CLIMATE RISK COUNTRY PROFILE

BOTSWANA

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This profile is part of a series of Climate Risk Country Profiles developed by the World Bank Group (WBG). The country profile synthesizes most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The country profile series are designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is managed and led by Ana E. Bucher (Senior Climate Change Specialist, WBG).

This profile was written by MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by Yunziyi Lang (Climate Change Analyst, WBG).

Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

CONTENTS

FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group is committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

The World Bank Group is investing in incorporating and systematically managing climate risks in development operations through its individual corporate commitments.

A key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all IDA and IBRD operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one stop shop' for global, regional, and country data related to climate change and development.

Recognizing the value of consistent, easy-to-use technical resources for client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group has developed this content. Standardizing and pooling expertise facilitates the World Bank Group in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For developing countries, the climate risk profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

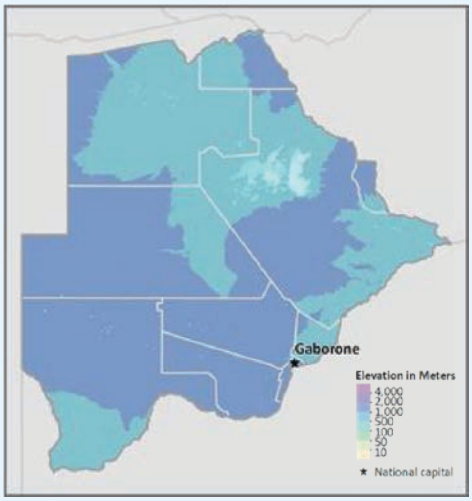
It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

Bernice Van Bronkhorst
Global Director
Climate Change Group (CCG)
The World Bank Group (WBG)

COUNTRY OVERVIEW

The Republic of Botswana is a landlocked country in Southern Africa, located between 20.0°–29.4° E and 17.8°–26.8° S. The country has a total land area of 600,370 square kilometers (km^2) and shares borders with Zambia and Zimbabwe to the northeast, Namibia to the north and west and South Africa to the south and southwest. Botswana has a distinct geography, which is dominated by the Kalahari Desert (a sand-filled basin averaging 1,100 meters (m) above sea level), the Okavango swamps covering over 18,000 km^2, and the Zambezi River. Botswana's climate is arid to semi-arid with warm winters and hot summers and highly erratic rainfall, most of which occurs from October to April.[1] **Figure 1** shows the topography for Botswana.

FIGURE 1. Topography of Botswana[2]



Botswana has had a relatively stable political environment with a multi-party democratic tradition and general elections are held every five years; however, the ruling party, Botswana Democratic Party, (BDP) has been in power since 1966.[3] Botswana has a population of 2.3 million people (2018) with an annual population growth rate of 2.2% and the population is expected to reach 2.8 million by 2030 and 3.4 million in 2050.[4] Around 77% and 84% of Botswana's population is expected to reside in urban areas by 2030 and 2050, respectively.[5] The country has a Gross Domestic Product (GDP) of $18.6 billion (2018), experiencing an annual growth rate of 4.5% in 2018.[6] Since gaining independence, the country has been one of the world's fastest growing economies, averaging 5% per annum over the past decade (**Table 1**). However, Botswana's unemployment is also among the highest in the Southern African Development Community (SADC) region at 17.6% (2016),[7] and is above both world and sub-Saharan Africa average rates.[8] It maintains a heavy reliance on international commodities and growth is expected to continue to be driven by mining activities, construction, and the services sector. Significant mineral wealth (diamond), good governance, prudent economic management, and a relatively small population have helped to make Botswana a generally stable and prosperous country since its independence in 1966.[9]

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1 Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

2 World Bank Group (2019). Internal Climate Migration Profile – Botswana.

3 World Bank Group (2020). The World Bank in Botswana – Overview. URL: http://www.worldbank.org/en/country/botswana/overview

4 World Bank Open Data, Data Retrieved April 2020. Data Bank: Population Estimates and Projections, Botswana. URL: https://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:-population-estimates-and-projections

5 World Bank Open Data, Data Retrieved April 2020. Health Nutrition and Population Statistics: Population estimates and projections – Botswana. URL: https://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:-population-estimates-and-projections

6 World Bank Open Data, Data Retrieved April 2020. Data Bank: World Development Indicators, Botswana. URL: https://databank.worldbank.org/data/reports.aspx?source=2&country

7 Statistics Botswana (2018). Botswana Multi-topic Household Survey, 2015/16. ISBN:978-99968-2-040-3. URL: https://www.statsbots.org.bw/sites/default/files/Botswana%20Multi%20Topic%20Household%20Survey%20REPORT%202015%2016.pdf

8 IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

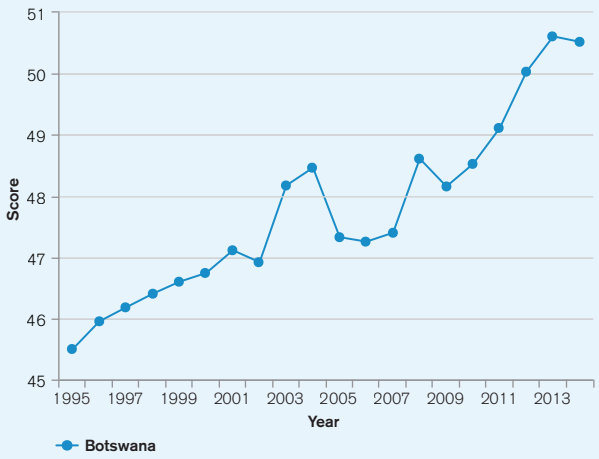
9 World Bank Group (2020). The World Bank in Botswana – Overview. URL: http://www.worldbank.org/en/country/botswana/overview

TABLE 1. Data snapshot: Key development indicators[10]

Indicator	2018
Life expectancy at birth, total (years)	69.3
Population density (people per sq. km land area)	4.0
% of Population with access to electricity	94.9%
GDP per capita (current US$)	$8,279.60

The ND-GAIN Index[11] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Botswana is recognized as vulnerable to climate change impacts, ranked 94 out of 181 countries in the 2019 ND-GAIN Index. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 2** is a time-series plot of the ND-GAIN Index showing Botswana's progress.

FIGURE 2. ND-GAIN Index for Botswana



Botswana is considered highly vulnerable to climate variability and change due to its high dependence on rain-fed agriculture and natural resources, high levels of poverty – particularly in rural areas, and a low adaptive capacity to deal with these expected changes.[12] Primary challenges are centered around water resource availability, changing precipitation patterns and increasing population demands. Climatic and socio-economic environments in semi-arid areas in Botswana make communities vulnerable to food insecurity and unstable livelihoods as well as unsustainable agroecological systems, crop failure and unproductive rangelands.[13]

Botswana submitted its Nationally-Determined Contribution to the UNFCCC in 2016, in support of the country's efforts to realize its development goals and increase its resilience to climate change, described in the Botswana Climate Change Response Policy.[14] The country published its Third National Communication to the UNFCCC in 2019.

[10] World Bank (2020). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

[11] University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

[12] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc

[13] ASSAR (2015). Understanding vulnerability and adaptation in semi-arid areas in Botswana. URL: http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Info_briefs/Botswana%20Information%20Brief.pdf

[14] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc

Botswana remains committed to developing a long term, low carbon development strategy and supporting the necessary mitigation and adaptation activities in order to reduce its vulnerability to climate change, and protecting the livelihoods of its population. Key focus is on the sustainability of the environment, water resources, sustainable land management, agriculture, and health sectors.[15]

CLIMATOLOGY

Climate Baseline

Overview

Botswana lies entirely within the shallow basin formed by the high-lying interior of the southern Africa plateau and is underlain by basement granites, which in turn are covered by the Karroo sedimentary layer within which the Ecca shales are found. These sediments host Botswana's coal deposits. Diamond-bearing ores are found in volcanic intrusions known as the kimberlite dykes located at Orapa, Letlhakane and Jwaneng. Three-quarters of the land surface is covered by the Kalahari sands. The Okavango Delta, the world's largest inland delta, is located in the northwest of the country and is characterized by vast areas of open water and wetlands and an abundance of wildlife. North-central parts of the country are dominated by the Makgadikgadi Pans, a large salt pan.[16] Central and West areas of the country are dominated by the Kalahari Desert and grassland and sandy soils; this area is best suited for livestock, as opposed to agriculture. Eastern areas have more fertile soils and grasslands with annual rainfall exceeding 400 millimeters (mm).[17]

