

BOTSWANA

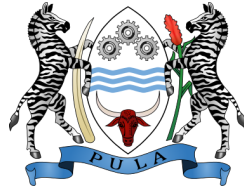
STATE OF ENVIRONMENT

AND OUTLOOK REPORT

2025



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OF
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BOTSWANA

STATE OF ENVIRONMENT AND OUTLOOK REPORT

2025



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Foreword

The preparation of State of the Environment and Outlook Reports at national, regional, and global levels has been ongoing since the Rio Declaration and the establishment of the Commission on Sustainable Development (CSD), where nations committed to pursuing sustainable economic growth. It has become increasingly evident that environmental stewardship is crucial for human well-being and prosperity. Recent extreme weather events, including unusually warm summers, severe cold spells, and widespread flooding, demonstrate that humanity has exceeded the planet's natural capacity for renewal. Like many developing nations, Botswana relies heavily on natural resources to fulfil her development aspirations. However, the country continues to face challenges such as overexploitation of resources, land degradation, water scarcity, poor soil quality, loss of biodiversity and ecosystem services, pollution, climate change, and deforestation, among others.

Botswana's Vision 2036, under Pillar 3 on Sustainable Environment, states that, ***"Botswana aspires that by 2036, sustainable and optimal use of our natural resources will have transformed our economy and uplifted our people's livelihoods."*** Similarly, the National Development Plan 11 (NDP 11) identifies the sustainable use of natural resources as one of the six national priorities. Achieving these aspirations requires accurate and timely environmental data and information to guide decision-making. In line with our commitments under the CSD, Botswana produced its first State of the Environment Report in 2001, followed by the Botswana Environment Outlook in 2010. Building upon these efforts, the Ministry of Environment and Tourism has now developed the State of the Environment and Outlook Report (SOE&OR) to inform national development processes and support sustainable economic growth.

This report presents the state and trends of Botswana's natural resources and the overall environmental outlook. It highlights key pressures and evaluates the country's responses in thematic areas such as biodiversity, climate change, waste management, water, and land. It also outlines possible future scenarios under varying environmental conditions.

It is my sincere hope that this report will inform the formulation of the National Development Plan 12 (NDP 12) and beyond. As we aspire to transition from an upper-middle-income to a high-income country by 2036, we must remember that the condition of our natural capital and environment directly determines the well-being of present and future generations.

This report should ideally be produced regularly to guide the development of all plans, policies, and programmes. Recognising that environmental conditions evolve continuously, my Ministry is establishing an Environmental Information System (EIS) to ensure ongoing data collection and continuous reporting for future SOE&ORs.

At the community level, I urge every citizen to use natural resources responsibly in their daily activities. I also call upon all sectors: public, private, academic, and civil society to use this report as a guiding tool in their planning and implementation processes. Let us work together as one nation to combat environmental degradation, climate change, and the loss of ecosystem services, for our collective survival depends on the health of our planet.



A handwritten signature in black ink, consisting of stylized letters and a long horizontal stroke.

Wynter Boipuso Mmolotsi

Honorable Minister of Environment and Tourism



Yellow Billed Stork
Photo credit: Duncan Mcnab/unsplash

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Acronyms

Acronym	Meaning	Acronym	Meaning
ABS	Access and Benefits Sharing	CITES	Convention on the Illegal Trade of Endangered Species
AERONET	Aerosol Robotic Network	CKGR	Central Kalahari Game Reserve
AfDB	African Development Bank	CMC	Catchment Management Committee
AFOLU	Agriculture, Forestry and Land- Use	CO	Carbon Monoxide
AIDS	Acquired Immunodeficiency Syndrome	CO ₂	Carbon Dioxide
AOD	Aerosol Optical Depth	COPD	Chronic Obstructive Pulmonary Disease
APPA	Atmospheric Pollution Prevention Act	COR	Certificate of Rights
APRU	Academic Programmes Review Unit	COVID-19	Coronavirus Disease 2019
ASSAR	Adaptation at Scale in Semi-Arid Regions	DALY	Disability Adjusted Life Years
AUDA	African Union Development Agency	DAR	Department of Agricultural Research
BBOS	Botswana Bureau of Standards	DDP	District Development Plan
BCA	Botswana College of Agriculture	DDT	Dichloro diphenyl trichloroethane
BCL	Bamangwato Concessions Limited	DEA	Department of Environmental Affairs
BIDPA	Botswana Institute of Development Policy Analysis	DEP	Department of Environmental Protection
BIUST	Botswana International University of Science & Technology	DFRR	Department of Forestry & Range Resources
BLDC	Botswana Livestock Development Company	DLUPU	District Land Use Planning Unit
BOCONGO	Botswana Council of Non Governmental Organisations	DoM	Department of Mines
BOCRA	Botswana Communications Regulatory Authority	DPSIR	Drivers-Pressures-State-Impact-Response
BOS	Botswana Standard	DRD	Department of Rural Development
BPC	Botswana Power Corporation	DRR	Disaster Risk Reduction
BTO	Botswana Tourism Organisation	DSM	Department of Surveys and Mapping
BUAN	Botswana University of Agriculture and Natural Resources	DTCP	Department of Town and Country Planning
BURS	Botswana Unified Revenue Service	DWA	Department of Water Affairs
BW	Business Wire	DWMPC	Department of Waste Management & Pollution Control
C	Celsius	DWNP	Department of Wildlife and National Parks
CAADP	Comprehensive Africa Agriculture Development Programme	DWS	Department of Water and Sanitation
CAR	Centre for Applied Research	EbA	Ecosystem-based adaptation
CBD	United Nations Convention on Biodiversity	EFR	Environmental Flow Requirement
CBFIM	Community Based Fire Management	EIA	Environmental Impact Assessment
CBNRM	Community-Based Natural Resource Management	EA	Environmental Assessment
CBO	Community-Based Organization	ENSO	El Niño-Southern Oscillation
CCC	Country Coordination Committee	EPR	Extended Producer Responsibility
CCD	Convention on Combating Desertification and Drought	EU	European Union
CFC	Chlorofluorocarbon	FAO	Food and Agriculture Organization of the United Nations
CFL	Compact Fluorescent Bulb	FAOSTAT	Food and Agriculture Organization Statistics
CH ₄	Methane	FGSG	Fixed Period State Grant
CHA	Controlled Hunting Area	FIS	Fire Information System
CIMA	Chartered Institute of Management Accountants	FMD	Food and Mouth Disease
		FRR	Forest and Range Resources
		GBD	Global Burden of Disease
		GCDL	Global Change Data Lab
		GDP	Gross Domestic Product

Acronym	Meaning	Acronym	Meaning
GEF	Global Environment Facility	MET	Ministry of Environment and Tourism
GHG	Greenhouse Gas	MoF	Ministry of Finance
GIF	Global Indicator Framework	MEA	Multilateral Environment Agreement
GIS	Geographical Information System	MEPS	Minimum Energy Performance Standards
GNI	Gross National Income	MFMP	Makgadikgadi Framework Management Plan
GoB	Government of Botswana	MTPW	Ministry of Transport & Public Works
HCFC	Hydro Chlorofluorocarbon	MLWA	Ministry of Lands and Water Affairs
HCS	Health Care Service	MME	Ministry of Minerals and Energy
HDI	Human Development Index	MOA	Ministry of Agriculture
HFA	Hyogo Framework of Action	MODIS	Moderate Resolution Imaging Spectroradiometer
HIV	Human ImmunoDeficiency Virus	MoH	Ministry of Health
IBA	Important Bird and Biodiversity Area	MLG&RD	Ministry of Local Government and Rural Development
ICT	Information and Communication Technology	MOMS	Management Oriented Monitoring Systems
IDMC	Internal Displacement Monitoring Centre	MSB	Millennium Seed Bank
IEA	International Energy Agency	N ₂ O	Nitrous Oxide
IEAR	Integrated Environmental Assessment and Reporting	NAMPAADD	National Master Plan for Arable Agriculture and Dairy Development
IFAD	International Fund for Agricultural Development	NAPHS	National Action Plan for Health Security
IHME	Institute for Health Metrics and Evaluation	NBDA	National Biological Diversity Authority
IHR	International Health Regulation	NBSAP	National Biodiversity Strategy and Action Plan
INDC	Intended Nationally Determined Contribution	NCCSAP	National Health Adaptation Strategy and Action Plan
IP	Implementing Partner	NCD	Non-Communicable Disease
IPCC	InterGovernmental Panel on Climate Change	NDMO	National Disaster Management Office
IPPU	Industrial Production and Product Use	NDP	National Development Plan
ISPAAD	Integrated Support Programme for Arable Agriculture Development	NDRMP	National Disaster Risk Management Plan
IUCN	International Union of Conservation and Nature	NEPAD	New Partnership for Africa's Development
IWRM	Integrated Water Resources Management	NFSD	National Framework for Sustainable Development
JICA	Japan International Cooperation Agency	NGO	Non-Government Organization
KAZA	Kavango Zambezi Transfrontier Conservation Area	NHP	National Health Policy
KBA	Key Biodiversity Area	NLUM	National Land Use Map
KD	Kgalagadi District	NMAPS	Non-Mining Productive Sector
KTP	Kgalagadi Transfrontier Park	NO ₂	Nitrogen Dioxide
LDN	Land Degradation Neutrality	NO _x	Nitrogen Oxides
LIMCOM	Limpopo Watercourse Commission	NPAD	National Policy on Agricultural Development
LIMID	Livestock Management and Infrastructure Development	NRTC	Natural Resource Technical Committee
LPF	Land Portal Foundation	NRDP	National Rural Development Programme
LRB	Limpopo River Basin	NRDPD	National Revised Policy on Destitute Persons
LUCF	Land-Use Change and Forestry	NSP	National Spatial Plan
LUMP	Land Use Management Plan	NSW RFS	New South Wales Rural Fire Service
LUPAG	Land Use Planning Advisory Group	NTS	National Transformation Strategy
M&E	Monitoring and Evaluation	OAG	Office of the Auditor General
MDG	Millennium Development Goal		

Acronym	Meaning	Acronym	Meaning
OCHA	United Nations Office for the Coordination of Humanitarian Affairs	RTC	Roads Training Centre
ODS	Ozone Depleting Substance	RVF	Rift Valley Fever
OECD	Organisation for Economic Cooperation and Development	SAB	Soda Ash Botswana
OKACOM	Permanent Okavango River Basin Water Commission	SABONET	Southern African Botanical Diversity Network
ORASECOM	Orange Sengu River Commission	SADC	Southern Africa Development Community
ORI	Okavango Research Institute	SADC RISDP	SADC Regional Indicative Strategic Development Plan
PCB	Polychlorinated-Biphenyl	SAREP	Southern Africa Regional Environmental Programme
PDL	Poverty Datum Line	SDG	Sustainable Development Goal
PET	Potential Evapotranspiration	SEFP	Secretary for Economic and Financial Policy
PM	Particulate Matter	SFM	Sustainable Forest Management
PMID	PubMed IDentifier	SIDA	Swedish International Development Cooperation Agency
POPS	Persistent Organic Pollutants	SLM	Sustainable Land Management
PPC	Physical Planning Committee	SMTA	Standard Material Transfer Agreement
PPE	Personal Protective Equipment	SOER	State of Environment Report
ppm	Parts per million	SO _x	Sulphur Oxides
PPPS	Public-Private Partnerships	SPEDU	Selebi Phikwe Economic Diversification Unit
PV	Photovoltaic	SSP	Shared Socioeconomic Pathway
RCP	Representative Concentration Pathway	STD	Sexually Transmitted Disease
RES	Renewable Energy Sources	SW	Southwest
RNRDP	Revised National Policy on Destitute Persons	TEA	Trade Effluent Agreement
RoB	Republic of Botswana	TFCA	Trans Frontier Conservation Area
RPI	Radiation Protection Inspectorate		
RSAP	Regional Strategic Action Plan		



Acronym	Meaning	Acronym	Meaning
TFWW	Total Freshwater Withdrawn	UNStats	United Nations Statistics Division
TGLP	Tribal Grazing Land Policy	US	United States
TRWR	Total Renewable Freshwater Resource	USA	United States of America
TSM	Towards Sustainable Mining	USAID	United States Agency for International Development
TWG	Technical Working Group	USD	United States Dollar
UB	University of Botswana	USDAFAS	United States Department of Agriculture Foreign Agriculture Service
UDP	Urban Development Plan	USEPA	United State Environmental Protection Agency
UN	United Nations	VIP	Ventilated Improved Pit
UNSDCF	United Nations Sustainable Development Cooperation Framework	WASH	Water, Sanitation and Hygiene
UN Water	United Nations Water	WAVES	Wealth Accounting and the Valuation of Ecosystem Service
UNCCD	United Nations Convention to Combat Desertification	WE	Water Efficiency
UNDP	United Nations Development Programme	WEF	World Economic Forum
UNDRR	United Nations Disaster Risk Reduction	WFP	World Food Programme
UNEA	United Nations Environment Assembly	WHO	World Health Organization
UNECA	United Nations Economic Commission for Africa	WMA	Wildlife Management Area
UNEP	United Nations Environment Programme	WRI	World Resources Institute
UNESCO	United Nations Educational, Scientific and Cultural Organization	WS	Water Stress
UNFCCC	United Nations Framework Convention on Climate Change	WUC	Water Utilities Corporation
UNFPA	United Nations Population Fund	WUE	Water-Use Efficiency
UNICEF	United Nations International Children's Emergency Fund.	WWF	World Wildlife Fund
UNRC	United Nations Resident Coordinator	WWTP	Wastewater Treatment Plant
		ZAMCOM	Zambezi Watercourse Commission



Female and immature Allen's Gallinule (*Porphyrio alleni*), at Chobe National Park
Photo credit: Derek Keats/flickr

Executive Summary

Introduction

Despite being a landlocked country with semi arid climate and a relatively small population of 2,346,179 million, Botswana is credited with sound economic performance driven by its rich natural assets and sound governance systems. In describing the state and trends of Botswana's generally pristine environmental conditions, this report acknowledges that conditions have been deteriorating over the years as demonstrated by extreme temperatures, increased drought frequencies and flash floods, land degradation, low water availability, and the loss of habitats and biodiversity. While this report monitors progress towards the achievement of targets as set out in Botswana's Vision 2036 and the Sustainable Development Goals, it also informs the country's future policy making by providing evidence of current policy failures, gaps, and overlaps.

Overarching policies

The analyses in this report are based on Botswana's developmental agenda, which is driven by its current 20-year national visioning - Botswana's Vision 2036 which is aligned with Sustainable Development Goals (SDGs), as well as with the SADC Regional Indicative Strategic Development Plan (RISDP).

In line with the SDGs, Botswana's Vision 2036 seeks to transform the country into a high-income nation as part of efforts to address poverty. The Vision 2036 is also linked to the RISDP whose objective is to deepen regional integration in Southern Africa by accelerating poverty eradication, creating a common market, ensuring food security and managing transboundary resources.

To deliver on its sustainable development agenda and Vision 2036, Botswana continues to strengthen its good and solid governance system, including building strong institutions to manage public resources. As much as the country looks at modernizing its governance and institutions, including by devolving authority to local levels, it also continues to preserve traditional local institutions, which are centred around *merafe* (ethnic groups) and administered by *dikgosi* (chiefs). The blend of traditional and elected governance systems is key in the orderly delegation of authority from

central Government to districts and local institutions, especially in as far as the management of key resources such as land and water is concerned.

Botswana is an active Member State of the Southern Africa Development Community (SADC), and the policy landscape and general state of the environment are also guided by the shared nature of resources, as well as regional policy instruments such as the SADC Revised Protocol on Shared Watercourse Systems.

Drivers of environmental change

Botswana's state of the environment is shaped by many factors including the country's demographic trends, economic development, climate, and its landlocked geo-location which calls for the country to cooperate with its neighbours in the Southern African Development Community (SADC).

The country's population is youthful and growing at a very slow pace though enough for natural replacement. About 64.9 of the country's population is of working age. Coupled with a healthy economy, Botswana's large proportion of population of working age, is partly the reason for the country's good economic performance. It is also worth noting that the majority of Botswana's working population is engaged in agriculture, making land a key national asset. Despite its small size, the country's population affects the environment through land mismanagement.

The country's economic performance also results in changes to the environment. Botswana's economic growth has been among the fastest in the world for the past 40 years, with average per capita GDP rising from US\$ 80 in 1966 to US\$ 6,924 in 2016. The country's economic growth is reflected in the significant reduction in poverty levels. The period between 2002-2010 saw the incidence of poverty falling from 30.6 to 19.4. While Botswana's economy has grown steadily, it has failed to diversify enough, with the diamond industry dominating even though most of the country's population remains engaged in agriculture as a key economic activity. Diamonds were discovered in Botswana in 1967, and a raft of economic policies and institutions, including the Financial Assistance policy, Botswana Export Development and Investment Agency, Botswana Investment and Trade



Centre and the Citizen Entrepreneurial Development Agency, have all aimed to push to diversify the economy.

Classified as semi-arid and arid, and receiving an average of 250 mm of rainfall per year in the southwest, and about 650 mm in the North, Botswana is prone to severe droughts and episodes of flash floods. High evaporation rates of 2, 200 mm per year result in the country having low rates of groundwater recharge and surface runoff. Average annual rainfall has also been decreasing across much of Botswana, while average temperatures are rising. Average temperatures in Botswana have increased by 0.85 °C since the 1960s. Climate change has effect on the country's state of the environment.

State and trends

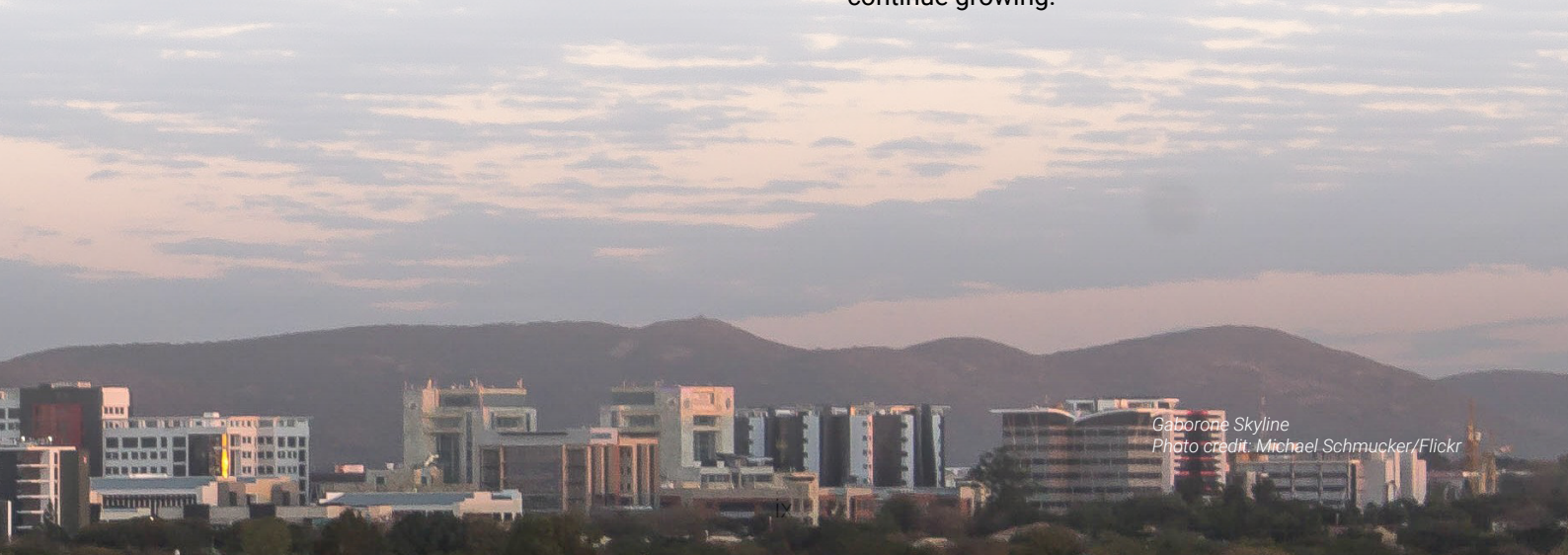
This report makes the following key findings in Botswana's environmental state and trends:

Agriculture

- Botswana's already limited agricultural potential due to the Kalahari Desert is characterised by low cereals productivity averaging only 23,000 tonnes in 2017. While cereal yields have been falling, Botswana's food demand has been increasing necessitated by a growth in population of 326 between 1960 and 2017. The population is continuing to grow at a rate of 2.2 per annum. The local production of cereals cannot meet demand. Other factors depressing crop production include declining soil fertility in arable lands and increasingly variable climatic conditions. The country is thus forced to import food, which in 2018, made up 12.3 of principal import commodity groups. The low agricultural productivity forces extensive agricultural practices often leading to encroachment into fragile land such as wetlands.
- Botswana's livestock sector depends on the quality of pasture and the availability of water. Recurring drought is having an adverse impact on the quality of rangeland resources. The country's cattle population which peaked at 2.2 million in 2011 declined to 1.74 million in 2018 largely due to drought conditions and recurrent outbreaks of livestock diseases. Some areas of the country have larger than permitted average livestock units, a situation that causes land degradation through soil erosion.

Biodiversity

- Botswana's rich and diverse habitats and ecosystems include the Kalahari xeric Savanna, Kalahari Acacia baikiaea woodlands, Southern Africa bushveld, Zambezian halophytics, the Okavango Delta and the Chobe river system. These habitats have largely been undisturbed due to the judicious harvesting and wise use of the various ecosystem services they offer.
- As general livelihoods in Botswana continue to improve, significant pressure is exerted on the country's rich biodiversity, resulting in habitat destruction, poaching, and incidences of wildfires, proliferation of alien invasive species, and the erection of barriers to stop wildlife movement.
- Botswana's over-dependency on livestock production, which makes up 85 of the country's agricultural output, results in not only greater competition with other land uses such as wildlife conservation and increased human-wildlife conflict, but also demonstrates some unintended consequences of some policies. The Tribal Grazing Land Act, which among other provisions, provides for leases of cattle ranges and fencing off some grazing areas, creates barriers to the free movement of wildlife in search of water and pasture. The expansion of fencing over the last 10 years is fragmenting the natural habitats slowly leading to the progressive isolation of some of the open ecosystems to several closed systems and from open communal land to partial privatisation and fenced commercial ranches. If this continues, it is likely to adversely affect the wildlife population on which Botswana's tourism industry greatly depends.
- The Okavango Delta, a key wildlife habitat, is vulnerable to significant changes to its hydrology with reduced inflows as water withdrawals are increasing in upstream Angola and Namibia. Botswana remains host to the largest elephant population in Africa due to the effectiveness of key conservation laws, including the National Parks Act, the Forest Act, and the National Biodiversity Action Plan. Botswana's elephant population was estimated at 131,600 in 2016. The future of the large elephant population is dependent on the continued availability of water. The number of human-wildlife conflict incidents is continuing to grow as the human population grows and expands into animal territory. The total number of incidents of human-elephant conflict increased from 2,295 in 2015 to 3,440 in 2019 and is expected to continue growing.



Water resources management

- Botswana has a physical shortage of water, receiving between 250 - 650 mm/year of rainfall while evaporation rates are as high as 1,900 - 2,200 mm/year. Over 44 of the country's population lives under conditions of water stress, water scarcity and absolute scarcity. With only 96 Mm³/year of sustainable aquifer yield and 73.2 Mm³/year that can sustainably be withdrawn from surface water sources such as dams, Botswana's total sustainable yield of water is 169.2 Mm³/year against demand estimated at 200 Mm³/year.
- The country's perennial rivers are all transboundary and shared with neighbouring countries, including the Limpopo, Okavango, Zambezi, Orange-Senqu and Shashe-Limpopo. The availability of water to Botswana from these perennial sources is not only limited by the regional instruments for the transboundary management of wild animals and sharing of resources such as the Revised Protocol on Shared Watercourse Systems, but also by how far these rivers are from key users and major settlements.
- The government has made important steps towards improving the water and sanitation services overall. Although trends in access to safe water in urban areas showed a slight decline - from 84.02 in 2000 declining slightly to 83.21 in 2017, the mortality rates from using unsafe water declined from 128.18 in 1990 to 46.16 in 2016 and to 27.38 per 100,000 deaths in 2017.
- Access to sanitation services is improving. By 2017, 60 of the population had access to sanitation services. But overall, there has been progress. For instance, the number of people using open defaecation decreased from 22 in 2000 to 10 in 2020. However, there needs to be better policy coordination between the Water Act, which provides for the infrastructure to deliver water, and the Public Health Act.
- The budget allocated to the water sector has been increasing. For instance, in 2020, the sector received 17.21 of the development budget and this increased to 22 in 2021.

Air pollution

- Botswana has experienced a significant amount of pollution due to rapid growth in its urban population, industrialization and rising demands for energy and motor vehicles. The combined effect of population dynamics and economic development has a noticeable effect on the air quality. While the outdoor air quality across much of Botswana is good, there are pockets where the quality is poor especially in urban and mining areas. For example, pollution levels in Gaborone reach as high as 216 micrograms per cubic metre with much of the pollutants coming from construction work, open burning of waste, and coal fired industrial activity and rail transport. Seasonal dust storms from the Kalahari sands are also common. Botswana has an air quality monitoring network of 25 monitoring stations and through the NDP 11 has been working to expand this network. This will provide the data required by the National Air Quality Management Programme for decision-making purposes.
- Indoor air quality is generally poor across the country due to the high dependency on fossil fuels for cooking, heating, and lighting in poorly ventilated homes. A national average of 37 households use fossil fuels with the situation being more severe in rural areas where 65 households depend on this form of energy. With as much as 2,300 deaths per year attributable to indoor pollution, the country's key legislation against pollution, including the Atmospheric Pollution Prevention Act and the Environmental Impact Assessment Act needs to be strengthened to stop or reduce the number of people dying from acute respiratory illnesses.

Sustainable cities - Waste management

- About 68.7 of Botswana's population lives in urban areas, making the country one of the most urbanized in Southern Africa. Gaborone is the country's capital and largest city with a population of over 269,000. Despite Botswana's population growth being slow and nearing replacement levels, urbanization is expanding with expectations to reach 87.9 by 2050. While urbanization reflects an expanding and industrializing economy, Botswana still grapples with providing all its residents with basic services such as safe drinking water and electricity, among other amenities. The country has managed to keep slum settlements to a minimum.
- Waste management is a challenge across much of Botswana, with urban areas generating four to seven



times more than rural areas. Even with their low waste generation rates, collection levels are exceptionally low in rural areas. Only 14 of waste is collected in rural areas. In Botswana's urban areas waste collection has been on the decline, with 81 of waste collected in 2001 compared to 76 collected in 2011. The amount of electronic waste generated in Botswana has increased from a per capita average of 2.83 kg per year in 2000 to 7.92 kg per year in 2019. Hospital waste which averages 0.1 kg to 0.75 kg per patient is a hazardous type of waste that Botswana grapples with as health care improves. Facilities for incineration and other types of waste management do not expand at the same pace. New types of waste such as face masks are emerging due to the COVID-19 pandemic. Mining waste, which amounted to as much as 871 tonnes in 2018, is another type of hazardous waste, which Botswana deals with at a time when landfills are not expanding at the same pace as the growth in mining output. The Waste Management Act, the Clinical Waste Management Code of Practice, and Miners and Minerals Act are not adequate for the handling of new types of waste, and neither do they discourage bad practices such as waste burning.

Suggested policy actions

This report suggests a raft of policy actions to ensure not only a well-protected environment, but also the achievement of Sustainable Development Goals and Vision 2036 targets. Some of the suggested actions are:

Agriculture

- Since the major limiting factor to Botswana's cereal crops and livestock production is the availability of water, the country is encouraged to continue investing in crop varieties and animal breeds that thrive under harsh arid conditions.
- The country needs to increase its investments, especially in off-grid renewable energy sources to pump water from groundwater sources. By embracing technologies such as drip irrigation as a means to improve water use efficiency while also using farming practices such as zero tillage and mulching to reduce evapotranspiration, the country can increase yields per unit area significantly, while livestock would have better access to drinking water and farmers can grow small-scale irrigated livestock fodder.

Biodiversity

- The many ecosystem services that Botswana accrues spur the country to continue to protect its diverse biological resources. Non-timber forest products such as marula, hoodia and mopane worms remain key to not only rural households as food and medicines, but increasingly to the national economy. Value addition in non-timber products such as dried mopane worms, which are high in protein content and have the potential to address food security, will result in foreign currency earnings to the country currently estimated at US\$3.3 million per year.
- Better policy coordination at the national and local levels, including amendment of the Tribal Grazing Land Act, could result in the peaceful co-existence between farmers and wildlife, with protected passage being given to migratory wildlife in search of grazing pasture and water.
- Botswana needs to continue engaging its neighbours to protect important habitats such as the Okavango Delta and the Chobe River system. Regional policy instruments such as the Revised SADC Protocol on Shared Watercourse Systems need to be applied so that the Okavango Delta in Botswana receives an equitable share of water needed for the maintenance of the ecosystem integrity of the delta, while upstream Namibia and Angola also receive a fair share of water for their irrigation and energy needs.

Water resources management

- Botswana is encouraged to invest in alternative and non-conventional sources of water. For example, the 73 Mm³/year wastewater that is produced can be treated for reuse in irrigation, industry, groundwater recharge and domestic use.
- Given the regional dimension of the water shortage problem, with neighbouring South Africa also facing similar challenges, joint efforts need to be explored to invest in withdrawing water from the water-rich Orange-Senqu River system of Lesotho.
- By addressing the country's water availability challenge, investment in sanitation, hand washing and access to safe drinking water can be made possible, resulting in a larger proportion of the population using safely managed sanitation services and hand washing facilities.



A mixed flock of Greater Flamingos (*Phoenicopterus roseus*) and Lesser Flamingos (*Phoeniconaias minor*) on a wetland in the Nata Bird Sanctuary near Nata
Photo credit: Arthur Chapman/Flickr

Air pollution

- In view of the poor outdoor air quality in urban centres, Botswana is encouraged to adopt a smart cities approach by investing in clean solar energy, and clean mass public transport, while also improving on waste collection and management. For example, solar energy needs to be expanded to cover industries and businesses, while the coal fired rail transport system should be discontinued and replaced with electric rail transport for mass transportation of passengers and goods.
- Houses in the rural areas need modernizing for adequate ventilation, while new and clean cook stoves need to be designed and rolled out.

Sustainable cities

- Urban expansion in Botswana needs to be matched with world class planning and service provision. Housing units need to be self-contained without the need for communal services such as water and toilets. Green spaces give cities the ambience and natural feel to attract small animals and birds while also helping clean the air in towns and cities.
- Waste collection in both rural and urban areas need to be regular, and this can be achieved with the greater involvement of the private and informal sectors, including waste pickers. The growing waste recycling industry allows for better waste sorting and collection. National policies and individual practices need to be geared towards a circular economy.

Outlook and Recommendations for achieving UN SDGs

Botswana's natural resources are critical to both the wellbeing of the people and the country. The government made a promise of 'prosperity for all', through the Vision 2036, to transform the country from a middle-income into a high-income one. It pegged the SDGs to the Vision 2036, thus formalizing and institutionalizing the achievement of the SDGs. To ensure positive outcomes it will be necessary for the country embrace policy adjustments, changes in habits and practices, and new technologies that will drive towards achieving the targets set under the Vision 2036 and the SDGs. The different chapters of this report articulate some of the actions needed to achieve the following environment-related SDGs and are listed below:

SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- Invest in forward planning for enhanced food security and better livelihoods through smart farming. Given that the major limiting factor to this industry is the availability of water, it will be important to invest in crop varieties that thrive under harsh conditions and to embrace technologies such as drip irrigation to improve water use efficiency while also using farming practices such as zero tillage and mulching to reduce evapotranspiration.
- Invest in off-grid solar energy to power the pumping of water from groundwater sources.
- Ensure implementation and compliance with key policies such as Tribal Land Act, Tribal Grazing Act and National Policy on Agricultural Development that allow Botswana to increase its livestock units and grow its national herd beyond the 2011 peak of 2.2 million.

SDG 3: Ensure healthy lives and promote well-being for all at all ages



- Improve policy coordination at the national and local levels, including the amendment to the Tribal Grazing Land Act to result in the peaceful co-existence between farmers and wildlife conservationists.
- Continue to participate in regional transfrontier conservation efforts such as the Kavango-Zambezi Transfrontier Conservation Area to support better conservation outcomes.
- Engage with neighboring countries to protect important habitats such as the Okavango Delta and the Chobe River system.
- Ensure fair application of regional policy instruments such as the Revised SADC Protocol on Shared Watercourse Systems so that there is equitable use of water in the Okavango Delta region by riparian countries (Botswana, Namibia and Angola).

SDG 6: Ensure availability and sustainable management of water and sanitation for all

- Invest in non-conventional water such as sand rivers, saline groundwater and wastewater reuse to close the current water yield gap.
- Invest in the transfer of water from the water-rich Lesotho through the Orange-Senqu River system from Lesotho

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

- Invest in renewable energies such as off-grid electricity such as from solar power to support efforts in sustainable forest management.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

- Invest in clean energy and clean mass public transport while improving waste collection and management throughout the country.
- Old laws such as the Atmospheric Pollution Prevention Act (1971) should be updated so that they consider changes in the types and amounts of pollutants.

SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

- Continue to invest in benefit sharing with local communities so that commercially important plant and animal species such as elephants, marula and mopane worms receive better protection, resulting in a reduced proportion of poached or illicitly traded wildlife.
- Develop and implement policies and practices geared towards a circular economy, aiming for resource efficiency, as well as integrated and sustainable human settlement planning and management.
- Implement a comprehensive overhaul of legislation such as the Waste Management Act, Miners and Minerals Act, and Botswana Clinical Waste Management Code of Practice to support the identification of new types of waste, but also improved waste collection and cleaner urban centres.

Conclusion

Botswana's natural environment provides a rich array of environmental goods and services that have supported and continue to provide opportunity for economic development and improved livelihoods. It is an endowment that requires a wise-use management approach so that future generations can benefit from them. That is the overarching goal of the government.



Introduction to the Report

Background

Over the past five decades, global population has doubled, extraction of materials has tripled and gross domestic product has quadrupled. The extraction and processing of natural resources has accelerated over the last two decades, and accounts for more than 90% of our biodiversity loss and water stress and approximately half of our climate change impacts. (Global Resources Outlook, 2019).

Botswana as a country has been preparing National Development Plans (NDPs) even before Independence, starting with the transition plan (NDP 1) of 1965, which was from 1965 – 1968 and is currently on her 11th NDP 2017 – 2023. The aim of preparing these NDPs inclusive of their Urban and District Development Plans is to achieve development within specific timelines and sectors. Development activities, especially in developing countries such as Botswana are heavily dependent on natural resources and hence the need for the development aspirations to take cognizance of the state of these natural resources.

At the time Botswana was preparing her first NDP, in the sixties, debates around the need to safeguard natural resources had already surfaced globally. There were indications of collapsing fisheries, deteriorating ground water resources, receding lakes, heat waves and disappearing species. Hence nations around the world adhered positively to the call to be part of the UN Conference on the Human Environment (the Stockholm Conference) of 1972 and later the United Nations Conference on Environment and

Development (UNCED) of 1992. The Environment Agenda was thereafter set at an international level for countries to prepare National Conservation Strategies (NCS) to enable the preparation of policies that would safeguard the environment. The National Conservation Strategy and Coordinating Agency (Department of Environmental Affairs (DEA)) was mandated to prepare State of the Environment Reports biennially to inform the environment decision making process in the country and provide environmental information to the public.

Botswana prepared the State of Environment Report in 2002 and Botswana Outlook Report in 2010. The DEA prepared this edition of the State of the Environment and Outlook Report through the GEF funded Cross-Cutting Capacity Development project. The United Nations Environment Programme (UNEP) extended support to the Government of Botswana in terms of environmental institutional strengthening for national reporting. The activity is an integral part of the roll out and implementation of the Country's second United Nations Sustainable Development Cooperation Framework (UNSDCF) under Outcome 3.2 and ties in well with previous work done by UNDP and UNEP in building a strong data and environmental information foundation.

It extrapolates from the current environmental trends and provides an indication of what the state of environment in Botswana may look like. Finally, it provides a series of recommendations for action. This information is vital for Botswana to carve a development pathway that is sustainable and inclusive to all members of society at all levels. The report is focused on identifying both current and emerging environmental issues, and analyzing how



the current policy, legal, strategic frameworks and plans are responsive to the issues. The report also advises on national policy formulation and budgeting.

The primary goal for preparing the State of Environment and Outlook Report is to present a picture of the condition of the Environment and Natural Resources. It extrapolates from the current environmental trends and provides an indication of what the future state of the environment in Botswana may look like. Finally, it provides a series of recommendations for action that should be considered to see improvement in the state of the environment over time. The information provided by the State of the Environment and Outlook Report is vital for Botswana to carve a development pathway that is sustainable and inclusive to all members of society at all levels. The report is focused on identifying both current and emerging environmental issues, and analyzing how the current policy, legal, strategic frameworks and plans are responsive to the issues. The report also advises on national policy formulation and budgeting.

Methodology approach

The report uses the Drivers – Pressures – State – Impact – Response (DPSIR) causal framework approach. This represents a systems analysis view in which the driving forces of social and economic development exert pressures on the environment and change the state of the environment. This change leads to impacts on human well-being and ecosystem health, which in turn triggers human responses to remedy these impacts. These responses influence the state of the environment, either directly or indirectly, through driving forces or pressures. Existing policy arrangements, institutional systems and traditional practices are discussed as part of a suite of response measures to address negative

changes to the environment and any impacts they may have on the drivers and impacts of environmental challenges. Furthermore, the Sustainable Development Goals (SDG) framework, using Goals-Targets-Indicators, have been used to track progress towards environmental goals.

The DPSIR methodology addresses high level political and cultural drivers of change to the pressure that is exerted resulting in modification and production of a particular state of environment. The resultant state impacts the environment and society in varying ways, often eliciting a response by both the Government and society.

The evidence in this report was gathered through the following methods:

- Review of data and analysis from available Government sources, reports by international organizations and peer-reviewed scientific papers.
- Analysis of hot spots of significant environmental changes using satellite data.
- Extensive comments and feedback received from various stakeholders and Government departments.

Guided by the DPSIR framework, authors compiled the chapters using Integrated Environmental Assessment and Reporting (IEAR) approaches. Through the IEAR approach disparate pieces of data and information were compiled and woven into a story. Draft chapters were subjected to reviews by Government officials and peer experts in other sectors of the economy, including the academic sectors. Before publishing, the report underwent both copy and technical editing.



Zebras at NG 11
Photo credit: Photography Section, BOPA

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Botswana traditional dancers
Photo credit: GCIS_GovernmentZA/Flickr



1

HISTORICAL, GEOGRAPHICAL AND SOCIOECONOMIC CONTEXT



1.1. Introduction

This chapter provides information on the historical background, geographic and socio-economic state of Botswana. These are important aspects as the current state of the environment is influenced by the geological, ecological, and climatic features of the country with changes driven primarily by human action such as demography, human settlement, and rapid urbanization as well as by the structure of the economy and the social-development context including the political situation and governance context (UNEP, 2019).

1.2. A brief history of Botswana

Botswana population increased from 2,024,094 in 2011 to 2,346,179 in 2022, representing a 15.91 percent growth between these census periods. Most of the population resides in the eastern part of the country where arable agriculture is possible. The country covers an area of 582,000 square kilometres lying between latitudes 17°30' north-west and 28° south of the Equator and longitudes 20° and 29° east of the Greenwich Meridian. The country is bordered to

the north by Zambia, to the north-west by Namibia, to the north-east by Zimbabwe and to east and south by South Africa as shown in Figure 1-1 (GoB, 2017).

Botswana obtained Independence in 1966 and is a multi-party democracy. It is a peaceful country that has held free and fair elections every five years since Independence. Botswana has also transitioned from a low income (in 1966) to an upper middle-income country (2020) mainly due to good governance and sound economic development frameworks.

1.3. Governance

Botswana is a democracy characterised by robust transformative policies, strong political will, good financial management and accountability and a sound economic environment. Strong institutions implement a functioning national development planning process (BIDPA, 2008). The country has a constitution that provides for political accountability through the separation of powers through three arms of Government - the legislature, judiciary and executive (Figure 1-2). This has enabled an efficient and effective system of checks and balances.



Figure 1-1: Location of Botswana
(National Atlas, 2005)

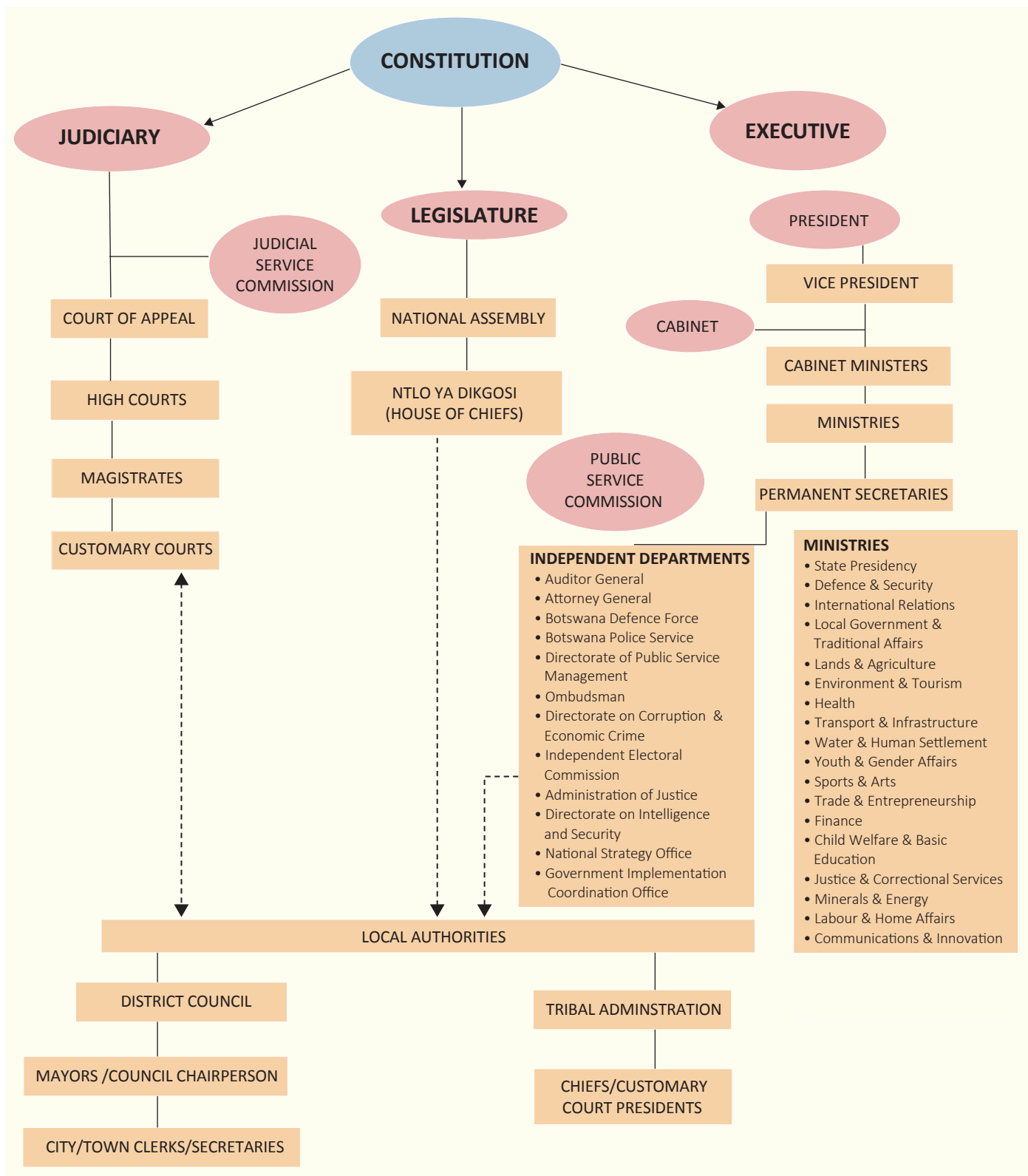


Figure 1-2: Botswana Governance Structure (GoB, 2017)

Inclusive political participation and representation is a key element of Botswana's democracy. People have access to public services and there are no constraints on the operations of civil society and the media (BIDPA, 2008). The Botswana Council of Non-Governmental Organisations (BOCONGO) is an umbrella body for these civil society organisations (including those in the environment sector) that was formed in 1995. In 2004, the Government of Botswana put in place a policy framework through which civil society organisations are supported financially and technically to meet the common objective of sustainably developing the country. They are also guided by a code of conduct. Environmental civil society organisations are in operation and contribute towards the national environmental management agenda.

National environmental governance

The primary custodian of environmental governance in Botswana is the Ministry of Environment and Tourism (MET). To effectively fulfil its mandate, MET works with

other Government ministries and civil society organisations. Departments under MET include the following:

- Department of Environmental Protection
- Department of National Museums and Monuments
- Department of Wildlife and National Parks
- Department of Forestry and Range Resources
- Department of Meteorological Services
- Department of Tourism
- Botswana Tourism Organization

Several environmental policy and legislative instruments have been enacted. These have been important in providing guidance on national environmental management approaches and related implementation mechanisms (Table 1-1).

Botswana National Assembly
Photo Credit: Photography Section, BOPA



Table 1-1: Policies, plans and laws related to environment management
(extracted from various government documents)

POLICIES/PLANS/LAWS	DESCRIPTION OF THE LEGAL FRAMEWORK
POLICIES	
Community-Based Natural Resource Management Policy, 2008	Aims to contribute to poverty reduction through employment creation, income generation and the provision of social services, while promoting biodiversity conservation and sustainable resource use.
Game Ranching Policy, 2002	Supports economic diversification in rural areas and increases economic returns from wildlife resources outside protected areas.
National Policy on Forestry, 2011	The policy is focussed on sustainable forest management.
National Policy on Natural Resources Conservation and Development (1990)	Calls for sustainable utilisation of natural resources, strengthening of governance systems and for mainstreaming of environment into development, to foster sustainable development.
Waste Water and Sanitation Management Policy, 2003	Assess the status of sanitation and waste water in Botswana and proposes improved management.
Wildlife Policy, 2013	Provides a framework for the conservation and sustainable utilisation of wildlife.
PLANS	
National Development Plan 11	NDP 11 implements six national priorities, including developing diversified sources of economic growth and the sustainable use of natural resources
Water Efficiency Plan	Discusses appropriate and efficient water resources management, their development and utilisation to elevate agricultural production and food security as well as the expansion of access to potable water and proper sanitation and improvement of water delivery services.
National Spatial Plan, 2017	This provides a holistic guidance for the country in terms of the best spatial development options. It was developed based on the principles of sustainable development, and through a participatory approach.
LAW / STRATEGIES / GUIDELINES	
Wildlife Conservation and National Parks Act, 1992	An Act to ensure the conservation and management of the wildlife of Botswana, through the establishment, control, and management of national parks. It also provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
Environmental Assessment Act, 2011	Provides for the use of strategic environmental assessment to assess the potential effects of planned developmental activities. It aims to determine and to provide mitigation measures for effects of such activities and to put in place a monitoring process and evaluation of the environmental impacts of implemented activities.
National Biodiversity Strategy and Action Plan, 2016	The vision of the plan is “by 2025, ecosystem, species and genetic diversity is valued, protected, and used sustainably and equitably, through the involvement of all sectors of society and the provision of sufficient resources for its sound management.”
Tourism Act, 1990	Promotes low-volume, high value tourism that benefits the country. Tourism Act was revised in 2009. Botswana Tourism Organization (BTO) is a parastatal corporate body established through the Botswana Tourism Organization Act of 2009 to amongst others: • Grade tourist accommodation facilities in Botswana and • Promote and improve industry (including environmental) standards
National Ecotourism Strategy 2002	Its goal is to ‘create an environment in which all elements of tourism development, planning and management, promote and reward the adherence of the key “principles” of ecotourism by all of those involved in the tourism industry’.
Botswana Ecotourism Best Practices Manual, 2009	Used by Botswana Tourism Organisation (BTO) to promote environmental best practise in the tourism industry. It provides ecotourism guidelines to encourage environmentally responsible tourism operations, attract environmentally responsible clients while protecting the natural resources.
Botswana Ecotourism Certification System	This is a voluntary certification scheme designed to encourage responsible environmental, social and cultural behaviour by tourism businesses and ensure they provide a quality eco-friendly product to consumers. Currently, Accommodation standards and Ecotour standards are being implemented.
National Action Plan for the United Nations Convention on Combating Desertification	The plan calls for sustainable and inclusive measures to combat desertification, management of forest resources and to avoid, stop or reverse land degradation.
National Strategy for Sustainable Development	Seeks to integrate the short and long term economic, social and environmental objectives of Botswana. The strategy contributes to the implementation of Agenda 2030.
National Vision 2036	Vision 2036 aims to achieve prosperity for all by transforming Botswana from an upper middle- to a high-income country by 2036. It is based on four pillars - sustainable environment, sustainable economic growth, good governance and by investing in people.
Strategy for Economic Diversification and Sustainable Growth (2008)	Sets out the strategy to diversify the economy.
Waste Management Act 1998	The aim of this act is to regulate the management of waste to prevent harm to humans, biodiversity, and the environment.

International and regional level environmental governance

In recognition of the transboundary nature of natural resources, the country is party to several Multi-lateral Environmental Agreements (MEAs). These agreements are important as they enable Botswana to work together with neighbouring and other countries to address critical environmental issues that are transboundary or global in nature, such as biodiversity, pollution, desertification, wetlands, and climate change, among others. Some of the key agreements that Botswana is party to are highlighted in Table 1-2.

Table 1-2: Multi-lateral environmental agreements (GoB, 2019)

TREATY	SIGNATURE	RATIFICATION
Agreement on the Conservation of African-Eurasian Migratory Water birds		01 Nov 2017
Paris Agreement	22 Apr 2016	11 Nov 2016
Nagoya Protocol		21 Feb 2013
Gaborone Declaration for Sustainability in Africa	May 2012	
Minamata Convention on Mercury		03 Jun 2016
Rotterdam Convention		05 Feb 2008
Basel Protocol on Liability and Compensation		17 Jun 2004
Kyoto Protocol		8 Aug 2003
Stockholm Convention		28 Oct 2002
Cartagena Protocol	01 Jun 2001	11 Jun 2002
Basel Convention		20 May 1998
United Nations Convention to Combat Desertification	12 Oct 1995	11 Sep 1996
Ramsar Convention	09 Apr 1997	09 Dec 1996
Convention on Biological Diversity	08 Jun 1992	12 Oct 1995
United Nations Framework Convention on Climate Change	12 Jun 1992	27 Jan 1994
Montreal Protocol		04 Dec 1991
Vienna Convention	04 Dec 1991	
United Nations Convention on the Law of the Sea	05 Dec 1984	02 May 1990
Convention on International Trade in Endangered Species of Wild Fauna and Flora	14 Nov 1977	12 Feb 1978

Lilac Breasted Roller (Coracias caudatus)
Photo credit: Michael Levine-Clark/flickr



1.4. Geographic context

Hydrology

Botswana is a semi-arid country with only seasonal rivers, apart from the Okavango and Linyanti/Chobe rivers which are in the northern part of the country. These two rivers originate outside the country's borders and therefore Botswana requires the agreement of her neighbours to use the waters, especially for large projects. For purposes of water resources management, the country is divided into six drainage basins or catchment areas (Figure 1-3). The drainage basins are of differing sizes, and each have unique features. The Okavango Delta basin is roughly 12,000 square kilometres in size. The Makgadikgadi Pans is an inland drainage basin that receives inflows from Mosetse, Nata and Boteti rivers during the wet seasons (National Atlas, 2005).

Weather and climate

Rainfall

Botswana's climate is semi-arid with seasonal and highly variable rainfall. The mean annual rainfall varies from less than 250 mm in the extreme south-western part of the country to over 650 mm in the north. The rains fall mostly in summer between October and March. Winter rainfall, though a rare phenomenon, has been recorded during some years between April and September (GoB, 2017).

Temperature

High insolation during the daylight hours means that the days are warm, but at night the low humidity causes night-time minimum temperatures to drop to about 0°C during the winter. The mean monthly maximum temperatures vary



Figure 1-3: Botswana River Flow System
(National Atlas, 2005)

between a low of 32°C to a high of 35°C. In the northern parts, the lowest monthly temperatures range between 5 and 7°C dropping to between 1°C and 5°C in the eastern and southern areas of the country (GoB, 2017).

Soil and vegetation

The climate has a large influence on the distribution of vegetation and consequently on the plant and animal life found. In terms of major soil groups, about 67 percent of the country is covered by the infertile red and grey sandy soils of the Kalahari Desert. Vegetation types that are found include forests, woodlands, bushland, grasslands, savannah, aquatic, and man-made plantations (GoB, 2017).

Given the climate, soil and vegetation profile, livestock rearing and the wildlife industry are important sectors of the economy and therefore sustainable soil and land management practices are key if these sectors are to be consistently productive. Some of the issues facing this sector include over-grazing, burning, alien invasive species, loss of biodiversity and, soil erosion among others (GoB, 2017) (National Atlas, 2005).



Baobabs
Photo credit: John Karwoski/Flickr

A sorghum field in Pandamatenga
Photo credit: Horst Vogel/flickr



1.5. Economic context

Economic growth and development

Botswana has enjoyed strong and stable growth since Independence, with sizable fiscal buffers, good governance and prudent policies playing a key role in shielding the economy, despite the volatility of the diamond market. The global economic slowdown and impacts on trade during the COVID-19 (coronavirus) pandemic are expected to have a great impact on Botswana's economy, particularly on the diamond industry and tourism.

The country's economic growth pattern is intricately linked with the discovery and subsequent trade in diamonds. For instance, in 1970 annual GDP growth was 17.1 percent (Figure 1-4). It averaged a growth of 12 percent per year between 1977 to 1987; and between 1988 and 2018, GDP growth averaged 5 percent per year in real terms (World Bank, 2020a). There is an over-reliance on mining, and this was evident during the global financial crisis where the economy shrank by 7.6 percent in 2008 due to a decline in diamond exports (World Bank, 2020a). In addition to minerals

and tourism, other important economic sectors include agriculture (livestock), service sector and manufacturing.

Compared to the rest of sub-Saharan Africa, the economy is doing well. For instance, in 2018, annual GDP growth in Botswana was 3 percent compared to 2.4 percent in sub-Saharan Africa. The country's economic success has been invested in national development projects in the areas of infrastructure, health, education and in improving livelihoods of the populace. Botswana's GNI per capita was four and half times greater than the Sub-Saharan Africa average as shown in Figure 1-5 (AfDB, 2020).

Economic development and Vision 2016

Botswana's approach to development is anchored and guided by a National Vision document which has a 20-year cycle. The first National Vision (referred to as the Vision 2016) was from 1996 to 2016 and the second National Vision (referred to as Vision 2036) runs from 2016 to 2036.

During the Vision 2016 period, per capita gross domestic product increased from US \$4,676 in 1996 to US \$7,797 in

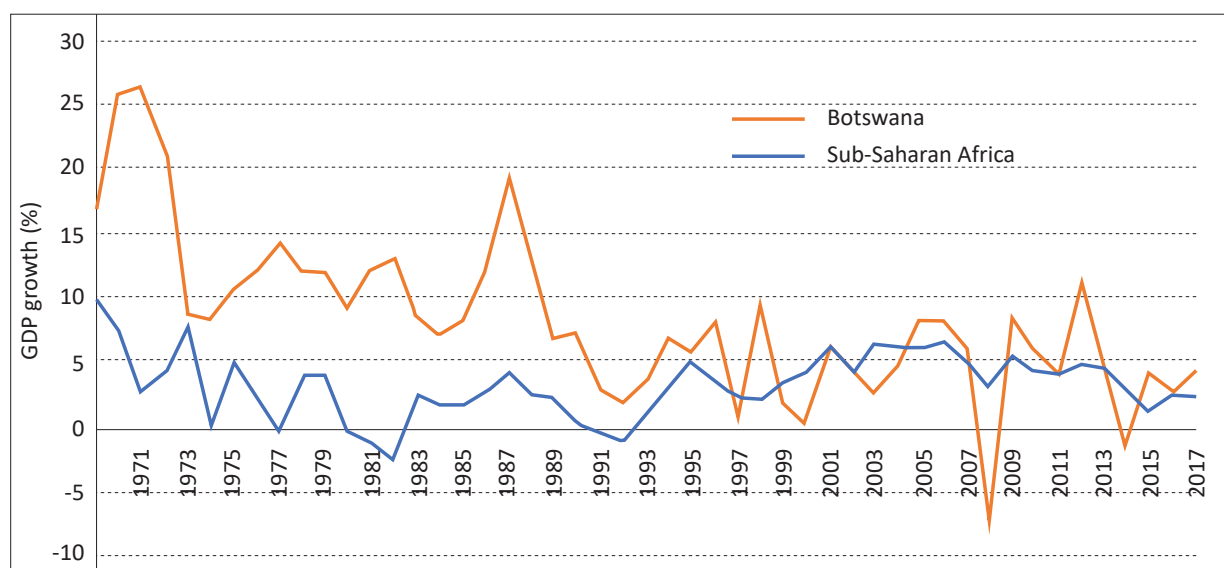


Figure 1-4: Annual GDP growth (%) in Botswana, 1970-2018 (World Bank, 2020a)

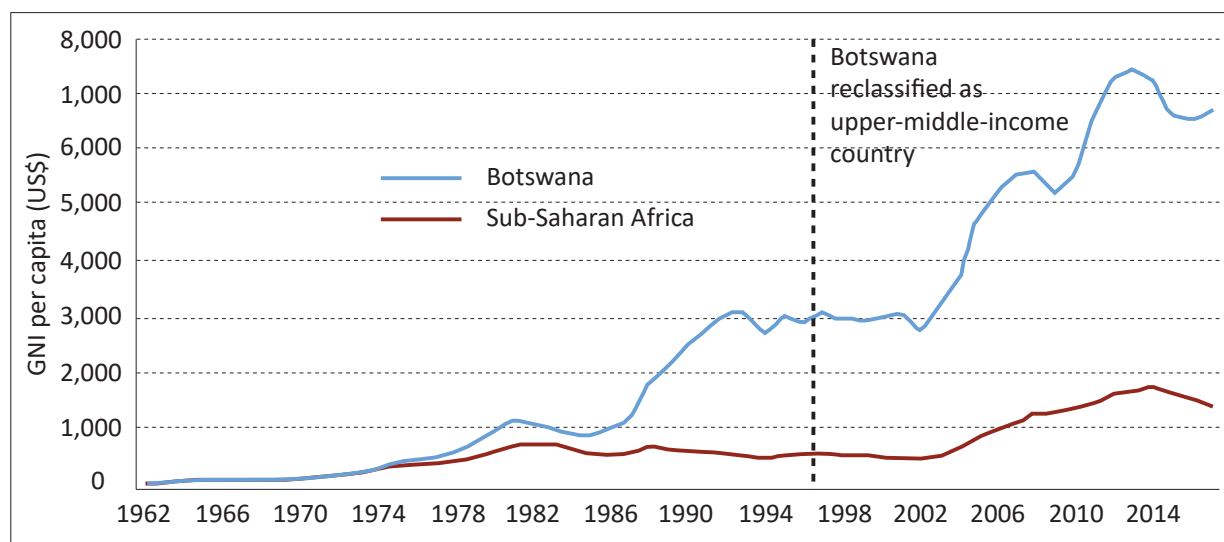


Figure 1-5: A comparison of Botswana's gross national income per capita with the average across Sub Saharan Africa, 1962–2016 (Calleja & Prizzon, 2019) extracted from World Bank data.

2016 at constant 2010 US\$ prices. Gross National Income increased from US \$4,432 to US \$7,062 at constant 2010 US\$ prices over the same time frame. These increases propelled the country to achieve upper-middle income status in 1991 (World Bank, 2020a).

The quality of life for the Batswana improved and poverty rates declined during the Vision 2016 period. The percentage of people below Botswana's Poverty Datum Line (PDL) declined from 30.6 percent in 2002/03 to 19.3 percent in 2009/10. In 2009/10, the national monetary value of the PDL basket was BWP 878.87. Of this, expenditure on food represented 77 percent of the total household expenditure, followed by 8 percent of other goods and 7 percent on shelter (Statistics Botswana, 2015b).

Mining

The economy of Botswana depends on its natural resources and specifically minerals as highlighted in Table 1-3. Between 1973 and 2017, total natural resources rents were an average of 3.15 percent of GDP. Mineral rents over the same time frame averaged 2.05 percent of GDP. The contribution of minerals to the total natural resources rents has averaged 46 percent between 1973 and 2017 (World Bank, 2020a). As

Table 1-3: The Importance of mining to Botswana's economy (Jefferis, 2016)

Macroeconomic Indicator	1985-1994	1995-2004	2005-2014
Mining (% of GDP)	42.2	30.9	22.0
Minerals (% of government revenues)	50.9	52.0	39.9
Minerals (% of merchandise export revenues)	77.4	76.9	71.6
Mining (% of overall GDP growth)	22.1	29.9	-12.8

De Beers diamond mine in Jwaneng, Botswana
Photo credit: Esther Dyson/Flickr



a result, mining generates most export earnings, and makes a major contribution to Government fiscal revenues. Key minerals that are mined include diamonds, copper, nickel, gold, coal, and soda ash (WAVES, 2016).

The country has been implementing a strategy to encourage diversification of the economy with some success. Between 2004-2014, the non-mining private sector grew by 128 percent, while the mining sector contracted by 13 percent (at constant 2006 price GDP) (Jefferis, 2016).

Agriculture

Subsistence agriculture, in particular livestock rearing, is the major livelihood activity in the rural areas where over 50 percent of the population live (World Bank, 2015). The national communal herd was 1,100,375 in 2017 declining to 934,732 in 2019. The number of goats increased by 2.4 percent from 1,199,661 in 2017 to 1,228,744 in 2019; and the number of sheep increased by 3.5 percent from 234,621 in 2017 to 242,911 in 2019 (Statistics Botswana, 2020a). Pandamatenga (known for both commercial and communal farming) and Tuli block (free hold area of farms) are the two regions that have significantly contributed to the agricultural sector of the country.

Despite this, domestic agriculture is unable to meet the country's food needs. In 2019, agriculture contributed 1.9 percent of GDP down from a high of 3.7 percent in the 1990s. Scarce water resources, infertile soils, high production costs, animal diseases outbreaks and the changing climate are some of the factors limiting growth in this sector. Food imports make up a sizeable proportion of the total imports. For instance, in 2006, food imports made up 13.7 percent of the total merchandise imports, decreasing to 7.8 percent in 2014 and finally increasing to 12.7 percent in 2019 (World Bank, 2020a; AfDB, 2020).

1.6. Social context

Between 1990 and 2018, Botswana's Human Development Index (HDI) value increased from 0.570 to 0.728, an increase of 27.6 percent. Table 1-4 reviews Botswana's progress in the HDI indicators (UNDP, 2020)

Table 1-4: Botswana's HDI trends based on consistent time series data (UNDP, 2020)

Year	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2011 PPP\$)	HDI value
1990	59.2	10.0	5.5	8,866	0.573
1995	54.4	10.6	6.7	9,916	0.576
2000	50.6	12.1	7.6	10,781	0.581
2005	52.1	12.1	8.3	11,498	0.601
2010	60.2	12.3	8.9	13,489	0.663
2015	67.3	12.6	9.2	16,237	0.717
2016	68.2	12.6	9.3	15,623	0.720
2017	68.8	12.7	9.3	15,981	0.726
2018	69.3	12.7	9.3	16,311	0.730
2019	69.6	12.8	9.6	16,437	0.735

Botswana's life expectancy at birth increased by 10.1 years, between 1990 and 2018, , mean years of schooling increased by 3.8 years and expected years of schooling increased by 2.7 years. Botswana's GNI per capita increased by about 92.9 percent between 1990 and 2018 (UNDP, 2020). Living conditions have improved for the Botswana people, as highlighted by the trends in GNI per capita based on purchasing power parity (PPP) which increased from US \$8,866 in 1990 to US \$16,437 in 2019. Purchasing Power Parity declined steadily from 29.8 percent to 18.2 percent between 2002–03 and 2009–10, and to 16.1 percent in 2015-16. This rapid poverty reduction can be attributed mainly to a combination of increasing agricultural incomes, including subsidies, and demographic changes (World Bank, 2020a).

Progress in reducing poverty has been accompanied by improvements in shared prosperity. The growth rate of consumption per capita between 2009-10 and 2015-16 for the bottom 40 percentile of the population was 0.42 percent annually, higher than the growth rate of the top 60 percentile.

However, Botswana's performance was only in the middle of the worldwide shared-prosperity distribution (UNDP, 2019).

Inequality has fallen as well, albeit still being high. Between 2010 and 2015, inequality, measured by the Gini index, fell from 60.5 percent to 53.3 percent. Among factors associated with Botswana's declining income inequality, the key one is regional convergence due to fast growth in rural areas and demographic changes. However, Botswana remains one of the world's most unequal countries (World Bank, 2020a).

The recent Botswana Multi-Topic Survey, Labour Force Module Report (Statistics Botswana, 2020b) indicates that the unemployment rate has gone up by 3.1 percentage points from 17.6 percent to 20.7 percent with youth unemployment posing a critical challenge. Addressing these challenges will require improving the quality of infrastructure (water and electricity), essential basic services (education, health, and social safety nets), as well as accelerating reforms to the business environment and effective support for entrepreneurship.

The World Bank's Human Capital Index (HCI) scores Botswana at 0.41 in 2020 (World Bank, 2020a). The purpose of the HCI is to promote attention and action to improving the level and quality of Government investments in child health, nutrition, and education given their strong links to labour productivity and economic competitiveness. Botswana's HCI score suggests that a Botswana child born today will only be 41 percent as productive as an adult, if they could have enjoyed complete education and health as they were growing up (World Bank, 2020a).

Botswana has maintained strong investment in the social sectors. In 2000 expenditure on health was 5.8 percent of GDP and this declined to 5.6 percent of GDP in 2016. Expenditure on health was 10.7 in 2005 decreasing to 9.6 percent in 2009 (World Bank, 2020a). Despite this budgetary support, availability of universal free primary education, there is still much to do for the country to be able create a skilled workforce. In comparison, Botswana's expenditure as a percentage of GDP on education is higher than the Sub-Saharan average of 3.6 percent in 2009 and the global average of 4.7 percent for the same year (World Bank, 2020a).

1.7. Demographic profile

Botswana is sparsely populated with a population density of 3.5 people per square kilometres and a total population of 2,346,179 in 2022. Forty-six percent of the population live in rural areas and depend on agriculture for their livelihood (Statistics Botswana, 2011). The annual average growth rate has been fluctuating at 2.37 percent between 1991 and 2001; at 1.86 percent between 2001 and 2011; and at 1.04 percent between 2011 and 2017 (Statistics Botswana, 2015a).

Population distribution

The term population distribution refers to the spread of the population over a specified geographical area. Botswana has been proactive in managing population distribution by formulating and implementing the National Settlement Policy 1998 to manage these developments (Statistics Botswana, 2018).

According to the 2017 Demographic Survey, 13.0 percent of the population is in Kweneng East followed by Gaborone city with 10.9 percent. A similar pattern was also observed in the 2011 Population and Housing Census where the two districts recorded 12.7 percent and 11.4 percent of the population, respectively. The share of population in other districts are as follows: Districts of Central Serowe Palapye 8.7 percent, Central Tutume 7.4 percent, Ngwaketse 6.3 percent and Francistown 5.0 percent. Ngwaketse West took a population share of 0.7 percent, Orapa 0.5 percent, Sowa Town 0.2 percent, Northeast 3.0 percent and Ngami West district 2.9 percent (Statistics Botswana, 2018) (Statistics Botswana, 2011).

Most people in Botswana are in Urban Villages (43.0 percent), 20.3 percent live in cities and towns, while 36.1 percent live in rural areas. This indicates that Botswana's population is predominantly urban with a least 63.9 percent of its population residing in urban areas (Statistics Botswana, 2018). Urban areas include cities, towns and urban villages and are defined as any settlement with a population of 5,000

or over of which 75 percent of the workforce is engaged in non-agricultural activities (UNSD, 2005). Urban villages are experiencing in-situ urbanization where the rural settlements are transforming themselves into more urban ones. They are like urban service centres and even have multinational chain retail shops and commercial banks, among others. However, traditional leadership systems such as the kgotla are still a central part of the neighbourhood system (Tarver, 1985).

Population age sex structure

The age-sex structure of a population is the age and sex composition of the population and is usually displayed graphically by a population pyramid (Statistics Botswana, 2016). The population pyramid for both the 2017 Botswana Demographic Survey and the 2011 Population and Housing Census has a broad-based age-sex structure. This implies that the country has a young population (Statistics Botswana, 2018).

Further analysis of the population by broad age groups confirms that the population is young - with 34.7 percent of the population being less than 15 years of age. The 2017 Botswana Demographic Survey indicates that the 59.8 percent of the population is working age (15-64 years) while the elderly (65+) comprise 5.4 percent of the population. This profile has remained basically the same over the years as noted by earlier studies such as the Demographic Survey of 2006 and the 2011 Census (Statistics Botswana, 2011) (Statistics Botswana, 2008) (Statistics Botswana, 2018).

Sex ratio

Sex ratio is the number of males per 100 females in the population. According to the 2017 Botswana Demographic Survey, there were 92.3 males per 100 females. This ratio remained constant during the 2006 Botswana Demographic Survey at 92 males per 100 females and at a 95.5 sex ratio in the 2011 Population and Housing Census (Statistics Botswana, 2011).

*Students at Tshwarangano Junior Secondary School in Maun, Botswana
Photo Credit: USAID/Flickr*





*Three Dikgosi Monument, Gaborone
Photo credit: Adrian Dutch*

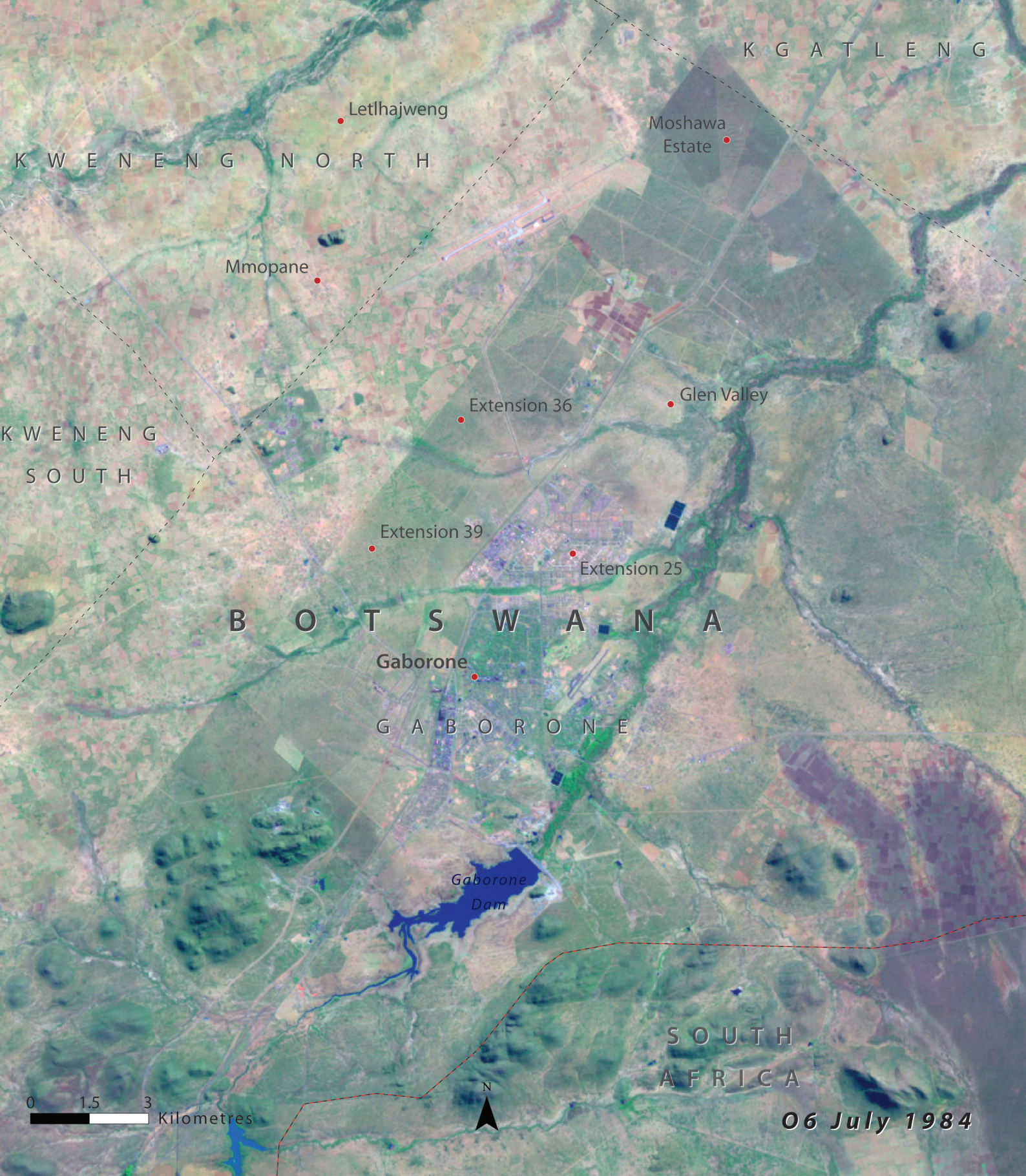
1.8 Conclusion

Although Botswana has a semi-arid climate with about two-thirds of the country covered with sandy soils, it has abundant environmental assets. It has extensive rangelands that support a thriving livestock industry, an extensive wetland and wildlife-base in the Okavango area that underpin a booming tourism industry, forests, and mineral resources.

The political stability of the country, robust transformative policies, strong institutions, good financial management and accountability and a sound economic environment have been a major boost ensuring the continued wise use of its natural resources and the growth of the economy. The quality of life has been improving in terms of life expectancy at birth, mean years of schooling, and reduced poverty, among others.

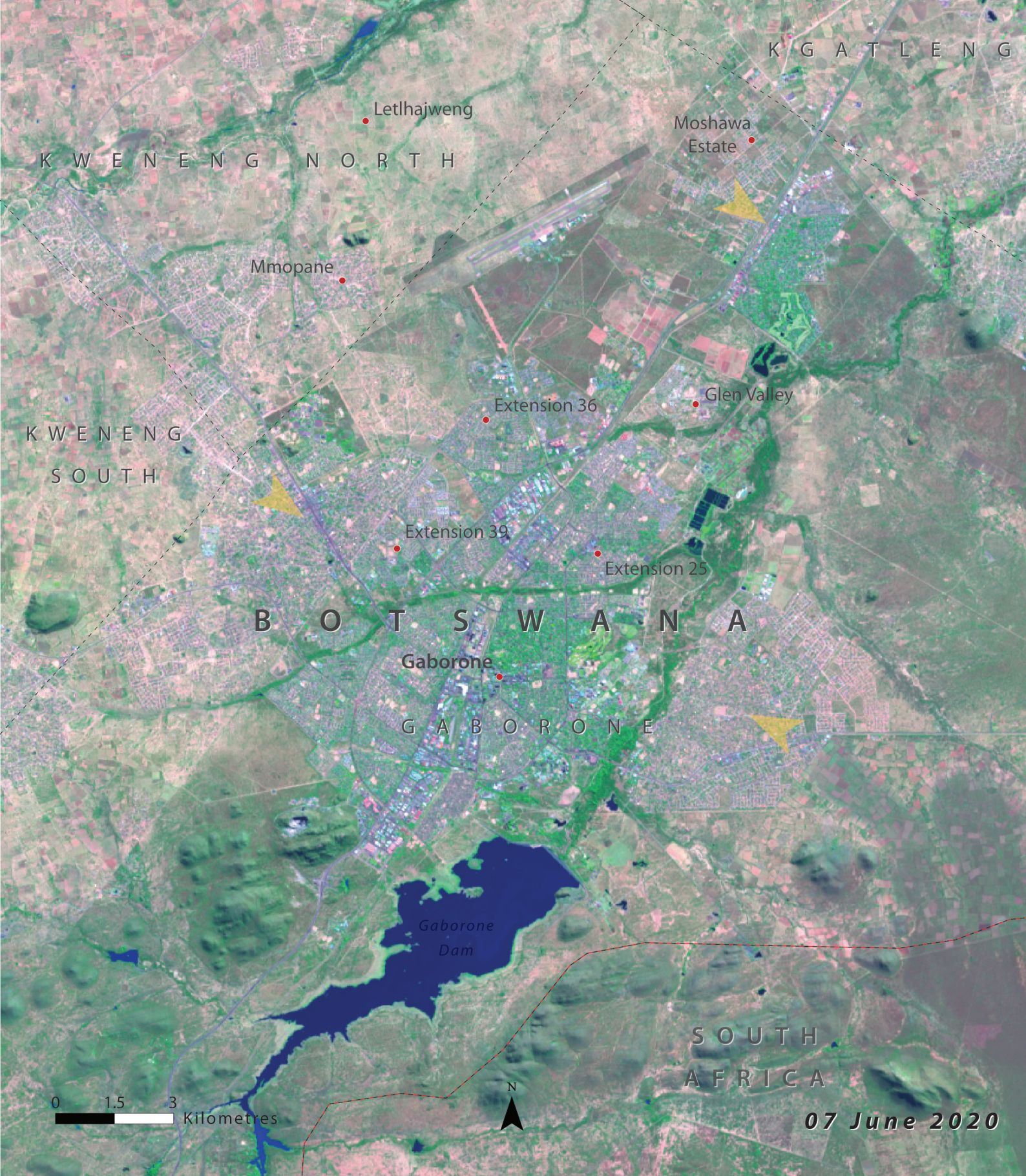
This rapid reduction in poverty can be attributed mainly to a combination of increasing agricultural incomes, including subsidies, and demographic changes. Minerals, in particular diamonds, have been the one main reasons behind the growth of the economy. The country has been working to reduce over-dependence on this sector.

Despite the documented successes highlighted above, the country still faces some environmental challenges. For instance, domestic agriculture is unable to meet the country's food needs and food insecurity is an on-going issue. Scarce water resources, infertile soils, high production costs and the changing climate are some of the factors limiting growth in this sector. Other challenges include loss of biodiversity, pollution, desertification, wetlands degradation, and climate change, among others.



Growth of Gaborone city

The population of Gaborone grew from a mere 3,855 in 1964 to its current population of 246,325, representing a 60 fold growth. This growth is anchored mainly on the stable supply of fresh water from Gaborone Dam, located south East of the city and availability of opportunities within the city.



These 2 Landsat images visualize the growth of the Gaborone between 1984 and 2020. They show how the city has expanded greatly with areas previously unoccupied now covered by housing estates or other human activities (yellow arrows).

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Lion and cub with family in the background
Photo credit: Birger Strahl/unsplash

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2

UN SUSTAINABLE DEVELOPMENT GOALS AND BOTSWANA



2.1 Introduction

Botswana joined the international community of nations in 1992 and signed the Commission for Sustainable Development and its associated Rio Conventions on Biodiversity, Desertification and Climate Change. As with most countries at the time, the coordination of most functions pertaining to sustainable development were traditionally located at the ministry responsible for the environment portfolio. Several instruments were developed to domesticate these Multilateral Environmental Agreements. One such instrument, mentioned in Chapter 1, is the National Policy on Natural Resources Conservation and Development of 1990, which encapsulates the national response to the Rio outcome document.

To date, the Ministry of Environment and Tourism (MET) has the mandate for managing the balance between development and environment in Botswana. Through its various departments and instruments, it brings together issues that consider economic development and environmental stability and the ability to perpetually grow, use and maintain these resources. Following her accession to the 2030 Agenda for sustainable development and its associated Sustainable Development Goals (SDGs), coordination of the SDGs was, in 2015, transferred to the Ministry responsible for Finance and Economic Development. Sustainable development has been at the centre of Botswana's development approach since Independence. Botswana has always pursued her developmental trajectory through long- and medium-term development frameworks including Vision 2016 (2006-2016) and the current Vision 2036 and the rolling 6-year National Development Plans (NDP). Currently the country is at its 11th Plan (NDP11) which runs from 1st April 2017 to 31st March 2023.

Botswana has undergone transformative economic growth that hinged on its mineral, especially diamond wealth, as illustrated in Chapter 1. Some challenges which include poverty, inequality, environmental degradation, water scarcity, waste management and human health, among others, remain. The Government has shown great political support towards addressing these issues by signing up to and implementing global policy plans.

Beside these goals, Botswana is a member of the African Union (AU) and the Southern Africa Development Community (SADC), and is committed to meeting regional targets and goals by signing up to their different strategic plans, such as the African Union's Agenda 2063. To aid implementation, elements of these regional strategies are localised and integrated into the NDPs and District Development Plans (DDPs).

