a higher incidence of malnutrition among children, starvation, and possible famine, especially affecting rural communities. Bahta et al. (2017) estimated that 30% of households engaged in subsistence farming produce food for home consumption. This has significant implications for the rural population given that a significant proportion of the country's population resides in rural areas, where poverty is prevalent. It is estimated that less than 36.1% of the country's population live in rural areas (Statistics Botswana, 2017), and the ones who do are dependent on subsistence farming for their livelihood (Bahta et al., 2017). Coincidentally, the crops that are projected to decline are the main staples that 79%–80% of households consume on an almost daily basis (Bahta et al., 2017). On the other hand, Statistics Botswana (2015) revealed that approximately 70% of rural households derive their livelihoods from subsistence dry-land arable agriculture. In terms of gender dimensions, the Ministry of Agriculture estimates that women are more involved in farming than men even though statistics indicate that 36% of farm holders are females (Statistics Botswana, 2017). This could be explained by the fact that women are engaged in basic subsistence crop production for home consumption. Consequently, a decline in food production could worsen the food security of female-headed households, the majority of whom are already living under poverty datum lines. It is estimated that female-headed households (55%) are more severely affected by poverty compared to those headed by males, at 45%, even though female-headed households constitute only 46% of the households in the country (Statistics Botswana, 2018).

With the regard to the livestock sectors, a decline in milk production will influence calving rates and the patterns of the livestock labour force. According to Statistics Botswana (2021), about 7.5% of the population is currently employed in the agriculture, forestry, and fishing industry in Botswana. Furthermore, gender differentials show that 11.9% of males are reported to be in the agriculture, forestry, and fishing industry compared to 3.2% of females (Statistics Botswana, 2021). Thus, a decline in livestock productivity will have an impact on national employment.

3.2.2 Water

Water resources (stock and flows) are highly driven by climatic variables, both temperature and rainfall. Precipitation determines the inflows and recharge (positive flow). On the other hand, temperature affects outflow (negative flows) through evapotranspiration. Based on the GCM/RCM ensemble and RCP 4.5 and 6.0 results, it is evident that temperature could increase by between 1.5^{o}C and 2^{o}C by 2050 (GoB, 2019). On the one hand, the model indicates a decrease in rainfall by as much as 15% although there are some insignificant rainfall increases for other percentiles. The results also showed that by 2050, climate change could contribute to an overall decrease in water inflow into dams by 3.5% to 19%, while projected evapotranspiration could increase by 3.7% to 7% from the baseline. The water recharge could experience a decline, influenced by the projected decline in rainfall and increase in temperature and evaporation.

The projected impacts of climate change have significant implications on both urban and rural water supply and accessibility. Approximately about 89.3% of households in Botswana in 2017 had access to safe drinking water (Statistics Botswana 2020). It is estimated that 97% of households have access to safe drinking water in urban areas (cities, towns, and urban villages) whereas in the rural areas it is 74%. Surface water (dams/reserves) constitutes 63% while 35% is sourced from groundwater for domestic consumption (GoB, 2017). The projected changes in increased evaporation and decline in runoffs will negatively affect water stocks and inflows into dams, which are the main source of urban water supply. Furthermore, the rural communities which are reliant on groundwater supply will be affected through reduced recharge rates. Thus, reduced water supply will have significant impacts on human health and national economic growth.

3.2.3 Health

Under the third NC, the country has not conducted the Health Impact Assessment (HIA). Consequently, an assessment of the third NC impacts on the health sector was primarily based on the desk review (GoB, 2019). Based on the review of various climate models, it was predicted that the country could be exposed to extreme climatic trends that impact human health. Some of these climatic events that will significantly impact public health include heat waves, drought, and declining water supply and water quality. These events could result in widespread malnutrition, particularly in rural areas.

It is also projected that climate change could cause an increase in the incidence of malaria and its spread to other parts of the country, which hitherto were malaria-free regions.

Increased flood events could also result in cholera and other waterborne disease outbreaks. The most vulnerable populations are the low-income households and rural communities, particularly those living on the floodplains around the delta and Chobe districts. The latter are the hardest hit because the majority of them live in extreme poverty and work in low-paying jobs; hence, they are financially unable to cope with and recover from the impacts of climate change. Furthermore, low-income communities are mostly affected by health risks such as heat stress as they do manual jobs which expose them to direct sun. ASSAR (2019) argues that high temperatures expose the population to dangerously high temperatures which in turn make people vulnerable to heat stroke and heat exhaustion. Furthermore, people living with pre-existing conditions as well as the rural populations without access to health services will be adversely affected (ASSAR, 2019).

3.2.4 Infrastructure

The preliminary infrastructure vulnerability assessment focused on six sectors: transport, water, energy, information technology communication (ICT), and building (residential, commercial, and public buildings). The analysis involved estimating the climate vulnerability index (CVI). This is a composite index that uses multi variables that determines the system's vulnerability to climate change impacts (Sullivan & Meigh, 2005). The variables used covered *exposure* (precipitation, strong winds, temperature), *sensitivity* (infrastructure integrity, age, climate-resilient design), and *adaptive capacity* (maintenance plan, resources for maintenance, land-use plan). The CVI value ranges from 0 to 1, zero (0) representing no vulnerability and one (1) representing total vulnerability. A value of .5 would imply moderate vulnerability.

The infrastructure vulnerability assessment involved extensive consultation on climatic impacts, infrastructure integrity, infrastructure age, climate-resilient designs, maintenance plans, resources for maintenance, and land-use plans. Ultimately, the data was analysed based on statistical techniques of standardisation. Overall, the analysis reveals that all types of infrastructure is impacted by floods, temperature, storms/hailstorms, and strong winds.

The transport infrastructure constitutes railway lines, roads, and runaways. These infrastructures are affected by precipitation and temperature. The analysis indicated that high temperature affects railways, roads, and runways—which are vulnerable to infrastructure bulking and rutting. These kinds of damage can cause accidents, some of which are fatal. The impact likelihood of temperature on this infrastructure was assessed to be significant. Precipitation also impacts the transport infrastructure through flooding. The analysis reveals that even normal rainfall in the country causes significant structural damage to the road networks (tarred and gravel). Regarding the railway, the above-normal rainfall causes flooding, which erodes the railway and destroys bridges.

Using the CVI, gravel and tarred roads were assessed as being strongly vulnerable to the impacts of climate change with a baseline CVI score of 0.75 and 0.82 respectively under the baseline. This was projected to increase to CVI scores of 0.77 and 0.87 by 2050, respectively, which shows increasing vulnerability.

The railway lines are impacted by extreme temperatures and precipitation. Extreme temperatures cause bulking, resulting in rail breakage and overturning carriages. Similarly, flooding destabilises railways by washing away railway lines and eroding sleepers. With a baseline CVI score of 0.47, the railway infrastructure was classified as average vulnerable and projected to increase to 0.68 by 2050. Thus, railways lines' vulnerability will increase to moderate vulnerability by 2050. Runways in the country were assessed to be impacted by rainfall and temperature. However, their low vulnerability of 0.4 is projected to increase to 0.5 by 2050. Thus, runways were categorised as being of average vulnerability under the transport sector.

Water infrastructure constitutes an important strategic sector that Botswana has used to adapt to drought episodes. The country has nine dams with a total capacity of 904 Mm^3 at full capacity. The water infrastructure constitutes dams, pipelines, wastewater treatment plants, and storage tanks. Like transportation infrastructure, water infrastructure is impacted by extreme temperature and rainfall. The vulnerability assessment indicates that dams are less vulnerable to change with a CVI of 0.2 and are projected to increase in vulnerability to 0.38 by 2050. Pipelines were classified as moderately vulnerable under baseline, which will increase to highly moderate by 2050. Strong winds and storms impact the pipelines and storage tanks. The CVI pipeline scored 0.59 under baseline and is projected to increase vulnerability slightly to 0.73. Thus, it may be moderately vulnerable by 2050.

