CLIMATE RISK COUNTRY PROFILE

NAMIBIA

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

This profile was written by MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by Jason Johnston (Operations Analyst, WBG), Yunziyi Lang (Climate Change Analyst, WBG) and Megumi Sato (Junior Professional Officer, WBG).

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

CONTENTS

FOREWORD

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

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

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

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

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

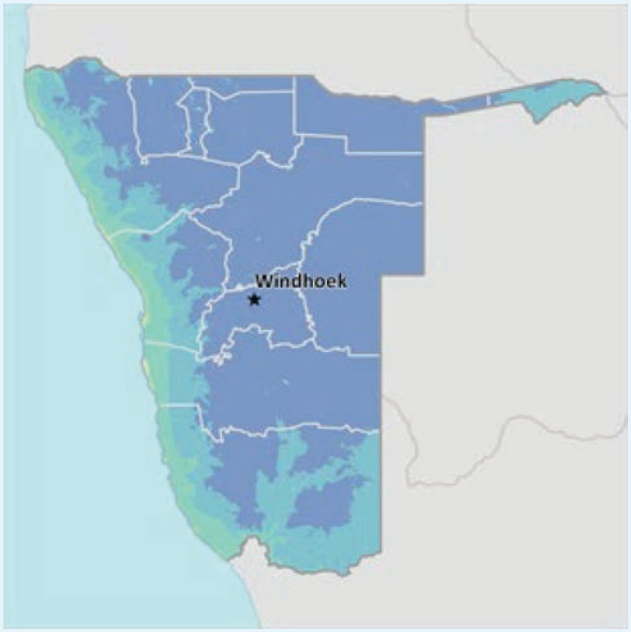
It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

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

COUNTRY OVERVIEW

Namibia is situated in the south-western region of the African continent, between latitude 17°S and 29°S and longitude 11°E and 26°E. The country covers a land area of 825,418 square kilometers (km^2) and has a 1,500 km long coastline along the South Atlantic Ocean.[1] Namibia shares borders with Angola to the north, South Africa to the south, Botswana to the east and Zambia in the northeast. The country is predominantly arid with two deserts, the Namib and the Kalahari, taking over large portions of the country's land to the east and west, respectively. Aridity reduces towards the central plateau regions and the great escarpment located between the central plateau and the Namib desert (**Figure 1**). Namibia's climate consists of persistent droughts, unpredictable and variable rainfall patterns, high temperature variability, and scarcity of water.[2]

FIGURE 1. Elevation of Namibia[3]



Namibia is an upper middle-income country, largely due to the country's natural mineral wealth and relatively small population. While Namibia has been able to reduce its poverty rates, job creation continues to stagnate and extreme socio-economic inequalities from the country's past apartheid system persist. Namibia has a population of nearly 2.54 million people (2020), growing at a rate of 1.8% (2020), which is expected to reach 3.01 million and 3.98 million in 2030 and 2050, respectively.[4] Currently 50% of the population lives in urban areas, primarily the capital city of Windhoek, and this is expected to increase to 61% and 72% by 2030 and 2050, respectively.[5] The country has a Gross Domestic Product (GDP) of $10.7 billion (2020) with a current annual growth rate of –01.1% (2019) and –8.0% in 2020 (**Table 1**).[6] Unemployment was 34.0% in 2016 and remains particularly

[1] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[2] Namibia (2016). Nationally Determined Contributions of The Republic of Namibia. URL: http://www.met.gov.na/files/files/Intended%20Nationally%20Determined%20Contributions%20(INDC)%20of%20Namibia%20to%20the%20UNFCCC%202015.pdf

[3] World Bank (2019). Internal Climate Migration Profile – Namibia.