2.2 The Sustainable Development Goals (SDGs)

Botswana signed up to the United Nations' 2030 Agenda for Sustainable Development, which was adopted by 193 Members States of the United Nations General Assembly in September 2015. Agenda 2030 consists of 17 SDGs, 169 targets and 230+ indicators against which progress can be measured. It is a blueprint to achieve a more sustainable

future with a focus on addressing global challenges including those related to poverty, inequality, climate, environmental degradation, prosperity, peace and justice.

If simultaneously implemented, the 17 SDGs target a variety of issues that are designed to further economic growth, social well-being, and environmental protection. The Government of Botswana has demonstrated strong political will and commitment to implementing the 2030 Agenda through integrating elements; the SDGs have been aligned with national development frameworks being NDP 11, District Development Plans (DDPs), Urban Development Plans (UDPs) and Vision 2036. Ministry of Finance (MoF) and United Nations Development Programme (UNDP) are currently assisting Line Ministries to integrate SDGs, their Targets and indicators into their planning processes – strategies, plans and programmes.

Transitioning from the MDGs to the SDGs

Botswana made a commendable progress during the 15-year Millennium Development Goals (MDG) implementation period (2000-2015) and managed to achieve nine out of the 12 MDGs. For instance, a perusal of key reports to some of the conventions shows Botswana made strides in maintaining 40 percent of her landmass under some form of conservation area managing to surpass the global target of 17 percent (DEA, 2015). Additionally, there was a net positive return on investment in dealing with degradation at community levels, the mainstreaming of biodiversity in different sectoral plans has been realized and integrated plans formulated for some of the areas of high biodiversity significance. Education on sustainable development has been localized through several initiatives including a more progressive school curriculum. Furthermore, the indicators for ambient air quality in the country remain acceptable and within national standards and Botswana remains a net sink of global carbon emissions (MENT, 2019; Sachs et al., 2020).

This was mainly due to the prudent macro-economic principles and good governance which spurred significant economic growth. Further, national planning frameworks as well as strong social development programs, provided the necessary guidance towards realizing indicators set to be achieved. This all contributed towards an improvement in the quality of life and standard of living for the citizens over this time. However, the country did not fare too well in meeting the targets of MDG 5 (Improve maternal health), MDG 7 (Ensure environmental sustainability) as well as part of MDG 8 (Develop a global partnership for development). These are being rolled over into Botswana's SDG implementation plan (RoB; UN, 2016).

Aligning SDGs to national priorities, the vision pillars and Agenda 2036

The shift from the MDGs to the SDGs came at an opportune time for Botswana coinciding with the national processes of preparing the different country development frameworks. These included Vision 2036 and the NDP11, the eighth DDP8, the fourth Urban Development Plan (UDP4) and the Draft National Framework for Sustainable Development. It was thus relatively easy for the country to align its medium to long-term national goals and priorities to those of the SDGs.

As these are the main vehicles through which Botswana has domesticated and mainstreamed the SDGs, it will be easy for future planning documents to add incrementally to the effort. Table 2-1 illustrates the interlinkages between the SDGs with the National Development Plan 11 and Vision

2036 priorities highlighting the basis for mainstreaming the SDGs.

Table 2-1: Interlinkages between SDGs, Vision 2036 and NDP11 priorities (GoB, 2017)

SDG	Vision 2036 Pillars	NDP 11 Priorities
Goal 1: End poverty in all its forms	Sustainable economic development	Developing diversified sources of economic growth
	Human and social development	Social development
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Human and social development	Social development
Goal 3: Ensure healthy lives and promote wellbeing for all	Human and social development	Social development
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Human and social development	Social development Human capital development
Goal 5: Achieve gender equality and empower all women and girls	Human and social development	Social development Human capital development
Goal 6: Ensure availability and sustainable management of water and sanitation for all	Human and social development	Social development
Goal 7: Ensure access to affordable reliable, sustainable and modern energy for all	Sustainable economic development	Developing diversified sources of economic growth Human capital development
Goal 8: Ensure access to affordable, reliable, sustainable economic growth, full and productive employment and decent work for all	Sustainable economic development	Developing diversified sources of economic growth Human capital development
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Sustainable economic development	Developing diversified sources of economic growth
Goal 10: Reduce inequality within and among countries	Sustainable economic development	Developing diversified sources of economic growth Human capital development
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	Sustainable economic development	Developing diversified sources of economic growth Human capital development
Goal 12: Ensure sustainable consumption and production patterns	Human and social development	Social development
Goal 13: Take urgent action to combat climate change and its impacts	Sustainable environment	Sustainable use of natural resources
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Sustainable environment	Sustainable use of natural resources
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt land degradation and halt biodiversity loss	Sustainable environment	Sustainable use of natural resources
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable and inclusive institutions	Governance, peace and security	Consolidation of good governance and strengthening of national security
Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development		Implementation of an effective monitoring and evaluation system

The institutional framework

Agenda 2030 underscored the importance of a strengthened institutional framework for sustainable development that integrates the three dimensions of sustainable development in a balanced at national and regional levels. The institutional framework for SDG implementation is illustrated in Figure 2-1 and the information in this section draws heavily from the SDGs implementation road map (RoB, 2019). At the helm, is the national SDG steering committee which is co-chaired by the Secretary for Economic and Financial Policy in the Ministry of Finance (MoF) and the United Nations Resident Coordinator. Membership is multisectoral and is drawn from line ministries, UN agencies, development partners, private sector, civil society, youth and women organisations media, academic and research institutions. Its function is to provide overall strategic and policy guidance to the SDG implementation process and provide country engagement and leadership at regional and international events.

The SDGs National Secretariat is headed by a Director and is located within the Population and Development Coordination section of the MoF. It provides coordination oversight to the steering committee. It supports programme implementation, ensuring that stakeholder capacity is built, providing budgeting support and implementing a monitoring and evaluation programme.

The SDG technical task force handles the technical aspects of the implementation designing strategic documents

and providing technical support in preparation of various documentation to support the process. It also ensures harmonisation of national policies with SDGs targets and indicators. The technical task force works closely with the national secretariat. Its members include representatives from the central and local Government, civil society, private sector, academic, research, youth, UN and other development partners.

The domesticated indicator framework and SDGs roadmap

The indicator framework for SDGs provides a means through which the goals and targets can be monitored. The SDG Global Indicator Framework (GIF) was developed by the Inter-Agency and Expert Group on SDGs and adopted by the UN General Assembly in July 2017. It served as the basis for the development of Botswana's national framework - the Domesticated Indicator Framework comprises of nationally applicable or relevant goals, indicators, and targets. Developed with the global ambition in mind, SD targets and indicators may be adjusted considering national circumstances and as part of the domestication and localization process. The process which is still ongoing, is pioneered through the implementation of the SDG Planning Guidelines that were developed to support SDG integration in the country. As of December 2018, the Domesticated Indicator Framework contained all the 17 Goals and 209 indicators that are considered relevant to Botswana (Statistics Botswana; UNFPA, 2018).

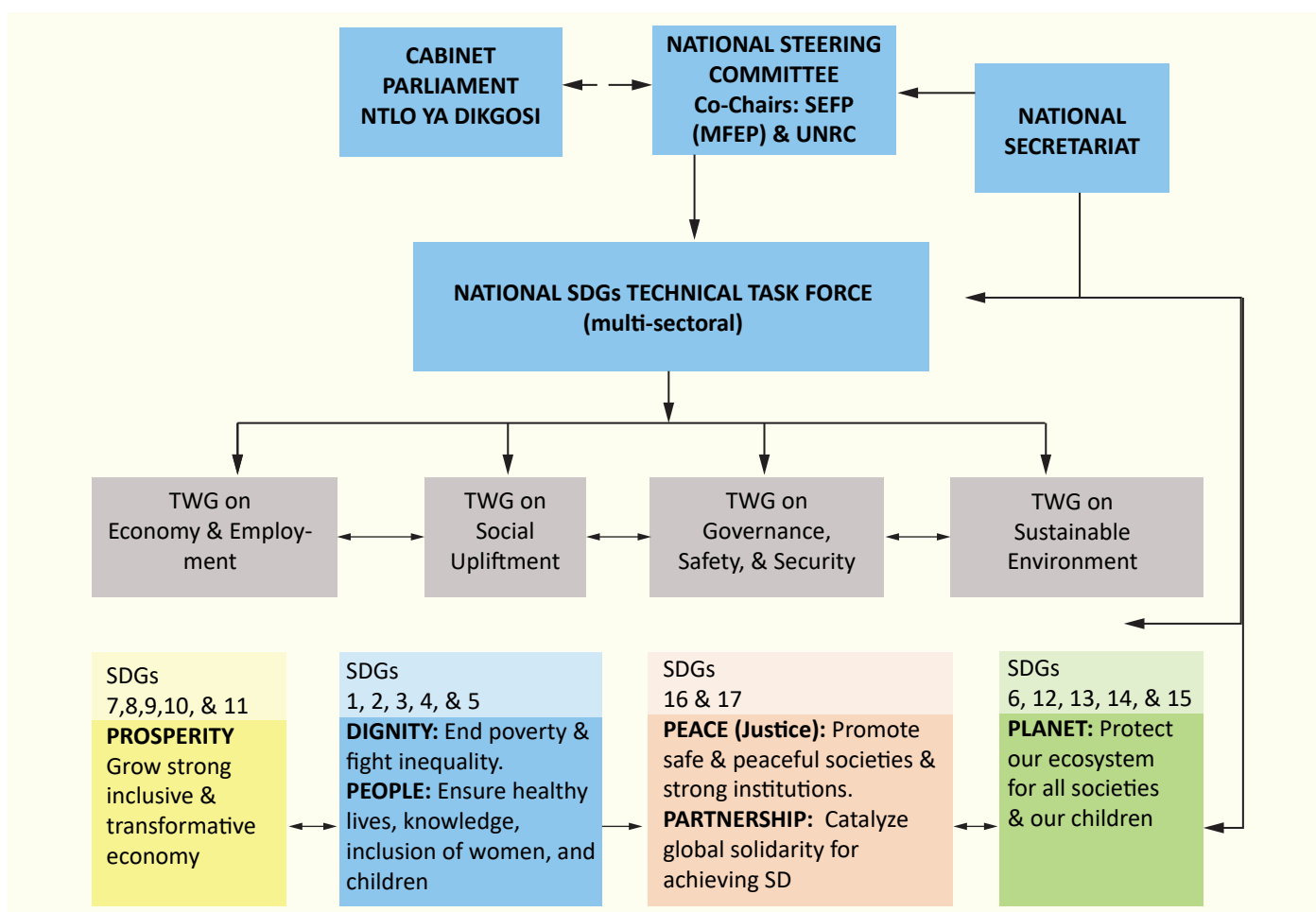


Figure 2-1: Institutional structure for SDG implementation in Botswana (MFED, 2019)

The Botswana SDGs Roadmap was launched in February 2018 as a strategic document to guide implementation of the SDGs in the country, including identification of key stakeholders and strategic areas of focus, namely, national ownership, leadership & coordination; advocacy, sensitization & awareness; planning & implementation; data monitoring, reporting & evaluation; institutional arrangements; and policy research (MFED, 2019). A Guidance Note has further been developed to support the implementation by amplifying specific tasks and institutions to undertake such tasks.

Multilateral environment agreements and the SDGs

“Healthy Planet, Healthy People” is a conceptual approach that considers the human dimensions for achieving a healthy planet. It underlines the importance of maintaining the

integrity of ecosystems and recognizes their interlinkages with socio-economic systems. It emphasizes that a healthy planet is a necessary foundation for human physical, psychological, social, economic, emotional health and well-being, hence it is critical for achieving all the SDGs (Bridgewater, Régnier, & Wang, 2012). It is worth noting that the MEAs individually provide a lot of detail per subject area but they remain deficient in addressing environmental issues as their implementation is quite often fragmented. Although less detailed than the MEAs, the SDGs provide a broader framework and common language meant to bring all these agreements and actions together. There are indeed important interdependencies between the MEAs and SDGs. Chapter 1 highlights MEAs to which Botswana is a signatory to and Table 2-2 shows some of the institutional and policy frameworks which the country has put in place to achieve sustainable development.

Table 2-2: Institutional and policy frameworks supporting sustainable development in Botswana (UN, 2020) (DEA, 2019)

Multilateral Environmental Agreement	Domestication document	Institutional set-up	Key initiatives
World Commission of Sustainable Development	National Policy on Natural Resources Conservation and Development (1990), Environmental Assessment Act of 2011, Botswana SDGs Roadmap, Draft National Framework for Sustainable Development	National Steering committee on SDGs	Botswana Vision 2036: Achieving Prosperity for All, National Development Plan 11, National Implementation Plan for SDG 4, CCD project, Botswana Domesticated Sustainable Development Indicators: Baseline Stats Brief; National SDG Communication Strategy, Draft Environmental Management Bill
UN Framework Convention on Climate Change (UNFCCC)	Draft Climate Change Policy, Nationally Determined Contribution to the Paris Agreement	National Climate Change Steering Committee	Renewable Energy Strategy, Draft Electricity Amendment Bill, Botswana Energy Regulatory Act 2016, 3rd National Communication Report to the UNFCCC
UN Convention on Biodiversity (CBD)	National Biodiversity Strategy and Action Plan, Makgadikgadi Framework Management Plan, Okavango Delta Management Plan	National Biodiversity Authority	6th National Report, The Domestication of the Nagoya Protocol on Access and Benefit Sharing, Draft ABS Bill
UN Convention to Combat Desertification (UNCCD)	National Action Plan, National Forest Act (1968)	National Taskforce for the Implementation of UNCCD	Forest Inventory, Valuation of Forest Resources, Sustainable Land Management (Ngami, Makgadikgadi, and Kgalagadi)
Stockholm Convention on Persistent Organic Pollutants (POPS)	National Implementation Plan for the Management of Persistent Organic Pollutants 2011	Department of Waste Management and Pollution Control	National Inventory of POPS
Basel Convention on The Movement of Hazardous	Waste Management Act (1998), Draft Waste Management Policy	Department of Waste Management and Pollution Control	National Report on the Basel Convention 2006, Waste Management Act 1998
Convention on The Illegal Trade of Endangered Species (CITES)	Wildlife Conservation and National Parks Act of 1992	Department of Wildlife and National Parks	National Biodiversity Strategy and Action Plan 2016, Botswana Threatened Species Management Policy, Implementation Strategy and Action Plan, 2007

2.3 Options to strengthen SDG implementation in Botswana

Deepening SDG outcomes and governance institutions

Although the country has the institutional framework designed to deliver the SDGs and implement other environmental management programmes, there are gaps in terms of capacity. The NDP11 highlights the need to strengthen the performance of institutions, which is a key focus area in achieving sustainable development. Some of the areas that require support include reporting for MEAs and other conventions, follow up in terms of enforcement and compliance and other accountability mechanisms. Increasing representation of different stakeholder groups and allowing for citizen engagement are some of the strategies for improving the SDG implementation outcomes. A good example is the Environmental Assessment Act (CAP 65:07) which incorporates the element of public participation. This has elevated the voice and participation of communities and different stakeholder groups (GoB, 2017). Going forward, this should be a key element of all Government programmes as this will enhance social accountability and improve public trust and ownership, making compliance and enforcement much easier.

Creating awareness on SDGs

The Botswana National Communication Strategy for the SDGs was developed as a channel for communicating the SDGs to all stakeholders in the country. Its primary goal is to ensure ownership and understanding by citizens, development partners, civil society, the private sector, national and local leaders, and parliamentarians to successfully engage them in the implementation and realization of the SDGs in Botswana. The three main strategic objectives of the Communications Strategy are to:

- Increase awareness and visibility of SDGs among target audiences.
- Share knowledge and lessons learnt for the attainment of the SDGs.
- Improve coordination and information exchange by generating dialogue among various stakeholders.

The full operationalization of this strategy, supported by specific communications plans for each sector, will go a long way in empowering stakeholders with knowledge, mobilizing them and ensuring their active participation in the implementation of the SDGs (OAG, 2019).

Improving policy implementation through systematic development planning

According to the United Nations Environment Assembly (UNEA), the 2030 Agenda “represents a paradigm shift to replace today’s growth-based economic model with a new model that aims to achieve sustainable and equitable economies and societies worldwide” (UNEA, 2017). Taking into consideration the interdependencies between various global, regional, and national policies, it is note worthing that the environment underpins almost all the SDGs. A paradigm

shift such as the one proposed in the draft Botswana National Framework for Sustainable Development and the Botswana National Spatial Plan to undertake development planning utilizing a more integrated approach is thus vital.

Botswana in her attempt to pursue these global goals in a more organized manner formulated a Performance Framework for the NDP11 and Vision 2036 that took into consideration the extensive indicators proposed by Agenda 2030 and localized these into the Botswana Domesticated Indicator Framework. These indicators are those for which the country can generate data; and will thus strongly support the process of reporting and evaluation of progress from the ground up. The process of compiling the indicator framework involved extensive stakeholder consultations from the local to the national level thus providing a unique and incremental approach to mainstreaming the SDGs across sectoral elements of the NDP. It will be necessary for Botswana to use these to evaluate progress on the SDGs in a systematic manner. To do so, it will be necessary to upgrade and broaden the data instruments, tools and information systems of the lead agencies, which are used, to ensure there is sufficient data collection against the identified indicators to monitor the SDGs.

Linking budgets to policy implementation for improved outcomes

Botswana already has an array of relevant policies and some of these documents (e.g the Forest Policy, Waste Management Policy, MEA Implementation Strategy, National Meteorological Services Act and the Mines and Minerals Act 1999) were reviewed during the last NDP10 period (2009-2016). Apart from addressing the policy framework, the gaps identified included the need to ensure integration and collaboration between the institutions to have more effective outcomes. The NDP11 identifies lack of technical capacities, poor collaboration between institutions, budgets not linked to outcomes, weak or absent implementation plans and monitoring and evaluation systems (GoB, 2017).

To better support environmental policy implementation and improve the effectiveness of outcomes, it is important that policies be formulated against a backdrop of up to date and timely data and information. The NDP11 recognizes that across several areas, local and sector plans are formulated based on outdated data which are not always adequately standardized or disaggregated to support the required analyses (GoB;UNSD, 2016) (GoB, 2017). Furthermore, Government investments in a sector do not often match the expected outcomes.

It is increasingly being recognized that budgets need to be linked to outcomes as a method of increasing effectiveness and accountability to Governments, stakeholders and to citizens (Figure 2-2). The budget, as an integral part of the national development strategy, is an expression of the political support of Government. As such, if national environmental implementation plans are integrated into the budget, it would promote effective policy design, policy integration and improve resource allocation and utilization. In the case of Botswana which has domesticated its SDG, linking the budget to the SDG implementation plan would support the national SDG agenda and could also be used

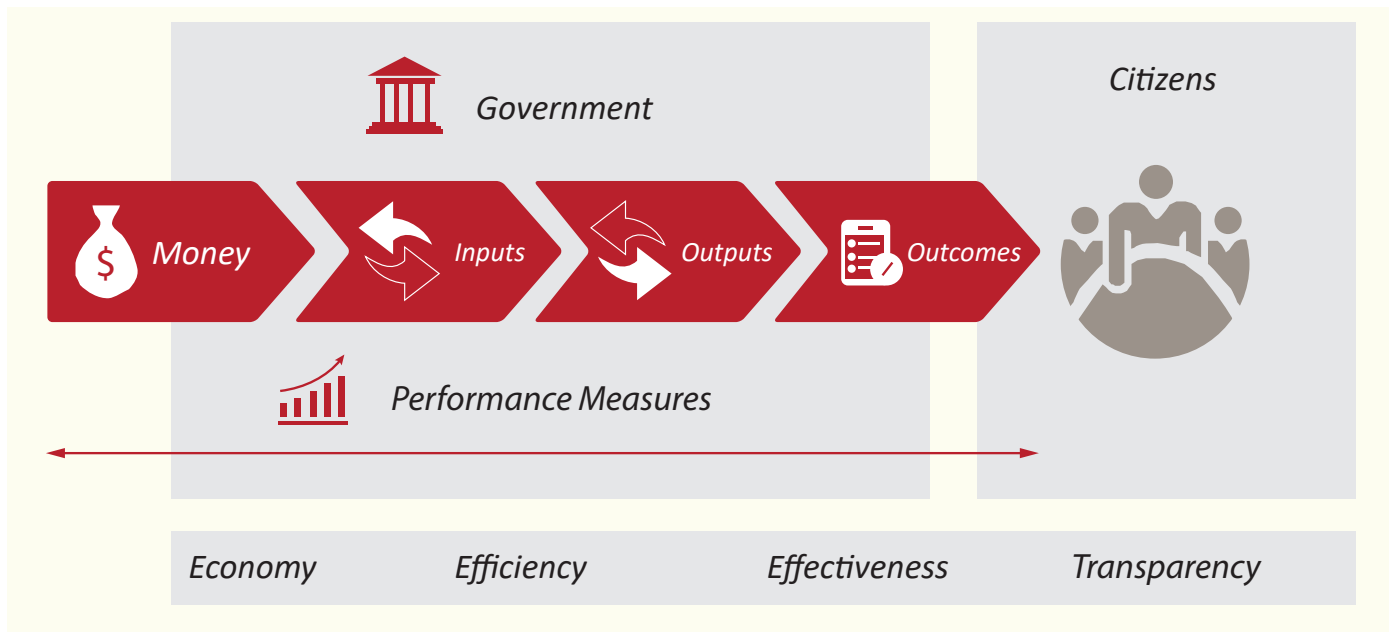


Figure 2-2: Process flow for outcome-based budgeting (OECD, 2016)

as a tool to assess overall Government performance (OECD, 2016).

As discussed in the previous Chapter, environmental degradation, biodiversity loss and the impacts of climate change continue to undermine the progress Botswana has made despite being a signatory to a multitude of global and regional MEAs including existing relevant national laws. The 6th National Report to the CBD and the 3rd National Communication to the UNFCCC demonstrate that the country still needs more investment to realize the aspirations of Prosperity for All as mentioned in the Vision 2036. The draft Climate Change and the Waste Management Policies make proposals for strengthening the coordination of MEAs whilst the Biodiversity Finance Initiative makes a call for improved efficiency, cost recovery (through effective pricing and fees in protected areas) and more resources mobilization in biodiversity and sustainable development.

Based on the above, it is important that the Government of Botswana ensures adequate funding to support effective and efficient programme implementation by the relevant institutions and the generation of environmental data and information systems required to underpin SDG monitoring.

Monitoring and evaluation: the role of Statistics Botswana

To keep track of the progress on implementing the SDGs, it is critical that a robust monitoring and evaluation platform be put in place. Indeed, countries that signed up to the 2030 Agenda agreed to intensify collective efforts to strengthen statistical capacities to monitor and report progress on the 232 indicators. In conjunction with Statistics Botswana and other relevant stakeholders, the MFED, which is the coordinating institution of the SDG implementation, need to develop SDG baselines for an effective monitoring and evaluation of SDGs implementation status.

The Botswana Domesticated Stats Brief outlines the applicable SDG targets and indicators in detail (Statistics Botswana, 2018a; UNFPA, 2018). The Ministry of Finance (MoF) is currently rolling out the SDG Planning Guidelines to facilitate integration of SDGs into Line Ministries planning processes. The Guidelines have five (5) stages to follow for integration and to date, nine (9) Ministries have started the process as a pilot and they are at different stages of the exercise. The process will be rolled out to other Ministries in due course.

Statistics Botswana is encouraged to take leadership in this area and to guide and encourage the sectors to incorporate new data collection tools and technologies, employ analytical methodologies and innovative reporting in their work.

Vervet monkey (*Chlorocebus pygerythrus*)
Photo credit: Michael Levine-Clark/flickr



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The Hands of Mosadiatshipi Mudinbura - Basket Weaver From Botswana
Photo credit: Bud Ellison

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Pandamatenga farms
Photo credit: Ministry of Agriculture



3

LAND RESOURCES



Photo Credit: Department of Wildlife and National Parks

3.1 Introduction

Botswana's land resource is a key enabler for the progress envisaged under both Vision 2036 and the National Development Plan (NDP11). Land has the potential to address poverty and promote human health by supporting food security and creating wealth and job opportunities. This chapter presents an overview of the state of land resources in Botswana. It describes the different land tenure systems, land uses and highlights some of the key issues affecting land resources including challenges associated with land tenure systems, land degradation and food security.

The land use regimes in Botswana vary according to the different biophysical factors associated with each land type. Among the key factors influencing their respective uses are the prevailing climate conditions, socio-economic circumstances, and the applicable Government policies. These uses put pressures on land resources leading to land degradation because of overstocking, soil erosion, uncontrolled application of agricultural chemicals and pollution from mines. The impacts of these activities have led to changes in the environment. The most dynamic changes have been in forest cover, which declined by 24 percent between 1990 and 2011. In this chapter, sustainable land management clearly stands out as an important issue.

The country has devised strategies to address some of these concerns. Revised land policy and strategies are being implemented to deal with some of the issues including land degradation and land tenure. Alongside these, the country is also implementing actions to achieve the land-related SDGs. For instance, progress has already been made on the conservation of plant and animal genetic resources, which is well recognized as an important means of conserving the genetic resources and agrobiodiversity necessary for food security.

3.2 Land governance in Botswana

Land, as a resource, plays a primary role in helping the Government address issues such as poverty, food security, livelihoods empowerment and social reconstruction through conflict resolution. Therefore, land governance, or the context within which land is managed, must support sustainable land use and development, access to land and land rights (Kolawole et. al., 2017; Sungirirai, 2019). Good land governance is a key component of NDP11 and Vision 2036 emphasizing the Government's commitment to striking a balance between the population utilizing the land, other development activities and ensuring sustainable land management.

A pride of lions relaxing
Photo credit: Birger Strahl/unsplash



Policy and legal instruments for land management

Land in Botswana is governed and managed through several policy and legal instruments that are summarized below (Sungirirai, 2019);

- Land Policy 2019 addresses land tenure, land rights (including those of vulnerable groups), access to land, administration, and market issues. The institutional framework allows for decentralization of functions to Local and Land Authorities, enhancement of institutional capacity and efficient land information management.
- The Town and Country Planning Act 2013 sets out the guidance for physical planning in the country with the aim of ensuring a safe environment for the people to live in.
- Tribal Land Act (32:02) of 1969 and amended in 2018, aims to improve land administration, rationalize land allocations, and introduce leasehold tenure. It provides for an institutional framework through the establishment of Land Board Committees and Land Boards. Land Boards are responsible for allocating land and title for tribal land under customary and common law. They also have authority to formulate their own policies in line with the framework of the existing law. The Land Boards replaced the local chiefs and tribal leaders who initially, with no formal registration, were responsible for land administration in rural areas.
- Deeds Registry Act (33:02) was enacted in 1960 and amended in 2018. Regulations to support operationalization of the 2018 amendment have been developed. The Deeds Registry (Amendment) Act commenced on 20th November 2020 while its regulations commenced on 30th December 2020. This Act empowers the Deeds Registry, to register all land (including customary land) in support of efficient, effective, and transparent land administration (MLWS, 2021).
- State Land Act (Cap 32:01) of 1966 defines state land as townships, rural state land, land acquired in foreign lands, game reserves, national parks and vests the management of these on the President. Land management is a delegated function with the ministry responsible for land management handling state land management, while district and urban councils are responsible for apportioning low- and middle-income residential lands.



Land tenure systems in Botswana

During pre-colonial times, Botswana's total land area of 581,730 km² was all classified as communal land. After the country became a Protectorate in 1885, three tenure systems emerged: Native Reserves, Crown, and Freehold land. These tenure systems evolved over the years to include Tribal, State and Freehold land which make up about 71, 26 and 3 percent of land respectively (Figure 3-1). About 37 percent of the land asset is dedicated to protected areas, while the rest is dedicated for use by citizens (Sungiriral, 2019).

Tribal land

Before Independence, tribal land was administered by Chiefs. Following the enactment of the Tribal Land Act in 1968, Land Boards took over the responsibility of land administration in the country. Tribal land can be granted through customary

law (certificate) and common law (lease). Customary grants are issued for dwellings, water points and for ploughing fields and the grant is perpetual as long as there a used for the same purpose acquired for. Customary grants may be converted to a common law lease and ultimately Title Deed. The length of the common law leases ranges from as short as a year or longer. On expiry the land reverts to the Land Board without compensation for any onsite developments, since the lessee has beneficiary utilized the land. With the enactment of the Tribal Land Act of 2018, new allocations shall be issued as Deed of Customary Land Rights (Sungiriral, 2019).

State land

State land is owned by the Government under the State Land Act Cap 32:01 of 1966 and is found both in rural and urban areas (Sungiriral, 2019). On state land, two types of



Figure 3-1: Distribution of land tenure systems during colonial (DTCP, 2020 and Bornegrim & Collin, 2010)

leases could be issued for residential purposes - the Fixed Period State Grant (FPSG) and the Certificate of Rights (COR). Both were designed to promote land ownership. COR leases have been widely used for self-help and squatter upgrading housing schemes targeting low income groups in urban areas. However, the COR has not been without challenges, as financial institutions would not accept it as collateral unless converted to FPSG (Sungirirai, 2019). With the passing of the Land Policy of 2019, the Government has since discontinued the issuance of CORs. Therefore, all new allocations will be issued FPSG and all COR shall be converted to FPSG.

FPSG landowners pay upfront for the FPSG lease and at the end of the 50- to 99-year lease period, there are conditions of renewal upon expiry. As the end-of-lease period approaches, the value of the land depreciates, because one needs to consider the remaining lease period when selling. The

duration of the lease also does not promote sustainable land utilisation as the owners might not invest in a land that will soon change ownership. Even though a lot has been done to promote land ownership through a tenure system, it has not always had the desired outcomes (Shabane, et.al, 2011; Hurni, 2000).

Freehold land

Freehold land was created for settlers during the colonial era, mainly for agricultural purposes. Ownership is permanent and it can be inherited and used to support financial transactions (Sungirirai, 2019). The state land and freehold land tenures are both administered by the Department of Lands.

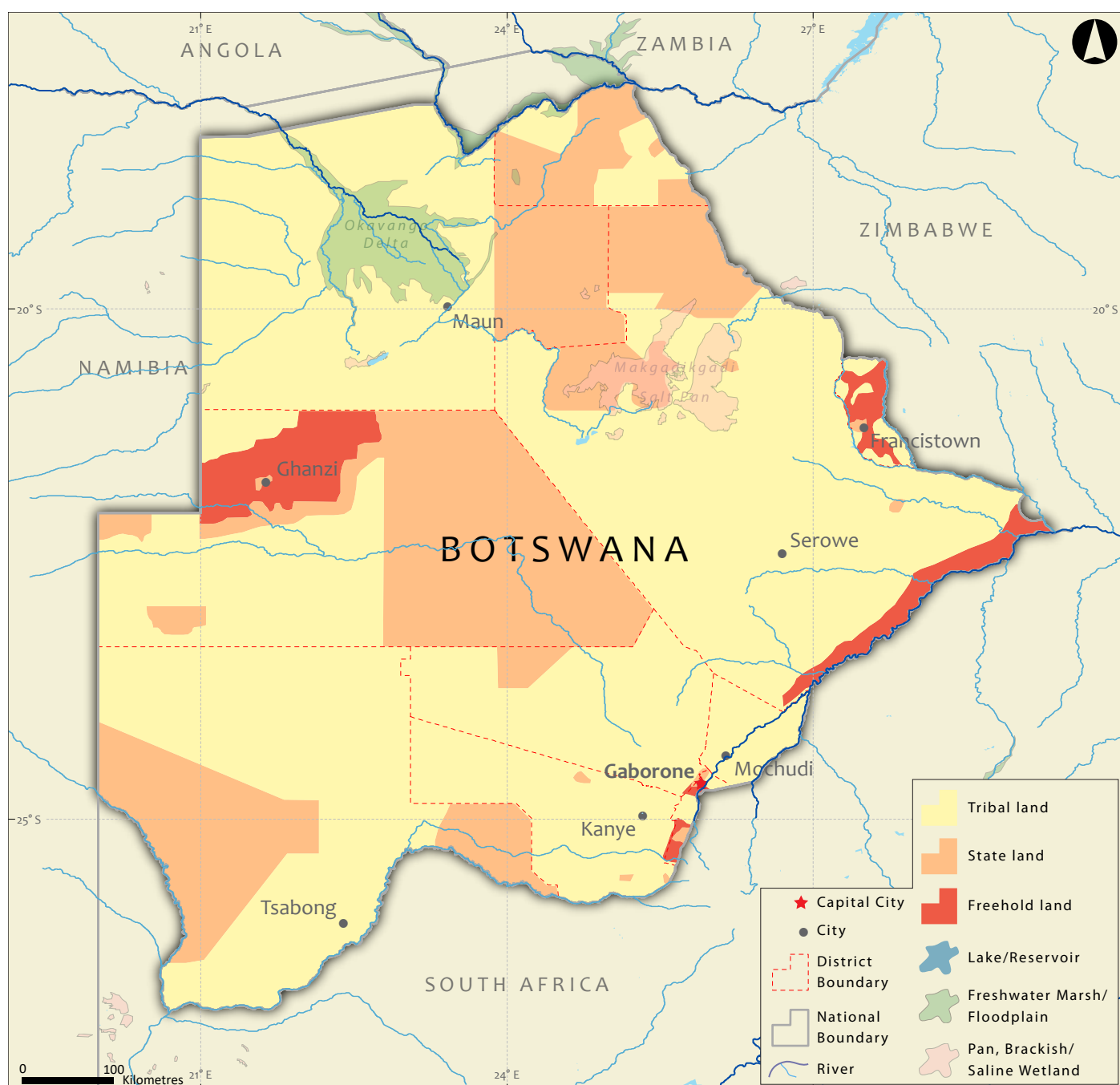


Figure 3-2: Distribution of land tenure systems in the post-independence era (DTCP, 2020 and Bornegrim & Collin, 2010)

3.3 Land use zones in Botswana

Within Botswana, land use is divided up into two large groups – the conservation areas consisting of protected area and wildlife management areas; and then the areas where human activities including agriculture, pastoralism, human settlement, and mining predominate. Given that Botswana has a large land mass with a low population, expansive protected areas have been established under the guise of environmental management.

Land use zoning in Botswana is based on resource distribution and primary uses of the land. This is in line with the Tribal Grazing Land Policy of 1975 under which the country was divided into three land use categories: communal, commercial, and reserved land. The aim of the policy was to improve management of rangelands and facilitate commercialization of cattle ranching. Later, a fourth category (wildlife management areas) was added to limit the displacement of wildlife resources. These land use zones are highlighted in Table 3-1.

Table 3-1: Land zoning categories in Botswana (Hitchcock, 2006) (MoLG and MLH, 2020)

Type of land	Land zoning category	Area (km ²)	Percentage of country
Freehold land	Freehold Farms	32,970	5.7
State land	Parks and Reserves	101,535	17.4
	Other	32,455	5.6
Tribal land	Communal	173,432	29.8
	Commercial	51,094	8.8
	Wildlife Management Areas	129,450	22.2
	Leasehold Ranches	3,351	0.6
	Remote Area Dweller Settlements	3,523	0.6
	Other	53,945	9.3
Total		581,720	100.0

Wildlife management areas

Thirty-seven percent of the country has been designated for conservation and recreational activities related to wildlife. These areas protect the wildlife key areas from intrusion by livestock, while also contributing to the advancement of the country's rural economy. Designated Wildlife Management Areas (WMAs) cover a total area of 122,600 km² (about 20 percentage of the country landmass), while 17 percent are protected areas such as national parks and game reserves. The WMAs range in size from 60 km² to over 15,800 km².

The protected area network in the country is important as it supports livelihoods and the national economy through revenues and employment opportunities. For instance, ecotourism plays an important role in supporting at least 2,000 jobs in the northern, central and south-western parts of the country. This provides a buffer for communities making them more resilient against hunger, food insecurity and climate change. This highlights the interlinkages between sustainable land management through wildlife conservation

and food security. In western Botswana, the benefits from wildlife as a land use activity are mainly harnessed through game farming.

In the south and south-western parts, the expansion of human settlements has led to dwindling wildlife populations and increased incidences of human-wildlife contact and conflict. The Government established fences in a bid to address this issue and limit the spread of disease. However, the unintended consequence has been the reduction of the livestock grazing reserves. Confining the bigger herbivores increases their vulnerability to droughts, limits their dispersal and drives land degradation and soil loss (Fynn, 2012).

WMAs were established under the Wildlife Conservation Policy (1986) to support a commercial wildlife industry, provide benefits to the local rural population, and increase the supply of game meat as part of the National Food Strategy. The strategy to increase land under agricultural activities may be viable in the long-term if actions to enhance co-existence with wildlife activities by safeguarding animal migratory routes are also implemented. Animal movements are a key attraction in ecotourism products. The literature has indicated that establishing and maintaining animal corridors may play an important role in sustaining land productivity for the communities (Winterbach, et.al., 2015). For instance, the mass migrations of Burchell's zebra (*Equus burchelli*) and the Blue wildebeest (*Connochaetes taurinus*) inside Makgadikgadi National Park, and movements of zebra between Makgadikgadi National Park and the Okavango Delta are important for the health of the ecosystem, they are impressive and contribute to livelihoods and the economy through tourism earnings (Winterbach et.al, 2015).

Agro-tourism

Agro-tourism which is a form of eco-tourism, links the agricultural and tourism sectors and is an opportunity for rural development, citizen empowerment through the provision of new income streams. The Government is supporting the promotion of this niche market through Presidential Directive CAB 14A of 2019, that approved changes in the Land Policy Development Control Code 2014, Government Notice No.77 of 2001, Integrated Agricultural Farming Guidelines and the Tourism Related Accommodation Guidelines, in order to facilitate the land usage needs for the public. Other supporting policy documents include the Development Control Code (with respect to mixed agricultural land use) and the Administrative Guidelines for Licensing of Agro-Tourism Operations and the proposed Citizen Economic Empowerment Policy.

Although the onset of the COVID-19 pandemic resulted in the closure of borders and a drastic drop in international tourism, the Government has sought to promote local tourism as a means of offsetting this impact. As a result, there has been a rise in mekoro and boat cruises in Ngamiland where the Okavango Delta is situated. This has created employment for the locals that had lost their jobs because of the pandemic. However, there is need for regulation to ensure adherence to the Governments' public health and safety guidelines including those governing the spread of Covid-19.

Forest cover

Botswana's forest area declined from 24 percent in 1990 to 19.1 percent in 2011, currently covering an area of over 4,500 km² (Lepetu et.al, 2009). The decline has been largely attributed to the growing population, severe late dry season veld fires and the policy regarding the consumption of natural assets (GoB, 2017). Woodlands in rural areas, whose immediate communities are mostly dependent on wood fuel for cooking and lighting, are among the most affected. Data on some of the forests are shown in Figure 3-3.

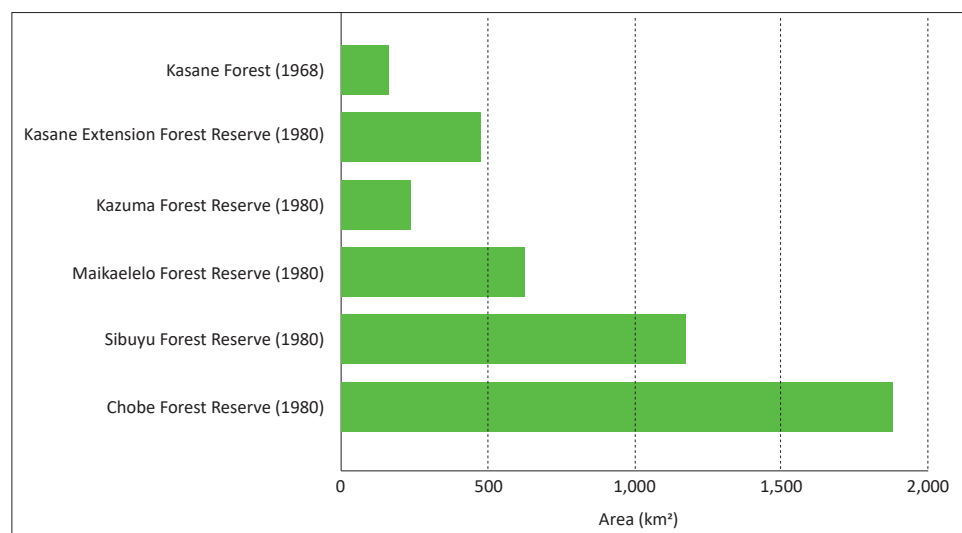


Figure 3-3: Botswana's areas of woodlands on state land forest reserves (Lepetu, Alavalapati, & Nair, 2009)

The negative trends witnessed in forest cover reduction are likely to hamper the country's commitments to the Paris Agreement on climate change as well as its progress on the Sustainable Development Goals especially SDGs 1 and 2, which focus on eradicating poverty, and ending hunger, respectively. Local (and poor) communities in the rural areas and informal urban settlements will be adversely affected by their limited capacity to adapt owing to their huge dependency on natural resources for their daily needs, including firewood and non-timber forest products (Lepetu et.al, 2009).

The country has been making strides to address forest-related challenges through legislative and policy interventions. Social forestry has been an emerging area since the 1970s with focus on addressing forestry matters in a more holistic manner, including the participation of local people and other forest-dependent communities in afforestation. The country has also adopted a policy of multiple zoning of forest areas. While Forest Reserves Management Plans are developed for the purpose of using forest reserves for ecotourism, the development of Land Use Management Plans (LUMP) has been initiated for specific Controlled Hunting Areas (CHAs).

In terms of the institutional framework, the Department of Forestry and Range Resources (DFRR) is housed within the Ministry of Environment and Tourism (MET). Its mandate includes technical responsibilities and objectives on forest matters.

Mining

The total area of mines in Botswana is 325,278 ha (DOM, 2020). The main minerals mined are copper, coal, diamonds, iron ore, nickel, potash, salt, silver, and soda ash. According

to (Statistics Botswana, 2016), minerals accounted for 22.4 percent of GDP in 2013 and over half of the Governments revenues, but less than 5 percent of employment in the private sector. Currently, diamonds are the biggest export earner. In December 2019, they made 93.5 percent of the principal exports compared to other goods which contributed 4.3 percent, machinery and electrical equipment accounted for 1.8 percent while salt and soda ash constituted 0.8 percent (Statistics Botswana, 2020a).

Some of the issues in the mining sector include human displacement, loss of fertile soils that support crop production, grazing and livelihoods, pollution, and the impacts of abandoned mines such as burrow pits, acid mine drainage, open wells, among others.

The Department of Mines has oversees the mining industry and regulates them under the Mines, Quarries, Works, and Machinery Act (CAP 44:02) and its subsequent amendments. It specifically calls for the protection of the environment including land and water resources as well as restoration where mining activities may have degraded the landscape. It also provides for the monitoring and management of waste and prohibits the release of harmful hazardous substances into the environment (DOM, 2020; GoB, 1995; GoB, 1973).

Agricultural land use

Agricultural land is defined as the share of land area that is arable, or under permanent crops and or pastures (LPF, 2020). Agricultural land use is estimated at 45.9 percent of the country's entire land area (World Bank, 2020). The agricultural sector in Botswana predominantly comprises rain-fed crop and rangeland-based livestock production systems. The contribution of agriculture to the GDP has declined from 43 percent at Independence in 1966 to 1.9 percent in 2019 (Figure 3-4) (World Bank, 2019). The growth of other sectors, primarily mining and tourism coupled with harsh climatic changes have seen agriculture's contribution to GDP spiral downwards overtime. Despite this, agriculture continues to be the mainstay of the rural livelihoods (MADFS, 2020).

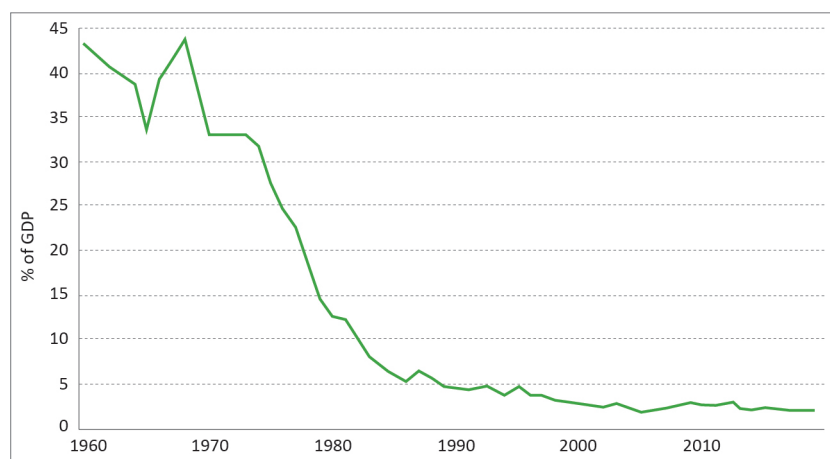


Figure 3-4: Contribution of agriculture, forestry and fishing value added (% of GDP) in Botswana, 1960-2019 (World Bank, 2019)

Policies that have a bearing on agricultural development include the Agricultural Guidelines of 2019 revised in 2020, Land Policy Government Paper No 4 of 2015, National Policy on Agricultural Development (NPAD) 1991, Fencing Component of the NPAD 1991, the National Policy on Tribal Grazing Land, Government Paper No 2 of 1975, the Development Control Code 2013 and the National Spatial Plan 2036 (where agriculture is recognized as an activity that can diversify the economy) (MoADFS, 2020).

Crop production

The total land allocated for rain-fed arable agriculture amounts to around 900,000 hectares. However, only roughly a third of this (i.e. 350,000 ha) is planted annually. Subsistence farmers utilize about 80 percent of this, with commercial farmers accounting for 20 percent of the cultivated area. A total of 130,000 ha of land is currently under commercial crop production and a further 4,500 ha has been proposed for commercial crop production (see Tables 3-2 and 3-3). Major crops produced under rain fed agriculture in Botswana are sorghum, maize, millet, and cowpeas (MADFS, 2020).

Crop production is the most vulnerable part of the agricultural sector due to overreliance on rainfall, recurring droughts, and poor soils fertility. This situation makes arable crop production highly risky. The crop subsector continues to experience limits on its growth posed by low availability

of water, limited skills, inadequate access to markets and marketing facilities, inadequate use of improved technology and low productivity which predisposes rural households to food insecurity and poverty.

About 70 percent of rural households derive their livelihoods from agriculture, through subsistence farming. The industry is dominated by small traditional farms with an average size of five hectares. About 63,000 arable farms fit under this category, while only 112 farms are larger than 150 hectares (MADFS, 2020; Statistics Botswana, 2019). There is pressure to provide food and other socio-economic needs to Botswana through crop production and its entire value chain, thus putting intense pressure on the natural environment (Statistics Botswana, 2018).

Other factors hampering crop production include declining soil fertility, low soil cation exchange capacity (CEC), land degradation by erosion and increasingly variable climatic conditions (Kolawole et.al., 2017). The country attempted to address the issue of poor soil fertility through the increased use of fertilizers. For instance, between 2011 and 2016, fertilizer use increased by 201 percent from 29.7 kg/ha of cropland to 89.6 kg/ha. However, cereal yields only increased by 5.65 percent from 452.5 kg/ha to 477.9 kg/ha over the same period. While the impacts of low and erratic rainfall on soil moisture might limit crop yields as it hinders the ability of crops to take up fertilizer (Kashe et.al, 2019), low CEC of arid soils in the Okavango Delta region would appreciably reduce the usefulness of chemical fertilisers

Table 3-2: Total area of crop production on commercial farms in production (MADFS, 2020)

Type of farming	Commercial farms	Area in ha
Arable farms	Pandamatenga	25,519.23
	Mosi	5,780.00
	Sedibeng	3,794.90
	Cluster fencing	94,592.74
Irrigation	Glen Valley	295.00
	Dikabeya	65.00
	Kubung	8.00
Total		130,054.87

Table 3-3: Proposed land for commercial crop production (MADFS, 2020)

Commercial Farms	Area in ha
Thune	445.0
Matopi	2,596.0
Lotsane	450.0
Grey water schemes	113.8
Nshakazhogwe	900.0
Total	4,504.8

in enhancing better crop yields. Instead, a combination of organic amendment and appropriate inorganic fertilisers could offer better results in soil and crop performance (Kolawole et.al, 2017). The situation is further complicated by the growing population which has increased much faster than the rate of cereal production, raising concerns about the ability of the country to feed itself (Figure 3-5). Between 1960 and 2017, the population increased by 326 percent, while cereal yields declined by 6.17 percent. Land used for cereal production declined by 59.75 percent over the same period. In absolute quantities, cereal production decreased from 62,161 tonnes in 1960 to 23,470 tonnes in 2018, a factor of 62.24 percent (Roser & Ritchie, 2020).

need to generate wealth through commercialization. As service industries such as tourism and mining have grown to become major income earners for the economy, commercial livestock production sector is also becoming more attractive and viable than communal production.

Another major challenge facing the livestock sector is the changing climate having a huge impact on the availability of fodder and water. This varies depending on the time of the year and the location within the country. The rainy season spanning November to March is the only period when livestock fodder is guaranteed. Protracted droughts that affect most parts of the country also limit vegetation

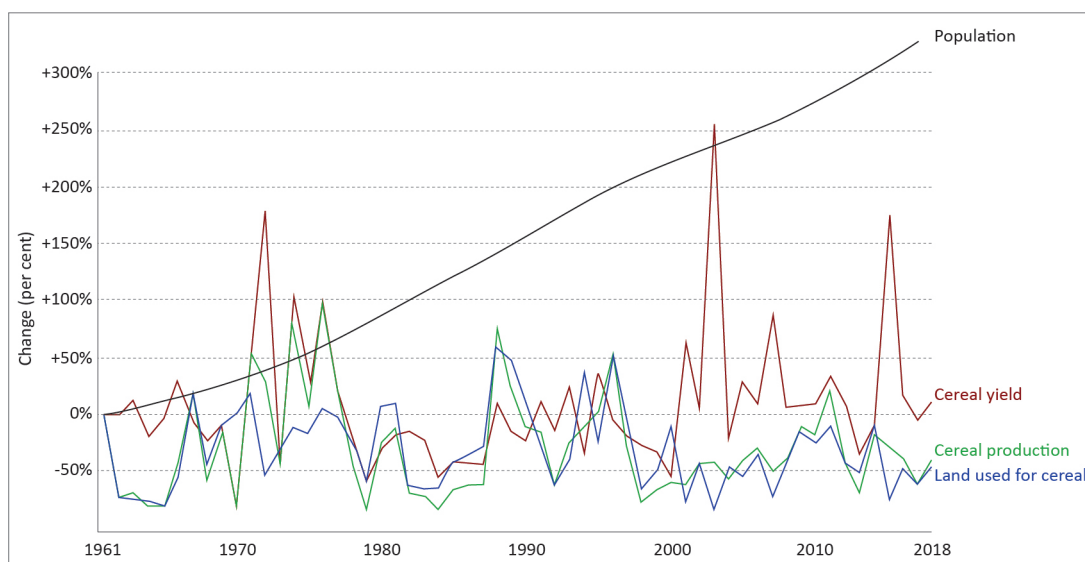


Figure 3-5: Change in cereal production, yield and land use, Botswana 1961-2018 (Roser & Ritchie, 2020)

Land for livestock production

Livestock production accounts for a significant land use in Botswana. The enterprise is vital to the country's livelihoods and nutrition, especially among its rural populations, most of who reside in its vast semi-arid areas. Livestock kept includes cattle, sheep, goats, pigs, chicken, horses, and donkeys. The national herd population currently stands at 1.74 million cattle and has been declining over the last 10 years. This decline is attributed to recurring drought, which continue to have an adverse impact on the quality of rangeland resources that are the basis of the cattle industry. About 80 percent of livestock are in the communal grazing areas while the remainder are in fenced commercial farms (Statistics Botswana, 2018). Sheep and goats are approximately 242,000 and 1.2 million, respectively. The livestock sector alone contributes 80 percent to agricultural GDP (MADFS, 2020). As indicated in Table 3-4, a total of 7,753,844 ha of land is used for livestock ranches and farms. These farms are owned by individual farmers, companies, community groups and Government. Most livestock farmers (especially subsistence farmers) use communal land for livestock production.

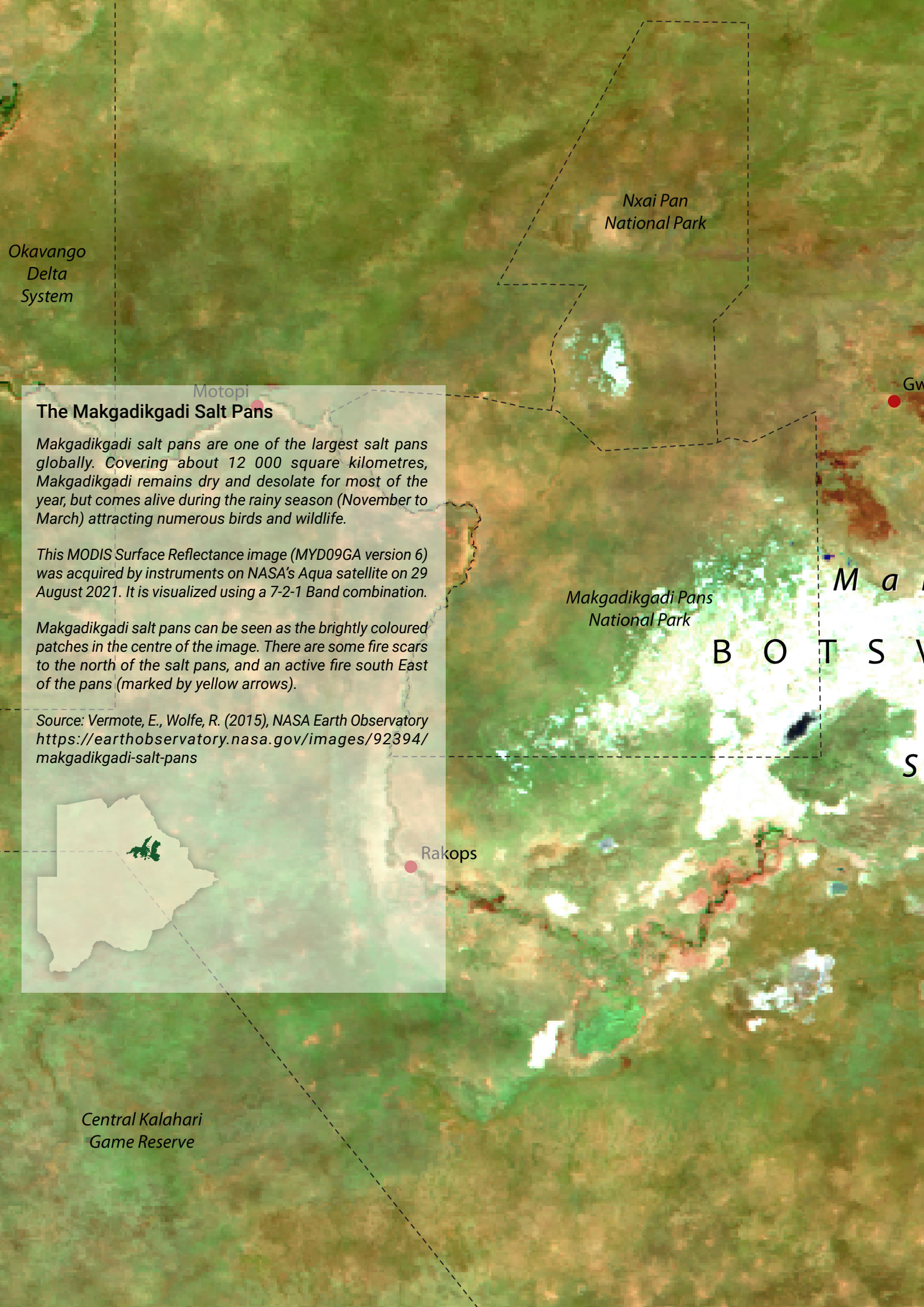
Livestock production is carried out under both communal and freehold land tenure systems and is highly regarded for its role in various levels of its value chain. However, the communal livestock sector is under threat from shifting policies, demographics, changing lifestyles and the growing

cover that could be used as feed for livestock and game. At the community level, human-wildlife conflict is also a major concern for livestock breeders and is fast becoming a major disincentive for the affected rural communities to invest in sustainable land management options (McNutt, et.al, 2017).

Other pressures include overgrazing and overstocking that leads to trampling and soil compaction, which in turn affects water infiltration capacity, thus resulting in more surface

Table 3-4: Total land area in hectares (ha) for livestock production (MADFS, 2020)

Land Use Type	Area in Hectares (ha)
TGLP Ranches	2,147,468.8416
Agric. Policy – Fencing Component Ranches	2,387,278.0015
Freehold Farms	1,948,233.1716
Leasehold Farms	940,528.1920
Former BLDC Ranches	43,317.4588
APRU Ranches	52,150.8134
AI Centres (Ranches)	35,423.2360
Quarantine Camps	184,785.5066
Small Stock Ranches	11,136.4259
Cooperative Ranches	2,680.8818
RTC Ranches	881.2577
Total	7,753,883.7869



Nxai Pan
National Park

Gw

The Makgadikgadi Salt Pans

Makgadikgadi salt pans are one of the largest salt pans globally. Covering about 12 000 square kilometres, Makgadikgadi remains dry and desolate for most of the year, but comes alive during the rainy season (November to March) attracting numerous birds and wildlife.

This MODIS Surface Reflectance image (MYD09GA version 6) was acquired by instruments on NASA's Aqua satellite on 29 August 2021. It is visualized using a 7-2-1 Band combination.

Makgadikgadi salt pans can be seen as the brightly coloured patches in the centre of the image. There are some fire scars to the north of the salt pans, and an active fire south East of the pans (marked by yellow arrows).

Source: Vermote, E., Wolfe, R. (2015), NASA Earth Observatory <https://earthobservatory.nasa.gov/images/92394/makgadikgadi-salt-pans>

Makgadikgadi Pans
National Park

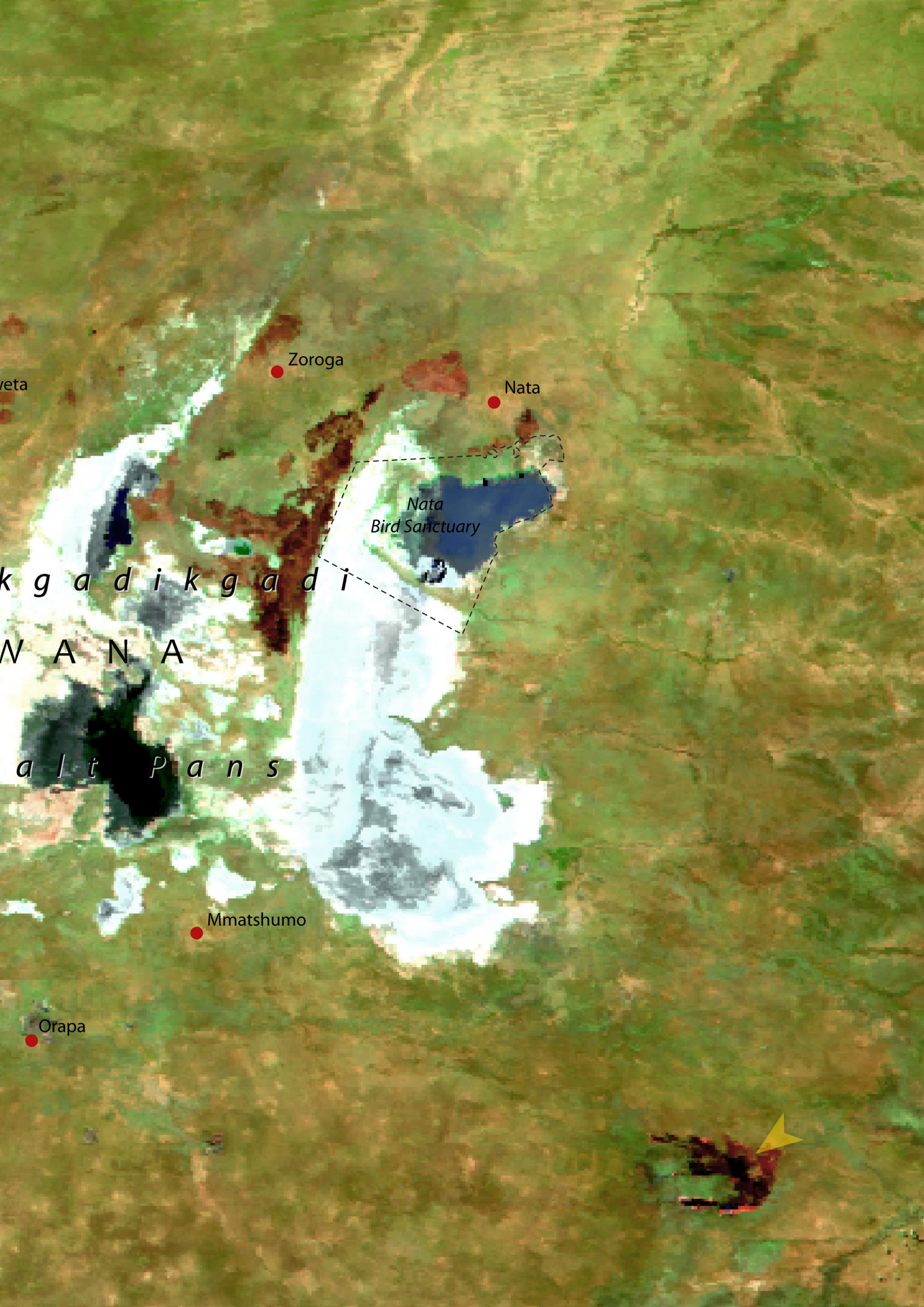
M a

B O T S W A

S

Rakops

Central Kalahari
Game Reserve



veta

Zoroga

Nata

Nata
Bird Sanctuary

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alt Plains

Mmatshumo

Orapa



run-off with a detrimental impact on the soils in the semi-arid areas. Addressing these challenges requires a multi-sectoral approach that combines rangeland management practices with infrastructural and other technical interventions that could benefit the ecosystems and the herding community through improved livelihoods.

The legal framework for livestock management includes the Control of Livestock Industry Act 1941, Cruelty to Animals Act 1966, Diseases of Animals Act 2008, Livestock Improvement Act 2009, and Botswana Meat Commission Act. Some of the key factors hindering enforcement and implementation are low awareness of the requirements of the laws, perceived lack ownership by farmers as they feel they were not part of the decision-making process and the fragmentation of land management functions amongst Government departments.

Livestock in traditional rearing systems, common in northern Botswana are prone to wildlife predation (McNutt, et.al, 2017).

3.4 Land use planning and management

Land use planning

FAO (1993) defines land use planning as *the systematic assessment of the land and water potential in a particular jurisdiction*. It aims to provide the best options for land utilization based on social and economic considerations while safeguarding the resources for the future. Land use planning needs to be flexible enough to allow for future changes to the way land is used or managed depending on the prevailing context (FAO, 1993). Some of these changes in land utilization may arise as new national and local laws are enacted, or transformative national development policies or visions articulated. Land use planning is institutionalised in the Tribal Grazing Land Policy 1975 and the Tribal Land Act (Cap, 32:02, 1968).

Land use planning is mainly a decentralized function undertaken by the Land Boards. The land use plans were then approved by the Land Use Planning Advisory Group (LUPAG) which later evolved to become the District Land Use Planning Units (DLUPU) whose roles include addressing issues of equitable distribution of land and on land management practices.

3.5 Issues, concerns, impacts

Food security

Food-related undernourishment continues to be a big challenge in Botswana affecting about 600,000 people between 2016 and 2018 (Figure 3-6). Although there have been some fluctuations over the years, the intensity of undernourishment in the population has remained constant. In 2016, a total of 177 kilocalories per person per day would have been needed to lift all undernourished people out of this situation; this was not significantly different from 168 kilocalories needed in 1992 (Figure 3-7). According to the data, the minimum dietary energy requirement for Botswana

between 2011 and 2013 was 2,020 kcal/capita/day. Declining rainfall, hot and dry conditions, droughts and heat waves along with intense rainfall events and flooding are a threat to food security.

Some of the interventions to address malnutrition include the School Feeding Programme, the Letlhafula Programme and the Vulnerable Group Programme. Support is monthly and includes the provision of food baskets with locally sourced foods to have a cascading effect on the communities.

Challenges with the current land tenure system

Some of the issues that have arisen with the current land tenure system include land administration, land use conflicts, valuation, taxation and compensation, land use planning and management and land information (Sungirir, 2019).

The major problem with land administration lies with the process and systems that are not providing the information and services that are required. Poor record keeping at Land Boards, lack of a common register for tribal land, lack of coordination and communication between institutions with the mandate for land administration have severely hampered service delivery. For instance, lack of proper records implies that a lot of time is wasted figuring out current ownership and allocations against applications. Furthermore, the lack of a well synchronized, common register and limited collaboration between Land Boards make it difficult to ensure equitable distribution of land as they may not be able to determine whether an applicant has been allocated land elsewhere in the country. Other challenges include lack of human and financial capacity and overlapping laws, among others (Sungirir, 2019; AfDB, 2016).

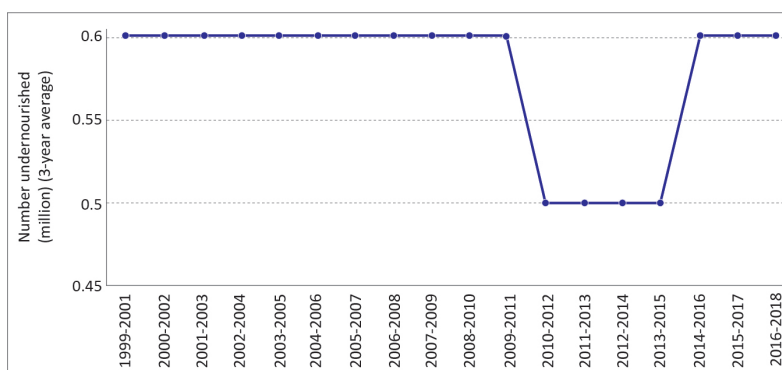


Figure 3-6: Food-related undernourishment (FAO, 2020)

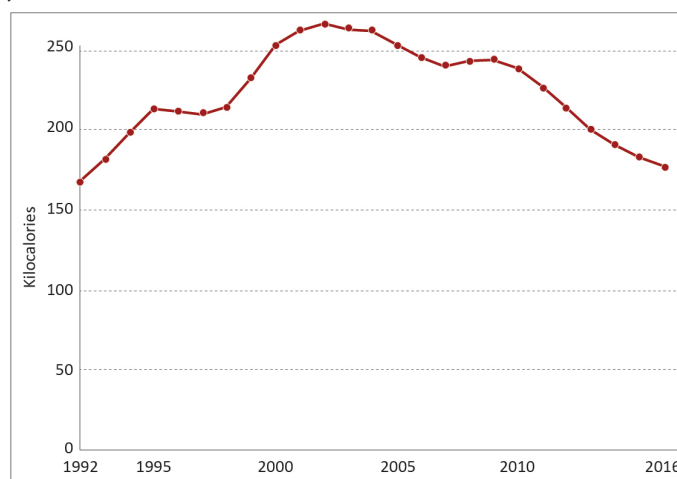


Figure 3-7: Food deficit 1992-2016. (Roser & Ritchie, 2020)

An emerging issue is that of land markets. Poverty and poor access rights are pushing many transactions into the informal sector outside state regulation. There is a growing trend that in which foreigners purchasing prime land in urban areas. While this is within the law, there is growing resentment towards such transactions. Changes in the Land Policy of 2019 and the amended Tribal Land Act of 2018 (on-going) have provisions to regulate the acquisition of land by foreigners and to address some of the related challenges (Manatsha, 2020).

Land degradation and desertification

Land and water are the natural resources and main input factors supporting agricultural productivity. However, agricultural activities are putting pressure on these resources, thus resulting in land degradation due to overstocking, deteriorating soil fertility and declining yields from forests, aquatic and arable agricultural systems. This has a knock-on effect on poverty, exacerbating food security and eroding people's savings and assets as they try to cope leaving them vulnerable to natural disasters such as climate change. Unsustainable land management practices such as conventional tilling (common amongst subsistence farmers and most commercial farmers) as opposed to conservation tillage, uncontrolled application of pesticides, fertilizers and herbicides also contributes to land degradation by contaminating soil and killing the soil biodiversity that are critical for maintaining soil health (MADFS, 2020; Sebegu, et.al., 2019)

This situation limits the capacity of land resources to support the population, especially in the rural areas, where livelihoods are mainly hinged on agricultural and livestock production. For instance, the huge reliance on rain-fed agriculture and natural soil fertility has heightened vulnerability to the changing climatic situations, which have resulted in food insecurity and poverty. Large development activities involving vegetation clearing for settlements, industrial activities and commercial agriculture may also have a negative impact on the environment resulting in habitat loss, deforestation and ultimately land degradation. For instance, the doubling of land used to grow crops during the Integrated Support Programme for Arable Agriculture Development (ISPAAD) project in 2008 is thought to have encroached into fallow and virgin land with potential impacts on soil and biodiversity as discussed in Chapter 4.

The rangelands that form the basis of livestock production, and which sustain cattle, sheep and goats, are also affected by land degradation as witnessed in poor pasture warranted by the recurrent droughts, over grazing and soil compaction. This has led to soil erosion, bush encroachment and a decline in the carrying capacity of the rangelands (Jefferis, et.al., 2013). Overstocking in both communal grazing areas and some fenced commercial farms also causes rangeland degradation due to excessive grazing pressure. This further erodes the already fragile soil and leads to low output, which compromises food security and people's livelihoods and food security. Low productivity of livestock occurs where farmers fail to adhere to the correct stocking rates. To

Photo Credit: Ministry of Environment and Tourism



address the shortage of livestock feed in the country, the Ministry of Agriculture Development and Food Security is in the process of developing a Fodder Production Strategy. This will stimulate the commercialization of fodder production in the country and help reduce the livestock feed import bill (MADFS, 2020).

Opportunities for overcoming the challenges of land degradation abound. For instance, well thought out policies, their implementation, monitoring and evaluation can be useful in boosting food security, improving livelihoods and helping people adapt and improve their resilience to environmental change. Leveraging global initiatives such as the United Nations Decade on Ecosystem Restoration 2021–2030 can provide impetus to national strategies.

Development planning

Development planning in Botswana has horizontal and vertical dimensions. Horizontally, development planning may be divided into economic development planning, spatial planning, and sectoral planning. Vertically, it may be divided into supra-national, national, regional, district and local level planning. Economic development planning, concerned with the financial and economic aspects of development, is overseen by the MoF and the National Strategy Office. It is being operationalized through the preparation of 6-yearly development plans at national level through the NDP; and at district level through the DDP and UDPs. The Ministry of Local Government and Traditional Affairs, through the offices of the District Commissioners, supervises and supports the preparation of the DDP and UDP by the District and Urban Councils, respectively.

Spatial planning

The National Spatial Plan 2036

Botswana has developed a national spatial plan (NSP) as a strategic guide to planning the distribution of people and activities in the different regions of the country. The need for an NSP was first identified in the National Settlement Policy in 2004. The NSP 2036 was approved in 2019. It identified the need for effective planning and administration especially in line with decentralised decision-making, investment and development initiatives across the country and the need for a hierarchical system of primary, secondary, and tertiary centres depending on the population size, administrative and economic functions.

The NSP 2036 is grounded in Vision 2036 and envisions the country as an integral part of the global community and seeks to guide the development process in a manner that aligns well with the country's growing population. Each of the chapters focuses on different thematic areas. Spatial governance is a key element in the NSP, which encourages the integration of relevant structures and processes in the national development planning process.

The NSP 2036 divides the country into 11 regions according to key spatial characteristics and economic potentials and guidance is provided on different initiatives with the aim of ensuring greater economic diversity as well as better social and human development outcomes. The agriculture and tourism sectors are the key target economic areas; while service delivery include housing, education, information and communication technology (ICT), health and social diversity

*Mahalapye cattle in Botswana
Photo credit: ILRI/Saskia Hendrickx/Flickr*



and inclusion. Sustainable environment approaches especially in the areas of energy, water and sanitation are also considered.

Environment considerations in the NSP

The NSP 2036 considers the concept of green corridors -an approach that would link protected areas and wildlife- habitats in Botswana to create an integrated, contiguous green zone in which human settlements and wildlife habitats could be managed together. Having continuous swathes of ecosystems will protect unique and fragile landscapes, allow for the healthy habitats that can adequately support wildlife populations, restore the natural migration patterns allowing animals to move more freely especially in the context of climate change (Lebner, 2017).

The concept also aims to deliver benefits for local communities within the corridor by adopting three main approaches. First, a buffer zone will be established between the protected areas and the human settlements. This will be done by locating game ranches along the edges of the corridor. The second approach is to define new roles for the settlements located inside or near the corridor. For instance, it is proposed that Maun will be an eco-city. This would allow for job creation, economic growth and strengthening of infrastructure, among others. Lastly, the concept will help to open up remote areas for more economic opportunities in eco-tourism. Botswana will thus be able to position itself as a model for nature conservation and eco-tourism where coexistence of unique landscapes, wildlife and the local communities thrive.

Spatial planning, concerned with the spatial, physical and land use aspects of development, is overseen by the Department of Town and Country Planning (DTCP) under the Ministry of Lands and Agriculture (MoLA), and is operationalized through a variety of plans or strategies at various geographical levels. Undertaken only in designated planning areas, the types of spatial plans are highlighted in Table 3-5. Sectoral planning is undertaken by various ministries at a variety of geographic levels. Some of the sector plans in process include the National Multi-modal Transport Master Plan and the National Infrastructure Plan under the Ministry of Transport & Infrastructure.

Advocating for joint development planning

NDP should be informed by both spatial and economic planning. Currently, these two are done separately and led by distinct entities. There would be better planning outcomes if these two planning systems were integrated into one national planning system. To facilitate multilevel spatial-socio-economic-environmental policy integration, spatial thinking must go beyond the purview of spatial planners. There is a need to ensure all Government agencies and other stakeholders to consider the spatial consequences of their decisions; to integrate policies for the development and use of land with other policies and programmes that influence the nature of places and how they function.

Merging the two would result in a comprehensive plan that speaks to where the envisaged developments will be, why, and how they will be financed. Most of the proposals in economic plans lack the spatial component while most of the proposals in spatial plans end up not funded all because of this separation

Table 3-5: Types of plans developed in Botswana

Spatial planning area	Name of plan
National	National Land Use Map
	National Spatial Plan
Regional	Western Region Master Plans
	SE Region Master Plans
District	District settlement strategies
	District integrated land use plans
Urban area	Settlement development plans
	Village development plans
Local level	Structure plans
	New development area layouts
	Upgrading area plans
	Specific area plans
Area-based	Okavango Delta Management Plan
Sector plans	Water Master Plan
	Integrated Water Resources
	Management and Water Efficiency Plan
	National Master Plan for Agricultural Development

*A view of a section of the Okavango Delta
Photo credit: Joachim Huber/flickr*



3.6 Status and trends of SDG indicators

SDG 2.4.1 Proportion of agricultural area under productive and sustainable agriculture

The land area planted with field crops in 2018/2019 was 263,752 ha (29 percent), while 3,190.85 ha was under horticulture (Table 3-6) (MADFS, 2020). The share of land used for agriculture remained constant at 0.7 percent between 1961 and 2015, but fell to a low of 0.3 percent in 2007 as shown in Figure 3-8 (GCDL, 2020).

Table 3-6: Proportion of agricultural area (livestock and crops) under productive and sustainable agriculture (MADFS, 2020)

Trends (%)					
2017/18		2018/19		2019/20	
Target	Actual	Target	Actual	Target	Actual
15	29.59	17	29.02	30	n/a

*n/a not available

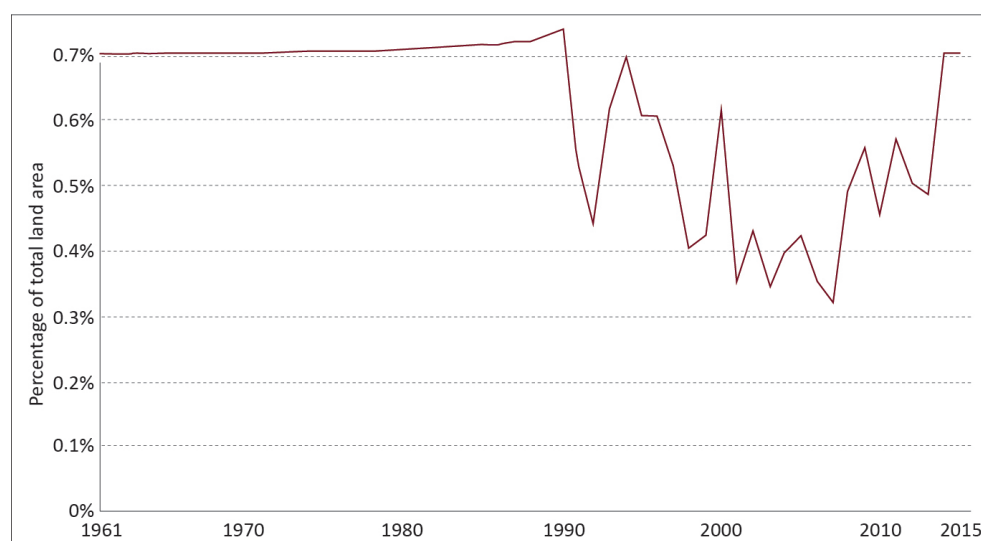


Figure 3-8: Share of land area used for arable agriculture, 1961-2015 (GCDL, 2020)

SDG 2.5.1 Number of plant and animal genetic resources for food and agriculture secured in either medium- or long- term conservation facilities

Figure 3-9 and Table 3-7 highlight the number of plant and animal species for which genetic materials have been stored. Through its research activities, the Ministry of Lands and Agriculture (MoLA) is developing crop varieties, which are suitable for the ecological conditions in the country while at the same time conserving the plant and animal gene pool (GoB, 2017). Key institutions involved in animal genetic resources research include the Department of Agricultural Research and Botswana University of Agriculture and Natural Resources (BUAN). In 2019, there were 2,992 plant breeds whose genetic resources have been adequately stored (UNStats, 2020a).

The collections of genetic resources are carried out annually in selected regions of the country to maintain and increase the number. Those already stored in the gene bank are rejuvenated so that their seeds do not lose viability and other are planted for characterization. In-situ conservation

is also on-going with some selected farmers; two farmers have been given 20 females and a bull of the Mosi breed for this purpose (MADFS, 2020).

SDG 2.5.2 Proportion of local breeds classified as being at risk, not at risk or at unknown level of risk of extinction

The proportion of local breeds classified as at risk were 50 percent in 2011 rising to 75 percent between 2012 and 2019 (UNStats, 2020). See, also, (Figure 3-10).

A total of three local breeds are classified as being at risk in 2018; and the risk status of 5 breeds is unknown since no updated population data were reported for the last ten years (FAO, 2019). Table 3-8 shows the risk status by number of local, regional transboundary (reported in only one region) and international transboundary (reported in more than one region) breeds. The breeds listed as at risk include Tswana pigs, Mosi breed and the Tswana camel as shown in Table 3-9.