Under the analysis, built-in infrastructure comprises residential, commercial, and public properties. These assets are impacted by extreme temperature, which affects paint, bricks, and roofing structure. Rainfall affects properties mainly through flooding and prolonged rainfall. For all three kinds of properties, traditional residential houses were classified as strongly vulnerable, with a CVI of 0.69 under the baseline, and with a projected CVI of 0.75 by 2050. These findings have significant implications for the vulnerable members of the communities who live in traditional houses. Traditional houses are constructed by poor members of the community, with fewer resources, the majority being female-headed households who are living under poor conditions. With extreme precipitation incidents of traditional house collapse and the resultant human causalities would increase. Thus, there is a need to allocate more resources for targeted responsive adaptation measures to address the most vulnerable groups.

Commercial properties such as offices and commercial malls were classified as moderately vulnerable with a CVI of 0.55 and 0.6 under baseline and 2050, respectively. They were assessed to be well maintained with sufficient resources for maintenance. Thus, their adaptive capacity and sensitivity were assessed as high and low, respectively.

Lastly, government infrastructure, mainly schools and health facilities, are ageing and gradually deteriorating. The age of these facilities compromises their adaptive capacity and increases their sensitivity to the impacts of extreme weather events (storms, hailstorms, and extreme temperatures). Furthermore, their functionality will be impaired under extreme temperatures. Based on their structural integrity and lack of resources for maintenance, the

school and health facilities were assessed to have a highly moderate vulnerability (a CVI of 0.69) that will increase to strong vulnerability (a CVI of 0.75) by 2050.

The energy infrastructure (power stations, substation, transmission lines, and solar PV systems) were assessed to have low vulnerability. Their CVI scores ranged from 0.38 to 0.46, with the transmission lines scoring 0.46 under the baseline. It is projected that the CVI will increase to a maximum of 0.56, demonstrating moderate vulnerability by 2050.

3.2.5 Biodiversity and Ecosystems

Rangeland ecosystems in the country are an important aspect of community livelihoods and contribute immensely to the national economy through agricultural and tourism sectors. They support community livelihoods and provide habitat for wildlife and livestock. Over the years, the rangeland ecosystems have been subjected to various pressures ranging from wildfires to over-exploitation from overgrazing. Consequently, Botswana rangelands can be characterised as generally degraded (Dougill et al., 2016). This makes them highly sensitive to the impacts of climate change with low adaptive capacity.

As rangeland productivity is closely coupled to rainfall (Shufen et al., 2015), it is expected that rangeland productivity will decline with climate change by 2050. The projections, based on the RCP 4.5, indicate a rangeland productivity decline by approximately 20%–30% in most parts of the country. The RCP 6.0 scenario suggests that rangeland productivity may be up: 38%, 42%, and 54% are projected for Maun, Palapye, and Kang, respectively.

Over the years, bush encroachment has been observed in Botswana, particularly around over-grazed localities and water points. Climate change is projected to accelerate the phenomenon through a combination of factors such as increased incidents of wildfires and drought, among others. It is projected that wildfires will increase because of above-normal rainfall years, resulting in accumulated biomass. This could affect the vegetation dynamic, as veldt fire tolerant plant species thrive while other species are suppressed.

Another potentially significant aspect of the rangeland ecosystem is invasive species. The country is experiencing a proliferation of invasive species such as *Verbesina encelioides* (wild sunflower), *Tecoma Stans* (yellow bells*), Parkinsonia Aculeata* (Jerusalem Thorn)*, Prosopis juliflora,* and others (Marumo, 2018). Increased drought, fire events, and other extreme climate conditions could provide optimal conditions for the proliferation of invasive species in the country.

Climate change could also significantly impact biodiversity through a decline in key ecosystems (rangeland and forest and savannah ecosystems). Like the livestock population, the wildlife population is affected by drought episodes, with strong oscillations around the drought periods. With the projected increase in drought events, it is projected that the wildlife population could decline over time. Furthermore, climate change could result in water scarcity (pan water) in the protected areas, leading to increased human–wildlife conflicts as wildlife encroach into settlements and farms in search of water. The human–wildlife conflict could significantly reduce the wildlife population numbers. In addition, wildfire events are

projected to increase in the country. Incidentally, fire events frequently occur around the protected areas where there is high biomass because of limited grazing. Thus, with a projected occasional increase in above-normal rainfall, grass productivity will increase, providing optimal conditions for veldt fire events. Therefore, a combination of drought and veldt fire events could affect biodiversity in the country (GoB, 2019).

The Okavango Delta is one of the most diverse ecosystems in the country. The wetland could be affected by reduced water inflow because of the decline in rainfall in the catchment areas as well as high evapotranspiration (Urich et al., 2020). The water situation could worsen with rising temperatures due to global warming, elevating evapotranspiration, leading to rapid water losses. The resulting impacts could be reduced species richness through extinction or migration. Mugari et al. (2020) also notes that droughts drive changes in vegetation cover and consequently the delivery of those ecosystem services which depend on healthy vegetation. Dube (2019) further reports that the 2019/20 drought did not spare wildlife, and as a result, national parks' authorities resorted to feeding starving hippopotami, while hundreds of elephants died.

4.0 National Adaptation Priorities, Strategies, Plans, and Challenges

Vision 2036 and the eleventh National Development Plan (NDP 11) guide Botswana's developmental planning processes. Vision 2036 is currently being implemented through the NDP 11. Vision 2036 aims to propel the country from a middle-income to a high-income country by 2036. This will be achieved through four pillars, namely sustainable economic development, human and social development, sustainable environment, and, lastly, governance, peace, and security. The sustainable environment thematic area acknowledges climate change as an impediment to achieving high-income status. Evidently, the country pledges to achieve the economic targets in the realm of climate change and its challenges through a robust national adaptation programme.

4.1 Adaptation in the Context of National Development Planning Process

Vision 2036, as the long-term strategic national guiding document, fully recognises the potential threat of climate change in disrupting economic growth and reversing the development achieved over the years. Furthermore, Vision 2036 acknowledges that climate change is irreversible at this stage. For these reasons, the Vision prioritises adaptation as the most pragmatic approach to achieving high-income status by 2036. Vision 2036 advocates strongly for undertaking climate change vulnerability assessment to facilitate and inform the development of adaptation plans. Furthermore, it calls for the mainstreaming of adaptation and mitigation in development planning at all levels. Similarly, NDP 11, the overall national development planning strategic document through which Vision 2036 is implemented, fully acknowledges the impacts of climate change on economic growth. In fact, the NDP 11 acknowledges the high vulnerability of the economy across all its sectors and ecological systems. One of the factors increasing the country's vulnerability to climate change, according to NDP 11, is "the ability to adequately commit resources and capacity to respond to the impacts of climate change which is at present inadequate" (GoB, 2017:134). In the endeavour to adequately address the impacts of climate change through a pragmatic approach of impacts minimisation, the government aims to mainstream climate change adaptation in all key sectors and ecological systems.

Furthermore, the GoB has declared drought, a climatic event linked to the El Niño Southern Oscillations, a permanent phenomenon that should be mainstreamed in annual budgetary and planning processes. This declaration will enhance and create an enabling environment for effective adaptation planning processes.

4.2 Botswana's NAP Process

The GoB submitted its initial NC in 2001 detailing adaptation measures across the economic sector and ecosystems. This was subsequently followed up by the submission of second and third NCs. However, the NAP process was established under the Cancun Adaptation Framework in 2010, thus Botswana's NAP process is still in its infancy. In fact, Botswana has not yet developed its national adaptation plan and sectoral plans. NDP 11 acknowledges this gap that the preparation of sector plans in NDP 10 did not sufficiently address adaptation and mitigation measures nor promote adaptation measures across the various sectors. Botswana has recently made significant strides in its adaptation process despite the slow uptake. The first significant step was developing and adopting the BCCRP in 2021, which guides the prioritisation of climate change adaptation actions from planning to implementation.