[4] World Bank Data Bank (2021). World Development Indicators, Namibia. URL: https://databank.worldbank.org/source/world-development-indicators

[5] World Bank Data Bank (2021). Population estimates and projections, Namibia. URL: https://databank.worldbank.org/source/population-estimates-and-projections

[6] World Bank Data Bank (2021). World Development Indicators, Namibia. URL: https://databank.worldbank.org/source/world-development-indicators

high among the young (43.4%), women (58.5%) and those living in rural areas (39.2%).[7] Disease burdens are high in the country. HIV/AIDS prevalence is still one of the highest in the world at 12% of the adult population, although this has declined significantly over the past two decades. About 51% of the population in Namibia still resides in rural areas and depends on agriculture (crop production, livestock rearing, and fishing) and the exploitation of natural resources for livelihoods.[8]

Significant parts of Namibia's population (mainly rural areas) live in poverty, without adequate access to basic services, and would benefit from more inclusive development policies. The lack of job opportunities is at the core of the high poverty levels, inequality, and of social and economic disparity in the country.[9] Namibia is one of the largest and driest countries in sub-Saharan Africa, with highly unpredictable precipitation patterns. The country's reliance on rain-fed agricultural and livestock increases its vulnerability to climate change and limits the capacity of poor households and communities to manage climate risk, increasing their vulnerability to climate-related shocks.[10]

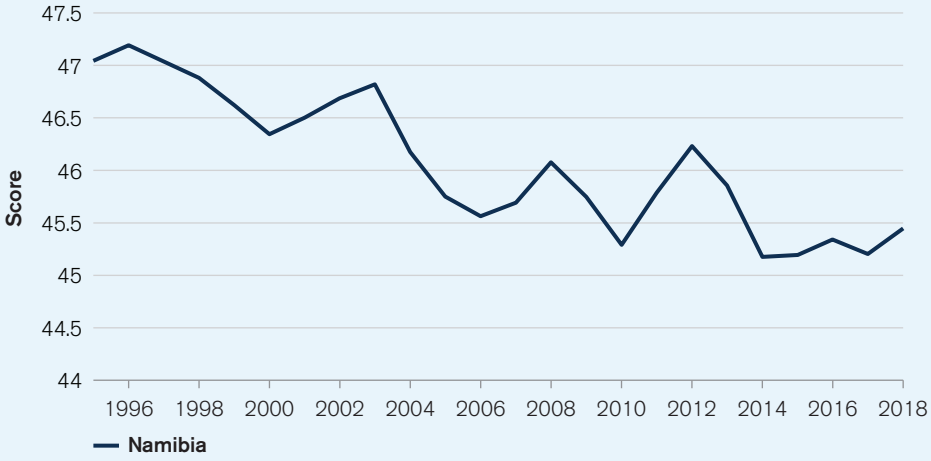
TABLE 1. Data Snapshot: Key Development Indicators[11]

Indicator	
Life Expectancy at Birth, Total (Years) (2019)	63.7
Population Density (People per sq. km Land Area) (2018)	3.0
% of Population with Access to Electricity (2019)	55.2%
GDP per Capita (Current US$) (2020)	$4,211.10

The ND-GAIN Index[12] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Namibia is recognized as vulnerable to climate change impacts, ranked 104 out of 181 countries in the 2020 ND-GAIN Index. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 2** is a time-series plot of the ND-GAIN Index showing Namibia's progress through 2018.

[7] World Bank (2021). Namibia – Overview. URL: https://www.worldbank.org/en/country/namibia/overview
[8] Human Development Indices and Indicators (2018). Statistical Update – Briefing note for countries on the 2018 Statistical Update (NAMIBIA). URL: http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/NAM.pdf
[9] World Bank (2021). Namibia – Overview. URL: https://www.worldbank.org/en/country/namibia/overview
[10] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf
[11] World Bank (2021). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators
[12] University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

FIGURE 2. ND-GAIN Index for Namibia



Climate change is expected to have significant impacts on key economic sectors and livelihoods. Rising temperatures and increasing extreme heat conditions, uncertain and increasingly unpredictable rainfall and extreme weather will introduce new challenges and exacerbate existing ones. Epidemics of water and vector borne diseases may increase and previously eliminated diseases may re-emerge. Staple crop production will decline, and rangelands will deteriorate thereby affecting livestock production, rural livelihoods, and incomes.[13] Rising sea levels and warming is likely to affect fish stocks, coastal livelihoods, natural ecosystems, and tourist activity. It is estimated that the effects of climate change and variability could result in annual decrease of GDP of 6.5%, thereby hindering economic development.[14]