Table 3-7: Number of plant and animal genetic material conserved (MADFS, 2020)

Species conserved	No.	Location
Plant species conserved		
Plant species	4,297 accessions	Sebele gene bank
Grass species:		
<i>Panicum maximum</i> , <i>Digitaria spp</i> , <i>E. regidor</i> , <i>S. kalihariensis</i> , <i>S. pappophoroides</i> , <i>C. ciliaris</i>	6	Kang
Livestock species conserved		
Tswana cattle	851	Makhi Ranch
Tswana goats	378	Impala Ranch
Tswana sheep	292	Impala Ranch
Indigenous chicken	75	Sebele & Impala Ranch
Tswana pigs	60	Sebele Ranch
Mosi breed	926	Morapedi & Dikgatlong

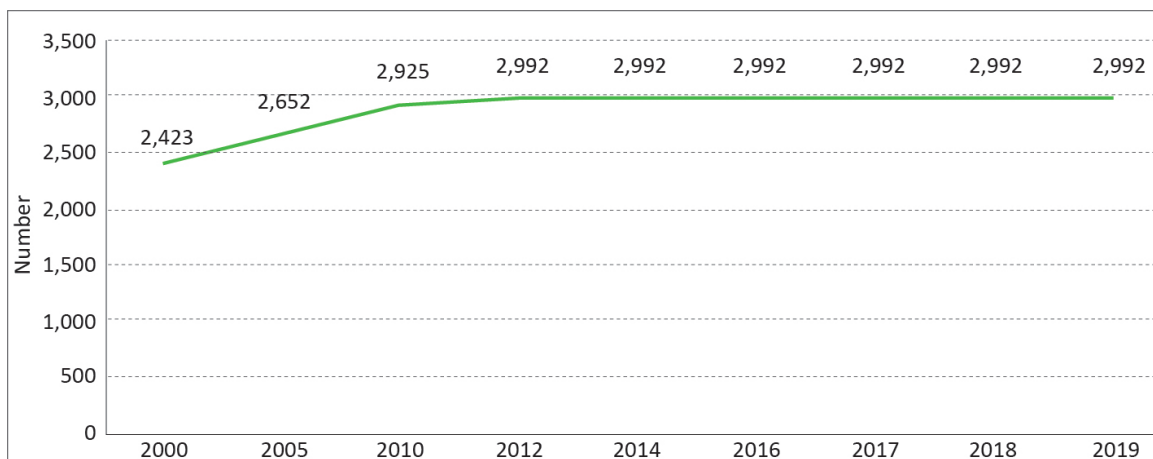


Figure 3-9: Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities (Unit: Number) (UNEP, 2020) (UNStats, 2020)

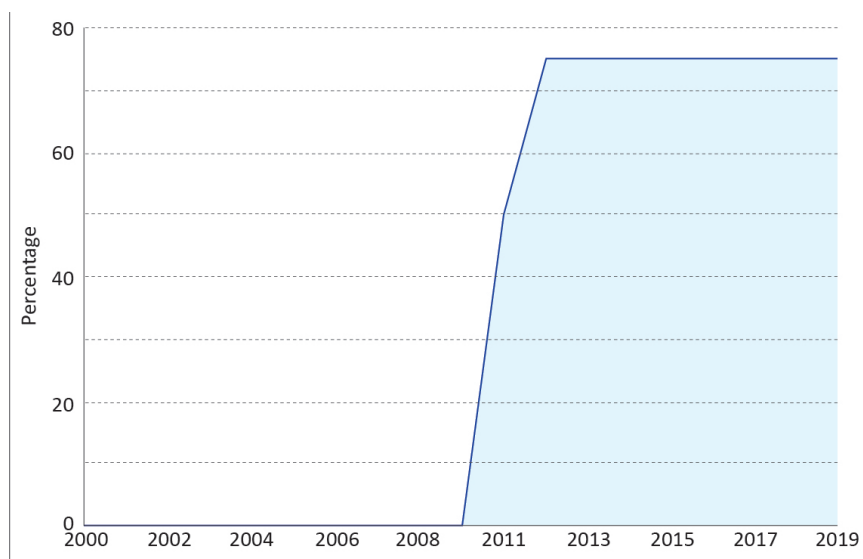


Figure 3-10: Proportion of local breeds, classified as being at risk, not-at-risk, or unknown level of risk of extinction (Unit: Percentage) (UNEP, 2020)

Table 3-8: Risk status of local, regional and international breeds, 2018 (FAO, 2019)

Country	Local			Regional			International			Total
	At risk	Not at risk	Unknown	At risk	Not at risk	Unknown	At risk	Not at risk	Unknown	
Botswana	3	1	5	0	4	2	2	39	3	59
Africa	27	67	719	3	19	75	40	160	69	1,179

Table 3-9: Number of livestock species at risk, not at risk & unknown classification (MADFS, 2020) (Statistics Botswana, 2018)

Livestock Species	Number			Comments
	Traditional	Commercial		
Tswana cattle	763,243	20,472	783,715	Not at risk
Tswana goats	835,024	11,939	846,963	Not at risk
Tswana sheep	138,684	4,036	142,720	Not at risk
Indigenous chicken	760,000			Not at risk
Tswana pigs	Range 300 to 500			At risk
Mosi Breed	Range 800 and 900			At risk
Tswana donkey	178,000			Not at risk
Ostriches	Range 1,000 and 3,000			Not at risk
Tswana camel	Less than 1,000			At risk

NB: Species with a number less than 1,000 is considered at risk.

Botswana has established a Farm Animal Genetic Resources Conservation Unit within the Department of Agricultural Research to drive and coordinate all activities of animal genetic resources in the country.

SDG 14.4.1 Proportion of fish stocks within biologically sustainable levels

Research on fish ecology and fisheries potential is an on-going area in the country and continues to drive the economic aspects of fisheries and their development. Data on fish populations are important for making informed decisions about the management of aquatic resources, including such decisions such as maintaining the highest possible catch (maximum sustainable yields) in the current environmental conditions. Within certain river systems, a positive correlation has been found to exist between flood pulse and fish production (Mosepele, 2008). Indeed, within the Okavango delta area, the main driver in fish populations is the size of the flood pulse – rising water levels triggering fish production processes. However, there is a dearth of data in this area and there have been questions on whether the concept of maximum sustainable yield is relevant in this floodplain fishery (Mosepele & Kolawole, 2017; Linhoss et.al, 2012). Table 3-10 highlights the proportion of fish stocks within biologically sustainable levels between 2017 and 2020.

Table 3-10: Proportion of fish stocks within biologically sustainable levels (MADFS, 2020)

Trends					
2017/18		2018/19		2019/20	
Target	Actual	Target	Actual	Target	Actual
287.9 kg	287.9 kg	302.3 kg	-	317.4 kg	274.2 kg

3.7 Responses and suggested future actions

The institutional, legal and policy framework

The institutional framework

Botswana has a legal and institutional framework in place to promote sustainable land management and to deal with national land issues. The institutional framework includes the Department of Lands which oversees acquisition, disposal, and administration of state land from national to local level, and the supervision and coordination of land administration matters (Kalabamu, 2019). Other institutions include the Land Tribunal and the DSM and the DTCP. At the local levels are Town/Urban Councils, District Councils, Land Boards, District Authorities, Land Boards and Village Development Committees. The DTCP is mandated to handle land planning and policy development in the country. It prepares the national physical plans that

guide the preparation of regional, district and local plans and monitors them. The Town and Country Planning Act of 2013 decentralized some of DTCP duties to Councils. This is carried out by the Physical Planning Committees (PPCs) at the districts, cities, and towns level. The PPCs handle land use change, consolidation and subdivision of plots and issue development planning permissions. The decisions of

the PPC are implemented by Land Boards.

The Natural Resource Technical Committee (NRTC), which is a sub-committee of the Rural Development Council (RDC) makes recommendations on the planning, protection, and wise use of natural resources through the departments that are vested with the mandates of natural resource management. The functions of the committee are also decentralized to the Local Authorities through the District Land Use Planning Units and District Development Committee.

The institutional framework is quite extensive with many entities involved and a lot of planning required. With the opportunity presented by decentralization is proposed to:

- Streamline the land use planning process to improve coordination and eliminate duplication between national- and lower-level institutions.
- Encourage community involvement in planning to create ownership in and effective implementation of plans and to avoid conflicting land uses that may lead to land degradation.

The legal and policy framework

The major strategy of the legal and policy framework is to encourage sustainable use of land resources and promote development in other parts of the country through multiple land uses, economic diversification, and livelihoods creation. Relevant policies include the: Tribal Grazing Land Policy 1975, Tourism Policy National Policy 1990, National Policy on Agricultural Development of 1992, and the Land Tenure Policy 1993. The Tribal Grazing Land Policy of 1975 and the Tribal Land Act 2018 improved the security of land tenure, especially with its incentives for improved land management practices at both individual and group ranches (Basupi et. al., 2017). Ranchers are allowed up to 25 years of the lease, with land rental payments being channeled to the Land Boards. The ranches, unlike communal grazing areas, are granted exclusive use of livestock foraging areas and other resources on their ranches. The developers of this ranching approach had hoped to use it as an incentive for improved rangeland management practices and by extension, the livestock output from the rural areas (Hurni, 2000; Morton and Ramsay, 2018; Basupi et. al., 2017).

The Government emphasised the creation of an enabling environment that would promote ownership, management, and participation of Botswana in the economy when it undertook a review of citizen economic empowerment programmes. Human capital development was highlighted as a key strategy to equip the people to take advantage of economic opportunities and compete effectively at global level. Some of the indicators of empowerment include:

- Ownership of land and property by citizenship;
- Ownership of businesses by citizenship;
- Employment at managerial and professional levels by citizenship;
- Reduction in unemployment rates by citizenship; and
- Tertiary education output by citizenship linked to requirements of the economy.

The Government has also developed a Consolidated Framework for Empowerment Programmes. A key feature of which is to separate economic empowerment programmes from social upliftment schemes. This is seen as critical in promoting entrepreneurship and enterprise development. Although social upliftment schemes are recognised as important for sustainable livelihoods, this new model places greater emphasis on entrepreneurship to address unemployment, economic growth, poverty eradication and economic diversification. The Government also seeks to increase citizen participation in the tourism sector by creating investment opportunities through strategies such as: reviewing the carrying capacities of the Wildlife Management Areas; subdividing the Wildlife Management Areas; identifying and gazettement new tourism sites; and introducing new products within existing Concessions.

Land is the underpinning environmental asset supporting social and economic development in Botswana. Given this scenario, it is, therefore, proposed that:

- Government should continue to support the economic empowerment programmes such as agro-tourism, while at the same time promoting sustainable use of land and the conservation of natural resources. This will support the overall country policy of diversification of both the national and rural economy.

Halting land degradation

Halting land degradation and desertification is a key requirement to addressing poverty and ensuring that the country remains on its development trajectory to 2036. Some of the initiatives the Government has implemented to accomplish this include public awareness, implementing land rehabilitation projects and promoting sustainable land management practices.

Given that most of the land users are subsistence farmers or small holders of land, community awareness and education is key. This has allowed dissemination of information on the causes and the possible mitigation measures which can be utilized to reduce land degradation. Over the last 10 years, community participation in land rehabilitation projects has increased especially in areas that have been affected by soil erosion. There is also greater participation in national awareness day's such as the National Tree planting Day, which was established in 1985.

Other activities include land rehabilitation projects that have tried to address soil erosion issues. Currently about 16,713 ha of land is under rehabilitation throughout the country. Sustainable land management activities are also on-going with the support of the Global Environment Facility (GEF) and the Japan International Cooperation Agency (JICA) for the Integrated Sustainable and Adaptive Management of Natural Resources. These are meant to support Land Degradation Neutrality and Livelihoods in the Miombo-Mopane landscapes. The strategy is to utilize an integrated approach to reverse land degradation. It brings together sustainable and adaptive woodland, rangeland, agriculture and water management while addressing the issue of human-wildlife conflicts.

The NDP11 has an allocation of BWP10 million to study the state of land degradation, develop an action plan and establish a monitoring system to manage land degradation at national level. In compliance with the United Nations Convention to Combat Desertification, it will also set voluntary Land Degradation Neutrality (LDN) Targets and its associated measures for the country. The project is supported by the FAO and implemented by the DFRR. Another project on Food Systems, Land Use and Restoration to be led by the World Bank and implemented by FAO is expected to start soon, having been delayed by the COVID-19 pandemic. The project aim is to ensure that areas used for agricultural production are integrated, provide ecosystem services, and contribute to environmental wellbeing.

To reduce and reverse land degradation, it is recommended that the:

- The government finalise and operationalise the development of the Forestry Master Plan;
- Enabling environment for the sustainable management of the Miombo and Mopane ecoregion of Botswana be strengthened considering their role in providing ecosystem services such as controlling soil erosion, maintaining soil fertility, supporting farming systems, supporting hydrological cycles, among others; and
- Implementation and compliance with key policies such as Tribal Land Act, Tribal Grazing Act and National Policy on Agricultural Development that promote sustainable land practices which allow Botswana to increase its livestock holdings and crop production be ensured.

Addressing the land tenure issue

The Land Policy (2019) has been revised to address issues of land management and administration. Population growth and the increase in the number of livestock and wildlife have resulted in land use conflicts. These conflicts manifest in the spiraling encroachment of land uses such as settlements expansion into arable land, arable land into grazing, and grazing into wildlife areas as people, domestic animals and migratory wildlife search for food and water. The ultimate effect of this is unsustainable resource management and environmental degradation. Thus, the policy intends to facilitate access, development, and wise use of land. Various sectors must secure portions of land and the development and utilisation of such land must be in line with national environmental guidance.

The 2019 Land Policy has made provision for the utilization of more than 50 percent of the land owned by a person for other purposes if they have acquired the proper planning permission. Agro-tourism is an opportunity for increasing citizen economic empowerment and to that end the agro-tourism guidelines have also been reviewed to allow the proportion of agricultural land that could be used for tourism to increase from 15 to 50 percent (MENT, 2020).

The different uses of land must be within the confines of the regulations under the Environment Assessment (EA) Act (Cap 65:07), which aims to improve the sustainability of land use. It provides for environmental impact assessment to be used to assess the potential impacts of planned developmental activities. In addition, it supports decision making on the

type of mitigation measures to be applied to prevent or reduce any significant adverse environmental impacts. Its other pertinent areas include monitoring the process and evaluation of environmental impacts of ongoing activities (MENT, 2020).

To address the land administration issues, the Ministry of Lands and Agriculture (MoLA) in partnership with the Swedish Mapping, Cadastral and Land Registration Authority established a project commonly known as Land Administration, Procedures, Capacity and Systems (LAPCAS) in 2009. The focus of the project was to develop an efficient land administration system based on simplified procedures, correct information on land parcels and land rights. The project is on-going and the legal and policy frameworks guiding land management and administration in the country are being revised to enable them to align with the LAPCAS requirements. LAPCAS has the following revised components:

- National Land Registration.
- Computerization of Land Records.
- Unique numbering of land parcels and location address.
- Improvement of land administration processes.
- Information Technology operations and maintenance (automation).
- National Spatial Data Infrastructure.
- Capacity Building.

The National Revised Policy on Destitute Persons (NRPDP) (2002) addressed property rights in the context of land use and land use planning. The policy strengthens and clarifies

land rights in rural areas and promotes land markets to make transfers easier. It is a pro-poor policy as it tried to address the issue of wealthy versus poor commercial farmers and shared access to land and sources of water (MoLG, 2002).

Going forward, it is proposed that:

- Compliance with the Regulations under the EA Act (CAP 65:07), which aim to improve sustainable land use be ensured;
- There is a need to complete the revision of the land management and administration policy guidance to align to the LAPCAS requirements; and
- It is necessary to streamline policy coordination at the national and local levels, including the amendment to the Tribal Grazing Land Act, 1968, which is meant to address the issues of conflicts between farmers and wildlife conservationists; including using a regional approach through SADC because migratory animals are a transboundary resource.

Addressing food security

Looking at fish as a food resource

There are opportunities to address food security through development and growth initiatives in the crop, fisheries, and livestock sub-sectors. Some of the causes of the persistent high levels of food insecurity can be attributed to lack of capacity building, policy implementation and a weak or

complicated institutional framework. For instance, the institutional framework for fisheries management was originally located within the MET. It was argued that this led to the fisheries resource being managed more through a 'wildlife conservation' approach instead of utilizing a more 'food production-oriented' methodology. As a result, fish was not treated as a resource to contribute to food and nutrition security in Botswana (Mosepele & Kolawole, 2017). However, the management approach is likely to change as the fisheries unit has now been moved to the MoA.

In order to better support the use of fish as a food resource, it is proposed that the:

- aquaculture industry should be strongly supported to promote food security and economic diversification particularly at a subsistence level; and
- government needs to invest in fish research and development to support the growth of the sector.

Supporting livestock development

Livestock development is seen as an important instrument for the Government to achieve poverty reduction and increase food security. Policies guiding the sub-sector include the following; Livestock Management and Infrastructure Development (LIMID), National Master Plan for Arable Agriculture and Dairy Development (which has now been phased out), Economic Diversification Drive, Young Farmers' Fund and the Poverty Eradication Program among others. These promote livestock production through subsidized loans, feed, and animal husbandry inputs and in support of construction of boreholes and free veterinary services. In addition, the NDP11 commits to improving the quality and quantity of beef, dairy small stock, poultry, and pigs (Statistics Botswana, 2020b).

Although these policies are present, implementation challenges persist. Given this scenario, the following recommendations are made:

- Government needs to invest technologies such as renewable energy that provide opportunities for production. An example is the water pumping from groundwater sources through renewable energy sources to enhance better access to drinking water by livestock and to support small-scale irrigation for cattle fodder.
- There is a need to improve the extension services at the grassroots level through capacity building, additional and upskilled human resources, and policy outreach. For instance, the beef industry capacity building could address skills such as animal physiologists and breeders, conservation of animal genetic resources, establishment of breed societies for different species and provision of equipment for the gene banks.

Supporting dryland crop production

Dryland crop production is constrained by low and erratic rainfall with high variability within and between seasons thus increasing the risk of crop failure. These constraints lead to low crop productivity. To address some of these issues, the Government has initiated a subsidy programme - the Integrated Support Programme for Arable Agriculture



A maize plantation at the Pandamatenga farms
Photo credit: Photography Section, BOPA

Development to improve productivity and food security. The MoA continues to lease out some of its land to potential investors such as in Pandamatenga, Musi and Sedibeng commercial farms to improve productivity and food security. It has also established some irrigation schemes in Dikabeya, Glen Valley and Kubung for irrigated farming.

Conservation agriculture is another strategy being adopted to improve dryland crop production. Although the land area under cultivation has increased, crop yields at subsistence level are still exceptionally low. However, that these yields could be improved with the use of appropriate technologies blended with local knowledge. Additional benefits of conservation agriculture include environmental and socioeconomic benefits. These include improved soil health, time and cost savings, reduction in biodiversity loss, among others.

To halt and reverse the decline of its national and local agricultural sector's capacity, the Government is ramping up measures aimed at boosting the country's soil fertility. Among them are its commitments under the United Nations Convention to Combat Desertification, the Ramsar Convention on Wetlands of International Importance, Stockholm Convention on Persistent Organic Pollutants, Africa-wide Comprehensive Africa Agriculture Development Programme and the 2003 Maputo Declaration on Agriculture and Food Security in Africa (AUDA-NEPAD, 2019). The NDP11 also includes policy and legislative measures it intends to employ to address the issues.

As the major limiting factor to the crop subsector is the unavailability of water, the Government is encouraged to:

- Continue investing in crop varieties and animal breeds that thrive under semi-arid conditions.
- Invest in water use efficiency technologies and practices such as drip irrigation, mulching and conservation tillage among others.

3.8 Measuring Botswana's progress on the land

Measuring progress on the SDG indicators related to land between 2000 and 2020 gives an idea of where the country is in its journey to 2030. Overall, the fact that the Government has integrated the land related SDGs into the Vision 2030 and the NDP11 highlights political support for addressing them. This will drive progress on these SDGs in an efficient and context-relevant manner.

In the context land issues as enshrined in the SDGs and outlined in this chapter, analysis show that there has been progress in SDG 2.5.1 (plant and animal genetic resources conserved). Here, the number of plant genetic resources for food and agriculture secured in either medium- or long-term conservation facilities increased from 2,423 in 2000 to 2,992 in 2019 (UNStats, 2020). For SDG 2.5.2, the number of local breeds classified as being at the risk of extinction has increased from 0 in 2000 to 75 in 2019. However, the Government has been proactive in this area and established a Farm Animal Genetic Resources Conservation Unit within the Department of Agricultural Research to drive and coordinate all activities of animal genetic resources in the country.

Lack of data is a challenge as reflected by some indicators that had no or insufficient data. This highlights the need for land information to be addressed as a matter of priority. There is opportunity for Statistics Botswana to take the lead in this area and strengthen the whole data and information lifecycle. The Ministry in charge of land matters would need to also investigate issues relating to land access documentation and policy information. Steps along this direction are already being taken as witnessed in the updated Land Policy 2019 and the LAPCAS project, among others.

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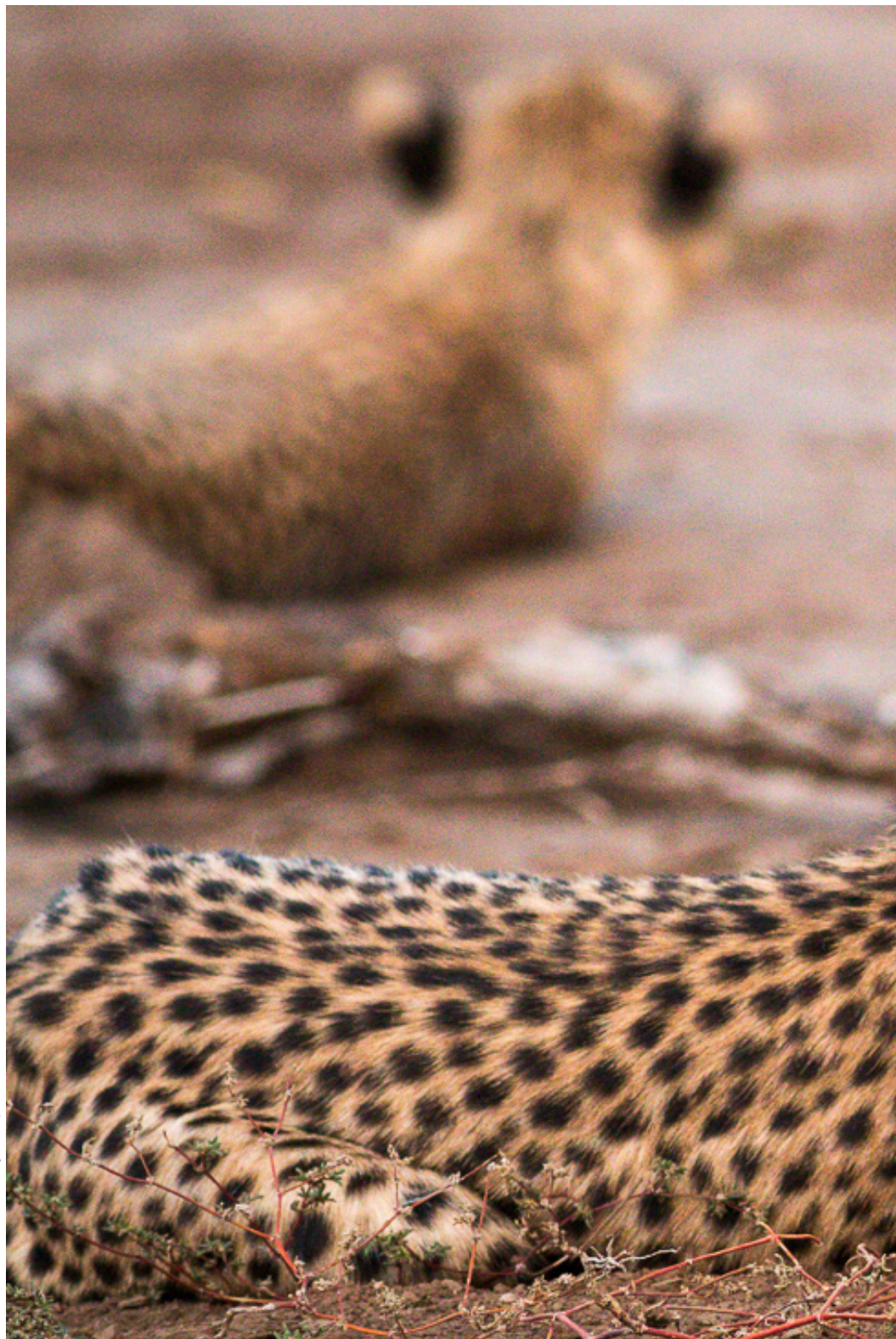
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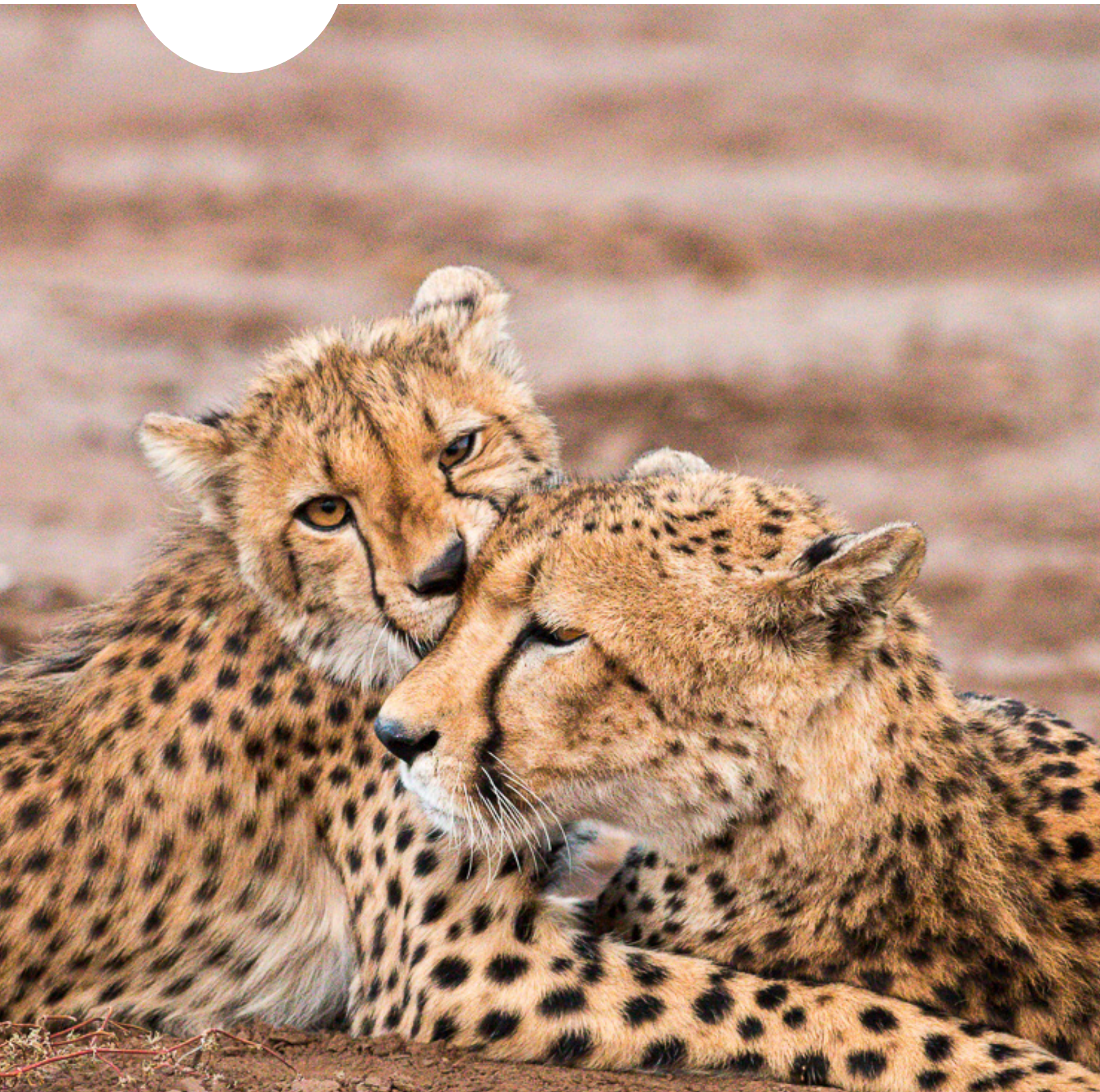
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Cheetahs at Play
Photo credit: Ryan Kilpatrick/Flickr



4

BIODIVERSITY



4.1 Introduction

Botswana is a vast country dominated by arid and semi-arid landscapes which are extraordinarily rich in biodiversity. The northern Botswana wetland ecosystems covering the Linyanti, Chobe-Zambezi, Okavango and Makgadikgadi are globally renowned for their species richness. The economy is thus significantly underpinned by the exploitation of its rich biodiversity for sectors such as energy, tourism, livestock, and arable agriculture. Many people especially in rural areas are dependent on the biodiversity resources, directly or indirectly, for their livelihoods.

Biodiversity is one of the key pillars for Botswana's development as highlighted in the National Biodiversity Strategy and Action Plan of 2016 which states that, "By 2025, ecosystem, species and genetic diversity is valued, protected, and used sustainably and equitably, through the involvement of all sectors of society and the provision of

sufficient resources for its sound management". Vision 2036 also states that Botswana will "have healthy ecosystems that support the economy, livelihoods and our cultural heritage as well as enhance resilience to climate change".

4.2 State of biodiversity

Botswana has abundant biodiversity, especially in the Okavango Delta area where the species richness index ranges between 9.3 and 15 (Figure 4-1) (The NBSAP Forum, 2019). The number of plant species in the country are estimated at between 2,150 and 3,000, 43 of these are on the IUCN Red List and 15 are endemic. There are 150 identified species of mammals (3 endemic and 112 on the IUCN Red List), 570 species of birds (1 near endemic species and 15 on the IUCN Red List), 131 species of reptile (2 red-listed), and 34 and 99 species of amphibians and freshwater fish respectively (DEA, 2016; DEA, 2009).

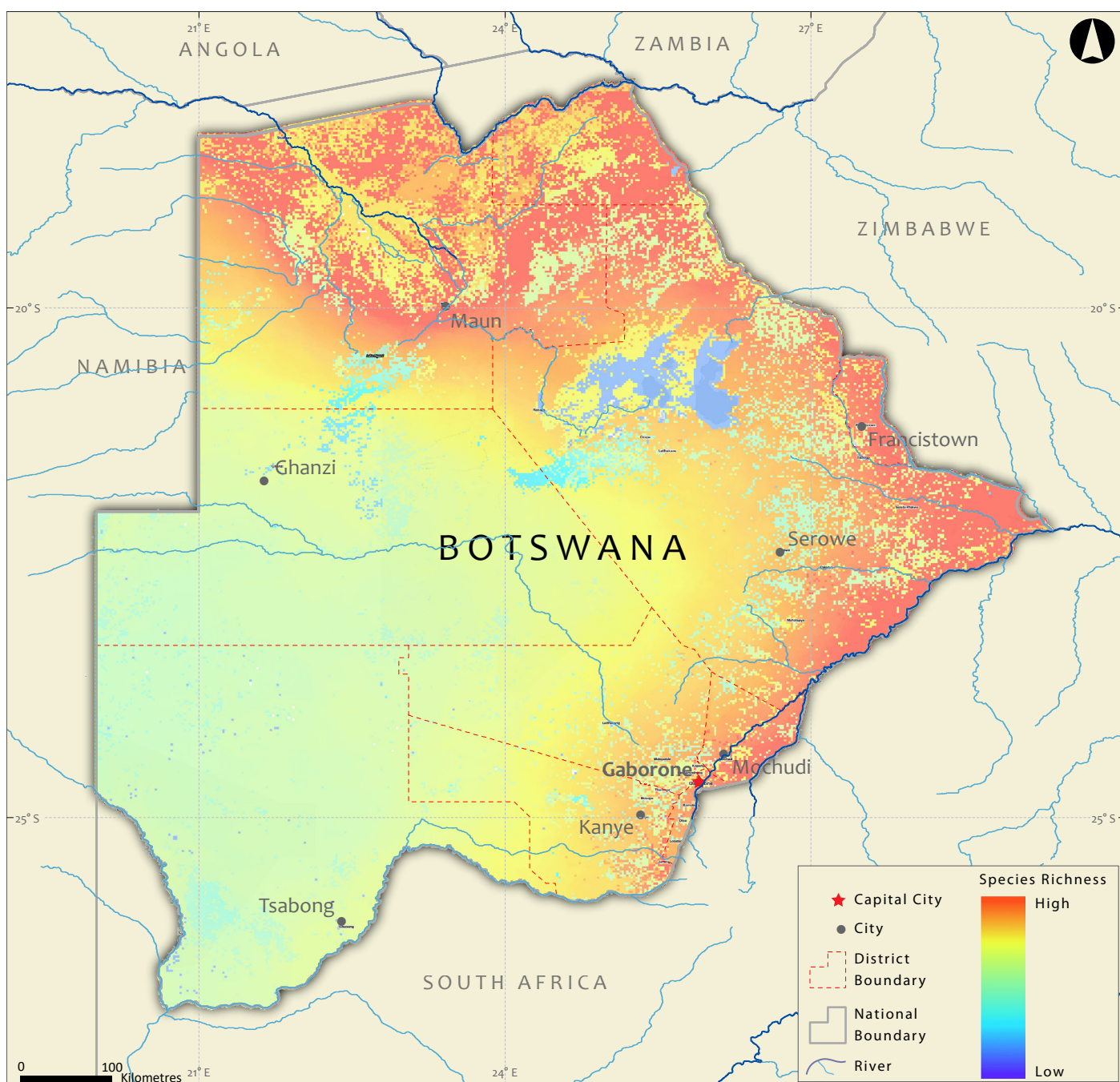


Figure 4-1: Botswana - species richness
(The NBSAP Forum, 2019)

The Zambezi flooded grasslands, the Zambezi and Mopane woodlands, and the Zambezi Baikiaea woodlands in Ngamiland and Chobe areas in northern Botswana are where the highest biodiversity is found. The Okavango Delta is also species rich with identified species in the area including 1,300 plants, 444 birds, 122 mammals, 71 fish, 64 reptiles and 33 amphibians (DEA, 2009). However, there is still much missing in terms of available data, distribution of species, breeds, and varieties. The gaps in knowledge on diversity, status of some species and critical habitats hinders evidence-based conservation efforts.

Ecosystem diversity

Ecoregions and ecosystem types of Botswana

There are seven ecoregions: Kalahari Acacia Baikiaea woodlands, Southern African bushveld, Zambezi Baikiaea woodlands, Zambezi Halophytics, Zambezi and Mopane Woodlands, Zambezi flooded grasslands, and the Kalahari Xeric Savannah. These are described in the sections that follow. The data borrows heavily from the National Biodiversity Strategy and Action Plan and the various national submissions to the Convention on Biological Diversity (DEA, 2016; DEA, 2009; DEA, 2015). Provisional data from Spatial Biodiversity Assessment undertaken by the Mapping Biodiversity Priorities (Box 4-1) is also used.

Box 4-1: Supporting planning through mapping biodiversity priorities

The Mapping Biodiversity Priorities (MBP) project (2017-2021) was a partnership between the Botswana Department of Environmental Affairs, UN Environment Programme World Conservation Monitoring Centre and the South African Biodiversity Institute (SANBI). The purpose of the project was to strengthen spatial biodiversity data, so that it could be used to determine the state of biodiversity in the country, identify national priorities and clearly communicate biodiversity issues. The project addressed the limited spatial data included in Botswana's current national biodiversity reporting.

The project applied the Spatial Biodiversity Assessment approach, which uses three basic spatial datasets – a map of ecosystem types (Figure 4.2), map of ecological condition (Figure 4-9) and map of protected areas (Figure 4-7). These are combined to provide indicators on ecosystem threat status and ecosystem protection levels that are relevant for a wide range of policy and reporting uses. The threat status assessment used the IUCN Red List of Ecosystems methodology, a recently adopted global standard for measuring the risk of ecosystem collapse. The output maps lend themselves to feeding into the NBSAP, the NDP and other sectoral frameworks to ensure that development does not erode a nation's natural capital.

The Mapping Biodiversity Priorities project was the first such Spatial Biodiversity Assessment performed nationally in Botswana. It sets the foundation for ongoing and repeated assessments that will track the status of the country's biodiversity over time. The assessment identified a number of gaps in the spatial data which can be filled to improve the analysis in future.



Photo credit: Joachim Riegel/Unsplash

Figure 4-2 and Table 4-1 summarize the key indicators of these ecoregions. The central and eastern Miombo woodlands and the Zambezian flooded savannah (Okavango system) form part of the Global 200 ecoregions identified by the World Wildlife Fund for Nature (WWF) as areas of exceptional biodiversity.

The Mapping Biodiversity Priorities project (Box 4-1) collated a map of the ecosystem types of Botswana at a finer scale than ecoregions. It identified 73 different ecosystem types within Botswana, including terrestrial, river and wetland ecosystem types integrated into a single map (Figure 4-2). There are still mapping improvements that can be made to the ecosystem types, particular for aquatic ecosystems, and the map would benefit from further field verification by ecologists. There are high quality maps for specific areas and these could be built into the map of ecosystem types in the future. As with species diversity (Figure 4-1) there is a greater variety of ecosystem types in the North eastern part

of the country than across the more arid central regions.

Ecosystem types across the country were assessed according the IUCN Red List of Ecosystems categories and criteria (A3 and C3). The IUCN Red List of Ecosystems is a global standard for ecosystem risk assessment (Bland et.al., 2017). It uses similar categories to the Red List of Threatened Species, but the criteria were developed specifically for ecosystems. The results show that while most of the ecosystem types in the country remain Least Concern (46 or 63 percent), there are 17 (23 percent) Vulnerable ecosystem types in Botswana, and a further 10 (14 percent) that are Near Threatened (Table 4-1 and Figure 4-3). Most of the threatened ecosystem types are found in the southeastern parts of the country, where human pressure is highest. In particular, 75 percent of the ecosystem types in the Southern African Bushveld ecoregion are Vulnerable.

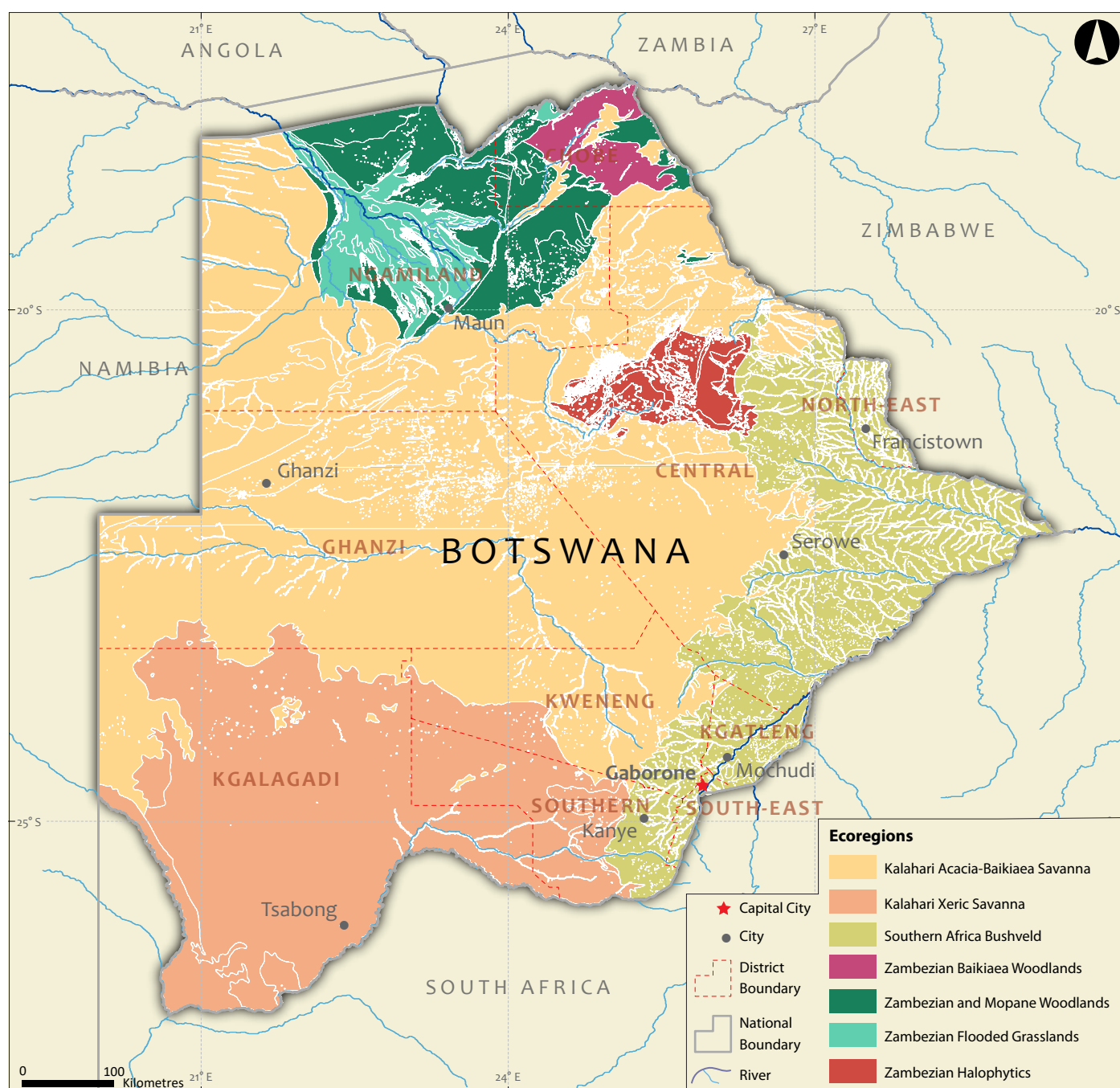


Figure 4-2: Eco-regions and ecosystem types (white outline) of Botswana (Ecoregions partially after WWF Ecoregions Map of the World) (DEA, 2016), ecosystem types from Mapping Biodiversity Priorities project, Box 4.1).

Table 4-1: Summary of the eco-regions and their economic and conservation value to Botswana (DEA, 2016).

Cover type	Eco-region	Area (km ² and % of total)	Number of ecosystem types	Threatened ecosystems (no. and %)	Well protected ecosystems (no. and %)	Includes area of special uniqueness to Botswana	Economic / environmental value
Tropical and subtropical grasslands, savannas, and shrublands	Kalahari Acacia Baikiaea woodlands	286,300 (49.5%)	25	2 (8%)	11 (44%)	Central Kalahari Game Reserve, Khama Rhino Sanctuary covers 4,300 ha of the Kalahari sand veld to facilitate reintroduction of white rhinos	Livestock & crop production, commercial wildlife. Harvesting of veld products
	Southern African bushveld	88,824 (15.4%)	16	12 (75%)	0 (0%)	Includes Gaborone and Francistown the largest urban centres and other smaller urban centres	Game ranching and harvesting of mopane worms (<i>Gonimbrasia belina</i>) most significant economic activity Has the highest level of species richness of insectivore in the country
	Zambezian Baikiaea woodlands	8,087 (1.4%)	2	0 (0%)	2 (100%)	Small area of Chobe Forest reserves (Miombo woodlands) high in biodiversity. Kavango-Zambezi TFCA* linking Botswana, Zimbabwe, Namibia, Zambia and Angola	The Chobe and the Zambezi rivers are used for tourism activities, agriculture and fishing.
	Zambezian and Mopane woodlands	41,828 (7.2%)	15	1 (7%)	14 (93%)	Western section in the ODMP** area and is protected by Chobe National Park, Moremi Game Reserve and WMAs	Tourism activities - hunting, game viewing and photographing Important for vertebrate diversity in southern Africa (especially mammals)
Flooded grasslands and savannas	Zambezian flooded grasslands	16,413 (2.8%)	4	0 (0%)	2 (50%)	Zambezian centre of endemism Okavango inland delta and a Ramsar site.	Molapo farming system important for agro-biodiversity
	Zambezian Halophytics	14,911 (2.6%)	3	0 (0%)	1 (33%)	• Invasive <i>Salvinia molesta</i> weed is an issue • Makgadikgadi wetlands and Pans in Kgalagadi is an Important Bird and Biodiversity Area and proposed for Ramsar status	• Boteti River important wintering site for migrant birds • Soda ash and salt extraction mine • Makgadikgadi pans breeding site for flamingos.
Deserts and xeric shrublands	Kalahari Xeric Savannah	121,512 (21.0%)	8	2 (25%)	2 (25%)	Three national parks Invasive <i>Prosopis</i> species and <i>Sancrus biffora</i> Central Kalahari Game Reserve burns regularly	Back bone of the Botswana's game ranching industry Tourism value Livestock, crop, tourism and game ranching. Valuable veld products e.g. hoodia, grapple plant and Kalahari truffle

*TFCA = Trans Frontier Conservation Area;

**ODMP = Okavango Delta Management Plan.

*** Ecosystem that are well represented in the existing network of protected areas and other effective area-based conservation measures, see section 4.3. *** This reflects the Threat Status for ecoregions (adapted from WWF and DEA, 2016). These values are being updated at a more specific ecosystem level using national data and following the IUCN Redlist of Ecosystems methodology.

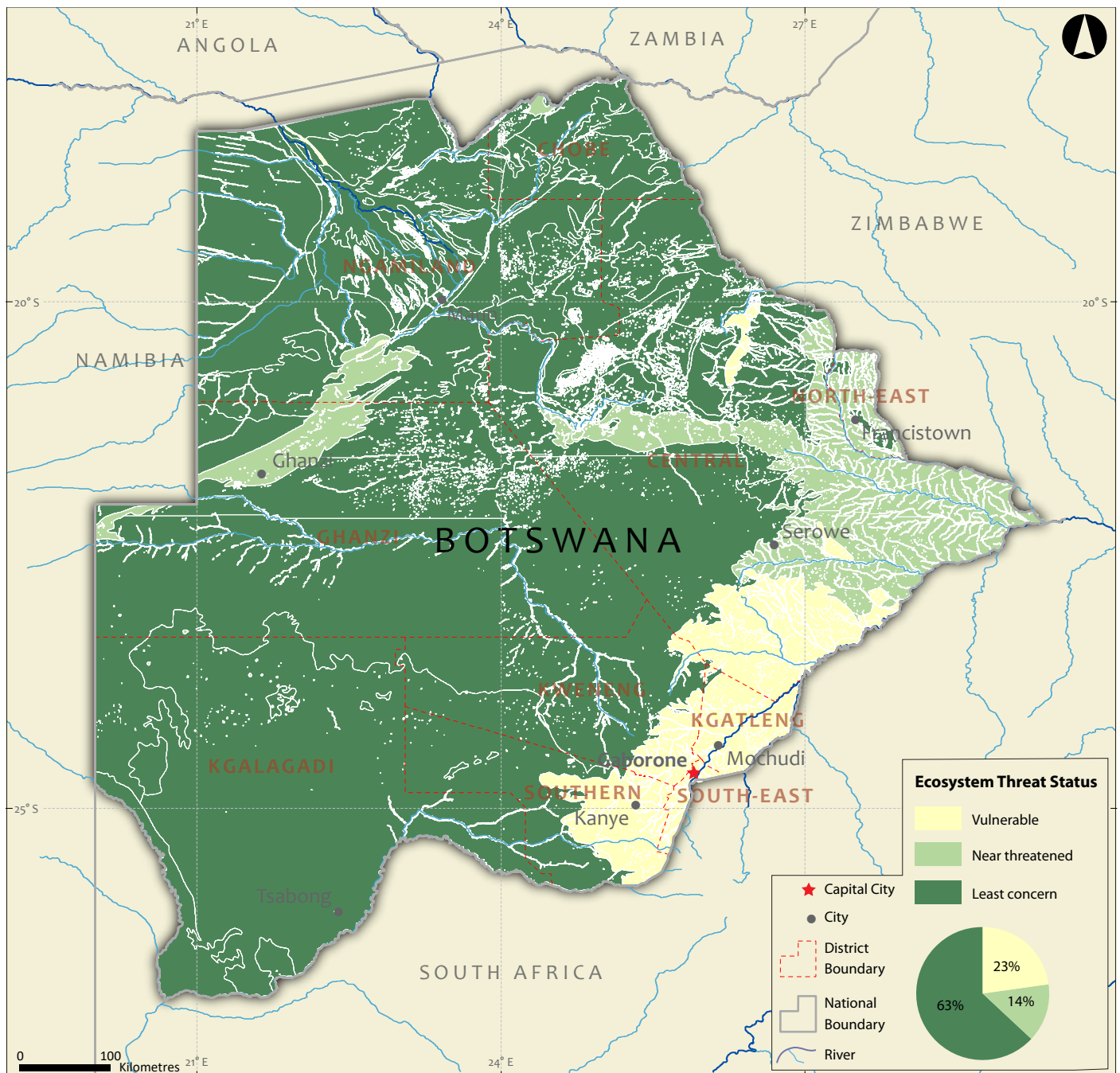


Figure 4-3: Ecosystem Threat Status of ecosystem types in Botswana. Ecosystem types were assessed using the IUCN Red List of Ecosystems categories and criteria. (Mapping Biodiversity Priorities project, Box 4-1).

Kalahari Acacia-Baikiaea Woodlands

The Kalahari Acacia-Baikiaea Woodland ecoregion has a semi-arid climate with highly variable rainfall mainly between October and March (Moyo et. al., 2014). The region rests primarily above sediments of the Kalahari group (Kalahari Sand) commonly referred to as the Sandveld or the Kalahari. The vegetation is influenced by climate. The southern part of the ecoregion, where the climate is more arid, the dominant vegetation is sparse and shrubby with some characteristics of the Xeric savanna ecoregion. To the north, the climate becomes wetter, and the vegetation consists of a mesic savanna or woodland dominated by *Baikiaea plurijuga*. The main vegetation found includes deciduous tree and bush savanna, with taller trees found in the low sandy ridges. The main species include *Acacia giraffe*, *Burkea africana*, *Combretum zeyheri*, *Combretum apiculatum*, *Croton grattissimus*, *Peltophorum africanum*, *Rhus tenuinervis*,

Senegalia fleckii, *Terminalia sericea*, *Vachellia luederitzii*, and *Ziziphus mucronata* (Campbell, 1990; Werger, 1978; Wild and Fernandez, 1967).

Grass species include *Stipagrostis uniplumis*, *Aristida congesta*, *Aristida meridionalis*, *Eragrostis pallens*, *Eragrostis superba*, *Cymbopogon excavatus*, *Digitaria eriantha*, and *Heteropogon contortus*. Shrub savanna is found on the plains between the sandy ridges. Shrub species include *senegalia mellifera*, *Bauhinia macrantha*, *Commiphora pyracanthoides*, *Dichrostachys cinerea*, *Grewia flava*, *Grewia flavescens*, and *Ximenia caffra*. South of the Makgadikgadi Pans moving towards the tree savanna, shrubs including *Dichrostachys cinerea*, *Grewia flava* and *Gymnosporia senegalensis*; and grass are well represented in protected areas (Table 4-1).

Zambezian Baikiaea Woodlands

This ecoregion falls within the Zambezian centre of endemism. The climate is hot and semi-arid, and the soils are poor and do not support cultivation. Mainly dry deciduous *Baikiaea plurijuga*, thicket, and secondary grassland are found. This ecoregion is home to the important miombo forest and many of Botswana's forest reserves are located here. Some of the species found include *Baikiaea plurijuga* (Zambezi teak, Zambezi redwood, Pod mahogany), *Diplorhynchus condylocarpon* (Horn-pod tree), *Friesodielsia obovate* (Northern dwaba-berry), *Lannea schweinfurthii* var. *stuhlmannii* (False marula), *Lannea schweinfurthii* var. *tomentosa* (Hairy false marula), *Ozoroa insignis* subsp. *reticulata* (African Resin tree) and *Ozoroa longipes* (Round-leaved resin tree).

The Zambezian Baikiaea Woodlands is the smallest ecoregion in Botswana, covering less than 1.5 percent of the country. It includes two ecosystem types, both of which are well represented in protected areas and categorised as Least Concern (Table 4-1).

Zambezian Halophytics

The ecoregion covers the Makgadikgadi Pan complex in the north-eastern part of the country, southeast of the Okavango Delta. Covering over 12,000 km², it is one of the largest saltpan complexes in the world. It consists of two large pans, Ntwetwe Pan and Sua Pan, surrounded by smaller pans, the larger ones being Nxai Pan, Kgama-Kgama Pan and Kudiakam Pan, all located to the north of Ntwetwe Pan. To the south is Lake Xau, which is a saline grassland. The climate is harsh with large daytime and seasonal temperature ranges. Middle of the day temperatures in summer range from 35 to 44°C while midday winter temperatures reach 17°C, dropping as low as -8°C at night.

The Zambezian Halophytics is a relatively small ecoregion, covering just 2.6 percent of Botswana. It includes three ecosystem types, including vegetated and non-vegetated salt pans. While only one of the three ecosystem types is well represented in protected areas (33 percent), none of the ecosystem types are considered threatened (0 percent).

During the rainy season blue green algae form a covering on the pans. The salt marshes at the outer edges of the pans have species such as *Portulaca oleracea*, *Sporobolus ioclados*, and *Saudea fruticosa*. Grasslands are found in the less brackish soil and include *Odyssea paucinervis* and *Cynodon dactylon*. Other species *Cenchrus ciliaris* and *Eriochloa meyeriana* are found on the higher parts of the calcrete escarpments (Wild and Fernandez, 1967). A few *Hypaene* palm trees are found towards the Nxai Pan. The fruit, commonly called vegetable ivory, are used to make necklaces and the heads of walking sticks.

The Makgadikgadi Pan is an Important Bird and Biodiversity Area, and it is the fourth most important breeding place for the globally threatened Lesser Flamingo (*Phoenicopeterus minor*) in the world (Birdlife International, 2020). It has been proposed as a Ramsar site. The pans also provide critical wet season ranges for migratory wildebeest and zebra, which migrate to these areas for the minerals to support lactation and foetus growth. Chobe zebra migrate to Nxai Pan (Kurungudla et. al., 2014), Some of the Okavango Zebra migrate to Makgadikgadi (Bartlam-Brooks et. al.,

2011), Boteti Zebra migrate to Makgadikgadi and Linyanti Zebra and wildebeest migrate to the Mababe Depression. On the western side of the Delta, zebra migrate to saline grasslands in NG5. In addition, in the CKGR some wildebeest migrate to Deception valley while others stay year round on these saline grasslands (Selebatso et al., 2018). Thus, these saline grasslands play a critical role in the ecology of large herbivores in northern Botswana, without which many of their populations would collapse. It provides a wide range of ecosystem goods and services that include veld products such as Moseme/Moretwa commonly known as Brandy bush (*Grewia flava*) which has edible fruits and hardy bark used for basket making, the mopane worms or edible caterpillars (*Gonimbrasia belina*), as well as the important Marula (*Scelocarya birrea*) whose edible berries are used to make a liqueur among others. Other natural resources that are provided include firewood, thatching grass, and wild fruits.

Zambezian and Mopane Woodlands

This ecoregion mainly surrounds the Okavango Delta extending to the east next to Zimbabwe. Conservation activities are quite strong here. Soils are not particularly good for agriculture, but due to the presence of water, the eastern side is being utilized for farming. Some red data listed plant species are found here including *Harpagophytum* species and the endemic and near endemic *Pycreus okavangensis*, *vachellia hebeclada* subsp. *chobiensis*, *Boscia matabelensis* and various orchids.

The Zambezian and Mopane Woodlands ecoregion includes 15 distinct ecosystem types of Mopane woodlands and wooded grasslands. Only one of these ecosystem types is categorised as Vulnerable (7 percent) and almost all the ecosystems are well represented in protected areas (14 or 93 percent).

The Zambezian and Mopane Woodland and the Zambezian Flooded grasslands show a high distribution of vulnerable and threatened species. This is an indication that continued protection of these ecoregions is paramount for conservation of vulnerable and threatened species. However, a high distribution of threatened plant species is found in the Kalahari Acacia-Baikiaea savanna, while the Zambezian flooded grasslands is important for threatened species of avifauna and mammals (DEA, 2009).

Zambezian Flooded Grasslands

The Okavango wetland, a designated Ramsar site, is found in this region. The wetland is home to about 1,300 different floral species. The most varied include the families of grasses *Poaceae*, followed by the sedges *Cyperaceae*; and the flowering plants of the families *Asteraceae* and *Fabaceae*, each of which have more than 20 genera and 50 taxa of species and lower ranks. Air humidity, soil moisture and water table levels play a big role in the location of these plant species. It is estimated that 60 percent of the total number of taxonomic groups found in the Okavango delta are found in the dryland settings and will not be found in the adjacent savannah habitats.

The Zambezian Flooded Grassland ecoregion includes four species *Cenchrus ciliaris*, *Digitaria milanijana*, *Eragrostis* spp. and *Dichanthium papillosum* become more common. The tree species include *Senegalia nigrescens*, *Colophospermum mopane*, *Combretum imberbe* and *Terminalia prunioides*.

NAMIBIA

Shakawe

Okavango Delta system
Ramsar Site, Wetland of
International Importance

The Okavango Delta

The Okavango, within the "Zambzian Flooded Grasslands ecoregion" is the largest inland delta in the world. Recognized as both a Ramsar and UNESCO World Heritage Site, Okavango covers over 600,000 ha, boasts of 1,300 different floral species and is home to numerous species of animals, some of which are endangered.

This MODIS Surface Reflectance image (MYD09GA version 6) was acquired by instruments on NASA's Aqua satellite on 29 August 2021. It is visualized using a 7-2-1 Band combination.

In this image, the delta vegetation is in dark green colour, while the other areas are a lighter shade of green or brown. The large brown patches (marked by yellow arrows) are fire scars.

Source: Vermote, E., Wolfe, R. (2015).



B O T S W A N A

Serongwe

Nokaneng

Okavango
World Heritage Site
(natural)



NAMIBIA

ga

Moremi
Game
Reserve

O k a v a n g o

N A N A

D e l t a

Maun

Maun Game
Sanctuary

go Delta
eritage Site
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Of the seven ecoregions in Botswana, the Kalahari Acacia-Baikiaea Woodland ecoregion is the largest and contains the most ecosystem types. There are 25 distinct ecosystem types in this ecoregion, including different types of Mopane woodlands, thorn tree and deciduous woodlands, and floodplain savannas. Only 2 (8 percent) of the ecosystem types are threatened and almost half (11 or 44 percent) of the ecosystem types are well represented in protected areas (Table 4-1).

Southern African Bushveld

This ecoregion, also called the Mopane savanna, experiences hot, wet summers and cool, dry winters. The average annual rainfall is between 350 mm to 750 mm. The common 'broad-leaved' savanna vegetation occurs on arid, fertile soils and is often dominated by the winter-deciduous mopane tree (*Colophospermum mopane*). The growth form of this tree varies, from a dense shrubland to tall, open woodland depending on the existing growth conditions or the extent of disturbance by elephants.

There are 16 distinct ecosystem types within this ecoregion, including rocky, sandy and escarpment bushveld types. This ecoregion contains the highest proportion of threatened ecosystems across of any of Botswana's seven ecoregions. As many as 12 (75 percent) of the ecosystem types in the Southern African Bushveld are categorised as Vulnerable, and a further 3 (19 percent) are Near Threatened. Concerningly, none of the ecosystem types (0 percent) in this ecoregion of which are threatened (0 percent). Two of the four are well represented in protected areas (50 percent).

Kalahari Xeric Savanna

This is the largest ecoregion in the country. The Kalahari sandy soils are poor and combined with extreme temperatures explain why plant species richness is amongst the lowest in the southern African region. Some of the species found include *Albizia anthelmintica* (Worm-cure false-thorn), *Acacia erioloba* (camelthorn tree), *Cadaba natalensis* (Mauve cadaba, Natal wormbush) and *Montinia caryophyllacea* (Wild clover bush).

The Kalahari Xeric Savanna ecoregion contains eight ecosystem types including mostly arid savanna vegetation. Two of these ecosystem types are classified as Vulnerable (25 percent), but also only two (25 percent) are well represented in protected areas (25 percent).

Forest biodiversity

Forest biological diversity is a broad term that refers to all life forms found within forested areas and the ecological roles they play. It includes plants, animals, trees, and micro-organisms that inhabit forest areas and their related genetic diversity. Complex interactions can occur within and among the differing levels of forest biodiversity (ecosystem, landscapes, populations, species, and genetics). This complexity allows for continuous adaptation and the maintenance of ecosystem functions.

Forest area in this context is land under natural or planted stands of trees of at least 5 meters in situ, with a tree canopy cover of more than 10 percent whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens. In 2016, forest area as a percentage of land area of Botswana was estimated at 18.95 percent, the lowest since 1990 when it was 24.21 percent (Index Mundi, 2016).

The country is endowed with a diversity of both herbaceous and woody vegetation. Over fifty (50) percent of the population, especially in rural areas are dependent on forest biomass as a source of energy (Forest Policy, 2011). One of the main threats to Botswana's forest resources is overexploitation for firewood and encroachment by settlements. The situation is made worse by periodic droughts, fires, and desertification. A forest distribution map was produced showing types of forests and their coverage.

Oryx (Oryx beisa) enjoying the shade during the heat of the day in the Kalahari desert, Botswana
Photo credit: Leon Pauleikhoff/unsplash



Species diversity

Vertebrates

Botswana is a hotspot for species richness with 157 mammal species recorded, including the largest remaining populations of the African wild dog (*Lycaon pictus*) and the largest remaining population of African elephant (*Loxodonta africana*) (DEA, 2015). In 2018, the Department of Wildlife and National Parks (DWNP) conducted an aerial survey covering the South-Central part of Botswana to estimate wildlife and livestock populations. The land use in that area was mixed, with 72 percent dedicated to pastoral, arable and residential use, while 28 percent was reserved for wildlife (DWNP, 2018). The results shown in Table 4-2 give an indication of some of the diversity found in Botswana.

Animals under threat

Botswana has 8 mammal species listed in the IUCN Red Listing of Threatened Species as shown in Table 4-3. Threatened species include those in the categories of critically endangered, endangered, or vulnerable.

There has generally been an increase in poaching in Botswana apparently driven by an extensive domestic market for illegal bushmeat. Much of the poaching takes place in remote areas. Poachers are also known to poison the carcasses of poached animals to kill vultures who might give away their location to the patrol units. This changed the status of vultures to critically endangered in the country. Species that are highly poached and are threatened with extinction include pangolins, rhinos, and elephants. Pangolins are classified as endangered species and are threatened to extinction by trafficking. Rhinos are critically endangered species under CITES Appendix I and are threatened to extinction by poaching. The African elephant is under pressure from poaching for tusks and is listed as vulnerable by IUCN and is listed under CITES Appendix I. Intensification and a multi-sectoral approach to enforcement and compliance is helping to reduce poaching.

Birds

There are 535 bird species recorded in Botswana, of which 18 are globally threatened. There are two near-endemic bird species namely: the Slaty Egret (*Egretta vinaceigula*) which has approximately 85 percent of its global population in the Okavango Delta, and the Short-clawed Lark (*Certhilauda chuana*), which has more than 90 percent of its global population in South-eastern Botswana. The salt pans are also habitat to the largest number of breeding Lesser Flamingos (*Phoenicopterus minor*) (Birdlife International, 2020).

Botswana is regionally important for many raptor species, including vultures. But their populations have been negatively affected due to the widespread use of poison on wildlife carcasses, leading to bird deaths. For instance, in June

Table 4-2: Wildlife and livestock numbers found in south-central Botswana, 2018 (DWNP, 2018) (DWNP, 2020)

Species	Estimated Number	Number Seen	Density (Animals per km ²)
Baboon	79	16	0
Brown hyaena	253	8	0
Cattle	1,630,710	37,749	5.03
Cheetah	401	12	0
Donkey	79,029	1,654	0.24
Duiker	5,848	176	0.02
Eland	50,597	1,645	0.16
Elephant	6,560	485	0.02
Gemsbok	88,160	2,736	0.27
Giraffe	3,270	269	0.01
Hartebeest	27,515	724	0.08
Horse	38,063	979	0.12
Impala	16,122	1,944	0.05
Jackal	1,748	52	0.01
Kudu	13,690	477	0.04
Lion	174	8	0
Ostrich	26,734	797	0.08
Sheep & Goat	1,597,251	33,479	4.93
Springbok	23,530	560	0.07
Spotted Hyena	28	6	0
Steenbok	13,907	412	0.04
Warthog	1,903	497	0.01
Waterbuck	252	19	0
Wildebeest	46,269	2,252	0.14
Zebra	5,130	496	0.02

2019 about 537 vultures were poisoned at a single elephant carcass in Botswana's Central District. The scale of the decline is not so clear due to lack of information on their population status (Bodin, 2014; Birdlife International, 2019).

The global vulture population has declined by over 90 percent. Threats include a decrease in the amount of large carrion (particularly during nesting), habitat loss from expanding human developments, direct and indirect poisoning, lack of available safe food, disturbance at breeding and feeding sites, traditional medicine captures and ignorance about the species. However, the main cause of population decline has been due to misuse of agro-chemicals used as bait against predators that attack livestock. Poachers also poison carcasses to prevent rangers from detecting their illegal activities. Vultures are currently categorized as Endangered and Critically Endangered on the IUCN Red List. The misuse

Table 4-3: Number of threatened species in each major taxonomic group in Botswana (IUCN, 2020)

Mammals	Birds	Reptiles	Amphibians	Fish	Molluscs	Other invertebrates	Plants
8	12	0	0	2	0	0	2

of poison has also affected the eagle species as seen in Figure 4-5. Other possible threats to their survival are electrocution, habitat fragmentation due to agriculture, medicinal use, trade, hunting, habitat destruction, nest raiding and disturbance, and the lack of reliable and clean food.

The White-headed Vulture (*Trigonoceps occipitalis*), Lappet-faced Vulture (*Aegypius tracheliotus*) and the White-backed Vulture (*Gyps africanus*) are all listed as critical on the IUCN Red list. Other birds found in Botswana that are globally threatened are listed in Table 4-4. Other birds, listed as near-threatened, for which Botswana is an important biome includes the African Skimmer (*Rynchops flavirostris*), Denham's Bustard (*Neotis denhami*), Chestnut-banded Plover (*Charadrius pallidus*), and the Lesser Flamingo (*Phoenicopterus minor*). The Okavango Delta hosts about 10 percent of the global population of African Skimmers (DEA, 2015).

There are opportunities in the policy arena to strengthen conservation of raptors by controlling the agrochemicals used to illegally poison vultures, especially carbofuran-based substances. Carbofuran is banned in the USA, Canada, and the European Union yet it is still in use in Botswana and in the wider African continent. The use of safer alternatives in agriculture and deterrent penalties could be encouraged. Although the Agrochemicals Act of 2000 provides for the management of agrochemicals in Botswana, enforcement and compliance is weak. Addressing inconsistencies and gaps in the Agrochemicals Act and the Waste Management Act (responsible for the waste aspect of chemicals management) would strengthen enforcement.

Migratory birds

Conservation of migratory birds is a challenge as they are a transboundary natural resource shared by the countries along their migrating routes. About 20 percent of all known species (2,000 species of birds) are migratory, travelling thousands of kilometers between their breeding and non-breeding habitats. Some of the challenges they face include the destruction and degradation of natural habitats, the loss of critical stopover sites such as coastal wetlands, illegal killing, poisoning, pollution, and collisions with poorly cited

infrastructure such as wind turbines, power lines or even aircraft. The sectors that affect migratory birds the most include agriculture, energy, hunting, climate change, tourism and waste management (Wotton, et al., 2017; Moleofi and Wotton, 2018).

Table 4-4: Globally threatened birds found in Botswana (DWNP, 2020)

Scientific Name	English Name	Global IUCN Red List Category
<i>Trigonoceps occipitalis</i>	White-headed Vulture	Critical
<i>NeCriticalosyrtes monachus</i>	Hooded Vulture	Critical
<i>Gyps africanus</i>	White-backed Vulture	Critical
<i>Balearica regulorum</i>	Grey Crowned Crane	Endangered
<i>Neotis ludwigii</i>	Ludwig's Bustard	Endangered
<i>Gyps coprotheres</i>	Cape Vulture	Endangered
<i>Torgos tracheliotos</i>	Lappet-faced Vulture	Endangered
<i>Aquila nipalensis</i>	Steppe Eagle	Endangered
<i>Oxyura maccoa</i>	Maccoa Duck	Vulnerable
<i>Bugerus carunculatus</i>	Wattled Crane	Vulnerable
<i>Egretta vinaceigula</i>	Slaty Egret	Vulnerable
<i>Sagittarius serpentarius</i>	Secretary bird	Vulnerable
<i>Polemaetus bellicosus</i>	Martial Eagle	Vulnerable
<i>Aquila rapax</i>	Tawny Eagle	Vulnerable
<i>Bucorvus leadbeateri</i>	Southern Ground-hornbill	Vulnerable
<i>Falco fasciinucha</i>	Taita Falcon	Vulnerable
<i>Agapornis nigrigenis</i>	Black-cheeked Lovebird	Vulnerable

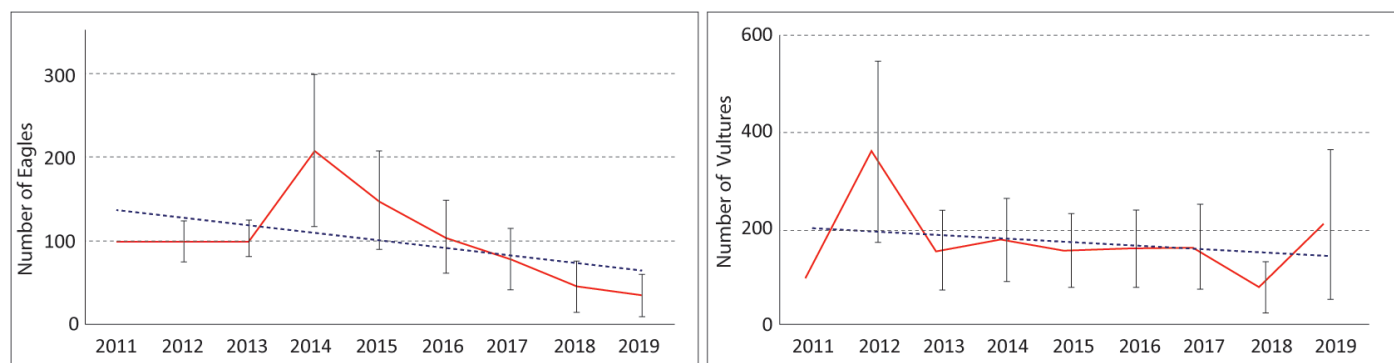


Figure 4-5: Trends in bird numbers of (a) eagles and (b) vultures between 2011-2019 (DWNP, 2020)



White backed vulture (*Gyps africanus*)
Photo credit: Department of Wildlife and National Parks

The population trends of most migrant birds are mixed. The overall trends of Afro-palearctic migrants such as the European Bee-eater (*Merops apiaster*), the Barn Swallow (*Hirundo rustica*) and the Spotted Flycatcher (*Muscicapa striata*) have shown significant moderate increases. However other bird species have experienced declines. For instance, populations of the Willow Warbler and Yellow-billed Kite have declined as shown in Figure 4-6.

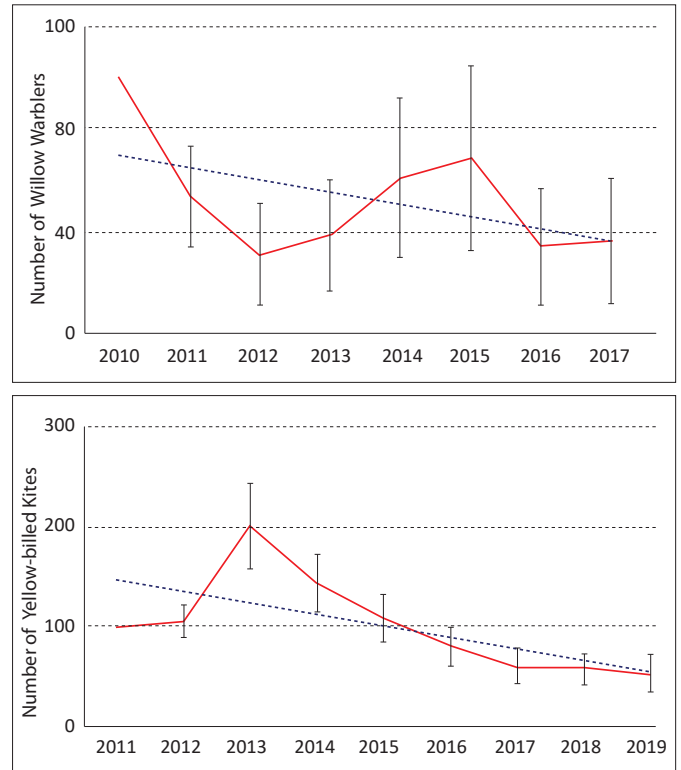


Figure 4-6: Willow Warbler and Yellow-billed Kite trends 2010-2017 (Molefi & Wotton, 2020).

Helmeted guineafowl (*Numida meleagris*) in the Khwai area of the Okavango Delta
Photo credit: Duncan McNab/unsplash



Fish

Fish species numbers are reported to be constant. Two species - *Oreochromis andersonii* and *Oreochromis macrochir*- are globally threatened due to fishing pressure and both face a predation threat from invasive species such as the Nile tilapia (*Oreochromis niloticus*) (DEA, 2015).

Reptiles and amphibians

The number of recorded reptiles and amphibians is 131 and 44 respectively; and there currently no reptile or amphibian species on the IUCN Red List (Table 4-3). A few inventories of invertebrates have been undertaken. Amphibian records have increased from 34 to 44 species and invertebrate records have improved from a total absence of species to a list of 10 taxa (DEA, 2015). Several taxa have been identified to family level while others have been left at higher taxonomic levels.

Insects

According to Hyde et. al., (2022) the number of insects found in Botswana are 363. The families identified include *Belostomatidae*, *Corixidae*, *Gerridae*, *Ceratopogonidae* and *Atyidae*, while *Coleoptera* species largely remain identified at order level, safe for (*Griniudae*).

Butterflies

There are 252 butterfly species listed for Botswana in the Butterflies of Africa Database. None of the known butterflies are endangered nor of conservation concern in the country (DEA, 2015).

Macroinvertebrates

Sixty-four taxa of macroinvertebrates occur in the Okavango Delta; and research has shown 31 taxa to be linked to the invasive *Salvinia molesta* in Moremi Game Reserve in the Okavango Delta (Mfundisi et. al., 2009).



Flap necked Chameleon (*Chamaeleo dilepis*)
Photo credit: Leon Pauleikhoff/unsplash

Plants

There are 3,096 plant species recorded in Botswana, with 10 new species having recently been identified (DEA, 2015). Two endangered plant species occur in the Okavango Delta (*Eulophia angolensis* and *Hyphaene petersianna*). The Southern African Botanical Diversity Network (SABONET) database lists 13 endemic, and 10 potentially endemic and 7 near endemic plant species in Botswana (DEA, 2015).

The currently known flora of the Okavango Delta comprises about 1,300 on the species and a significant proportion of about 60% occur in dryland settings on islands or sandveld tongues. However, despite their terrestrial character many of these taxa are absent in the surrounding savanna habitats as they require a different air humidity or soil moisture regime or higher ground water table (DEA, 2009).

Salvinia, water lettuce and water hyacinth are part of the aquatic systems in Botswana. As a major threat, *salvinia* has been common in the lower Okavango Delta on the northwest and Kwando-Linyanti-Chobe River systems bordering Botswana and Namibia on the northeast of the country (Kurungudla et. al., 2016).

yellow lotus (*Nelumbo lutea*) flower
Photo credit: Maria Baltazzi/unsplash



4.3 Protected areas

Current protected area network

Biodiversity is one of Botswana's prime national advantages—the basis for the tourism industry and an important element for the country's future development. For this reason, the country has already put in place an existing network of protected areas to provide protection towards its ecosystems and species.

The Mapping Biodiversity Priorities project (Box 4-1) collated a map of the existing protected areas across the country. It includes state protected areas with strong legal standing, such as national parks, game reserves, and forest reserves. Botswana's network of 16 primary protected areas (Table 4-5) covers an area of 109,413 km² or 18.9 percent of the land area (Figure 4-7).

Table 4-5: Primary protected areas in Botswana.

1	Central Kalahari Game Reserve	9	Maikaelelo Forest Reserve
2	Chobe Forest Reserve	10	Makgadikgadi Pans National Park
3	Chobe National Park	11	Maun Game Sanctuary
4	Gemsbok National Park	12	Moremi Wildlife Reserve
5	Kasane Forest Reserve	13	Nata Sanctuary
6	Kazuma Forest Reserve	14	Northern Tuli Game Reserve
7	Khama Rhino Sanctuary	15	Nxai National Park
8	Khutse Game Reserve	16	Sibuyu Forest Reserve

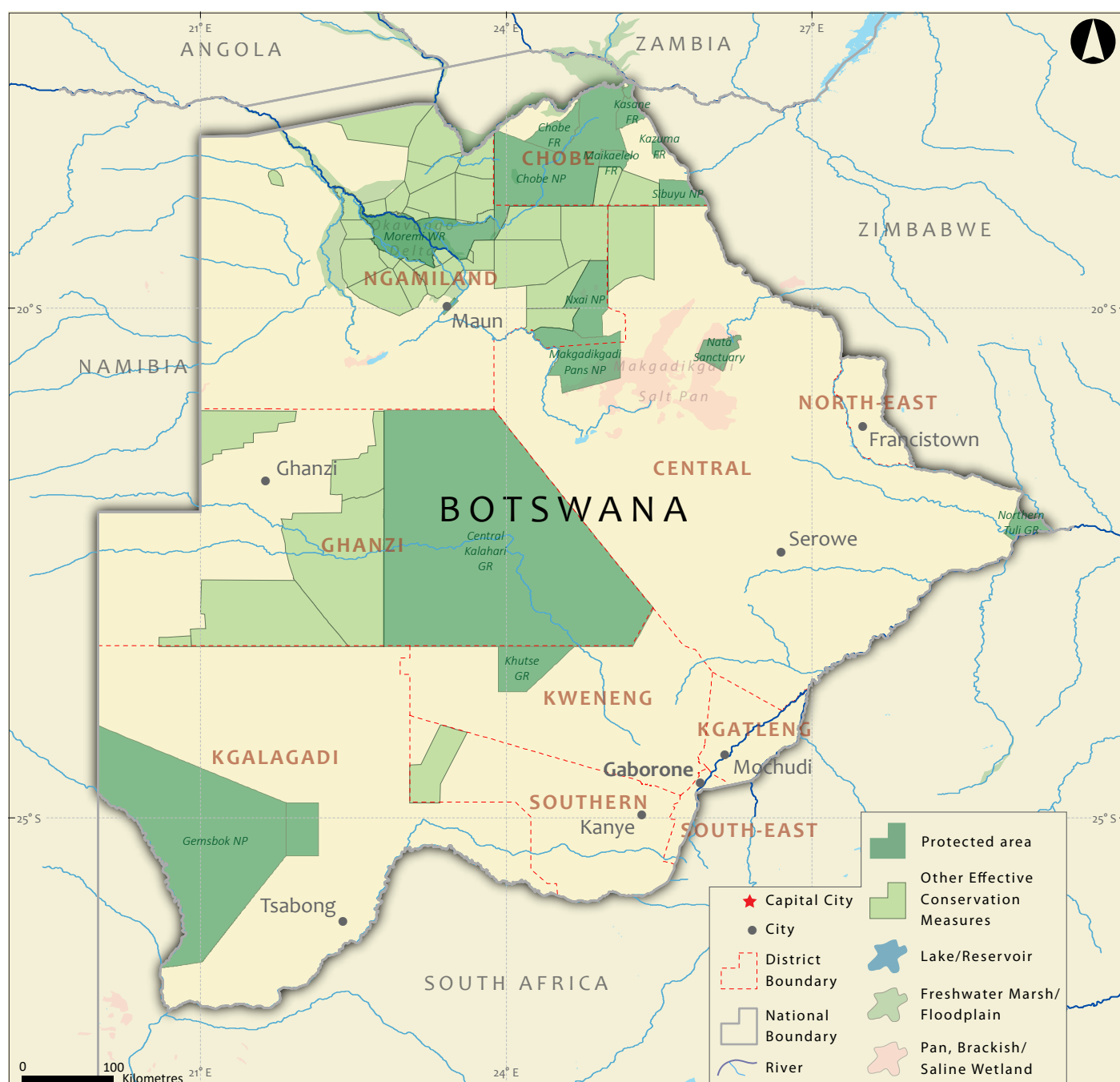


Figure 4-7: Protected Areas and Other Effective Area-based Conservation Measures (OECMs) in Botswana.
(Mapping Biodiversity Priorities project, Box 4.1)

The map of protected areas also includes areas with other types of protection, such as gazetted Wildlife Management Areas which include private conservation leases and community wildlife utilisation areas. These alternative ways of achieving protection of biodiversity can be considered as 'Other Effective Area-based Conservation Measures' (OECMs) e.g. Mokolodi Nature Reserve and Khama Rhino Sanctuary. Globally, OECMs are becoming an increasingly important approach for protecting biodiversity beyond traditional protected areas.

The area covered by OECMs is 68,970 km², bringing a further 11.9 percent of the country under protection. In total, more than 30 percent of the land area of Botswana has some form of protection. This extensive coverage of protected areas reflects the country's commitment to protecting its natural biodiversity.

Assessment of ecosystem protection levels

An assessment was carried out to determine how well Botswana's 73 ecosystem types are represented in the current protected area network. Ecosystem protection level is an indicator that tracks how much of each ecosystem type is found within protected areas. It is measured by comparing the map of ecosystem types (Figure 4-2) to the map of protected areas (Figure 4-7). Ecosystem types are then categorised based on a percentage target. The assessment uses the Convention on Biological Diversity's new target under the Global Biodiversity Framework for 30 percent area protected.