Overall, the country is arid to semi-arid with highly erratic rainfall. Botswana's climate is determined by its inland location, astride the subtropical high-pressure belt. During the summer months (November to March) the Inter-Tropical Convergence Zone (ITCZ) brings moisture to the northern areas and becomes progressively drier towards the country's western areas. The mean annual rainfall ranges from over 650 mm in the northeast to less than 250 mm in the southwest; annual rainfall covers a range from 620 mm in the northern Kasane area to 300 mm in the southwestern Tsabong area. The national average rainfall is 475 mm per year. Most rain occurs in the months from October to April, and falls as localized showers or thunderstorms. Temperatures for the country are generally warm to hot, with mean monthly maximum temperatures ranging from 29.5°C to 35°C summer, and 19.8°C to 28.9°C in winter. Mean monthly minimum temperatures range from 14.6°C to 20.8°C in summer, and 2.9°C to 11.6°C in winter. Botswana is highly vulnerable to climate change and the sparse and highly variable rainfall. The high evaporation rate and the virtual absence of permanent surface water over large parts of the country combine to ensure that water is a scarce resource in Botswana.[18]

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[15] Botswana (2016). Botswana Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/BotswanaFirst/BOTSWANA.pdf

[16] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[17] CIMA Research Foundation (2018). Disaster Risk Profile – Botswana. UNISDR. URL: https://www.unisdr.org/we/inform/publications/63281

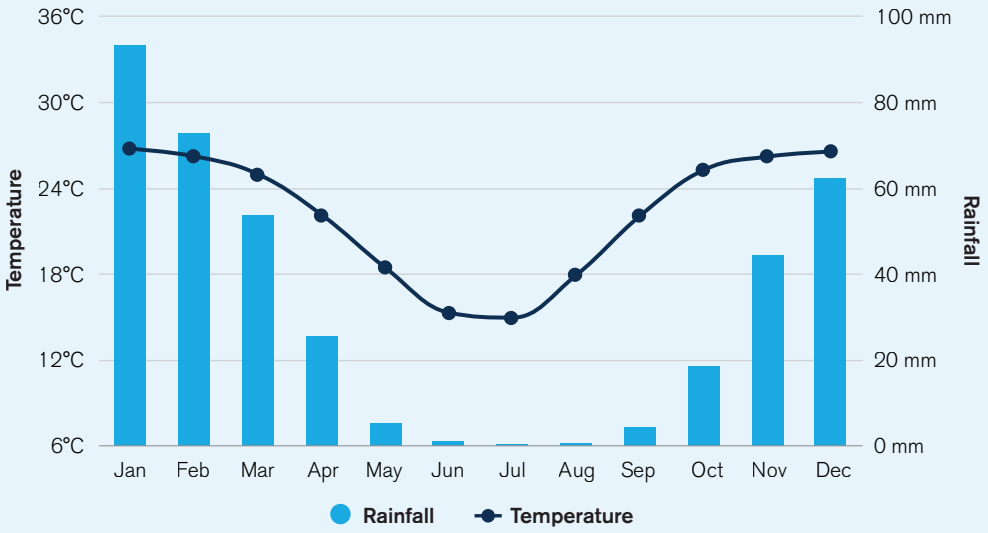
[18] National Disaster Management Office (2013). National Disaster Risk Reduction Strategy 2013–2018. URL: http://www.bw.undp.org/content/dam/botswana/docs/Gov%20and%20HR/Botswana%20National%20Disaster%20Risk%20Reduction%20Strategy-April%202013.pdf

TABLE 2. Data snapshot: Summary statistics

Climate Variables	1901–2019
Mean Annual Temperature (°C)	**21.6°C**
Mean Annual Precipitation (mm)	**396.2 mm**
Mean Maximum Annual Temperature (°C)	**29.6°C**
Mean Minimum Annual Temperature (°C)	**13.6°C**

Data from the World Bank Groups's Climate Change Knowledge Portal (CCKP) (**Table 2**) shows historical information for 1901–2019. Mean annual mean temperature for Botswana is 21.6°C, with average monthly temperatures ranging between 26°C (December, January) and 14°C (July). Mean annual precipitation is 396 mm, with highest rainfall occurring December through March, with extremely low precipitation occurring between June to August (**Figure 3**).[19] **Figure 4** shows the spatial variation of the observed average annual precipitation and temperature across Botswana.

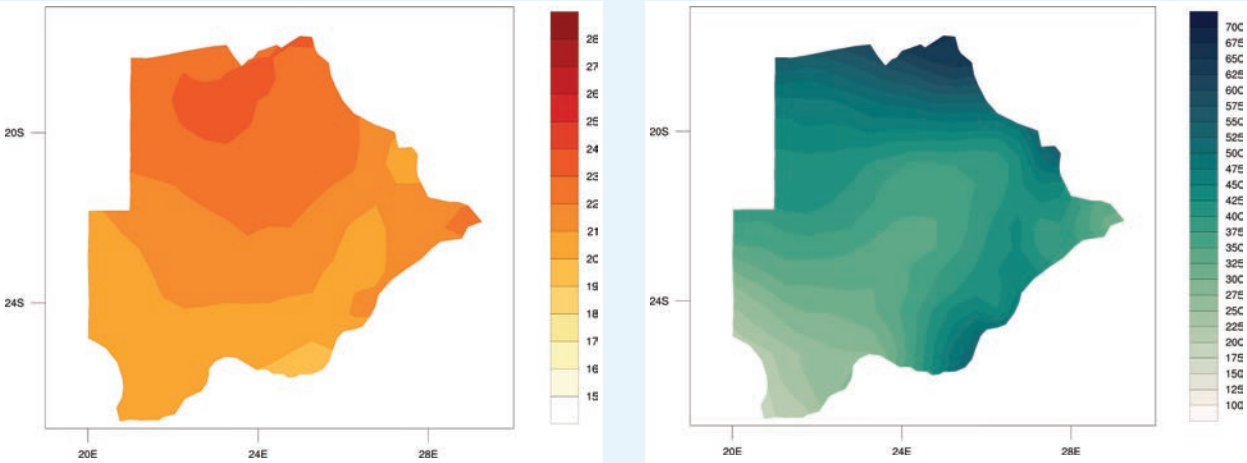
FIGURE 3. Average monthly temperature and rainfall for Botswana, 1991–2019[20]



[19] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-historical

[20] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-historical

FIGURE 4. Map of average annual temperature (left); annual precipitation (right) of Botswana, 1901–2019[21]

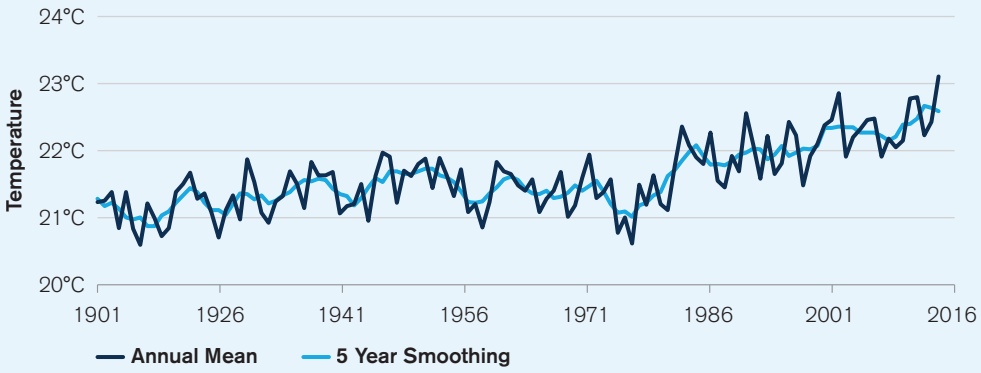


Key Trends

Temperature

Botswana has observed considerable temperature increases and since the 1970s and average temperatures have increased 1.5°C,[22] (**Figure 5**) with central, arid parts of the country's interior observed to have increased by as much as 2°C. The most noticeable increases in temperature have been observed between November to March. Throughout the southern Africa region, including Botswana, an increase in the number of warm days and nights have been observed along with a decrease in the number of cold days and nights.[23]

FIGURE 5. Observed temperature for Botswana, 1901–2019[24]



[21] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-historical

[22] CIMA Research Foundation (2018). Disaster Risk Profile – Botswana. UNISDR. URL: https://www.unisdr.org/we/inform/publications/63281

[23] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[24] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-historical

Precipitation

Trends in precipitation for Botswana remain highly variable, however an overall reduction in precipitation has been observed for the southern Africa region; characterized by below normal rainfall and more frequent droughts.[25] Botswana has observed a reduction in late summer precipitation, primarily from November to March. Changes in the onset, duration, and intensity of rainfall, including increased frequency of dry spells have also been observed. This has resulted in an increased frequency of intense rainfall events being experienced, as well as the frequency of more intense and longer lasting droughts.[26] Impacts have been most pronounced in the east and southern areas of the country.[27]

Climate Future

Overview

The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project No.5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for essential climate variables under high emission scenario (RCP 8.5) over 4 different time horizons. **Figure 6** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

TABLE 3. Data snapshot: CMIP5 ensemble projections

CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Monthly Temperature Anomaly (°C)	**+0.6 to +2.2** (+1.4°C)	**+1.6 to +3.5** (+2.5°C)	**+2.8 to +5.2** (+3.8°C)	**+3.9 to +7.1** (+5.0°C)
Monthly Precipitation Anomaly (mm)	**−18.8 to +11.9** (−2.4 mm)	**−24.9 to +9.5** (−5.3 mm)	**−25.6 to +9.3** (−7.1 mm)	**−32.1 to +6.1** (−9.5 mm)