Namibia released its Fourth National Communication (NC4) in March 2020, which detailed the country's commitment to climate change mitigation efforts and supporting the resiliency of its population. Namibia submitted its Nationally Determined Contribution (NDC) to the UNFCCC in 2016, which outlines the country's efforts to promote sustainable economic development goals and the country's path towards a low-carbon economy which increases the resilience of its population. Namibia has prioritized key adaptation efforts around food security, water resources, human health, infrastructure, biodiversity, energy, tourism, coastal zones, urban development, and sustainable resource base management. To reach these goals and implement prioritized adaptation efforts, Namibia has outlined the needs for (i) improving national level and sub-national technical capacities, (ii) implementing appropriate agricultural adaptation strategies e.g. drought resistant crop and livestock breeds, (iii) improved ecosystem management, (iv) facilitating better integration of policies and practices in vulnerable sectors. Policies are aimed at alleviating poverty, increasing social welfare and inclusion, as well as improving individual well-being, and ensuring a healthy environment.[15] At the time of writing, Namibia's Updated NDC was undergoing a public comment review period.

[13] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[14] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[15] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

Through its Updated NDC, Namibia has further committed to robust, comprehensive and ambitious adaptation and mitigation actions, in which the Updated NDC presents a progressive shift above its 2015 pledge to reduce emissions from 89% to 92% by 2030.[16]

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

CLIMATOLOGY

Climate Baseline

Overview

Namibia is one of the largest and driest countries in sub-Saharan Africa, characterized by high climatic variability through persistent droughts, unpredictable and variable rainfall patterns, variability in temperatures and water scarcity. The climate is generally hot and dry with sparse and erratic rainfall. 92% of the land area is defined as very-arid, arid or semi-arid. The country ranks second in aridity after the Sahara Desert. The dryness of the country is largely a function of the northward flowing Benguela current, which brings cold air to the western shores, driven by a high-pressure system. This combination generally suppresses rainfall. However, during the summer periods, the Inter-Tropical Convergence Zone (ITCZ) draws moisture from the equator to the northern and eastern regions of the country, leading to the rainfall season between October and April.[17]

[16] Republic of Namibia (2021). Namibia's Updated Nationally Determined Contribution. Ministry of Environment, Forestry and Tourism. Unpublished.

[17] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008). Climate change vulnerability and adaptation assessment Namibia. *Final Report. March*. URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

Historically, rainfall in Namibia is extremely variable. Mean annual rainfall is only 278 millimeters (mm), with a variation from 650 mm in the northeast to less than 50 mm in the southwest and along the coastal areas. In the Namib Desert, rainfall is extremely scarce. Rainfall peaks in January, February, and March where mean monthly rainfall averages approximately 62 mm, 66 mm, and 55 mm respectively. From a hydrological point of view, Namibia is an arid, water deficient country. High solar radiation, low humidity, and high temperature lead to very high evaporation rates, which vary between 3,800 mm per annum in the south to 2,600 mm per annum in the north. Over most of the country, potential evaporation is at least five times greater than average rainfall.

Namibia is characterized by high temperatures, with mean annual temperatures ranging from 14.3°C to 24. 2°C. Mean annual temperatures are high in continental regions, reaching above 22°C in the north and lower in the coastal areas (this is moderated by the Benguela current), reaching below 16°C in the southern coast. Apart from the coastal zone, there is a distinct seasonal temperature regime, with the highest temperatures occurring just before the wet season in the wetter areas or during the wet season in the more arid parts of the country. The lowest temperatures occur during the dry season months of June to August.[18] Daily maximum temperatures of above 40°C are recorded regularly and average temperatures do not fall below 0°C.[19] In the continental regions, relative humidity averages between 25% and 70%. Both rainfall and temperature in Namibia are sensitive to the El Niño–Southern Oscillation (ENSO) effect, and rainfall is below average during El Niño conditions.[20]

Analysis of data from the World Bank Group's Climate Change Knowledge Portal (CCKP) (**Table 2**) shows information for the latest climatology, 1991–2020. Mean annual temperature for Namibia is 20.6°C, with average monthly temperatures ranging between 24°C (November to March) and 16°C (June, July). Mean annual precipitation is 269.2 mm. Rainfall occurs from October to April, with minimal rainfall in May and September, across the latest climatology, 1991–2020 (**Figure 3**).[21] **Figure 4** shows the spatial variation of observed average annual precipitation and temperature across Namibia.