As many as 32 (or 44 percent) of Botswana's 73 ecosystem types can be considered well represented in protected areas (Figure 4-8). This means that the target is met for these ecosystem types – a significant achievement of

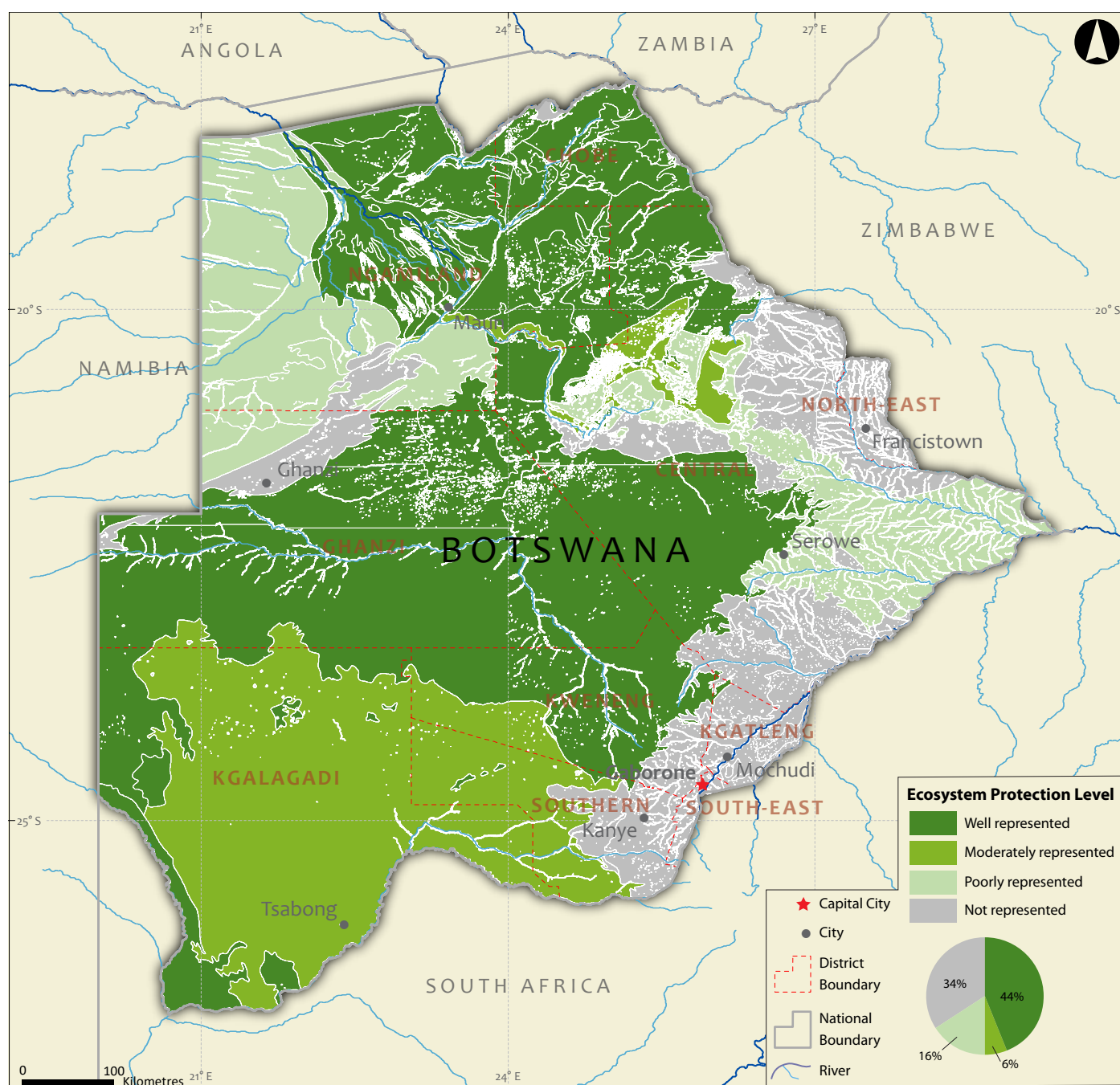


Figure 4-8: Protection levels for ecosystem types in Botswana.
(Mapping Biodiversity Priorities project, Box 41).

the current protected area network. However, 25 (or 34 percent) ecosystem types currently have no representation in protected areas. The assessment highlights a number of ecosystem types in the southeastern, eastern and North western parts of Botswana that have insufficient protection. These ecosystem types are at risk because no sites are currently protected, and their entire extent may be lost to other land uses. In addition, this is where the majority of the threatened ecosystem types also occur (Figure 4-3). These threatened and under-protected ecosystems are a high priority for future protected area expansion and other conservation efforts.

4.4 Issues, concerns, impacts

Habitat destruction, conversion and disturbance

The main causes of habitat destruction and disturbance include human-related activities such as agriculture, mining, barriers restricting wildlife movement, over-harvesting of biodiversity, tourism, fire, alien invasive species and climate change.

Land use change, agriculture and settlements

Habitat destruction and conversion that arise from deforestation and changes in land use are major causes of biodiversity loss. The major drivers are settlement expansion, encroachment of mining, and expansion of livestock and agricultural activities into sensitive wildlife-rich areas. For instance, since the start of the Integrated Support Programme for Arable Agriculture Development (ISPAAD) project in 2008,

more than 300,000 ha of land was cleared. This was an additional 50 percent more land than is usually used for field crops. This increase has had negative impacts on topsoil and biodiversity conservation, which are critical elements of the agro-ecosystem environment. Tilling of the soils affect soil micro-organisms and other underground biodiversity and can lead to soil erosion, increased break down of soil organic matter and release of carbon-dioxide into the atmosphere. Old agricultural machinery is inefficient, and the use of fertilizers, pesticides and herbicides contributes to soil and water pollution. To help limit the negative impact caused by agro-chemical pollution, Botswana has set targets for the amounts to be used in agricultural production. These are highlighted in Table 4-6. The challenge going forward is to establish baselines for agro-chemicals to allow tracking against the targets.

Table 4-6: Handling and disposal of fertilizers, pesticides and herbicides used in agricultural production in Botswana. (MOA, 2020)

Trends (%)					
2017/18		2018/19		2019/20	
Target	Actual	Target	Actual	Target	Actual
5	-	8	-	12	-

Deforestation and habitat destruction particularly affect breeding colonies and migratory birds. Their habitats are usually located in quiet, isolated areas such as islands, open pans (protected through seasonal flooding) and cliffs. However, activities that bring humans ever closer to them such as fishing, hunting and ecotourism are threatening birds breeding and nesting.

*High resolution satellite image of the Orapa diamond mine located in Orapa
Source: Maxar Technologies - CNES/Airbus*



The Mapping Biodiversity Priorities project (Box 4-1) gathered a range of data on land use and degradation to develop a single map of ecological condition for the country (Figure 4-9). The map of ecological condition places land into three categories: natural (not significantly changed from a natural state), degraded (e.g. overgrazed areas) and not natural (areas that have been permanently changed e.g. built-up areas). It is recognised that the spatial data available for some types of habitat degradation can still be improved. For example, more direct data on rangeland agriculture, fragmentation and the spatial coverage of invasive alien species could provide a clearer view of the levels of habitat degradation in the country.

The map of ecological condition currently shows that the majority of the country (70.6 percent) remains in natural condition. Only 7.2 percent is irreversibly transformed to land uses such as urban areas. A further 22.2 percent is

considered to be in degraded condition as a result of land uses such as agriculture, in particular overgrazing by cattle. By far the majority of the degraded and lost areas are located in the southeastern parts of the country where the human population density is highest.

Overuse and over-collection of wild plant species

The growing population is, in certain areas of the country, putting pressure on certain valuable plant species such as medicinal plants, wood and veld products are under threat in Ghanzi and Kgalagadi Districts and in eastern Botswana. Other forest and rangeland resources such as Morama (*Tylosema esculentum*), Phane (*Imbrasia Belina*) and Grapple (*Harpagophytum procumbens*) are stable because the plants are plentiful and harvesting pressure is low (DEA, 2015). Unsustainable harvesting practices can be addressed

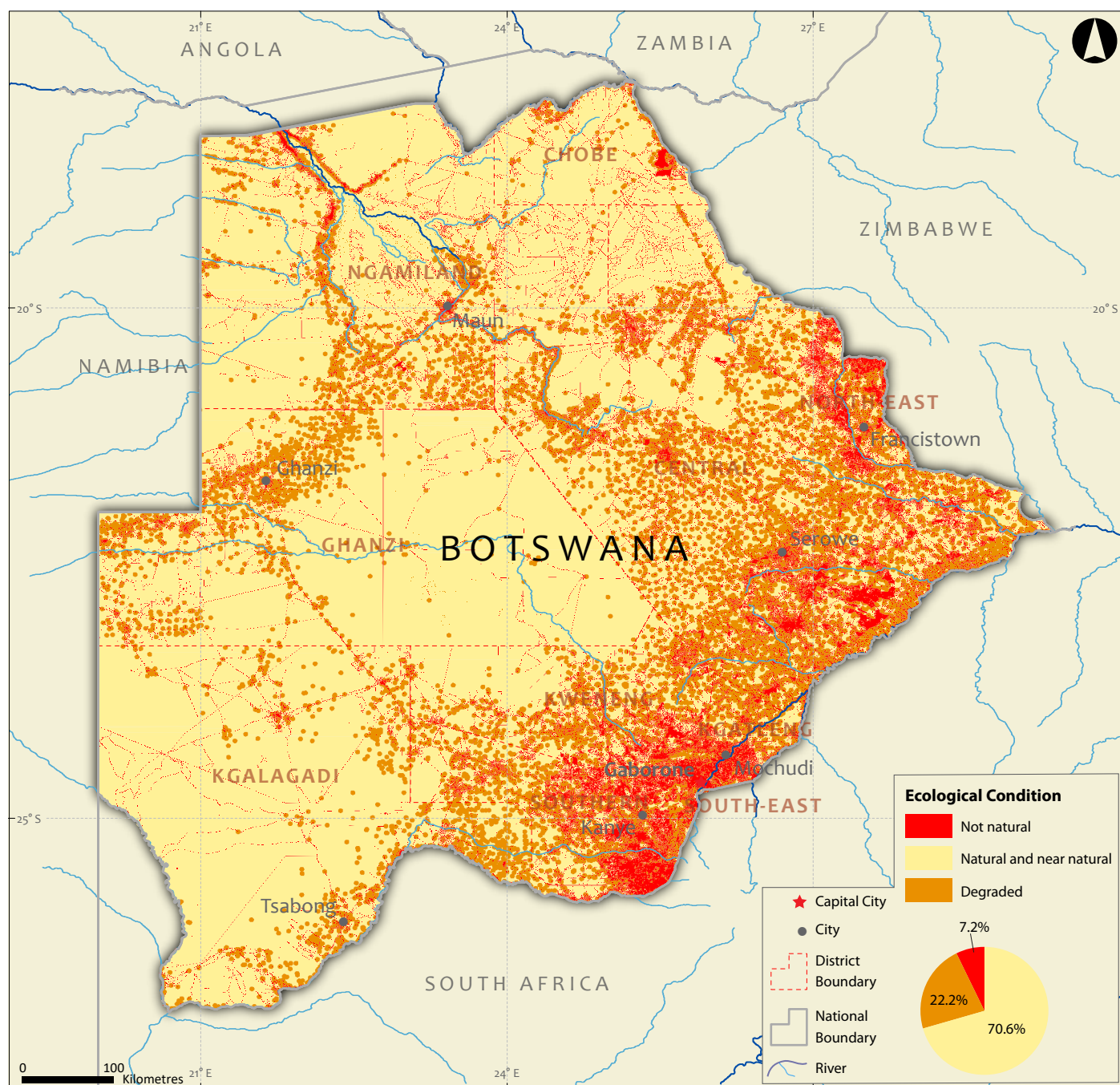


Figure 4-9: Map of ecological condition for Botswana.
(Mapping Biodiversity Priorities project, Box 41).



Tsodilo hills.
Photo credit: Photography Section, BOPA

through increased awareness and education. Unfortunately, there has been little value addition in this sector and there has not been much progress in the commercialisation of veld products.

Mining

Mining contributes significantly towards the country's GDP and makes up about 80 percent of export earnings. The sector is dominated by diamonds. In 2018, Botswana was the second largest diamond producer by value and volume in the world. Other minerals mined are aggregate, brickmaking clay, coal, dimension stone, soda ash, gemstones, gold and salt.

Growth and diversification of the mining sector contributes to habitat destruction. Activities such as illegal river and sand pit mining and water extraction to supply mining activities may affect hydrological levels impacting the vegetation and other biodiversity. Other impacts include habitat modification for breeding and wildlife migration routes and corridors. For instance, expansion of soda ash abstraction in Sua Pan towards the newly established Flamingo Sanctuary is likely to negatively impact this vulnerable specie. The squatter camps that can spring up around mines and the effects of air pollution from the mine on human health, soil, water and vegetation in the area also have important implications for biodiversity conservation.

The Towards Sustainable Mining® (TSM) initiative adopted in February 2020 by the Botswana Chamber of Mines calls for developers to subscribe to the principles of responsible mining and extraction of minerals. Adoption of these principles would allow industry to adhere to sustainable minerals development practices and strive towards continual improvement. To that end, it requires an annual assessment in the six areas of biodiversity conservation, community

Tourism

The entire tourism product lifecycle, by its very nature, has both positive and negative economic, environmental, and social impacts. Tourism consumes resources including water, energy, land, water, and biomass and this puts pressure on the natural resources through the waste created that contributes to the environmental pollution load. Waste produced includes solid waste (plastic bags, cans, and bottles) and sewage. For instance, the increase of tourism facilities in the Okavango Delta that use septic tanks as their sanitation system are likely to increase the potential for ground water pollution. Other environmental impacts include loss of biodiversity from building construction and roads, noise pollution from motor vehicles, aircraft, and motorized boats.

To sustain the tourism industry, it is essential that the quality of the environment is maintained. In fact, one of the positive outcomes of tourism is the awareness created indirectly increases the economic and conservation value of these natural areas. Botswana has implemented a sustainable tourism approach to reduce the negative impacts of tourism on biodiversity. Sustainable tourism aims to utilize the tourism resource wisely while minimizing any environmental impacts. Some of the activities include incorporating cleaner production technologies and the use of green building standards such as improving energy efficiency and waste minimization.

Policy framework to reduce environmental impact from tourism

Several policies have been developed to support this approach. These include Botswana Tourism Policy of 2021, Botswana Tourism Master Plan (2000) and the National Ecotourism Strategy (2002). The Tourism Master Plan emphasizes a high value-low volume strategy in fragile areas to protect the environment. This is the same approach

adopted by the Ecotourism Strategy which encourages the integration of sustainability approaches in tourism planning, development, and management, as well as encouraging community participation in tourism and environmental conservation. Awareness creation, re-investment of revenues in conservation and quality experiences are the additional guiding principles.

Botswana is a leader in the Community-Based Natural Resource Management (CBNRM) model having implemented it for over 20 years. It involves local communities in the conservation and management of tourism, natural resources, archaeological and cultural resources with the aim of improving local livelihoods and wise use of the environmental assets. In 2016, there were 53 active Community Based Organisations and revenues from their activities were estimated to be around BWP 300 million between 1997 and 2015. Wildlife-based tourism is a popular activity especially within the photographic and hunting safari sectors. Some CBNRM projects have been successful while others have not fared very well. Major challenges concern the availability of skilled personnel or lack of capacity building, reinvestment of CBNRM revenue or misappropriation of funds, strong community cohesion or lack of it. Where it has succeeded, CBNRM has made a significant contribution to livelihoods of the communities involved through the creation of employment, income generation, and provision of social services like water.

An Ecotourism Manual and a certification system to recognise best practice by the tourism sector was also put in place. The Ecotourism Certification System is a voluntary scheme intended to encourage a sustainable tourism approach and the development of quality eco-friendly tourism products. It is comprised of two standards; the Accommodation Standard and Ecotour Standards. By December 2019, 84 facilities had been certified.

The undertaking of environmental assessments enables the integration of environmental mitigation measures especially where the project may be large or located in a sensitive area. A management plan is developed with the carrying capacity or limits of acceptable change established and guidance for tourism operators. Examples of existing management plans include the Okavango Delta Management Plan (ODMP) and Makgadikgadi Framework Management Plan (MFMP). At a regional level, the management plans for the Kavango-Zambezi and the Kalahari Transfrontier Parks are being implemented while the development of the Greater Mabumbungwe Transfrontier Park Management Plan will start once the agreement between Member States is signed.

Dam tourism has been introduced to diversify the current tourism product. The primary purpose is to attract tourists to other parts of the country so that tourism is not only confined to the northern part of the country. Tourism Master Plans have been developed for the following dams: Thune, Letsibogo, Shashe, and Gaborone Dams. These provide guidance to ensure ecosystem sustainability while allowing the dam to be used for its primary water provisioning purpose. Currently the Letsibogo and Shashe Dams are piloting this initiative.

Barriers to wildlife movement

Seasonal variations in surface water and the quality and quantity of forage are key factors driving animal movements. Such mobility is easily disrupted by habitat fragmentation and physical barriers such as fences, roads or settlements. This is particularly pronounced in the more arid southern part of country with adverse impact on the wildlife population. The northern parts are relatively stable, particularly the Okavango – Linyanti and the Chobe areas (Ecosurv, 2012), although maintaining migratory corridors with the broader Kavango Zambezi Transfrontier Conservation Area (KAZA – TFCA) remains a challenge.

Since 1954, veterinary cordon fences for disease control have been erected to separate Foot and Mouth Disease (FMD) carrying buffalo populations in the North from livestock populations in the South, and control the spread of other diseases, so as to protect the beef export industry and livestock farmers' livelihoods. The last half century has seen the expansion of fencing due to the policy to allocate fenced ranches in communal areas. The country is slowly changing from open ecosystems to several closed systems and from open communal land to partial privatisation and fenced commercial ranches. This is fragmenting the natural habitats. For instance, the combination of increased fencing and the growth in livestock distribution has led to the permanent separation of the CKGR system from the Makgadikgadi/Nxai Pans complex; progressive isolation of the SW Kgalagadi from the CKGR and Ghanzi WMAs; isolation of the Quibaba WMA and Lake Ngami from the Okavango Delta; the growth of a significant barrier between the Chobe and Zimbabwe wildlife systems (DEA, 2015).

Alien invasive species

Alien invasive species are a major threat to biodiversity in Botswana. Transboundary aquatic systems are the most vulnerable. In the Limpopo River Basin, the water hyacinth (*Eichornia crassipes*) is a problem. It blocks the water ways due to excessive growth and causes eutrophication. In the Okavango Delta, *Pistia stratiotes* and *Salvinia molesta* pose a threat to the aquatic environment. Tourism has been a major driver in the spread of these invasive species especially in the Okavango Delta (Mendelsohn et. al, 2010). Other common invasive species are Burweed (*Achyranthes aspera*), Cocklebur (*Xanthium stramonium*), Catclaw mimosa (*Mimosa pigra*), *Sesbania* species, and *Melia azedarach*, thorn apples (*Datura ferox* and *Datura stramonium*) and Golden Crownbeard (*Verbesina encelioides*). In eastern Botswana, alien species found include *Argemone* (Yellow-flowered Mexican poppy) which invades areas undergoing land cover change; while *Melia azedarach* (*Syringa*) and *Jacaranda mimosifolia* (*Jacaranda*) are found along rivers in eastern Botswana (Setshogo, 2005). Table 4-7 lists the alien and native invasive species found in Botswana.

Dryland invasive plant species are also emerging as a major threat to ecosystem integrity in many areas. In the southwest of the country *Prosopis glandulosa* is a significant problem, estimated to cover 5,154 ha of the country in 2016. *P. juliflora* and *P. grandulosa* were introduced into the Kgalagadi desert in the early 1980s to combat desertification and stabilise sand dunes and have currently hybridised with each other. *P.*

Table 4-7: Alien and native invasive species found in Botswana (Moleofi, 2021)

Type	Life form	Scientific name	Common name
Fauna	Bird	<i>Bubulcus ibis</i>	
Fauna	Bird	<i>Columba livia</i>	
Fauna	Bird	<i>Estrilda astrild</i>	
Fauna	Bird	<i>Porphyrio porphyrio</i>	
Fauna	Bird	<i>Sturnus vulgaris</i>	
Fauna	Fish	<i>Clarias gariepinus</i>	
Fauna	Fish	<i>Cyprinus carpio</i>	
Fauna	Fish	<i>Micropterus salmoides</i>	
Fauna	Insect	<i>Ceratitis capitata</i>	Medfly
Fauna	Mammal	<i>Civettictis civetta</i>	African civet
Fauna	Mammal	<i>Cricetomys gambianus</i>	
Fauna	Mammal	<i>Cynictis penicillata</i>	
Fauna	Mammal	<i>Genetta genetta</i>	
Fauna	Mammal	<i>Myocastor coypus</i>	
Fauna	Mammal	<i>Vulpes chama</i>	Cape fox
Flora	Aquatic plant	<i>Lagarosiphon major</i>	
Flora	Aquatic plant	<i>Salvinia molesta</i>	
Flora	Aquatic plant	<i>Trapa natans</i>	Bull nut
Flora	Grass	<i>Cenchrus ciliaris</i>	
Flora	Grass	<i>Panicum repens</i>	
Flora	Grass	<i>Rottboellia cochinchinensis</i>	
Flora	Herb	<i>Bidens pilosa</i>	
Flora	Herb	<i>Commelina benghalensis</i>	
Flora	Shrub	<i>Abrus precatorius</i>	
Flora	Shrub	<i>Launaea intybacea</i>	
Flora	Shrub	<i>Senecio inaequidens</i>	
Flora	Shrub/ Tree	<i>Ricinus communis</i>	
Flora	Tree	<i>Leucaena leucocephala</i>	
Flora	Vine	<i>Cardiospermum grandiflorum</i>	

juliflora and its hybrids have invaded adjacent districts with undesirable socio-economic and ecological consequences, including the depletion of scarce groundwater resources. The invasion of *P. juliflora*, led to a decline in the density of many native tree species leaving the area dominated by extensive areas of *Prosopis* species. *Prosopis* is now well established in Gantsi district, and part of Hukuntsi district and there is potential for it to spread throughout the country (Muzila et. al., 2011; Statistics Botswana, 2016).

The invasive bird, Common myna (*Acridotheres tristis*), invades areas undergoing land cover change when colonizing a new area and its presence is correlated with the built-up areas. It is listed amongst the World's top 100 worst invaders. Its range in Botswana has expanded from its first sighting in Mahalapye in 1975 to Gaborone in 1991, the Makgadikgadi Pans National Park in 2005, and recently from Kazungula on the Botswana–Zimbabwe border. The Common myna competes for food with native species and affects the abundance of other cavity-nesting species smaller than it (Peacock et al., 2007).

Botswana has enacted national legislation for the prevention and control of invasive alien species (Aquatic Weeds Control Act of 1971) and is also supporting the implementation of programmes to address this issue. Biological control of *Salvinia* using insects introduced by the Department of Water and Sanitation has proved effective. The department constantly monitors the different water basins (Okavango-Chobe-Linyanti and Limpopo River Basins) for invasive water weeds.

Disruption of natural fire regimes

Botswana experiences frequent unplanned fires that are driven by a combination of factors including depressed precipitation, population encroachment, poor fire management policies, land use and social behaviour such as clearing bush for agriculture or to stimulate the emergence of fresh pasture. They occur throughout most of Botswana and are putting major pressure on the biodiversity. For instance, in 2008, forest reserves along Chobe National Park were greatly affected by fire (88 and 92 percent of Kasane Forest Reserve and Kazuma Forest Reserve burned respectively). In 2010 veld fires affected a total of 40.45 percent in protected areas including Chobe, Maikaelelo, Sibuyu Forest Reserves, Khutse and Central Kalahari Game Reserves. The fires, depending on the timing, also affect the breeding colonies of wildlife, vulnerable birds, and aquatic biodiversity. For

instance, the April pre-flood fires in the Okavango Delta are of particular concern to the floodplain nesting of birds (DEA, 2015). Figure 4-10 shows the occurrence of fire in relation to protected areas around the country.

The Zambezian Baikiaea Woodlands are subject to the highest frequency of fires followed by the Zambezi flooded grasslands the arid Kalahari Acacia-Baikiaea savanna and Kalahari xeric savanna. The frequency varies significantly in the Zambezian flooded grasslands (Okavango Delta) with lower frequency and percentage during high flood periods (UNDP, 2014).

Addressing the fire threat

The fire management system is a function led by the central Government and focuses on fire suppression. As a result, there has been less focus on fire management from a land use and livelihoods perspective yet human activity accounts for most fire outbreaks. Other challenges include lack of financial and human resources.

Some of the responses have included the development of the Integrated National Wildland Fire Management Strategy in 2013. Strategies include the development of a Geographical Information System (GIS)-based Fire Information System (FIS) that utilizes satellite data to support decision making. The near real-time nature of satellite information means that district officers can be deployed in a timely manner. Training, increasing public awareness, maintenance of the 10,000 km firebreak country-wide network and development of district fire contingency plans, are some of the activities being carried out. The Department of Forestry and Range Resources and the National Disaster Management Office are key in supporting the development and implementation of these contingency plans. The community is involved through the community-based fire management programme. A National Wildland Fire Management Policy is also being developed. It will guide the development and operationalization of the institutional arrangement for wildlife fire management plans and strategies.

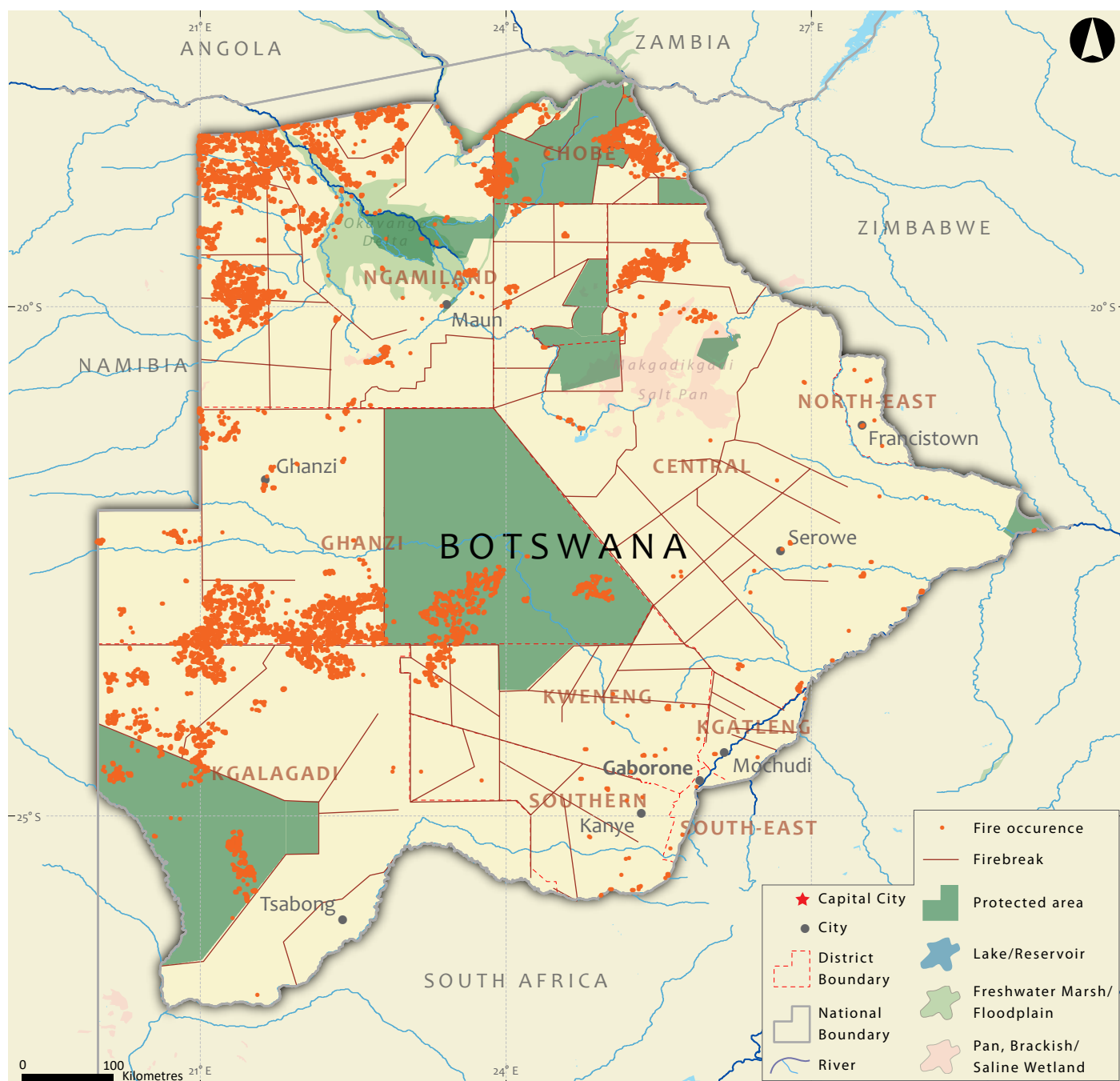


Figure 4-10: Fire events as detected by MODIS and Terra Aqua – 2019 Fires
(Source: Department of Forestry and Range Resources).

Hotter and drier conditions due to climate change has also exacerbated the wildfire hazard and coupled with over a century of fire suppression has resulted in severe and catastrophic fires in the late dry seasons. Using fire expertise from New South Wales Rural Fire Service, Australia, has been training and equipping the appropriate community members in North eastern Botswana to undertake prescribed burns in the aearly dry seasons, so as to reduce the fuel load available to wildfires later in the season.

Climate change

The present predictions for Botswana are that there will be an average increase of 2°C in temperature by 2030. The warming will be most noticeable over the desert regions. Droughts and 'heatwaves' will increase while the number of extreme cold events will decrease. Depending on their sensitivity, these changes will probably lead to reductions in biodiversity, crop, and livestock productivity. Vulnerable and endangered species will be most at risk and could even be pushed to extinction (IPCC, 2019; Nkemelang et al., 2018). The rate of predicted temperature increases in such that many species seem unlikely to be able to adapt in time, with the required range shifts for many mammals compromised by the increasingly fragmented nature of habitats.

There is also likely to be greater variability in rainfall with extreme events increasing. In some areas, rainfall is predicted to decline by 25 percent while in other areas it might increase by up to 10 percent. With the timing and transitions of the dry and wet seasons becoming more variable, vegetation resources will become increasingly important. Ecologically it seems likely that there will be accelerated conversion of woodlands to shrublands and open savannas happening faster due to the interactions between increasing temperatures, reducing rains, fire, and elephants (MEWT, 2012).

A decline in the rains over several years would also affect the hydrology of inflowing rivers impacting the breeding of aquatic biodiversity, water quality and water flow. The biggest system that relies on river inflows in the country is the Okavango Delta. It is also the major biodiversity hotspot in the country. A sustained decline in rains over a couple of years could reduce the flow of the Okavango River putting greater pressure on the biodiversity that is reliant on the wetland system. The upshot of reduced rainfall is a decline in runoff into surface waters and an increase in flash flooding events (DEA, 2015).

Climate change is integrated into the national development frameworks. Vision 2036 commits to 'observe the ecosystem's carrying capacity, applying the limits of acceptable changes, and promoting maximum sustainable yield for renewable resources'. The NDP 11 (2017-2023) also has sustainable environment as one of its four thematic areas. The themes are further broken down into four priority areas: sustainable management of natural and cultural resources, climate change mitigation and adaptation, integrated planning for human settlements and healthy environment for healthy population.

Human-wildlife conflict

Human-wildlife conflict often undermines the objectives of wildlife conservation and sustainable use initiatives. Although the benefits of utilizing wildlife may be directed to communities through CBNRM programs, wildlife threats to human life and property damage these benefits and arouse negative attitudes towards wildlife ultimately eroding their value. As the requirement for land for settlement and agriculture grows, and as livestock population increases, the likelihood of encroachment into wildlife protected areas increases and so does the potential for predator attack. Table 4-8 presents a summary of reported conflict incidents for selected species over a 5-year period.

Table 4-8: Total reported human-wildlife conflict incidents for selected species (DWNP, 2020)

Species	Year					
	2015	2016	2017	2018	2019	TOTAL
Elephant	2,295	2,165	3,427	3,842	3,440	11,729
Lion	1,248	1,199	2,022	1,814	2,231	8,514
Leopard	1,381	1,038	1,104	1,066	1,123	5,712
Wild dog	949	733	987	1,014	910	4,593
Hyena	240	192	185	158	140	915
Cheetah	89	70	111	75	96	441
TOTAL	6,202	5,397	7,836	7,969	7,940	35,344

Elephants

Botswana has the largest elephant population in Africa with the Chobe River supporting up to 50,000 in the dry season. The rapid increase in elephant population in Botswana is attributable to the success of anti poaching measures and contrasting civil unrest in neighbouring countries which as led to the in-migration of elephants to Botswana for the protection it affords them. Other areas of Botswana such as the Okavango Delta also have high concentrations of elephant due to the presence of a permanent water source. The relative difficulty in accessing the wildlife areas has also allowed the elephant population to grow.

Elephants move beyond their traditional range, causing habitat disturbance and modification, and moving close to human settlements and thereby contributing to human-elephant conflict. At times this results in the loss of human life. Elephant populations increased from 8,000 in 1960 to 207,500 in 2013. Habitat modification caused by the high densities of elephant is depressing populations of other wildlife species and causing significant damage to crops and property (DEA, 2015; DWNP, 2018).

Less than 30 percent of Botswana's elephant population live within protected areas. The main areas of human-wildlife-conflict are Chobe, Ngamiland and the Central districts, dominated by crop conflicts and livestock conflicts. These are mainly regions where the human population has been expanding out and encroaching into former wilderness area. Animal migration patterns in search of pasture play a big

role in the conflicts. Most farm holdings are established near water. The harvest season tends to fall in March and April, when elephants are dispersed throughout their wet season range, and even beyond. The loss caused to the small-scale farmers can be devastating as elephants sometimes trample a fence and eat the whole seasons' crop triggering household food insecurity.

The total number of incidents of human-elephant conflict has been on the increase from 2,295 in 2015 to 3,440 in 2019 as shown in Table 4-8 (DFRR, 2020). The Central and Ngamiland regions have registered the highest number of cases. Interestingly, despite having a higher elephant population, Chobe region continues to register a relatively few incidences of elephant conflicts. Most incidents occur during the dry season with the elephants moving towards human settlements in search of water when most of their natural sources have dried up.

The Department of Wildlife and National Parks has been promoting a combination of low- and high-cost measures to minimize crop damage by elephants. These include:

- **Chili pepper plant fences** – the smell deters elephants, and the chili peppers support the farmers livelihoods.
- **Burning chili pepper bricks** – the strong smell of these burning bricks also keeps elephants at bay. The bricks are made from elephant dung, chili pepper seeds and grease which allows them to smoulder for a long time.

- **Early maturing seeds** – early maturing crops allow for the harvest to be brought in before the migration of the elephants thus minimizing conflict.
- **Electric predator proof fence kraals** – this simple solution can be effective at deterring elephants. However, installation costs and maintenance are major limiting factors for this option. There are also questions about interruptions to migration routes and alterations to existing elephant population dynamics.

Other problem animals

Other problem animals include lions, leopards, cheetahs, wild dogs, and hyenas. As livestock populations increase, their expansion into wildlife areas has led to high levels of predator attacks. The number and trends in incident occurrences are shown in Table 4-8 and Figure 4-11. Lions, leopards, and wild dogs are the animals that cause the most damage. The damage caused by lions has also shown an incremental trend over the years and is quite prevalent in the Central and Ngamiland regions. Leopard and wild dog incidents are mostly reported in Central and Kgalagadi respectively. Such cases are accentuated by tendency of many livestock owners to avoid actively herding their stock, such that many animals are not kraaled at night. Projects designed to increase herding in key areas and foster co-existence between livestock and wildlife are currently being implemented in Northern, Southern and Eastern Botswana.

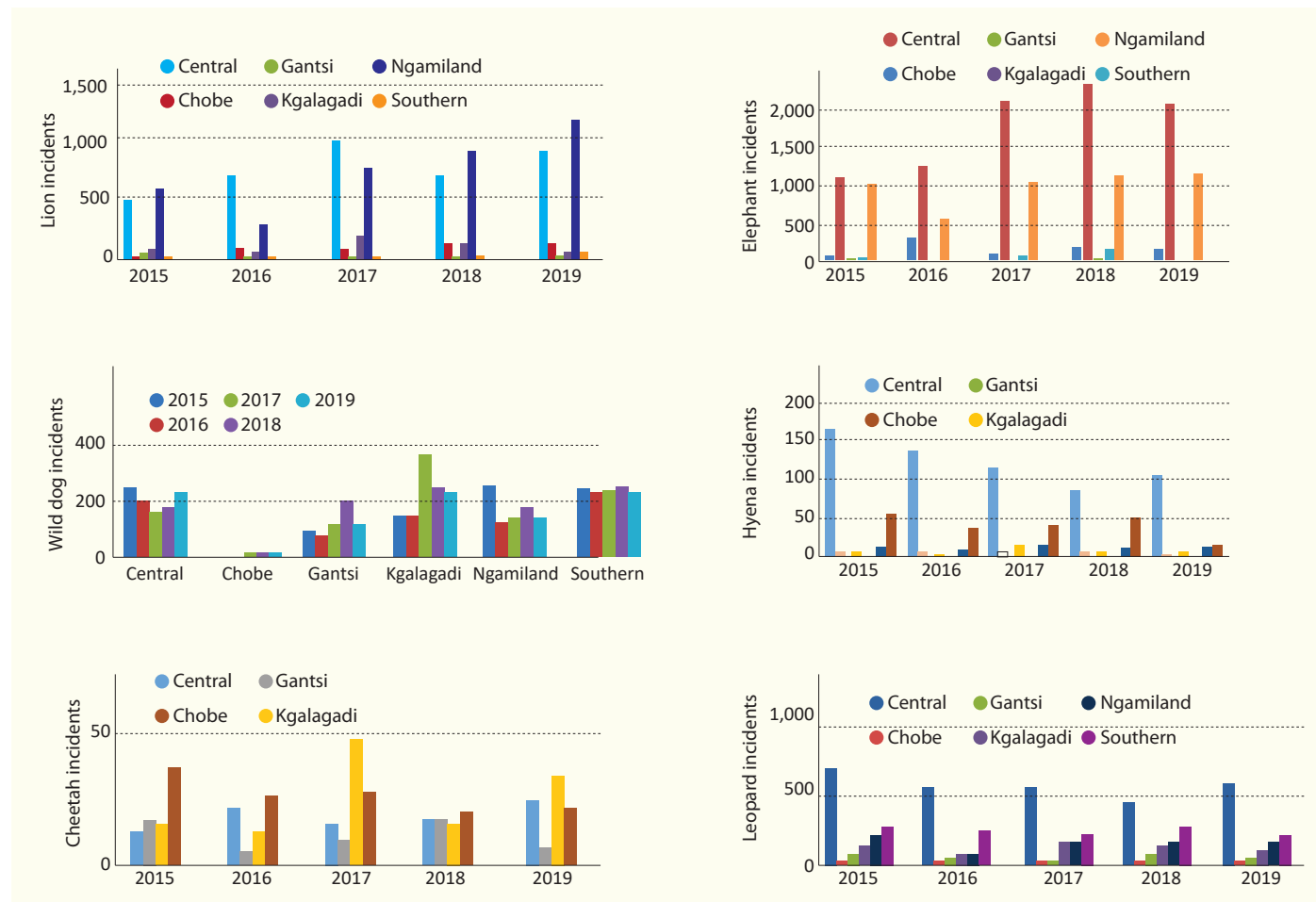


Figure 4-11: Reported human-animal conflict incidents in different regions (DWNP, 2020)



Chilli pepper plants planted for elephant control
Photo credit: Department of Environmental Affairs

4.5 Status and trends of SDG indicators

This section highlights how Botswana is doing on the SDGs related to biodiversity.

SDG 15.1.1: Forest area as a proportion of total land area

Land area covered by forest declined from 31.1 percent in 2000 to 26.9 percent in 2020 (UNStats, 2020b) as shown in Table 4-9 and Figure 4-12.

Table 4-9: SDG 15.1.1 Forest area in Botswana 2000-2020
(UNStats, 2020b)

Unit	Year							
	2000	2010	2015	2016	2017	2018	2019	2020
Thousand ha	17,620.7	16,437.7	15,846.2	15,727.9	15,609.6	15,491.3	15,373	15,254.7
%	31.09	29.00	27.96	27.75	27.54	27.33	27.13	26.92

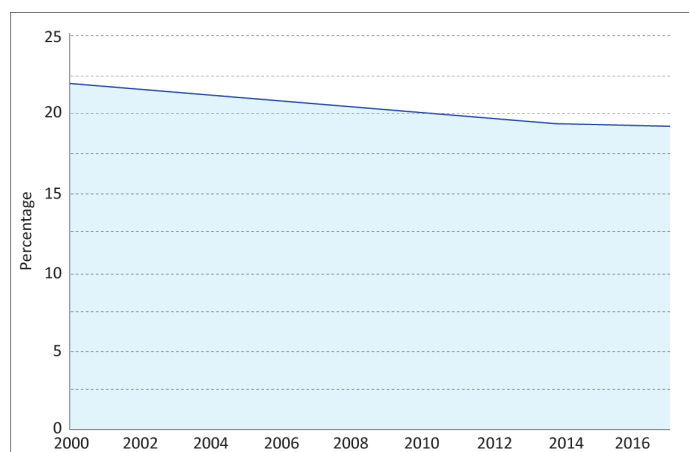


Figure 4-12: Forest area as a proportion of total land area 2000-2017
(% of land)
(UNEP, 2020b)

SDG 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type

To enhance the conservation and wise use of biodiversity, important sites may be set aside as protected areas for the management of freshwater and terrestrial biodiversity. In Botswana, the average proportion of freshwater key biodiversity areas (KBAs) covered by protected areas was 52.1 percent

in 2019 and the average proportion of terrestrial key biodiversity areas (KBAs) covered by protected areas in the same year was 51.1 percent (UNStats, 2020b).

As much as 18.9 percent of Botswana's land area is formally protected, and a further 11.9 percent is under other types of protection, in total covering 30.8 percent of the country (Figure 4-7). The protection levels indicator (see section 4-3) reveals that many ecosystem types (44 percent) are well represented in Botswana's current protected area network. However, 25 (or 34 percent) ecosystem types have no representation in protected areas, and these are important priorities for protected area expansion.

Important Bird and Biodiversity Areas (IBBA)

BirdLife Botswana has designated twelve sites as Important Bird and Biodiversity Areas. Four of them (Chobe National Park, Central Kalahari Game Reserve, Kalahari Trans-frontier Park and Manyelanong Game Reserve) are fully within protected areas; while three (Okavango Delta, Linyanti swamps and Makgadikgadi pans) only partially overlap the protected areas (Birdlife International, 2020) (Figure 4-13). The rest - Lake Ngami, Tswapong Hills, Bokaa Dam, Phakalane sewage ponds, and South-eastern Botswana - are not under legal conservation protection. The Phakalane Ponds do not technically qualify for IBA status at present due to human encroachment and poor management. The presence of dogs and quad bikes has chased many of the birds away; and the presence of vagrants makes the pond area unsafe for bird watchers. IBAs are site-specific areas designated specifically for the rich biodiversity and are identified using globally standardized criteria based on

the presence of species of global conservation concern, collections of range and biome-restricted species, and large concentrations of congregatory species.

The status of Botswana's IBAs that entirely overlap protected areas is better than those that are less protected. This is because protected areas experience relatively less pressure from human activities while also receiving better conservation response in the form of management planning. However, the effects of climatic conditions such as prolonged droughts affect all birds and their habitats. The overall score of threats to Botswana's IBAs indicates that the level of threats is medium. In general habitat destruction and reduction and barriers to movement are the main threats to birds. Agricultural expansion in the form of crop and livestock production has been noted around IBAs and is of concern. Intensified livestock grazing damages habitats for bird species. For example, field monitors have noted that livestock destroy the fence and graze within the Nata

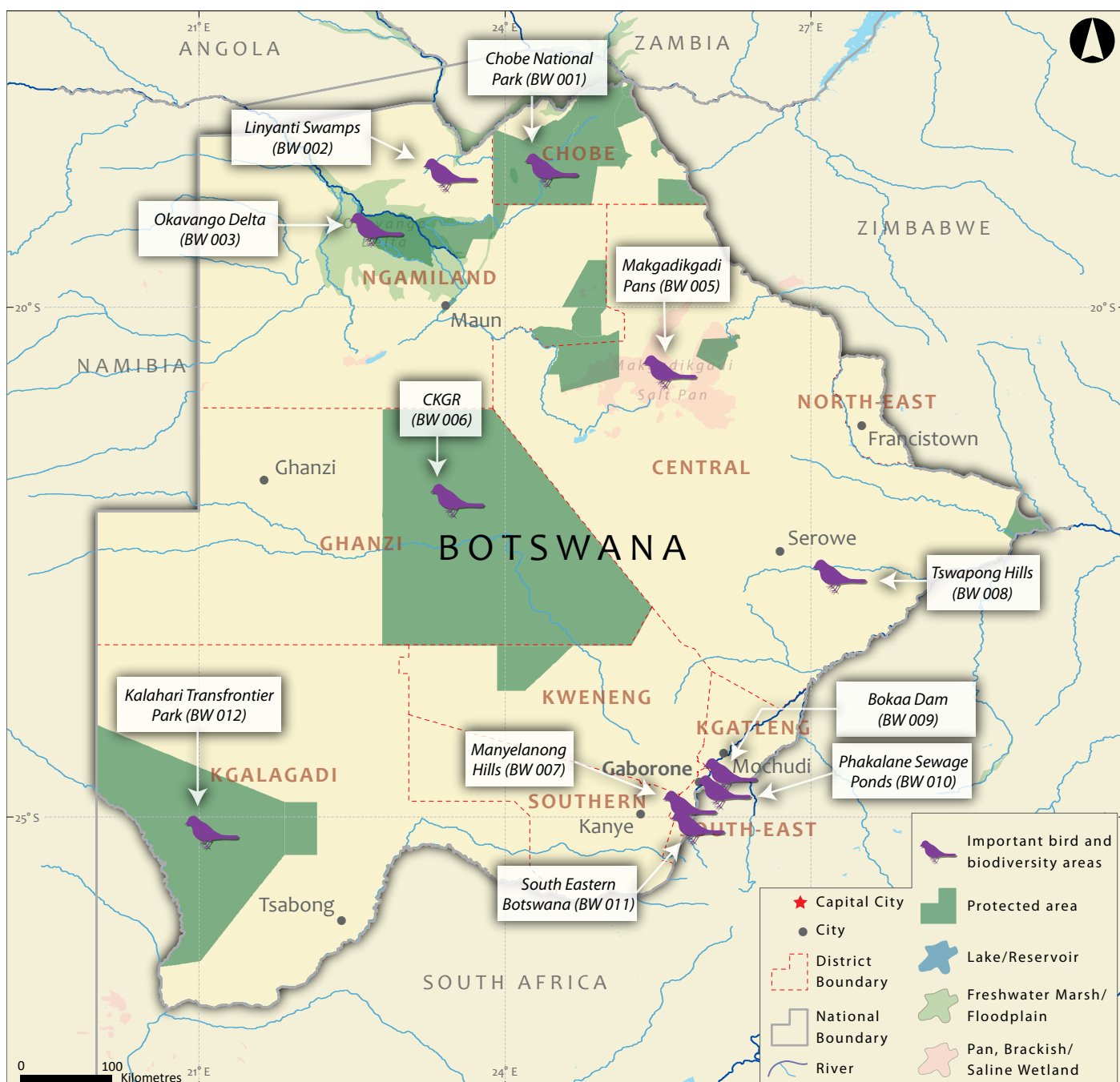


Figure 4-13: Locations of important bird and biodiversity areas (Moleofi, 2021)

Bird Sanctuary, whereas cattle also destroyed birds' eggs at Lake Ngami before it dried up.

SDG 15.2.1: Progress towards sustainable forest management

There has been a net loss in forest area declining from -0.96 in 2005 to -1.01 in 2010 to -0.92 in 2015. Although forests are being lost, the rate of this loss is slowing. The annual net change rate of forest area in 2020 was -0.74 percent in 2020, but the rate of forest loss in the two 5-year periods (between 2010-2015 and between 2015-2020) indicated in Table 4-10 is declining (UNStats, 2020b). This is an important sign that some of the policies being implemented are slowly making a difference.

Table 4-10: SDG 15.2.1 Forest area annual net change rate (%) 2010-2020 (UNStats, 2020b)

2010	2015	2020
-0.69	-0.73	-0.74

The proportion of forest area under long-term management plans and within legally established protected areas in Botswana was 10.81 percent by 2020. The above-ground biomass stock in forests in the same year was 155.25 tonnes per ha and this has been stable since the year 2000 (UNStats, 2020b). The stability of the above-ground biomass indicator

means that as a country, sustainable forest management policies are having an impact as there is a balance between the gains in biomass stock due to forest growth and losses due to wood removals for woodfuel, timber, natural losses, and fires among others.

SDG 15.3.1: Proportion of land that is degraded over total land area

In 2015, the share of land that was classified as degraded was 51 percent (UNStats, 2020b). As per nomenclature and definitions adopted in the Multilateral Environmental Agreements (UNCCD, UNFCCC, and UNCBD) of which Botswana is party to, "land degradation" means reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns.

The map of ecological condition (Figure 4-9) reveals that much of the country (70.6 percent) remains in a natural condition. However, degradation is present across more than 127 000 km² or 22.2 percent of the country. Additional efforts to improve the mapping of ecological condition will allow for more accurate monitoring and reporting on land degradation.

Giant salvinia, salvinia molesta, weed
Photo Credit: Botswana Government official Facebook page



Land degradation and desertification are significant threats to the productivity of Botswana's land resources. They are driven mainly by human activity and may be seen through loss of soil fertility, decline in freshwater resources, vegetation cover and other forms of biodiversity. For Botswana to be in line with its subscribed commitments to Agenda 2030 for Sustainable Development as well as its national development priorities and processes, such stress on land and land-related resources should be averted.

Some of the underlying causes are related to the existing land tenure system. Land conflicts are a major problem and are increasing in frequency, mainly due to socio-economic and demographic transformations. Expansions due to urbanization, agriculture and conservation initiatives are some of the drivers of such conflict. For instance, the privatization of formerly communal lands encouraged by rangeland policies have been central in ousting communal customary land systems in favour of private property rights.

SDG 15.4.1: Coverage by protected areas of important sites for mountain biodiversity

Botswana is a relatively flat country with only a few hilly areas. These include the Manyelanong Hill rising to an altitude of just over 1,490m and the Tsodilo Hills, a UNESCO World Heritage Site at 1,400m. Manyelanong Game Reserve is in south-eastern Botswana rising to about 1,356 m. The surrounding areas include communal and commercial farming activities and open Acacia and Combretum woodlands.

In 2015 the average proportion of Mountain Key Biodiversity Areas (KBSs) covered by protected areas was 96.3 percent. The Manyelanong and Tswapong Hills are Important Bird and Biodiversity Areas; and are the only breeding habitat for Cape Vulture Gyps coprotheres which is endemic to southern Africa. The estimated breeding population in Botswana is 600 pairs, with 100 pairs at Manyelanong and about 500 pairs in the east at Tswapong Hills (eastern Botswana), Goo-Moremi, Goo-Tau and others. The Cape Vulture listed as endangered on the IUCN 2017 Red List (Borello and Borello, 2002; Wolter et al., 2014) (IUCN, 2021).

Southern Lechwe (*Kobus lechwe*)
Photo credit: Martha de Jong-Lantink/flickr



SDG 15.4.2: Mountain Green Cover Index

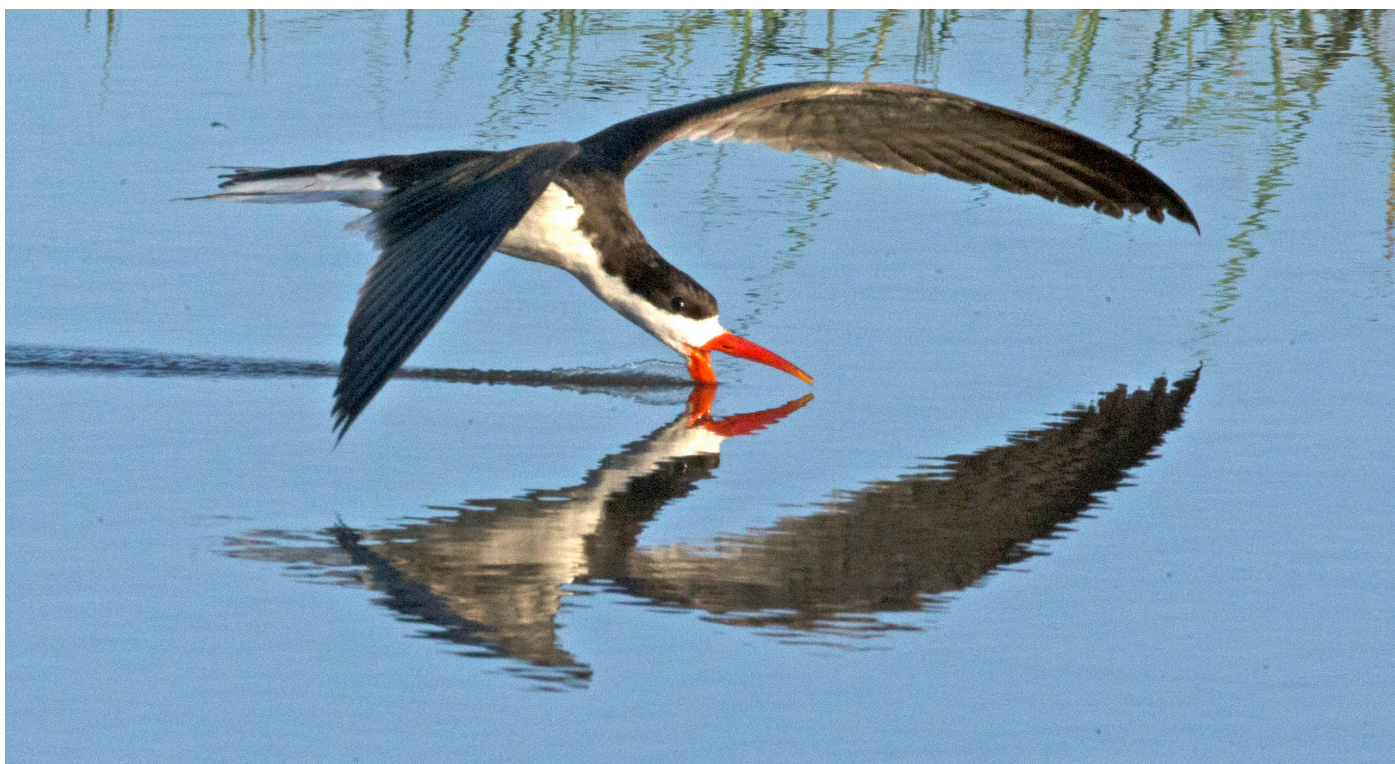
Data indicates all (100 percent) of the 1.73 km² of mountain areas were covered with forest, shrubs, grass, or crops in 2017 (UNStats, 2020b).

SDG 15.5.1: Red List Index

The SDG 15.5.1 Red List Index for Botswana is 0.98. On a scale of 0 (extinct) to 1 (least concern), Botswana scored 0.97 (between the years 2000 and 2019) on the IUCN Red List of Threatened Species index. This value implies that while most species are not expected to become extinct soon, there is still some level of biodiversity loss (UNStats, 2020b) (IUCN, 2020). Table 4-11 highlights some of the species on the IUCN Red List.

Table 4-11: Some of Botswana's species under the IUCN Red List Index (IUCN, 2021)

Species	Red List Status	Year assessed	Population trend
Kori bustard	Near Threatened	2016	Decreasing
White Rhino	Near Threatened	2012	Increasing
Chestnut-banded Plover	Near Threatened	2016	Stable
Black-winged Pratincole	Near Threatened	2016	Decreasing
Southern Lechwe	Near Threatened	2017	Decreasing
Puku	Near Threatened	2016	Decreasing
Tsodilo Thick-toed Gecko	Near Threatened	2010	Unknown
Brown Hyaena	Near Threatened	2015	Stable
Lesser Flamingo	Near Threatened	2016	Decreasing
African Skimmer	Near Threatened	2016	Decreasing
Ground pangolin	Endangered	2019	Decreasing



African Skimmer (*Rynchops flavirostris*)
Photo credit: Lip Kee/flickr

SDG 15.8.1: Prevent alien invasive species on land and in water aquatic ecosystems

Botswana has adopted relevant national legislation and is actively addressing the prevention or control of invasive alien species. The Aquatic Weeds (Control) Act, the Noxious Weeds Act and the Plant Diseases and Pests Act address both aquatic and terrestrial invasive species. There is also regional cooperation in the control of invasive species. For instance, at a bilateral level, Botswana and Namibia have been cooperating on the management of *Salvinia* (*Salvinia molesta*) and the Water hyacinth (*Eichhornia crassipes*). Furthermore, Botswana is a member of the SADC working group on aquatic weeds addressing invasive species.

SDG 15.9.1: Integration of ecosystem and biodiversity in planning

Botswana is one of the few African countries which prioritize biodiversity in its national development plans and programs. Biodiversity is an integral part of the Vision 2036 and the NDP 11. Botswana first developed a National Biodiversity Strategy and Action Plan in 2004. It has been revised twice – in 2007 and then in 2016 to bring it into alignment with the Aichi Biodiversity Targets, the Cartagena Protocol and the Nagoya Protocols. The NBSAP 2016-2025 was developed through a multi-stakeholder approach. Its vision states “by 2025, ecosystem, species and genetic diversity is valued, protected, and used sustainably and equitably, through the involvement of all sectors of society and the provision of sufficient resources for its sound management”.

One of the strategic actions is that by 2025, planning processes at all (district, urban and national) levels, and national accounting and reporting systems in Botswana contain explicit actions to promote biodiversity conservation. To achieve this the country will integrate the ecosystem-based

approach into plans at national and subnational levels, and into Environmental impact Assessments and Strategic Environmental Assessments. It will also develop a natural capital accounting system and use the valuations to highlight the benefits the country receives from its ecosystems and their services. Reporting will be an integral part of achieving this goal, helping to raise awareness while at the same time supporting policy and decision making in the ecoregions.

Conducting Spatial Biodiversity Assessment at a national scale (Box 4-1) is an important foundation for integrating biodiversity into planning. The outcomes of a Spatial Biodiversity Assessment can be used to guide efforts towards reaching NBSAP targets, integrate biodiversity into Environmental Impact Assessment and contribute to ecosystem accounting as part of natural capital accounting systems.

SDG 15.a.1: Official development assistance and public expenditure on conservation and sustainable use of biodiversity and ecosystems

In 2017, Botswana received US \$12.1 million (at constant 2017 US\$) in development aid for biodiversity conservation and wise use. This was an increase from US \$0.18 million in 2006. The total amount received in assistance for biodiversity increased from US \$4.2 million in 2002 to US \$6.3 million dollars in 2018 (UNStats, 2020b; MENT, 2019).

SDG 15.c.1: Proportion of traded wildlife that was poached or illicitly trafficked

The proportion of traded wildlife that is poached or illicitly trafficked is not known. However, baseline data from 2015 indicates that number of animals poached was 22.3 per 10,000, illicitly trafficked skins 24, live mammals 23, animal trophy 79 (Moleofi, 2021).

4.6 Responses and suggested future actions

Implementing the strategy for biodiversity management

The country has articulated policies, strategies and plans that focus on the conservation and protection of biodiversity resources, including adopting and mainstreaming global Multilateral Environmental Agreements (MEAs) and protocols in national legislative framework and policies. The country has been party to the Convention on Biological Diversity (CBD) since 1995, ratified the Cartagena Protocol in 2001 and acceded to the Nagoya Protocol in 2013.

The NBSAP provides a framework strategy that allows multiple sector issues to be addressed, including agriculture, water, wildlife management and land degradation/rehabilitation. This approach of joined up planning is addressing the challenge of fragmentation of environmental issues which used to make implementation challenging. Furthermore, biodiversity valuation and spatial analyses is being incorporated in the national and local planning, accounting, and reporting processes as described in Box 4-1. Defining the value of biodiversity, raises its importance and clearly justifies and provides evidence for conservation or wise use of the natural resources.

It is recommended that Botswana should:

- Continue to prioritize biodiversity in its national development plans and programs by integrating the ecosystem-based approach into plans at national and subnational levels, and into Environmental Impact Assessments and Strategic Environmental Assessments.
- Develop and report against a natural capital accounting system and use the valuations to highlight the benefits the country receives from its ecosystems and their services.

Building community awareness for biodiversity management

The Department of Forestry and Range Resources continues to build awareness among land owners and communities. CBNRM Policy allows the communities to form trusts in their areas to better manage their environment for better beneficiation. There are also Conservation Committees across the country in each District facilitating public awareness on Environmental issues. Sustainable Land Management (SLM) has been piloted in Tsodilo and Makgadikgadi in the last three years. Currently one SLM project is ongoing in the Kgalagadi and Ghanzi Districts.

Other activities to improve land management include fire management activities. In collaboration with the Australian Government through the New South Wales Rural Fire Services, the Government of Botswana has been implementing the Community Based Fire Management (CBFiM) since 2009. About 5,300 volunteers have been trained on basic fire fighting skills, provided with fire beaters and personal protective clothing. However, prescribed burning is rarely done due to shortage of resources. Back burning is not

commonly used yet it is a handy tool the traditional people use. Fire suppression techniques are also not correctly applied. Northwest, Chobe, Ghanzi and Kweneng districts have developed and implemented area specific Bushfire Risk Management Strategies. Kgalagadi and Central districts are in the process of developing theirs. Botswana is not zoned for fire danger which leads to a waste of resources in suppressing fires which are not a high risk to lives and infrastructure (Dube, 2013). There is need for landowners (ranches, tourism entities, and farms) to construct fire breaks around their properties as required by the Herbage Act of 1987 and Forest Policy of 2011.

The opportunity exists to better manage land that is already allocated to Government departments. Existing land can be managed efficiently, using strategies such as building upwards to maximize space. The land and housing sector can also improve the biodiversity footprint in Botswana by ensuring that buildings designs are sympathetic to the flora and fauna. Fallow land should be reclaimed or reallocated to avoid pressure on allocation of new plots resulting in additional pressure on biodiversity.

Against this background it is proposed that the Government:

- Continue to implement programmes to address unsustainable land use and harvesting practices.
- Support the implementation of the Integrated National Wildland Fire Management Strategy 2013 and finalise the National Wildland Fire Management Policy which is in development.
- Continue to invest more in benefit sharing with local communities so that the pressure for over-exploitation on non-timber and veld products such as marula, hoodia, and mopane worms is reduced. Value addition and commercialization of these species could also be encouraged as a means of increasing awareness in the value of biodiversity conservation.
- Encourage the role of traditional knowledge and involvement of communities in biodiversity conservation and management.

Strengthening institutional arrangements

The Ministry of Environment and Tourism (MET) is the host institution for the NBSAP. The Department of Environmental Affairs (DEA) is the National Focal Point for the CBD. It has the responsibility of overseeing implementation of the NBSAP supported by the National Biological Diversity Authority (NBDA) in an advisory role. Other organisations have a role to play in ensuring that the biodiversity resources are well taken care of, and this should be encouraged.

To further enhance the effective implementation of the NBSAP and to achieve its goals and targets it is recommended that:

- A biodiversity Institute be established. The Okavango Research Institute which already has capacity in biodiversity data handling could easily take up this responsibility.
- Innovative initiatives such as Towards Sustainable Mining® (TSM) initiative adopted in February 2020

by the Botswana Chamber of Mines that encourage self-improvement by developers be supported.

Implementing the legislative framework

Botswana has a considerable set of policy, regulatory and legal instruments for biodiversity management and conservation and to address some of the identified challenges such as human-wildlife conflict. There is, however, inadequate implementation due to insufficient resources and fragmented institutional arrangements. Pieces of legislation and policies on biodiversity have been developed and are implemented by different Government agencies, including the Game Ranching Policy, Wildlife Policy, Water Policy, Draft Botswana National Energy Policy, and Draft Botswana National Wetlands Policy, among others, at the which aim the protection and management of components of biodiversity resources.

The principal national legislation for conservation of biodiversity is the Wildlife Conservation and National Parks Act of 1992. Other complementary legislations which focus on single species protection, or a component of the ecosystem include the Agricultural Resources Act, Forest Act, Water Act, Waste Management Act and Fisheries Act.

Several strategies and action plans have been articulated to operationalize the conservation principles. These include the Water Master Plan, the Elephant Management Plan within the joint strategy adopted by Angola, Botswana, Namibia, Zambia and Zimbabwe, which together make up the KAZA-TFCA. Others include the Ostrich Management Plan, Renewable Energy Strategy and Environmental Research Strategy, for management and the conservation of biodiversity. The Millennium Seed Bank (MSB) and Botswana National Plant Genetic Resources Centre have to-date stored seeds

from 595 Botswana species as part of the research and conservation program.

For stronger implementation of this varied and expansive legal framework, it is proposed that:

- A more joined-up strategy of planning and implementation be instituted. This would avoid duplication of efforts and encourage more efficient use of human and financial resources. This could be achieved through implementation of the overarching Environment Management Act.
- Better policy coordination at national and local levels, including the amendment to the Tribal Grazing Land Act, could reduce the human-wildlife conflict by supporting protected passage for migratory wildlife, while transfrontier conservation efforts such as the Kavango-Zambezi Transfrontier Conservation Area could support the same at a regional level.

Maintaining heritage and culture

Botswana has over 20 years' experience in involving the community in environmental management. Through the CBNRM approach there has been much focus on the improvement in rural livelihoods and in so doing ensuring the environmental assets that support the livelihoods (the natural resources) are protected. This reduces human-wildlife conflicts and encourages rural development.

It is recommended that the Government continues to support the development of new and innovative tourism products as this sector is a strong pillar of sustainable growth, and could support the diversification of the economy.

*River traffic on the Okavango
Photo credit: Andrew Ashton/flickr*



World Heritage Sites

The Okavango Delta and Tsodilo hills are designated World Heritage sites and a further 7 sites have been proposed for listing as shown in Table 4-12 and Table 4-13. The communities who live adjacent to these heritage sites have for long been interacting with the natural resources and hence have a role to play in maintaining and protecting them. The Community Management of Protected Areas Conservation (COMPACT) initiative is being undertaken to demonstrate the role of community-based initiatives in increasing the effectiveness of biodiversity conservation in these globally significant protected areas.

It is recommended that the mapping of biodiversity project (discussed in Box 4-1) be expanded to include heritage and cultural parameters for protected areas so as mainstream these into the national and local planning processes.

Table 4-12: World Heritage Sites

Site	Inscribed	Category	Reviews	Rating
Okavango Delta	2014	Natural	2	4.04
Tsodilo	2001	Cultural	11	3.01

Table 4-13: Tentative World Heritage Site list

Site	Added	Reviews
Central Kalahari Game Reserve	2010	0
Chobe Linyanti System	2010	2
Gcwihaba Caves	2010	0
Makgadikgadi Pans Landscape	2010	0
Mapungubwe Cultural Landscape (Trans-boundary Listing)	2010	0
Toutswemogala Hill Iron Age Settlement	1999	0
Tswapong Hills Cultural Landscape	2010	0

4.7 Measuring Botswana's progress on the biodiversity-related SDGs

From the foregoing discussion, it is obvious that Botswana is progressing well on the biodiversity-related SDGs. There has been progress made in SDGs 15.8.1 (Prevent Alien Invasive Species on Land and in Water Aquatic Ecosystems), 15.9.1 (Integration of Ecosystem and Biodiversity in Planning), 15.a.1 (Official Development Assistance and Public Expenditure on Conservation and Sustainable Use of Biodiversity and Ecosystems) and 15.c.1 (Proportion of Traded Wildlife That Was Poached or Illicitly Trafficked). Botswana has fully met SGG 15.9.1 by establishing national targets in accordance with the Aichi Biodiversity Target 2 in its NBSAP. These are also integrated in the national accounting and reporting system and are being implemented and reported on.

Three SDGs - 15.3.1 (Proportion of Land That is Degraded Over Total Land Area), 15.4.1 (Coverage by Protected Areas of Important Sites for Mountain Biodiversity) and 15.4.2 (Mountain Green Cover Index) do not have enough quantitative data required for the SDG reporting framework; and the outlook seems to be poor. However, qualitative analysis shows that the Government is making progress in some of these areas. For instance, the new Land Policy 2019 is set to address some of the issues that are leading to land degradation in SDG 15.3.1.

A renewed emphasis on quantitative data and information is called for. Statistics Botswana already compiles data on elements of biodiversity following the guidance of the United Nations Framework for the Development of Environmental Statistics. There is opportunity to use the existing policy and political support to support information management for biodiversity conservation.

Okavango Delta
Photo credit: Photography Section, BOPA



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Letsibogo dam
Photo credit: Photography Section, BOPA

5

WATER AND SANITATION



5.1 Introduction

Botswana is a water scarce country due to its low rainfalls and salinity of the groundwater resources in some areas. Both surface and groundwater resources are limited and unevenly distributed over the country. The total annual runoff is estimated to be 696 Mm³ (DEA, 2013). Most the runoff cannot be captured due to lack of suitable dam sites, high variability of runoff as well as high evapotranspiration (MMEWR, 2013). Total groundwater resources are estimated at around 100 billion m³ with an average annual recharge at 1600 Mm³ per annum (SMEC et. al, 1991). Despite the scarcity of water resources, the SDG 6.1.1 indicator on access to water and sanitation is high (UN-Water, 2020). The growing population and subsequent need for water, sanitation and food security are some of the drivers that are putting pressure on Botswana's scarce water resource. Recurrent droughts are common and coupled with changes to the climate are of major concern as they affect human wellbeing.

Over the years, there have been several water suppliers in Botswana. The Water Utilities Corporation (WUC) has been supplying towns and cities. In addition, it has been supplying the then Department of Water Affairs (DWA) and District Councils with bulk water for further distribution to the remaining areas in the Country. It was through the review of the National Water Master Plan (2005-2006) that a major restructuring of the water sector was recommended. This included amongst others, the separation of water resources management from water service delivery (<https://www.water.gov.bw/wsector.html>). WUC assumed all the responsibility of domestic water supply and Department of Water Sanitation (DWS) is mandated with water resources management; water resources monitoring and protection against any form of exploitation and pollution and development of water resources; wellfields, dams and boreholes.

The Government continues to make important steps towards improving water and sanitation services. However, infrastructure challenges still exist, leading to the pollution of surface and ground water sources in some areas. Some of the impacts are seen in the form of degradation of

ecosystems, for instance in the Okavango Delta which is a haven for biodiversity and a big tourist attraction.

Water and sanitation are some of the key areas that the Government is focusing on during the NDP 11. Several water related instruments amongst others Water Act, Boreholes Act, Water Utilities Corporation Act and Aquatic Weed (Control) Act are being reviewed, human capital to manage water resources is being developed and the Government is actively involved in local and regional efforts to better manage the water resource.

5.2 Situational analysis of water resources

Rivers and lakes

Although water is a scarce resource in Botswana, there are some water bodies that provide fresh water for the population and economy. These include the five major river basins of Kwando/Linyanti/Chobe, Limpopo, Molopo, Makgadikgadi and several internal seasonal rivers. Most of these major river basins are transboundary and therefore shared water courses. The use of water resources from shared transboundary courses is subject to Southern Africa Development Community (SADC) Protocol on Shared Water Courses. For instance, the Okavango River originates in Angola and flows through Namibia before entering Botswana where it forms a large inland delta/wetland, the Okavango Delta. The wetland ecosystems of the delta are a rich biodiversity habitat and a tourist attraction. Moremi Game Reserve is part of this wetland ecosystem.

All, apart from the Okavango and Kwando/Linyanti/ Chobe rivers, are seasonal. The Okavango Delta separates into distributary channels and some of the major channels include the Kunyerere/Xudum/Matsibe which feeds onto Lake Ngami while other channels feed onto the Thamalakane River which in turn feeds onto Boteti River. Boteti River flows into the Makgadikgadi Salt Pans all the way to Lake Xau (DEA, 2020). Other rivers that flow into the Makgadikgadi Salt Pans include the Moseitse and Nata.

Makgadikgadi Pans
Photo credit: Photography Section, BOPA



In Botswana, equitable and sustainable water management is of critical importance due to the semi-arid climate and the general scarcity of water. Water equity means that every citizen will have access to safe, clean, affordable drinking water and wastewater services, with well-maintained water supply infrastructure. This is one of the cornerstones of the Water Policy of 2012 and the Water Utilities Corporation Act of 2008.

eastern and northern parts of the country through capital intensive water transfer schemes. Though the northern part of Botswana has numerous surface water sources, there are still some areas which do not have water due to inadequate water supply infrastructure.

Infrastructure and systems to transfer water around the country are in place, but the system water losses are immense (GoB; UNDP, 2012). For instance, by 2013 the country-wide system losses were estimated at 50 percent (DWA, 2013). Some of the reasons for this included water losses through leakages, poorly maintained infrastructure networks, unmetered standpipes, and inefficient meters. A strategic framework to reduce water losses is being implemented to resolve the situation and includes timely response to issues, leak detection, a water meter replacement programme and the use of economic tools to improve water use efficiency.



Rainfall

Botswana is generally a dry country with low, erratic, unevenly distributed rainfall, and high rates of evapotranspiration. Limited water resources is one of the biggest challenges the country faces in its development. The annual average rainfall is 416 mm, with the highest annual average rainfall (650 mm) received in the north and the lowest (250 mm) in the southwest as shown in Figure 5-2. Annual evaporation rates in open water sources range from 1,900 to 2,200 mm and is highest in the summer months when 80-95 percent of the rainfall is received (FAO, 2005).

Climate variability

October to March is the rainy season, but this has been changing with the challenge of climate change leading to recurrent droughts that are predicted to increase in frequency and severity. Droughts or less than normal rainfall are usually

associated with the El Niño Southern Oscillation effect.

Rainfall is highly variable across the country and the seasons are changing too. Instances of flooding have been recorded for example during the early part of 2000. The periods of above-normal rainfall have been associated with the La Niña climate effect. Daytime temperatures may reach a high of 40 °C in the summer months and go as low as 1°C in winter. For instance, between April and September 2019, the lowest mean monthly minimum air temperature recorded was in Kgalagadi North at Ngwatle at 1.2 °C. In June 2019, the settlement of Tsabong in Kgalagadi South recorded a minimum daily temperature low of -4.6 °C (Statistics Botswana, 2019b).

The variability in climate is having an impact on the availability of fresh water in the rivers. Key pressures of drought and desertification, low amounts and variability in rainfall patterns has translated into scarcity of the surface

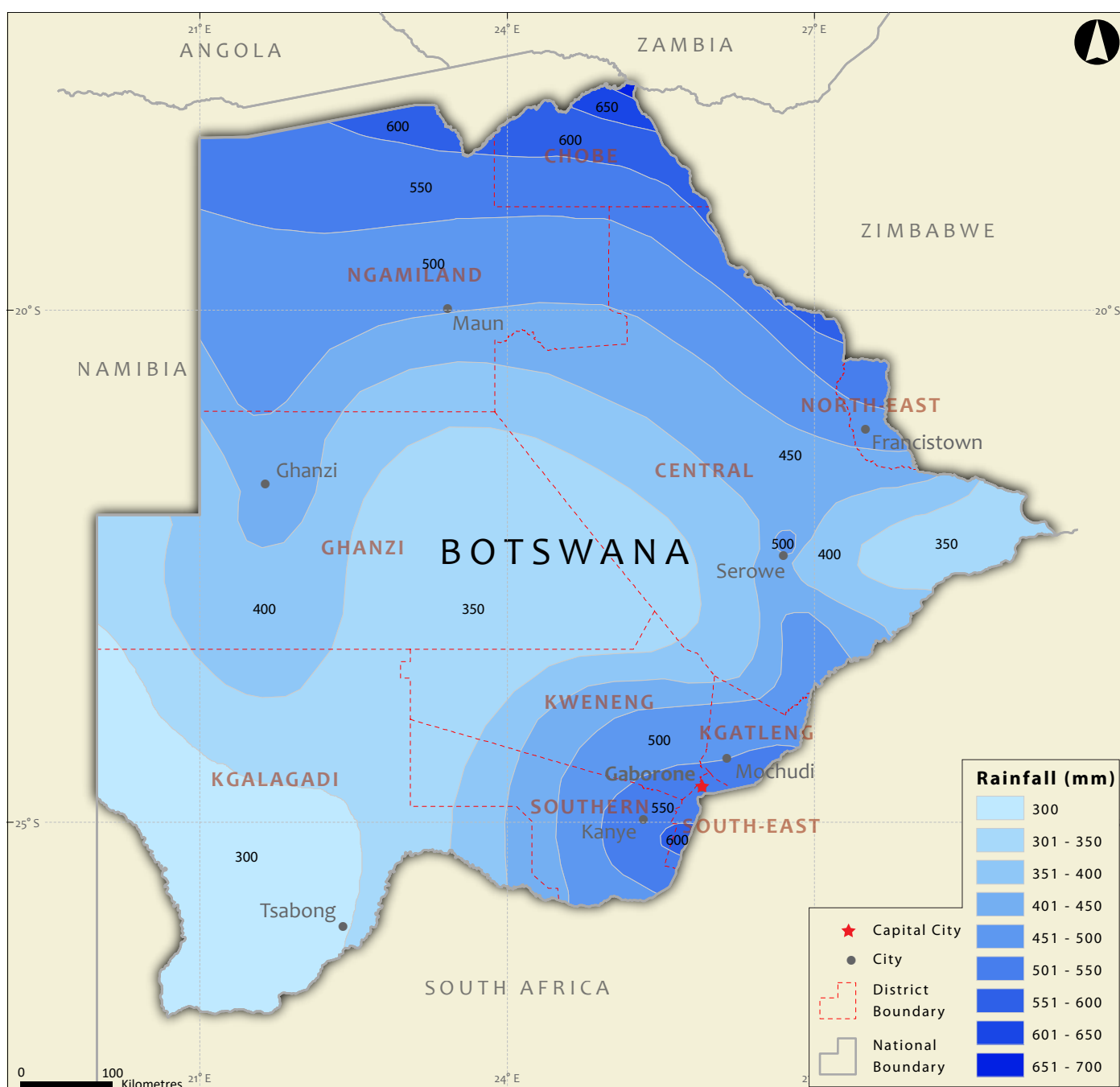


Figure 5-2: Rainfall map of Botswana showing average annual rainfall (in mm) (DEA;CAR, 2006); (DWA, 2013)



*Drying Marsh at Lake Ngami
Photo credit: Kabelo Tamocha/WMO/Flickr*

water resources leaving ground water as one of the few reliable sources (Darkoh, 2018) though with challenges of groundwater recharge rate.

Groundwater

Botswana's total groundwater resources (including saline) are estimated at around 100 billion m³ with a low average annual recharge of 1.6 billion m³. This is of concern as pressures from climate change and high demand and competition from various sectors could be depleting the limited aquifer resources. Groundwater is the major source of water for the country with slightly over 60 percent of the population depending on it.

Yield and demand

Groundwater collects in aquifers and is abstracted through wellfields for agriculture, mining and domestic purposes. The sustainable yield of aquifers is estimated at 96Mm³/annum and even when the sustainable yield of dams (73.2 Mm³/annum) is added it is still below the estimated annual demand of 200 Mm³/annum. This highlights the need for additional water sources to be brought online to satisfy the demand.

The main pressures limiting ground water include the high cost of abstraction, poor water quality, low yields, and the remoteness of aquifers relative to the demand centres.

Aquifer recharge

Aquifer recharge varies across the country and may be low even during the rainy season, making groundwater a fragile resource that needs to be managed to ensure sustainability. Groundwater recharge rates range from almost zero in the west of the country rising to 40 mm in the north (MMEWR, 2013). Most wellfields are located along an east to south corridor between Francistown and Lobatse/Kanye. Abstraction is a challenge due to low yields, remoteness of the aquifers, high costs of abstraction, and poor water quality (MMEWR, 2013). There were fears in the past over the environmental impact of groundwater abstraction in some areas such as Ngamiland District which has designated Ramsar and World Heritage Sites (MMEWR, 2013; DEA, 2006).

Groundwater depth is a function of rainfall level (and recharge) and ranges from a high of 100 m deep in the southwest to as low as 20 m in northern Botswana as shown in Figure 5-3. There are recommendations to improve the state of groundwater data to support systematic exploration, development, and monitoring to assess and support the sustainable use of available quantities (DWA, 2013).

There are opportunities to expand groundwater usage from the Kalahari aquifer (near Gweta) and the Ntane sandstone aquifer (near Bobonong) which are currently underutilised. More exploration also needs to be undertaken on the sustainable yields of other untapped aquifers in the country such as in the North and West of Maun in Ngamiland, Masama, Gweta, Botlhapatlou, Paje, Kang and Phuduhudu. However, the general potential for increasing water supply from groundwater is limited as abstraction already exceeds recharge.