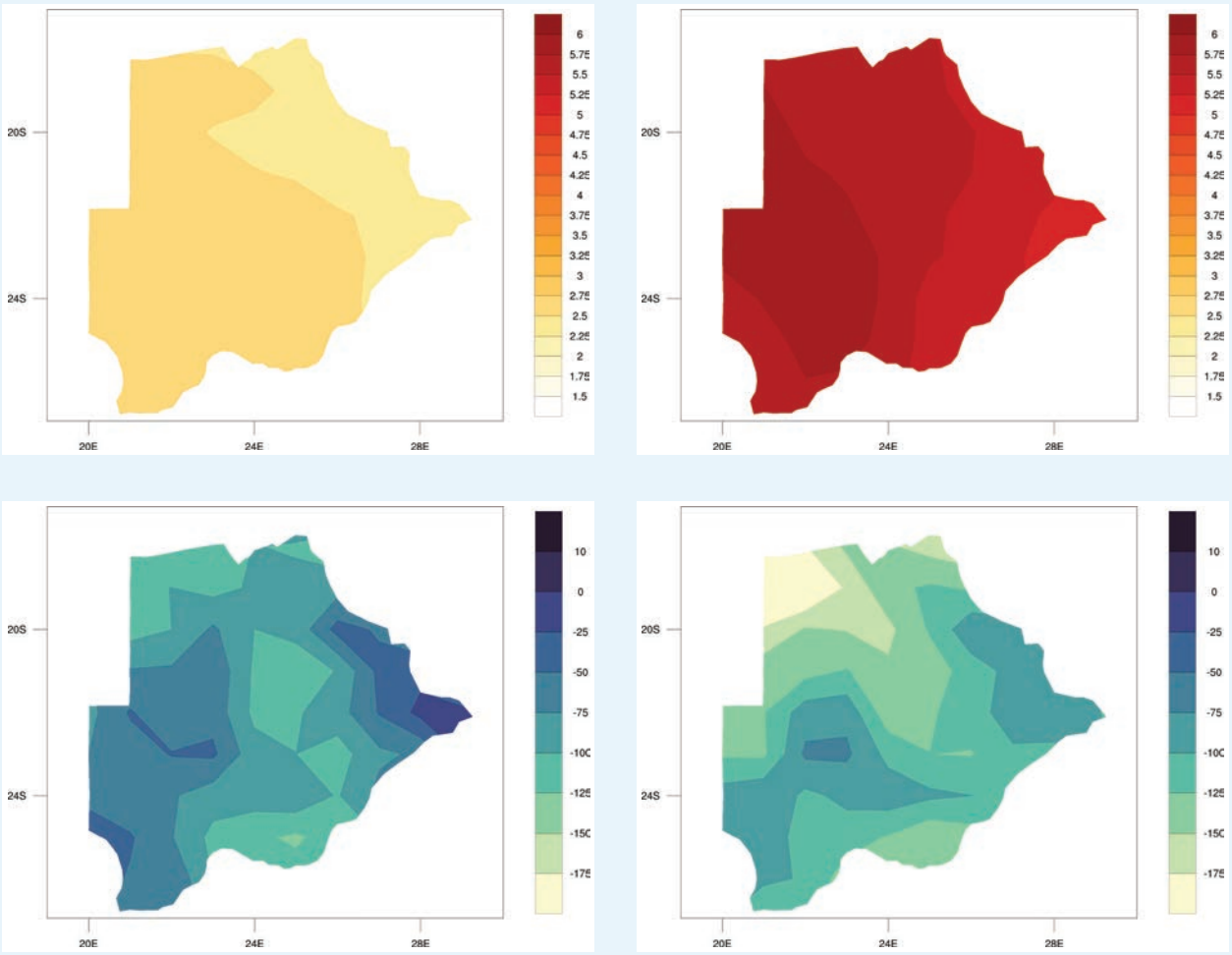
Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th-90th Percentile) and values in parentheses show the median (or 50th Percentile).

[25] SADC Secretariat (2016). Climate Change Adaptation in SADC, A strategy for the Water Sector. URL: https://www.sadc.int/files/2213/5293/3544/SADC_Climate_Change_Adaptation_for_the_Water_Sector_booklet.pdf

[26] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[27] CIMA Research Foundation (2018). Disaster Risk Profile – Botswana. UNISDR. URL: https://www.unisdr.org/we/inform/publications/63281

FIGURE 6. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), relative to 1986–2005 baseline under RCP8.5[28]



Key Trends

Temperature

Increased temperatures are expected for southern Africa and specifically for Botswana, with mean monthly temperature changes expected to increase by 2.5°C for the 2050s and by 5.0°C by end of the century, under a high-emission scenario. The number of 'hot' days are expected to increase by an additional 138 days by the end of the century, under a high-emission scenario. The most rapid increases are expected from November to March. Temperature increases are also expected to result in more intense heat waves and higher rates of evapotranspiration, which will affect multiple aspects of local economic development and agricultural productivity.[29]

[28] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Projected Future Climate. URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-projections

[29] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

Temperature rise are projected to increase across all emission scenarios throughout the end of the century. As seen in **Figure 7**, under a high-emission scenario, average temperatures are expected to increase rapidly by mid-century. An increase is also expected for the change in the number of summer days (Tmax > 25°C), and the change in number of days across the seasonal cycle is projected to significantly spike from April to September as shown **Figure 8**. Increased heat and extreme heat conditions will result in significant implications for human and animal health, agriculture, ecosystems as well as energy generation.

FIGURE 7. Historical and projected average temperature for Botswana from 1986 to 2099[30]

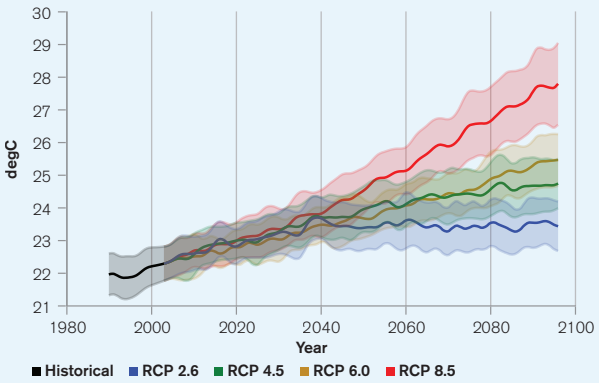
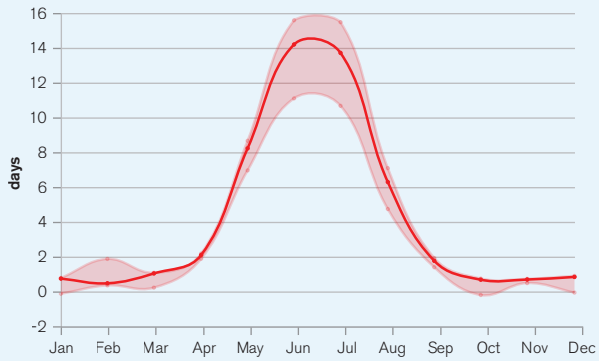


FIGURE 8. Projected change in summer days (Tmax > 25°C)[31]



Precipitation

While Botswana's projected precipitation has a high degree of inter-annual variability and high degrees of uncertainty, it is expected that overall, average rainfall will decrease across the country. Given the country's large area, arid environment, and diverse landscape, most of the country is expected to experience decreased rainfall, however the northeastern areas are likely to see increases in precipitation. Slightly drier conditions are anticipated for April to September, which is likely to also result in the increased frequency of droughts and dry spells.[32] Changes in monthly precipitation are shown in the graph below, with the greatest reduction in rainfall expected during the country's primary rainy season (October to April).

For areas of projected decreased precipitation, water resources are likely to be increasingly strained. In addition to warmer temperatures, this is expected to accelerate the rate of evapotranspiration for the country. With more frequent and severe droughts, the southern Africa region may also experience negative impacts on its water supply and water quality, posing a serious threat to the health of wetland ecosystems and agriculture and livestock communities.[33]

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[30] WB Climate Change Knowledge Portal (CCKP, 2020). Interactive Climate Indicator Dashboard - Agriculture. Botswana. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=BWA&period=2080-2099

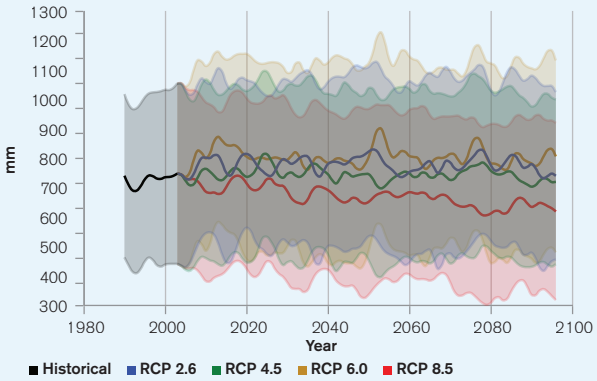
[31] WB Climate Change Knowledge Portal (CCKP, 2020). Climate Data – Projections, Botswana. URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-projections

[32] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[33] ASSAR (2015). Understanding vulnerability and adaptation in semi-arid areas in Botswana. URL: http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Info_briefs/Botswana%20Information%20Brief.pdf

Figure 9 shows the change in the projected annual average precipitation for Botswana. Water routing, storage and other management options can be highly varied depending if precipitation input comes frequently or with long periods of aridity in between rainfall.[34] As seen below, annual average precipitation is expected to decrease slightly by the of the century, under a high emissions scenario of RCP8.5.