Furthermore, Botswana developed its NAP Framework in 2020 as an overarching strategic document to guide the adaptation process. The NAP Framework details the approaches and guiding principles that must be followed in developing and implementing the adaptation measures across the various economic sectors and natural ecosystems. One of the fundamental guiding principles that Botswana adopted is that climate change adaptation concerns development and economic growth. This approach will ensure that adaptation is integrated and mainstreamed into the sector development plans and the District Development Plans (DDPs).

Following the formulation of the NAP Framework, sectors have gained interest in the NAP process and considering developing their sectoral adaptation plans. For instance, the Ministry of Health is preparing to develop the health sector climate change adaptation plan. Furthermore, Botswana is preparing a proposal to seek support from the Green Climate Fund (GCF) Readiness and Preparatory Support Programme for the development of the NAP. It is hoped this assistance will enable Botswana to develop the NAP and the sector adaptation plans.

4.3 National Strategies and Plans

There are existing national strategies and plans that support and create an enabling environment for the country's adaptation process. These include the National Climate Change Strategy for Botswana (NCCSB) of 2018, National Climate Change Action Plan for Botswana (NCCAPB), and Disaster Risk Reduction Policy, among others. Furthermore, there are also sectoral strategies that support adaptation, such as climate-smart agriculture under the Department of Crop Production.

NCCSB aims to create an enabling environment and facilitate the country's adaptation and mitigation to propel the country to meet its socio-economic development goals, achieving Vision 2036 targets and the SDGs. The NCCSB identified 11 priority adaptation areas between 2018 and 2030. In addition, it identifies seven cross-cutting themes that include gender; education, training, and capacity building; equality and equity; innovation, research, and development; communication and knowledge management; climate services; and resource

mobilisation (GoB, 2018). The NCCSB has identified a set of implementable high-level adaptation strategies and actions for the 11 sectors' activities.

Another apex strategy that informs climate change adaptation is the National Climate Change Action Plan for Botswana (NCCAPB). It is a plan intended to implement and monitor the NCCSB (GoB, 2018a). Consequently, it lists all key performance indicators (KPIs) and the targets for monitoring the adaptation measures as identified in the NCCSB.

The National Disaster Risk Reduction Strategy (NDRRS) will support and facilitate the implementation of climate change adaptation in the country. It advocates for strengthening disaster preparedness and climate change adaptation at all levels as one of its specific strategic goals by 2018. One of the strategic activities highlighted by the NDRRS for strengthening climate change adaptation is to ensure that the Climate Change Response Policy and the Climate Change Strategy and Action Plans are effectively implemented (GoB, 2013).

The GoB developed a national policy on disaster management in 1996 to deal with disasters, which are an inherent part of economic systems. Recently, this policy has been updated and aligned to accommodate the paradigm shift from managing disasters toward a focus on reducing disaster risk as outlined by the Sendai Framework for Disaster Risk Reduction (DRR) 2015–2020. The new national policy on disaster risk management of 2018 duly emphasizes the DRR and meteorological services, which is one of the key priority areas for climate change adaptation. The objectives of the policy are to;

- Facilitate the development of national and district disaster risk management strategies and plans.
- Mainstream and integrate DRR into development at the national, district, and local levels.
- Establish and strengthen institutional capacities and arrangements to implement disaster risk management.

These objectives will be achieved by implementing strategic activities as outlined in the policy.

The National Biodiversity Strategy and Action Plan (NBSAP) is another working strategy that promotes climate change adaptation with an emphasis on an ecosystems-based approach. The first strategic action of the NBSAP is to minimise the anthropogenic pressures on ecosystems to increase their resilience and adaptive capacity, by 2025 (GoB, 2016). The second strategic action which is aligned to the adaptation process is "By 2025, ecosystem integrity in all Botswana's ecoregions will be conserved through the adoption of ecosystem-level management approaches built around key ecological processes, so that they contribute to climate change mitigation and to combat desertification" (GoB, 2016).

Consequently, the NBSAP is well aligned with the NAP Framework, as it promotes EbA for managing ecosystems in the country.

The National Drought Plan (2020) is another strategy that the GoB has developed to mitigate the impacts of drought in the country. The National Drought Plan calls for adaptation plans to enhance arable farming subsector resilience among other strategic activities (GoB, 2020a). In addition, the drought plan recommends the establishment of a communication strategy to disseminate information on climate change adaptation measures.

4.4 NDC Processes

Botswana communicated its Intended Nationally Determined Contribution (INDC), as per decisions I/CP.19 and 1/CP.20, in 2015. It was converted to a Nationally Determined Contribution (NDC) in 2016. As per the Paris Agreement Article 10, which requires parties to submit the next round of updated NDCs by 2020, the GoB updated its NDC which is planned for submission in 2022. The NDC covers both the adaptation and mitigation sections. The adaptation section covers the adaptation measures for the national priority areas as per Vision 2036, NDP 11, and the NCCSB. These priority areas are

- agriculture
- water
- health and wellness
- infrastructure/human settlements
- biodiversity and ecosystems
- forestry and land use
- disaster risk reduction and meteorological services.

This implementation period for the country's NDC is from 2020 to 2030. Implementation of the adaptation section will involve the development of the NAP as an overarching strategic plan and as a component of sectoral plans.

The priority areas and their identified adaptation measures are highlighted in the next section.

4.5 Botswana's Adaptation Measures for the Priority Areas

Feasible adaptation measures have been identified for the country's priority areas. These adaptation measures have been reported in the NDC and the NCs. They are highlighted under each priority area.

4.5.1 Agriculture

The agriculture sector constitutes food production and livestock. Under the revised NDC, a total of 10 adaptation measures have been identified as feasible and effective in minimising the impact of climate change on agriculture. The adaptation measures for the crop subsector that have been proposed under the NCs and the revised NDC are

- Continued development of and switch to crops with the following traits:
  - drought-tolerant
  - tolerant to high temperatures
  - short maturity.
- Support programs for smart climate/conservation agriculture, with a specific focus on those living in poverty, female-headed households, and ethnic minorities.
- Shift to Integrated Pest Management.
- Promote Integrated Soil Management to reduce synthetic fertiliser use.
- Improve the crop markets.
- Reduce storage losses.
- Promote urban and peri-urban agriculture.
- Rehabilitation of degraded agricultural lands.

Livestock subsector, adaptation measures include the following components and directives:

- Introduce heat-tolerant livestock breeds through research and development.
- Promote commercial fodder production due to unreliable rainfall to augment a shortage of vegetation, as there is a high dependency on range land.
- Promote drought-tolerant breeds such as Mosi, the Tswana breed, Tuli, and small-bodied animals.
- Use assistive reproductive technology, namely artificial insemination and embryo transplant.
- Ensure adherence to prevailing stocking rates based on rangeland carrying capacities, especially where livestock product markets are limited (market-based adaptation).
- Use herding and directed-area grazing for health and range management.
- Implement projects for the rehabilitation of degraded lands.
- Use an emergency forage storage and distribution system.
- Promote game farming as a heat- and drought-tolerant alternative to livestock farming.
- Fence off grazing areas for individuals or syndicates.
- Promote small stock that is more resilient during drought episodes.
- Improve livestock markets.
- Improve livestock value chain.