The use of non-conventional water sources should also be explored such as the sand rivers in the east which are estimated to have annual sustainable yields of 2.5 to 55 Mm³/km of sand river. Saline groundwater, common in the North and West, could also be explored to support mines with their processing water requirements. Another non-conventional potential source of water is treated effluent which is estimated to reach 73 Mm³ by 2030 (DWA, 2013).

Surface water

The renewable internal freshwater resource per capita was 1,106.72 m³ in 2014 (GCDL, 2020). Surface water is found in lakes, wetlands, pans, rivers, and dams. Surface waters is scarce with internal rivers only flowing for between 10 and 75 days in a year. The Okavango Delta that has about 6,000 km² of permanent swamp and between 7,000 and 12,000 km² of seasonally inundated swampland has about 11 km³

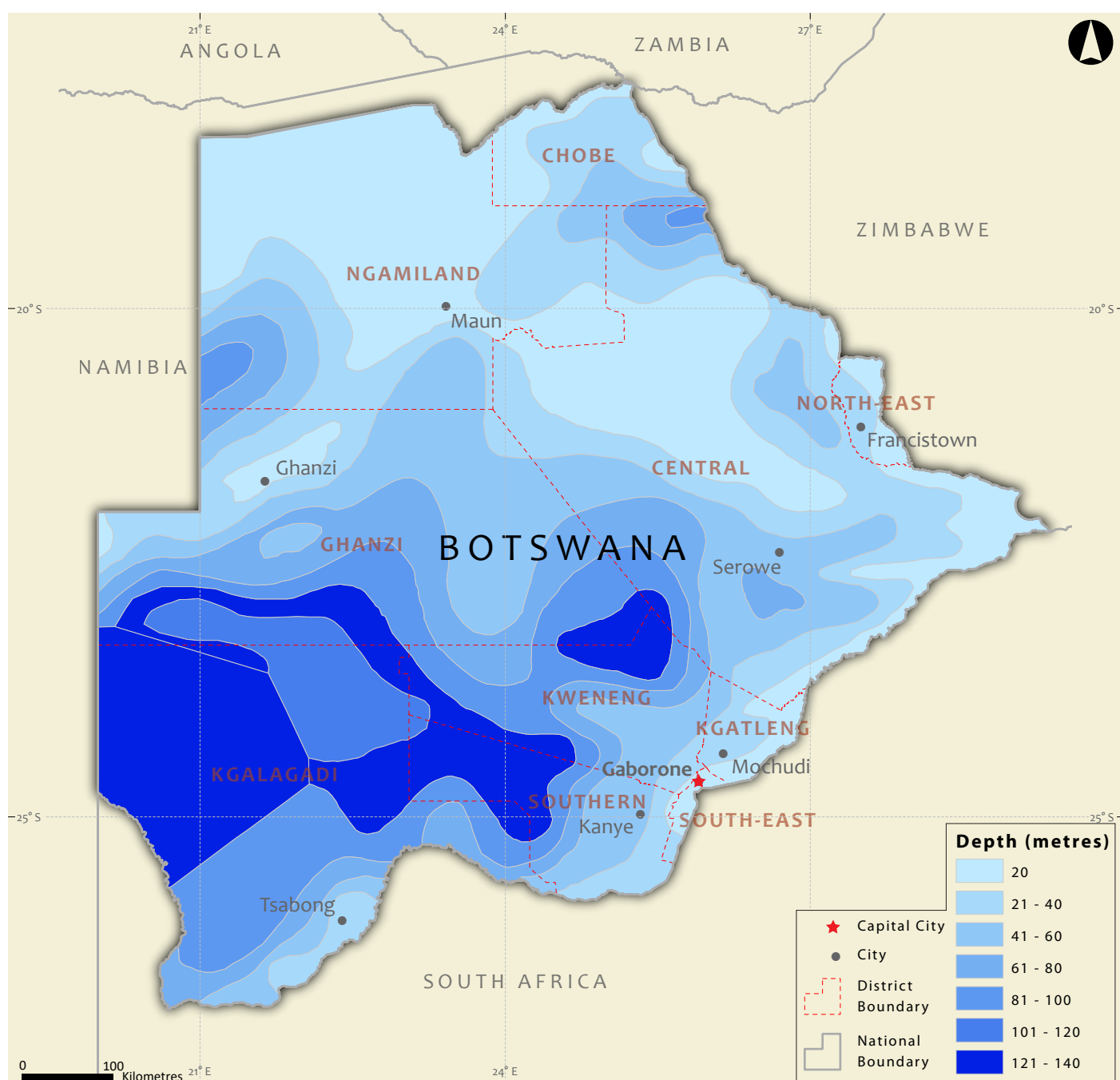


Figure 5-3: Average depth of groundwater (metres below surface) (DWA, 2013)

of water flowing through it every year, but most of it is lost through evapotranspiration.

Botswana's ten (10) major dams are listed in Table 5-1 and besides there are over 100 smaller ones. Dikgatlhong is the largest with a capacity of 400Mm³. All of Botswana's perennial rivers are shared with neighbouring countries. The shared river-basins are Okavango, Zambezi, Orange-Senqu and Shashe-Limpopo. Botswana's dam storage capacity is one of the lowest in the region, owing to its flat topography. The multipurpose dams in Botswana contribute to water security allowing water stored to be used for activities such as household use, irrigation, industry, aquaculture, and transport.

The Molatedi Dam in South Africa augments Botswana's water supply as well as supply consumers in South Africa. Botswana gets 5.03 million cubic meters per annum from this dam. The supply is reduced in line with operating rule when the dam level reduces below 33%.

Water levels in the dams are affected by extensive droughts and declines in rainfall due to climate change. Furthermore,

studies indicate that Botswana has reached capacity in terms of suitable dam sites and will have to explore other sources such as treated waste water reuse and the regional water transfer schemes to meet water supply demand. Small dams, some of which need rehabilitation, are mostly used for agricultural water supply.

Water withdrawals and balances

Table 5-2 highlights key indicators that show the water balance in Botswana. Current demand per year is around 200 Mm³ compared to the actual sustainable yield of 169.2 Mm³ from the combined aquifers and dams. Water withdrawals have increased almost two-fold between 1992 and 2017 as shown in Table 5-3 and demand continues to rise. There is potential to expand water extraction from the Okavango River Basin where water demand is currently 1 percent of the total discharge. However, even with additional supply, the country will have to implement strict water use efficiency strategies and expand, through collaboration and negotiation for the use of shared water resources (DWA, 2013 and Mosepele K., et al., 2019).

Table 5-1: Botswana's major dams (WUC, 2020)

Dam	Capacity (Mm ³)	Current level (%) 11/02/2020	Same date last year level (%) 11/02/2019	Months of supply without inflow	Area Supplied	Percentage contribution to area supplied
Gaborone	141.4	67.8	58.1	22	Greater Gaborone	38
Molatedi	201	19.5	23.4	30	Greater Gaborone	3.6
Bokaa	18.5	101.1	37.8	13	Greater Gaborone	12.8
Nnywane	2.3	98.6	82.5	13	Lobatse	10
Letsibogo	100	91.6	76.8	22	S/Phikwe, BCL & Mmadinare	100
Shashe	85.0	88.7	88.3	21	Greater Francistown	100
Ntimbale	26.5	94.0	101.1	42	North East & Tutume District	50 (The other 50 from Maitengwe Wellfield)
Dikgatlhong	400	70.0	84.3	24	Greater Gaborone	48
					Mahalapye	95
					Palapye	68
Lotsane	42.35	68.7	66.5	23	22 villages of Tswapong North	100
Thune	90	59.9	57.4	39	Babirwa Cluster	-

Table 5-2: Key indicators for Botswana's water resources and sector (DWA, 2013)

Indicator	Yield
Sustainable yields of aquifers:	96Mm ³ /annum
Current sustainable yields of storage dams:	73.2Mm ³ /annum
Additional sustainable yields of dams under construction:	72.7Mm ³ /annum
Sustainable yield per capita/day:	216Litres/person/day
Planned sustainable yield per capita/day:	415Litres/person/day
Potential sustainable yields from shared water courses:	550 – 1,750Mm ³ /annum

Table 5-3: Agricultural, municipal*, and industrial water withdrawal (billions of cubic meters) (FAO, 2020)

Sector	1985	1992	1995	2005	2007	2012	2017
Agriculture		0.054	0.064	0.08		0.074	0.069
Industry		0.023	0.028	0.035	0.039	0.036	0.023
Municipal		0.036	0.052	0.079	0.088	0.084	0.100
Total	0.09	0.113	0.143	0.194		0.194	0.193

* *Municipal is the descriptor used by FAO. In this context, it refers to the public or urban water distribution network.*

Water use

There is increasing competition for water among the various sectors in the country. Agriculture accounted for 48 percent of total water consumption in 2015-2016, putting a lot of pressure on the rivers and groundwater. Over the same time frame, the water consumption for households was 23 percent, 16 percent for mining, 7 percent for other industries and 6 percent for Government (DWA, 2017). The Government in this context includes the central and local Government and is made up of all public administration sections (excluding education, health and social work activities) (DWA, 2017).

Unlike most countries in sub-Saharan Africa where agriculture is primarily rain-fed, the semi-arid climate in Botswana makes agriculture a major water user, making food security a driver of water scarcity. Irrigation is an important technology for mitigating against the negative impact of declining precipitation and variability. This is a growth area as only 30 km² or 0.005 percent of the land is equipped for irrigation (FAO, 2020). Kitting the land for irrigation, and the type of technology used could be one way of increasing water conservation and water use efficiency and thus decreasing the volume of water used by the sector. Indeed, in a country like Botswana where evapotranspiration rates are so high, using a drip irrigation system that delivers water directly to the roots would conserve a lot more water than using an overhead irrigation system.

5.3 Issues, concerns, impacts

Potable water

An improved drinking water source is clean, always available and located on the premises. Examples of improved sources relevant to Botswana include piped water – both indoors and in the yard, communal taps, water bowser (tanker), rainwater, protected wells, protected springs or bottled water.

Botswana exhibits inequalities in service levels and between rural and urban areas in terms of access to safe sources of water. When disaggregated by location, 83.3 percent of the population in urban areas have to access to a safe source of water, 13.87 basic source of water and 1.15 percent to a limited source of water. In the rural areas, 75.53 percent have access to a basic source of water and 18.5 percent to a limited source of water (WHO; UNICEF, 2020).

Access to safe water is a prerequisite to healthy life and reduces the Government's health burden. People without access to safe water are prone to water borne diseases such as diarrhoea which can be fatal especially in young children. Although the number of diarrhoea cases and mortality rates has been on the decline (Table 5-4) there is still need for improvement. Between 2011 and 2017, the top three Districts by incidents of diarrhoea cases were Kweneng East, Gaborone and Palapye districts with Gaborone emerging in 2017 (Statistics Botswana, 2020a). This was attributed to the high population densities in those districts.

Botswana has developed water quality standards (BOS 32:2015 – drinking water – Specification) and legislation (Public Health Act, 2013) to regulate water quality for house hold use.

Table 5-4: Diarrhoea cases (2011-2017) (Statistics Botswana, 2020a)

Year	Diarrhea Cases
2011	24,785
2012	22,232
2013	17,898
2014	15,867
2015	10,298
2016	10,234
2017	7,859

Classification of drinking water sources

"Drinking water from an improved source is classified as basic if the collection time is not more than 30 minutes for a roundtrip including queuing and limited if the collection time is longer than 30 minutes for the roundtrip including queuing.

(WHO; UNICEF, 2020)

Pollution

Pollution of water is among several environmental health risks recognized by the World Health Organization in 2012 as contributing to 25 percent of global childhood deaths and disease burden that could have been prevented. Other environmental health risks include air pollution, climate change, e-waste, hazardous chemicals and waste, radiation, and inadequate water, sanitation and hygiene (Erick, 2020).

In Botswana, water pollution is a major environmental risk factor driven by the increasing population, rapid urbanization, and pressures from economic growth. Activities that degrade the quality of water include poor waste management (domestic and industrial), siltation caused by poor catchment management, intensive irrigation, leachate from landfills, water pollution from mine wastes, inadequate legal protection of groundwater and use, monitoring and poor sanitation (Erick, 2020).

Inadequate sanitation facilities are a major contributor to poor surface and ground water quality. About 43.6 percent of people in the rural areas use pit latrines and seepage from these can pollute surface and ground water sources. For instance, in 1996, seepage from pit latrines in Ramotswa village caused the nitrate levels to rise above the approved 50 mg/l leading to the discontinuation of Ramotswa wellfield abstraction. In Lobatse, use of two aquifers was withdrawn due to water contamination - now only the Pitanyane aquifer is operational. Urban expansion of Maun has led to encroachment into the well field increasing the risk of water contamination. Water pollution of nearby rivers in Maun is due to poor sewage disposal from lodges in the Gomoti and Upper Boro areas (DWA, 2013).

Saline water

Salinity, odour, colour and chemical pollution are some of the other factors affecting the quality of water. Salinity occurs where evaporation rates are exceedingly high leading to high salts in the water. For instance, the high evaporation rates in the hydrologically closed Okavango Delta have led to the presence of saline water in the channels and swamps, although the levels are low. In the Northern and Western parts of Botswana groundwater is naturally saline. This is a potential source of water especially in areas where water demand is high, and the freshwater sources are inadequate.

Water scarcity

Botswana is a water stressed country as the demand far outweighs the supply and the situation is compounded by the extremely dry climate, urban growth, and poor infrastructure. Water stress is a measure of the pressure on the available water resources. Botswana was ranked at number 17 out of 150 countries rated as being at an extremely high risk of facing water scarcity (Figure 5-4). According to the study, countries at extremely high-water stress are using up to 80 percent of the available surface and ground water supply annually (Dormido, 2019). The impacts are visible with hotels and industry already rationing water. Furthermore, the pace of infrastructure investment (rehabilitation and construction) is not keeping pace with demand.

As extreme weather events become more severe and more frequent, the country has been exploring options to ensure water security. For instance, along with South Africa and Namibia, Botswana is looking to import water from Lesotho, using a 224-mile pipeline that will run across South Africa (Pasley, 2019).

Extremely high

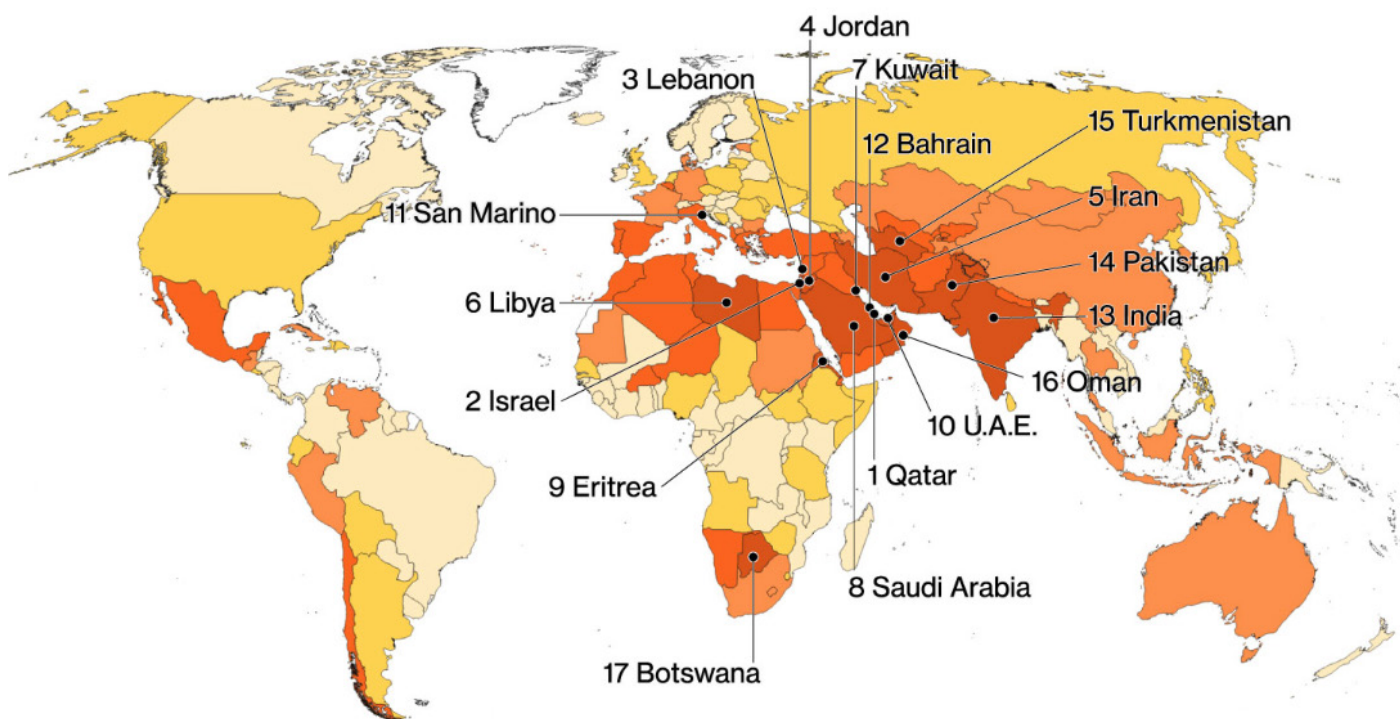


Figure 5-4: Countries at risk of extremely high-water stress (Dormido, 2019)

Wastewater

Wastewater or used water emanates from domestic households, businesses, and industries. Much of the wastewater produced has been changed in a way that means it cannot be used again unless it is treated. In Botswana, the increased demand and connections for water supply, expansion of sewerage systems and wastewater treatment facilities and population growth have all combined to grow the volumes of wastewater being produced. Together with the dilapidation of Wastewater Treatment Plants (WWTP) and low quality of treated effluent this is having environmental implications including pollution of surface and groundwater sources with the potential for international conflict. For example, the inefficiencies in the Mambo WWTP have resulted in the pollution of Dikgatlong Dam. The Mambo WWTP discharges into the seasonal Tati River (a tributary of the Shashe River) and finally into the Limpopo River. This has international implications as the Shashe River contributes about 12.2 percent of the Limpopo's mean annual runoff. The Limpopo is an international river shared by South Africa, Zimbabwe, Botswana, and Mozambique (World Bank, 2017). Rehabilitation of run-down wastewater treatment plants would result in improved water quality and reduced negative impacts on the environment.

The use of treated wastewater that is otherwise discharged into the environment presents an opportunity for reuse as a new water source. For instance, Namibia has been turning sewage water into drinking water at the Goreangab waste treatment plant since 1969; and water treatment plants in Washington D.C. and Xiangyang China reuse or sell the nutrient rich by-products captured during wastewater treatment (Hofste, et. al, 2019; du Pisani, 2006). Treating effluent in Botswana to a quality level where it can be re-used is a major objective as it can then be used by mines, local stadia, golf courses or even agriculture for irrigation. So far in Botswana, farmers use treated sludge as compost (Masundire, et. al, n.d.). With the operationalization of the National Master Plan for Arable Agriculture and Dairy Development, the Ministry of Agriculture has planned to utilize recycled water from Gaborone City Sewage Treatment Plant. This will also be rolled out in other cities around the country. Furthermore, Government institutions such as some schools and army barracks have established grey water recycling facilities and thus reduced the demand on clean water for uses such as gardening and brickmaking (GoB; UNDP, 2012).

The Integrated Water Resource Management (IWRM) and Water Efficiency Plan of 2013 stipulates that all treated wastewater should be reused or recycled to avoid water wastage; and the Government has set an ambitious target of 96 percent reuse of wastewater outflows by 2030 (World Bank, 2017; RoB and World Bank, 2016).

The Government realises that indicators need to be developed for wastewater as the lack of data implies that no annual accounts or indicators can be compiled. This is important as it is estimated that if treated to international standards, wastewater could contribute about 16 percent of the country's available water resources (Masundire et. al, n.d).

It is thus recommended that capacity for reuse and recycling be explored; and the economics of wastewater reuse and recycling be established. In addition, water quality categories, inflows and outflows of water treatment for input into the water accounts, new or improved technology options should also be explored.

Infrastructure

Poor maintenance of water infrastructure

Poor maintenance and dilapidated water supply infrastructure, record-keeping and monitoring are some of the challenges facing the entire water supply and sanitation sector. Some of these issues such as leaky water pipes in urban areas result in huge financial and precious water resource losses. For instance, the 2014 Botswana water accounts suggest that system water losses average 19–26 percent or 3.5Mm³ a year, costing roughly \$1.01 million (DWA, 2017).

Construction of strategic water infrastructure, such as water transfer schemes, dams and wastewater treatment plants are expensive. The current Water Policy emphasises increasing supply. This could be better supported by paying attention to the complicated distribution problems and by incorporating the use of financial and economic instruments to help access finances required to develop the water-related infrastructure.

Siltation of dams

Siltation is a major problem for dams, as it reduces their storage capacity and life span. It is a common problem in Botswana and can sometimes be caused by improper dam siting in areas where the landscape and valley geomorphology are not ideal for efficient dams. Other causes of siltation include environmental degradation in the wider catchment areas. Deforestation, waste from mines and urban areas such as loess deposit (fine-grained soil formed by accumulation of wind-blown dust), soil erosion from agricultural activities, poor livestock delivery systems such as drinking troughs has, in some instances, led to the structural damage of dam embankments. For instance, a combination of human and environmental factors has contributed to the siltation of small dams in the Pidimane sub-watershed in the Lotsane watershed area. Steep slopes, many streams without a flood plain, developments and farming activities in the areas near the streams and reservoirs are all contributing factors (Alemaw, et. al, 2013). The literature indicates the average annual sedimentation rate in the Lotsane catchment area ranges between 0.54 and 85.29 ton/ha/yr; with annual average soil loss rate predicted to be 26 tons/ha/year (Alemaw, et.al, 2013).

Since siltation is a normal occurrence for dams all over the world, the recommendation is for decision makers and managers to use such data to plan for adequate dam operation and factor in maintenance to fully utilize dam capacity.

Food security

Water and food insecurity

In 2018, the per capita GDP of Botswana was US \$8,258. This is one of the highest per capita levels of income in Africa. Despite this, food security is a major issue. The prevalence of food insecurity between 2014 and 2016 was 35 and 41.3 percent respectively. Furthermore, over a quarter (26.4 percent) of the total population between 2016 and 2018 was undernourished as shown in Table 5-5. Undernourishment can have long term negative impacts on health and development including a high health burden (Akombi, et al., 2017). More recent data from 2019, indicated that approximately 38,300 people are permanently or temporarily food insecure in the country, an increase of 9.3 percent from 2018; and that the percentage of children underweight in the same year was 4.3 percent and was growing (OCHA, 2019).

Table 5-5: Food insecurity trends in Botswana
(FAO, IFAD, UNICEF, WFP and WHO, 2019)

Location	Prevalence of undernourishment in the total population (%)		Prevalence of severe food insecurity in the total population		Prevalence of wasting in children under 5 (2018)	Prevalence of stunting in children less than 5 years of age (%)		Prevalence of overweight in adults over 18 years of age (%)	
	2004-2006	2016-2018	2014-2016	2016-2018	%	2012	2018	2012	2016
Botswana	31.9	26.4	35.0	41.3	n.a	n.a	n.a	14.7	16.1
Southern Africa	6.5	8.3	24.3	30.7	3.5	30.5	29.3	23.2	25.6
Africa	21.3	19.6	19.7	22.1	7.1	32.6	30.0	10.4	11.8

n.a. – Not available

The main drivers of this food insecurity include the low rainfall and the structure of the economy. Agriculture accounts for only 1.9 percent of GDP and yet it is the sector that uses the most water (Statistics Botswana, 2020b). About 70 percent of the population lives in the countryside and in the eastern parts of the country where arable farming is better on account of more favourable climate and soil conditions (Bahta et al., 2017).

The western part of the country is more suited to livestock rearing and the main source of water for both domestic and livestock use is groundwater. However, pressures from livestock such as overstocking and overgrazing are fueling desertification. This is a vicious cycle as food security and livelihoods are also impacted negatively by the scarcity of grazing and water for livestock.

Agricultural growth has stagnated over the years and the country is a net importer of food as shown in Figure 5-5. Productivity in the subsistence sector is much lower than the commercial sector. For instance, in comparison with the 2015 planting season, key indicators from 2017 show an increase in area harvested but declines in both area of land holdings and area planted. For example, area of land planted declined from 158,000 ha to 127,000 ha between 2015 and 2017 respectively (Statistics Botswana, 2019a). Apart from the small area of arable land, other reasons for the low production include aridity (low and erratic rains), poor soils, overdependence on rain-fed agriculture and lack of uptake of modern practices in the subsistence sector.

Increasing productivity and water use efficiency in agriculture is one way of boosting incomes and addressing the issue of food security as stipulated in Vision 2036 (GoB, 2016). Promoting animal rearing could also be an avenue to foster

alleviation of malnutrition and contribute to food security, especially in rural areas.

Inadequate water sources

Inadequate quantities of water and poor water quality are some of the issues that drive food insecurity at household and national level. Shortage of water leads to poor hygiene practices, and consumption of unsafe drinking water.

On the other hand, even when water is available, climate events (e.g. floods) affect food production and cause damage to infrastructure that allows access to food such as roads, bridges and telecommunications.

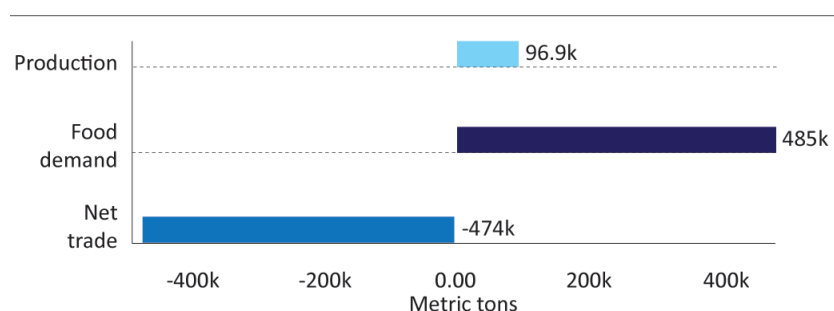


Figure 5-5: Volume of crop production, demand for food and net trade in Botswana
(WRI, 2020)

In Botswana, low rainfall during the December to March growing season is likely to have negative impacts on rain-fed crops, pasture, and water availability. Crops grown under irrigation may be impacted if ground water levels decline because of poor rainfall over a series of years. For instance, in 2018/2019, poor rainfall during the rainy season and higher than normal temperatures throughout the season led to crop failure. Cereal production dropped from 66,093 tons in 2017/2018 to 5,356 tons in 2018/2019 (OCHA, 2019).

Agriculture is the largest water user in the country, with most water sources coming from groundwater, surface rivers and treated wastewater (RoB and World Bank, 2016). The proportion of water used by the agriculture sector over total water use was 41 percent compared to 18 and 41 percent in the industry and services sector respectively (FAO, 2018). In the face of climate variability and widespread aridity in the country, irrigation needs to be a central part of the national

strategy for food security in the country. It is important that to support food security, the proposed additional water sources should be explored and employ the highest water use efficiency to reduce impacts to the environment and human wellbeing. In Botswana, it is impossible to meet national food needs from rain-fed farming alone and the risk of water stress is real.

Irrigation water for agriculture is an under-tapped resource. There is much potential for reuse of wastewater to expand the area under irrigation and increase yields thus reducing food insecurity (Figure 5-6). With over 210,000m³/day in wastewater, the 3,000 ha under irrigation can easily be doubled with a corresponding increase in food production. However, irrigation as a response could in turn put pressure on the environment from risks such as pollution from fertilizers, and soil salinisation from overwatering if appropriate technology such as drip irrigation is not applied.

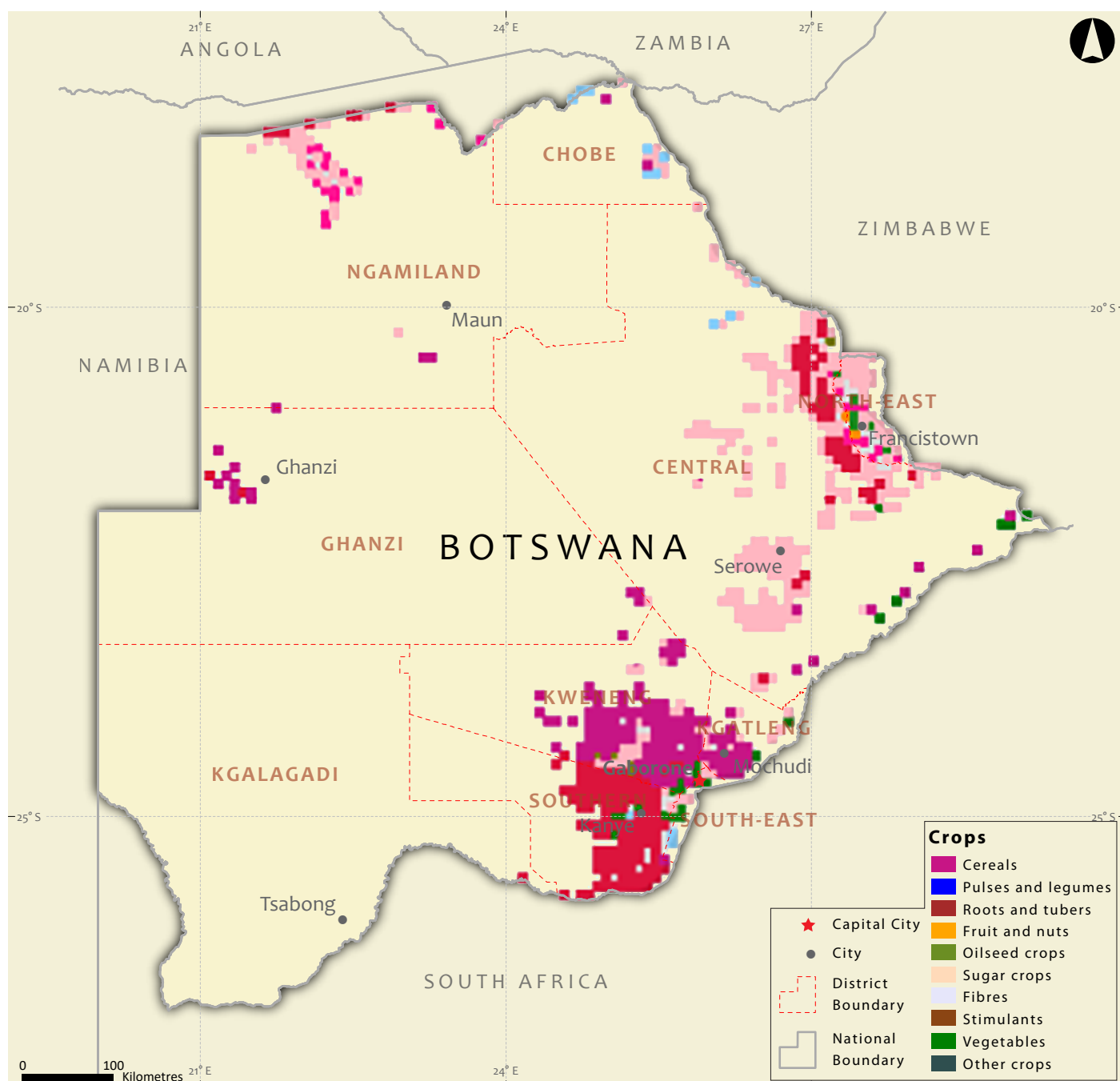


Figure 5-6: Irrigated and rain-fed crop producing areas in Botswana (WRI, 2020)

The policy direction that Government is considering is to increase agricultural water use efficiency. Vision 2036 highlights the need to improve productivity by increasing efficiency in the agriculture sector. It is also recommended that water supply and quality issues be tackled by investing in dams and other water supply infrastructure, and by environmental restoration activities.

Governance

Institutional framework for water management in Botswana

The National Water Master Plan Review in 2006 recommended a series of institutional reforms to improve the efficiency, sustainability, and equitability of water supply in the country. Although some institutions have not yet been established, the reform process started in 2008 and culminated in the below mentioned approved institutional frameworks.

The Ministry of Water & Human Settlement is mandated to ensure supply of fresh water and reuse of grey water for both domestic and agricultural development in the country through the approved institutional structure. The Department of Water and Sanitation, within the Ministry, oversees planning, development and monitoring including the development of large water supply infrastructure schemes.

The Water Utilities Corporation (WUC) oversees delivery of water to domestic, commercial and industry stakeholders. This is decentralized by WUC management centres. However, the more remotely located mining and energy institutions generally develop their own groundwater supplies. The remit of WUC also includes wastewater and water treatment and responsibility for sanitation services.

The institutional framework includes a Water Regulator, yet to be established, in charge of enforcement and compliance monitoring with rules and regulations. It will also set tariffs and ensure financial sustainability across the water sector. A Water Resources Board (not yet established) will be responsible for policy, allocation of the water resources and supervision of the Catchment Management Committees (CMC) at the water catchment level. The Catchment Management Committees (also not yet established) have responsibility for local level planning and monitoring within the catchment or watershed area.

Legal and policy framework for water management in Botswana

The main law of the sector is the Water Act of 1968. However, the review of the Water Act and other water related legislation is ongoing under the Botswana Emergence Water Security and Efficiency Project funded by the World Bank.

The focus of the Draft Water Policy of 2012 is on conservation and water demand management. However, it is still awaiting parliamentary approval prior to implementation. The Draft Water Policy is based on the three foundational pillars of equity, sustainability, and produced Integrated

Water Resources Management and Water Efficiency Plan 2013-2020 (IWRM-WE). The IWRM-WE plan aims to "Improve people's livelihoods and welfare and contribute to sustained economic growth, economic diversification, social justice and poverty eradication through efficient, equitable and sustainable water resources development and management". The collaborative and joint approach of the IWRM and Water Efficiency plan hopes to improve water use by capitalising on the efficiency to elevate agricultural production, food security and to expand the number of people accessing safe water and sanitation.

A key factor of the IWRM-WE is the integration of transboundary water management protocols and ideals into the water resources management of the country. Many of Botswana's surface waters are shared; and like other countries in the region, Botswana takes its cue from regional policies.

Trade Effluent Agreement (TEA)

The Water Utilities Corporation is tasked with treatment of wastewater to ensure disposal of effluent that meets the requirements of the BOS 93:2012 Standard (Wastewater – Physical, Microbiological, and Chemical requirements - Specification). Industrial waste is a major contributor to the overloading of the wastewater treatment facilities as some industries or traders discharge effluent which does not comply with the requirements of the BOS 93:2012 Standard. As a result, the Corporation has developed the Trade Effluent Agreement which requires industries to discharge prescribed pre-treated industrial effluent into its sewer system. By March 2019, 244 Trade Effluent Agreements had been signed by industries (WUC, 2019).

Implementation of the Trade Effluent Agreement enables the WUC to manage the quality of effluent received from various industries including abattoirs, breweries, textile industries, hospitals, hotels, restaurants, chemical industries, and motor vehicles industries. To support implementation and enforcement, the WUC in partnership with the BITRI worked to integrate local Government by-laws into the Trade Effluent Agreements.

SADC instruments for water cooperation

Water is a sensitive resource in Southern Africa as many of the water bodies are shared. Water is also of special concern as much of Southern Africa relies on agriculture for livelihoods and the sector is a major water user. As such, the SADC has prioritized the need to manage and utilize these shared resources in an environmentally sound manner that promotes equity and balance while minimizing conflict (Mosepele et al., 2018).

Some of the key policy instruments include the Regional Water Strategy of 2006 and the Regional Water Policy of 2005. The Regional Water Strategy aims to increase access to safe drinking water and sanitation. Its strategic objectives focus on the areas of regional cooperation, water for poverty alleviation and for environmental sustainability, water related disasters and information management. It also supports the development of a regional institutional framework, financing and stakeholder participation and capacity building.

The SADC Vision of Water, Life and the Environment in the 21st Century presents a vision for a sustainable environment in the face of competing water uses. It is grounded on IWRM principles and one of its strategic actions is access to water, sanitation, and waste management. Some of the issues it seeks to address are the unbalanced distribution of water and equitable access to water and sanitation. For instance, it recognises that the lack of adequate infrastructure and inefficient water use are a barrier to the ideal distribution of domestic water and sanitation services especially to the poor. Some of these will be addressed through the IWRM focus that naturally takes note of competing demands between water users, inter-basin transfers, upstream-downstream interactions, and so on. It also focuses on equity in water use and access through good governance and people-centred development.

Cooperation is at the heart of the SADC Revised Protocol on Shared Watercourses 2000, and this drives information sharing, management and wise use of the environment and water resources. There is an institutional framework and strategy to facilitate the implementation of this Protocol at the transboundary level and to guide countries on sustainable management and development of the shared water resources. The Regional Strategic Action Plan (RSAP) on Integrated Water Resources and Development

Management implemented through 5-year rolling plans helps to operationalize the Protocol. The focus of the latest RSAP IV (2016-2020) is on the development of water infrastructure in the region to enhance water security for domestic, industrial, energy and food security.

The SADC Regional Fund for Water Infrastructure and Basic Sanitation (the SADC Water Fund) is the key financing facility for the development and integration of the water sector in the region. Water supply projects are at the forefront of the funding and some of the projects could include small water retaining structures for drinking water supply or small irrigation schemes to support agricultural production.

Transboundary river basin cooperation arrangements

Botswana is a signatory to the four transboundary river basin commissions that govern its shared water courses. These are the Okavango River Basin Commission (OKACOM), Orange Senqu River Commission (ORASECOM), Limpopo Watercourse Commission (LIMCOM) and the Zambezi Watercourse Commission (ZAMCOM) (Gondo and Kolawole, 2016). The transboundary nature of Okavango Delta's catchment is illustrated in Figure 5-7.

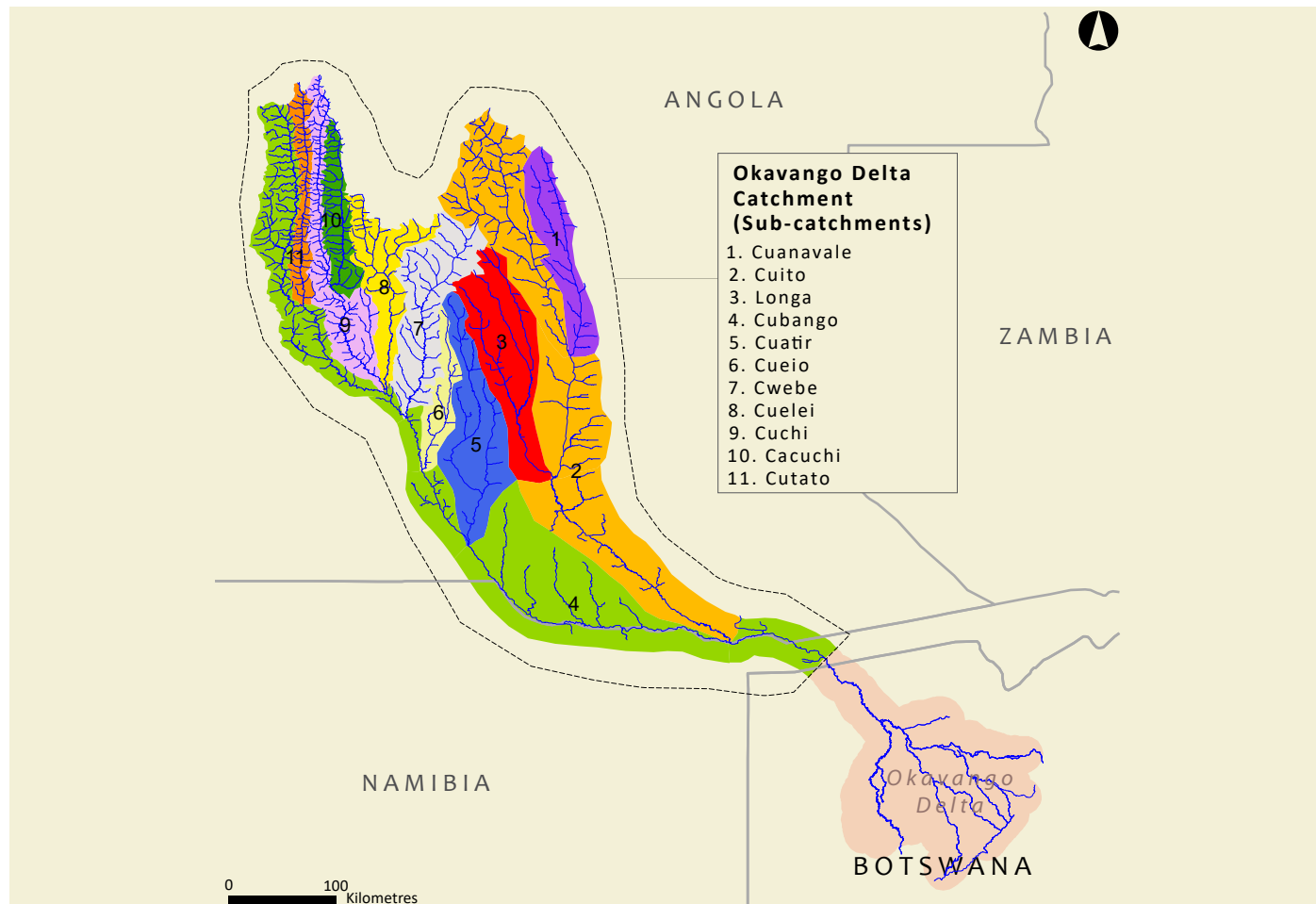


Figure 5-7: Catchment (and sub-catchments) of the Okavango Delta
UNEP 2008

5.4 Status and trends of SDG indicators

SDG 6.1.1: Proportion of population using safely managed drinking water services

Botswana trends in access to safe water in urban areas show a slight decline from 84.02 percent in 2000 to 83.21 percent in 2017 as shown in Figure 5-8 (UNStats, 2020b).

Table 5-6 shows that in 2017, a total of 83.5 percent of the population had access to a safe water supply; 28.9 collected water from pipes inside their houses, 46.2 from pipes in their yards, 8.4 from communal taps, 2.0 delivered by bowser (tanker) and 1.6 percent bought bottled water from the shops (Statistics Botswana, 2020a).

SDG 3.9.2 Death rate attributed to an unsafe water source

There has been improvement in this indicator. Mortality rates from using unsafe water declined from 128.18 in 1990 to 46.16 in 2016 and to 27.38 per 100,000 deaths in 2017 as shown in Figure 5-9. In actual terms by 2017 there were 414 deaths per 100,000 people down from 766 in 1990 per 100,000 people (UNStats, 2020b; GCDL, 2020; IHME, 2017).

Table 5-6: Main source of water by housing location in 2017 (percentage)
(Statistics Botswana, 2020a)

Source of water	Location			Total
	Cities & towns	Urban villages	Rural villages	
Piped indoors	48.4	32.0	11.5	28.9
Piped outdoors	45.7	58.1	32.5	46.2
Communal tap	0.1	2.7	21.0	8.4
Bowser/tanker	0.6	0.7	4.5	2.0
Well	-	-	2.8	1.0
Borehole	-	0.1	12.1	4.3
River/stream	-	-	1.7	0.6
Dam	-	-	1.4	0.5
Rain water tank	-	-	0.2	0.1
Bottled water	2.4	1.9	0.6	1.6
Other	2.7	4.2	11.7	6.4
Not stated	0.1	-	-	-

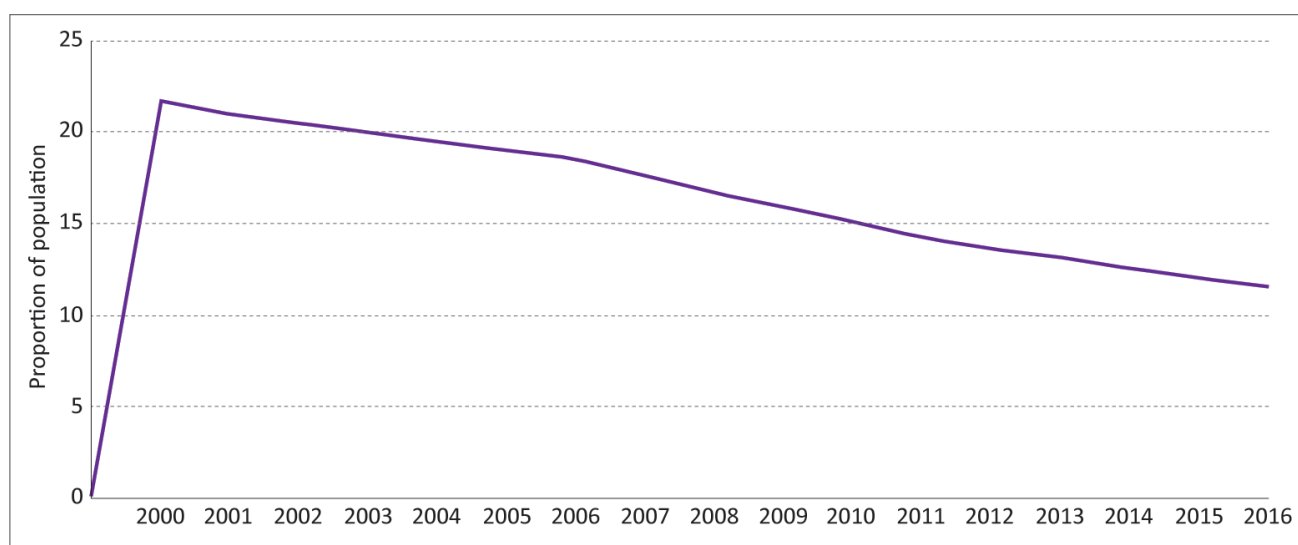


Figure 5-8: SDG 6.1.1 Proportion of urban population using safely managed drinking water service (%) 2000-2017
(UNStats, 2020b)

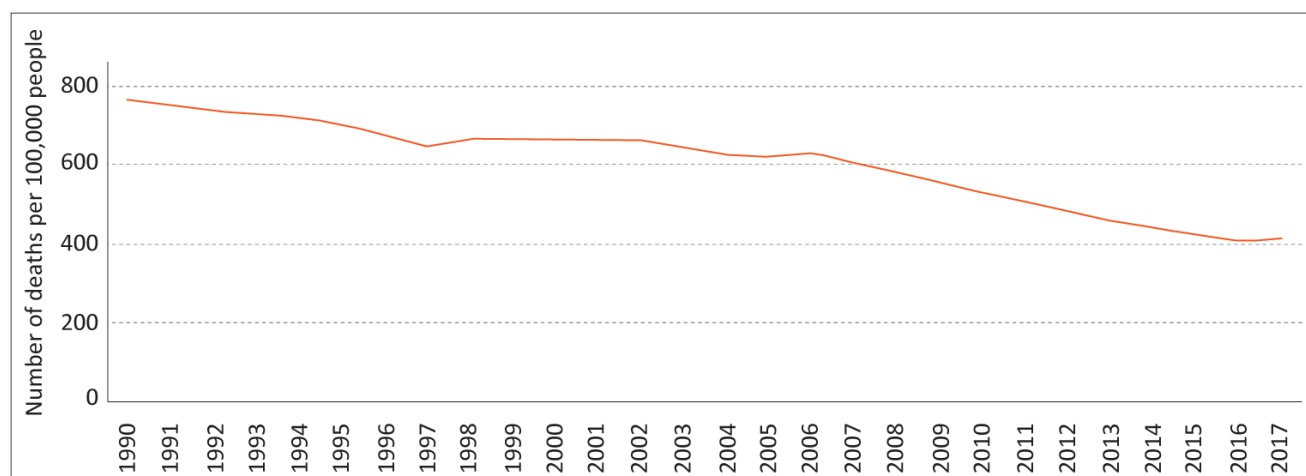


Figure 5-9: Deaths from unsafe water sources 1990-2017
(GCDL, 2020)

SDG 6.2.1: Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water

Sanitation targets are; to have 89 percent of both rural and urban populations covered by basic services to sanitation by 2023; and to have no people practicing open defecation by 2030. Current data (Figure 5-10 and Table 5-7) shows that 43.7 percent of households use their own flush toilet up from 24.4 percent in 2006. When disaggregated by location, 78.5 percent of households in urban areas and 46.9 percent in urban villages have flush toilets. The most common toilet type in the rural areas is pit latrines (43.6 percent). At national level, 38.7 percent use a pit latrine while 10.8 percent have no toilet at all (Statistics Botswana, 2020a).

SDG 3.9.2 Mortality rate attributable to unsafe water, sanitation, and hygiene (WASH)

Access to safe sanitation and hygiene is important in preventing water related communicable diseases. The increase in access to sanitation facilities is positively

correlated with a decline in mortality rates, for example, diarrhoea (Figure 5-11). For instance, in 2010 the mortality rate was 60 per 100,000 deaths while in 2016 the mortality rate was 46.16 per 100,000 deaths. This points to a positive response from the policy intervention in this sector.

SDG 6.3.1: Proportion of wastewater safely treated

No data.

SDG 6.3.2: Proportion of bodies of water with good ambient water quality

Department of Environmental Protection plays a central role in water quality monitoring. Wastewater is treated to specified standards to safeguard the environment from pollution and to maintain public health and to serve as early warning. Table 5-8 highlights the proportion of water bodies with good water quality in Botswana. As shown in Table 5-8, open water and rivers have good water quality compared to ground.

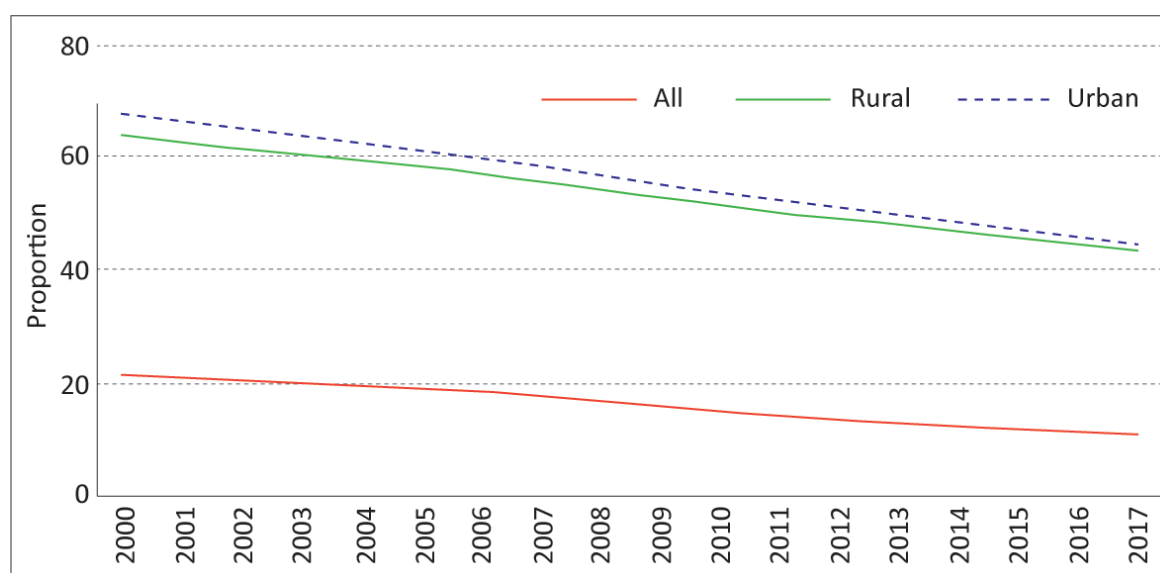


Figure 5-10: SDG 6.2.1 Proportion of Botswana population practicing open defecation (%) 2000-2017 (UNStats, 2020b)

Table 5-7: Percentage distribution of housing units by type of toilet facilities and place of residence 2017 (Statistics Botswana, 2020a)

Toilet Facilities	Place of Residence							
	Cities and Towns		Urban Villages		Rural Villages		Total	
	Number	%	Number	%	Number	%	Number	%
Own: Flush toilet	123,637	78.5	124,701	46.9	35,896	15.8	284,234	43.7
Own: Ventilated Improved Pit Latrine (VIP)	585	0.4	2,523	0.9	1,831	0.8	4,939	0.8
Own: Pit latrine	29,378	18.7	123,023	46.3	98,785	43.6	251,186	38.7
Own: Enviro-loo	93	0.1	-	-	2,090	0.9	2,183	0.3
Communal: Flush toilet	1,272	0.8	1,704	0.6	1,807	0.8	4,782	0.7
Communal: Pit latrine	942	0.6	1,059	0.4	1,119	0.5	3,120	0.5
Communal: Neighbours toilet	916	0.6	7,904	3.0	20,140	8.9	28,959	4.5
None	514	0.3	4,628	1.7	64,944	28.6	70,086	10.8
Not stated	87	0.1	158	0.1	72	-	317	-
Total	157,423	100	265,701	100	226,681	100	649,806	100

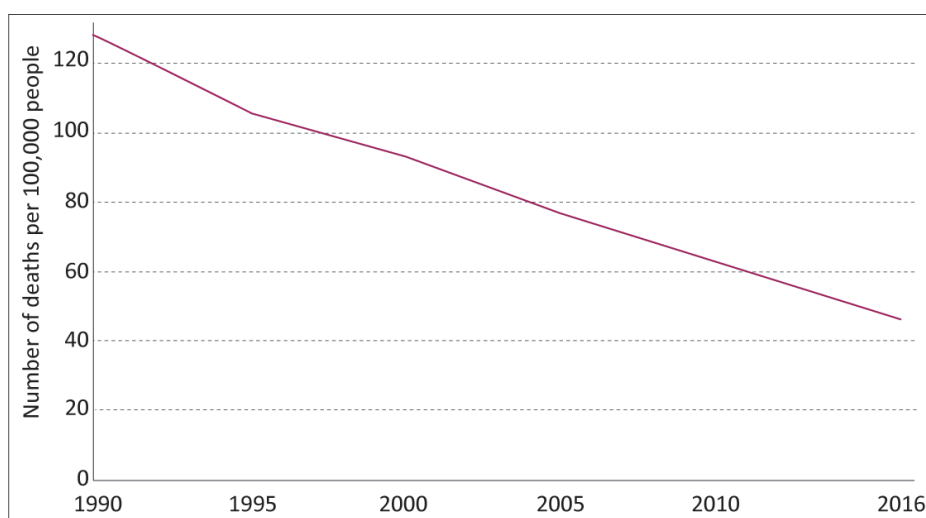


Figure 5-11: Mortality rate attributable to unsafe water, sanitation, and hygiene (WASH)
(GBD, 2016)

Table 5-8: Proportion of water bodies with good water quality in Botswana 2011-2017
(UN Water, 2018); (UNStats, 2020b)

Assessment period	Percentage of water bodies with good water quality				Number of assessed water bodies	Number of monitoring locations	Number of monitoring values
	Open water	River	Groundwater	Total			
2011-2017	94.44	94.74	7.69	50	76	114	46

Shared water courses are also monitored. For instance, the Kavango-Zambezi Transfrontier Conservation Area project includes an element to monitor the water quality of the Okavango Delta and the Chobe River. Five water quality stations monitor biological and chemical components giving information on the health of the rivers. There are plans to upscale this project at the Limpopo River with plans for ten water quality monitoring stations.

SDG 6.4.1: Change in water use efficiency over time

SDG 6.4 aims to 'substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity'. The Water Use Efficiency (WUE) for Botswana was US \$74.3/m³ in 2015 decreasing to US \$71.0/m³ in 2017 (UNStats, 2020b) (Statistics Botswana and DWSS, 2017). However, other more recent data indicates that the WUE for Botswana was US \$38.2/m³ at par with Europe and North America, and well above the global average of US \$15/m³ and that for sub-Saharan Africa at US \$7/m³. The water use efficiency by sector is US \$102.1/m³ for industry, US \$48.5/m³ for the services sector while the agricultural registers a

zero (FAO, 2018). Table 5-9 shows the water use efficiency data by sector.

SDG 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

Water stress is defined as the total quantity of freshwater withdrawals as a share of internal resources. This includes water withdrawn from agricultural, industrial, and domestic uses. It is the ratio between Total Freshwater Withdrawal (TFWW) by all major sectors and Total Renewable Freshwater Resources (TRWR), after considering the Environmental Flow Requirements (EFR).

Categories of water stress

Low stress <10%

Low-to-medium 10-20%

Medium-to-high 20-40%

High 40-80%

(GCDL, 2020)

Table 5-9: Water use efficiency 2016
(Statistics Botswana and DWSS, 2017)

Irrigated Agriculture Water Use Efficiency	MIMEC sector Water Use Efficiency	Services Water Use Efficiency	Water Use efficiency
0.085 USD/m ³	198.837 USD/m ³	89.714 USD/m ³	70.90 USD/m ³

Botswana's submission to Aquastat, shown in Table 5-10, indicates the level of water stress between 2013 and 2017 was 2.01 percent putting Botswana in the low stress band (FAO, 2020; UNStats, 2020a). However, if no action is taken, both human and environmental wellbeing are likely to suffer.

SDG 6.5.1: Degree of integrated water resources management implementation

On a scale of 0-100, the degree of IWRM was 41 in 2018 as shown in Figure 5-12 (UNStats, 2020b). This is categorised as medium low on a scale where 100 is extremely high and 0 is very low. The indicator is measured against four dimensions; financing, enabling environment, management instruments, and institutions and participation. The strategic tools, legal and policy framework (enabling environment) are in place to support the implementation of IWRM with the country earning a score of 48. The institutional framework is also in place and has a score of 47. The financing dimension could prove to be a barrier to IWRM implementation especially at the local levels with a score of 20. However, this is likely to change as the budgeting and financing made available and used for water resources development and management is increased.

SDG 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation

All (100 percent) of Botswana's shared water bodies are under some form of transboundary cooperation system (UNStats, 2020b). The Okavango River Basin Water Commission (OKACOM) was created in 1994 between

Table 5-10: Water stress (%) indicator for Botswana 1988-2017 (FAO, 2020)

1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017
1.182 (1992)	1.5 (1995)	2.029 (2000)		2.032 (2012)	2.018 (2017)

Angola, Namibia, and Botswana to serve as an instrument for cooperation between these riparian states. Zambezi Watercourse Commission (ZAMCOM) was created in 2004 between the eight countries sharing the basin. Recently they launched a Strategic plan for the Zambezi Watercourse and the Zambezi Water Resources Information System – Decision Support system. Common data from the information system will support decision making and better delivery of the ZAMCOM objectives through better planning and implementation.

SDG 6.6.1: Change in the extent of water-related ecosystems over time

The permanent water body extent stood at 7.2 percent of total land area in 2018 as shown in Table 5-11 (UNStats, 2020a). The area covered by water bodies is 221,198 km², out of which 208,286 km² is rivers, 12,910 km² is covered by wetlands and 2.68 km² is open water (UNStats, 2020c).

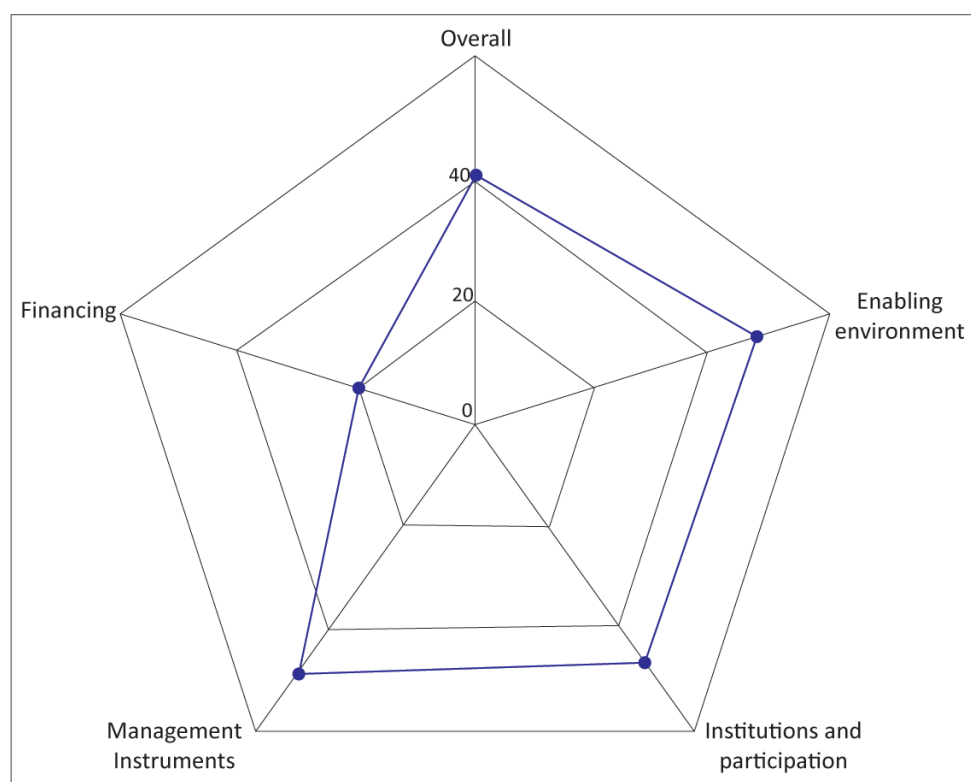


Figure 5-12: Degree of integrated water resources management implementation (0-100) in Botswana, score by dimension (2017) (UN Water, 2017)

Table 5-11: SDG 6.6.1 - Water body (permanent and maybe permanent) extent 2005-2018
(UNStats, 2020c)

Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
% of total land area	2.58	1.96	2.28	2.30	2.80	2.68	2.85	2.60	3.52	4.36	5.76	6.46	6.62	7.21
Km ²	146.4	111.1	129.2	130.5	158.9	151.9	161.4	147.2	199.3	246.7	326.4	365.9	375.0	408.4

5.5 Responses and suggested future actions

Monitoring Botswana's water resources

A good monitoring programme is central to providing the evidence base for making sound decisions on how best to manage Botswana's water resources. Water monitoring happens at different governance levels, different timings and utilizes a variety of technologies. More and more, where data is scarce and where physical in-person monitoring may not be viable, the Department of Water and Sanitation is utilizing remote sensing technologies to provide data (DWS, 2020). Remote sensing is also used to support water balance analysis, identification of additional water resources, performance of water resources, land use and land cover trends including analysis of water catchment areas, flood, and drought risk assessments, among others.

Groundwater quality is monitored by the Department of Geological Survey and the water quality section of the Department of Water and Sanitation; the Water Utilities Corporation monitors the surface water quality of its dams. The fragmentation of water monitoring creates some duplication and redundancies. It is thus recommended that:

- The whole area of water quality monitoring would benefit from an integrated (groundwater, surface water, springs, wastewater, and treated effluent) approach.
- An improved water monitoring and compliance programme should be implemented, and this should include adopting appropriate technologies for the Botswana context (GoB, 2017).
- To support the improvement of water quality, the proposal from the Department of Water and Sanitation to establish a reserve protection zone around water source be implemented.

Addressing water governance issues

A key element affecting water governance is the need to update the Water Act and the fact that the Water Policy is still in draft form. Although the water policy framework puts emphasis on conservation and demand management, implementation is limited. This is because of lack of knowledge and scientific data on which to base decisions.

Monitoring, a good source of data, is ineffective and basic information such as water balance information is lacking. For instance, the groundwater abstraction limits are set at 22.75Mm³ a year (for mining, agriculture, and industry), however enforcement is weak and arbitrary.

There are policies to manage drinking water at both rural and urban areas; and those for sanitation are currently

under review. Other programs such as the Botswana Ecotourism Certification System have positive impacts on water governance. For instance, Principle 1: Water Use and Conservation Policies and Principle 3: Prohibits the use of hazardous chemicals, hydrocarbon spillages in riverine areas and promotes use of biodegradable cleaners. These have environmental, industrial and community benefits.

Against this background it is proposed that:

- The Water Act be reviewed, and the Water Policy finalized and published
- Enforcement and compliance with the legal framework for wastewater and sanitation be strengthened.
- Data management including indicator development for the different water sub-sectors should be developed to support evidence-based policy and decision making

Investing in water infrastructure

Severe water shortages and droughts in the recent past have pushed the Government to focus on increasing water storage capacity. The Dikgatlong Dam was completed during the NDP 10 period, and the NDP11 is focusing on completing the construction of the North South Carrier II pipeline to assist in water transfers. In addition, the Government will be implementing wastewater recycling and use and implementing technology investments for efficient water use especially within the agriculture and mining industries.

In the 2020 budget, the Ministry of Water and Human Settlement (MWHs) was allocated the largest share of the proposed Development Budget at 17.21 percent (BWP 2.07 billion). This was to support improvement of water supply and management across the country. Some of the projects include the North-South Carrier 2 from Dikgatlong-Palape-Mmamashia-Gaborone, which is meant to provide water to the southern part of Botswana; Kanye NSC Connection, Moshupa sanitation project, Land servicing at Mochudi, Selibe Phikwe, Mabutsane, Gantsi and Moshupa as well as the Botswana Emergency Water Security and Efficiency project. The water and sanitation sector again in 2021 took the largest share (22 percent) of the development budget allocation. The major projects include: Masama-Mmamashia 100km Water Pipeline; Connection of Tswapong Villages to Mahalapye (Phase 2); Moshupa Sanitation; the North South Carrier 2.3 and the Lobatse Water Supply Master Plan. The Government is also focusing on the sanitation sector. The MWHs and USAID/Resilient Waters have developed a Sanitation Roadmap to guide the sector (WHO, 2019). In 2018, the reported WASH budget of Botswana by most recent fiscal year was US \$145 per capita (US \$339 million), and out of a total of 60 countries surveyed, Botswana was ranked 15th in terms of the total budget to water (WHO, 2019).

As discussed, there is strong political and policy support for this, and it is recommended that:

- The Government invest in wastewater recycling and use as an alternative source of water.
- Invest in technology to increase the water storage capacity of the country.

Improving water use efficiency

Water use efficiency is about using the relationship between economic growth and the use of water resources to provide policy makers with the information required to identify and target actions in sectors that have high water usage and low levels of WUE. The FAO defines water use efficiency - WUE - as the value addition from the use of water in primary sectors of agriculture, industry, and services. Industry in this context includes mining and quarrying, manufacturing, construction, and energy (FAO, 2018).

There is policy support for WUE. For instance, one of the strategic areas of the 2013 Botswana Integrated Water Resources Management and Water Efficiency Plan is efficiency of sector water allocation. Other water related policies include the National Water Master Plan 2006, National Water Policy 2012 and the National Masterplan for Wastewater and Sanitation 2003.

WUE is important because water is in short supply in Botswana and as the population and the economy grows, so does the differing demands for water. For instance, water is a major factor limiting agricultural productivity. Already, Botswana uses groundwater at a rate faster than it is being replenished and efforts to improve water use efficiency are urgently needed (Kgathi, 1999). It is believed that if irrigation technologies and other agricultural practices were made more efficient there would be more water for mining, urban and other environmental uses. The literature indicates that progress in efficiency of water use has been notable in the diamond mining sector (GoB; UNDP, 2012). Irrigation is an important technology for mitigation against drought. Investments could include technologies such as drip irrigation and farming practices such as zero tillage, mulching and mixed cropping. These could be complemented by boosting water supply through small-scale pumps powered by renewable energies.

Botswana must make better use of its water supply as the resources to continue increasing water supplies are just not there. The Government should consider:

- Technology investments for more efficient water use in the services and agriculture sectors as advocated for in Vision 2036.
- Encouraging conservation agricultural practices.
- Boosting water supply and quality by investing in dams and other water supply infrastructure, and by environmental restoration activities.
- Investing in drought-resistant plants for crop agriculture.

- Reducing water losses through implementing a trace and track system for addressing leakages, a maintenance programme that would allow for the systematic replacement of old pipes (MIHD, 2020).

Capacity for water management

Addressing human resources capacity gaps within the water and sanitation sector is a focus for the Government. Although Botswana has a strong set of training programmes and degree opportunities linked to water and sanitation – covering technical and health-related aspects – the content is often not structured to incorporate current technology. Tertiary institutions of learning need to address these gaps (WHO, 2019).

The human capital at the local levels to implement water management programmes is also another area that needs addressing. Staffing capacity to implement plans for water and sanitation at rural and urban levels ranges between 50 and 75 percent (WHO, 2019). To that end, it is recommended that capacity building at national and local Government levels be carried out to support the different water resources management programmes.

5.6 Measuring Botswana's progress on the water-related SDGs

Between 2000 and 2017, Botswana made progress on the SDGs 6.1.1 (safely managed drinking water) and 6.2.1 (safely managed sanitation and handwashing services),

6.4.1 (change in water use efficiency over time) and 6.6.1 (change in the extent of water-related ecosystems over time) (UNEP, 2020a). There is strong political and policy support for water and sanitation programmes as highlighted in the NDP11 and the 2021 budget. The implementation of the Integrated Water Resources Management and Water Efficiency Plan 2013 and the Water Accounting and Valuation of Ecosystems Services programme are all geared towards ensuring increased access to water supply and sanitation services.

Although there appears to be insufficient data to report adequately on SDG's 6.5.1 (degree of integrated water resources management) and SDG 6.5.2 (proportion of transboundary basin area with an operational arrangement for water cooperation), there is much work done in these areas. So far Botswana has ratified four (4) river basin commissions to ensure equitable management of the shared water resources. The NDP11 has planned for a review of the National Water Master Plan that provides a guide on national water demand use and development. It will be reviewed to emphasize the role of transboundary water resources in water security.



Water Utilities Corporation Onion tower
Photo Credit: Photography Section, BOPA

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Clouds above the Okavango
Photo credit: Department of Wildlife and National Parks



6

ATMOSPHERE AND CLIMATE CHANGE IN BOTSWANA



6.1 Introduction

This Chapter examines air quality, climate change, and disaster risk reduction strategies in Botswana through the lens of SDGs 3, 7, 9, 11, 13 and 15. It explores the current and potential implications of the changes, and institutional responses to it. The welfare of the people, the performance of the economy, and the state of the environment in Botswana are all very intricately linked to the climate. According to the Government of Botswana, the country is “highly vulnerable to climate change” due to its fragile ecosystems and semi aridity (Gunilla and Emelie, 2008).

Climate change is likely to add to existing stresses in Botswana causing significant changes in prevalent vegetation and rangeland cover, affecting species types, composition, and distribution, as well as other species depending on these habitats.

6.2 Air pollution

Air is a component of the environment that plays an important life-sustaining role. Clean air is considered one of the necessities of human health and well-being (Akinola et. al, 2017; WHO, 2006). Air pollution poses a significant threat to health worldwide, where nine (9) out of ten (10) people breathe polluted air (WHO, 2020). Exposure to indoor and outdoor air pollution was responsible for 6 - 7 million premature deaths in 2016 (WHO, 2018; GBD, 2018). Like many developing nations, Botswana has experienced a significant amount of pollution due to rapid growth in its urban population, industrialization and rising demands for energy and motor vehicles (Wiston, 2017). The combined effect of population dynamics and economic development has a noticeable effect on the environment in terms of increased waste generation and poor waste management (Wiston, 2017).

Air quality in Botswana

Since Independence, Botswana is gradually developing into an industrialized country (Akinola et. al., 2017). Over the years, Botswana has experienced an influx of motorised transport and a significant growth in the mining, energy, transport, textile, manufacturing, and other sectors. This growth has been accompanied by an increase in emission of pollutants which have significantly contributed to atmospheric pollution (Wiston, 2017). A report on unintentionally produced persistent organic pollutants reveals that open burning of waste (particularly at waste dumpsites) is a common practice across the country. In 2019, open burning was observed at 34 assessed waste dumpsites and is one of the top contributing sources of air pollution and unintentionally produced persistent organic pollutants (Modiga and Modise, 2019).

Air pollution contributes to a wide range of chronic and acute diseases, especially cardiovascular and respiratory disease (Zhu et al., 2018; Garshick, 2014; McCracken, et al., 2012; Brook, et al., 2010).

Ambient (outdoor) and indoor air pollution in Botswana

Urbanization, industrialization, agriculture, and biomass burning are the most common anthropogenic drivers of air pollution in Botswana (Schwela, 2012). These drivers lead to the following pressures: increased vehicular emissions, emissions from burning of waste within households and at landfills; emissions of particulate matter from veld fires and windstorms; smoke from burning biomass as fuel; and emissions from smelters, power plants and industries (Schwela, 2012).

*Open burning of waste observed at one of the dumpsites in Kweneng District.
Photo credit: Department of Waste Management and Pollution Control, 2019*



In addition to the anthropogenic drivers and pressures listed above, a significant amount of air pollution also occurs from natural sources. For instance, vast amount of mineral dust originating in the Kalahari Desert are carried by westerly winds (Akinola et.al, 2017). The adverse impacts on human health and the environment necessitated the strengthening of the air pollution monitoring system in Botswana.

Botswana's response to air pollution

To guide their air pollution policies, many countries have developed national ambient air quality standards, or guidelines for several common pollutants (Kutlar Joss et al., 2017). To this end, Botswana has an air quality monitoring network of 25 monitoring stations and a mobile laboratory (shown in Figure 6-1). The monitoring stations are strategically located along the eastern corridor where polluting entities and operations are concentrated.

Botswana's commitment to air quality monitoring is illustrated by an investment of BWP 5.6 million allocated to maintain the network operation in 2014. During NDP 11, the Government of Botswana allocated BWP 5 million for the ongoing network expansion which is anticipated to be completed in 2021.

Currently, the network consists of monitoring stations with 18 analytical analysers and seven (7) low-cost sensors. The network is aimed at supporting the National Air Quality Management Programme in generating the ambient air quality data needed for decision-making purposes. These stations monitor both criteria pollutants and meteorological parameters. Some of the monitored pollutants include particulate matter (PM₁, PM_{2.5}, PM₄, and PM₁₀), oxides of nitrogen, sulphur dioxide and carbon monoxide.

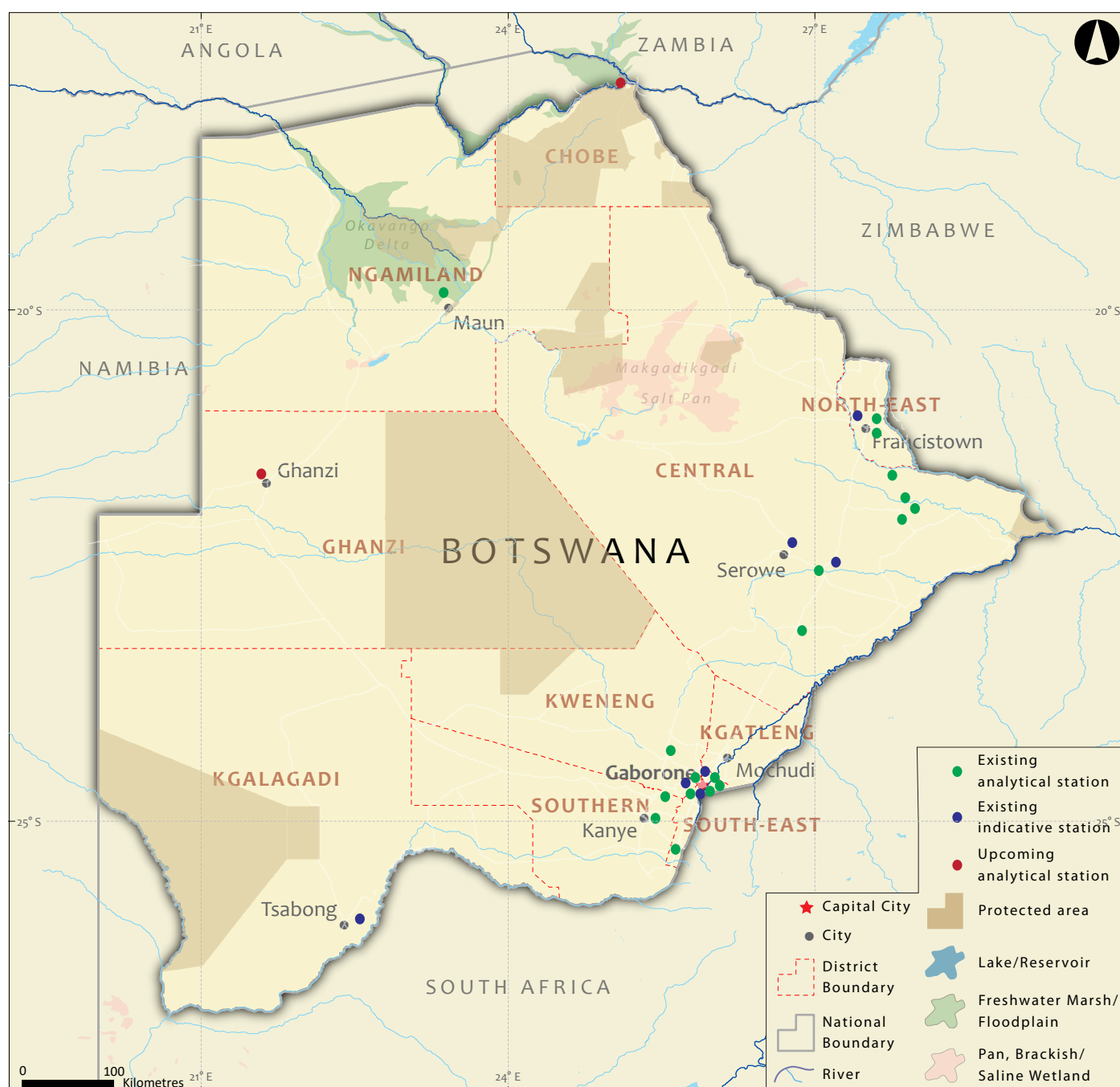


Figure 6-1: Existing air monitoring stations in Botswana
(GoB, 2020)

In 2012, Botswana developed a Standard for Ambient Air Quality (BOS 498:2012) which replaced the World Health Organization (WHO) Air Quality Objectives (Table 6-1).

Botswana has also developed its Vehicle Emission Standard (BOS ISO 134:2005). In 2016, the Government of Botswana developed a draft National Air Quality Management Framework to guide the implementation of its Air Quality Programme. Based on the recommendations of the Framework, Botswana developed a Standard for Air Emissions from Stationary Sources (BOBS, 2019). The country has also enacted several laws as highlighted in Table 6-2.

Alongside these, Botswana is a signatory to several multilateral agreements including the Vienna Convention for the Protection of the Ozone Layer (ratified in 1991), the Montreal Protocol on Substances that Deplete the Ozone Layer (ratified in 1991) and its London and Copenhagen Amendments (ratified in 1997), the United Nations Framework Convention on Climate Change, Agenda 21, and the Stockholm Convention on Persistent Organic Pollutants.

Table 6-1: Botswana and WHO air quality guidelines for selected common air pollutants (Wiston, 2017)

Pollutant	Threshold ($\mu\text{g}/\text{m}^3$)		Average period	
	Botswana	WHO	Botswana	WHO
Sulphur dioxide (SO_2)	350	20	1 hr	24 hrs
	120	500	24 hrs	15 min
Nitrogen dioxide (NO_2)	200	40	1 hr	1 yr
	40	200	1 yr	24 hrs
Carbon monoxide (CO)	-	10,000	-	8 hrs
	30,000	30,000	1 hr	1 hr
	10,000	60,000	8 hrs	30 min
	-	100,000	-	15 min
Particulate matter < 10 μg (PM10)	200	20	Monthly	1 yr
	100	50	1 yr	24 hrs
Particulate matter < 2.5 μg (PM2.5)	-	10	-	1 yr
	-	25	-	24 hrs

Table 6-2: Laws passed by Botswana in response to air pollution (GoB, 2020)

Law	Year passed	Major provisions
The Atmospheric Pollution (Prevention) Act (APPA)	1971	- Prevention of the pollution of the atmosphere from industrial processes. - Administered by the Department of Waste Management & Pollution Control. - Specifies fines that may be imposed on anyone convicted under the Act. - Setting of emission and air quality standards
Environmental Assessment Act (Cap 65:07)	2021	- Provides for the Environmental Impact Assessments to be used to assess the potential effects of planned developmental activities (Power plants and Incinerators) - Determine and to provide mitigation measures for effects of such activities as may have a significant adverse impact on the environment - Put in place a monitoring process and evaluation of the environmental impacts of implemented activities
The Mines and Minerals Act	1977, 1999	Prohibits wasteful mining and processing

Okavango Delta
Photo credit: Serena_tang/flickr



Ozone depletion

The Ozone Layer plays a vital role in protecting life on earth by absorbing harmful ultra-violet radiation from the sun. Botswana ratified the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that deplete the Ozone Layer on the 4th of December 1991. The country, through the Department of Meteorological Services (DMS), has been phasing-out Ozone Depleting Substances (ODS) as required by the Montreal Protocol. Chlorofluorocarbons (CFCs) were phased-out in the refrigeration and air-conditioning (RAC) sector by 1st of January 2010 and has since been maintained at zero consumption in the sector.