FIGURE 9. Annual average precipitation in Botswana for 1986 to 2099[35]



CLIMATE RELATED NATURAL HAZARDS

Overview

Botswana has a high degree of risk to natural hazards. The country's vulnerability is exacerbated due to its high level of poverty and its dependence on key sectors most likely effected by climate change: agriculture, water, tourism, and health. While the country is at high-risk to natural disasters such as both flooding and drought, it's topographic diversity and poor rural areas increase this vulnerability. Projected trends indicate a decline in rainfall for much of the country with an increased likelihood of drought, particularly for northern, eastern and central areas. Countrywide, projected warming trends coupled with decreased rainfall are likely lead to increased water stress.[36] Temperature rise as well as the increase in the frequency and intensity of extreme droughts and floods is likely to reduce crop yields and cause a loss in livestock, which will have important implications for food security.[37] Additionally, non-climate stressors such as inadequate infrastructure, structural inequalities, ill-prepared governance structures and an increasing population are also impacting the vulnerability to natural disaster sensitivity and climate change resiliency.[38]

[34] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Water Dashboard. Data Description. URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-sector-water

[35] WB Climate Change Knowledge Portal (CCKP, 2020). Climate Data-Projections. Botswana. URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-data-projections

[36] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[37] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[38] ASSAR (2015). Understanding vulnerability and adaptation in semi-arid areas in Botswana. URL: http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Info_briefs/Botswana%20Information%20Brief.pdf

Botswana is exposed to numerous hazards including droughts, floods, earthquakes, strong winds, land fires and pest infestations. Recurring droughts and floods have the most severe impact on the population and the country has a long history of both recurring floods and droughts, however the magnitude, frequency, and impact has been observed to have increased.[39] The current trends of weather variability for Botswana are expected to lead to droughts, as well as floods, and soil erosion particularly along river areas and embankments. Indications point to the incidence of floods and droughts that have been increasing over recent years. Climate variability is already negatively impacting livelihoods and this is expected to continue. Droughts and floods are the most destructive climate-related natural hazards in Botswana.[40]

Data from the Emergency Event Database: EM-Dat database,[41] presented in **Table 4**, shows the country has endured various natural hazards, including floods, landslides, epidemic diseases, and storms.

TABLE 4. Natural disasters in Botswana, 1900–2020

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	6	0	1,344,900	47,000
Epidemic	Bacterial Disease	1	2	15	0
	Parasitic Disease	1	183	14,618	0
Flood	Flash Flood	1	20	5,500	0
	Riverine Flood	7	23	164,609	5,000
Insect Infestation	Locust	1	0	0	0
Storm	Convective Storm	1	0	400	0

Climate Change Impacts

Climate change is expected to increase the risk and intensity of flooding as well as increase the likelihood for water scarcity for northern, central and eastern areas of the country. Increased potential for higher intensity rainfall events will lead to the heightened risk of flooding, loss of life, and damage to property and infrastructure. Intense rainfall and flooding may also result in soil erosion and water logging of crops, thus decreasing yields and increasing food insecurity. The increased likelihood of increased aridity and drought stress is expected to lead to water scarcity in some areas, resulting in increased demand for water, raising the potential for conflict and biodiversity loss. Higher temperatures with increased aridity may also lead to livestock stress and reduced crop yields.[42] This

[39] CIMA Research Foundation (2018). Disaster Risk Profile – Botswana. UNISDR. URL: https://www.unisdr.org/we/inform/publications/63281

[40] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

[41] EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/

[42] National Disaster Management Office (2013). National Disaster Risk Reduction Strategy 2013–2018. URL: http://www.bw.undp.org/content/dam/botswana/docs/Gov%20and%20HR/Botswana%20National%20Disaster%20Risk%20Reduction%20Strategy-April%202013.pdf

is likely to result in significant economic losses, damage to agricultural lands and infrastructure as well as human casualties. Furthermore, land degradation and soil erosion, exacerbated by recurrent flood or drought, adversely impacts agricultural production, further affecting the livelihoods of the rural poor. Small rural small farmers, are more sensitive to impacts of disasters (floods, dry periods) because they have limited resources with which to influence and increase their adaptive capacity.[43]

Floods are the most frequently occurring disaster event in Botswana and are primarily caused by heavy rains that mainly affect communities in flood-prone areas. Disasters have historically been concentrated along rivers such as the Zambezi River, the Okavango River and its delta, Boteti River and Limpopo River. Storms, typically emanating from tropical cyclones occurring in the region from the Indian Ocean, result in heavy rains and flooding. Increasing urbanization has increased flood risk locations due to the absence of functioning water drainage systems. Urban areas such as Gabarone, Francistown, Molepolole, Selebi-Phikwe and Maun (the five largest and most population-dense towns in Botswana), as well as Tutume, Mahalapye, Serowe and Letlhakane, have already been heavily affected by flood disasters.

Botswana as a whole, is also prone to drought, recurrent dry spells, and desertification. Nearly 2/3 of the country is covered by the Kalahari Desert. Botswana shares the Limpopo, Okavango, Orange and Zambezi river catchments with neighboring countries, and the country's water shortages imply a dependency on these countries for Botswana's domestic water needs. Expected changes in weather patterns are thus likely to increase the country's vulnerability to scarce water resources. Additionally, the heavy reliance on cattle and livestock as a key livelihood generator increases population vulnerability to drought. Overgrazing and intense rainfall may result in flash flooding experienced in some areas. This is likely to further drive rural-to urban migration patterns and contribute to urban population pressures.[44]

Disaster Risk from increased temperatures is expected to (i) exacerbate existing tensions between agricultural and livestock needs as well as human population needs for water, especially during the dry season, (ii) alter the quality of available water from surface water and groundwater, and (iii) increase pressure on urban zones due to increased urbanization.[45] Changing rainfall patterns are expected to play a significant role in agricultural production and harvest seasons, with later onsets expected to impact crop productivity as well as livestock health. Droughts have remained one of the key drivers of food insecurity, with increased aridity and drought resulting in crop damage, loss of pasture and water sources, loss of animals, hunger, disease outbreaks, asset depletions, malnutrition and migration. Increased temperatures and degraded agricultural conditions are expected to adversely affect 'working days', impacting livelihoods and the economic resilience of vulnerable groups.[46] The resulting likely sharp reductions in agricultural output and related productive activity and employment creates a multiplier effect on both regional and national economies. **Figure 10** demonstrates the risk of water scarcity and extreme heat for Botswana.

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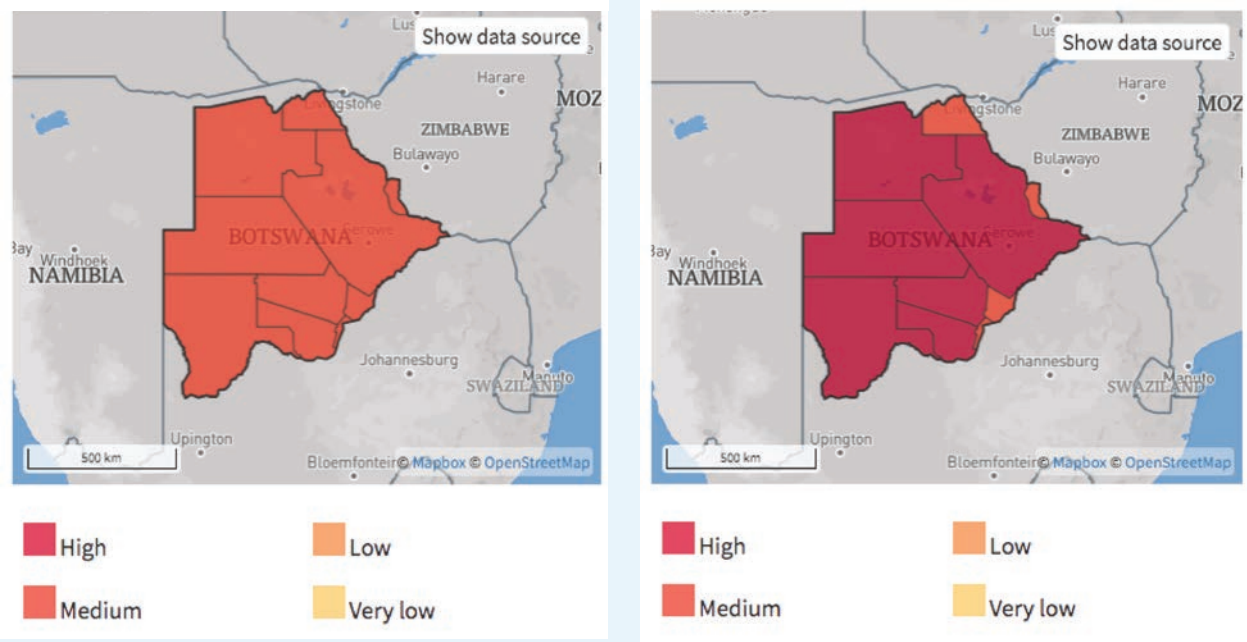
[43] FAO (2014). Country Programming Framework for Botswana 2014–2016. URL: http://www.fao.org/3/a-bp626e.pdf