4.5.2 Water

Water resources availability in the country is classified as acute shortage. The situation is exacerbated by the population distribution, which is concentrated in the eastern part of the country, where there are no major rivers. The adaptation measures include both soft (policy) and engineering solutions. They include the following:

- Construct pipelines and connect to existing ones to transmit water to demand centres/Water Transfer Scheme (WTS). The water transfer scheme programme started in 2000 with the completion of the North-South Water Carrier, Phase 1.
- Reduce water loss during transmission by investing in telemetric monitoring systems/advanced water leak detection systems and smart water meters.
- Implement Integrated Water Resource Management (IWRM) strategies which include
  - loss reduction
  - water recycling
  - rainwater harvesting
  - water pricing
  - water restrictions.
- Enhance conjunctive groundwater-surface water use to improve its resilience.
- Use water demand management strategies such as increasing water tariffs for higher consumption brackets and rates for commercial users.
- Strengthen transboundary agreements on watercourses and catchments.
- Install rooftop rainfall catchment systems on public buildings.
- Implement the desalination water treatment plants.
- Manage aquifer recharge projects through the construction of earth dams and artificial recharge projects.
- Implement national water recycling projects.
- Optimise recycling of greywater.

4.5.3 Health

There is evidence that climate change could increase the geographical spread of tropical diseases such as malaria increase and incidents of cholera. In addition, health issues associated with extreme temperatures could be on the rise. Some of the adaptation measures that are prioritised under the health sector include

- Intensification of the malaria elimination program.
- Improvement of Water, Sanitation, and Hygiene (WASH) infrastructure and associated WASH programmes.
- Intensify targeted vulnerable groups' health-specific emergency response programs.
- Improvement of health management information systems to incorporate indicators of climate stress linked to major health impacts, including those related to reproductive, maternal, neonatal, child, and adolescent health.
- Regulate and monitor working hours for construction workers to minimise exposure to direct heat.

4.5.1 Infrastructure

The sectoral infrastructure constitutes an important sector as both an enabling and adaptation sector. For instance, the government has successfully used dams and water transfer schemes to adapt to drought and water shortages. Based on the results of the CVI method (which measured exposure, impact likelihood, and adaptive capacity), it is evident that infrastructural sectoral vulnerability varies in the country. Some infrastructure has been compromised, making it more susceptible to the impacts of climate change. For example, roads in the country, both gravel and tarred, have a high sensitivity to climate events, particularly rainfall. Health and school facilities also displayed a highly moderate vulnerability. However, infrastructures such as dams and power stations have low vulnerability because of their high adaptive capacity and less sensitivity to the impacts of climate change. The proposed adaptation measures include both soft (policy) and engineering solutions. They include the following:

- Improve the drainage systems along the infrastructures to accommodate extreme flood events.
- Adherence to the engineering maintenance plans for the infrastructures.
- Regular inspections and timely maintenance of the infrastructures.
- Greater use of material with high tolerance levels for strong winds, temperature, and flooding.
- Design the structure to accommodate extreme events.
- Revision of building codes to accommodate strong winds and extreme events to ensure safety, environmental, and other measures are incorporated into the built environment.
- Establish building material standards (bricks, roofing) that prioritise tolerance to high temperatures and other extreme weather events.
- Retrofitting the roofing to improve the natural ventilation systems for schools and health facilities and increase their resilience against storms and strong winds.
- Improve land-use planning to minimise flooding events.
- Promote traditional knowledge of hut construction to increase traditional houses' resilience to climate change impacts.
- Improve on the early warning systems and water levels monitoring systems to manage water release from the dams to lessen the flooding energy on the dam walls.
- Promote EbA to enhance ecosystem service to regulate extreme climate events such as floods and extreme temperatures.

4.5.5 Biodiversity and Ecosystems

Ecosystems provide services that regulate and dampen extreme weather events such as flooding and drought. In addition, they support community livelihoods by providing food, fibre, and building materials. The NAP Framework recognises the importance of ecosystems' roles in regulating and reducing the impacts of climate change. It recognises that healthy ecosystems can withstand climate change impacts and provide services to dampen climate change impacts on community livelihoods and biodiversity. Thus, the NAP Framework

emphasizes an EbA approach as one of the guiding principles in developing the adaptation process. Some of the adaptation measures that are highlighted in the NCs and the NDC include the following:

- Intensify efforts to prevent the spread of alien invasive species.
- Develop comprehensive fire management plans around the protected areas.
- Increase and maintain wildlife corridors to ensure wildlife movements between habitats.
- Enhance and optimise operational management effectiveness of the protected areas.
- Intensify the provision of water for wildlife through Artificial Water Points in the protected areas.
- Promote and support human–wildlife coexistence to reduce human-wildlife conflicts.
- Promote co-management of the protected areas as a holistic strategy for their management effectiveness.
- Promote EbA for effective ecosystem management.

4.5.6 Forestry and Land-Use

Forestry and land-use adaptation measures have multiple co-benefits and transit between adaptation and mitigation. Like ecosystems and biodiversity, forestry and land-use adaptation are prioritised due to their co-benefits (adaptation and mitigation). Some of the feasible adaptation measures include the following:

- Reducing land-cover conversion by promoting ecotourism activities in forestry ecosystems.
- Promoting and restoring community woodlots.
- Controlling bush encroachment in rangeland ecosystems.
- Promoting agroforestry in ploughing fields.
- Promoting intensification of agroecosystems using greenhouses and hydroponic systems to increase food production and reduce encroachment into forestry and other ecosystems.
- Promoting EbA to enhance ecosystems services from forestry.

4.5.7 Disaster Risk Reduction and Meteorological Services

The country's adaptation approaches recognised that meteorological information must inform the country's adaptation. Thus, the country prioritises strengthening early warning systems to inform sectors' preparedness to extreme events such as drought, intense precipitation, and heat waves. Furthermore, the adaptation process will involve pragmatically conducting a comprehensive DRR strategy following the Sendai Framework for Disaster Risk Reduction. In an effort to enhance early warning systems for DRR, the prioritised strategic activities under meteorological services include:

- Expand multiple-hazard Early Warning Systems (EWS) to serve multiple sectors and cover hazards such as drought, fires, floods, and heat waves by increasing automated synoptic stations network.

- Improve information dissemination and access to all stakeholders.
- Develop a climate risk mapping system for all the hazards at the national level.
- Establishment of a system for climate projections, climate change impacts climate risk mapping.
- Adopting and operationalising a national framework for climate services.
- Capacity building on EWS, information dissemination, and systems for climate projections impacts and risk mapping.

5.0 Implementation and Resource Needs

Adaptation requires adequate resources and implementation plans with transparent monitoring and evaluation tracking tools. The implementation plans, progress made, and resources needed are discussed. The information was gathered from the consultation with various stakeholders and desk review of relevant documents such as NC and the NAP Framework.

5.1 Implementation Plans

Adaptation measures and their implementation are spread across several sectors and often carried out largely for sectoral mandates rather than climate change adaptation (GoB, 2022). Although there are no sectoral adaptation plans, at the sectoral level the sectoral adaptation measures implementation occurs as a co-benefit of implemented sectoral mandates. The NAP Framework has identified this gap and requests the development of the NAP, sectoral adaptation plans, and their implementation plans (GoB, 2020).

As per the NAP Framework guidelines, the sectoral adaptation plans should include aspects, such as

- Projects and programs to be undertaken
- Outlining the proposed strategic activities
- Budgets
- Time frames
- Projected climate change impacts reductions with the co-benefits.

5.2 Implementation Progress and Resources Committed

Botswana has made some firm and significant progress in implementing adaptation projects. This was achieved through mobilising domestic, international, public, and private resources. However, there are no measures and instruments currently in place to gauge implementation progress and results in the NDC adaptation section. A snapshot of some of the significant adaptation projects that have been implemented over the past years include

- **Ngamiland dryland project**: This was a 5-year project funded by UNDP/GEF at USD 3.7 million. The objective was to mainstream sustainable land management into the productive landscapes of the Ngamiland District. This is an EbA project aimed at restoring and enhancing the rangeland ecosystem services to support community livelihood. It has components of fire management and control of invasive plant trees. It has also introduced sustainable projects for vulnerable communities to improve their adaptive capacity. Some of the initiated projects include the sustainable production of oils from Mongongo fruit trees, sustainable charcoal production from cut invasive species timber, and piggery for women.
- **Ecosystem-Based Adaptation and mitigation in Botswana's Communal Rangelands**: This is an eight (8) year adaptation project with a mitigation component project

funded by Green Climate Fund at USD 39.2 million. It involves the collective management of livestock and ecosystems to restore communal rangelands and reduce GHG emissions. Furthermore, it intends on building the climate resilience of vulnerable groups across 104 villages in Ngamiland, Kgalagadi, and Bobirwa districts. The target is to implement EbA measures that will result in rangeland ecosystems restoration of about 4.6 million hectares.