Furthermore, to facilitate the implementation of the phasing-out of Ozone Depleting Substances (ODS), Botswana developed the ODS Regulations in 2014 under the National Meteorological Services Act of 2014. These Regulations control the imports and exports of ODS and ODS-dependent equipment. The Regulations ban imports of CFCs, Halons and Carbon Tetrachloride, Methyl Bromide and strengthen the control of imports of Hydrochlorofluorocarbons (HCFCs) and HCFC dependent appliances leading to reduction and eventual prevention of possible emissions. The country has a functional licensing and quota system which imposes restrictions on HCFC imports and maintains records of imports and exports of ODS and ODS dependent equipment.

Data on imports of ODS and ODS dependent equipment is captured at ports of entry by Botswana Unified Revenue Service (BURS) Customs office. The Customs office form the first line of defence against illegal imports. The baseline for consumption of HCFC was 11 ODP tonnes in 2009-2010 (MEWT, 2014). The targets of HCFC phase-out are to achieve reductions of consumption of HCFC by 10 percent by 2015, 35 percent by 2020, 67.5 percent by 2025, 97.5 percent by 2030 and total phase-out by 2040 (see Table 6-3).

Table 6-3: HCFC consumption phase-out schedule for Botswana (MEWT, 2014)

Base level	Average: 2009-2010
Freeze:	January 1, 2013
10 reduction	January 1, 2015
35 reduction	January 1, 2020
67.5 reduction	January 1, 2025
97.5 reduction (averaged over ten years 2030 - 2040)	January 1, 2030, and thereafter consumption restricted to servicing refrigeration and air-conditioning equipment existing at that date
100 reduction	January 1, 2040

Botswana's phase-out management plans are supported through the Multi-Lateral Fund. The country has made progress in achieving a phase-out of 3.61 ODP tonnes of HCFCs as of 2019 against the targeted 3.85 ODP tonnes by 2020. It is expected that the 35 percent reduction target compared to the baseline of 11 ODP tonnes on consumption of HCFCs by 2020 will be achieved ahead of schedule. Table 6-4 shows that consumption of HCFCs has decreased since the year 2014. This is attributed to the vigilant monitoring and enforcement of the ODS regulations and licensing system along with the awareness raised among Refrigeration and Air Conditioning (RAC) technicians and the public in general.

The reduced demand for HCFCs has resulted in the increased demand and consumption of Hydrofluorocarbons (HFCs), Hydrocarbons and natural refrigerants. Consumption of these alternatives has been rather stable over the period from 2014 to 2019. However, the use of HFCs and their blends continue to increase in the RAC servicing sector as seen in the results shown in Table 6-5.

HFC-134a is the most dominant HFC followed by R-404a. The use of these low Global Warming Potential (GWP) alternatives is being promoted even in the servicing sector although the uptake is still low. Botswana is required to develop enabling policies that will promote increased uptake of low GWP technologies. Hence, Botswana ratified the Kigali Amendment in September 2020 which seeks to phase-down the production and consumption of HFCs.

Table 6-4: Reported consumption of HCFCs from 2014 to 2019 (UNEP, 2020)

Substance (ODP Tons)	2014	2015	2016	2017	2018	2019	Baseline
HCFC-22	10.45	9.70	9.38	8.58	7.74	6.875	11
HCFC-141b	0.06	0.05	0.05	0.00	0.04	0.022	
Total HCFCs	10.51	9.75	9.43	8.58	7.78	6.897	

Table 6-5: HCFC alternatives imported and consumed in the period 2014 to 2019 (GoB, 2020)

Refrigerant	Imports (Metric Tonnes) / Yr					
	2014	2015	2016	2017	2018	2019
R134a	37.0	41.5	48	55.2	62.3	79.0
R227	0.75	1.85	1	1.2	1	-
R404A	14.4	15.8	12	15	17	59.0
R407C	8.5	4.9	4.9	4.9	5.2	1.1
R410A	8.8	9.6	10.2	12	14.2	20.3
R507	8.3	6.8	7.3	8	12.1	50.9
R290	0.5	0.75	1.2	1.8	1.8	1.8
R600a	1.2	1.7	2.3	2.9	3.2	4.8
R744	10.5	13.8	8.0	9.0	9.0	4.5
R717	9.5	15.7	13.2	12.0	13	6.9

6.3 Climate change in Botswana

In Botswana, climate change manifests itself in the form of increased variability of key climate elements such as temperature and rainfall, and through an increase in the frequency and severity of extreme events such as heat waves, destructive rainfall, flash floods, and droughts. The main concerns for Botswana are increased energy and water stress because of rising temperatures and changing rainfall patterns, losses in rangeland productivity and reduced agricultural yields which are profoundly threatening food security.

Greenhouse gas (GHG) inventory for Botswana

In 2020, CO₂ emissions per capita for Botswana was 2.92 tonnes which is an increase of 5.33% (average annual rate) from 0.41 tonnes in 1971 ([https://knoema.com/atlas/Botswana/CO₂-emissions-per-capita](https://knoema.com/atlas/Botswana/CO2-emissions-per-capita)).

Botswana's GHG emissions in 2015 were 9310.72 Gg CO₂ eq. from Energy, 1221.69 Gg CO₂ eq. from Industrial Production and Product Use (IPPU), 644.42 Gg CO₂ eq. from Waste and -947.94 Gg CO₂ eq. from the Agriculture, Forestry and Land-Use (AFOLU) sectors (see Table 6-6). Net emissions after accounting CO₂ removals by AFOLU was 10,228.89 Gg CO₂ eq. Therefore, the largest emitting sector is energy accounting for 91 percent of total emissions (including AFOLU) and 83 percent emissions without AFOLU (MENT,

2019). GHG emissions according to sector and by gases are provided in Figure 6-3 and Figure 6-4. Figure 6-2 illustrates that total emissions during 2000–2013 (excluding those from the Land use, land-use change and forestry (LULUCF) sectors) increased from 7342.81 Gg CO₂ eq in 2000 to 11158.07 Gg CO₂ eq in 2013: an increase of about 52 percent.

Climate in Botswana, trends and projections

Botswana has a semi-arid climate with hot and dry conditions for most of the year. There is an erratic, unpredictable and spatially varied rainy season, which runs through the summer months from October to March, while winter is from May to August and is usually dry. The rainfall ranges from 250 mm in the southwest to around 650 mm in the north. Botswana's diurnal temperature range is high and varies spatially (MENT, 2019).

Climate trends

Temperature trends over the last several decades indicate that Botswana has experienced a considerable increase in temperature over recent years. An analysis of climate data from 1970 to 2015 (Figure 6-5) shows an average rise of temperature by around 1.5°C (Harris et. al., 2014). In contrast, the mean global surface temperature was found to have increased by 1.2°C above the pre industrial level by 2020 (WMO "State of the Global Climate 2020", 2021).

Table 6-6: GHG emission by sector for the year 2015 (MENT, 2019)

Sector	(Gg)					% Share without AFOLU	%Share with AFOLU
	CO ₂	CH ₄	N ₂ O	HFCs	Total Emissions		
Energy	8,295.95	849.81	164.96	0	9,310.72	83	91
Industrial Processes	1,221.14	0	0	0.55	1,221.69	11	12
AFOLU	-2,803.00	1,592.44	262.62	0	-947.94	-	-9
Waste		621.33	23.09	0	644.42	6	6

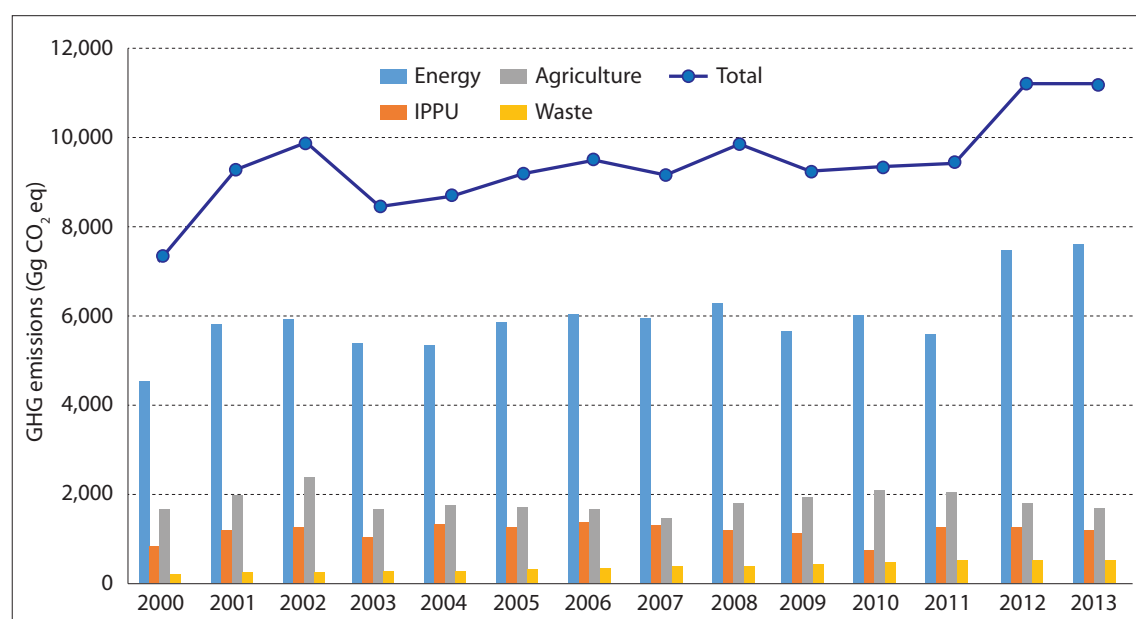


Figure 6-2: Trend of Botswana's GHG emissions (without LUCF) by sector: 2000–2013 (MENT, 2019)

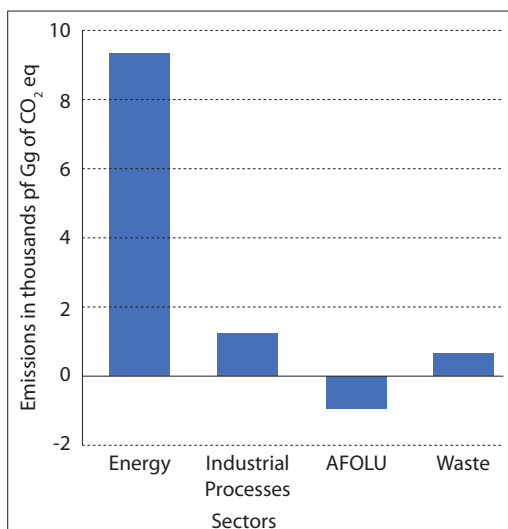


Figure 6-3: GHG emissions by Sector for the year 2015 (MENT, 2019).

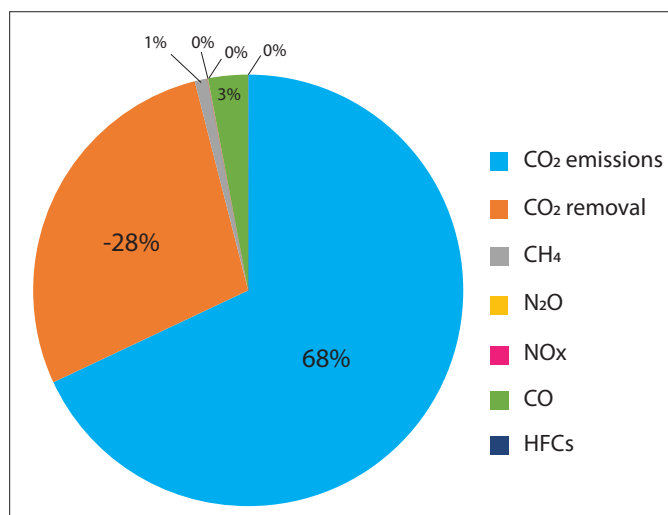


Figure 6-4: GHG emissions by gas (MENT, 2019))

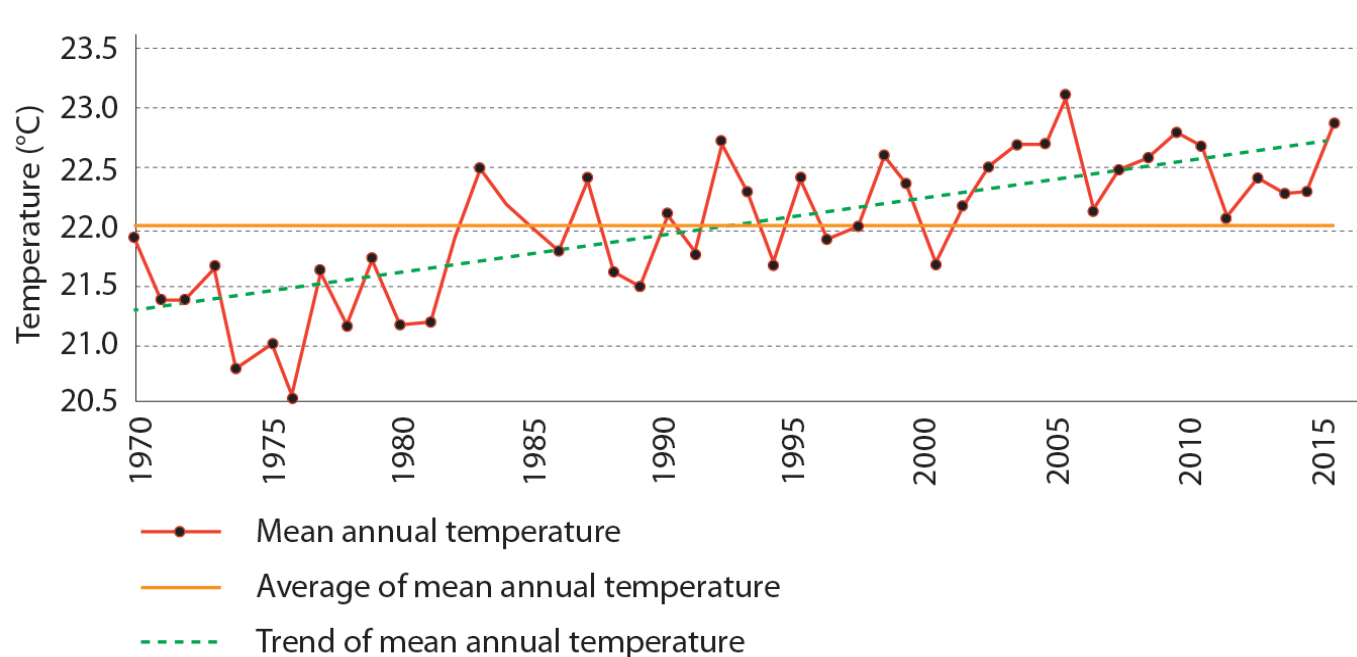


Figure 6-5: Temperature trends of Botswana 1970-2015 (CIMA; UNISDR, 2018)



Morupule power station
Photo credit: Photography Section, BOPA

As already mentioned, rainfall is highly variable in time and space. Rainfall variability is an important feature of semi-arid climates, and climate change is likely to increase that variability in many of the regions of Botswana (Batisani and Yarnal, 2010). The average annual rainfall for Botswana is approximately 405 mm, while the mean number of wet days is around 53. Trends for annual average rainfall across Botswana indicate a general decline (Figure 6-6) (MENT, 2019).

Climate projections

By 2050, most of the country will experience high average annual temperatures ranging between 25°C and 26.9°C, thus the country will be hotter than relative baseline temperatures (MENT, 2019). Figure 6-7 illustrates historical annual mean temperatures and temperature projections for 2050 using two Representative Concentration Pathways (RCPs) - RCP 4.5 and RCP 8.5.

Representative Concentration Pathway (RCP) 4.5 is a scenario with long-term, global emissions of greenhouse gases of short-lived species, and land-use-land-cover conditions which stabilise radiative forcing of 4.5 Watts per square meter (W/m^2) and atmospheric CO_2 -equivalent concentration of approximately 650 ppm in the year 2100. RCP 8.5 refers to

the concentration of carbon that delivers global warming at an average of 8.5 watts per square meter across the planet (<https://climatenexus.org/climate-change-news/rcp-8-5-business-as-usual-or-a-worst-case-scenario/>).

The seasonal and annual mean precipitation of Botswana has a general decreasing trend as of 2050 (MENT, 2019). According to a study by Nkemelang et. al., (2018), Botswana is projected to experience significant increases in temperature and rainfall extremes as Global Mean Surface Temperatures (GMST) increase from 1.0°C through 1.5°C-2.0°C above pre-industrial levels. The changes are particularly strong for temperature extremes; for each increment of global warming (1.0°C through 1.5°C-2.0°C) temperature extremes are statistically different, indicating markedly different regional climates over Botswana at different levels of global warming (Nkemelang et. al., 2018). Similarly, there are projected statistically significant decreases in mean rainfall and increases in dry-spell length at each modelled global temperature level. In contrast, the increases in intense rainfall indices are not statistically distinguishable at each increment of temperature although an overall median increase was observed (Nkemelang et. al., 2018). Figure 6-8 illustrates historical annual mean precipitation and precipitation projections for 2050 using RCP 4.5 and RCP 8.5.

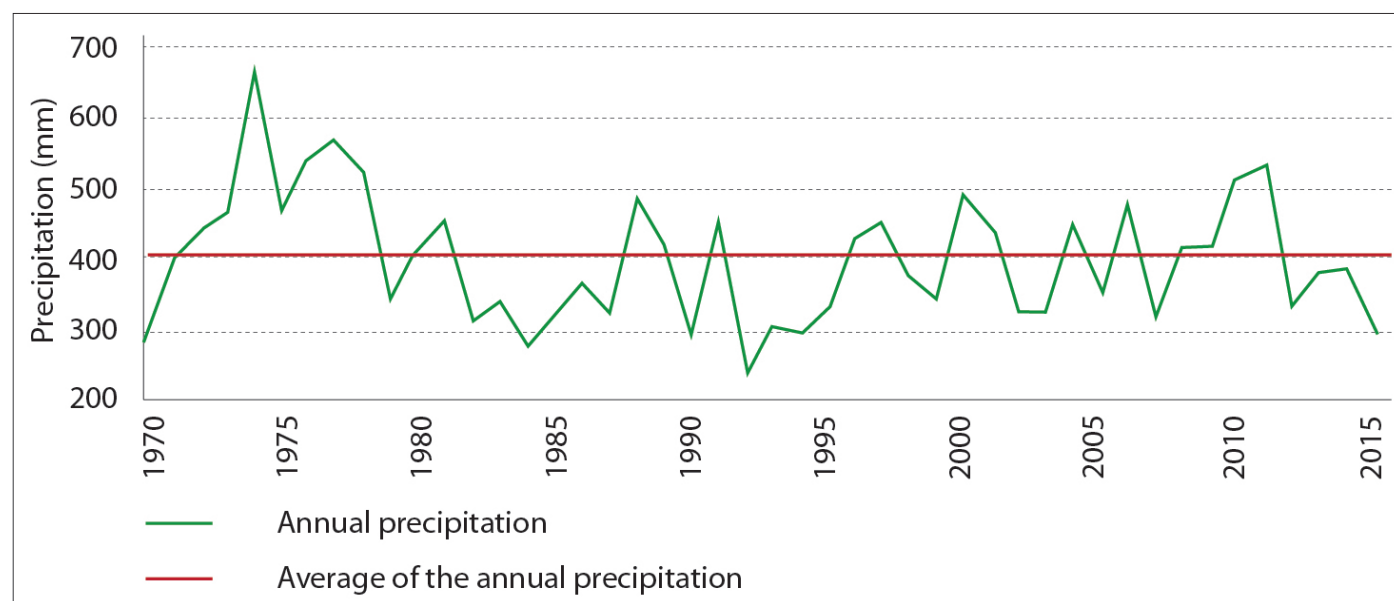
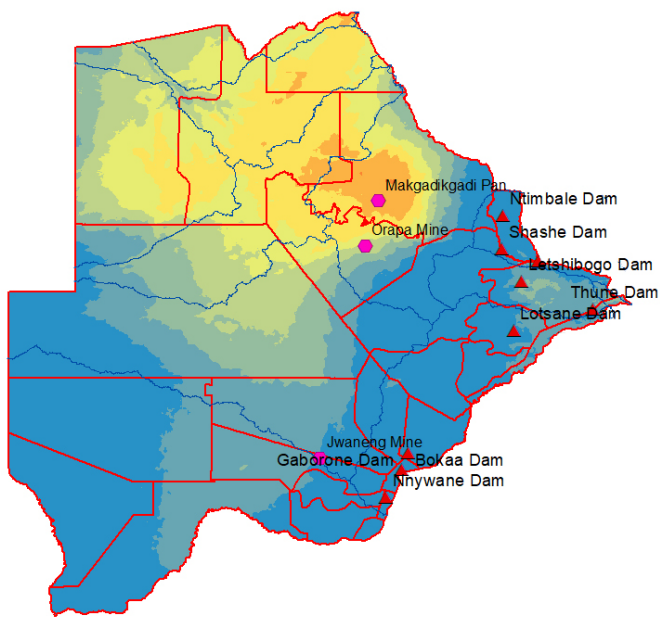
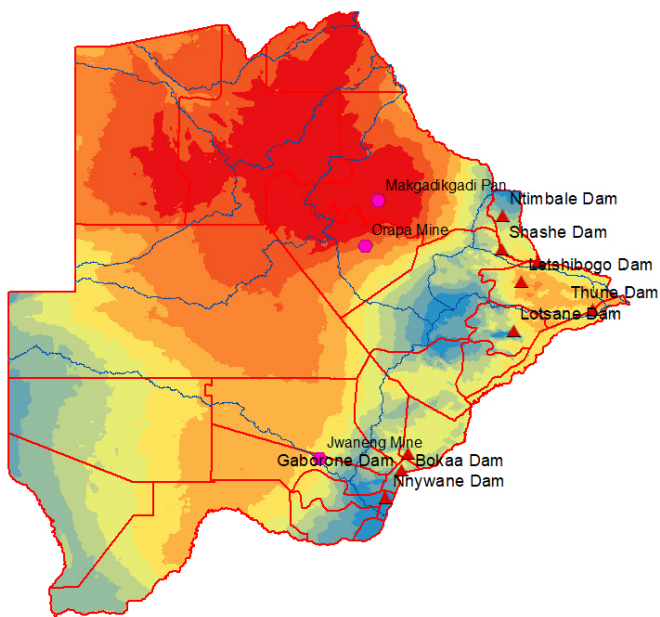


Figure 6-6: Precipitation trends of Botswana 1970-2015
(CIMA; UNISDR, 2018)

Historical Annual Mean Temperature (Celcius)



Year 2050 RCP4.5 Annual Mean Temperature (Celcius)
GCM/RCM Ensemble Median



Year 2050 RCP8.5 Annual Mean Temperature (Celcius)
GCM/RCM Ensemble Median

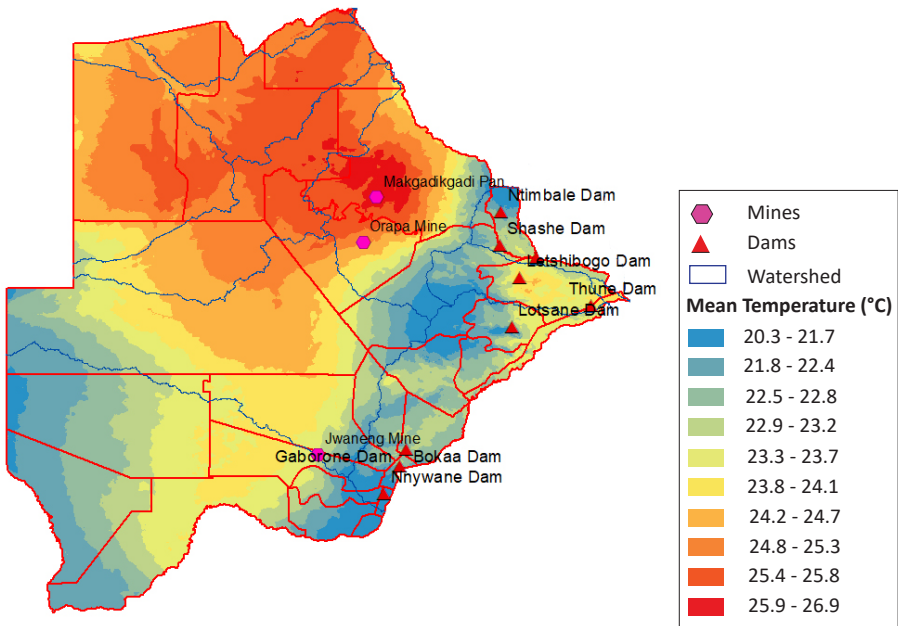
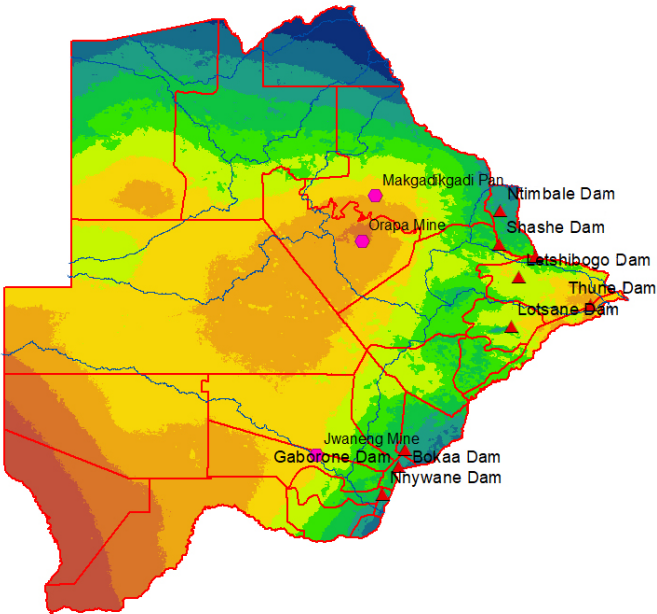
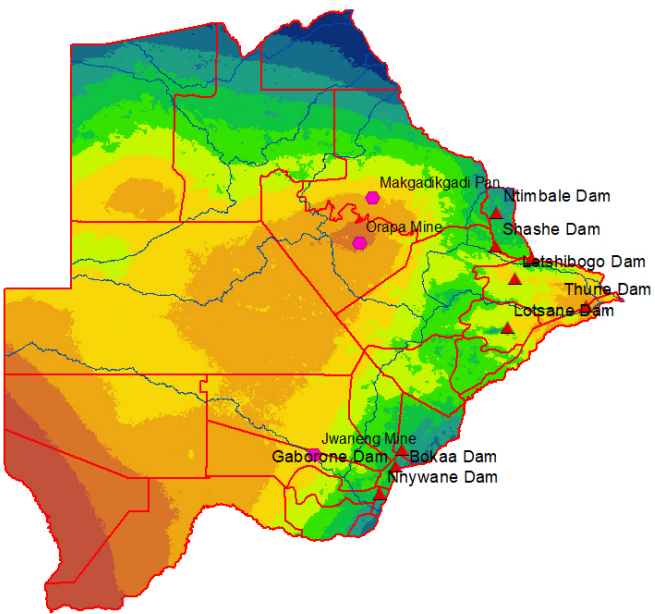


Figure 6-7: Historical annual mean temperatures and temperature projections for 2050 using RCP 4.5 and RCP 8.5 (MENT, 2019)

Historical Average Annual Precipitation (mm)



Year 2050 RCP4.5 Annual Precipitation (mm)
GCM/RCM Ensemble Median



Year 2050 RCP8.5 Annual Precipitation (mm)
GCM/RCM Ensemble Median

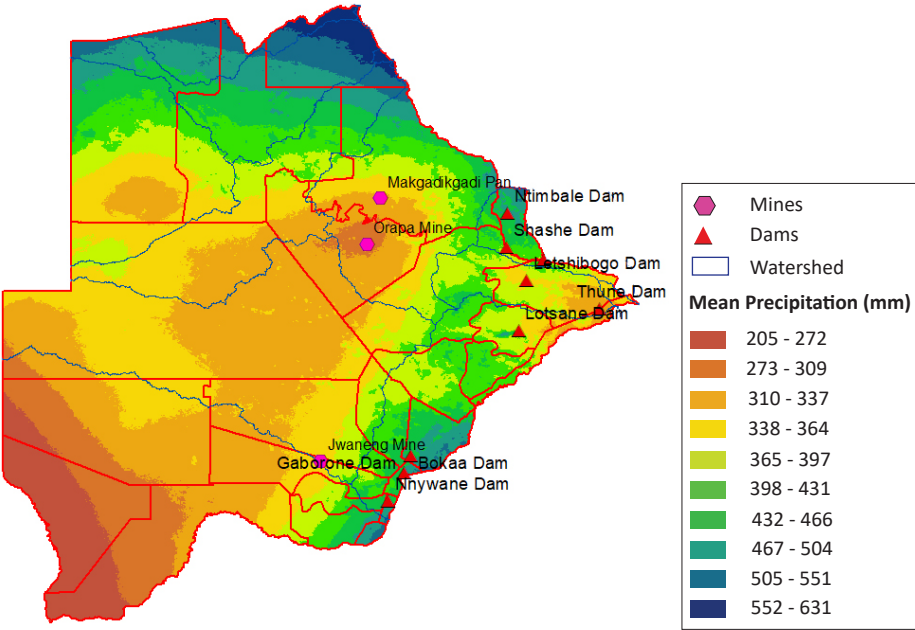


Figure 6-8: Historical annual mean precipitation and projections for 2050 using RCP 4.5 and RCP 8.5 (MENT, 2019)

6.4 Vulnerable sectors, impacts and adaptation strategies

For a climate-stressed country such as Botswana, even small increments in global mean temperature have serious societal consequences that will demand progressively more radical adaptation responses (Nkemelang et. al., 2018). These changes in extremes as detailed above present a growing adaptation challenge between 1.5°C and 2.0°C for key economic sectors in the country.

Water

Botswana is already water-stressed; the projected decreases in mean annual rainfall, together with increased length of dry spells, will escalate stress, leading to more frequent water shortages in today's rural, urban and agricultural supply systems. In studies using the General Circulation Model/Regional Climate Model (GCM/RCM) ensemble and RCP 4.5 and 6.0, the results indicate that at a temperature increase between 1.5°C and 2°C, rainfall could decrease by as much as 15 percent though there are some insignificant rainfall increases for other percentiles (MENT, 2019).

The RCP 6.0 scenario uses a high greenhouse gas emission rate where total radiative forcing is stabilized after 2100 at 6.0 W/m² by employment of a range of technologies and strategies for reducing greenhouse gas emissions. 6.0 W/m² refers to the radiative forcing reached by 2100 (<https://sos.noaa.gov/catalog/datasets/climate-model-temperature-change-rcp-60-2006-2100>).

The changes predicted in the above model will have a negative impact on the water resources in the country. The model indicates that by 2050, climate change will result in a decrease in water inflow into dams by between 3.5 to 19 percent which represents an actual loss of 34 to 75 mm by 2050. Using the Potential Evapotranspiration (PET) equation it is projected that evaporation could increase by 3.7 percent to 7 percent from the baseline (MENT, 2019).

Furthermore, based on the projected decline in rainfall and increase in temperature and evaporation, it is projected that ground water recharge would also decline. Increasing periods of surface water scarcity will result in greater ground water abstraction and thus water depletion by 2050 (MENT, 2019). Based on the results referred to above, it is imperative that the country undertake significant investment in water adaptation projects. Implementing these feasible water projects will ensure that the water resources which are already under stress become less vulnerable to climate change. Examples of economically feasible water adaptation projects include:

- Construction of water transfer schemes
- Rain water harvesting
- Artificial groundwater recharge.
- Investing in advanced water leak detection systems.
- Introducing smart meters.
- Strengthening of dam walls.

*A young boy accessing water through domestic water pump, Seronga village near Okavango Delta
Photo credit: Benjamin Noury/Water Alternatives/Flickr*



Agriculture

Crops

In Botswana, 80 percent of the population is dependent on dryland arable agriculture (GoB, 2011; Parson, 1984) and rainfall variability is the most important factor limiting dryland farming in Botswana (Chipanshi et. al, 2003) and this calls for smart initiatives such as hydro culture which is indicatively low water consuming with relatively high yields (Chicho, 2020).

Possible adaptation strategies for crops could include:

- Adopting conservation agriculture to improve yields in the future.
- Application of nitrogen fertilizer to cowpea crop (most of the small-scale farmers do not apply nitrogen fertilizer to a cowpea crop).
- Integration of smart water saving farming initiatives and practices such as hydro culture and permaculture.

Livestock and rangelands

Climate change and associated shocks are expected to result in a future decline in the reproductive performance of cattle (MENT, 2019). Consequently, calf births are likely to be lower than the baseline and this is more obvious under RCP 6.0 by 2070. This may be due to low conception rates attributed to the poor body condition of breeding cows caused by feed shortages in the rangelands. In addition, increased heat stress could also reduce the fertility of bulls and thus lead to a lower calving rate. Table 6-7 shows

various adaptation strategies for projected climate risks for the sector as indicated in the country's Third National Communication to the UNFCCC (MENT, 2019).

Biodiversity

Climate change and its interactions with other stressors influence biodiversity and those species with small distribution, low abundance and specialized habitats are particularly most vulnerable (Rockström et al., 2009). Birdlife appears to be threatened by changes in rainfall distribution and temperatures (Darkoh and Mbaiwa, 2014), partially due to a shift in the composition of natural resources in their habitat. A shift in the proportions of woody and grassy vegetation would be stimulated by changes in carbon dioxide concentration in the atmosphere and rainfall patterns. An increase in the frequency, intensity and extent of extreme events such as drought and fires, will place vegetation under stress and cause habitats to change. Wildlife survival options under the projected changes will be obstructed by the inability to migrate first within a country and more especially between countries, due largely to habitat fragmentation and man-made barriers.

Possible adaptation strategies for biodiversity could include:

- Monitoring of ecosystem processes and biodiversity and facilitating the development of effective and adapted policies and strategies to reduce the risks.
- Improving the design and enforcement of corridors to ensure connectivity between protected areas through migration.
- Promoting Ecosystem-based Adaptation (EbA).

Table 6-7: Livestock and rangeland adaptation strategies to climate risks (MENT, 2019)

Risks	Adaptation	Strategies
Increased temperature Reduced rainfall Increased drought frequency Increased risk of Wildfire	Ecosystem based adaptation	Ecosystem-based adaptation (EbA) and its key components are conservation of biodiversity that results in resilient ecosystem services leading to improved livelihood
	Breeding for adapted animals	Breeding efficient livestock under the future climate leading to shift in vegetation composition and increased temperatures. Crossbreeding the indigenous breeds with exotic breeds could improve adaptive capacity and ensure that economically important traits (e.g., growth rate) are maximized through heterosis.
	Fodder production	The forage deficiency resulting from declining rangeland productivity will be addressed through fodder production.
	Supplementation	Provision of supplementary feeds such as crop residues (stover), dicalcium phosphate and drought pellets
	Destocking	A proactive and coordinated market is essential to reduce livestock loss associated with climate risks.
	Livestock mobility	The livestock has to be continually moved to areas with sufficient grazing resources and overgrazed land allowed to rest.
	Development of sustainable water sources	Water harvesting technologies to be exploited to ensure continuous water supply for the livestock industry.
	Wildfire Control and Management	Production and operational of Fire Management Strategies and firebreak maintenance as well as use of early warning systems.

- Sustainable ecosystem management for protecting the resilience of habitats and related biodiversity.
- Adaptive management actions to protect vulnerable ecosystems such as the promotion of co-existence between local communities and wildlife in key areas, strategic artificial water provision, adaptive fire management (early dry season prescribed burns in key areas), conducting a National Forest Inventory, promotion of agroforestry practices, *in-situ* conservation, reforestation and afforestation (MENT, 2019).

Health

Climate change is a real threat to the well-being of the population (GoB, 2011). The National Health Policy (NHP) of Botswana predicts that the impacts of climate change on health will exacerbate the incidence of malaria due to increases in temperature and rainfall in some parts of the country. There will also be an increase in the incidence of cholera and an increase in malnutrition due to reduction in domestic food production and crop yields. Exposure to heat stress is likely to become an issue especially for agricultural and construction workers.

Possible adaptation strategies for health could include:

- Revision of the Public Health Act and National Health Policy to include climate change (based on evidence).
- Assessment of the status of health facilities and their preparedness in handling casualties from climate change events including addressing biological, psychological and social problems as well as ability to work with local community structures and groups to enable protection of the severely injured and those disabled by mental disorder.
- Strengthening of the integrated environment and health surveillance.
- Developing a set of risk reduction interventions required to protect nutrition from climate related risks.

Adaptation strategies

Adaptation is a priority to Botswana and at present, sectors vulnerable to climate change impacts are promoting and implementing some adaptation measures. The following adaptation actions are currently being implemented by the Government nationally to help communities adapt to the impacts of climate change.

Water

- Construction of pipelines and connections to existing ones to transmit water to demand centres.
- Reduction of water losses during transmission by investing in telemetric monitoring systems.
- Enhancement of conjunctive groundwater-surface water use.

Agriculture

- Improvement of genetic characteristics of livestock such as Musi breed.
- Improvement of livestock diet through supplementary feeding.
- A switch to crops which are drought resistant, tolerant to high temperatures and have a short maturity period.
- Promote smart farming practices especially in urban spaces.

Health

- Public education and malaria campaigns.
- Malaria strategy.
- Control of diarrhoeal diseases.

Mitigation strategies

Defining the low emission pathway for the country is based on feasible mitigation projects and these include addressing Botswana's energy needs to meet the targets of SDG 7 while keeping emissions within the nationally determined targets for the Paris Agreement. This is an opportunity to reduce Botswana's production of GHGs through an increased utilization of renewable energy sources and improved energy efficiency. Botswana envisions that biogas plants, solar power stations, solar-powered boreholes, streetlights and geysers, together with air quality monitoring systems are measures that would mitigate against emissions from its energy sector.

Biogas plants

Biogas plants generate methane (CH₄), an energy gas from agro waste (mainly livestock manure) and municipal waste (wastewater and solid waste). Botswana already has several operational biogas projects at Nkoyaphiri, Moshupa, Mmathethe and Mmamashia and some large-scale projects which are ready for piloting, for example the Botswana Meat Commission biogas plant. The installation of household and small farm biogas digesters are also envisioned as they will also contribute to reduction of fossil fuel usage.

A planning scenario of the construction and installation of 1,000 household biogas digesters per year was used to simulate a low emissions pathway from 2020 to 2030. The projected GHG emissions reduction would increase to approximately 190 Gg CO₂ eq. by 2030. In addition, there is another project that is currently being undertaken at the Glen Valley wastewater treatment plant where methane is captured and flared to heat up oxidation ponds and thus to speed up anaerobic processes. Methane as an energy gas can be captured and used for generating electricity, as cooking gas and various heating and lighting processes. Capturing methane reduces GHG emissions by 53 Gg of CO₂ eq. and is projected to increase to 400 Gg of CO₂ eq. by 2030.

Solar power stations

As part of its commitment to reducing GHGs, the Ministry of Minerals and Energy (MME) is in the process of procuring a 100 MW Solar PV Plant to be built and operated by an independent power producer. There are other various mini on-grid to off-grid solar power stations which are either planned or operational. For example, 12 solar PV grids-tied plant systems of 35 MW capacity are in the planning phase.

Solar powered streetlights

This is another mitigation project that is being actively pursued by the Government in partnership with BITRI. There are currently 850 solar powered streetlights installed throughout the country with an estimated GHG emissions reduction of 0.24 Gg of CO₂ eq. Adopting a planning scenario of installing 1,000 streetlights per year, it is projected that they have the potential to reduce national GHG emissions by 3.87 Gg of CO₂ eq. by 2030. In some constituencies such as Letlhakane, constituency funds are used in the installation of solar streetlights.

Solar-powered boreholes

Local farmers are voluntarily switching from diesel powered pumps to solar powered boreholes influenced mainly by their cost-effectiveness. Like other solar appliances, solar powered boreholes replace the use of fossil fuel and petroleum simulated at 28.3 Gg of CO₂ eq. and products and thus reduce GHG emissions. It is estimated that there are currently about 537 solar powered boreholes across the country with emission reduction potential of 0.55 Gg CO₂ eq. but these are projected to increase and will reduce emissions by 169 Gg of CO₂ eq. by 2030 (MENT, 2019).

Solar geysers

Although solar geysers have been in existence for over 50 years in the country, the uptake rate has been extremely low. According to a household survey done in 2011, only 0.14 percent of households were using solar for heating, while Botswana Power Corporation (BPC) estimated that only 3 percent of high-income households were using solar geysers. Using a figure of 0.14 percent, it is estimated that 750 households use solar energy for heating. This translates into 0.07 Gg of CO₂ emissions reduction which is projected to increase to 8 Gg of CO₂ emissions reduction by 2030.

Air monitoring systems (power plants)

Gas emissions from the generation of electricity are monitored by BPC through online stack emissions as a self-monitoring exercise, at their Morupule power plants in Palapye. The air monitoring stations are in the area of influence within approximately 8.5 km, of the power stations. Additional monitoring stations are being established in the Palapye area. The stations measure SO_x, NO_x and PM 2.5, 4 and 10. Additional monitoring is conducted to monitor ash disposed off at dumps which are prone to causing dust pollution. Dust monitoring of particulate matter of 50 µm is monitored around the power stations with 17 dust fall buckets located around the ash dumps, coal and limestone stockpiles.

In addition to the above, the University of Botswana Main Campus in Gaborone is part of the global AERONET network. AERONET collaboration provides globally distributed observations of spectral Aerosol Optical Depth (AOD), inversion products and precipitable water in diverse aerosol regimes.

Costs and future actions needed

As of 2016, it was estimated that to achieve the set target of 15 percent GHG emission reduction by 2030, the country would require approximately US \$18.4 billion. These funds will be allocated to the energy and transport sector infrastructural developments which will contribute most to emissions reductions (MENT, 2016). Future activities that need to be conducted to support these costs include::

- Identification of sources of funding for implementation of the mitigation measures.
- Share of Government and international contribution to support the mitigation measures.
- An assessment of the impacts on national economic growth from allocating national resources to mitigation measures.
- Development of a conducive legal framework to support the targeted 15 percent emission reductions.

6.5 Clean energy

By 2019, national access to electricity stood at 70 percent. The rate of access varies highly between the urban and rural populations as shown in Figure 6-9. The rate of access to electricity among the urban population was 88 percent in 2019 while that of the rural population was 28 percent in the same year (UN Stats, 2021).

With rural villages in Botswana remaining poorly electrified, there is opportunity for SMART mini grid-based electrification given the scope and success of these PV systems. These SMART mini grids could include smart futures after practical considerations. Since most areas receive ample sunlight, solar PV models can be chosen in conjunction with biomass (Kumar et. al., 2018).

Clean fuels and technology

The proportion of the population primarily relying on clean fuels and technologies is at 53 percent, while the access to clean cooking energy is at 65.6 percent (IEA, 2020; UN Statistics Division, 2018). Almost half the population uses

wood as a source of fuel. The use of unclean energy sources for cooking, lighting and heating is believed to have negative effects on health. It is estimated that in Botswana about 27 child deaths per year are attributable to household air pollution as shown in Table 6-8 (CCA, 2021).

Botswana takes a synergetic approach to electricity and clean cooking access by jointly considering both sectors for electrification planning.

Renewable energy

As illustrated in Figure 6-10 Botswana is heavily dependent on fossil fuels to meet its energy demands. Renewable Energy Sources (RES) constitute 28 percent of the total final energy consumption but it is worth noting that a majority of this is traditional biomass (IEA, 2020).

Solar power stations

Installed capacity of renewable energy sources stood at below 1 percent of total installed capacity in Botswana in 2018 (Bader, 2018). These installed capacities include

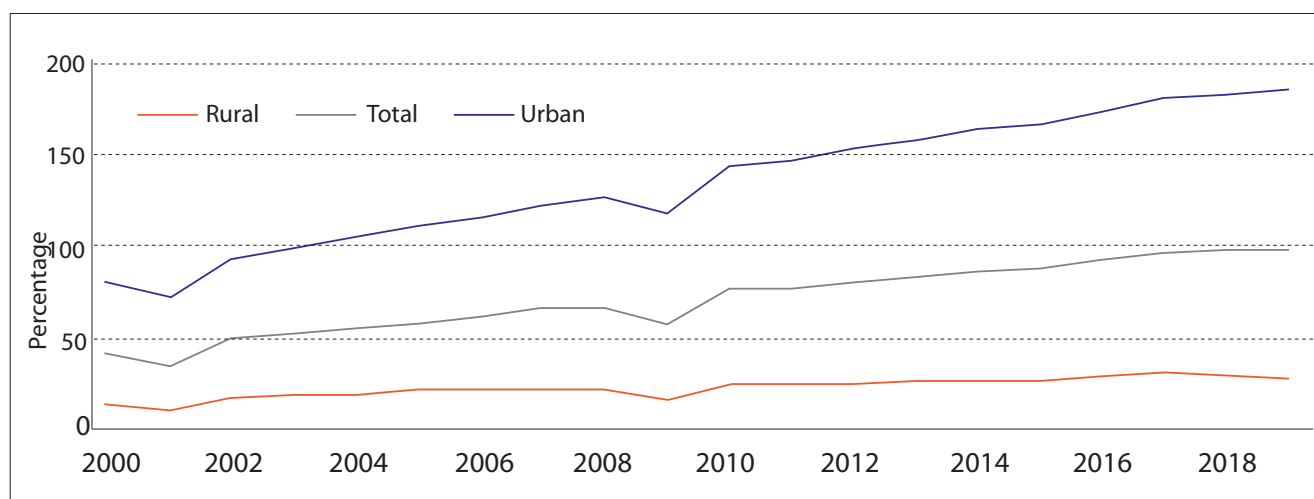


Figure 6-9: Proportion of population with access to electricity by location 2000-2019 (UNStats, 2021).

Table 6-8: Cooking fuel access and HAP in Botswana (CCA, 2021)

Cooking fuel access fuels in Botswana	Extent of access
Number of people affected by Household Air Pollution (HAP)	741,447
Number of households affected by HAP	176,535
Number of deaths per year attributable to HAP	311
Number of child deaths per year attributable to HAP	27
Urban population using solid fuels	<5%
Rural population using solid fuels	52.7%
Population using wood for cooking	43.4%
Population using dung for cooking	0.1%
Population using charcoal for cooking	0.0%
Population using coal for cooking	0.1%
Population using kerosene for cooking	3.3%
Population using gas for cooking	45.8%
Population using electricity for cooking	7.2%
Population using other fuels for cooking	0.1%

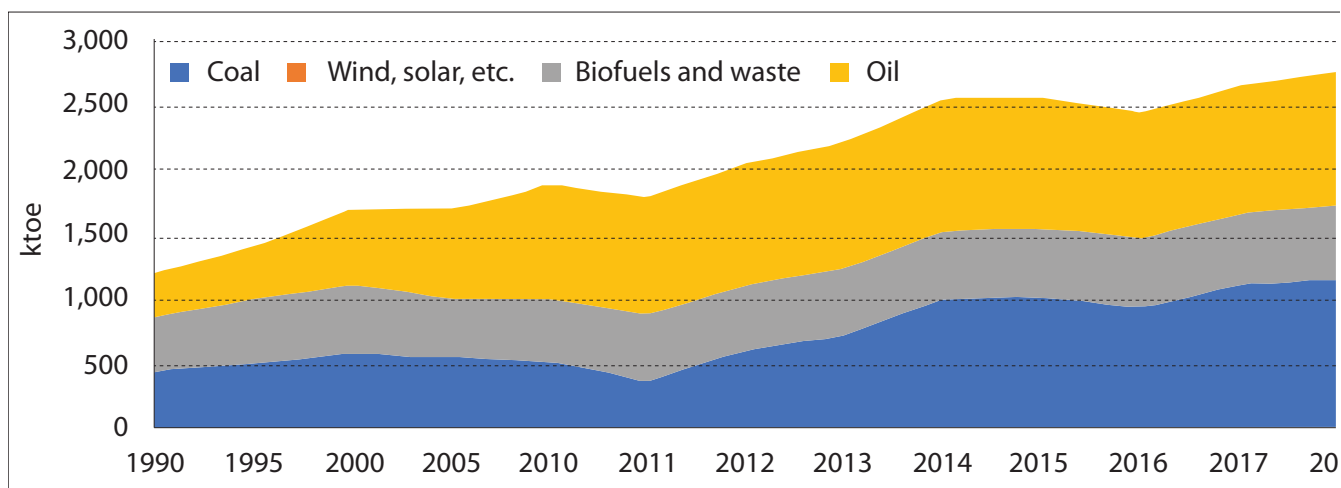


Figure 6-10: Total primary energy supply (TPES) by source, Botswana 1990-2018 (IEA, 2020)

photovoltaic (PV) systems which are operational; 1.3 MW Phakalane station and 29 solar PV systems that are installed in primary schools to support educational programmes. The size of the plants that are built in schools average 60 kW each. Apart from the above-mentioned Government initiatives there are several privately owned solar PV plants in the Okavango Delta that supply energy to the hotels, lodges, and off-grid remote wildlife camps. The average capacity of the PV plants at the lodges is 32 kW. At fully operational level, the solar power stations have the potential to reduce GHG emissions by 261 Gg of CO₂ eq. by the year 2030. As demonstrated in Figure 6-11, the share of renewable energy sources in Botswana's energy mix is very low and has been dropping over the period 1990 to 2015. However, the untapped potential for the expansion of these sources is demonstrated in Figure 6-12.

Energy efficiency

Efforts to reduce electricity demand have been explored in Botswana through some initiatives at household level, such as replacement of incandescent bulbs with compact fluorescent bulbs (CFLs) in selected households. This was an initiative implemented by BPC in 2012, aimed at reducing electricity consumption through demand-side management. This initiative resulted in an average national demand reduction of 33.5 MW at the time. However, this strategy was not sustained as users reverted to the use of cheaper incandescent bulbs for replacements afterwards (DoE, 2017). It is estimated that CFLs can save up to 60 percent of electricity relative to the incandescent light bulbs hence this CFL mitigation action contributed to GHG emissions reduction of about 145 Gg CO₂ eq. in 2012 and

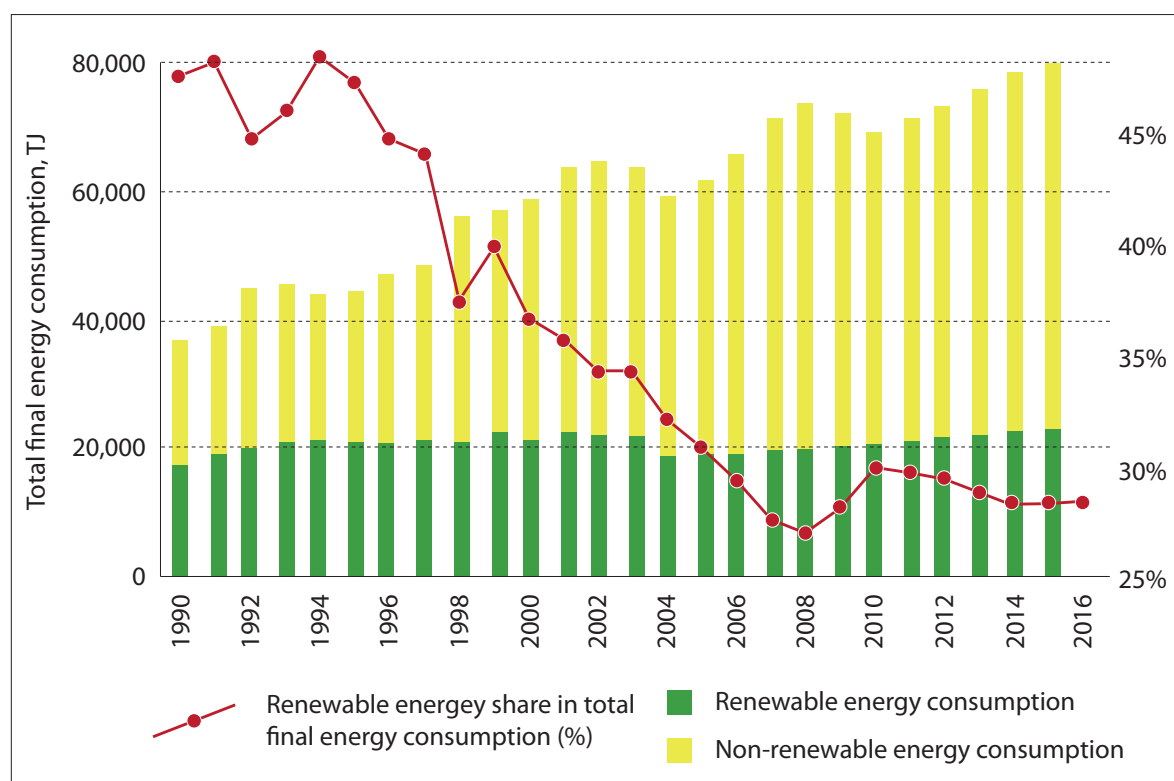


Figure 6-11: Renewable energy share in total final energy consumption, 1990-2015 (World Bank, 2019)

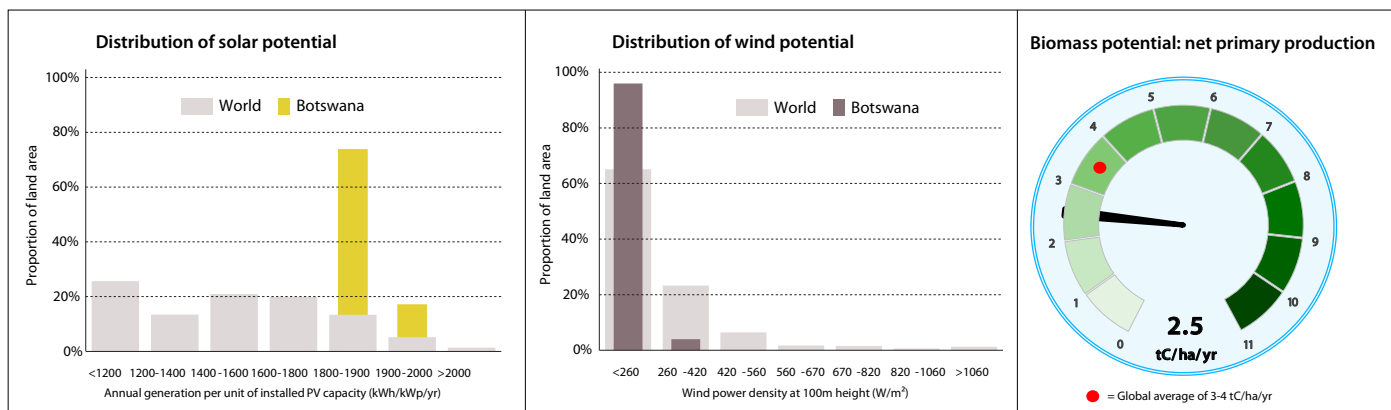


Figure 6-12: Solar PV, onshore wind and biomass potential in Botswana (IRENA, 2017)

was projected to achieve 300 Gg CO₂ eq. by 2030. Smart meters have also been installed in towns and cities for remote control of geysers in households during peak hours. No data is available for energy savings obtained nor for reduction in GHG emissions resulting from this initiative.

Considering this, in 2017 the Department of Energy (DoE), under MME developed an Energy Efficiency Strategy. The strategy highlighted some energy saving potentials in various energy consuming sectors as indicated in Figure 6-13.

The Government has resorted to first developing some energy management statutory documents which can assist in regulation of the implementation of energy efficiency

measures across all energy consuming sectors. This will also assist in sustaining and avoiding premature failure of energy efficiency initiatives as was the case with the BPC roll out of 1,000 CFLs in households in 2012. These statutory documents include:

- An energy efficiency technical booklet for incorporation into the Botswana National Building Control Regulations (completed).
- Energy management standards in buildings (in progress).
- The Minimum Energy Performance Standards (MEPS) for products such as lighting, air conditioners and distribution transformers (in progress).

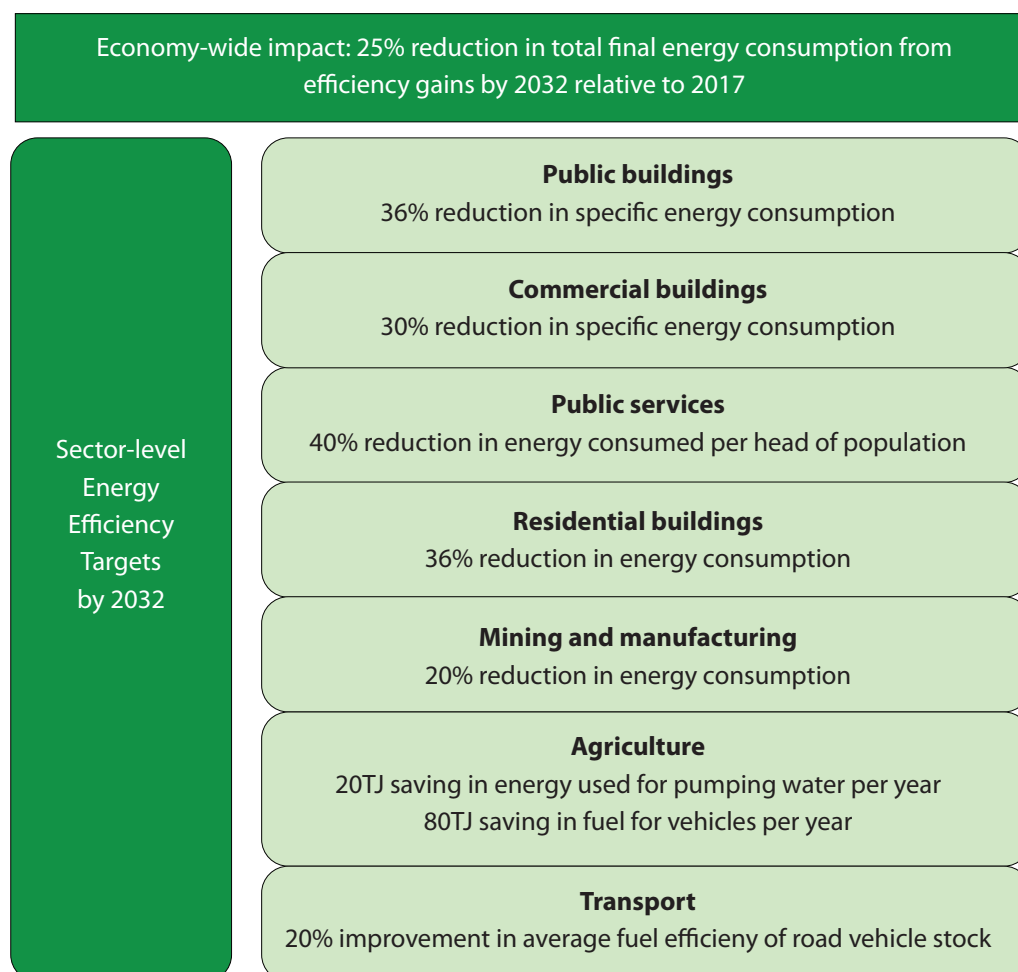


Figure 6-13: Energy saving potentials in various energy consuming sectors, Energy Efficiency Strategy, 2017 (SADC, 2018; DoE, 2017)

6.6 Disaster risk reduction

Disasters in Botswana are expected to increase in frequency and magnitude due to the predicted increase in extreme weather events caused by climate change. The United Nations Office for Disaster Risk Reduction (DRR) defines a disaster risk as “the potential disaster losses in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period” (CIMA; UNISDR, 2018).

The United Nations General Assembly adopted the Sendai Framework 2015-2030, a voluntary, non-binding agreement of which Botswana has adopted and endorsed. The framework recognizes that a primary role of the state is to reduce disaster risk. Various targets in the Sendai Framework are in alignment with SDG 1.5; to minimize the loss of life and property and build the resilience of vulnerable communities through effective DRR strategies by facilitating the integration of DRR into development and day to day risk-reduction-related decision making.

Botswana: disaster risk profile

Disaster risks in Botswana can be seen as the possibilities of hazards affecting the vulnerable population of the country, and as a result causing disasters. Some of these risks are indicated in Table 6-9, in no particular order.

Table 6-9: Disaster risks in Botswana (NDMO, 2009)

Type of Disaster	Disaster	Vulnerable Communities
Natural	Flooding and storms	Communities located in flood prone areas; in developed areas that lack proper storm water management system
Natural	Drought	Communities whose livelihoods are based on agricultural activities
Natural	Animal epidemics	Communities whose livelihoods are based on agricultural activities
Natural or human-made	Wild land fires	Communities whose livelihoods are based on agricultural activities
Natural	Earthquakes	
Human-made	Urban fires	Occurs mostly in Gaborone and Francistown.
Natural	Human epidemics (HIV/AIDS, Cholera, Diarrhoea, and Malaria)	Communities living in poor sanitary conditions with constrained resources and improper nutrition
Human-made	Motor-vehicle accidents	Animals on the roads; those driving in poor road conditions;
Human-made	Potential civil unrest	Immigrants, refugees, poor, women, elderly

Displacement associated with conflict tends to receive more attention, but natural disasters triggered over 7,920 internal displacements between 2009 and 2018 in Botswana as shown in Figure 6-14 (IDMC, 2019). Internally displaced persons are defined as people or groups of people who have been forced or obliged to flee or to leave their homes or places of habitual residence, because of natural or human-made disasters, and who have not crossed an international border.

Floods

Flooding is an impacting natural hazard in Botswana affecting an average of 8,000 people annually, which equates to approximately 0.4 percent of the total population of the country. Most of the affected people are concentrated in the Central District, which is the most populous district, and in Ngamiland, where the Okavango Delta is located (Figure 6-15). The national economy is also highly exposed to floods. On average about US \$90 million of GDP per year can be potentially affected by floods. This corresponds to about 0.56 percent of the total yearly GDP at country level.

As climate models predict a significant increase in temperature and a likely decrease of precipitation, the flood affected population as well as potentially affected GDP are likely to decrease under future climate conditions and when compared to the values evaluated under the current climate

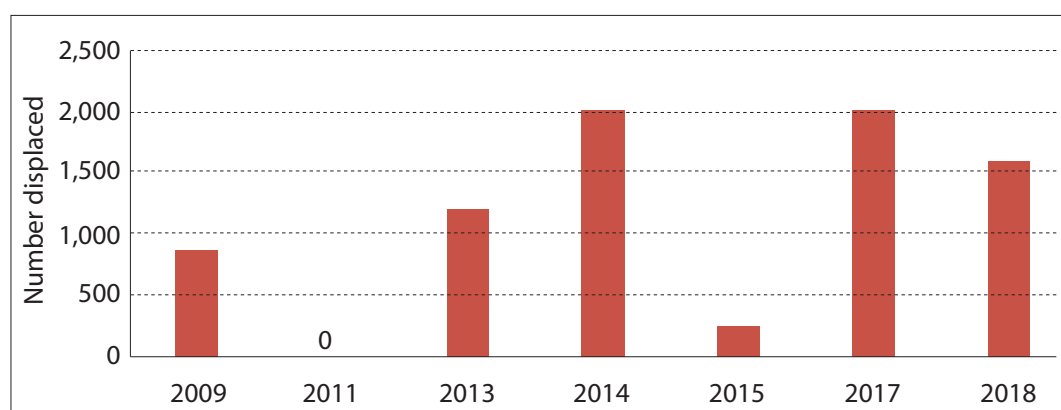


Figure 6-14: Internally displaced persons (IDP) from natural disasters, 2009 to 2018, Botswana (Statistics Botswana, 2017)

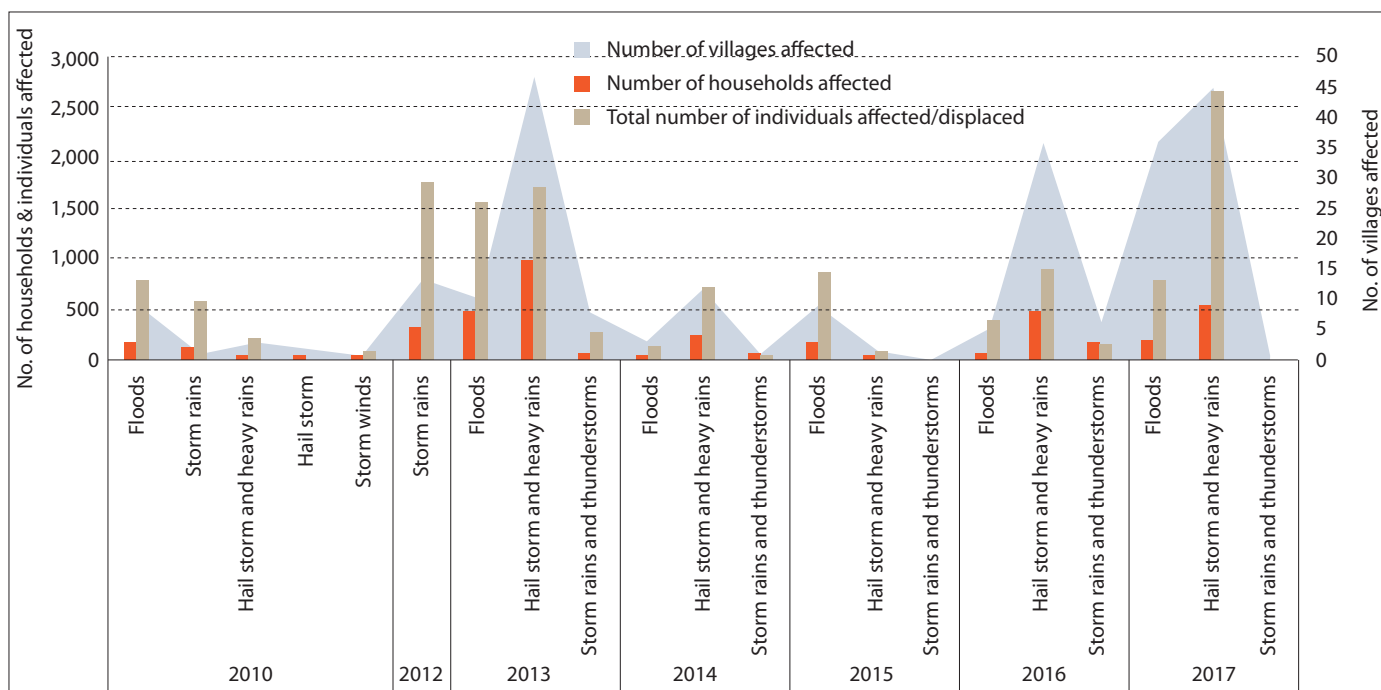


Figure 6-15: Distribution of individuals & households affected by floods and storms, 2010-2017
(Statistics Botswana, 2018)

conditions (Figure 6-16). However, climate projections are inherently uncertain, and this needs to be taken into consideration in policy development and in developing risk reduction strategies.

Droughts

It is likely that in future, large parts of Botswana will experience frequent droughts. In the present climate trends, about 687,000 people (31 percent of the total 2016 population) are annually affected by droughts as shown in Figure 6-17 (CIMA; UNISDR, 2018). Under future climate conditions, this number is expected to increase by up to 82 percent (on average 2.2 million people if population growth is accounted for).

The average annual percentage of GDP affected by droughts (in other words, the economic value produced in areas hit

by droughts) is about 31 percent of the total GDP. This is equivalent to US \$4.7 billion per year which could be impacted by droughts. Under future climate conditions this may rise to 81 percent of the GDP (US \$12 billion), which could amount to US \$70 billion if socio-economic projections are accounted for (CIMA; UNISDR, 2018). This is highlighted in Figure 6-18.

Currently, crop production losses are concentrated in the southern and eastern parts of Botswana. Under future climate conditions, losses increase in most areas of Botswana except in the central part of the country.

Under the current climate, livestock affected by drought amount to about 0.7 million units (36 percent) as highlighted in Figure 6-19. Under future climate conditions (but keeping the current number of livestock), the number of affected livestock is projected to increase by up to 1.7 million units or 83 of the total (CIMA; UNISDR, 2018).

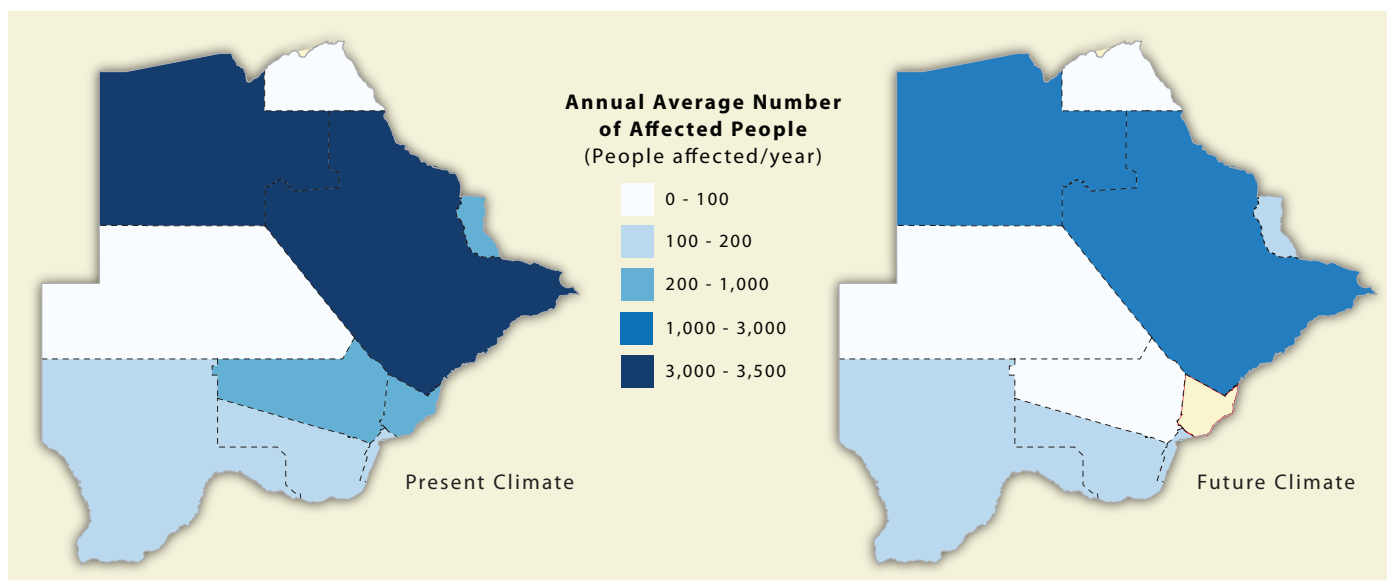


Figure 6-16: Annual average number of affected people, present and future
(CIMA; UNISDR, 2018)

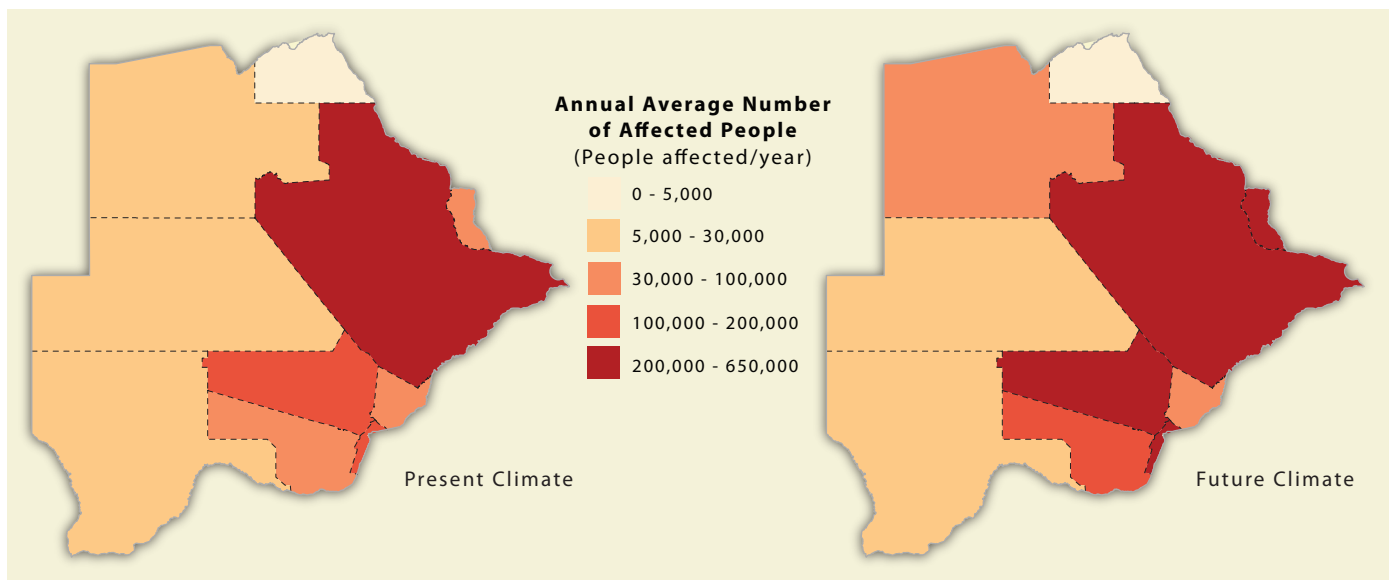


Figure 6-17: Annual average number of people affected by floods
(CIMA; UNISDR, 2018)

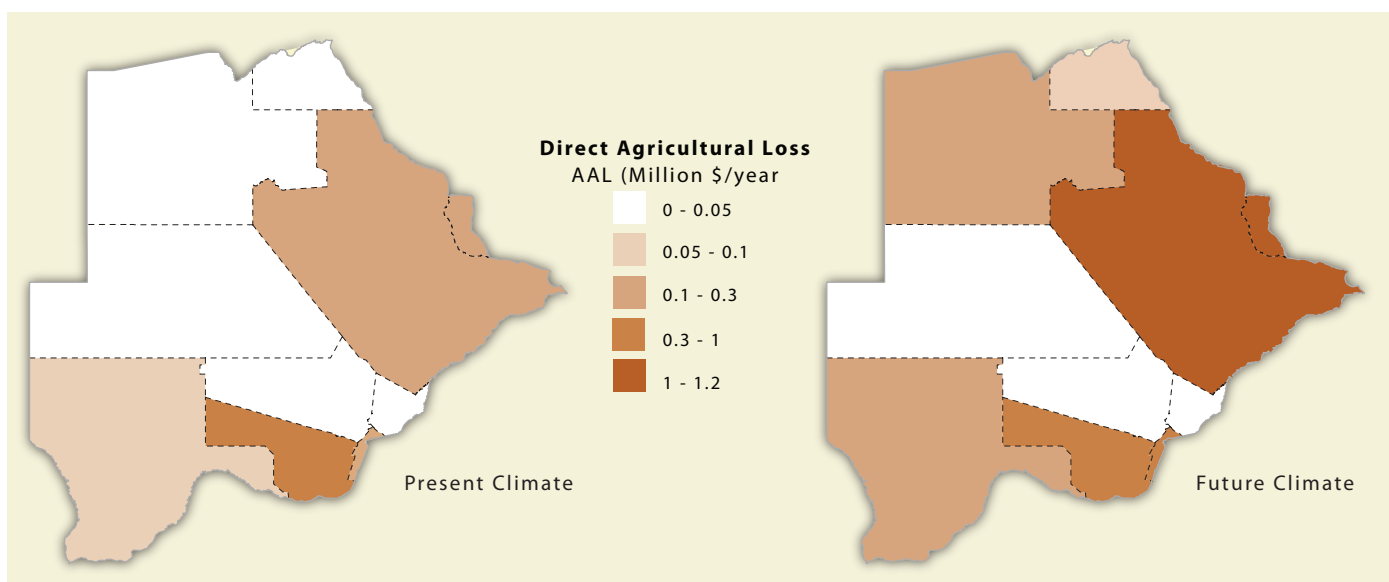


Figure 6-18: Direct agricultural loss
(CIMA; UNISDR, 2018)

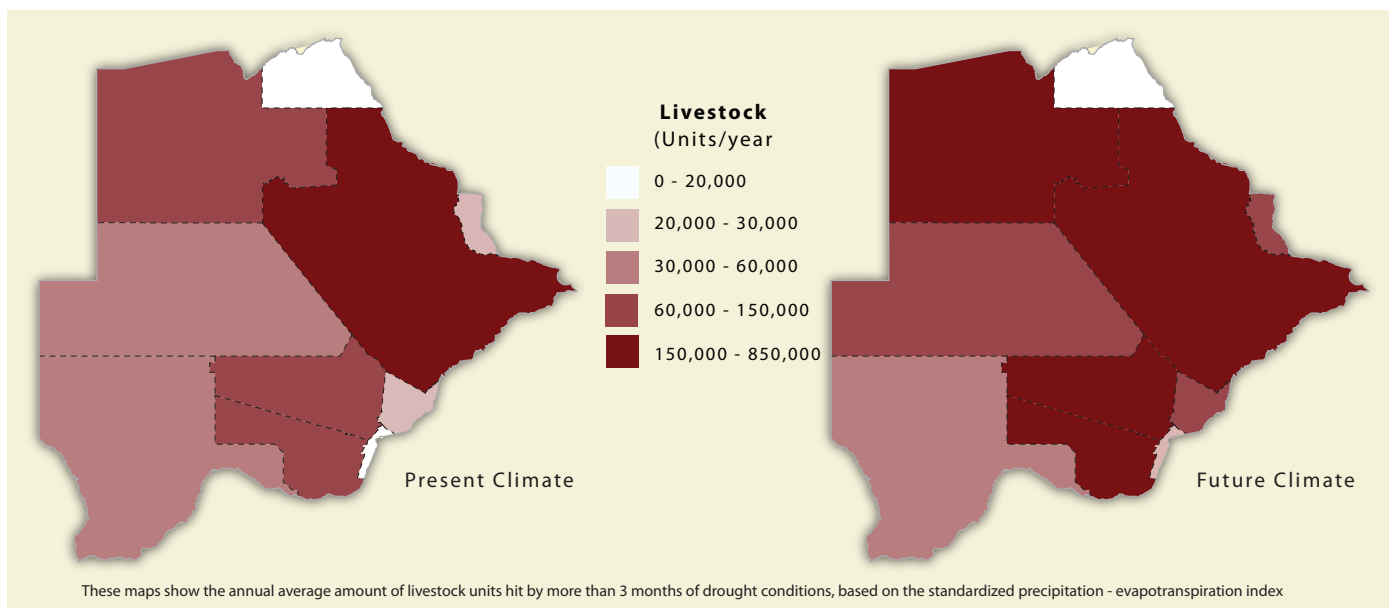


Figure 6-19: Average amount of livestock units hit by more than 3 months of drought
(CIMA; UNISDR, 2018)

Disaster risk management in Botswana

Policy and institutional framework

The current National Policy on Disaster Management (1996), and the National Disaster Risk Management Plan (NDRMP) 2009, addresses all aspects of disaster risk management in Botswana (NDMO, 2013). The NDRMP adopts a multi-sectoral and multiple level approach for disaster risk assessment and response, in line with the Hyogo Framework of Action (HFA) 2005-2015. Under the umbrella of the NDRMP, the 'Disaster Risk Reduction Strategy 2013-2018 acts as a framework for disaster risk reduction implementation in the country (Figures 6-20 and 6-21; NDMO, 2013).

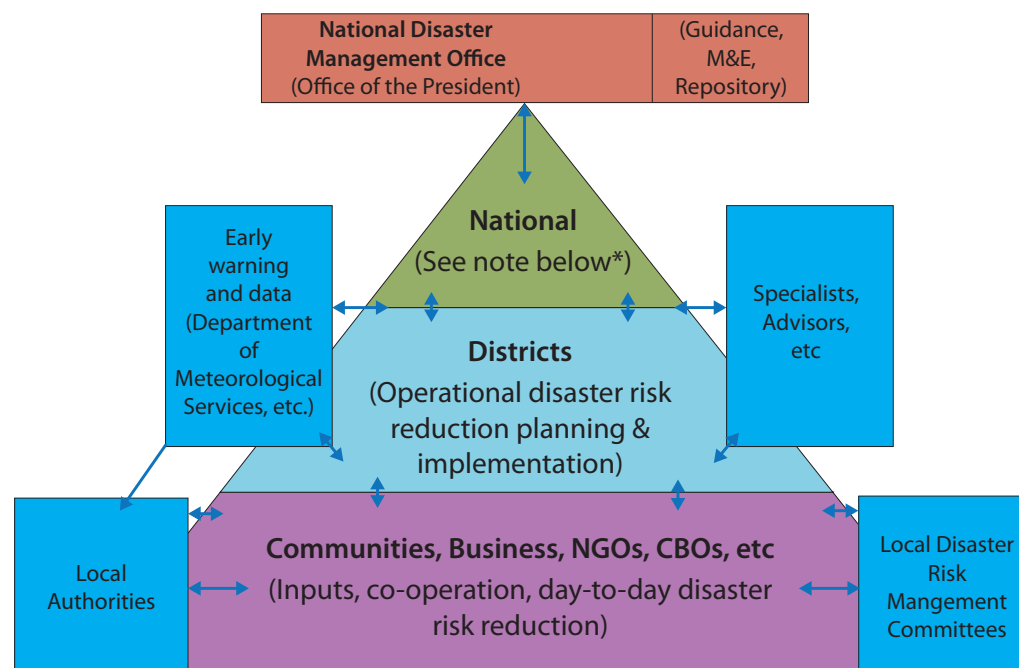
Botswana specific strategic goals for disaster reduction

Specific strategic goals for disaster risk reduction in Botswana:

1. Improving the legal and institutional basis for efficient disaster risk reduction
2. Mainstreaming disaster risk reduction and emergency management into development policy, programmes and projects
3. Building disaster risk reduction capacity at national, district, community and household levels



Figure 6-20: Strategic levels where DRR is being implemented in the country (NDMO, 2013)



* National sectors, ministries and institutions: Provide Policy and Legislation, Strategic guidance, Capacity Building, Co-ordination of implementation, Communication, M&E & Inter-Gov/Sector & International Co-ordination assisted by National Disaster Management Committees and Specialists, with District and Regional Co-operation and Inputs

Figure 6-21: Strategic levels where DRR is being implemented in the country (NDMO, 2013)

Disaster Risk Reduction activities

The status of disaster risk reduction in the country is summarised in Table 6-10 which indicates the extent to which measurable disaster risk reduction activities and principles have been implemented to date.