[44] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

[45] National Disaster Management Office (2013). National Disaster Risk Reduction Strategy 2013–2018. URL: http://www.bw.undp.org/content/dam/botswana/docs/Gov%20and%20HR/Botswana%20National%20Disaster%20Risk%20Reduction%20Strategy-April%202013.pdf

[46] CIMA Research Foundation (2018). Disaster Risk Profile – Botswana. UNISDR. URL: https://www.unisdr.org/we/inform/publications/63281

FIGURE 10. Risk of water scarcity (L)[47]; risks of extreme heat (R)[48]



Implications for DRM

The Government of Botswana is focused on the prevention, mitigation, preparedness, response and recovery to disasters and is working to integrate an effective disaster management strategy into sectoral policies and programs. Existing disaster risk reduction measures are being implemented by various sectors such as Agriculture, Forestry and Health. However, this work is looking to scale across all sectors.[49] The National Disaster Risk Management Plan was developed in 2009, with the goal to enable achievements towards sustainable development by carrying out disaster risk reduction activities, reducing vulnerability and increasing resilience. Legislation and policies are currently coordinated through the National Disaster Risk Management Plan.[50]

Botswana also relies on support from regional strategies and action, through the Africa Regional Strategy for Disaster Risk Reduction (2004) and the Southern African Development Community's Disaster Risk Reduction Strategy and Plan of Action 2010–2015. These strategies emphasize effective disaster risk management and increased resilience to climate change by (i) increased political commitment to disaster risk reduction; (ii) improved identification and assessment of disaster risks; (iii) enhanced knowledge management for disaster risk reduction; (iv) increased public

[47] ThinkHazard! (2020). Botswana. Water Scarcity. URL: http://thinkhazard.org/en/report/35-botswana/DG
[48] ThinkHazard! (2020). Botswana. Extreme Heat. URL: http://thinkhazard.org/en/report/35-botswana/EH
[49] National Disaster Management Office (2013). National Disaster Risk Reduction Strategy 2013–2018. URL: http://www.bw.undp.org/content/dam/botswana/docs/Gov%20and%20HR/Botswana%20National%20Disaster%20Risk%20Reduction%20Strategy-April%202013.pdf
[50] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

awareness of disaster risk reduction; and (v) improved governance of disaster risk reduction institutions.[51] Within Botswana, public awareness and education has formed the cornerstone of Disaster Risk Management (DRM) initiatives designed to enhance individual and community resilience. These strategies are improving efforts on multi-hazard risk analysis and strengthened early warning systems at regional and national level.[52]

CLIMATE CHANGE IMPACTS TO KEY SECTORS

Botswana remains highly vulnerable to climate variability and longer-term climate change, particularly for the country's water, agriculture, public health,[53] forestry, and mining sectors.[54] Impacts of climate change are already being experienced across the southern Africa region. Water scarcity and drought conditions are expected to increase risks of food insecurity and may exacerbate conflict situations over scarce resources and population movements.[55] Heavy rains, flooding, and soil erosion puts both urban and rural infrastructure at risk, particularly for poor and vulnerable groups. Furthermore, increased occurrences of aridity and drought conditions and reduced rainfall across much of the country (predominantly east, central, northern areas) will impact agriculture, livestock, food security, and human health. Environmental degradation, impacted water resources, and loss of biodiversity and ecosystem services constitute serious obstacles to the country's continued development and poverty reduction efforts. Botswana's increased vulnerability to risks and hazards increases the importance for sustainable adaptation and resilience measures.[56]

Agriculture

Overview

Botswana imports 90% of its food overall.[57] Agriculture in Botswana is predominantly rain-fed, making the country inherently vulnerable to climate variability and change. Projected climate change trends threaten the regional cereal production and the export/import of key staple crops for both Botswana and wider southern Africa, threatening

[51] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc

[52] National Disaster Management Office (2013). National Disaster Risk Reduction Strategy 2013–2018. URL: http://www.bw.undp.org/content/dam/botswana/docs/Gov%20and%20HR/Botswana%20National%20Disaster%20Risk%20Reduction%20Strategy-April%202013.pdf

[53] Botswana, (2016). Botswana Nationally Determined Contribution. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Botswana/1/BOTSWANA.pdf

[54] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[55] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

[56] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[57] Moseley, W. (2016). Agriculture on the Brink: Climate Change, Labor and Smallholder Farming in Botswana. *Land*. 5(21). doi:10.3390/land5030021

import supplies, food pricing, and thus food security; already yield staples have reduced in recent years.[58] For Botswana, grain prices and market dependency are regionally-tied, and the country relies on imports to meet national demand for key staples: maize and sorghum, which is derived mainly from South Africa.[59] More than half of the population lives in rural areas and remains largely dependent on subsistence crop and livestock farming. The domestic agriculture sector meets only a small portion of local food needs and contributes little to GDP, however the sector remains a social and cultural standard.

Crop production in Botswana is hindered by traditional farming methods, recurrent drought, erosion, and pest disease. The principal crops for domestic use are sorghum, corn, and millet.[60] Most of the land under cultivation is in Botswana's eastern region. Livestock, dominated by cattle currently estimated at 2–3 million head, has experienced a protracted decline in recent years.[61] Given the expectation of increased temperatures and reduction in precipitation, particularly for key agriculture zones in the eastern areas of the country, yields of maize and sorghum are expected to reduce by 10% to 35% by mid-century and will also present serious challenges to livestock.[62]

Climate Change Impacts

Botswana's agriculture sector is vulnerable due to its under-developed infrastructure, stagnating farm incomes, reduced support for agricultural extension services, lagging technological innovation and research, poor farming practices and an increase in pests and diseases. Regionally, climate impacts on the sector will be largely detrimental, placing greater emphasis on intra-regional markets and trade to meet food security demands.[63] As the sector relies heavily on ground and surface water supply, both of which are sensitive to localized land use and precipitation patterns. As such, the sector is likely to experience decreasing recharge and quality due to reduced precipitation in some areas; increasing evapotranspiration. An expected trend of reduction in rainfall can have consequences for agriculture and water quality, especially in more arid areas. Increased temperatures and the threat of waterlogging of fields may also result in an increased presence of pests and diseases harmful to yield production and quality. Changes in seasonality of precipitation will lead to further soil erosion and loss of soil fertility. The total annual cost of land degradation is estimated at $353 million; equal to 3.2% of the country's GDP. A significant share of the costs of land degradation (73%) is due to the decline in provisioning ecosystem services (e.g. food availability, wood production, etc.), which has a significant impact on the population of the country. Continued land degradation often stems from land-use decision-making processes, often driven by high market prices of specific ecosystem services.[64]

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[58] Bahta, S., Wanyoike, F., Katjiuongua, H., and Marumo, D. (2017). Characterization of food security and consumption patterns among smallholder livestock farmers in Botswana. *Agriculture and Food Security*, 6(65). DOI 10.1186/s40066-017-0145-1. URL: https://agricultureandfoodsecurity.biomedcentral.com/track/pdf/10.1186/s40066-017-0145-1

[59] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[60] WFP (2016). El Nino: Undermining Resilience. Implications of El Niño in Southern Africa from a Food and Nutrition Security Perspective. URL: https://www.wfp.org/content/el-nino-undermining-resilience-southern-africa-food-nutrition-security-february-2016

[61] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

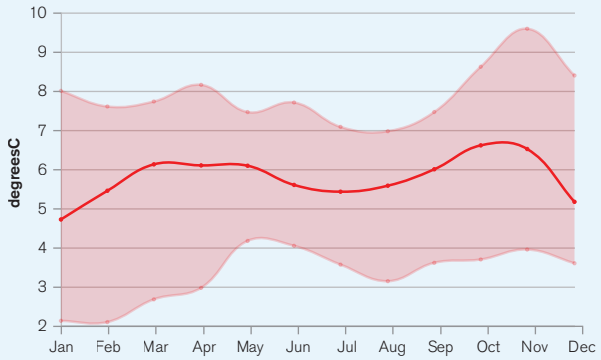
[62] ASSAR (2015). Understanding vulnerability and adaptation in semi-arid areas in Botswana. URL: http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Info_briefs/Botswana%20Information%20Brief.pdf

[63] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[64] Global Mechanism of the UNCCD (2018). Country Profile: Botswana. Investing in Land Degradation Neutrality – Making the Case. URL: https://www.unccd.int/sites/default/files/inline-files/Botswana_3.pdf

Increased likelihood of droughts and prolonged dry periods will increase soil erosion and exacerbate land degradation. Increased temperatures, particularly the increase in hot days is likely to increase the presence of pests and increase risks of fires. Increased frequency and intensity of extreme events may change or impact species' composition and alter 'regulating services' such as soil water maintenance, base flows and filtration.[65] Impacts to seasonal trends are projected to be most pronounced from July until October, resulting in full months of 'dry days' by the end of the century. **Figure 11** shows the average daily max-temperature across seasonal cycles. These higher temperatures coupled with increasing numbers of dry-days will have implications for impacts to soil moisture and crop growth and as seen in the graph below, increased temperature is expected throughout the year, impacting planting and harvest seasons as well as livestock health.