- **Enhancing a National Forest Monitoring System for the Promotion of Sustainable Natural Resources Management**: A four-year Japan International Cooperation Agency (JICA)-funded project to support the Department of Forestry and Range Resources (DFRR) in establishing the methodology for the national forest inventory and in developing Forest Geographic Information System (GIS) Database. The expected output is to enhance sustainable forest management to ensure ecosystems services flow to support biodiversity and community livelihood.
- **Managing the human-wildlife interface to sustain the flow of agroecosystems services and prevent illegal wildlife trafficking in the Kgalagadi Ghanzi Dryland**: This is a 5-year UNDP/GEF funded project at a tune of USD 2.9 million. Its main components include enhancing wildlife protection by communities through increased financial returns from natural resources exploitation and reducing human-wildlife conflicts, improving landscape planning in the conservation areas and SLM practices in communal lands, and securing migratory wildlife corridors. Consequently, the project is aligned to the EbA to improve rangelands and agroecosystems to improve ecosystems services flow as an adaptation to climate change.
- **National biodiversity planning to support the implementation of the CBD 2011–2020 Strategic plan in Botswana**: A multi-donor project funded at USD 27.2 million over 5 years. It promotes the EbA approach to build ecosystems' resiliency and enhance the flow of ecosystem services to support community livelihoods under a changing climate. See Box 1 for more details on Botswana's EbA approach.
- **Malaria control programme**: Over the years, the GoB has intensified malaria control with the target of elimination by 2030. Through increased investment in malaria control and upscaling programmes such as insecticide-treated bed nets and indoor residual spraying, public education, and malaria campaign through print, the country reduced malaria cases from 100,000 cases in 1997 to 507 in 2013 (WHO, 2013). Malaria incidences dropped from 0.99 to 0.01 %, and deaths attributed to malaria declined from 12 to 3. The government developed and implemented a Malaria Strategic Plan 2010-2015. The malaria budget for the period 2010–2015 was estimated at USD 48,655,209,[2] which translates to an annual expenditure of USD 9,731,041 (Ministry of Health, 2010). In Botswana, it is projected that climate change could result in malaria spreading southwards to new areas that were previously malaria free (Ryan et al., 2020). With projections that climate change would escalate the malaria death by an additional 60,000 between 2030 and 2050 (WHO, 2019), the malaria control programme is a critical adaptation programme which needs to be intensified.

[2] USD 1 = P11 (average for 2015).

- **Diarrheal diseases control programme**: The GoB has an Integrated Disease Surveillance and Response program that aims to reduce diarrheal diseases projected to increase with climate change. This programme constitutes an array of adaptation measures such as access to safe water, improved sanitation, clean water technologies, and medical interventions. The government invested significantly in wastewater treatment plants, sewerage lines, infrastructural development, and access to health facilities. To ensure access to safe/potable water, the GoB through WUC expended an estimated USD 82.5 million on water treatment and distribution in 2019, which increased from the 2018 estimate of USD 75.5 million (WUC, 2019).
- **Water infrastructure development projects**: The GoB has, over the years, prioritised the water development and transfer schemes as an adaptation strategy against drought episodes resulting from climate variability and change. This has resulted in the construction of dams and water transfers over time. For the budget year 2022/23, the government has allocated approximately USD 347.45 million for water development projects. In 2019/2020, the budget for water development was USD 228 million. The major water development projects included the North-South Water Carrier, Phases 1 and 2, with an estimated cost of USD 400 million in 2000 and USD 58.8 million in 2017. Furthermore, various dam and aquifer developments have been undertaken to transit water to water-scarce areas around greater Gaborone.
- **Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL):** This is a joint initiative among five southern African countries (Angola, Botswana, Namibia, South Africa, and Zambia) and Germany to address climate change issues through research and capacity development in five thematic areas: climate, water, forestry, agriculture, and biodiversity. Through its work SASSCAL contributes to issues of early warning systems. Overall SASSCAL funded adaptation projects to the tune of EUR 2.861 million. Details of these projects are enumerated in Table 1.

Table 1. SASSCAL-funded adaptation projects in Botswana

Task No	Task Name	Lead Institution	Budget
Agriculture			
Task 308	Water use efficiency and grain quality of crops under water deficit conditions	BUAN	EUR 150,603.10
Task 316	Making use of the wild legume resource to improve arable and livestock farming in Botswana	BUAN	EUR 200,402.00
Biodiversity			
Task 314	Exploring human–wildlife interactions in agroecosystems in northern Botswana	UB	EUR 179,795.50
Task 304	Development of strategies for sustainable use and management of savannah ecosystem resources and services in northern Botswana through remote sensing-based spatial database tools	UB	EUR 294,366.50
Task 321	Vegetation survey of Botswana	BUAN	EUR 156,165.00
Climate			
Task 332	Historical and ongoing Climate Data Management	DMS	EUR 250 955.70
Task 341	Impacts of climate change on livelihoods and implications for adaptive strategies in the Kalahari ecosystem	UB	EUR 322 336.27
Forestry			
Task 335	Cultivation, value addition and marketing of climate smart emerging crops to improve food security	BUAN	EUR 331 034.80
Task 311	Improved forest resource assessment including socio-economic base-line in Botswana	BUAN	EUR 105 320.10
Water			
Task 344	Improved database on water quality and quantity: Botswana	UB	EUR 268 835.90
Task 337	Toward improved spatial data for hydrological modelling and implications for water resources management: the case of Notwane catchment in Botswana	UB	EUR 202,908.49

- **Disaster risk reduction and recovery adaptation measures:** The government has developed and implemented various disaster risk reduction and recovery measures to address the impacts of climatic events, such as a drought relief programme (DRP). As drought is a permanent feature in Botswana, the introduction of the DRP can be traced to the early 1970s (Seekings, 2016). This was initially provided through programmes administered by the chiefs and the World Food programme. The DRP has five components, including the supplementation of food supplies to reduce malnutrition among vulnerable groups, the creation of rural employment opportunities to compensate for lost agricultural income, assistance to arable farmers to facilitate productive recovery, and reducing the impact of drought on livestock mortality. The

budget for DRP is a function of the drought's intensity, longevity, and spatial coverage. For instance, in 2014, the total cost of the drought relief programme was estimated at approximately USD 20 million. In 2018/19, the government spent USD 77.8 million on drought relief projects to mitigate drought impacts.