Botswana's achievements of the specific strategic goals for disaster risk reduction:

1. Improving the legal and institutional basis for efficient disaster risk reduction

- Endorsed the Sendai Framework of Action 2015-2030.
- The NDMO is reviewing the National Policy on Disaster Management. The purpose of the review is to further strengthen institutional framework and also to align with the Sendai Framework of Action and other International and Regional Frameworks. The revised Policy also seeks to mainstream cross cutting issues such as gender, people with disabilities, youth, elderly, climate change etc. The Policy is to be presented to Parliament in July 2022.

- The Disaster Risk Management Act is also being developed. The purpose of the Act is to provide for a comprehensive and proactive legal framework to manage disaster risk in the country. The Act is to be finalized in 2023.

2. Mainstreaming disaster risk reduction and emergency management into development policy, programmes and projects

- The Revised Policy on Disaster Management provides for the mainstreaming of Disaster Risk Reduction into development policies.
- The advent of COVID-19 pandemic in 2020 saw the establishment and operationalization of the multi-sectoral Emergency Operations Centre and its purpose primarily to provide real time information to the Districts and responsible sector/s and the NDMO. Additionally, funds for the establishment and equipping of a permanent structure have been acquired. The project is due to be completed in 2023/24 financial year. Furthermore, plans to establish sector based Emergency Operation Centres are ongoing, for instance, Public Health and Cybercrime.

Table 6-10: Status of Botswana disaster risk reduction initiatives (NDMO, 2013)

Item/ Action / Outcome		National Status*
1	The implementation of risk reduction or other initiatives are based on the disaster risk assessment results	1
2	Case studies, initiatives and lessons learned in risk reduction have been documented and disseminated	2
3	Risk reduction-related projects and initiatives have been included in development Plans	1
4	Disaster risk reduction programmes, projects and initiatives have been Implemented	2
5	Progressive application of disaster risk reduction techniques and measures are reported in annual reports and submitted to the National Disaster Management Office.	2
6	Effective and appropriate early warning strategies have been developed and implemented and the information communicated to stakeholders to enable appropriate responses	2
7	Disaster risk reduction is the focus of all disaster risk management awareness Programmes	2
8	Awareness of disaster risk management is promoted at schools and in communities known to be at risk	2
9	Awareness of disaster risk management is widespread, and risk-avoidance behaviour is integrated into the day-to-day activities of all stakeholders	1
10	Articles and news on disaster risk management are regularly published in the Media	3
11	Disaster risk reduction is included as a standard agenda item for consideration at meetings of all governmental role players and stakeholders	1
12	Disaster risk reduction is included as a standard agenda item for consideration at meetings of all non-governmental role players and stakeholders	1
13	Budgets in all spheres of government include the costs of routine disaster risk reduction measures and activities	1
14	Feasibility studies for capital projects include information drawn from disaster risk assessments and appropriate risk reduction measures	1
15	Capital budgets clearly reflect the costs of disaster risk reduction	1
16	There is a clear correlation between disaster risk reduction and effective law, bylaw and policy enforcement	1
17	Vulnerability have decreased in the last five years because of risk reduction initiatives	2

*1=Not yet addressed/achieved; 2=Started-in process/Partially achieved; 3=Fully addressed/achieved

3. Building disaster risk reduction capacity at national, district, community and household levels

- Sectors and District trained regularly on elementary Disaster Risk Management and Emergency Management. In this regard, Sector Disaster Plans and District Contingency Plans have been developed to effectively and efficiently respond to disasters.
- Established a multi-sectoral Search and Rescue Team
- Established Standing Boat Operations Team that assists during the rainy season at flood prone zones. The team annually conducts refresher training in October of each year as part of preparedness before the rainy season.
- Risk and Vulnerability Assessment studies conducted in selected disaster prone villages such as Gweta, Nata, Nxaraga, Charleshill, etc.
- Memorandum of Understanding (MOU) have been established with the 3 mobile service providers for them to disseminate early warning information on the imminent hazard.
- MOU between NDMO, Department of Metrological Services and Department of Water and Sanitation for severe weather, flood warning and emergency management.

*Improvised hand-washing station at
Tshwarangano Junior Secondary School in Maun
Photo credit: USAID/Flickr*



6.7 Status and trends of SDG indicators

SDG 3.9.1: Mortality rate attributed to household and ambient air pollution

The age-standardized mortality rates attributed to ambient air pollution and household air pollution were 52 deaths per 100,000 population and 60 deaths per 100,000 population in 2016 respectively (UN Statistics Division, 2018). In Botswana, air pollution accounts for 40 percent of an estimated 330 child deaths due to acute lower respiratory infections (WHO, 2016).

SDG 7.1.1: Proportion of population with access to electricity.

As shown in Figure 6-9, earlier in the chapter, access to electricity in Botswana is increasing, albeit slowly. It has grown from 27 in 2000 to 70 in 2019 (UN Stats, 2021).

SDG 7.1.2: Proportion of population with primary reliance on clean fuels and technology

The proportion of population with primary reliance on clean fuels and technologies was at 53 in 2019 (Figure 6-22). Between 2000 and 2004, which is taken as the baseline, it averaged 48.4 (IEA, 2020; UN Statistics Division, 2018). The change is negligible and highlights that there is still much to be done in this area to achieve a significant number of people using clean energy.

SDG 7.2.1: Renewable energy share in the total final energy consumption

Renewable Energy Sources (RES) constitute 28 of the total final energy consumption (Figure 6-10) but it is worth noting that a majority of this is traditional biomass (IEA, 2020).

SDG 9.4.1: CO₂ emission per unit of value added

The indicator CO₂ emissions per unit of value added represents the emissions from fuel combustion produced by an economic activity, per unit of economic output. Carbon dioxide emissions per dollar of GDP at constant prices of 2010 were 0.2 kg in 2017 (UN Statistics Division, 2018). Statistics indicate that carbon dioxide emissions per dollar of manufacturing value added at constant prices of 2010 decreased from 0.2 kg in 2000 to 0.1 kg in 2017 (UN Statistics Division, 2018). This trend results from changes in the average carbon intensity of the energy mix used, in the structure of the manufacturing sector, in the energy efficiency of production technologies in each sub-sector, and in the economic value of the various output. For instance, the manufacturing industries generally improve their emission intensity as countries move to higher levels of industrialization, but it should be noted that emission intensities can also be reduced through structural changes and product diversification in manufacturing.

SDG 11.6.2: Annual mean levels of fine particulate matter (PM_{2.5} and PM₁₀) in cities (population weighted)

In 2016, the annual population-weighted average mean concentration of fine suspended particles of less than 2.5 microns in diameter (PM_{2.5}) was 20.9 micrograms per cubic metre in Botswana (Figure 6-23). This is above the maximum level for safety set by WHO of 10 micrograms per cubic metre. Therefore, this presents a relatively high levels of particulate matter pollution. Botswana's baseline Annual mean levels of fine particulate matter (PM_{2.5}) in 2015/2016 was 85% (Botswana Domesticated SDG Indicators, n.d).

Household air pollution largely emanates from the burning of solid fuels (biomass or coal) for cooking. This disproportionately exposes women and children to greater

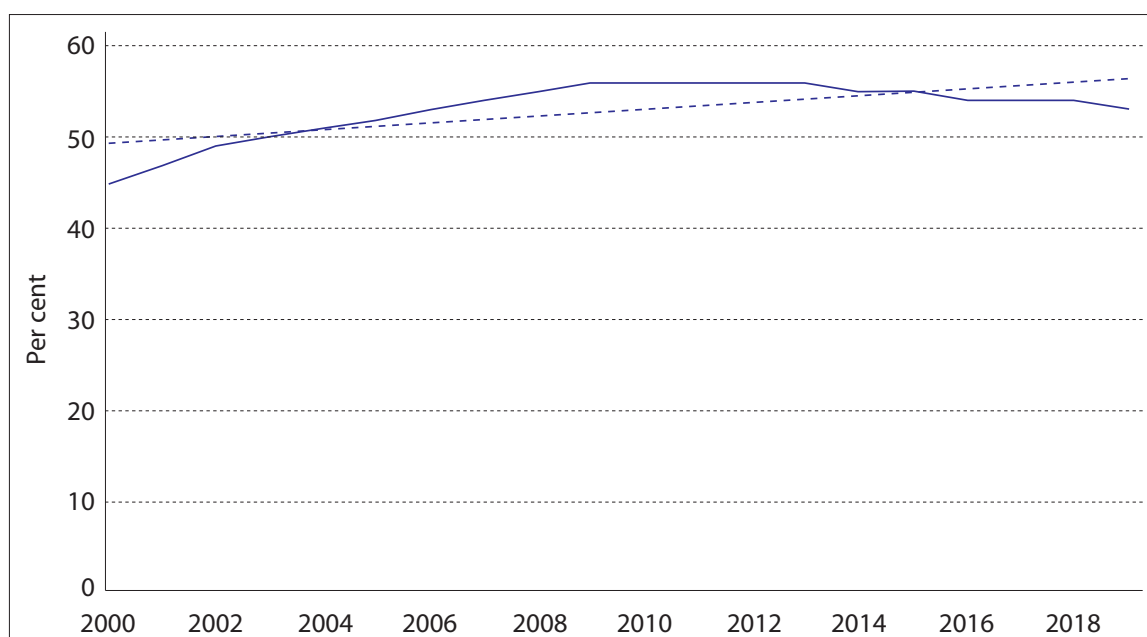


Figure 6-22: Proportion of population with primary reliance on clean fuels and technology (IEA, 2020; UN Statistics Division, 2018)

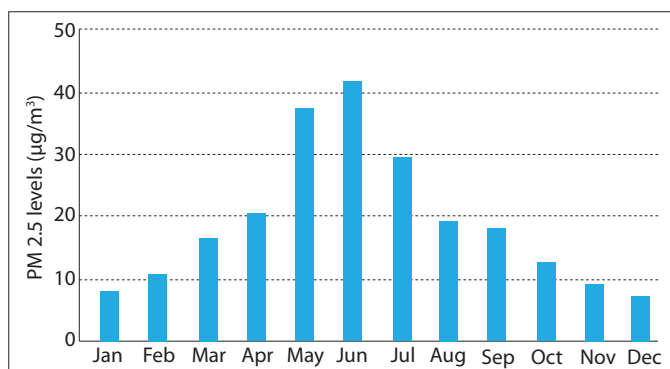


Figure 6-23: Level of PM (2.5) in Gaborone in 2017 (GoB, 2020)

risk of diseases. Household air pollution is responsible for a larger proportion of the total number of deaths from ischaemic heart disease, stroke, lung cancer and Chronic Obstructive Pulmonary Disease (COPD) in women compared to men (WHO, 2016).

SDG 13.1.1: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population

In 2018, there were 6,106 people affected by disasters. Zero deaths and missing persons were reported, whilst 2,035 people incurred damages to the dwellings due to disasters. However, there were 20 deaths in 1995, decreasing to 12 deaths in 2013 as highlighted in Figure 6-24 (GCLD, 2017).

SDG 13.1.3: Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

The proportion of local Governments that adopt and implement local disaster risk reduction strategies in line with national DRR strategies was 28.1 in 2018.

SDG 13.2.1: Integration of climate change measures into national policies, strategies, and planning

Botswana has communicated the establishment or operationalization of an integrated strategy which increases its ability to adapt to the adverse impacts of climate change, and fostering climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production. This promotes mainstreaming of climate actions to all sectors of development. In addition, Botswana has committed to reduce emissions by 15% (nationally determined contribution), three national communications to the UNFCCC (in 2001, 2011 and 2019), a first biennial update report in 2019 and a national adaptation plan framework in 2020. The impact on vulnerable sectors and suitable adaptation strategies planned by the Government of Botswana are detailed in the sections that follow (SDGs 13.3.1 and 13.3.2).

SDG 13.3.1: Integration of mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula

Botswana has conducted trainings for Red Cross volunteers, and integrated climate change mitigation related activities into the school curricula.

SDG 13.3.2: Communication of the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions

Botswana has undertaken community-based capacity building in all the 10 districts of the country, through training of community members on forestry related aspects, capacity building of communities targeting women's groups for participation in regional gatherings and information dissemination exercises.

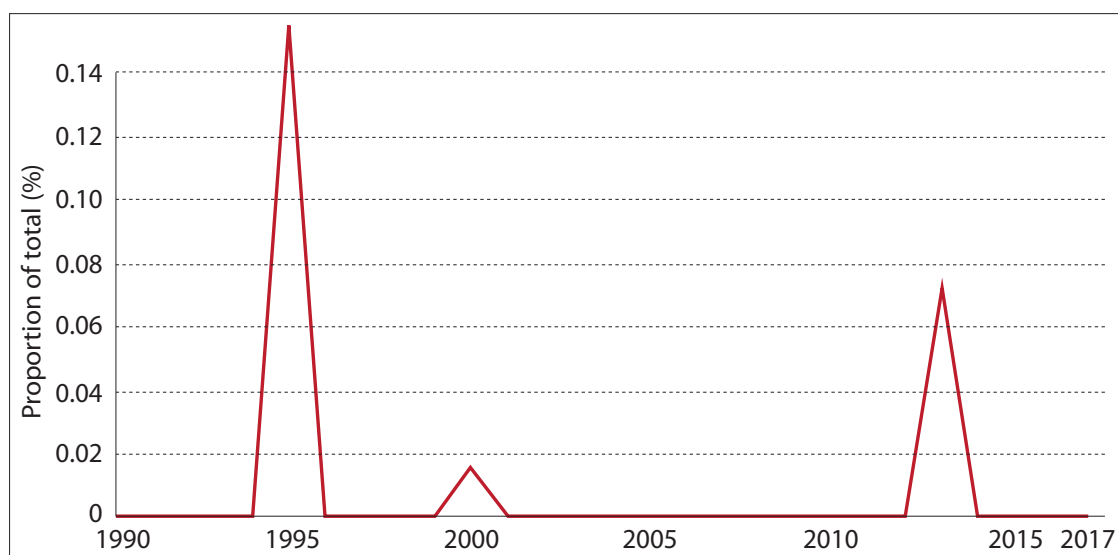


Figure 6-24: Deaths from natural disasters as a share of total deaths, 1990 to 2017, Botswana (GCDL, 2017)

6.8 Responses and suggested future actions

Air pollution

Air pollution and climate change have environmental implications and socioeconomic ramifications for the people of Botswana. The communities are at times exposed to air pollutants exceeding WHO air quality guidelines limit values for particulates. Data for particulates, especially PM_{2.5} has been non-existent until the country started the monitoring in 2016 only in Gaborone. However, in 2019, the air quality monitoring network expansion project stretched the coverage around the country.

Despite these efforts, insufficient funding remains the major challenge associated with air quality monitoring, data collection and information dissemination in Botswana. Other challenges includes inferior environmental regulations and weak institutional mechanisms to enforce and administer air quality monitoring programme.

Climate change

Botswana's communications to the UNFCCC suggests that the country requires US \$18.4 billion to successfully undertake mitigation measures that will ensure that its commitment to 15 percent reduction of GHGs will be achieved by 2030 (<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Botswana%20First/BOTSWANA.pdf>).

Botswana's abundant renewable energy potential, particularly in solar and biomass remains largely untapped. NDP 11 promotes increased energy efficiency and integration of renewable energy in the power mix by aiming to develop cost effective and environmentally sustainable sources of energy generation and seeks to develop a comprehensive renewable energy strategy aimed at facilitating investments in the sector by:

- Mobilising the support of private sector investment into RES by ensuring a stable policy framework that boosts investor confidence.
- Designing incentive schemes and long-term MEPS for promoting energy efficiency in all sectors.
- Ensuring increased energy access with the help of flexible RES solutions to suit the national context.

In addition to mitigation, mobilising adequate funding for adaptation should also be prioritised.

Disaster risk reduction

- For droughts, due to the slow-onset nature of the disaster, adequate risk reduction policies may include facilitation of alternate livelihoods on a seasonal basis to those dependent on agriculture. In contrast, the other major risks (of floods and storms) are sudden onset and largely unpredictable.
- For both slow and sudden onset environmental disasters, the aspect of mobility and immobility during the preparedness and response phases of disasters should be focused on, for both humans and animals to minimise losses.
- Migrant communities are among the most vulnerable communities when the host region is in crisis. Therefore, immigrants and refugees should be given a special focus in DRR plans.

6.9 Measuring Botswana's progress on the climate-related SDGs

There is progress on some of the climate-related sustainable development goals. These include SDG 7.3.1 on energy efficiency, SDG 9.4.1 on CO₂ emission per unit of value-added, SDG 13.1.2 on national disaster risk management, and on SDG 13.1.3 on local disaster risk management. For instance, out of a list of 17 disaster risk outcomes in the National Disaster Risk Reduction Strategy 2013-2018, seven have been started and are in process or partially achieved while nine (9) have not yet been addressed. One outcome on communication has been fully achieved with articles and news on disaster risk management being regularly published in the media.

In terms of communications to the UNFCCC, Botswana is progressively engaged, and this puts the country on a good footing to achieving SDG 13.2.1 on integration of climate change into national policies. On SDG 13.3.1 (education on climate change), the country has integrated climate change into school curricula and energy efficiency awareness programmes are on-going at different levels such as for Red Cross volunteers. Other activities geared towards raising awareness include the National Tree Planting events. On SDG 13.3.2 on building capacity for climate change, activities are on-going in the 10 districts. There have been community-based trainings on forestry related aspects, and women's groups have been intentionally targeted.

Despite these successes there is still much to be done to achieve the targets and goals. For instance, there is a need to set up the network of air quality monitoring stations that will be required to provide the data to report with confidence on SDG 11.6.2 on urban air pollution. Integrating air quality issues into national planning at different levels is a matter of urgency for public health.

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Amazing tall and old tree in Okavango Delta, Botswana
Photo credit: Datingjungle/unsplash

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Gaborone Central Business District
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7

SUSTAINABLE CITIES AND WASTE MANAGEMENT



7.1 Introduction

SDG 11 on 'sustainable cities and communities' aims to renew and restore the quality of cities and human settlements. It attempts to bring together social and economic development utilizing the natural resources to create a sustainable living environment for people. Some of the impacts of human settlements in Botswana include environmental degradation from emissions from the transport sector, urban sprawl and pollution of soil and water due to inadequate services such as water supply, sanitation, and waste management, among others. The pressures from poor waste management can threaten the natural resources required to sustain livelihoods and economic development and can also contribute to poor health.

The discussion in this chapter focuses on waste management, its impacts, and opportunities for better management.

Waste management and the concept of sustainable cities

Waste management is the cycle of activities that governs how waste is handled from its receipt to the final disposal including collection, transport, treatment, and final disposal. The way waste is handled can make it a useful resource or an environmental hazard resulting in air, soil or water pollution. There is a renewed focus on waste management because of the hazards to habitats, biodiversity and even to human health that waste can pose but also because of interest in developing circular economies. In such economies, waste is 'designed out' and resources are given a long useful life by being reused/utilized for as long as possible.

Proper waste management is central to the concept of the sustainable city in that it aims to remediate the environmental problems associated with waste management. Indeed, Botswana has a regulatory framework to monitor, enforce and ensure compliance with the law. However, there are challenges with implementation. As indicated in NDP 11, the Government will continue to work to create a sustainable healthy environment using a mix of measures that will include waste reduction, reuse, recycling, and other green technologies. The implementation of these measures is expected to contribute to the reduction of health risks associated with environmental degradation or pollution and create better quality living conditions in the country.

Botswana can measure progress in achieving SDG 11 on sustainable cities and communities by assessing the extent at which urban planning and city management initiatives integrate the four dimensions of a sustainable city. These are environmental sustainability, resilience to natural disasters and inclusive and competitive communities (World Bank, n.d.). The outcome will be seen through the elimination of extreme poverty and a shared prosperity at all levels (World Bank, n.d.). However, there is much to do in terms of establishing baseline data foundation to drive monitoring and evaluation of the indicators that measure sustainable cities.

Vision 2036 perceives a sustainable city as a hub providing social and economic opportunities for individual and societal growth; and it pledges to plan and design settlements to be 'socially inclusive, environmentally friendly and economically vibrant'. Underpinning all these are linkages between urban and rural areas for national sustainability and cohesion (GoB, 2016).

What is waste?

The Waste Management Act of 1998 defines waste as including the following substances and any combination thereof which are discarded by any person or accumulated or stored by any person for the purpose of recycling: undesirable or superfluous by-products; residue or remainder of any process or activity; any gaseous, liquid or solid matter.' It further states that 'waste is defined by place of origin or generation (household, industrial, mining waste etc.).'

Any material that is no longer needed or is unusable may be termed as waste. In many instances materials or objects may be thrown away after being used or because they have either lost value, have become worn out or malfunctioned. Sometimes what one considers as waste may still have the potential to be processed into a new product for use in other applications.

Waste can be classified in a variety of ways –either as hazardous or non-hazardous; or depending on its source, its composition, or its state (solid, liquid, or gaseous). Examples of sources of waste include domestic, commercial, municipal, agricultural and industrial. Waste classified by composition may include things like plastic, metal, glass, paper, biodegradable, or non-biodegradable wastes (Dladla et. al, 2016). Table 7-1 highlights some of the different types of wastes in Botswana and how much is produced on an annual basis (Kgosiesele and Zhaohui, 2010).

Table 7-1: Annual quantities of waste in Botswana (Kgosiesele & Zhaohui, 2010)

Waste Type	Quantity (tonnes/year)
Solid waste at landfill (excluding mine waste)	270,425
Solid hazardous waste	1,560
Hazardous clinical waste	2,500
Scrap metal waste	20,000
Household waste	250,000
Liquid hazardous waste ('000m ³)	34,610
Tyres (number)	90,651
Household dry cell batteries (number)	24,000
Lead acid batteries (number)	46,000
Oil waste (1000 litres annually)	5,600

Urbanization - a driver of waste generation

Waste management has long been a major challenge in Botswana. As the population increases, the volume and complexity of waste produced also grows, driven by the growth in and densification of urban areas, changing consumption patterns, industrialisation, advancements in technology, economic growth and the consequent rise in incomes.

By 2017, more than half (68.7 %) of Botswana's population were living in urban areas (GCDL, 2020). In comparison with its neighbours, the share of the total population living in urban areas in the same year in South Africa was 65.34, Namibia 47.96 and Zimbabwe 32.3 (GCDL, 2020). The number of people living in urban areas in Botswana has been growing steadily ever since the discovery of diamonds in the early 1970s; and it is expected that 87.9 % of the population will be living in urban areas by 2050. Gaborone, the capital city, has a population of 244,107. Botswana's average population density increased from 2.28 people per square km in 1991 to 3.71 people per square km in 2017 (Statistics Botswana, 2020a; GCDL, 2020).

7.2 Solid and liquid waste

Solid and liquid waste management are regulated under the Waste Management Act of 1998. The Government recognises that there is a direct correlation between sanitation, health, and human and environmental well-being. Against this background, it is keen to ensure that the level of cleanliness in the cities and rural areas is maintained through the prudent management of solid and liquid waste as stated in NDP 11. In addressing these urbanisation challenges, Government aims to attain SDG 11.

Solid waste

Solid waste can be defined as waste that is in a solid format and generated from household, agricultural, industrial or commercial sources. There are vast differences in the mass and volume of waste generated from different localities. As shown in Table 7-2, the per capita quantity of waste generated in urban areas is greater by almost four (4) times by volume and almost seven (7) times by mass than that generated in rural areas (Mmerekhi, 2018).

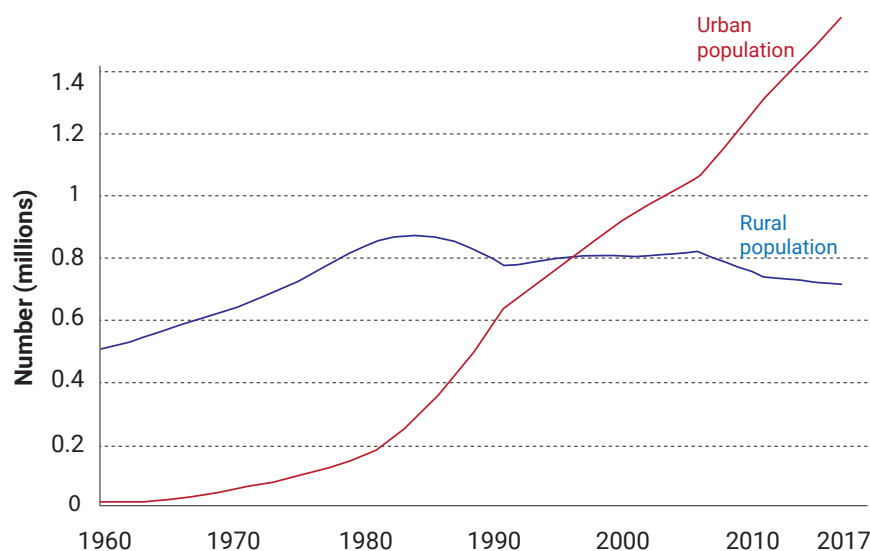


Figure 7-1: Number of people living in urban and rural areas in Botswana 1960-2017 (GCDL, 2020)

Table 7-2: Mean per capita waste generated by locality (Mmerekhi D., 2018)

Area	Waste generated (m ³ /capita/year)	Waste generated (kg/capita/year)
Rural	0.62	0.2
Urban	2.32	1.32

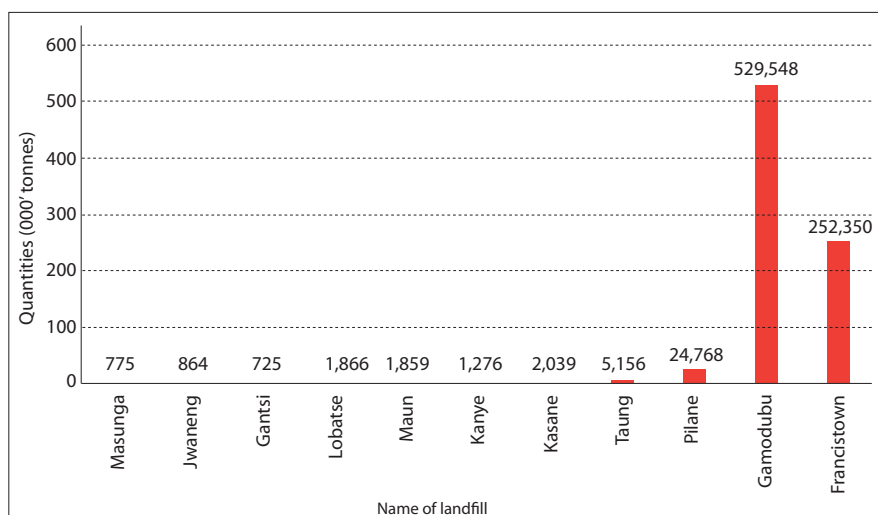


Figure 7-2: Annual average quantities of solid waste disposed at various landfills in 2015 (Keabetswe, 2020)

State of solid waste in Botswana

Most solid waste in Botswana is disposed of in landfill sites. There are 14 landfill sites in Botswana which are at Kasane, Lobatse, Maun, Francistown, Gantsi, Jwaneng, Gamodubu, Selibe Phikwe, Tsabong, Serowe, Masunga, Ramotswa, Pilane and Kanye. In December 2019, a total of 62,978 tonnes of solid waste (excluding sludge) was disposed of in eight (8) of the 14 landfill sites, as shown in Table 7-3 (HCSD, 2020). Figure 7-2 highlights the annual quantities of waste taken to the different landfill sites in 2015. Gamodubu and Francistown landfill sites received largest quantities because they service two (2) cities of Botswana.

Table 7-3: Waste material reported for the month of December 2019 from 8 reporting landfills in Botswana (HCSD, 2020)

Waste	Amount	Units
Solid Waste*		
General	13,615.35	Tonnes
Building rubble	46,099.58	Tonnes
Carcass	26.924	Tonnes
Clinical	65.6	Tonnes
Commercial	1,088.68	Tonnes
Cover material waste from Ghanzi Landfill	10.44	Tonnes
Foodstuff	71.5	Tonnes
Garden	878.00	Tonnes
Poultry	966.72	Tonnes
Scrap metal	14.91	Tonnes
Sludge	39.02	Tonnes
Soil cover/rocks/stones	0	Tonnes
Special waste from Ghanzi Landfill	14.94	Tonnes
Tyre	86.16	Tonnes
Total Solid	62,977.824	Tonnes
Liquid Waste		
Used oil	0.3	Kilolitres

A study in Gaborone classified solid waste into five categories; general waste, soil, wastes from gardens, clinical waste, and that from construction sites. General waste being the biggest waste stream comes mainly from households and is mostly organic in nature. It also contains inorganic objects made from metals, tyres, plastics and glass and e-waste including discarded computers, cellphones and other electronics. Other cities around the country have similar waste composition (Nagabooshnam, 2012). In Gaborone, about 50,000 tonnes of waste per year is generated. Of this, 28,000 tonnes is household waste, 15,000 commercial, 1,600 industrial and 5,000 tonnes is other types of waste (Nagabooshnam, 2012).

Waste collection coverage varies across the country. For instance, the municipal solid waste collection coverage (SDG 11.6.1) in Gaborone in 2013 was 91.1 (UNStats, 2020a). In rural areas, waste collection rates improved from 6 to 14 between 2001 and 2011, but the situation in cities and towns was different with waste collection declining from 81 to 76 respectively over the same time frame (GoB, 2017). Countrywide, collection rates from households average 50.84. However, the mining towns of Jwaneng, Orapa and Sowa Town regularly have their waste collected. Some of the pressures leading to poor waste collection include rapid economic growth, an increasing population, rapid urbanization and weak enforcement of waste management policies. The Government, under its Rural and Urban Sanitation (Solid Waste Management Collection) Programme has improved waste collection in the country.

Waste collection is usually done from specific pick-up points. However, the situation is sometimes compounded by poor public attitudes which cause littering and illegal dumping leading to councils spending more time and money to clean up (GoB, 2017). Where waste is not collected, people find other means of disposing or treating it. Countrywide, 20.5 of the population deal with their waste by burning it. This is especially common in Ngamiland West where more than half (50.89) of households dispose of their waste through burning (Statistics Botswana, 2020a).

*A composting unit at a household in Paje, north of Serowe
Photo credit: SuSanA Secretariat/flickr*



Sorting of waste is almost non-existent in Botswana and the situation is worsened by the fact that Botswana does not have a strategy for source separation of waste; and while there are arguments for and against this, at least sorting out the biodegradable waste would allow for it to be more easily reused.

Waste needs to be stored safely before collection. Most waste collectors provide containers or provisional storage equipment such as plastic bags, open bins, street bins or communal collection points depending on the type of clientele (households, institutions, commercial entities) being served. However, some of the challenges faced have included lack of waste storage containers at the source, poor maintenance of the containers, low collection frequency and lack of waste separation at source. In most urban areas, residents pay for waste collection and therefore the standard of service is much higher than in the rural areas where it is free. Insufficient funding of this sector by Local Authorities has resulted in a very inefficient waste collection system especially in the rural areas (Mmereki, 2018).

Impacts of poor solid waste management

Solid waste management in Botswana is characterized by inefficient collection methods, insufficient waste disposal plant, poor facility management and lack of law enforcement leading to illegal waste dumping. This is compounded by the fact that there is no system in place for waste revenue collection thus not all Botswana pay for waste collection services. Waste collection which is administered by the Government in urban areas is more costly in relation to the revenue generated. Furthermore, over the years waste management in general has not been allocated the budget it deserves. The impacts of plastic litter on the livestock sector in Botswana are highlighted in Box 7-1.

Waste disposal in Botswana is done by landfilling or at dump sites. There are 14 landfills in Botswana and 34 large dump sites. A landfill is an organised way of managing waste and is usually regulated by the law while a dump site is not managed and therefore may result in environmental and public health issues. Weighing of waste disposed is done only at landfills not at dump sites and this results in insufficient basic data on waste quantities and composition. Dump sites receive only general waste and are mostly used in villages or settlements where there are no landfill sites. Landfills receive general waste, and as for hazardous waste only clinical waste is received and incinerated. Some waste is dumped illegally which may lead to pollution, blockages of storm drains and foul odours within residential neighbourhoods.

The environmental impacts of landfilling and use of dump sites include emissions of greenhouse gases, air pollution, leachate leading to contamination of groundwater and soil affecting the below-ground biodiversity. Although landfills have been built in Francistown, Pilane, Selebi Phikwe, Jwaneng, Orapa and Lobatse, gas and leachate escape into the environment because they were not engineered (during design and construction) to deter them from escaping into the environment. Other challenges may occur where a storm water channel is joined to leachate ponds creating potential for flooding or overflowing of the ponds during rainy season. The contamination of water sources is a threat to public health and the livestock industry. For instance, seepage from the closed Gaborone landfill was found to have affected the adjacent soils with some of the leachate plumes moving towards the Notwane River. A more recent study confirmed the impacts of leachate on surface water surrounding the closed Gaborone landfill showing that key parameters such as pH, turbidity, BOD₅ tests surpassed the stipulated BOS standard for drinking water quality (Gwisai et al., 2019; Ngole et al., 2002; Ranganai et al., 2004).

Box 7-1: Impacts of plastic bag litter on the livestock sector in Botswana

Plastic bags have been popular in Botswana since the mid-1970s, and the convenience of their use led to widespread usage. However, they have negative impacts on the environment; they are unsightly when not disposed of properly and are slow to degrade thus spoiling the land for agriculture. They have negative impacts on biodiversity with animals often mistaking plastic bags for food. For example, a study estimated the prevalence of plastic bags in the rumen of livestock in Kenya at about 50 and the impacts of these on livestock included general weakness affecting both milk and beef production (Lange et al., 2018). If left unchecked, the impacts on the livestock subsector could be huge.

Livestock rearing is a major agricultural activity in Botswana accounting for 57 of agriculture's contribution to GDP and it is also the main employment and source of income for about 70 of the rural population. It is thus seen as an important instrument for the government to use in reducing poverty and increasing food security and incomes. To reduce the impact of plastic bags on such an important section of the economy, the message for policy is to effectively regulate the use and availability of plastic bags and to implement tools that encourage their reuse and recycling as stipulated in Vision 2036 and NDP 11. Although the government legislated against plastic bags in 2005, a recent study in Maun shows that the law has not led to a decline in the use of plastic bags. This situation needs to be urgently addressed.

(Statistics Botswana, 2020c) (Mogomotsi, Mogomotsi, and Phonchi, 2019)

Addressing the challenges of solid waste management

Waste collection services are usually undertaken mainly by the Local Authority or councils, although outsourcing of waste collection has been done in some areas across the country by the Government. Private sector participation in waste collection has grown over the years as now businesses have to account for their waste, thus hiring private companies for waste collection.

The informal sector has stepped up to collect recyclable materials. Waste pickers or scavengers go door to door or to landfills to collect materials such as plastics, glass, paper and metals at landfills. These are then sent to the large towns such as Gaborone or Francistown from where they may be exported to neighbouring countries for further processing. Some of those involved include companies like Dumatau which exports wastepaper and plastic within southern Africa; and Somarelango Tikologo, a non-Governmental organisation, which ships plastic and glass to South Africa and paper to Zimbabwe. There is no doubt about the value of waste pickers and scavengers, however there is a need to regulate the sector, ensure waste separation to reduce the amount of waste going to landfill and avoid instances of human harm by hazardous chemicals or clinical waste. Implementing a resource recovery strategy would help reduce the amount of waste that gets disposed of in landfill sites. As shown in Table 7-4 and Figure 7-3, there is much potential to do so. For instance, in Francistown, only 3% of waste disposed of is recovered. Some of the policies in support of recycling include the Waste Recycling Guidelines and the Integrated Waste Management Policy.

The Rural and Urban Sanitation Programme on Solid Waste Management focuses on several areas to improve the handling of waste by providing waste management equipment and machinery for the local authorities. These include compactor trucks, vacuum tankers, skip loaders

and vehicles to carry clinical waste. The programme further encourages waste management systems, construction of dump sites and Ventilated Improved Pit (VIP) latrines thus reducing underground water pollution by avoiding percolation into the ground without some treatment being done to the waste.

Credible waste data is a fundamental requirement for the planning and designs of waste management programmes and for allocation of resources. In the NDP 9 and NDP 10 periods the Government of Botswana established five engineered landfills to improve provision of proper solid waste disposal sites. However, it is also recommended that the Government consider elements of the circular economy, an approach that seeks to improve waste management practices, stimulate recycling and innovation in materials management and reuse and thus limit the use of landfill sites (Mäkelä, 2017). For instance, as the case study on waste tyres (Box 7-2) shows, there are opportunities to use well established technologies and innovation to produce new goods and products from the increasing volumes of waste tyres in Botswana.

Where landfills produce gas and leachate, there is potential to use the gas for useful purposes. For instance, the Water Utilities Corporation's (WUC's) Glen Valley Wastewater Treatment Plant (WWTP) produces 876,000 m³/ year (2,400 m³/day) of biogas. About a quarter of the gas produced is used to maintain the digester temperature and for incineration, while the rest is flared to heat treatment ponds (GoB, 2017).

Liquid waste

Liquid waste can be defined as wastewater or sewage from domestic sources and may include hazardous household liquids such as expired chemicals, fats, cooking oil, grease and used engine oil. Other liquid wastes include commercial and industrial wastewater that may include cleaning fluids, pesticides, or the by-products of manufacturing processes.

Table 7-4: Landfills in Botswana – Material (tonnes) disposed and recovered – 2018 (HCSD, 2020)

Landfill	Disposed	Recovered
Francistown	48,896.86	1,419.42
Ghanzi	1,830.01	29.35
Jwaneng	3,209.43	45.8
Lobatse	6,037.06	25.32
Kasane	5,675.37	607.73
Gamodubu	94,344.49	665.74
Masunga	2,243.75	15.08
Serowe	4,129.68	29.1
Ramotswa	30,534.34	129.08
Kanye	2,126.54	136.21
Tsabong	81.72	0.578
Selibe Phikwe	7,762.73	33.98
Maun	7,305.47	269.72
Total	214,177.5	3,407.108

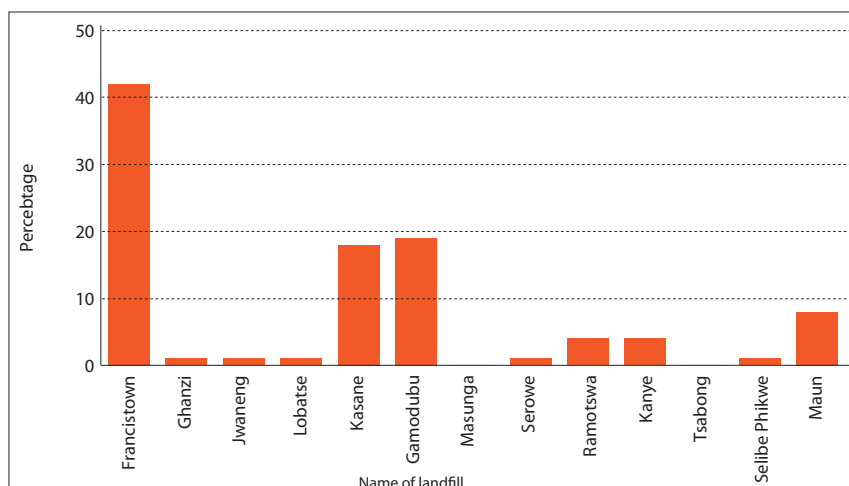


Figure 7-3: Percentage of waste recovered by landfill in 2018 (HCSD, 2020)

Box 7-2: Management of waste tyres

The management of waste tyres is a growing problem in Botswana. Between 2014 and 2018, the mass of waste tyres sent to landfill increased from 833 to 1,713 tonnes respectively. Currently they are stockpiled at landfills or subject to open burning for energy or to extract the steel wires within the tyres which are then sold off to metal dealers. However, this is unsustainable and presents environmental risks. Open burning releases toxic gases such as dioxins and particulates that present human health risks. Stockpiling at landfills is not sustainable because the tyres take up space and are not biodegradable. This is evident at the Gamodubu landfill in Kweneng District Council, among others.

Tonnes of tyres deposited in Botswana landfills 2014-2018
(HCSD, 2020)

Year	2014	2015	2016	2017	2018	Total
Tyres (tonnes)	833.2	620.7	930.6	297.2	1,713	4,394.728

Although Botswana does not have facilities to process the resulting waste, there are opportunities to recycle or reuse the tyres. For instance, if the tyre is still structurally sound it may be reconstructed (re threaded) for reuse on vehicles. Recovery of material through shredding may allow for use in various civil engineering processes such as thermal or sound insulation or road construction. The high content of combustible material means there is also potential for recovery of energy resources. Finally, tyres may be utilized as a building material in the construction of foundation or in entire building (so called earth ships).

To improve waste tyre management efficiency, the Government should harmonise policies for dealing with this waste stream, including implementing recovery and recycling methods for waste tyres, prohibiting the stockpiling of waste tyres at landfill sites and using economic instruments to regulate them and by adopting a circular economy.

(Mmereki et al., 2019)

Wastewater

Wastewater dominates liquid waste in terms of quantities produced per day in Botswana. Wastewater comes from domestic sources such as toilets, washing machines, kitchen sinks and bath water. It may also come from commercial and manufacturing entities. It consists of organic and industrial effluent but varies greatly in terms of flow and pollution strength, making it difficult to assign fixed values to their constituents. In general, industrial wastewaters may contain suspended, colloidal, and dissolved (mineral and organic) solids. In addition, they may vary greatly in pH and in concentrations of coloured matter.

In Botswana liquid waste is mostly discharged into the sewer system without pre-treatment and with no thought as to any potential adverse effects it may have on the sewer system. However, effluent should be pre-treated prior to release into the sewer system; similarly, it requires pre-treatment in instances where the effluent is discharged directly into the environment. Nevertheless, this is a rare occurrence in many industries, especially in Gaborone and this reduces the treatment efficiency at the main treatment plant in Glen Valley.

By volume, wastewater and treated effluent constitute 16 of all water resources. Only 20 of this is re-used, representing an enormous potential resource in this water stressed country (Nagabooshnam, 2012).

Urban sewerage infrastructure

The urban sewerage infrastructure is the system of pipes (drains, sewers and manholes) which conveys sewage, rain and stormwater to the wastewater treatment plant prior to

release into the environment. It is an important part of the urban infrastructure required for proper sanitation. Lack of sanitation often affects social and economic development and is also a source of significant environmental pollution leading to disease outbreaks and destruction of biodiversity (Uzuh et. al, 2019).

Rapidly growing cities in southern Africa are facing problems with sewage disposal and Botswana is no exception. Most of Botswana's population (68 by 2017) is urban. Between 2001 and 2011, the number of urban centres grew by 47 , representing an annual growth rate of 4.4 (Gwebu, 2015). Rapid urbanisation, lack of commensurate physical planning, inadequate and dilapidated infrastructure combine to put pressure on the existing sewerage system. This, together with lack of financial and human resources for sanitation development and upgrading, this has led to sewage water leakages and inadequately treated effluent, among others.

In Francistown for instance, the sewerage pipes run along the Tati and Ntsho river systems which flow through the town. Sewage water leakages have changed the physical and aesthetic values of the two rivers. The naturally sandy beds of these ephemeral rivers hold water only for a few days in a year, but the constant leaking of the sewers has resulted in open pools of untreated sewage in the riverbeds. The riverbeds are now covered with vegetation mainly Eucalyptus species and an alien invasive aquatic weed. The Water Utilities Corporation has identified Monarch, Area S, Kgaphamadi, Riverside, Bluetown-Madzibalori, Sommerset West and East and Block 1 as the main problem areas.

Mambo Wastewater Treatment Plant which services Francistown, does not have the capacity to handle all of the sewage it receives. The plant was built in 2003 with a 10-year life span and the capacity to handle 15,000 litres per day. The plant is located about 100 m from Tati river and receives sewage from households, mining, commercial and industrial facilities. The biggest challenge is wastewater which has not been pre-treated; there are fats and blood from the Botswana Meat Commission; dyes and other chemicals from the Northern Textile milling company. Mechanical breakdowns of the plant are frequent, and it often receives storm water causing it to overflow. Overflows have detrimental effects on the environment as raw sewage gets released into the river system. The mechanical breakdowns also mean that the wastewater may not be treated to the required standard (Herbco Technical Services, 2011).

Used oil

The United States Environmental Protection Agency defines the term 'used oil' as any petroleum or artificial oil that has been used, and during that process contaminated with impurities such as water, dust, metal filings, chemicals, among others (EPA, 2020). Any oil that has been adulterated with hazardous substances is automatically branded as hazardous waste and must be handled accordingly. The term 'waste oil' is a generic term for any oil that has been made impure, while 'used oil' has more regulatory applications. Waste or used oil must be handled appropriately to minimize damage to the environment.

Mismanagement of used oil is a growing problem in Botswana and emanates mostly from motor vehicle repairs and maintenance in established to informal garages. It is the second most produced liquid waste in the country after wastewater. According to unpublished data from

Tshole Trust in 2016, it is estimated that imports of new oil into the country amount to between 12.5 to 15 million litres per year, while the annual collection rate is 3.5 million litres. This huge volume of unaccounted for used oil is of great concern. There are currently 33 used oil receptacles tanks around Botswana where people can dispose used oils. Despite this, people still fail to bring used oil to these receptacle tanks making management of used oil a great challenge in the country. Some of it even ends up going to the landfill. For instance, in the month of December 2019, 8 landfills reported receiving 0.3 KL of used oil (Table 7-3; HCSD, 2020).

If not handled and disposed of properly, used oil can contaminate the soil, ground and surface waters, harm aquatic plants and animal biodiversity; as well as spoiling the natural beauty of the area. Its negative impacts result from the presence of toxic chemicals and heavy metals (including chromium, nickel, and lead), which are insoluble and persistent (Odeh, 2013).

Managing used oil

There is an opportunity to safely reuse and recycle used oil. The oil can be cleaned for re-use as lubricants or can be re-refined into products for the petro-chemical industry. In recent years, this recyclable waste has been exported to South Africa by local companies for refining as there are currently no such industries in Botswana.

Environmental regulations should be put in place to guide those who trade in lubricants and the entire waste stream. There should be public awareness through workshops, school visits and the media amongst other activities on used oil throughout the country. To better support decision making, there should also be more data collected in this waste stream subsector to better support decision making.

The Ntshe and Tati rivers up-and downstream the city centre of Francistown. Picture A shows the sand in this river in the northern suburb before the sewerage pipe. Picture B shows the riverbed after the Ntshe has joined the Tati downstream the city centre, receiving sewage water from the sewerage plant pipe with accompanying invasive plant species due to the sewerage water.
Photo credit: Vincent Basupi, May 2019.





Used oil contaminated area, Mogoditshane.
Photo credit: Tshole Trust, 2020

Used oil receptacle tank Kasane Landfill.
Photo credit: Tshole Trust, 2020



Hazardous waste

The Waste Management Act of 1998 defines hazardous waste as 'controlled waste which has the potential, even in low concentrations, to have significant adverse effect on public health or the environment on account of its inherent chemical and physical characteristics, such as toxic, ignitable, corrosive, carcinogenic or other properties'. Hazardous waste includes e-waste, clinical waste, used oils, radioactive waste, mining waste and chemical waste, among others. The chemicals these items contain, even in small quantities, can have adverse impacts on public health and the environment. The management of this type of waste usually aims at reducing the volumes and toxicity levels of the waste produced and to reduce or eliminate exposure to this waste.

Hazardous waste is generated from many sources, ranging from wastes from manufacturing processes to households and businesses which may come in several forms; liquids, solids, gases, and sludge as shown in Table 7-5. Although these are some of the most common hazardous wastes in Botswana, the list is not exhaustive. In recent years clinical waste has emerged as the most common in terms of production and quantities, followed by expired chemicals and asbestos.

E-waste

E-waste can be defined as 'electrical or electronic equipment or products that have become obsolete or have reached the end of their useful state' (BOCRA, 2015). It includes electronic equipment of all forms from both domestic and imported sources. E-waste is dangerous because it contains hazardous substances such as lead, mercury and brominated flame retardants all of which have negative public health impacts. But it also includes valuable materials such as aluminum,

iron, steel, and copper, as well as; precious metals including gold, palladium, platinum, and silver. Other materials found in electrical or electronic equipment include plastic and glass among others (Mmereki and Li, 2014). Figure 7-4 shows what is in a typical mobile phone, while Table 7-6 lists some of the materials found in common household appliances. While there is great potential for the recovery of some of these materials, the potential for negative human and environmental impacts is immense if they are not well handled.

E-waste comes from households, commercial, and industrial sources and includes household equipment such as Information and Communications Technology (ICT), televisions, refrigerators, washing machines, irons, printers and many others. Quantities, especially of new emerging technologies such as cell phones, laptops, and desktop computers, have been rising over the years as shown in Table 7-7. Some are bought new, whilst others are old. For example, old computers may be donated or recovered by informal recyclers. Much e-waste ends up in a landfill site co-mingled with other waste. In 2011, 423.6 tonnes of e-waste was discarded and mingled with municipal waste in the Gamodubu landfill. The total mass of household items classified as e-waste increased from 2,215 tonnes in 2005 to 6,128 tonnes in 2010 (Mmereki et. al., 2015).

Growth of ICT technology and E-waste generation

ICT, especially computers and accessories, are the biggest contributor to the e-waste stream and the quantities continue to grow rapidly, driven by urbanization, youthful population and high national income. The Revised National Youth Policy of 2010 recognizes a youth as being between 15-35 years of age, and they form 34.6 percent of the population while children (under 15 years) form 34.7 percent of the population. This means that almost 79 percent of the population was under 35 years of age in 2017 (Statistics Botswana, 2018).

Table 7-5: Hazardous waste characterisation in Botswana (DWMPC)

Type	Description
Metals	Waste that contains or is contaminated with cadmium, lead, selenium, mercury or other heavy metals or their compounds. It also includes the ashes from the incineration of insulated copper wire, waste lead-acid batteries, asbestos among others.
Electronics	Waste electrical or electronic assemblies or scrap containing accumulator or other batteries, mercury switches, activated glass, Polychlorinated Biphenyls (PCBs)
Oils	Waste mineral oils, including that contaminated by Polychlorinated Biphenyls (PCBs). Used oil and grease are classified hazardous, Waste oils, wastewater, hydrocarbons/water mixtures, emulsions.
Pesticides	Waste containing or contaminated with pesticides Persistent Organic Pollutants (POPs).
Clinical	Clinical waste from medical care in hospitals and health facility, waste pharmaceuticals, drugs and medicines.
Chemicals	Waste chemical substances, formulation and use of photographic chemicals and processing materials, pulping, textile industries, waste tarry residues arising from refining, distillation and any pyrolysis treatment including mining processes.
Effluent	Effluent from commercial, industrial processes as well as households as discussed above.



Figure 7-4: What is in E-waste?
(WEF, 2019)

Table 7-6: E-waste (tonnes) generated from household devices used in Botswana in 2010
(Mmereki, Li, & Li'ao, 2015)

Composition	Refrigerator	Electrical Ovens	Washing Machines	Air Conditioners	Total
Fe	1,798	891	128	1,353	4,170
NF	43	11	5	611	671
Plastics	599	11	13	115	739
Glass	65	6	2	80	153
Diverse	22	92	14	80	208
Total	2,527	1,011	162	2,239	5,941

Table 7-7: Household ownership and access to ICT technology (%) 2001-2014
(Statistics Botswana, 2017a)

Technology	Percentage					
	2001	2003	2006	2008	2011	2014
Radio	67.55	62.60	72.31	76.45	61.49	59.40
Television	25.13	25.00	41.72	56.82	54.09	60.33
Fixed telephone	33.49	16.00	14.58	27.61	10.53	9.45
Mobile cellular telephone	-	40.50	63.66	80.22	89.73	94.05
Desktop computer	3.99	-	7.74	-	9.63	10.89
Laptop	-	-	-	-	11.23	20.59
Fax	-	-	-	-	-	1.45
Internet	-	-	-	-	-	40.56

In 2014, 41.4% of the population aged 10 and over, used a computer (Figure 7-5). The majority were in the 15-24 age group and most (56.7%) of them used the computers for education. Computers and other communication equipment formed 54.7 percent of the imports of commercial goods in 2018 from 49.3% in 2010 (World Bank, 2020; Statistics Botswana, 2017a).

Despite the benefits of electrical and electronic equipment, the handling of obsolete equipment is becoming a challenge as the quantities continue to grow. For instance, the volumes of e-waste grew from 2.83 kg per capita in 2000 to 7.92 kg per capita in 2019 (Figure 7-6). In absolute terms this amounted to 18,837 tonnes of e-waste in 2019 (UNStats, 2020b). The number of mobile cellular subscriptions also rose steadily from 2,363,411 in 2011 to 3,381,228 in 2018 (against a population of 2,024,904) (World Bank, 2020). The Government has committed to extend mobile phone signals and services throughout the country especially to the under-served areas. While this encourages access to information, financial services, and education among others, it also increases the amount of e-waste as mobile phones quickly become obsolete with people frequently upgrading their devices.

Impacts of poor E-waste handling

Dismantling of electrical and electronic equipment by the informal sector to recover valuable components is done without much protection or technical capacity resulting in public health threats. Waste pickers scavenge for recyclable materials and given their lack of the know-how and protective equipment are exposed to health hazards. Weak institutions and inadequate laws are some of the pressures fueling this situation.

It is thought that the burning of e-waste releases endocrine disrupting chemicals, and these have negative impacts on human health (WHO and UNEP, 2013). It is mostly women and children who are at the forefront of picking through e-waste and therefore are most exposed to these chemicals. There is a need for data and research to investigate this thoroughly (Lundgren, 2012; Moukaddem, 2011).

Managing E-waste sustainably in line with the sustainable cities concept

The rapid diffusion of ICT and related technologies are an opportunity to improve the lives of Botswana through access to information and education and by improving the efficiency of services and generating new economic opportunities. In line with the sustainable cities concept, it is important to keep people at the centre of each initiative and ensure that any ICT innovations rolled out contribute to human and environmental wellbeing.

There is a market, especially in India, China and elsewhere in Africa for second hand and secondary resources obtained from the refurbishment or dismantling of this equipment; and this is driving the informal recycling sector in Botswana. These usually consist of intensive manual dismantling of equipment and recovery of valuable components which are then exported.

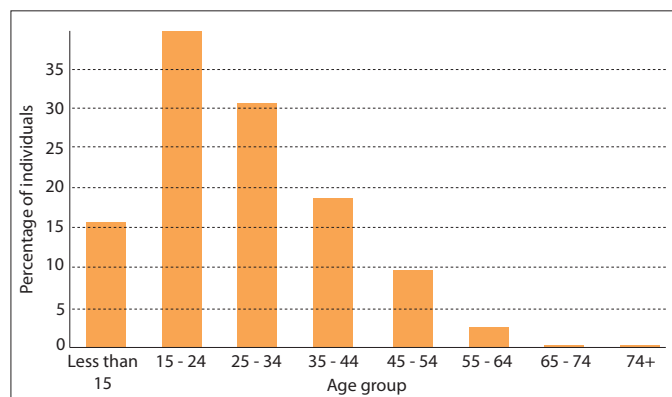


Figure 7-5: Percentage of individuals who used a computer by age group, 2014
(Statistics Botswana, 2017a)

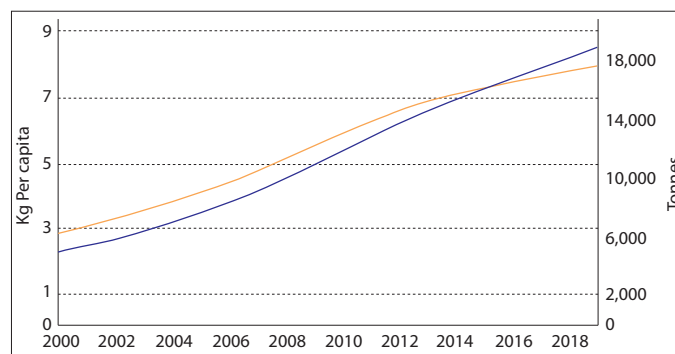


Figure 7-6: E-waste generation in Botswana 2000-2019
(UNStats, 2020b)

Although the Waste Management Act does not specifically mention e-waste, it includes a general definition of hazardous waste. This, however, is insufficient. Effective management of this waste stream, requires an e-waste management policy and legislation. Furthermore, the Waste Management Act of 1998 should be updated. Other recommendations for managing e-waste from Mmereki et.al, (2015) and BOCRA, (2015) include:

- Strengthening the role of the Department of Waste Management and Pollution Control (as the focal point for the Basel Convention) in e-waste management.
- Strengthening e-waste lifecycle and documentation system to better support decision making and policy.
- Domesticating provisions of the Basel Convention into national legislation.
- Integrating the informal into the formal sector and implementing e-waste recycling to improve overall recovery efficiency rates, reduce pollution and provide economic opportunities for informal waste pickers.
- Reforming the e-waste management system from collection through transportation to disposal. Monitoring the post consumption flows of e-waste.
- Encouraging private-public-partnership to help offset and support the costs of e-waste management especially at the local Government level. The establishment of an environmental e-waste levy could help fund some of the costs in this sector.
- Implementing an integrated framework for monitoring and managing e-waste. This will need to include a strategy for source separation for reusable and recyclable materials as well as building the technical capacity to dismantle and retrieve usable components.

- Establishing and maintaining a national data base on the amount and types of e-waste generated.
- Implementing schemes such as Extended Producer Responsibility (EPR) where the producer is responsible for recycling, reuse, or disposal at the end of a product's life.

Clinical waste

Sources of clinical waste

Botswana's Waste Management Act of 1998 defines clinical waste as "waste which, unless rendered safe, may prove hazardous to any person, animal or plant coming into contact with it, arising from human or animal tissue, blood or other body fluids, excretions, drugs or other pharmaceutical products, radioactive materials, swabs or dressings, microbiological cultures and potentially infected waste from pathology departments or syringes, needles or other sharp instruments; or any other waste which may cause infection to any person, animal or plant coming into contact with it arising from- medical, nursing, dental, veterinary, pharmaceutical or similar practice; investigation, treatment, care, teaching or research; or the collection of blood for transfusion".

The sources of clinical waste in Botswana include hospitals, health centres of various categories, mortuaries and autopsy centres, dentists, blood banks, animal and plant research centres, testing laboratories and home care centres. However, these same facilities also produce general waste which does not pose any public or environmental health risks. General waste forms about 48 percent of the total waste generated in these facilities (Table 7-8). It may include typical office waste such as paper, packing materials and food remains among others (Mmereki et.al, 2017). Chemical or pharmaceutical waste is the next largest waste stream from health facilities. The daily waste generation rates range between 0.1-0.3 kg per patient for clinics and health posts while for a biggest referral hospital like Princess Marina in Gaborone the daily rate is much higher at 0.75 kg/patient (Kudoma, 2013).

Table 7-8: Proportion of clinical waste generated in Botswana
(Mmereki, Baldwin, Li, & Liu, 2017);

Type of Clinical Waste	Proportion (%)
General waste	48
Sharps	13
Chemical/pharmaceutical waste	22
Pathological/infectious waste	17

Table 7-9: Number of health care facilities in Botswana 2014-2016
(Statistics Botswana, 2017b)

Type of facilities	2014	2015	2016
General hospital	18	18	18
Primary hospital	17	17	17
Clinics with beds	105	104	105
Clinics without beds	206	214	230
Health posts	351	347	349
Mobile stops	931	973	973

As the population grows, so does the demand for animal and human health care services; and as medical and veterinary services and products improves and expands so does the amount of clinical waste generated. Table 7-9 shows the number of health care facilities in Botswana. Most have not changed in number but clinics without beds increased by 11 percent between 2014 and 2016, while mobile stops increased by 4.5 percent between 2014 and 2015 (Statistics Botswana, 2017b).

Sustainable management of clinical waste

Clinical waste management presents challenges for Botswana. Clinical waste is disposed of in Landfills and dumping sites and by incineration. These methods have implications on the environment, human and animal health. Incineration is convenient in that it requires less land than landfilling; it reduces waste volumes by up to 90 . However, fly ash and emissions produced need to be managed carefully since they are potentially hazardous containing high concentrations of heavy metals such as cadmium, copper, lead, and zinc as well as small amounts of dioxins and furans and the combination of pollutants can amplify their toxicity (Nagabooshnam, 2012).

The handlers of clinical waste also need an organised system to curb any public health risks and occupational health hazards. Segregation of infectious and non-infectious waste at source is especially important. It is critical that these wastes remain separate until their final treatment and disposal. There is evidence that the waste storage and collection system from health centres does not operate as effectively and efficiently as it should. The poor management of clinical waste poses a risk of the spread of viruses and pathogens. Although there are new emerging technologies to handle clinical waste, in Botswana incineration continues to be an attractive solution for the treatment and disposal of clinical waste. Indeed, the amount of clinical waste incinerated has more than doubled from 549,594 kg to 1,404,493 kg between 2014 and 2018 as shown in Figure 7-7.

There is need also to improve the management of clinical waste in more remote areas. For instance, the inaccessibility of most camps in the Okavango Delta means that operators must use the more costly option of transporting waste by air instead of by road if the waste is to be treated at the appropriate facilities. In such cases, onsite treatment may be a more viable option.

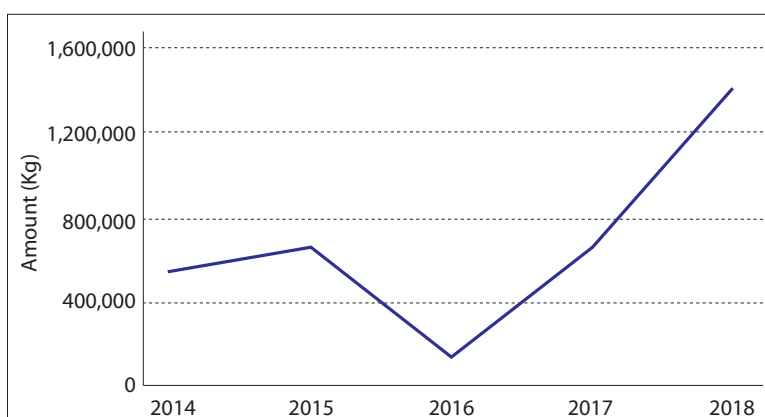


Figure 7-7: Clinical waste incinerated 2014-2018
(HCSD, 2020)

The Government has been regulating the sector through the Botswana Clinical Waste Management Code of Practice of 1996 and the Waste Management Act of 1998. These advocate for the safe and sustainable collection, transport, treatment and disposal of all healthcare waste, including liquid and chemical waste. However, there is need for a law that clearly defines the roles and responsibilities of the healthcare personnel responsible for the handling and disposal of waste streams at the point of generation at health care centres and to formulate a more robust healthcare waste management system (Mmereki et. al, 2017).

Mining waste

The economic contributions from the mining sector have been central in the development of the country, allowing huge infrastructure and other development projects to be undertaken. However, mining activities also contribute to environmental pollution. Heavy metals have been found in the soil adjacent to mines. For instance, mining activities at the Bamangwato Consolidated Limited (BCL) copper-nickel mine in Selibe-Phikwe town, has contaminated the soil with heavy metals and sulphur. This is evident in leaves of the *Grewia bicolor* plant in the nearby areas that were found to contain sulphur. Although the concentration of heavy metals and sulphur decreased with distance from the mine, there is risk of bioaccumulation in the food chain because the leaves of *Grewia bicolor* are used as fodder for farm animals and as traditional medicines (Letshwenyo, 2016).

Diamond mining results in large swathes of land being exposed due to removal of vegetation. This can lead to soil erosion and the nutrients it contains. Airborne dust that includes toxic chemicals can also lead to respiratory impacts on human and animals. Diamond mining also uses large volumes of water in the mining and processing stages.

Other impacts may be from the mining waste generated which may be in solid, liquid and gaseous form. These include wastewater effluent, tailings, waste dumps (sand and waste rocks), overburden (waste with potential economic recovery value), oil and fuel spills, and particulate gases. Other types of waste may include chemical waste, slimes dam and deposits (DoM, 2020; Asare and Darkon, 2001)

The amount of waste generated may be substantial and some contain chemicals that have harmful human and environmental effects. But others may have potential reuse options for instance in construction as building materials. Table 7-10 highlights some of the mining waste generated by one of the mines in Botswana.

Table 7-10: Examples of mining waste from Selibe Pikwe mine (Darkoh, M., 2001)

Type of Waste Generated	Amount of Waste Generated per hour (tonnes)
Fissure water	977
Tailings water	300
Waste rocks	345,833
Slag	833,394

Reducing the Impact of Mining Waste

The institutional framework for mining in Botswana includes the Department of Mines (DoM) and the Department of Environmental Affairs (DEA) whose responsibilities include minimizing impact on the environment (Ziga and Mgadla, 2020). Section 65 of the Mines and Minerals Act of 1999 requires permission to mine through a mineral concession or permit. The applicant must then go through a comprehensive Environmental Impact Assessment as part of the Project Feasibility Study Report. If approved, the environment management plan submitted in tandem is followed to ensure enforcement and compliance with the mining industry standards. The Act also requires the developer to minimize and control waste in order to minimize damage to human health and environmental resources and to treat pollution and environmental contamination events immediately.

Handling of mining waste is specific to the type of mine. For example, diamond mining waste is disposed of through recycling, landfill, and incineration. According to the DeBeers Group, in 2018, 8,375 tonnes of metal was recycled, while 1,840 tonnes of non-hazardous waste and 871 tonnes of hazardous waste was sent to the landfill. In the same year, a total of 592 tonnes of waste was incinerated on site (DeBeers Group, 2020).

The Atmospheric Pollution Prevention Act of 2008 and the Ambient Air Quality - Limits for Common Pollutants of 2012 published by the Botswana Bureau of Standards aim to prevent air pollution from industrial activities including mining; and requires the developer to be in possession of an air pollution registration certificate especially if the activity occurs in a controlled area. For example, the Morupule, Jwaneng and Orapa mines are designated controlled areas.

Chemical waste

Chemical waste is another source of pollution in Botswana, especially in the urban areas. There are limited policy options to protect from chemical waste, yet many waste sources have chemicals in them, for instance, cleaning detergents in household wastewater. Sound management of chemicals and waste is critical to sustainable health and to support good quality of life and enhance biodiversity. Actions to mitigate pollution and implement solutions should be urgently undertaken.

Managing chemical waste

Chemicals are managed under the Chemicals Safety Guidelines and there are plans to address the deficiencies in this sector in NDP 11. Some of these include the following (GoB, 2017):

- Develop and implement a national chemicals' strategy and management plan.
- Adopt and localise the MEAs relevant to chemicals and waste management.
- Develop hazardous waste treatment and disposal facilities.
- Finalize and operationalize the Chemical Substance and Products Bill.



Open pit, Orapa Mine, the world's largest open-pit diamond mine by area, located in Botswana.
Photo credit: Photography Section, BOPA

- Build in-country capacity for health impact assessment and industrial chemical assessment.
- Explore public private partnerships for the management of chemicals treatment and disposal facilities
- Establishment of a coordination mechanism for MEAs on chemical management in compliance with the country's obligations.

Agro-chemicals are managed under the Agro-chemicals Act of 1999 and the Agro-chemicals Regulations of 2003, but enforcement is weak. In 2000, an inventory of six stockpile sites maintained by the Department of Crop Production and Forestry identified over 18,000 metric tonnes of waste chemicals. This included 50 metric tons of toxic compounds, 1,400 metric tons of highly contaminated soils and 16,000 metric tons of lightly contaminated soil. There is currently limited capacity to monitor and control the flow of pesticides into and within the country which is a key to preventing the accumulation of new stocks of obsolete pesticides (GoB, 2005). This is an area that needs urgent attention.

It is urgently recommended that a chemicals waste management programme be developed and a legal and institutional framework to regulate domestic and industrial chemicals be developed and operationalized..

Radioactive waste

Sectors that generate radioactive waste in Botswana include agriculture, construction, hospitals, industry, mines and research facilities. Mines, hospitals use sealed radioactive materials for various operations. A sealed radioactive source is one where the radioactive substance is permanently

sealed in a container in a solid form. This is to prevent the radioactive material from escaping accidentally into the environment while being used. The number of registered sealed sources in Botswana continues to increase, and by August 2020 stood at 650. The number of disused or spent sealed sources stored at end user's facilities is decreasing, albeit slowly, as end-users continue to make efforts to return their disused or spent sealed sources to the manufacturer or supplier as required by law.

Botswana has about 5.4m³ of radioactive soil that resulted from an incident involving a well logging sealed radioactive source that was damaged and thus contaminated the soil with Caesium-137 (Cs-137). The soil is kept in 27 drums in long term storage under the care of the radioactive source owner, to allow the Cs-137 to decay to acceptable concentrations because the Cs-137 cannot be chemically separated from the soil. Cs-137 has a half-life of 30 years.

With unsealed sources, contamination is a major hazard as the radioactive source, which may be in liquid, solid or gaseous form, is easily released from the container (NFCC, 2018). Unsealed radioactive sources or materials are mostly used in hospitals for diagnostic and therapeutic purposes such as for the detection or treatment of cancer. Mostly the elements involved have short half-lives. For example, Technetium-99m (Tc-99m) has a half-life of 6hrs, while Iodine-131 (I-131) has a half-life of 8 days. Radioactive solid and liquid waste is securely kept in designated storerooms in storage tanks or plastic containers, until their radiation concentrations are reduced or decay to permissible levels for such waste to be released into the public main sewage system or disposed at landfills.

Scrap metal dealers are not users of radioactive materials but because of the nature of their work, they may encounter radioactive materials because in most cases such materials are shielded or covered with heavy metals, like lead (Pb) to contain the radiation. Botswana's Radiation Protection Inspectorate (RPI) has collaborated with registered scrap metal dealers, to sensitize them on how to recognize radiation sources or materials, as a way of preventing radiation exposure and reducing the hazards to scrap metal workers, the public and also the environment, in case such materials end up in a scrap metal yard.

Large scale mining, such as occurs in Botswana, has been known to increase the naturally occurring background levels of radiation. Radon, a radioactive gas is the most important source of ionizing radiation of natural origin, coming from rocks and soils. It is a major contributor to the ionizing radiation dose received by the general population and is a well-known human carcinogen. It accumulates in enclosed and poorly ventilated spaces such as underground mines. For instance, a study in the BCL underground mine in Selibe Phikwe in 2012 undertaken by the RPI showed that radon concentrations at different depths ranged from 14.26 to 237.65 Bq per cubic meter. All findings were below recommended IAEA value of 300Bq per cubic meter (Table 7-11).

Table 7-11: Radon concentration levels at BCL mine in 2012 compared to the recommended IAEA activity concentration of 300Bq/m³ (RPI, 2012)

Location	Radon concentration (Bq/m ³)*	Depth (m)
Shaft 3; Section 3M	219.12	930
Shaft 3; Section 3M	237.65	390
Shaft 3; Section 2P	110.45	930
Selebi	14.26	750

*Becquerels per cubic meter

While some data collection is ongoing, there is a need for more regular data collection and research to determine the average indoor and outdoor levels that the population is exposed to countrywide. This would help to come up with mitigation strategies if they are needed. Other challenges faced in this sector include compliance with and enforcement of the Radiation Protection Act of 2006 and the Radiation Protection Regulations of 2008, low use of radiation detectors for data collection at border points and the lack of a radioactive sources' storage facility (RPI, 2017).

Managing radioactive waste

The legal framework is guided by the Radiation Protection Act of 2006 and its Regulations of 2008 which are both under review. The institutional framework for radiation management includes the Radiation Protection Board and the Radiation Protection Inspectorate. The Environmental Monitoring Laboratory monitors radiation in the environment, while the National Dosimetry Laboratory monitors workers exposed as an occupational hazard. Currently, Botswana does not have a centralized disposal facility for radioactive waste. There are plans to construct a national storage and conditioning facility for spent sealed sources (GoB, 2017). Radioactive

waste shall be stored in such a way as to protect human health and the environment and shall not be stored in the vicinity of corrosive, explosive or easily flammable materials.

Some of the international agreements which Botswana is signatory to, include: the Convention on Early Notification of a Nuclear Accident; Convention on the Physical Protection of Nuclear Material; Convention on Assistance in Case of a Nuclear Accident or a Radiological Emergency. The country has also joined the International Atomic Energy Agency Illicit Trafficking Database and has developed an Integrated Nuclear Security Support Plan.

7.3 Status and trends of SDG indicators

SDG 11.3.1: Ratio of land consumption rate to population growth rate

Land cover is altered principally by direct human use; through agriculture, livestock raising and forestry activities and urban and suburban construction and development. The SDG 11.3.1 indicator helps policy makers to monitor urban development by measuring how efficiently cities utilize land. It compares the urban expansion rate against the population growth rate. The value for Botswana between 2000 and 2004 was 3.01 people/km² this which increased to 3.98 people/km² in 2018 as shown in (Figure 7-8) (UNEP, 2020c).

SDG 11.6.1: Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities

The share of urban solid waste regularly collected in Botswana's cities in 2013 was 91.2 . In comparison the average proportion of solid waste collected in the urban areas of Sub-Saharan Africa is only 43.4 (UNStats, 2020b; (GCDL, 2020).

SDG 11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities

Although there is no data for this indicator, Botswana has in place a legal framework for urban planning which is the

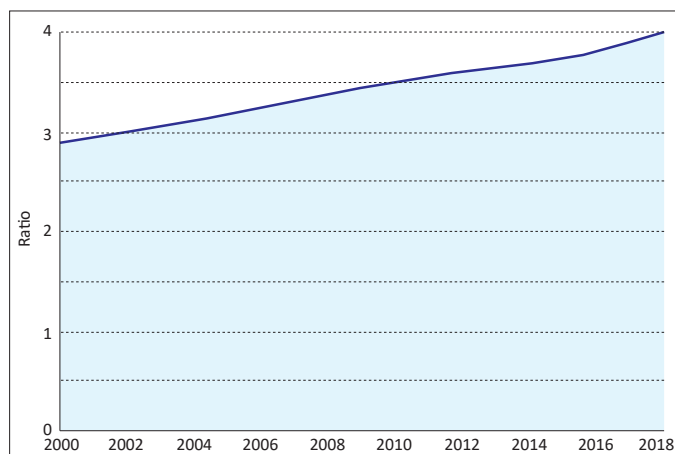


Figure 7-8: Ratio of land consumption rate to population growth rate 2000-2018 (UNEP, 2020a)

Town and Country Planning Act of 2013 as discussed in Chapter 3: Land. It replaced the Town and Country Planning Act 1977. The 2013 Act decentralized the planning function to local authorities but does not explicitly allow for public (or disadvantaged group) participation in the process.

The Urban Planning Standards 1992 guide the planners in land use and infrastructure allocation while the Development Control Code 2013 regulates and ensures compliance with the locality-specific spatial development plans and contexts. The flexibility afforded by the Development Control Code allows for localities to embrace and promote their uniqueness while allowing for the different stakeholders that reside there.

12.4.1: Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement

This indicator tracks the extent to which Botswana has complied with MEAs on hazardous waste and other chemicals (including the Montreal Protocol, Basel Convention, Rotterdam Convention and Stockholm Convention). It evaluates compliance with process requirements such as submitting national reports, appointing a focal point and so on. As shown in Figure 7-9 Botswana is fully compliant with the Montreal Protocol, but there is still much to do with some of the other MEAs.

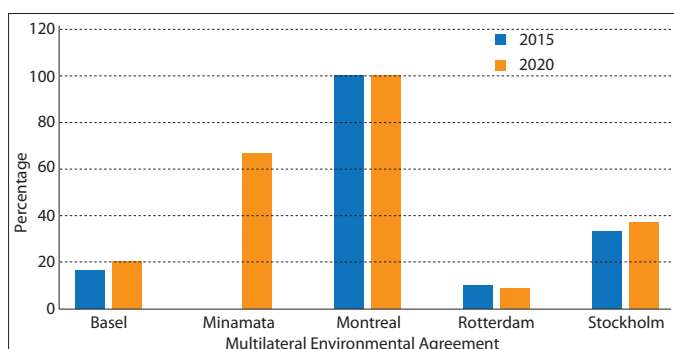


Figure 7-9: Share of parties to international multilateral environmental agreements on hazardous waste and other chemicals 2015 and 2020 (UNStats, 2020b)

7.4 Responses and suggested future actions

Waste management and pollution prevention and control programme

The changing nature and increasing volumes of waste is forcing many Governments, including that of Botswana, to create innovative management strategies. The current situation in the country is less than ideal. Waste collection facilities are inadequate, illegal dumping and open burning of waste are common and hazardous waste is not managed well. Some landfills are not well engineered leading to environmental pollution, with the accumulation of non-degradable solid waste causing additional problems.

There are different types of wastewater treatment plants in Botswana, the most common of which is the lagoon or the pond system. In most cases they discharge effluent directly into the environment due to poor compliance with existing physical, microbial, and chemical standards for wastewater disposal (BOS 93:2012). Strengthening compliance with existing standards will require the monitoring of influent and effluent quantities at these wastewater treatment plants. It may also be necessary to establish minimal requirements for the wastewater treatment plants as recommended by the Department of Environmental Protection. Inadequate maintenance is a key issue as many treatment plants had flow meters installed, but never repaired. Moreover, desludging of ponds is not regularly implemented. Underpinning all of these recommendations is the issue of data. Botswana has limited data on the quantities of wastewater reaching the plants, which would indicate quantities of waste produced. This is an integral aspect of plant operation and would be used in future development planning.

Improvements in wastewater treatment also require innovative strategies to provide adequate and sustainable solutions that can extend these benefits throughout the country (Kivaisi, 2001). Against that background, it becomes necessary to change the way in which wastewater is viewed; in the face of water scarcity recycling and reuse of wastewater is an important strategy to utilise. It is also recommended that mining companies develop and implement environmental management plans that focus on rehabilitation of land, prevent biodiversity loss and address adverse impacts on affected communities.

Going forward, there is urgent need to:

- Implement a waste management and pollution prevention and control programme, employing a variety of types of innovative technology, infrastructure and mitigation measures relevant to the country situation.
- View solid waste, including e-waste, as a resource and exploit opportunities to integrate its economic value into natural resources planning and management. Some of the strategies that Government could employ include adopting green growth strategies, resource efficiency and the circular economy.
- Establish minimal standards for the management of wastewater treatment plants as recommended by the Department of Waste Management and Pollution Control.

Integrated waste management

Given the array of waste and the need for coordinated development and management of wastes, land and related resources, there is a push towards the Integrated Waste Management (IWM) approach. This describes an approach in which decisions on waste management take account of different waste streams, collection, treatment and disposal methods so as to achieve a balance between collection and treatment methods. The aim is to balance cost, social acceptability and environmental sustainability as required under the concept of a sustainable city. This approach will require a range of data and information to support the required analysis and select suitable options for immediate



*Chairs made from used tyres
Photo credit: Lindsay Clark/THINK Global School/Flickr*

implementation and to allow for scenario analysis as waste streams grow. Some of the benefits of IWM are that, as part of a wider resource management system it will move the country towards identifying wastes as potential resources. In addition, it will encourage inter-sectoral collaboration (between environmental protection, public health, resource conservation, financial management and good governance) providing even more opportunity to implement measures for further improvement of waste management systems.

It would be useful to consider different approaches and methodologies such as Enhanced Landfill Mining, a strategy that collects valuable materials such as metals and e-waste and stores them separately in specific areas of a landfill. These are then subjected to sorting for recycling. The benefits here are these materials do not get comingled with other general waste thus easing the process of recovery.

From this perspective, it is recommended that an integrated waste management strategy be developed and implemented and this should also consider elements of the circular economy.