FIGURE 11. Average daily max temperature for Botswana[66]



Adaptation Options

Both the sensitivity of the agricultural sector to the climate and the high reliance of this sector on rain-fed agriculture have important implications for Botswana. The Botswana National Adaptation Plan (NAP) and Action Plan (under development) will highlight priority areas for improved land management as well as promote Climate Smart Agriculture techniques such as low to zero tillage and multi-cropping to increase mulching can reduce evapotranspiration and soil erosion.[67] The country is focused on increasing its resilience for sustainable crop production and livestock practices for increased food security and higher farmer incomes.[68] As such, improvements should be made concerning soil and water conservation and water storage as well as investments in irrigation structures throughout the country, particularly in more arid agricultural areas. Improvements can also be made regarding conservation agriculture, watershed management, and nutrient and crop management as well as the diversification of crops and livestock and the use of more drought resistant crop varieties; shifting from maize to sorghum to pearl millet.[69]

[65] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[66] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=BWA&period=2080-2099

[67] Botswana (2016). Botswana Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/BotswanaFirst/BOTSWANA.pdf

[68] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[69] ASSAR (2015). Understanding vulnerability and adaptation in semi-arid areas in Botswana. URL: http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Info_briefs/Botswana%20Information%20Brief.pdf

Diversification of income away from the reliance on farming operations can also be an effective strategy for making farmers more resilient to climate change risks and more food secure for the future. Financing options for farmers should be more accessible as well as the development of insurance schemes for farmers to protect against climate change.[70] Improvements can also be made to the weather monitoring network and associated weather information systems, including the publication and distribution of agriculture-specific weather forecasts on a frequent basis (e.g. short-term and seasonal forecasts, monitoring of heavy rainfall, etc.). The introduction of improved genetic characteristics for livestock breeds, improved livestock diets and the promotion for the switch to drought resistant strains, such as high temperature tolerant and short maturity crops will also help farmers to integrate climate smart agricultural techniques.[71]

Water

Overview

Groundwater is the main source of potable water supply in Botswana. Except for the urban centers and a few major villages, most villages depend on groundwater for their water needs. However, groundwater recharge is very limited and surface water resources are the main source of water supply for urban areas. Supply from surface water was expected to rise to 57% of consumption in 2020, with the Limpopo and Zambezi Rivers viewed as potential sources to meet the country's future water needs. The main threats to the water resources are over-exploitation and pollution. The main sources of pollution are industrial and domestic effluent from settlements, human waste from pit latrines, and waste disposal on the dam catchment areas and shallow aquifers. Water sources are monitored on a regular basis to assess the deterioration in the quality.[72]

Climate Change Impacts

Changes in water quality and availability is expected to be the predominant impact in Botswana in future climate scenarios. Stream flows for the Okavango catchment is projected to decrease by 20% and more variable rainfall will also likely increase disasters associated with droughts, floods and waterborne diseases. As such, transboundary water management presents a unique opportunity and challenge. Botswana experiences supply deficits (November to March), limiting development. Rising demands and increasing levels of pollution across shared water resources are a critical problem.[73] Expected changes in weather patterns are likely to increase the country's vulnerability and further stress domestic water dependency. Unpredictable rainfall patterns and water scarcity, dry spells and desertification, and crop diseases put agricultural production at risk, mainly exposing rural areas and subsistence farmers to unsustainable agricultural livelihoods, food insecurity and health vulnerabilities.[74] While droughts and

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[70] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[71] Global Mechanism of the UNCCD (2018). Country Profile: Botswana. Investing in Land Degradation Neutrality – Making the Case. URL: https://www.unccd.int/sites/default/files/inline-files/Botswana_3.pdf

[72] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[73] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

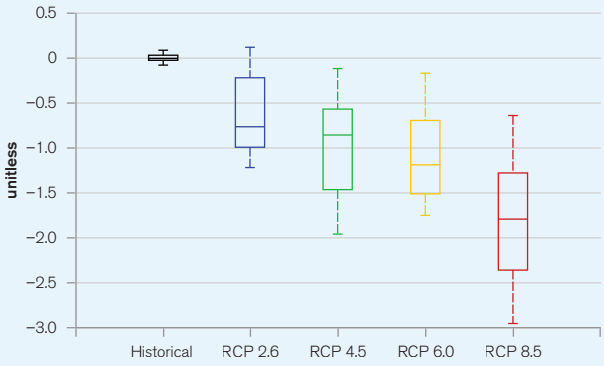
[74] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

floods are normal events in the region's climate context, increased frequency and intensity is cause for concern. Furthermore, groundwater exploitation is at risk of exhausting wellfields and supplies from surface water is expected to rise to 57% of consumption by 2020.[75]

Projected increases in the frequency of droughts, increased evaporation and evapotranspiration along with potential changes in rainfall patterns and runoff may further reduce availability in water-scarce regions (northern, eastern and central).[76] Rainfall and evaporation changes also impact degrees of surface water infiltration and recharge rates for groundwater and low-water storage capacity increases the country's dependence on increasingly unreliable rainfall patterns. Changes in rainfall and evaporation translate directly to changes in surface water infiltration and groundwater re-charge. This has the potential for further decreased reliability of unimproved groundwater sources and surface water sources during droughts or prolonged dry seasons. Increased strain on pump mechanisms leading to breakdowns if maintenance is neglected and the potential for falling water levels in the immediate vicinity of wells or boreholes, particularly in areas of high demand.[77] Additionally, temperature increases have the potential to result in increased soil moisture deficits even under conditions of increasing rainfall.

The projected annual Standardized Precipitation Evapotranspiration Index (SPEI) is an index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration and providing insight into increasing or decreasing pressure on water resources. Negative values for SPEI represent dry conditions, with values below –2 indicating severe drought conditions, likewise positive values indicate increased wet conditions. This is an important understanding for the water sector in regards to quantity and quality of supply for human consumption and agriculture use as well as for the energy sector as reductions in water availability impacts river flow and the hydropower generating capabilities. As seen in **Figure 12**, Botswana is projected to experience heightened dry conditions and increased pressure on water resources by mid-century and by end of the century is likely to be experience severe drought conditions and water scarcity.

FIGURE 12. Annual SPEI Drought Index in Botswana for the period, 1986 to 2099[78]



[75] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[76] USAID (2015). Risk Vulnerability & Resilience in the Limpopo River Basin. Climate Change, Water and Biodiversity – a synthesis. URL: https://www.climatelinks.org/sites/default/files/asset/document/Risk,%20Vulnerability%20and%20Resilience%20in%20the%20Limpopo%20River%20Basin%20-%20A%20Synthesis_0.pdf

[77] IOM (2017). Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. Disaster risks and disaster risk management capacity in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. URL: https://publications.iom.int/system/files/pdf/spaces_of_vulnerability.pdf

[78] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/water/land-use-/-watershed-management?country=BWA&period=2080-2099

Adaptation Options

Botswana should address the challenges of its water resources arising from increasingly variable rainfall patterns. Minimal data on groundwater resources exists and further resources should be invested to support existing monitoring of irrigation, groundwater wells and aquifers.[79] Sustainable and reliable development and proper use of the water resources of Botswana is necessary and should be led through a water resources management policy which will enhance and promote national efforts towards the efficient, equitable and optimum utilization of available water resources. Botswana has integrated water management into all important economic sectors and has developed a National Water Master Plan to support its broader climate change adaptation agenda.[80] As the country continues to develop and urbanize, increasing pressure can be expected on the water demands and related infrastructure. As such, development planning for urban expansion should be coordinated through the country's climate change adaptation strategies to ensure appropriate water management strategies are used and enacted. Planning and adaptation strategies for water resources should also be included within development strategies for agriculture, infrastructure, and energy sectors.[81] Improvements to the country's water infrastructure should be a priority.