- **Botswana Sustainable Miombo-Mopane Landscape Management Project**: A Global Environment Facility-funded project implemented by Ministry of Environment and Tourism; Ministry of Agriculture. The project's main objective is to promote the integrated management of Miombo and Mopane landscapes in Chobe and Tutume-Mosetse sub-basins through the implementation of sustainable land management (SLM) and sustainable forest management (SFM) interventions designed to achieve Land Degradation Neutrality targets. The time frame for the project is 2021 to 2026, with a budget of USD 5.35 million.
- **Climate Smart Agriculture (CSA):** This is a 10-year strategic program that started in 2015 and ends in 2025. The strategy program is jointly implemented by the Ministry of Agriculture and the Ministry of Environment and Tourism. The Government of Botswana identified six strategic priorities as sources of Botswana's agricultural development and growth in a changing climate. The six strategic priorities are improved productivity and incomes; building resilience and associated mitigation co-benefits; value chain integration; research for development and innovation; improving and sustaining agricultural advisory services; and improved institutional coordination.
- **Building climate resilience of agricultural systems in the North-East and Central districts of Botswana:** A GoB and GCF co-funded project at USD 31.25 million. The project aims at building community resilience to climate change by i) strengthening institutional capacity to support climate-resilient agriculture; ii) strengthening the technical capacity of small-scale farmers to implement adaptation measures and improving their access to finance through the design and implementation of dedicated climate adaptation loan programmes (funded by state banks); and iii) improving the production and dissemination of climate information services for agricultural decision making at all levels.
- **Research and development:** Botswana Institute for Technology Research and Innovation (BITRI) is one of the key organisations responsible for driving research and development on climate change adaptation and mitigation in Botswana. Through the Climate Change Division, BITRI focuses on understanding the impact of climate change on Botswana's economic sectors, such as agriculture, water resources, energy, and health. This is done through improving climate science and impact assessments, which also incorporate the views of local communities (at the grassroots level) on potential adaptation responses to the impacts of climate change. Major research undertaken at BITRI focuses on the following thematic areas: climate-proofing growth and development; climate projections including developing methods for monitoring climate change and the impacts; incorporating new climate science into the risk-assessment framework; including the social and economic effects of climate in policy responses; and developing CSA Manual, among others. Furthermore, since 1980, Botswana developed its composite breed (the Mosi cattle) through research and

development, and the cattle became commercially available in the decade of 2010 (MoA, 2011). According to the Department of Agricultural Research (DAR), the Mosi breed was developed using the pre-existing cattle that were used in Phase 1 crossbreeding studies. The total cost for the development of 360 Mosi cows and 31 Mosi bulls was USD 81,689, while recurrent costs over the 40-year period are estimated at USD 683,528. Recurrent costs related to Mosi breed development included labour costs and maintenance (supplementary feeds, veterinary requisites, vaccinations, and drugs).

Box 1. Botswana's EbA approach

The promotion of the EbA is at the core of adaptation in Botswana, it is an approach for the sustainable management, conservation, and restoration of ecosystems providing services that enable communities to adapt to the impacts of climate change (GoB, 2020). Vision 2036 acknowledges the functions and services that are supported by the health ecosystems. Realizing the critical role of ecosystems in the national economy and community livelihood, Vision 2036 calls for the promotion of healthy ecosystems through EbA. The EbA approach is a cost-effective adaptation measure with multiple co-benefits, which are also pro-poor (Nill et al., 2016; GoB, 2020). Further to its contribution to economic growth, the EbA approach can also contribute to poverty alleviation by supporting rural community livelihoods and contribute to the generation of rural household income (GoB, 2020). The EbA aligns adaptation process with several national strategies, including Vision 2036 – for promotion of healthy ecosystems; NDP 11 – which requests the sustainable of natural resources; Wealth Accounting and Valuation of Ecosystem Services (WAVES) – which aim to promote sustainable development by mainstreaming natural capital in development planning and national economic accounting systems; the Community-Based Rural Development Strategy of 1996 and Revised Rural Development Policy of 2002 – which encourage community-based sustainable development through the sustainable use and conservation of natural resource-based systems (GoB, 2020).

To successfully implement an EbA approach, it must be mainstreamed into adaptation projects at all levels—national and local. The GoB (2020) emphasises the need for adaptation process to be community-centred, hence adopting the Community-based Approach (CbA). This is attributed to the fact that there is a direct relationship between climate change and communities. According to the GoB (2020), CbA is closely linked to both the EbA approach and the principles of vertical integration, and the three combined will ensure that communities are fully engaged in the adaptation process design and implementation. The adoption of the CbA approach aligns the adaptation process to the following important policies and strategies: BCCRP of 2021, the Community-Based Natural Resource Management policy of 2007, the Revised Rural Development Policy of 2002, and NDP 11 (GoB, 2020). These national documents highlight the need for community participation and involvement in planning and decision making.

5.3 Implementation Resources Needs

Climate change adaptation has multiple benefits, including increasing resilience, productivity, and economic development. It is thus imperative that significant financial resources are allocated for the implementation of sectoral adaptation measures. The NDC reported a partial budget for the adaptation measures. The adaptation measures with estimated expenditure are presented in Table 2 below.

Table 2. Adaptation measures with estimated expenditure

Sector	Adaptation Measures	Estimated Expenditure (USD)
Climate and Disaster Resilience	Climate Information and Early Warning System (CIEWS)	7.06 million
Water (collection, treatment, and supply)	Water: pipeline installations, construction, and strengthening and maintenance of water storage tanks	51.9 million
Agriculture (crops)	Crop production (new crop varieties, irrigation schemes)	35 million
	Total	**93.96 million**

However, it must be emphasised that this NDC adaptation budget has not included vital adaptation sectors and programmes such as health, infrastructure, DRP, and ecosystem and biodiversity, among others. It should also be noted that Botswana intends to develop the NAP and sector NAPs which will fully elaborate on the resources needed for implementing specific adaptation measures. Thus, a revised and comprehensive adaptation budget that includes all the priority sectors is required.

Based on the current expenditure for adaptation measures such as the malaria eradication programme, water development, and DRP, the budget for NDC adaptation will exceed the estimated budget of USD 93.96 million. For instance, the DRP for 2018/19 drought was USD 77.8 million and assuming four drought events between 2022 and 2030, the expenditure on DRP will be more than USD 300 million. Similarly, water project budget for financial year 2022/23 is USD 364 million and there are other planned major water projects such as Lesotho-Botswana Water Transfer Scheme and Pandamatenga transfer scheme which are expensive investments. Furthermore, the malaria eradication programme was estimated at USD 10 million annually which will translate into USD 80 million.

It is worth noting that national budgeting for climate change adaptation is a complex task. The resource needs for adaptation are a function of the degree of climate change (temperature and precipitation) and the resultant impacts. For instance, the adaptation resource needs for global warming of 2 ^{o}C and resultant extreme events will be significantly higher than adaptation resources needed for global warming of 1 ^{o}C. Consequently, there is a high degree of uncertainty inherent in estimate the adaptation resources requirements. It is thus important that estimating the optimal resources should be based on climate scenarios

which will yield a range of budgets based on projected degree of climate change. Consequently, global mitigation efforts have a strong bearing on adaptation resources needs.

Additionally, there is also insufficient capacity for undertaking comprehensive adaptation costing and budgeting that is linked to the climate scenarios. This activity requires expertise in computable general equilibrium models to enhance capacity for budgeting.

5.4 Capacity Building and Technological Transfers

Development and implementation of the sectoral adaptation plans will require capacity building. Likewise, implementation of the sectoral and national adaptation plans will require the provision of guidance, tools, and technical know-how to the stakeholders at all levels. Furthermore, as per the Paris Agreements Article 10 there will be a need to track the NDC adaptation. These adaptation activities will require stakeholders' capacity building at all levels. To have an effective adaptation capacity building, it is critical that a capacity needs assessment is undertaken to identify areas of capacity development focus.

Botswana will need advanced technologies to implement the identified adaptation measures. The NAP Framework recognises the potential contribution of technology development in the adaptation process (GoB, 2020). The technological transfers will be needed for all priority areas, such as agriculture for minimal tillage, early warning systems, fire management systems, and the health and water sectors.

Botswana conducted its technology need assessment in 2004 which is being updated in collaboration with UNEP, funded under the GCF. The technology needs assessment of 2004 identified three priority areas of technology needs, of which two are adaptation related. These priority areas cover water technologies and agricultural technology. The water technologies that were identified include waste stabilisation ponds, trickling/percolating filter, and reverse osmosis. Under the agricultural sector, the technologies that were identified include livestock breeding and conservation tillage technologies. An attempt to determine the extent to which the identified technological needs have been funded and transferred and successfully implemented proved futile as no monitoring and evaluation have been undertaken to track progress on these technologies. Consequently, it is important that tracking tools for the adaptation process are developed for the financial support received and technological transfers, among others similar to the NDC mitigation measures.