TABLE 2. Data Snapshots: Summary Statistics

Climate Variables	1991–2020
Mean Annual Temperature (°C)	**20.6°C**
Mean Annual Precipitation (mm)	**269.2 mm**
Mean Maximum Annual Temperature (°C)	**28.0°C**
Mean Minimum Annual Temperature (°C)	**13.2°C**

[18] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[19] Spear, D, M Baudoin, S Hegga, M Zaroug, A Okeyo and E Haimbili (2015). Vulnerability and adaptation to climate change in the semi-arid regions of Southern Africa, ASSAR Working Paper, CARRIA, Ottawa, ON. URL: https://www.weadapt.org/sites/weadapt.org/files/legacy-new/knowledge-base/files/1590/553a4354b2680east-africa-rds-full-report.pdf

[20] Reid, H, L Sahlén, J Stage and J MacGregor (2008). Climate change impacts on Namibia's natural resources and economy', Climate Policy, Vol. 8, pp. 452–66. URL: http://pubs.iied.org/pdfs/15509IIED.pdf

[21] WBG Climate Change Knowledge Portal (CCKP, 2019). Namibia. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-historical

FIGURE 3. Average Monthly Temperature and Rainfall for Namibia, 1991–2020[22]

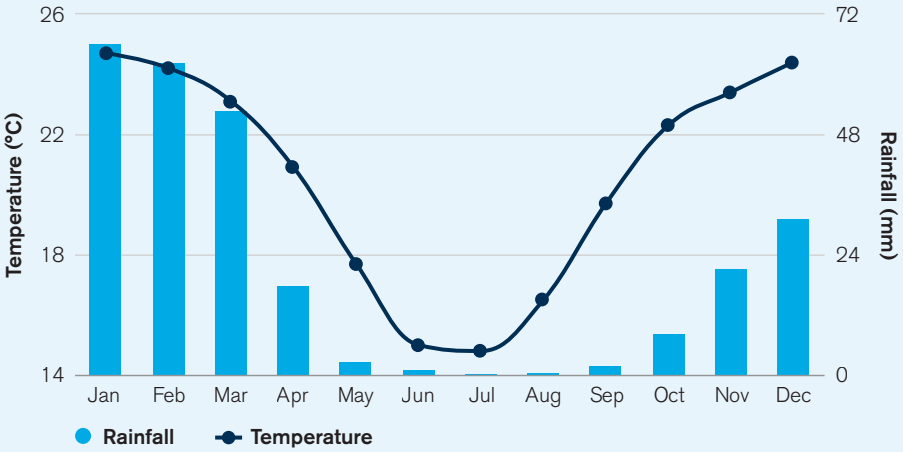
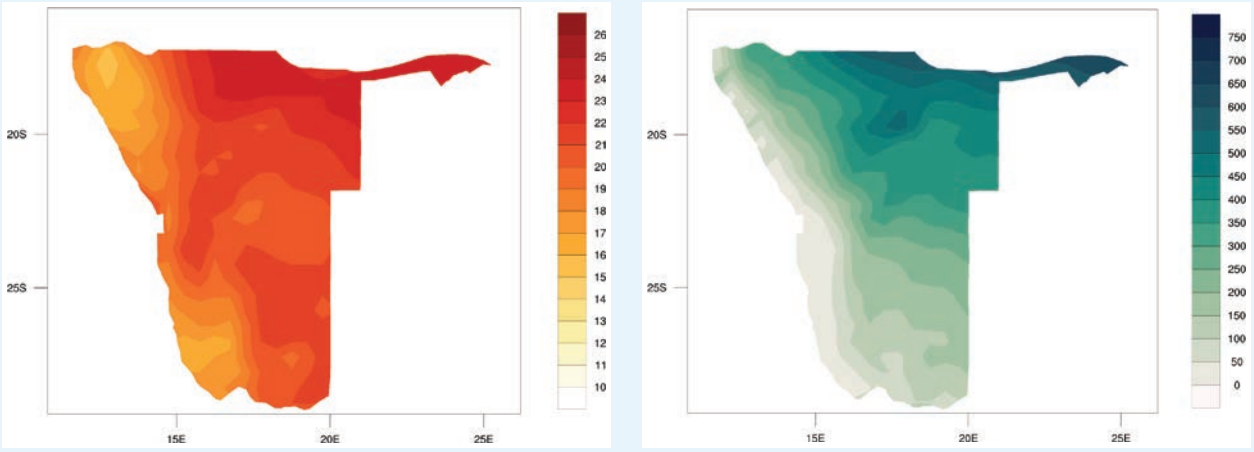