Energy

Overview

The Energy Sector is key for Botswana's overall development and the sector contributes significantly to GDP and national employment as 54% of the country's energy consumption comes through the transport sector.[82] The Botswana Power Corporation (BPC) is the state-owned company for electrical power generation, transmission and distribution in Botswana. It was established in 1970 and is currently the only electricity supplier in the country. Botswana's energy sources consist primarily of electricity, fuel wood, liquefied petroleum gas (LPG), petrol, diesel and aviation gas. Solar, biogas and biodiesel constitute approximately less than 1% combined. Rural electrification has been an important component of the national development agenda for Botswana. However, the high cost of rural grid electrification programs has continued to be a barrier. Approximately 17% of the total rural population had access to grid electricity services, compared to 36% in the urban areas.[83] Botswana imports nearly 100% of its petrol, diesel and paraffin from South Africa, making it highly dependent upon South African and regional supplies, which are at risk to the reduction in regional precipitation.[84] Energy storage for the region lags behind most other regions in Africa, as does generation due to limited infrastructure, regulatory frameworks

[79] SADC Secretariat (2016). Climate Change Adaptation in SADC, A strategy for the Water Sector. URL: https://www.sadc.int/files/2213/5293/3544/SADC_Climate_Change_Adaptation_for_the_Water_Sector_booklet.pdf

[80] Botswana (2016). Botswana Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/BotswanaFirst/BOTSWANA.pdf

[81] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[82] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[83] Renewable Energy and Energy Efficiency Partnership (2014). Botswana Energy Overview. URL: https://www.reeep.org/botswana-2014

[84] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

and financing in the sector.[85] Household energy is dominated by fuelwood which contributes 58% to the total primary energy supplied. However, fuelwood usage has been declining over the years while LPG and electricity consumption has been on the rise, due to increasing electricity access, urban populations and affluence.[86]

Climate Change Impacts

Increased temperatures are likely to threaten cooling capacities of power generating stations with potential to impact generation and transmission. Increased production costs are likely to coincide with periods of increased demand; increasing prices for consumers. Projected trends are also expected to increase costs of maintenance and repairing of power and energy infrastructure as well as disrupt power supply.[87] Cooling Degree Days shows the relationship between daily heat and cooling demand, typically sourced through a form of active cooling or an evaporative process (**Figure 13**). The change in cooling degree days provides insight into the potential for extended seasons of power demand or periods in which cooling demand (power demands) might increase. As seen in the graph below, seasonal increases for cooling demands are expected to increase over an extended summer period (September to April). The Warm Spell Duration Index represents the number of days in a sequence of at least six days in which the daily maximum temperature is greater than the 90th percentile of daily maximum temperature. As shown in **Figure 14,** warm spells are expected to sharply increase in the second half of the century.

FIGURE 13. Change in cooling degree days (65°F) in Botswana for the period 2080–2099[88]

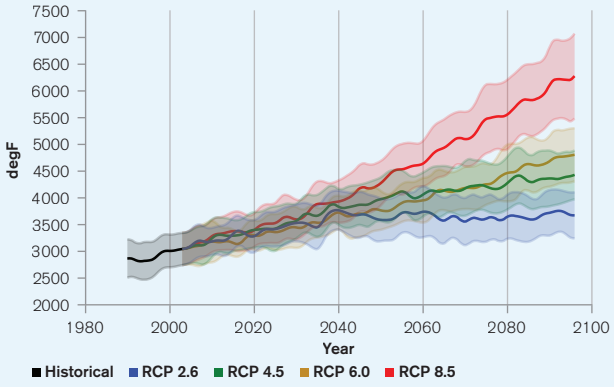
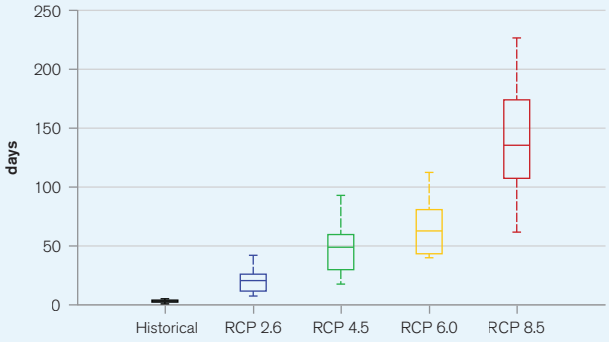


FIGURE 14. Warm Spell Duration Index in Botswana for the period 1986 to 2099[89]



[85] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[86] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[87] USAID (2016). Climate Change Risk Profile – Southern Africa. Regional Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Fact%20Sheet%20-%20Southern%20Africa.pdf

[88] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana – Energy. URL: https://climateknowledgeportal.worldbank.org/country/botswana/climate-sector-energy

[89] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Energy Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/energy/oil-gas-and-coal-mining?country=BWA&period=2080-2099

Adaptation Options

Effective energy generation, transmission and expanded use is critical to the country's overall development agenda and Botswana is under pressure to develop its energy generating capabilities in order to become more resilient to climate change and meet its development goals.[90] This is proposed to be achieved through the implementation of research programs, more efficient use of energy sources and the transition from wood fuel to LPG and electricity at household level; as outlined in Botswana's Vision 2016[91] and in support of Botswana's green economy.[92]

There is high potential for clean energy generation, however, the country's legal framework and institutional capacities should improve in order to facilitate this. The National Energy Policy is aimed at improved access, security, and reliability of energy supply to all sectors, particularly low income and marginalized groups through effective institutional arrangement and service delivery. Botswana's Vision 2016 has recognized the potential role that solar energy can play in meeting the energy requirements of rural communities not served by the national grid. While the Government of Botswana has implemented several strategies to advance the use of renewable energy in Botswana,[93] strengthened institutions and individual capacity needs to be built in renewable energy technology and management and policies should be designed to promote private investment in renewable energies such as increased hydropower capacity and solar.

Health

Overview

Currently, 30% of the population of Botswana is exposed to some risks of malaria infection every year. The majority of cases occurring in the Northern Districts, with Bobirwa, Tutume, Serowe, Palapye and Boteti are in the transition zone for malaria. During years of heavy rainfall, the risk of malaria shifts westwards and southwards. During the dry and cold months from May to September, there is typically little to no transmission. Additionally, diarrheal disease may be exacerbated by climate variability and change as variable rainfall patterns are likely to compromise the supply of fresh and clean water.[94]

Climate Change Impacts

Botswana is expected to have significant adverse health effects dude to climate change, primarily in relation to the expected increasing incidence of rising temperatures, floods, droughts and changing disease patterns. The country has a high incidence of climate-sensitive diseases and the risk of vector-borne diseases such as malaria and dengue fever are likely to increase by the 2070s.[95] Effects will be manifested through the increase in vector-borne and water-borne diseases, severe malnutrition, and increases in flood incidence and displacement of people.

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[90] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[91] Government of Botswana (2016). Vision 2016: Towards Prosperity for All. URL: https://paris21.org/sites/default/files/3144.pdf

[92] Government of Botswana (2016). Long Term Vision for Botswana. URL: https://paris21.org/sites/default/files/3144.pdf

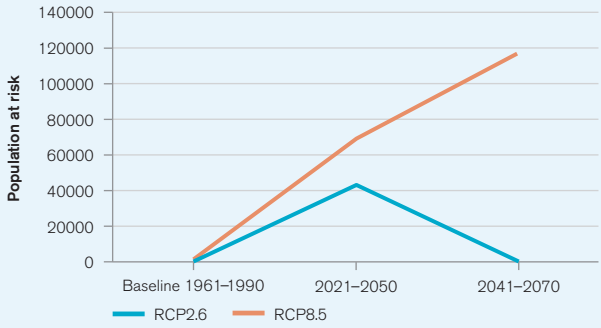
[93] Renewable Energy and Energy Efficiency Partnership (2014). Botswana Energy Overview. URL: https://www.reeep.org/botswana-2014

[94] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[95] WHO (2015). Climate and health country profile – Botswana. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

Under a high emissions scenario, the population at risk of malaria will continue to increase through the 2050s. Malaria infection in Botswana is unstable and epidemics are influenced by periods of heavy rainfall and thus the population is particularly susceptible to changes in environmental conditions. Climate change with increased variability in rainfall and extreme weather events may also impact the geographic and seasonal distribution of malaria risk in Botswana. **Figure 15** shows the projected risk of malaria in Botswana under a low (RCP 2.6) and high (RCP8.5) emission scenario.