Nevertheless, as the country has identified additional adaptation measures for the priority sectors that will require supporting technological needs, it is inevitable that the ongoing technological needs assessment will identify additional technological needs for the adaptation process.

5.5 Implementation Challenges and Gaps

Various challenges, barriers, and gaps have been identified in the country's adaptation process. The challenges, barriers, and gaps were identified through stakeholders as represented by the public, private, and community sectors. Furthermore, the updated NDC also identified various challenges and gaps in the adaptation sections. These are highlighted below.

- **Insufficient continuation/sustainability plans for the externally funded projects**: Some climate change adaptation projects are externally funded with a defined duration. Once the funding comes to an end, the project closes due to the lack of funding. This, unfortunately, implies that the benefits of the adaptation end abruptly.
- **Weak legal and policy framework to enhance the adaptation processes**: Besides the national climate change response policy, there is a need to develop legal acts and regulations to strengthen the policy. Acts and regulations are the instruments through which policies are enforced and implemented. It is thus important that legal acts and regulations are developed and implemented.
- **Insufficient gender adaptation measures across sectors**: The NAP Framework acknowledges that vulnerability across gender groups differs significantly. For this reason, it is important that gender response measures are developed instead of blanket adaptation measures. Currently, there is a gap, as there are no gender-response adaptation measures.
- **Inadequate youth-centric adaptation programme:** One of the immediate implications of climate change is to transfer the economic cost to future generations. The NAP Framework recommends a youth-centric approach to climate change where the focus is on the youth. However, currently, there is no policy and legal framework that create an environment where an emphasis is based on youth-centred adaptation programmes.
- **Delays in the development of sectoral plans and implementation frameworks**. The sectors have not yet developed the sectoral adaptation plans and their implementation plans. This is a significant barrier and challenge, as the sectors have no adaptation plans to guide the implementation. Consequently, the sectoral adaptation measures are not synchronised with the NDC targets. It is important that sectoral adaptation and implementation plans are aligned with the NDC targets.
- **Inadequate financial resources to implement the identified adaptation measures**: The limited resources are thinly spread among the competing socio-economic needs ranging from education to poverty alleviation and reduction schemes. This challenge implies that some of the proposed adaptation measures from the 11 priority areas may not be implemented. Consequently, there will be a significant financing gap for the NDC adaptation sectors. Insufficient financial resources affect all entities, including line ministries, departments, the private sector, and the communities at the grassroots.

- **Weak markets for adaptation measure products**: Markets play a critical role in adaptation practises, such as destocking based on early warning systems and switching to small stock as an adaptation strategy against drought. However, the markets in the country do not give the farmers the option to destock before the drought sets in. Furthermore, some farmers are discouraged from switching to small stock mainly because of limited markets and the low prices offered by the available markets.
- **Low implementation capacity from both grassroots and implementing entities**: The communities are the main implementers of some of the adaptation measures such as sustainable rangeland management, water demand management, CSA, fire management, and biodiversity management, among others. However, the community members do not have adequate skills and capacity to implement the adaptation measures. Consequently, capacity building—covering training—and resources, among other elements, are required to enhance the capacity for implementation.
- **Weak coordination among the implementing entities**: The adaptation process and adaptation measures are cross-cutting and require coordination among the implementing partners. For instance, implementing rangeland adaptation strategies will involve government agencies, civil society, local communities (farmers, veldt product users), the private sector representing markets, and the line ministries as represented by the departments. This requires coordination of the various activities. Currently, there is no robust coordinating strategy and functional body to ensure the harmony of the activities to avoid conflict that could negatively impact adaptation measures.
- **Insufficient research capacity in the areas of climate change adaptation**: The GoB has invested significantly in capacity building in research and development. However, there are areas that need to be strengthened, such as research on projecting the impacts of climate change, including its effects on gender vulnerabilities and health, among other issues. There is thus a need to improve research capacity in these areas to inform robust formulations of adaptation measures. It is also important to strengthen the development components in R&D to implement adaptation measures that are country specific.
- **Low technical capacity to undertake comprehensive budgeting based on climate scenarios**: Budgeting for climate change adaptation is a complex task as it is a function of the degree of climate change. This requires modelling such as computable equilibrium models to quantify the required resources needed to adapt to projected climate changes. There is low technical capacity nationally in this area.
- **Limited ability to present the adaptation measures as business opportunities to the business community**: Members of the communities are economic agents, and an economic agent always wants to maximise benefits. Climate change adaptation investment could be perceived by the business community as a social responsibility than profit making. Therefore, if adaptation measures are not presented with the co-

benefits and opportunity for income generation for community members, the business community will be reluctant to participate.

- **The impacts of Covid 19 pandemic**: While Botswana has mobilised resources (domestically and internationally) for climate change adaptation, the COVID-19 pandemic presents a challenge. The COVID-19 pandemic has resulted in the reallocation of resources from developmental projects (some of which were adaptation inclined) to purchase COVID-19 vaccines and protective clothing. Thus, this financial reallocation will slow the climate change adaptation process due to limited funds. Furthermore, the tourism sector, one of the sectors that have been earmarked for diversification, has been significantly affected by COVID-19 due to international and national travel restrictions. A combination of the reallocation of financial resources and the impacts of COVID-19 on the tourism sector has resulted in an increased economic budget deficit to 5.1% of GDP for the financial year 2021/22 (GoB, 2022). Subsequently, COVID-19 could have long-term unprecedented impacts on the implementation of the adaptation process in the country.

6.0 Linking Adaptation Actions and Economic Diversification Plans, and Mitigation Co-Benefits

The GoB prioritised economic diversification to reduce reliance on the mining sector as the main source of economic growth. The country's economic diversification is driven by the strategy for economic diversification and sustainable growth of 2008. Some of the strategic activities for economic diversification include improving efficiency, improving the value-adding potential of sectors such as agriculture, commercialisation of the agricultural sector, and enhancing ecosystems and biodiversity to promote tourism, among others. The adaptation process in the country can benefit greatly from the economic diversification strategy and simultaneously contribute to economic diversification.

There is a strong symbiotic/reciprocal relationship between economic diversification and the adaptation process. According to the NCCSB, the economic diversification strategy offers opportunities for the adaptation sector. The NCCSB noted that "the Environmental Protection Program (EPP) offers useful policy alignment to climate change. Through the EPP, Botswana aims to develop adaptation strategies for economic diversification, agriculture, malaria eradication, among other vulnerable and priority sectors for early adaptation" (UNDP, 2018). Subsequently, the EPP falls under the ecosystems and biodiversity adaptation area.

Areas of synergies between the national strategy for economic diversification and adaptation are more inclined to the agricultural sector and the ecosystem and biodiversity. Some of the strategic activities highlighted in the strategy for economic diversification that the climate change adaptation can benefit from include

- Commercialising, restructuring/rebuilding the livestock sector.
- Improving the value chain in the agricultural sector for both crops and livestock.
- Increasing investment in agro-industry projects.
- Increasing investment in the tourist sector and biodiversity conservation.

Similarly, the NDC and the NCCSB emphasise the need to prioritise adaptation projects with co-benefits. The EbA adaptation projects have ample ventures for reducing GHG emissions reduction. By promoting small stock as an adaptation strategy, climate change adaptation measures can reduce GHG emissions from the livestock sector.

7.0 Gender-Responsive Adaptation Action

Climate change will affect gender groups differently, and some groups will be disproportionally affected more than others. Female-headed households are generally more vulnerable to economic hardships (poverty, unemployment) than males (Lesetedi, 2018). It is estimated that female-headed households (55%) are living in poverty compared to male-headed households at 45%. The economic status of women thus makes them highly vulnerable to climate change because of their low adaptive capacity to climate change adversities. Women in rural areas, where poverty is endemic, are particularly vulnerable to the impacts of current climate change as they are totally dependent on subsistence agriculture. Consequently, the projected climate change impacts on all economic sectors will worsen the vulnerability of the female-headed households who are currently facing economic hardship from the current climate change events.