Strengthening the institutional framework

Botswana has put in place some structures to manage waste both locally and in the international arena. The Department of Waste Management and Pollution Control has oversight over this sector. However, there is a need to address issues of institutional framework and build capacity amongst the relevant technical staff in order to facilitate an effective and efficient implementation process of these frameworks, so as to realise the expected outcomes.

Regarding multi-lateral environmental agreements, the Department of Waste Management and Pollution Control is the designated authority and focal point for the Basel Convention, official contact point for the Stockholm Convention and the designated national authority for industrial chemicals and pesticides under the Rotterdam Convention. The institutional set-up needs to support regular inspections of all polluting industries, ensure rehabilitation

of contaminated sites, and work with industry to ensure compliance with developed environmental and waste management plans for all of the waste they produce.

Strengthening the institutional framework should be a priority of the Government. It is becoming a perennial problem with each National Development Plan indicating that lack of technical capacity is delaying implementation of planned projects. As time goes on, the quantities of waste generated increases and is mounting. This is creating a real challenge in how to deal with the backlog in an environmentally acceptable manner (GoB, 2017).

The Government is encouraged to:

- Build capacity in the Department of Waste Management and Pollution Control to strengthen the implementation of waste management strategies in the country. This will support the existing institutional framework and help it to perform better.
- Regulate the informal waste management sector, including waste pickers and scavengers.

Strengthen policy and legal frameworks for improved waste management

There is an urgent need to strengthen the policy and legal frameworks for waste management. Currently, management of waste in the country is guided by the Botswana Waste Management Strategy of 1998. The aims of this Strategy are to decrease the waste generated by the industry, households and commercial entities, increase recycling, reuse and propose well-defined collection, transportation, and disposal facilities for waste (Ednah and Luo, 2010). The Waste Management Act of 1998 regulates general waste and manages the transboundary movement of hazardous waste and their disposal. The Agrochemicals Act of 1999 registers all companies that deal with and import agrochemicals and collects all agrochemical containers for safe keeping and disposal. The Drugs and Related Substances Act of 1993 registers all companies, retailers, manufactures and importers of drugs.

These are all outdated laws which are in dire need of review and revision. Furthermore, the country does not have law to regulate the use of domestic or industrial chemicals. This gap was highlighted in NDP 10 which proposed a legal and administrative framework for the management of industrial chemicals. It also proposed the need for an integrated chemicals management framework in Botswana. Some of the key areas for attention were highlighted in the section on chemical waste.

It is thus recommended that:

- The legal framework for waste management be reviewed and updated considering recent developments in the sector and the economy as whole.
- A resource recovery strategy be implemented to help reduce the amount of waste that gets disposed of in landfills.
- Strengthen the compliance and enforcement of the various laws and standards to adequately support pollution control including the Wastewater Effluent Standard (BOS 93:2012), the Air Quality Standards, Radiation Protection Act, and the Environment Impact Assessment requirements among others.

Addressing the data void

For Botswana to have a responsive, effective and efficient waste management programme, it is essential that its plans and strategies for sustainable and integrated waste management be grounded on high-quality national data and information. Lack of good data on many aspects of waste generation and management, as highlighted through out this Chapter, restricts what can be achieved. For instance, lack of data on volumes and types of total household waste streams can seriously impact the capacity of waste handling infrastructure installed. Data and indicators should be closely tied to local socio-economic information systems. Global

data on e-waste generation or even estimates of data may be able to give a general picture, but it misses out on many of the nuances that locally generated data would present. Furthermore, the methodologies used for data collection at the global level may differ from those at the national level.

Improving the entire waste management data life cycle at all levels will better support monitoring and evaluation and provide robust evidence for decision makers (GoB, 2017).

7.5 Measuring Botswana's progress on the sustainable cities and waste management related SDGs

The data from the UN indicates that Botswana has only made positive progress on one out of the five SDG indicators being tracked in this Chapter; that related to sustainable cities and waste management in Botswana. On SDG 12.4.1, the country has signed up to several MEAs relevant to waste management and is implementing, albeit slowly, strategies and plans to meet its obligations. In 2015, the country had implemented 31.96 of required obligations under this indicator and this had increased to 46.56 in 2020 (UNEP, 2020b; UNStats, 2020a).

For the other four (4) indicators: SDG 6.3.1 (Proportion of domestic and industrial wastewater flows safely treated), SDG 11.6.1 (Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities), SDG 12.4.2 (Hazardous waste generated per capita; and proportion of hazardous waste treated, by type of treatment) and SDG 12.5.1 (National recycling rate, tonnes of material recycled), data is available. Proxy indicators have been identified that would provide the data to show progress on the indicated SDGs. It is now imperative, that reporting against these indicators be done so as to present a true picture of the effectiveness of the country's measures that are in place (MFED and UNDP, 2020).

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8

HEALTH AND ENVIRONMENT



8.1 Introduction

The environment is a primary determinant of individual and community health. Interacting with physical, chemical, and biological risk factors can harm human health in various ways. Environmental risk factors contribute to 23 of the global burden of disease from all causes in Disability Adjusted Life Years (DALYs), and to 22 of all deaths. It is also estimated that as much as 26 of deaths and 25 of DALYs among children under five years old are attributable to environmental factors (Prüss-Üstün et al., 2008). About 28 of the disease burden in the African regions is attributable to the environment, with deaths per capita higher than the global figure (Prüss-Üstün et al., 2008).

Almost all diseases have some links to environmental factors, but the most important of these are diarrhoea, respiratory infections, and malaria, which are quite common in Botswana. Globally, these three diseases are responsible for around 60 of deaths and attributable to the environment (WHO, 2015). Other contributors to the global disease burden with a significant environmental fraction are road traffic injuries, Chronic Obstructive Pulmonary Disease (COPD), perinatal conditions, ischemic heart disease, drownings, and HIV/ AIDS, amongst others. Similarly, exposure to environmental risks is higher in most African countries including Botswana when compared with global levels.

This chapter therefore will focus specifically on these environmental risk factors and their health linkages in the context of Botswana. It traces the current state, trends and reports on responses to issues and progress against the related SDGs.

8.2. Environment and health linkages in Botswana

In Botswana, in the early 1990's, average life expectancy was 68.8 years for females and 58.6 for males (as shown in Figure 8-1). However, contrary to expected increase in the life expectancy, Botswana experienced a drastic increase in cases of the Acquired Immunodeficiency Syndrome (AIDS), a chronic condition caused by the Human Immunodeficiency Virus (HIV). This led to a decrease in life expectancy of

the population. However, due to the implementation of universal access to free antiretroviral treatment (ART), the HIV prevalence in the country population fell gradually from 26.1 in 1999 to 20.3 in 2018, which in turn led to the gradual increase in average life expectancy to 70 years in females and 67.1 in males (Knoema, 2019).

Although, there has been a decrease in new infections of HIV/ AIDS, the prevalence rate among adult population (age 15 to 49) is still quite high - 18.6% (UNAIDS, 2021). Other major causes of in-patient mortality in Botswana include lower respiratory infection (pneumonia), diarrheal and ischemic heart diseases which are attributed to environmental risks (Table 8-1). Additionally, by having an economy that is largely based on livestock production, there is also high prevalence of cattle-human diseases such as anthrax.

Numerous communicable and non-communicable diseases are directly attributed to environmental risk factors such as air pollution, lack of access to safe water, sanitation and hygiene, occupational risks including exposure to chemicals and hazardous waste and other environmental risks including food contamination and human-wildlife interaction.

There is an array of new challenges, including climate change and rapid urbanization. Climate change threatens to exacerbate today's health problems including deaths from extreme weather events such as drought, heat wave, floods, malnutrition, cardiovascular, respiratory and infectious diseases, whilst undermining water and food supplies, infrastructure, health systems and social protection systems.

In Botswana, droughts and rainfall variability are predicted to increase with climate change, and as a result, slowed agricultural production, increasing food insecurity and increased water stress have already been witnessed, and are likely to increase (Botswana INDC, 2015). Furthermore, extreme events associated with climate change are likely to lead to an increased incidence of vector-borne diseases such as malaria and bilharzia (Botswana INDC, 2015).

The attribution of the burden of disease to environmental risks including climate change highlights the importance of environmental protection for people's health and can inform priority setting for the targeted management of



Figure 8-1: Average life expectancy in Botswana, observed and expected (1990-2017) (IHME, 2018)

Table 8-1: Major causes of all age mortality (excluding neonatal deaths) in Botswana, 2014
(Statistics Botswana, 2018)

2014				
Diagnosis/cause	Male	Female	Both Sexes	Percent
HIV disease resulting in mycobacterial infection	198	125	323	6.3
Pneumonia, unspecified	161	150	311	6.1
Septicaemia, unspecified	96	129	225	4.4
Diarrhoea and gastroenteritis of presumed infectious origin	111	106	217	4.2
Unspecified human immunodeficiency virus (HIV) disease	86	86	172	3.4
Stroke, not specified as haemorrhage or infarction	52	87	139	2.7
Congestive heart failure	53	76	129	2.5
Tuberculosis of lung, without mention of bacteriological or histological confirmation	95	33	128	2.5
Unspecified renal failure	69	57	126	2.5
HIV disease resulting in pneumocystis carinii Pneumonia	54	59	113	2.2
Causes Specified Above	1,029	967	1,996	39.0
Other Diagnosis	1,667	1,457	3,124	61.0
All Diseases and Conditions	2,696	2,424	5,120	100

environmental determinants. By focusing on reducing the environmental and social risk factors, nearly a quarter of the global burden of disease could be prevented (WHO, 2016).

The next sections will focus in detail on the various environmental challenges prevalent in Botswana and their health impact.

Air pollution and related health impacts

Air pollution can be a result of both indoor and outdoor air pollution. Outdoor air pollution results from an elevated level of fine particulate matter (PM10 and PM2.5) in ambient air (WHO, 2003). Major sources of outdoor air pollution in Botswana include industrial operations, manufacturing, and small-scale plants in big cities like Gaborone and Francistown, mining activities and smelters, stone or sand

crushers and traffic emissions along with natural sources such as bush fires and dust generation resulting from rapid soil loss and desertification due to factors like overgrazing (Wiston, 2017). However, according to the WHO (2016) ambient air pollution database, outdoor air pollution data was not available for Botswana.

Burning of fossil fuels (such as wood and biomass) which remains one of the major energy sources used for cooking, heating and power generation in households significantly contributes to indoor pollution. Around 37% of the population primarily use solid fuels for cooking in Botswana, with a higher proportion (65%) among rural population (WHO, 2016). Collectively these are associated with increased daily and long term illness and premature mortality, due to cardio-pulmonary diseases including tuberculosis, acute respiratory infections and cancers (WHO, 2015). Additionally,

Smoke from burning biomass
Photo credit: Youngbrov/flickr



the use of fossil fuels by households exposes women and children to greater risk of disease and are responsible for a larger proportion of the total number of deaths from ischemic heart disease, stroke, lung cancer and COPD in women as compared to men (WHO 2016). In Botswana, air pollution accounted for 40 of the total 330 child deaths due to acute lower respiratory infections (WHO, 2016). Figure 8-2 and Figure 8-3 highlight some of these trends.

Vector-borne diseases

Vector-borne diseases are illnesses caused by pathogens and parasites invading human populations. The distribution of these diseases is determined by a complex array of environmental and social factors. Pollution, poor waste management, floods, general poor hygiene, urbanization and climate change among others are contributing factors to vector-borne diseases. Disease vectors thrive where waste, including human excreta, is indiscriminately disposed of without due regard to the implications for human health. Malaria is a notifiable disease of key concern, whose spread is highly influenced by climatic and environmental conditions. The country is targeting malaria elimination and therefore malaria is one of the weekly notifiable priority diseases. Most of malaria in Botswana is caused by the malignant *Plasmodium falciparum* sporozoites and the *Anopheles arabiensis* mosquito (UCSF, 2016). The *Plasmodium falciparum* protozoan parasite released by the *Anopheles*

mosquito is responsible for over 98 of malaria disease in Botswana. The *Anopheles arabiensis* breeds in temporary and sunlit freshwater, feeds and rests both indoors and outdoors (Botswana National Malaria Programme, 2013).

The transmission of malaria cases in Botswana is seasonal, unstable, and occurs mostly during the rainy season between October and May. Although the entire population is susceptible to malaria, there is an uneven distribution of transmission intensity across the country. The areas with relatively high levels of transmission are concentrated predominantly in the northern and eastern parts of the country including Okavango, Bobirwa, Palapye and Mahalapye Districts, where most of the rains occur. The number of cases and deaths from malaria also varies from year to year. For instance, in 2017, there were 1,635 cases reported, although the number declined to 272 cases in 2019 (Figure 8-4). However, there is data indicating incidence of malaria even in areas not known to be prone to malaria in Botswana.

Impact of climate variability on malaria transmission

The increased variability in rainfall and extreme weather events that are brought on by climate change are adversely impacting the geographic and seasonal distribution of malaria risk in Botswana (WHO, 2016). Significant variations in the number of malaria cases across the years (2014, 2016 and 2017) and the regional differences are directly influenced by periods of heavy rainfall which are an effect of changing climate. According to predictions by the WHO, under a high emissions scenario (that is RCP 8.4), the population at risk of malaria will continue to increase towards 2070 in Botswana, as shown in Figure 8-5.

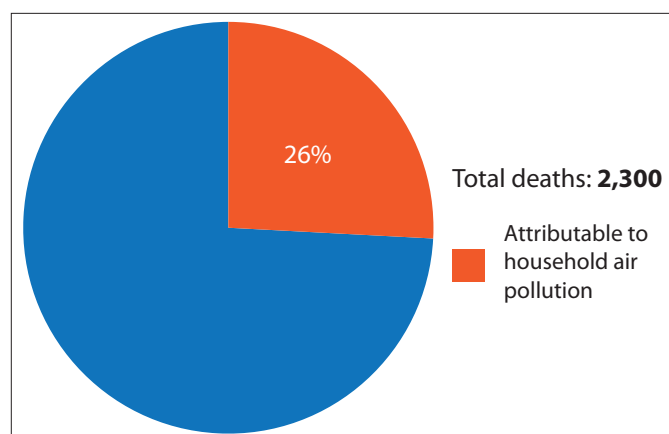


Figure 8-2: of total deaths from ischaemic heart disease, stroke, lung cancer, chronic obstructive pulmonary disease (18 years +) and acute lower respiratory infections (under 5 years) attributable to household air pollution, 2012 (WHO, 2016)

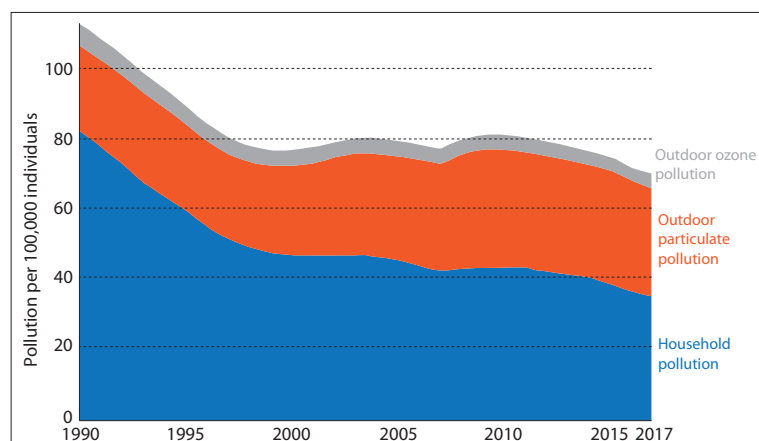


Figure 8-3: Death rates from air pollution in Botswana (Ritchie, Roser, Mispy, & Ortiz-Ospina, 2018)

Schistosomiasis infection is transmitted by snails living in fresh water such as lakes, rivers, streams and ponds in Africa, and some countries in Southeast Asia, South America, and the Caribbean. Risk increases with rainfall and water flow patterns. *S. haematobium* has been reported along the Limpopo River valley and its tributaries. Localized risk has been reported in Mabule (on the Molopo River), Kanye, and the northeastern areas of Southern District; Lobatse, Otse, Ramotswa, and Gaborone in South-East District; Molepolole and the southeastern areas of Kweneng District; Mochudi and southern areas of Kgatleng District; Xhumo, Nata and areas extending north between the Limpopo River and Palapye (Central District); Francistown (North-East District); Tsau, Maun, Kavimba, Kasane, and Pandamatenga (North-West District). The districts of Kgalagadi and Ghanzi (Kalahari Desert) are risk free (<https://www.iamat.org/country/botswana/risk/schistosomiasis>).

Lack of access to water, sanitation and the prevalence of water-borne diseases

Safe water supplies, hygienic sanitation and good water management are fundamental to public health. Globally, it is estimated that, safer water could prevent 1.4 million child deaths from diarrhoea, 500,000 deaths from malaria and 860,000 child deaths from malnutrition, annually (Prüss-Üstün, et al., 2008). As per the 2010 Health statistics in Botswana, diarrhoea

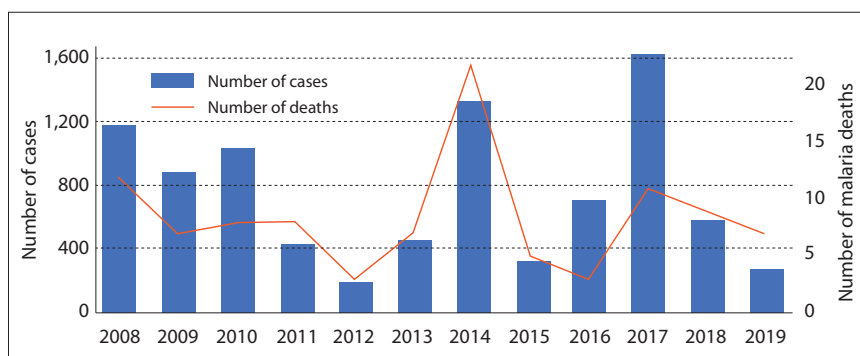


Figure 8-4: Botswana trends of malaria cases and deaths 2008-2019.
This figure was generated using variables from National Malaria Programme database

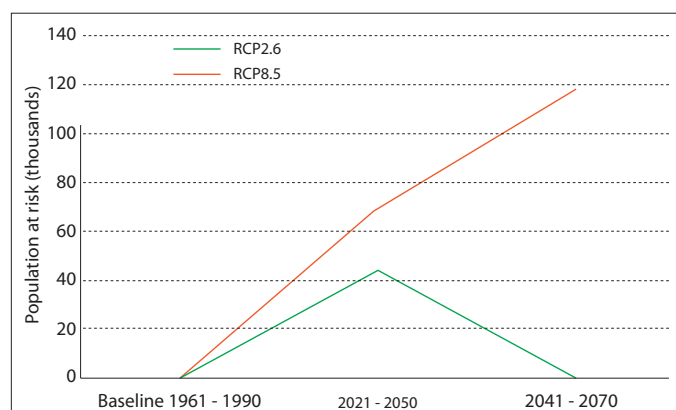


Figure 8-5: Population at risk of malaria in Botswana, under high emission (RCP 8.5) and low emission scenario (RCP 2.6) (WHO, 2016)

remains the major cause of infant morbidity (20) and can be linked to lack of safe drinking water, sanitation and malnutrition as highlighted in Figure 8-6 (Statistics Botswana, 2017).

According to recent data, access to services as adopted by the SDG targets and indicators, 90 of the population of Botswana had access to 'at least basic' services for drinking water (UNICEF; WHO, 2019). While there is no information on the access to 'safely managed' services, data reveals that 79 of the national population had water in their premises, with a significant gap between urban population (93) and the rural population (47) (UNICEF; WHO, 2019). Similarly, among the total number of households with access to improved water through a piped or tapped water source in 2011, 65 resided in towns and urban villages, while 35 were in rural villages. In 2017, about 73 of households in towns and urban villages had access to a piped or tapped water source while only 27 of households in rural villages had access to a piped or tapped water source. These results

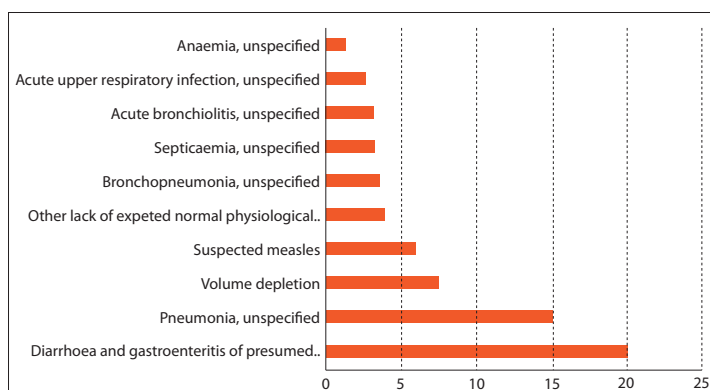


Figure 8-6: Major causes of infant morbidity – 2010 (Statistics Botswana, 2017)

also highlight that even though there was an increase in the number of households with access to piped or tapped water source in towns and urban villages, rural villages incurred a decrease (Statistics Botswana, 2020).

With regards to access to sanitation services, 72 of the population had access to at least basic sanitation, when this is disaggregated it shows that 77 had access to "latrines and others" as their source of improved sanitation, 5 had access to septic tanks, and only 1 to sewer connections. The data also highlights that 11 of the national population still practice open defecation, with 33 in rural areas. These statistics indicate that there is potentially a significant difference between the achieved coverage of improved water and sanitation, and that of 'safely managed' water, sanitation and hygiene management in Botswana, especially in rural areas, which could be a reason for water-borne diseases specifically diarrhoea to circulate (UNICEF; WHO, 2019).

Botswana's Third National Communication to UNFCCC also confirms that the health of communities with poor sanitation and hygiene deficiencies are at a greater risk of diarrhoeal and other communicable vector-borne diseases (MENRCT, 2019). Therefore, efforts to improve water quality, sanitation and personal hygiene in the rural areas would be a step towards reducing episodes of diarrhoea and other vector borne diseases in Botswana.

Communicable diseases

Sexually Transmitted Diseases (STDs) are a major communicable disease, along with other diseases such as diarrhoea and tuberculosis.

As noted in the previous section, environmental risk factors such as lack of access to safe drinking water, sanitation, unhygienic food consumption, malnutrition and climate change contribute to diarrhoeal outbreaks. According to Heaney et al., (2019), climate change and factors like the El Niño-Southern Oscillation (ENSO) contributed to outbreaks of diarrhoea along the Chobe Basin in Botswana. The study results suggested that the cooler temperatures, increased rainfall, and flooding associated with La Niña years added up to about a 30 rise in the number of childhood diarrhoea cases (Heaney et al., 2019).

As per the recent data available, a total of 13,208 diarrhoea cases were reported in 2018 resulting in 51 deaths (Figure 8-7). This is an increase of 26.5 from 10,441 cases

recorded in 2017 (Statistics Botswana, 2020). This rise in cases is attributed to a nation-wide outbreak of diarrhoea which was reported in September 2018 affected mainly children under five. The diarrhoea outbreak started in the central part of the country and then spread to other districts. At the peak of the outbreak, 18 of the 27 districts in Botswana reached epidemic level (WHO, 2018c). However, in general the total number of reported diarrhoea cases has been decreasing since 2008.

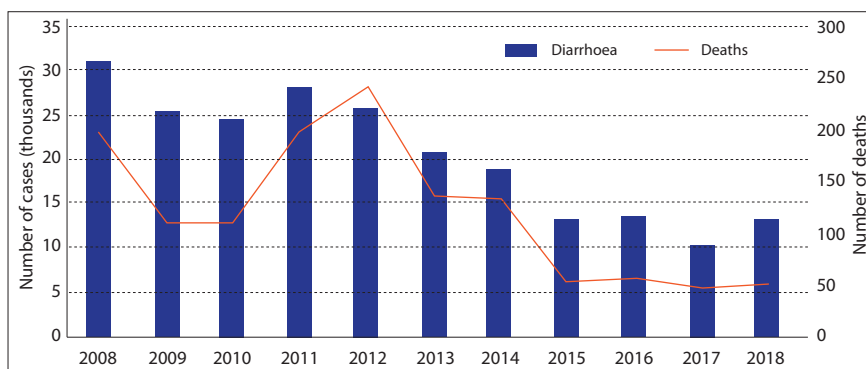


Figure 8-7: Trends in out-patient attendances and deaths for diarrhoea, Botswana 2008-2018
(Statistics Botswana, 2020)

Similarly, tuberculosis has long been linked anecdotally with environmental risk factors that go together with poverty: indoor air pollution, tobacco smoke, malnutrition, overcrowded living conditions, and excessive alcohol use (Schmidt, 2008). In Botswana, WHO estimated a tuberculosis incidence rate of 414 per 100,000 populations and a tuberculosis prevalence rate (all forms) of 326 per 100,000, in 2017 (WHO, 2018a).

Chemicals and hazardous waste

Chemical substances and their derivatives are vital in many economic activities including health, agriculture, mining, infrastructure, research and industrial processes. However, the large-scale production and use of chemicals has been accompanied by the release into the environment of many types of substances that consequently contaminate the air, water and soil. This has exposed humans and other biodiversity to levels of chemicals that cause adverse impacts on their health and the environment (WHO, 2014).

Other sources of chemical pollution come from the relocation of chemical production to developing countries and increasing urbanisation. These pressures contribute to increased exposure to chemicals with associated health risks in developing countries. In Botswana, the risks they pose are exacerbated by the increasing number of extractive industries.

According to an assessment report by WHO regional office for Africa (WHO, 2014), hazardous pesticides, mainly organophosphates and organochlorines, benzene, including Polycyclic Aromatic Hydrocarbons (PAHs), air pollutants (including carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone) and Persistent Organic Pollutants (POPs), including dioxins, furans and Polychlorinated Biphenyls (PCBs) were the chemicals that were reported to cause public health concerns in Botswana. Among these, the group of chemicals which is of the greatest environmental and health concern has been pesticides, that includes organochlorines such as DDT, endosulfan and lindane. Due to their importance in agriculture to combat outbreaks of locusts, mosquitoes, quelea birds, tsetse flies and pests, they have been used for more than 40 years now. Indiscriminate use of pesticides has contributed to soil contamination, water pollution, destruction of useful organisms and development

of pesticide resistance in pests, and consequently leading to harmful effects on the health of both farmers and food consumers (Leiss and Savitz, 1995). Moreover, as per the latest data available (2008), Botswana has reported having high stocks of obsolete pesticides (100,000 kg), which when not managed properly can present a serious public health and environmental concern by contaminating the air, soil, water, and food sources (WHO, 2014). Often the lack of designated disposal sites is a major factor forcing farmers to store obsolete pesticides in open spaces or on farms, which eventually results in pesticides leaching into the soil during rain.

In an assessment conducted by WHO regional office for Africa (WHO, 2014), Botswana reportedly has two sites in Sebele and Kasane regions which are contaminated with endosulfan, a pesticide that has severe health impact such as reduced fertility, genital birth defects, breast cancer, diabetes and damage to the developing foetus's brain. Apart from this, higher arsenic levels that exceed acceptable standards set by WHO have also been reported in groundwater in the Okavango Delta, that have severe health impacts such as cardiovascular diseases, chronic skin-related illness including skin cancer, developmental abnormalities, neurological and neuro-behavioural disorders. Chemicals-related fatal incidents reported in Botswana in the last two decades are summarized in Table 8-2.

Animal-human interaction and the prevalence of zoonotic diseases

Table 8-2: Chemicals-related incidents reported in Botswana (2000-2015)
(WHO, 2014)

Incident	Year	Location
Occupational exposure to benzene	2002	Caratex locality, Gaborone
Methanol intoxication in students	2003	Macha Senior Secondary School, Kang
Inhalation of sodium hypochloride	2010	Poultry in Gaborone North

Humans coexist in a complex, interdependent relationship with wild animals as they depend on them for food, livelihoods, and well-being, as well as with the environment. The interface between humans, animals, and the environments they share can also be a source of diseases impacting public health and the social and economic well-being of the world population. Such diseases, transmissible from animals to humans through direct contact or through food, water, and the environment, are commonly referred to as 'zoonoses' (WHO, n.d.).

In Northern Botswana, the Okavango Delta and Chobe National Park are hotspots of zoonotic diseases due to the animals living in these Transfrontier Conservation Areas (TFCAs). Animals living in these TFCAs are exposed to the introduction of pathogens from neighbouring countries and to increased opportunities of transmission between wildlife, livestock and human populations. These pathogens can have serious impacts on the health of livestock, wildlife and people if they come across susceptible or native populations in which they can amplify (Jori, et al., 2014). Common endemic zoonotic diseases found in Botswana are anthrax, bovine tuberculosis, Rift Valley Fever (RVF), brucellosis, cysticercosis, echinococcosis (hydatid disease), rabies and zoonotic trypanosomiasis (sleeping sickness) (WHO, 2009).

Climate change and its health impact

The National Health Policy (2011) of Botswana identifies climate change as a real threat to the well-being of the population. It is now widely accepted that a warming planet causes a variety of negative health consequences that include heat stress, changing distribution and intensity of diseases, food and water insecurity leading to thirst and malnutrition, as well as a range of immediate threats such as deaths, injury and other health emergencies arising from extreme events (GoB, 2011). The disadvantaged communities

are at the most risk of facing such risks while having very few resources to respond to them.

Heat-related health impacts

In Botswana, under a high emission scenario (RCP 8.5), it is projected that heat-related deaths in the elderly (65+ years) may increase to about 136 deaths per 100,000 by 2080 compared to the estimated baseline of approximately 3 deaths per 100,000 annually between 1961 and 1990 (Figure 8-8) (WHO, 2016).

On the other hand, a rapid reduction in global emissions could limit heat-related deaths in the elderly to about 20 deaths per 100,000 in 2080 (WHO, 2016). Similarly, climate change is causing the spread of communicable diseases (as discussed in the previous sections) and exacerbates the risks associated with non-communicable diseases. Additionally, in recent times, climate change effects are also causing threats to wildlife in Botswana, as described in Box 8-1.

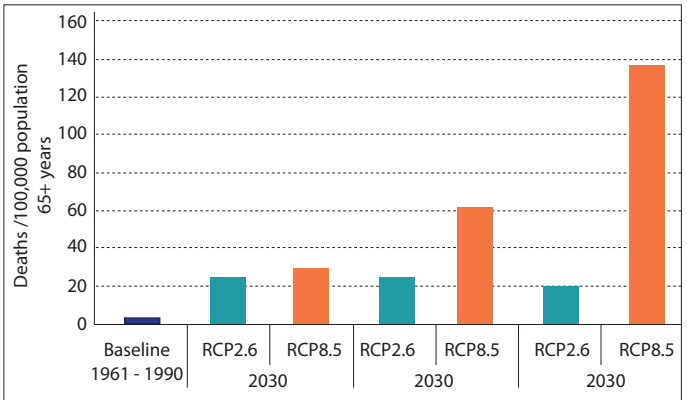


Figure 8-8: Heat-related mortality in population 65 years or over, Botswana (deaths / 100,000 population 65+ years) (WHO, 2016)



Dead elephant at Linyanti area
Photo credit: Photography Section, BOPA

Non-communicable diseases (NCDs) and under-nutrition

As the global surface temperature rises, incidents of heat waves, droughts, storms and floods will increase and become more severe, and these changes will bring heightened risks to human health and likely to exacerbate the cases of some of the chronic Non-communicable Diseases (NCDs) including cardiovascular diseases (hypertension and cardiac disease), chronic respiratory diseases, type 2 diabetes, some cancers and their lifestyle risk factors. Other related conditions include mental disorders and injuries, among others (MENRCT, 2019). According to WHO, in 2016, NCDs are estimated to account for 46% of all deaths in Botswana (WHO, 2018d).

Along with these health risks, climate change, through higher temperatures, land and water scarcity, flooding, drought and displacement, also negatively impacts agricultural

In general, malaria cases have been on the decline in Botswana. In 2018, incidence or the number of new malaria cases was 0.5 per 1,000 population at risk down from 44 per 1,000 population at risk in 2000 (UNStats, 2020).

SDG 3.9.1: Mortality rate attributed to household and ambient air pollution

The crude death rate attributed to household air pollution and ambient air pollution in 2016 was 53 per 100,000 population. Crude death rate attributable to ambient air pollution only was 27 per 100,000 population in 2016 (UNStats, 2020). This is also discussed in Chapter 6.

SDG 3.9.2: Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe water, sanitation and hygiene for all (WASH) services)

Box 8-1: Mass elephant deaths in Okavango Delta

Since March 2020, there has been growing concern over reported deaths of over 330 elephants in the areas around Seronga in the Okavango Delta of Botswana. According to officials from the Department of Wildlife and National Parks, the cyanobacterial neurotoxins found in water bodies are suspected to be the probable cause of death of elephants. Local sources suggest 70% of elephants died near water holes containing algal blooms, which can produce toxic microscopic organisms called cyanobacteria.

The late heavy rainfall received this year after many years of drought is one of the reasons cited for these algal blooms in the water bodies in Okavango Delta. Climate change is increasing both the intensity and severity of harmful algal blooms, making this issue more likely to re-occur. According to veterinarians and wildlife experts, other possible causes for the elephant deaths include anthrax poisoning, poisoning by humans, viral infection from rodents, or a pathogenic microbe.

(Weston, 2020)

production and causes breakdown in food systems. This disproportionately affect those most vulnerable people already at risk from hunger and can serve to heightened food insecurity. Vulnerable groups are susceptible to food and nutrition crisis if exposed to extreme climate events. Without considerable efforts being made to improve climate resilience, it has been estimated that the global risk of hunger and malnutrition could increase by up to 20% by 2050 (WHO, 2016).

In Botswana, the prevalence of stunting in children under age 5 was 23.4%, and the prevalence of underweight children and wasting in children under 5 was 11.2% (as of latest data in 2008) and 4.6%, respectively (UNICEF, 2020).

In this context of exacerbation of health risks resulting from climate change, there is an urgent need for Botswana's National Health Adaptation Strategy and Action Plan as adjunct to National Climate Change Strategy and Action Plan (NCCSAP) to be adopted and implemented during NDP 11 as a public health approach to adaptation to climate change.

8.3 Status and trends of SDG indicators

SDG 3.3.3: Malaria incidence per 1,000 population

This is discussed in chapter 5.

8.4 Responses and suggested future actions

Implementing the Libreville declaration on health and environment in Africa

As described in the previous sections, reducing the environmental risks is expected to greatly benefit public health and will contribute to attaining the Sustainable Development Goals, most importantly Goal 3 of ensuring and promoting healthy lives. The Libreville declaration was signed in 2008 by 52 African countries including Botswana aiming to secure political commitment for catalysing the policy, institutional and investment changes required to reduce environmental threats to health, in support of sustainable development. The declaration was based on the principle that the health and environment sectors have the potential to design mutually reinforcing policies and strategies and turn them into concrete actions. Out of the 11 actions proposed as part of the Libreville declaration, Botswana has successfully implemented nine actions (WHO, 2018b). Botswana has also set up a multi-sectoral Country Coordination Committee (CCC) to follow up on the implementation of the joint actions

of the Libreville declaration. The Ministry of Health and the Ministry of Environment and Tourism are jointly leading the CCC.

A draft implementation Monitoring and Evaluation Framework for the National Plan of Joint Action for environmental and health activities has been developed. For greater and deeper action on this declaration, it is proposed that:

- The implementation activities of the CCC be scaled up for greater impact.
- Financial and other required support to implement the remaining two actions be given for faster implementation.

National institutional and policy framework for health

The concept of environmental health has been considered in the recent NDP 10 and NDP 11, the National Health Development Plan, the Integrated Health Services Plan, the National Malaria Elimination Strategic Plan (2014-2018), the Ministry of Health and Wellness Strategy 2017-2023, and the National Health Policy 2011.

There have also been measures taken to strengthen Botswana's health and environment surveillance systems by establishing national multi-sectoral committees responsible for monitoring, preparedness and response to health emergencies. These committees usually deal with contingency plans for the health sector and have a joint health and environment reporting mechanisms on health issues. Botswana is also working at establishing functional linkages between health and environment surveillance systems. Surveillance at ports of entry has already been established and is being strengthened. The country International Health Regulation (IHR) core capacity assessment was done in 2017 and the development of National Action Plan for Health Security (NAPHS) was also completed recently (WHO, 2018b).

Therefore, to effectively address the emerging concerns related to the environmental-health linkages, coordinating, and acting across sectors will be necessary, as many different sectors play a crucial role (for instance, energy, industry or manufacturing, water and sanitation, agriculture, housing, and transport) in determining environmental risks and conditions. Additionally, the direct and indirect impacts of emerging risks, such as climate change and ecosystem change, need to be tackled urgently, as they are set to

become the most challenging risks populations will face in the coming decades (WHO, 2015). In addition to these cross-sectoral interventions, there is also a need to focus on the vertical dimension: action is needed at all levels of governance. Actions by local governing bodies can also be a key determinant in shaping the local use of resources and management of health determinants.

Henceforth, successfully tackling the interlinkages between environment and human health can provide a common platform and multiplier effect to sustain progress across many of the Sustainable Development Goals and Africa's Agenda 2063 in a more cost-effective and beneficial manner. To support this it is recommended as follows:

- Urgently integrate and tackle climate change, ecosystem change and health as part of the joint plan of action.
- Encourage the joint health-environment approach at the local Government and lower levels.

8.5 Measuring Botswana's progress on the health and environment-related SDGs

In as far as implementing the SDGs related to health and environment, Botswana has shown progress on SDG 3.3.3 on malaria incidence per 1,000 population. Between 2000 and 2018, there was a decline of 99% in the incidence per 1,000 population. Although this SDG goal does not specify the targeted level of reduction, when compared against other WHO targets, the country is doing well. For instance, one of the strategy goals for the WHO Global Technical Strategy for Malaria 2016–2030 is to reduce the malaria case incidence by 90%. This clearly highlights how well Botswana is doing on this target (UNStats, 2020; WHO, 2015b).

As discussed in chapters 5 and 6, the trend data for SDG 3.9.1 on mortality rate attributed to household and ambient air pollution and SDG 3.9.2 on mortality rate from unsafe water, sanitation, hygiene (WASH) both show an overall decline implying the effectiveness of current Government interventions in these sectors (Ritchie et al., 2018).

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A reticulater giraffe at Chobe National Park
Photo credit: Di/Flickr

9

FUTURE SCENARIOS



9.1 Introduction

Botswana covers an area of about 581,730 km² (MEWT, 2012) out of which 80 is the Kalahari Desert (Darkoh and Darkoh, 1999). Despite the predominantly harsh semi-desert conditions, the country has seen steady growth in Gross Domestic Product (GDP) in the past, averaging 6 per year in the period 1966 -1996 (UN, 2002). The economy is slowly diversifying, with mining now dominating over agriculture. In the period leading up to 2000, sectors such as transport and finance services grew at a fast rate of 11 - 14 per year (UN, 2002). Much of the country's economic activity remains spurred by mining, which contributed 25.9 and 19.9 of GDP in 2011 and 2017, respectively. Diamond mining is the country's largest export commodity, which contributed 88 of total exports in 2016 (UN, 2002). COVID-19 (coronavirus) has brought in challenges to Botswana, leading to an estimated GDP contraction of almost 8 in 2020 (World Bank, 2021).

According to the 2022 population census, Botswana has a population of 2,346,179. Over the past years, Botswana's small population has judiciously used its fairly diverse natural capital base, inclusive of minerals, land, biodiversity and freshwater resource (Fei and Shuang-Qing, 2012). As such, the country has high aspirations to meet its socio-economic growth targets as laid out in Botswana's Vision 2036 and in the 2030 Sustainable Development Goals (SDG) agenda.

Botswana's future will partly be shaped by the global commodities markets, especially for diamonds, and their effect on the country's economy. By being a net importer of key commodities such as cereals and petroleum products, global and regional economic and political trends may affect the landlocked country's future outlook. Due to its semi-arid to arid landscape, Botswana remains exposed to

the negative effects of climate change, although years of endurance have made the country resilient to drought and desert conditions. The drive to continuously diversify the country's economy will make a significant economic growth.

Environmental scenarios are important in policy setting and in planning future decisions. Botswana's future will be guided by its current state and trends in the environment and uncertainties, as well as local and global changes in the social, political and economic landscapes. This Chapter considers Botswana's state and trends in the environment and use them to create likely future pathways through the Business as Usual scenarios framework. The Chapter also explores Botswana's future that is defined by a significant shift in policies, human preferences and practices, as well as a future that is guided by the need to achieve targets under Vision 2036 and Agenda 2030 for Sustainable Development, and this is discussed through the Sustainability scenario. Both scenarios will be affected by a raft of drivers, including climate change, demographic changes and economic development, among others. The country's future outlook will also be affected by uncertainties, with the Covid-19 pandemic being the most recent and major one.

A scenario is a story that is concerned with the way in which the future could unfold, and such stories can be useful in offering lessons on how to direct the flow of events towards sustainable pathways and away from unsustainable ones (UNEP, 2002). A scenarios is "a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships" (Fei and Shuang-Qing, 2012). Scenarios can also represent a vision about the future (Chermack, 2003), and can assist one to look into and rehearse the future without being predictive but plausible and factual (Peterson et al, 2003). As such, scenarios are considered to be neither

*Diamond mining operation at Jwaneng
Photo credit: Department of Mines*



predictions nor forecasts but provide a plausible image of how the future might be (Patel et al, 2007). A scenario deals with the question “What might happen, if” and they do not predict what will happen in the future (UNEP, 2002).

The discussed Botswana scenarios are guided by a time horizon to 2030 when the country concludes the 2030 Sustainable Development Agenda. The other time horizon of interest to Botswana is 2036, which not only marks the end of the country’s Vision 2036, but is also a milestone in the country’s history marking 70 years of Independence.

9.2 Drivers of environmental change

There are many factors at play in shaping Botswana’s environmental outlook, and these include the country’s demographic trends, economic development, regional integration, governance and national aspirations. A steady growth in the small but youthful population, will not only result in the need to address unemployment, but also raise concerns about the equitable distribution of national resources. The predominantly desert conditions across the country will not only concentrate the country’s population in the urban and wetter parts of the country, but also worsen environmental degradation in those parts, causing soil erosion and loss of biodiversity.

National vision and aspirations

Botswana’s developmental agenda has over the years been driven by its 20-year national visioning, including the 1996 vision, 2016 vision and the present 2036 vision. The country’s Vision 2036 is aligned with not only the global agenda under the Sustainable Development Goals (SDGs), but also the SADC regional framework for development under the Regional Indicative Strategic Development Plan (RISDP).

In line with the SDGs, Botswana’s Vision 2036 seeks to address poverty by transforming the country into a high income nation. Similarly, the vision is linked to the RISDP whose objective is to deepen regional integration in Southern Africa with the aim of accelerating poverty eradication, creating a common market, ensuring food security and effectively managing transboundary resources. In order to move to a high-income status, Botswana acknowledges the small domestic market, and therefore seeks to not only diversify its economy but also increase its exports. Mining, agriculture, tourism and services will remain major pillars of the country’s economy. As a semi-arid to arid country, Botswana’s development will be underpinned by water security, with efforts being targeted towards water use efficiency. The energy sector will be transformed to renewable forms, especially solar, while sustainable land use and management will be practised.

Governance and institutional structures

Botswana’s good governance, especially of public resources, as well as strong institutions, is key to the country’s success not only on the economic front but also on matters of access and use rights to resources such as land, water and wildlife. The country’s governance and institutions are aided by the devolution of authority to local levels. During the pre-Independence era, Botswana had strong

local institutions centred around morafe (ethnic groups) which were administered by dikgosi (chiefs). Colonial rule moulded the morafe into tribal reserves, and the dikgosi into chiefs (Mamdani, 2018). The central governance system that came at Independence in 1966, acknowledged traditional governance systems through the dikgosi, while also working with elected local and district council officials. This blend of traditional and elected governance systems is acknowledged for the orderly process of delegation of authority from central Government to districts and local institutions, especially as far as the management of key resources such as land and water is concerned. For example, the management of land resources devolved from central Government to local authorities, run by Land Boards. District Development Committees and Village Development Committee are key in the decisions made at the local level (Kleinbooi et al, 2009).

As an active Member State of the Southern Africa Development Community (SADC), Botswana’s policy landscape and general state of the environment are guided by the shared nature of resources, as well as regional policy instruments such as the SADC Revised Protocol on Shared Watercourse Systems. Wildlife migration routes cross borders, as well as the country’s major water basins such as the Cubango-Okavango, Orange-Senqu, Zambezi and Limpopo are transboundary, a situation that calls for a regional approach to policy making.

Demographic trends

There is a direct link between population trends and access to or use of environmental resources, including land and water. The extent to which resources are degraded is also dependent on population trends and densities.

Botswana’s population growth was highest between 1971 and 1981 when annual growth rate averaged 4.6 . Population growth rate has considerably slowed down since 1981, averaging 1.9 per year, and is slowly turning towards replacement levels (Nkwe et al, 2017). Low fertility rates and the negative impact of HIV/ AIDS are some of the causes of the slowing population growth rate.

About 64.9 % of the country’s population is of working age (Nkwe et al, 2017). Coupled with a healthy economy, Botswana’s large ratio of working population, is partly the reason for the country’s good economic performance. It is also worth noting that the majority of Botswana’s working population is engaged in agriculture, making land a key national asset.

While the national average population density is 4 individuals per km², the distribution is not even, with Gaborone being the most densely populated place with as many as 11.4 persons per km², while the mining town of Sowa has an average of 0.2 persons per km² (Statistics Botswana, 2020).

Economic development

Botswana's economic growth has been among the fastest in the world for the past 40 years, with annual GDP growth rates of as high as 9 in 1965/66 and 2005/06 (Maipose, 2008). As a result of the high economic growth rates, the country's average per capita GDP rose from as little as US\$80 at Independence in 1966 to US\$6,924 fifty years later in 2016 (UN, 2002).

Botswana's economic growth has been reflected in significant reduction in poverty levels and an increase in real consumption levels. The period between 2002 - 2010 saw the incidence of poverty falling from 30.6 to 19.4, while real consumption per capita increased by 47.6 in rural areas. However, urban poverty is on the rise with indications showing that the ratio of the poor living in urban villages rose from 27.1 in 2002 to 37 in 2010 (Sulla, 2015). Botswana's strong economic performance is attributed to the country's resilience in the face of significant global environmental challenges such as climate change.

While Botswana's economy has grown significantly, it has not greatly diversified, with the diamond industry dominating the economy. Diamonds were discovered in Botswana in 1967 (Barclay, 2008). A raft of economic policies and institutions, including the Financial Assistance Policy, Botswana Investment and Trade Centre and Citizen Entrepreneurial Development Agency, have been tried in order to diversify the economy, but these have had limited success. As a result, the country faces challenges of high levels of formal sector unemployment and inequality (Nkwe et al, 2017). Unemployment was 19.9 in Botswana in 2011 (Statistics Botswana, 2014a), declining to 17.6 in 2015 before rising to 20.7 in 2019 (Statistics Botswana, 2019b).

Despite agriculture's contribution to GDP declining from 2.5 in 2008 to 2.3 in 2013 (Statistics Botswana, 2014), and falling further to 2.2 in 2017 (UN, 2002), the sector employs 30 of

the population (Barclay, 2008). The country's key agricultural activity is livestock production, with the activity contributing 87 of the agricultural sector's contribution to GDP. The climate is generally harsh for crop farming, resulting in low or stagnant productivity in output over the years (FAO; GoB, 2014). In addition to low crop productivity, Botswana suffers occasional incidences of livestock diseases such as foot and mouth and anthrax.

Tourism is the second largest sector of Botswana's economy after mining, with the Okavango Delta and Chobe being major destinations due to their large populations of wildlife. The direct contribution of tourism to Botswana's GDP was estimated at 4.9 in 2016, and employed 18,670 people (UNWTO, 2018). The Covid-19 pandemic has significantly affected the tourism sector by imposing travel restrictions on international tourists to the region over the last two years. The Okavango Delta has an attractive mosaic of dryland and wetland habitats, which are home to big game, birds, fish, reptiles and amphibians and also offers recreational activities such as canoe rides, site seeing, motor boat cruises and game fishing (Gumbrecht et al, 2004; Alonso and Nordin, 2003). The delta, which has its upper catchment in Angola and Namibia, must contend with the needs of upstream countries with whom the country should agree terms on the shared resources of the basin. Besides challenges in the transboundary management of shared resources, Botswana's wildlife-based tourism also suffers from human-wildlife conflict. The expansion of livestock farming into natural wildlife areas in the buffer zones next to game reserves such as Moremi and Chobe National Park has resulted in livestock predation by wildlife (Gusset et al, 2009).

Climate change and variability

Classified as semi-arid and arid, Botswana receives an average of 250 mm of rainfall per year in the southwest,

Kazungula bridge
Photo credit: Photography Section, BOPA



and about 650 mm in the north. The country is prone to severe droughts and episodes of flash floods. Evaporation rates are as high as 2,200 mm per year. As a result, the country has low rates of groundwater recharge and surface runoff (Lindhe et al, 2020). Average annual rainfall has been decreasing across most of Botswana. The annual precipitation was projected to decrease by 5 by 2015 (MENT, 2019). A major feature of Botswana's rainfall patterns is seasonal variability, with average rainfall amounts changing between different seasons, while in other cases the onset of the rainy season is delayed or starts early. Annual rainfall averages in central Botswana have been recorded to swing from less than 100 mm in very dry years to more than 300 mm in wetter years (Daron, 2014). The rainfall season is typically in months of November to March, and tends to be erratic and unpredictable.

As much as the globe has been warming, Botswana has not been an exception. In the Southern Hemisphere average temperatures have increased by at least 0.5°C from the 1960s

to the 1990s, while in Botswana they increased by 0.85°C during the same period (van Regenmortel, 1995). Estimates by the MEWT (2012) show that average temperatures in Botswana's interior have increased by as much as 1.6 to 2.0°C over the past 50 years. Temperature increases of between 1.5 - 2°C, and average rainfall reduction of 15 are projected by 2050 (MENT, 2019).

9.3 Scenario assumptions

The Business as Usual scenario is also referred to as the baseline scenario, "Laissez-faire", Orthodox Growth and Currents scenarios. The IPCC defines Business as Usual scenario as "the reference for measurable quantities from which an alternative outcome can be measured" (Partnership for Market Readiness, 2013). Under the United States of America's Energy Information Administration (EIA)'s Business as Usual scenarios, assumptions are that energy sector policies remain unchanged into the future (EIA, 2010). Following this definition, the Sustainability scenario becomes

*Flooding at Pandamatenga farms.
Photo credit: Ministry of Agriculture*



the alternative scenario through which changes in policy, technology and market forces, among other factors, are needed in order to reach the goals and targets as defined under the Sustainable Development Goals and Botswana's Vision 2036. Figure 9-1 shows Botswana's desired future against what could be possible if current state and trends were to be maintained.

Based on the definitions for Business as Usual and Sustainability scenarios, Table 9-1 shows some assumptions used in this chapter to characterise the two scenarios.

9.4 Scenario narratives

The Business as Usual scenarios depicts Botswana's future environmental development which is built on a continuation of current trends without major policy shifts. In this regard, Botswana's economy will continue to grow as the country embraces new technologies, especially in diamond mining, livestock production, and the services sector including tourism and financial services. The process of regional integration driven by regional initiatives such as the Regional Indicative Strategic Development Plan (RISDP) will be slow but solid enough to create a regional export market for Botswana's goods and services. With a stagnant and ageing population, Botswana will pin its economic growth on new technology to replace manual labour.

The Sustainability scenario depicts a future where Botswana

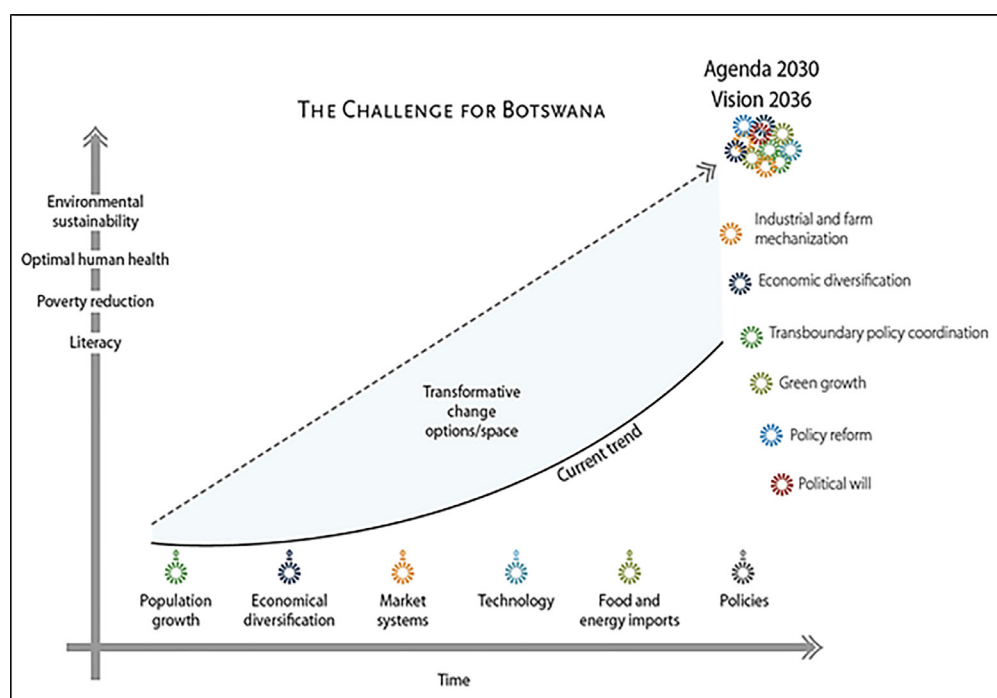


Figure 9-1: Botswana's challenge in reaching its desired future
(This graphic was originally created by Washington Ocholla and adapted for Botswana).

Table 9-1: Scenarios' assumptions
(Based on the author's characterization of the scenarios)

Scenario type	Assumptions
<i>Business as usual</i>	- The economy remains undiversified, with diamonds dominating the export sector - While the country's governance system is strong, Botswana's dependence on shared resources such as water resources and wildlife migration routes calls for the country to rely on regional integration efforts and policies - The country continues to depend on imports for cereal foods and petroleum products - While the country aspires to meet its goals and targets under the SDGs and Vision 2036, there is lack of policy coordination to drive an integrated development agenda.
<i>Sustainability</i>	- A scenario that describes Botswana's future based on policy adjustments, changes in habits and practices, new technologies, and performance that is based on set thresholds as defined by targets under the SDGs and Vision 2036 - There are increased levels of mechanisation in industry and on farms as a means of addressing labour shortages. Better health care results in longer lives, while higher literacy levels result in smaller family sizes. - The economy diversifies, with significant growth in the financial services and tourism sectors - There is greater cooperation among SADC countries, paving way for regional economic integration, transboundary conservation, and regional trade corridors, among others - Botswana becomes a leader in green growth, including renewable solar energy - Policy adjustments and political will see the country moving towards reaching all its goals and targets under the SDGs and Vision 2036

will make conscious efforts to manage the environment in a way that the country will meet agreed international development goals such as the Sustainable Development Goals. The management approaches will also seek to move the country towards reaching its aspirations under its Vision 2036. Under this scenario, Botswana will pursue a transformative agenda on the policy front, with the aim of reducing environmental degradation and loss of biodiversity, improving water use efficiency and creating smart towns and cities. The policy transformation will ensure that the country attains its desired environmental outcomes, and that the benefits to society result in prosperity and good health. The Sustainability scenario can also be described as the "Desired Future" scenario whereby there is not only environmentally sustainable development but also sustainable economic growth with improved livelihoods. While the Sustainability scenario is built around the current state and trends, it focuses largely on efforts needed to change the future course of the trends.

Land

Business as usual scenario

Botswana's agricultural potential is greatly limited by the expansive Kalahari Desert, which takes up two thirds of the country's land area. About 90 of Botswana's arable land is under seasonal crops, producing mainly cereals. Agricultural productivity of the cereals is low and declining. Total cereal yields in 1960 were about 62,000 tonnes before falling to 23,000 tonnes in 2017. The dry climate and country's poor sandy soils, which limit soil enrichment with nitrogen fertilizers along with the low and unreliable rainfall are critical to understanding Botswana's poor cereal yields per unit area.

Nitrogen fertilizer use dropped from 42.86 kg/ha in 2009 to 31 kg/ha in 2017 as the dry conditions are not suitable for intensive applications of nitrogen fertilizer. While cereal yields have been falling, Botswana's food demand has been increasing necessitated by a growth in population of 326 between 1960 and 2017. While current population growth is low, local production of cereals cannot meet demand, a situation that seems likely to persist into 2030. Food imports, which made up 12.6 and 12.3 in 2017 and 2018, respectively (Statistics Botswana, 2019a), continue to fill the nation's cereal gap and will undoubtedly increase going into 2030.

Botswana's livestock sector depends on the quality of pasture and the availability of water. The cattle population peaked at 2.2 million in 2011 before declining to 1.74 million in 2018 largely due to drought conditions and recurrent outbreaks of livestock diseases (Statistics Botswana, 2020). While livestock production remains key to Botswana's food needs, the sector has also been important for the country's exports. Beef exports have been declining since the 1970s, with export value and volume declining by 68 and 53, respectively, during the period 1976 - 2010 (Seleka and Kebakile, 2015), and this decline in beef exports seems likely to continue into 2030.

National food security continues to be driven by Botswana's positive economic growth and transparent governance system. While the economy remains undiversified, the wise use of proceeds from, mainly diamond exports, ensures that the country is food secure and that cases of hunger are

few. Key policy instruments such as the Integrated Support Programme for Arable Agriculture Development, Livestock Management and Infrastructure Development and Poverty Eradication do not only ensure that Botswana achieves its SDG 2 to end hunger, achieve food security and improve nutrition and promote sustainable agriculture, but also SDG 1 to end poverty in all its forms. Botswana's efforts to meet SDG 1 and 2 are emboldened by the country's national development planning under Vision 2036 pillar for human and social development.

With 90 of its arable land already under cultivation and farmers continuing extensive farming practices, new areas reserved for forests and wildlife conservation are opened up for crop production. The area covered by forests which fell from 24 in 1990 to 19.1 in 2011 is further encroached into, while fragile lands are exposed to soil erosion and other forms of land degradation, resulting in further advancement of the Kalahari Desert. The situation is not helped by the country's land tenure policies, which while bringing land management to the local level through Land Boards, are hindered by the privatisation of some land for rangeland uses. The current rangeland leases of up to 25 years expose rich pastures to overgrazing and soil erosion.

Sustainability scenario

Although Botswana is generally food secure, the country continues with forward planning for enhanced food security and better livelihoods through smart farming. The country's thrust is to produce more food per unit area and to ring-fence and grow its lucrative export market for livestock products.

The major limiting factor to Botswana's cereal crops and livestock production is the availability of water. Investing in crop varieties that thrive under harsh conditions, as well as in renewable energy sources is also what Botswana embraces for a fully integrated economy. Although Botswana currently uses its groundwater at a higher rate than replenishment levels (Kgathi, 1999), the country strives to greatly improve on water use efficiency. The country's groundwater potential is estimated at $1.7 \times 10^9 \text{m}^3$ per year, with an extractable volume of about $1.0 \times 10^9 \text{m}^3$ per year (Kgathi, 1999; AO, 1995). The country embraces technologies such as drip irrigation as a means to improve water use efficiency while also using farming practices such as zero tillage and mulching to reduce evapotranspiration. At the same time, significant investments are made in off-grid solar energy to power the pumping of water from groundwater sources. Yields per unit area are increased significantly, while livestock have better access to drinking water and farmers can grow small-scale irrigated cattle fodder. As 2030 approaches, Botswana is not only food secure and a high income economy, but is also producing more than enough cereals so as to cut down on food imports.

The high yields per unit area, as well as full compliance with key policies such as Tribal Land Act (TLA), Tribal Grazing Act (TGA) and National Policy on Agricultural Development, allow Botswana to increase its livestock units and grow its national herd beyond the 2011 peak of 2.2 million. The appetite to use more arable land and open forests for agriculture is reduced, with significant gains in ecosystems and biodiversity richness. The exposure of fragile land to

soil erosion is also reduced. Figure 9-2 shows some land and agrarian policy options for Botswana.

Biodiversity

Business as usual scenario

Botswana's rich and diverse habitats and ecosystems that include the Kalahari xeric Savanna, Kalahari Acacia baikiaea woodlands, Southern Africa bushveld, Zambezi halophytics, the Okavango Delta and the Chobe river system, have largely been undisturbed due to the judicious harvesting and wise use of the various ecosystem services they offer. The little disturbances on these ecosystems are due to many factors including the small and sparse population and effective governance systems. Going into 2030, the country continues to benefit from ecosystem services such as firewood, medicinal plants such as hoodia, food such as the marula fruit and mopane worms, and economic benefits such as tourism. Demand for firewood for cooking and lighting continues to fall as the country expands its rural electrification from 53 (BPC, 2011) to near full national coverage by 2030, owing to the availability of cheap options such as off-grid solar power. With the widespread

investments in off-grid electricity, Botswana makes small but significant progress towards SDG 15, especially in as far as sustainable forest management is concerned.

As general livelihoods in Botswana continue to improve, significant pressure is exerted on the country's rich biodiversity, resulting in habitat destruction, poaching, incidences of wild fires, proliferation of alien invasive species, and the erection of barriers in wildlife movement areas. Botswana's over-dependency on livestock production, which makes up 85 of the country's agricultural output (USDAFAS, 2015), results in not only greater competition with other land uses such as wildlife conservation and increased human-wildlife conflict, but also demonstrates some unintended consequences of some policies. The Tribal Grazing Land Act, which among other provisions, provides for cattle ranging leases and fencing off of some grazing areas, creates barriers to the free movement of wildlife in search of water and pasture.

The Okavango Delta, a key wildlife habitat, witnesses significant changes to its hydrology with reduced inflows as water withdrawals are increased in upstream Angola and

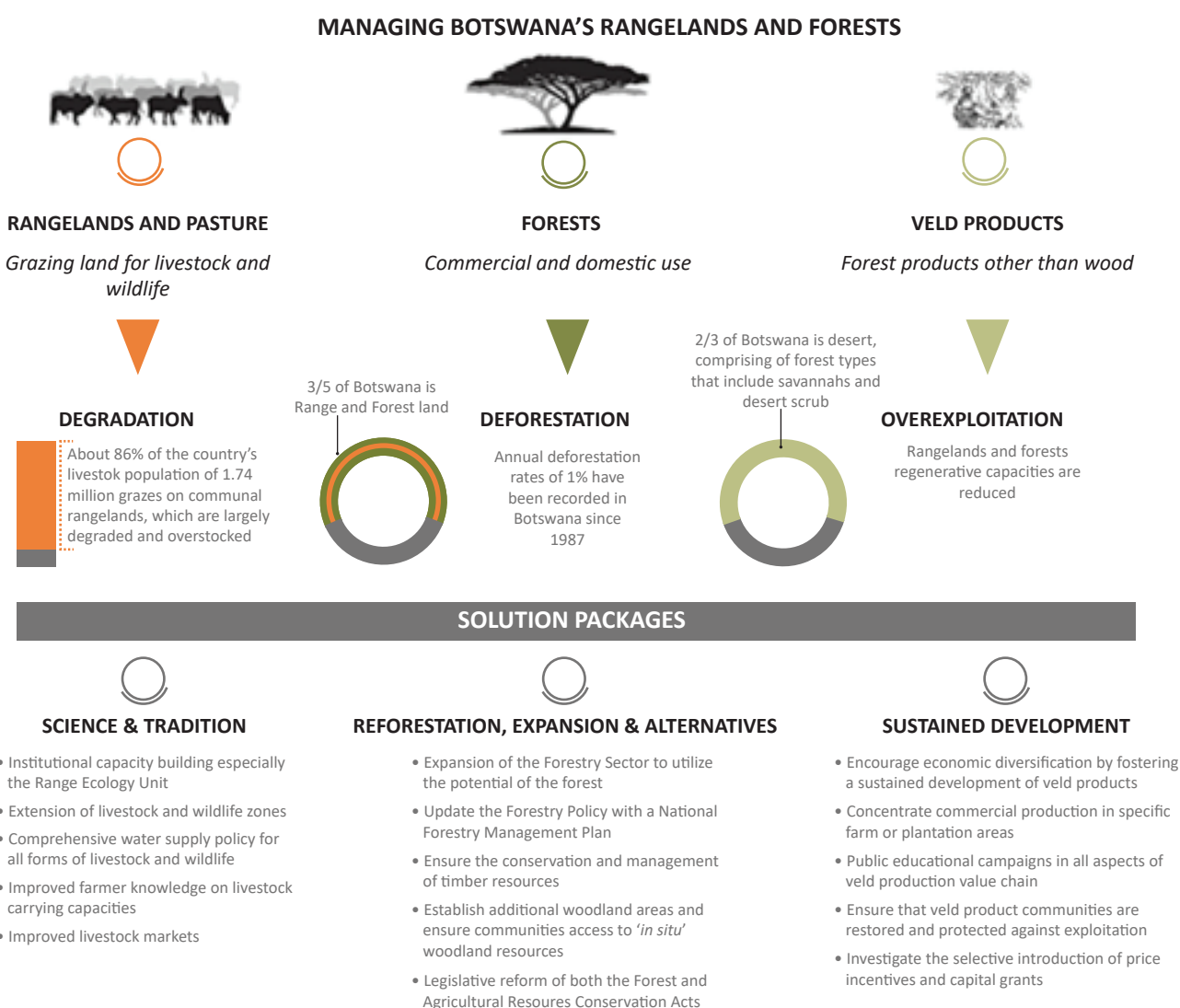


Figure 9-2: Some land and agrarian policy options for Botswana



A relaxing leopard
Photo credit: Dolin Watts/unsplash

Namibia. Going into 2030, the population of some key wildlife species is reduced and so are revenue streams from tourism. However, Botswana remains host to the largest elephant population in Africa, emanating from the effectiveness of key conservation laws, including the National Parks Act, the Forest Act and the National Biodiversity Strategy and Action Plan. Botswana's elephant population, estimated at 131,600 in 2016 (Thouless et al., 2016), remains stable going into 2030, due to conservation corridors such as the Kavango-Zambezi Transfrontier Conservation (KAZA) area, which opens up free movement of not only elephants but also other wildlife species, Botswana's law enforcement strategy through the Botswana National Anti-poaching Strategy (2015), the 2014 hunting suspension, and plans such as the SADC Biodiversity Action Plan (2013), and the SADC Wildlife Protocol.

As a result of the competing land use types and competition for water over transboundary resources such as the Okavango River Basin, Botswana makes little progress in increasing the proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas as targeted under SDG 15.

Sustainability scenario

The many ecosystem services that Botswana accrues spur the country to continue to protect its diverse biological resources. Non-timber forest products such as marula, hoodia and mopane worms remain key to not only rural households as food and medicines, but increasingly to the national economy as their economic values increase. Dried mopane worms are high in protein content and have the potential to address food security. Botswana's mopane worm trade was worth US\$3.3 million in 1995 (Styles, 1996),

and this trade figure is much higher today. With the country investing more in benefit sharing with local communities, commercially important plant and animal species such as elephants, marula and mopane worms receive better protection, resulting in a reduced proportion of poached or illicitly traded wildlife under the SDG 15 (sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss).

Better policy coordination at the national and local levels, including the amendment of the Tribal Grazing Land Act, result in the peaceful co-existence between farmers and wildlife conservationists, with protected passage being given to migratory wildlife in search of grazing pasture and water. At a regional level, transfrontier conservation efforts such as the Kavango-Zambezi Transfrontier Conservation Area take route, opening wildlife movements and better conservation.

Botswana and neighbouring countries Namibia, Zambia and Zimbabwe significantly increase the proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas by ecosystem type, with fewer species on the IUCN Red List Index by 2030.

Botswana successfully engages its neighbours to protect important habitats such as the Okavango Delta and the Chobe River system. Regional policy instruments such as the Revised SADC Protocol on Shared Watercourse Systems are fairly applied so that the Okavango Delta in Botswana receives an equitable share of water needed for the maintenance of the ecosystem integrity of the Delta, while upstream Namibia and Angola also receive a fair share of water for their irrigation and energy needs.

Water and sanitation

Business as usual scenario

Botswana has a physical shortage of water, receiving between 250 - 650 mm/year of rainfall while evaporation rates are as high as 2,200 mm/year. Over 44% of the country's population lives under conditions of water stress, water scarcity or absolute scarcity (World Data Lab, 2020). With only 96 Mm³/year of sustainable aquifer yield and 73.2 Mm³/year that can sustainably be withdrawn from surface water sources such as dams, Botswana's total sustainable yield of water is 169.2Mm³/year against demand of 200 Mm³/ year. Going into 2030, the country continues to have a water availability challenge. The situation is aggravated by the low aquifer recharge across much of the country as this reduces the amount that can sustainably be withdrawn from aquifers. Moreover, the water availability is exacerbated by the increasingly extreme variation in climate. Through investments in the water sector, as much as 99.5% and 83.5% of the population in urban and rural areas, respectively, has access to safe drinking water. Going into 2030, the country achieves universal access to safe drinking water although many still depend on shared communal water sources.

The country's perennial rivers (Cubango-Okavango, Chobe-Zambezi, Orange-Senqu and Shashe-Limpopo) are all transboundary and shared with neighbouring countries. The availability of water to Botswana from these perennial sources is not only limited by regional instruments for the transboundary management and sharing of resources such as the SADC Revised Protocol on Shared Watercourse Systems, but also by the distance the rivers are from key users and major settlements.

As of 2017, Botswana had a national average of 60% access to sanitation services, with a huge disparity between urban and rural access. Only 39% had access in rural areas while 75% had access to sanitation services in urban areas (UN Water; WHO, 2018). Without policy coordination between the Water Act, which provides for the infrastructure to deliver water, and the Public Health Act, which covers sanitation, the proportion of Botswana's population using safely managed sanitation services and hand washing facilities does not meet the country's targets under both the SDGs and Vision 2036. In addition, the country fails to reduce the ratio of people practicing open defecation, which was recently as high as 33% in rural areas (UN-Water and WHO, 2018).

Steady economic growth brings huge demand for water for use in the agriculture, domestic and industrial sectors. Improved water use efficiency, especially in the agricultural sector, continues to spur growth in the sector, while at household level technologies such as dry sanitation help to free up water for other uses. Currently agriculture uses 48% of the water available to the country, while domestic uses and mining use 23% and 7%, respectively. Going into the future, agriculture continues to dominate water use.

Sustainability scenario

Botswana acknowledges water availability as its major challenge and invests significantly in non-conventional water sources. Sand rivers, which can yield between 2.5 – 55 Mm³/year, and saline groundwater are tapped into and processed for potability, industrial use and irrigation. While the current gap of 30.8 Mm³/year in sustainable water yield is met, the increasing water demand brought about by a growing economy needs addressing. Additional efforts are made to adequately treat the 73 Mm³/year of wastewater for reuse in irrigation, industry, groundwater recharge and domestic use (Centre for Applied Research, 2006; SMEC et al, 2003).

Given the regional dimension of the water shortage problem, with neighbouring South Africa also facing similar challenges, joint efforts are made to invest in withdrawing water from Lesotho. Both South Africa and Botswana are keen to see to fruition the transfer of water from water-rich Lesotho through the Orange-Senqu river system.

By addressing the country's water availability challenge, investment in sanitation, hand washing and access to safe drinking water makes it possible to meet SDG 6 for the proportion of population using safely managed sanitation services and hand washing facilities, and for proportion of water safely treated, as well as for expanding water sources. Additional benefits to be realized are on the significant reduction of mortality and morbidity attributed to unsafe water, poor sanitation and hygiene.

Air quality, climate change and disaster risk reduction

Business as usual scenario

While the outdoor air quality across much of Botswana is good, there are areas where the quality is poor especially in urban and mining areas. For example, pollution levels in Gaborone reach as high as 216 micrograms per m³ with much of the pollutants coming from construction work, open burning of waste, coal fired industrial activities and rail transport. Seasonal dust storms from the Kalahari are also common. With increased industrial activity and growth in urban population, outdoor air pollution levels in urban and mining areas are set to remain high. As a result, the country fails to meet SDG target 11.7, which aims to reduce the environmental impact of cities by improving air quality.

Indoor air quality is generally poor across the country due to the high dependency on fossil fuels and wood for cooking, heating and lighting in poorly ventilated homes. A national average of 37% of households use fossil fuels with the situation being more severe in rural areas where 65% of households are dependent on this form of energy. With as many as 2,300 deaths per year attributable to indoor pollution, the country's key legislation against pollution, including the Atmospheric Pollution Prevention Act and the Environmental Assessment Act are not deterrent enough to stop or reduce the number of people dying from acute respiratory illnesses. Off-grid solar energy solutions are only good for lighting while fossil fuels continue to be needed for cooking and heating. As a result, Botswana fails to meet SDG target 7.1.2 which seeks to ensure access to clean

energy in homes, as well as SDG target 3.9 which calls for a substantial reduction in deaths and illnesses from air pollution. Acute lower respiratory infections continue to afflict many women and children.

Botswana has witnessed a temperature increase of 1.5°C between 1970-2015, with a further 1.0°C temperature expected by 2050 (Climate Risk Profile: Botswana, 2021). Such a temperature rise worsens Botswana's already precarious water availability as evapotranspiration rates rise by 3.7 - 7 percent. Sustainable water yields from surface water sources are reduced, with widespread impacts on domestic, agricultural and industrial users. For example, the quality of grazing and the availability of watering points for cattle are reduced, causing farmers to reduce their livestock units. With many households dependent on livestock farming, Botswana's efforts towards rural poverty reduction do not yield much success while food imports increase to eliminate the food gap.

As a semi-arid to arid country, Botswana's mean rainfall received per year does not change much, although mid-season dry spells become more common and even longer than currently experienced. Cereal production is reduced, forcing the country to import more food. Even with its reduced rainfall levels, the country remains prone to intermittent flash floods with parts of Ngamiland being prone to more severe floods.

Sustainability scenario

In view of the poor outdoor air quality in urban centres, Botswana adopts a smart cities approach, investing in clean solar energy and clean mass public transport, while also improving on waste collection and management. Solar energy, currently confined to street lighting, borehole water pumping and household water geysers, is expanded to cover industries and businesses, while the coal fired rail transport system is discontinued and replaced with electric rail transport for mass transportation of passengers and goods. Manufacturing industries are retooled with mandatory replacement of coal-fired boilers with solar boilers. A comprehensive revision of the country's urban planning and energy laws drives the transformation towards smart cities in Botswana. As a result, the country meets SDG target 11.7 with a significant reduction in the environmental impact of cities through improved air quality.

Houses in rural areas are modernised for adequate ventilation, while new and clean cooking stoves are designed and rolled out. With lighting provided through clean solar power, incidents of acute lower respiratory illnesses are reduced as there is little to no indoor pollution. Outdated laws such as the Atmospheric Pollution Prevention Act of 1971 are revised so that they take into account changes in types and quantities of pollutants. Moving into 2030, there is a substantial reduction in deaths and illnesses due to air pollution while both rural and urban homes have access to clean energy and better ventilation.

The global nature of climate change forces Botswana to invest more in adaptation than in mitigation. With the water sector greatly affected by the rise in temperature and increase in mid-season droughts, Botswana invests in the treatment and reuse of wastewater and in water harvesting across all sectors including homes, as well as exploring new sources of water such as drawing water from the Orange-Senqu River system and from sand rivers. New varieties of small grains are grown, which have a short growing season and can stand low rainfall. Yields are fair but not enough to meet demand and as such cereals continue to be imported but at lower quantities than currently.

Sustainable cities and waste management

Business as usual scenario

About 68.7% of Botswana's population lives in urban areas, making the country one of the most urbanized in Southern Africa. South Africa and Namibia are 65% and 48% urbanized, respectively (Global Change Data Lab, 2020). Gaborone is the country's capital and largest city with a population of over 244,107. Despite Botswana's population growth rate now having slowed and nearing replacement levels, the urban population is increasing with expectations to reach 87.9 percent by 2050. Urbanisation reflects an expanding and industrialising economy and Botswana will struggle to provide all of its residents with services such as drinking water and electricity, among other amenities. Botswana has kept to a minimum the mushrooming of slum settlements, because of proactive legislative and urban planning aimed at the creation of sustainable human settlements. Going into 2030, the country continues to have well run towns and cities with proper housing even though some communities still share communal water and toilets. As such Botswana will ensure access to all to adequate, safe and affordable housing and basic services by 2030.

Waste management is a challenge across much of Botswana, with urban areas generating four to seven times more waste than rural areas. Even with their low waste generation rates, collection levels are very low in rural areas. In 2001 only 6 percent of waste was collected, and this ratio grew to 14 percent of waste in rural areas in 2020. While this indicates an upward trend, the situation in Botswana's urban areas has been on the decline, with 81 percent of waste collected in 2001 but only 76 percent collected in 2011. With infrastructure support for waste collection failing to cope with a growing population and high urbanisation trends, Botswana faces more challenges in waste collection going into 2030. Waste separation and recycling have still not become the norm and although there is greater involvement of informal waste pickers, especially for recyclable materials such as glass, paper, metal, E-waste and some plastics, these efforts are inadequate, resulting in the country failing to realise the SDG targets to reduce the adverse per capita environmental impact of cities, including air quality and municipal waste management.

The amount of E-waste generated in Botswana has increased from a per capita average of 2.83 kg per year in 2000 to 7.92 kg per year in 2019 (UNStats, 2020). More electronic waste is generated going into 2030. Hospital waste, which averages 0.1 kg to 0.75 kg per patient (UN Stats, 2020) is another hazardous type of waste that Botswana grapples with as health care improves, but facilities for incineration and other types of waste management do not expand at the same pace. New types of waste such as face masks have emerged during the Covid-19 pandemic. Mining waste, which amounted to as much as 871 tonnes in 2018, is another type of hazardous waste, which Botswana deals with at a time when landfills are not expanding at the same pace as the growth in mining output. The Waste Management Act, Botswana Clinical Waste Management Code of Practice, and Miners and Minerals Act are not adequate for the handling of new types of waste, as well as not deterrent enough to stop bad practices such as waste burning. Current practices such as those prevailing in Ngamiland West where 50.89 of waste is burnt do not just continue into 2030, but have also spread to other areas.

Sustainability scenario

Urban expansion in Botswana is matched with world class planning and service provision. A notable achievement by 2030 is the planning for each housing unit to be self-contained

without the need for communal services such as water and toilets. Green spaces give cities the ambience and natural feel and function as healthy functioning ecosystems while also helping clean the air in towns and cities. While all urban residents are provided with safe and affordable housing, they are also provided with green public spaces, which are safe, inclusive and accessible, especially to women, children, the old and disabled.

Waste collection in both rural and urban areas is regular, due to the greater involvement of the private and informal sectors, including waste pickers. The growing waste recycling industry requires waste sorting prior to collection which the public supports. Consumer interests in organic foods results in the conversion of all bio-degradable waste into organic fertilizers. National policies and individual practices are all geared towards a circular economy, with bulk waste such as wastewater increasingly being regarded as a resource, rather than waste. As a result, Botswana adopts and implements integrated policies and plans towards maximising resource use efficiency, as well as integrated and sustainable human settlement planning and management.

A comprehensive overhaul of legislation such as the Waste Management Act, Mines and Minerals Act and Botswana Clinical Waste Management Code of Practice results in not only the identification of new types of waste, but also improved waste collection and cleaner urban areas.

*Champs Botswana, Integrated Waste Management Facility
Photo credit: Champs Botswana*



9.5 Conclusion

The above scenarios analyse and outline plausible features obtained in Botswana with the Business as Usual compared to the Sustainability scenarios. The Business as Usual scenario highlighted some policy gaps and policy coordination challenges, while the Sustainability scenario portrayed Botswana's aspirations, including aspirations for a new policy landscape and high quality lives of its citizens. In the two scenarios are the strong institutions in Botswana (Business as Usual), although these can still be transformed and modernised (Sustainability scenario).

A notable feature of Botswana is its strong economy and small population, which offer people wide choices, including choices that will help achieve sustainable development. Challenges noted on the economic front are the high dependency on the diamond industry where there is room to diversify into other sectors such as the financial and tourism services and the current high reliance on the importation of food especial cereal and of petroleum.

Botswana's future will be shaped by developments in neighbouring countries, with which the country shares key resources such as river basins and wildlife migration routes. As such, regional policy and developmental plans such as the SADC Regional Indicative Strategic Development Plan will be key to shaping Botswana's future.

While the SDGs targets are generally ambitious, Botswana has the potential to successfully achieve them under the Sustainability scenario, although this will require adjustments if or when unforeseen challenges such as COVID-19 are encountered. The long term implication of COVID-19 pandemic on people's health and national economies is still unknown.

Bush squirrel (Paraxerus cepapi)
Photo credit: Chris Sstenger/unsplash



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