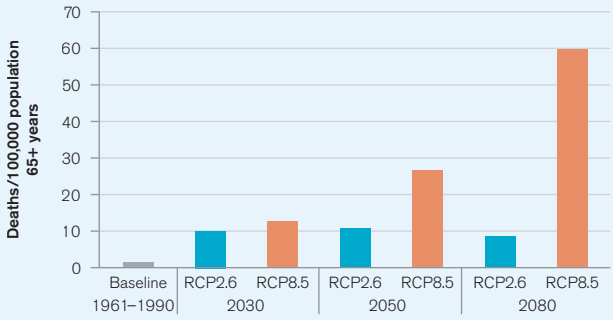
FIGURE 15. Population at risk of Malaria[96]



World Health Organization research suggests that higher temperatures, land and water scarcity, flooding, drought, and displacement in Botswana will negatively impact agricultural production, causing a breakdown in food systems. This is expected to disproportionally put the most vulnerable people at risk to undernutrition and food insecurity. Vulnerable groups risk further deterioration into food and nutrition crises if exposed to extreme climate events. In Botswana, the prevalence of stunting in children under age 5 was 31.4% in 2008, the prevalence of underweight children and wasting in children under 5 was 11.2% and 7.2%, respectively, in 2008; indicating high degrees of vulnerability for the country and specifically its poor and rural populations.[97]

Increasing temperatures along with water scarcity is an increasing concern for Botswana.[98] Under a high emissions scenario for heat-related deathin the elderly (65+ years) are projected to increase to about 136 deaths per 100,000 by the 2080s compared to the estimated baseline of approximately 3 deaths per 100,000 annually between 1961 and 1990. A rapid reduction in emissions could limit heat-related deaths in the elderly to about 20 deaths per 100,000 in the 2080s (**Figure 16**).[99]

FIGURE 16. Heat related mortality in population 65 or over in Botswana[100]



[96] WHO (2015). Climate and health country profile – Botswana. P. 3. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

[97] WHO (2015). Climate and health country profile – Botswana. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

[98] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[99] WHO (2015). Climate and health country profile – Botswana. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

[100] WHO (2015). Climate and health country profile – Botswana. P. 4. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

In Botswana, the annual distribution of days with a high-heat index provides insight into the health hazard of heat. **Figure 17** shows the expected Days with a Heat Index >35°C for the 2090s; showing a sharp increase towards the latter half of the century under a high-emission scenario. Night temperatures (>20°C) are also increasing for Botswana, resulting in decreased opportunity for natural cooling. Increased health threats can be projected and monitored through the frequency of tropical nights. Tropical Nights (**Figure 18**) represents the projected increase in tropical nights for different emission scenarios (CMIP5 ensemble) to demonstrate the difference in expected numbers of tropical nights.

FIGURE 17. Days with a Heat Index > 35°C[101]

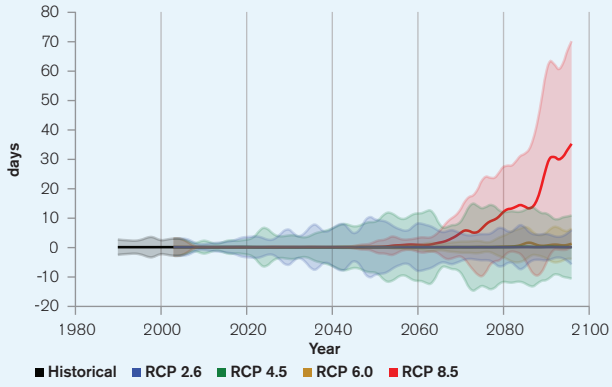
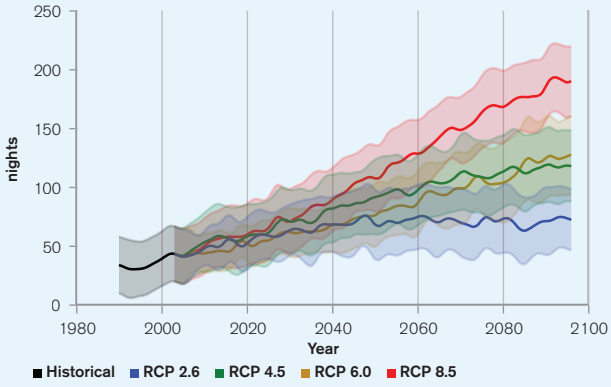


FIGURE 18. Number of Tropical Nights (Tmin > 20°C)[102]



Adaptation Options

Botswana's health-care infrastructure can be upgraded to support more systemic climate change resilience. Capacity needs to be built to support the adaptation to extreme weather events and support the necessary response capacities. Health care system personnel are not fully aware of the relationship between climate change, seasonal variability and health impacts. Increases in training and capacity can improve the level of knowledge and skills to prevent diseases connected with climatic factors, however this knowledge remains relatively limited among the general population. However, Botswana's health sector has implemented multiple adaptation measures to combat the impact of climate change on water and vector-borne diseases and food insecurity. These include its Malaria Control Program, Control of Diarrheal Diseases Program and improving access and support for social safety nets and public works programs which support increased food security.[103] Botswana can continue to increase its resilience capabilities to projected climate change impacts by developing and implementing programs on health adaptation to climate change, support training and capacity building efforts across the health sector and support an Integrated Disease Surveillance and Response (IDSR) system.[104]

[101] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Health Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=BWA&period=2080-2099

[102] WB Climate Change Knowledge Portal (CCKP, 2020). Botswana Health Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=BWA&period=2080-2099

[103] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[104] WHO (2015). Climate and health country profile – Botswana. URL: https://apps.who.int/iris/bitstream/handle/10665/246151/WHO-FWC-PHE-EPE-15.33-eng.pdf?sequence=1&isAllowed=y

Institutional Framework for Adaptation

Botswana's Department of Meteorological Services, under the Ministry of Environment, Wildlife and Tourism, serves as the country's climate change focal point and is responsible for developing, implementing and overseeing guidance as well as provide ad-hoc, sector-specific support in regards to Botswana's climate change adaptation and resilience strategies.[105] The National Climate Change Committee has been established as an advisory body to government. The committee shall be comprised of members with technical expertise on climate change that could facilitate credible advice to inform government decisions; central government shall take the lead in implementation of climate change response policy. A legal framework that establishes a National Climate Change Unit and ensures its responsibility for implementation, monitoring and compliance with climate change response measures is under development.[106]

Policy Framework for Adaptation

Botswana submitted its Third National Communication to the UNFCCC in 2019 and its Nationally-Determined Contributions to the UNFCCC in 2016. These provide the platform to integrate responsible environmental management with climate change adaptation strategies, that also account for the country's social and economic development targets, as set out in its Vision 2016. These strategies focus on the preparation and strengthening of institutional frameworks for improved management of climate change effects and to make available the necessary resources to support strategic adaptation activities and to advance low emission and climate resilient development.[107]

National Frameworks and Plans

- Third National Communication (2019)
- Climate Change Policy draft (2017)
- Botswana Vision 2016 (2016)
- Nationally-Determined Contributions (2016)
- National Disaster Risk Reduction Strategy 2013–2018 (2013)
- Integrated Water Resources Management and Water Efficiency Plan (2013)
- National Water Policy (2012)
- Second National Communication (2011)

[105] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

[106] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc

[107] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

Recommendations

Research Gaps

- Improve understanding of the occurrence and magnitude of climate change-driven events, as well as the related the key vulnerabilities, development impact, and possible adaptation responses
- Widen the participation of the public, scientific institutions, women and local communities in planning and management, accounting for approaches and methods of gender equity[108]
- Strengthen environmental monitoring capabilities for more effective environmental management
- Enhance Botswana's adaptive capacity through continuing investment in weather stations and expanding the country's national hydro-meteorological monitoring system and improved networking for the measurement of climate parameters[109]
- Strengthen the technical capacity to integrate climate-smart agriculture and climate change risk management into farmer's and the wider agricultural sector[110]

Data and Information Gaps

- Improve observational data through the additional of weather stations and hydro-meteorological instrumentation
- Improve technical capacity to analyze hydro-met data and project impacts across sectors
- Establish institutional capacity for providing timely early warning systems in coordination with IDSR systems
- Develop early warning systems about dangerous hydrometeorological phenomena and climate risk management

Institutional Gaps

- Ensure integration of National Environmental Strategy goals are developed within sectoral and southern Africa regional plans[111]
- Implement cross-sectoral climate-smart solutions at national and subnational levels
- Integrate climate change concerns into relevant policies and planning processes at the state and national levels[112]

[108] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf
[109] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc
[110] SADC Secretariat (2016). Climate Change Adaptation in SADC, A strategy for the Water Sector. URL: https://www.sadc.int/files/2213/5293/3544/SADC_Climate_Change_Adaptation_for_the_Water_Sector_booklet.pdf
[111] UNDP (2017). Botswana Climate Change Response Policy, Draft. Version 2 – December 2017. URL: https://info.undp.org/docs/pdc/Documents/BWA/DRAFT%20CLIMATE%20CHANGE%20RESPONSE%20POLICY%20%20version%202%20(2).doc
[112] Ministry of Environment, Wildlife and Tourism (2011). Second National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/bwanc2.pdf

CLIMATE RISK COUNTRY PROFILE

BOTSWANA

WORLD BANK GROUP