The difference in the vulnerability of the gender and social groups requires a robust responsive adaptation strategy. Groups that are more vulnerable should be prioritised to facilitate a more pragmatic adaptation response. This is because groups that are more vulnerable to climate change will also have greater economic challenges to adapt to climate change than groups that are less vulnerable. While women-headed households are vulnerable to climate change impacts, they have a significant role to play in the adaptation process. First, they constitute 51% of the national population. Second, women are highly involved in natural resource harvesting relative to men. Thus, targeting women on EbA approaches will bear fruit.

To create a robust adaptation process that fully mainstreams gender, it is ideal that gender needs be integrated across the sectoral plans. Ultimately, all the sectoral adaptation plans need to have specific gender-strategic activities. This is important since gender cuts across all the national priority areas.

Already the NCCSB has identified high-level strategic activities for gender-responsive adaptation activities, such as

- Promote equitable participation of women farmers and female-headed households in CSA programmes, agritourism, and access to conservation agriculture technologies.
- Ensure gender-equitable access to the proposed endowment fund providing low-cost finance to climate change adaptation projects aligned with similar projects.
- Develop a national Climate Change Gender Action Plan, encouraging women to drive climate resilience and including water, energy, and healthcare issues in households.

8.0 Mainstreaming Traditional Knowledge in Adaptation Process

Climate science has long recognised the importance of traditional and Indigenous knowledge in adapting to climate change. Traditional knowledge has been used locally and in countries such as Australia for fire management. Similarly, the NAP Framework takes a pragmatic approach to recommend the infusion of traditional and Indigenous knowledge into the adaptation process. The infusion of traditional and Indigenous knowledge will be purely evidence-based. This will be achieved by undertaking a pilot project to determine the effectiveness of traditional adaptation practices (GoB, 2020). Based on evidence generated, information will be shared on their effectiveness as well as lobbying for national upscaling. Furthermore, a cost-effectiveness analysis of the pilot adaptation measures will ensure economic efficiency. Similarly, the NCCSB advocates for the use of traditional and Indigenous knowledge in climate change adaptation. Some of the strategic activities identified include strengthening and building the capacity of the existing Community Based Natural Resources Management Programme with a mandate and resources to guide and implement sustainable ecosystem management by both traditional practices and forestry sector best practices, such as establishing community woodlots.

To promote the use of traditional and Indigenous knowledge, sectoral plans must promote the use of traditional adaptation practises based on the NAP Framework cost-effectiveness approach.

9.0 Cross-Cutting Issues

Research and Development (R&D) is fundamental for an effective adaptation process. Subsequently, it is cross-cutting across all the national priority areas. The NAP Framework promotes R&D for the identification, design, and implementation of sectoral adaptation measures. It is thus important that all the identified sectoral adaptation measures are thoroughly researched and appropriate measures be developed. Consequently, for Botswana to promote the use of R&D in adaptation processes, there is a need to build capacity on climate change adaptation R&D. Subsequently, R&D should be supported by appropriate technological transfers and collaboration with regional and international research institutions on climate change vulnerability and impacts assessment and adaptation.

Gender and vulnerable groups also cut across all sectors. Female-headed households and vulnerable groups are particularly vulnerable to climate change impacts as climate change affects almost all the economic sectors in which they are actively involved. Thus, the adaptation plans should design gender- and vulnerability-specific adaptation measures to ensure that vulnerable groups' weaknesses are lessened.

10.0 Monitoring and Evaluation

The NAP Framework underpins the importance of Monitoring and Evaluation (M&E) for the NDC adaptation section. M&E is critical for tracking the progress made on the implementation of adaptation measures at both the national and sectoral levels (including the grassroots).

It is thus imperative that the national and sectoral adaptation plans' development should comprise strategic activities, their implementation plans, and M&E plans. Thus, these plans should be developed at the same time to ensure that M&E is undertaken once the implementation commences. Botswana has an existing National Monitoring and Evaluation system (NMES), which is used to monitor and evaluate the NDP project and programmes. The NMES covers the climate change adaptation priority areas (agriculture, water, health, infrastructure, land use, and ecosystems and biodiversity). It is thus vital that the M&E plans for the adaptation process are mainstreamed into the existing NMES for national tracking.

11.0 Improvement Plan and Support Needs

Botswana has made and is continuing to make significant strides to climate-proof its economy and community livelihood. This is despite the economic challenges of limited financial resources that have recently been worsened by COVID-19. To accelerate the country's adaptation, there is a need to address institutional capacity and financial, technological, and legal constraints. Some of the priority areas that need support to expedite the adaptation process—which are aligned to the NDC, NCCSB, NCCAPB, and NCCRP—are as follows:

1. **Enhance climate financing skills and competencies/climate finance**: Funding for implementation of climate change-related projects is insufficient. Furthermore, there is evidence of a lack of capacity to access climate finance in Botswana. Therefore, there is a need for institutional capacity building to facilitate access to international climate financing to support NAP projects. Furthermore, there is also a need to build capacity on budgetary processes to ensure that climate change adaptation measures are included in the sectoral and national budgets.
2. **Development of national and sectoral adaptation and implementation plans**: The country has made commendable progress in implementing adaptation projects from domestic and international funding. However, these adaptation projects have been done in a less organised manner and not guided by a comprehensive adaptation process implementation system. To have an impactful adaptation process there is a need to develop national and sectoral NAPs and their implementation plans. The development of the national and sectoral NAPs and implementation plans requires technical capacity and financial resources.
3. **Increase institutional, technical, and human resource capacity/Adaptation capacity building**: It is evident from the stakeholder consultation that there is limited understanding and awareness of both climate change mitigation and adaptation actions. There is also low institutional, technical, and human capacity to implement the prioritised climate change adaptation measures. The support needed to overcome the aforesaid barriers include undertaking national and sub-national capacity building through the formulation of a national adaptation sub-committee within the NCCC. The objectives of the sub-committee will be to mobilise resources, information sharing, public education and training, and community and institutional capacity to initiate and manage climate change adaptation actions across all sectors of the economy. The support is also needed for advancing adaptation planning, such as support to develop sectoral strategies and action plans.
4. **Strengthening the Legal framework for climate change**: There is an existing BCCRP, which guides the climate change action for the country. However, there are no legal acts and regulations to implement the policy. It is therefore imperative that climate change legal instruments are developed to strengthen the climate change legal framework for the country.

5. **Strengthening of strategy for implemented project sustainability**: Most of the EbA projects are internationally funded and once the international funding stops, the projects collapse. There is therefore a need to strengthen the project continuity strategy.
6. **Development of an NDC financing strategy**: Implementing the adaptation plans at the national and sectoral levels will require significant financial resources. The cost will include the development of the sectoral adaptation plans, building capacity for implementation, and the actual implementation. It is thus critical that the NDC financing strategy is developed detailing the financing gaps, identification of the possible financing sources, and strategic activities to mobilise the resources from the identified sources.

12.0 Conclusion

Botswana aims to attain high-income status by 2036 and recognises climate change is a significant challenge to this target. The country has thus prioritised climate change adaptation to climate-proof its national economic and community livelihoods. There is therefore a need to accelerate the adaptation process. This will require support in the form of finance, capacity development, technology development and transfer, and strengthening the legal framework for all its priority sectors.

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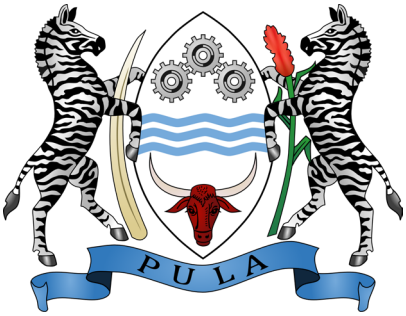

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