FIGURE 4. MEAN Annual Temperature (°C) (left); Annual Precipitation (mm) (right) of Namibia, 1991–2020[23]



[22] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-historical

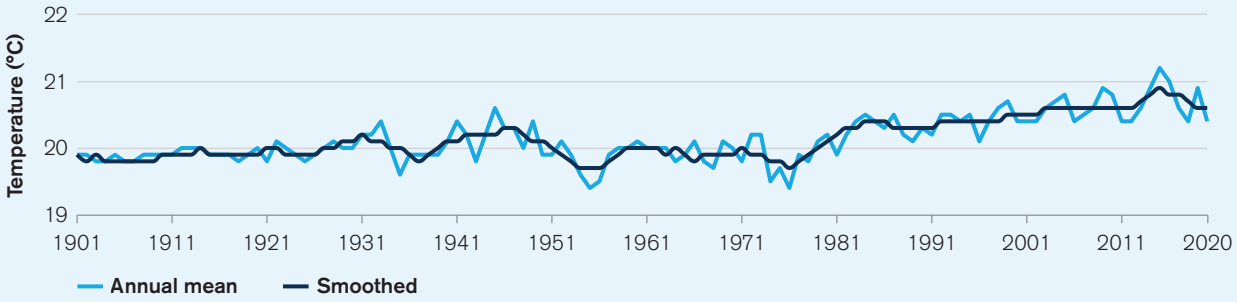
[23] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia, Historical Climate. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-historical

Key Trends

Temperature

Namibia is characterized by high temperatures. Apart from the coastal zone, there is a marked seasonal temperature regime, with the highest temperatures occurring just before the wet season in the wetter areas or during the wet season in the drier areas. The lowest temperatures in the country occur during the dry season months of June to August.[24] Since the 1960s, increased mean, maximum, and minimum temperatures have been observed, with a more rapid increase in nighttime, minimum, temperatures (**Figure 5**). Warming in Namibia has been higher than the global average. There have been significant increases in the frequency of days with maximum temperatures above 25°C and 35°C, with decreases in the frequency of days with minimum temperatures below 5°C.[25]

FIGURE 5. Observed Temperature for Namibia, 1901–2020[26]



Precipitation

The movement of the ITCZ towards the south during the Namibian summer results in the rainy season, November through April. In the far south, the Temperate Zone moves northwards during the winter, resulting in the winter rains that occur in the far southwest of the country. Small variations in the timing of these movements result in considerable differences in the weather experienced in Namibia year on year. The country's 'maize triangle' of Tsumeb, Grootberg, and Otavi typically receives more rainfall than would be expected in that geographic location. In the southern parts of the country, winter rains account for up to 50% of annual rainfall. In the Western part of the Namib Desert, coastal fog is an important source of water for the desert fauna and flora. Fog precipitation is five

[24] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[25] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008). Climate change vulnerability and adaptation assessment Namibia. *Final Report. March*. URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[26] WB Climate Change Knowledge Portal (CCKP, 2021). Namibia URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-historical

times greater than that of rain and is far more predictable.[27] Since the 1960s summer precipitation is expected to increase, however changes in onset, duration, and intensity of rainfall have been observed, indicating an increase in heavy rainfall events.[28]

Climate Future

Summary Statistics

The main data source for the World Bank Group's CCKP is the CMIP5 (Coupled Model Inter-Comparison Project Phase5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for selected essential climate variables under high emission scenario (RCP 8.5) over 4 different time horizons. **Figure 6** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

TABLE 3. Data Snapshot: CMIP5 Ensemble Projection

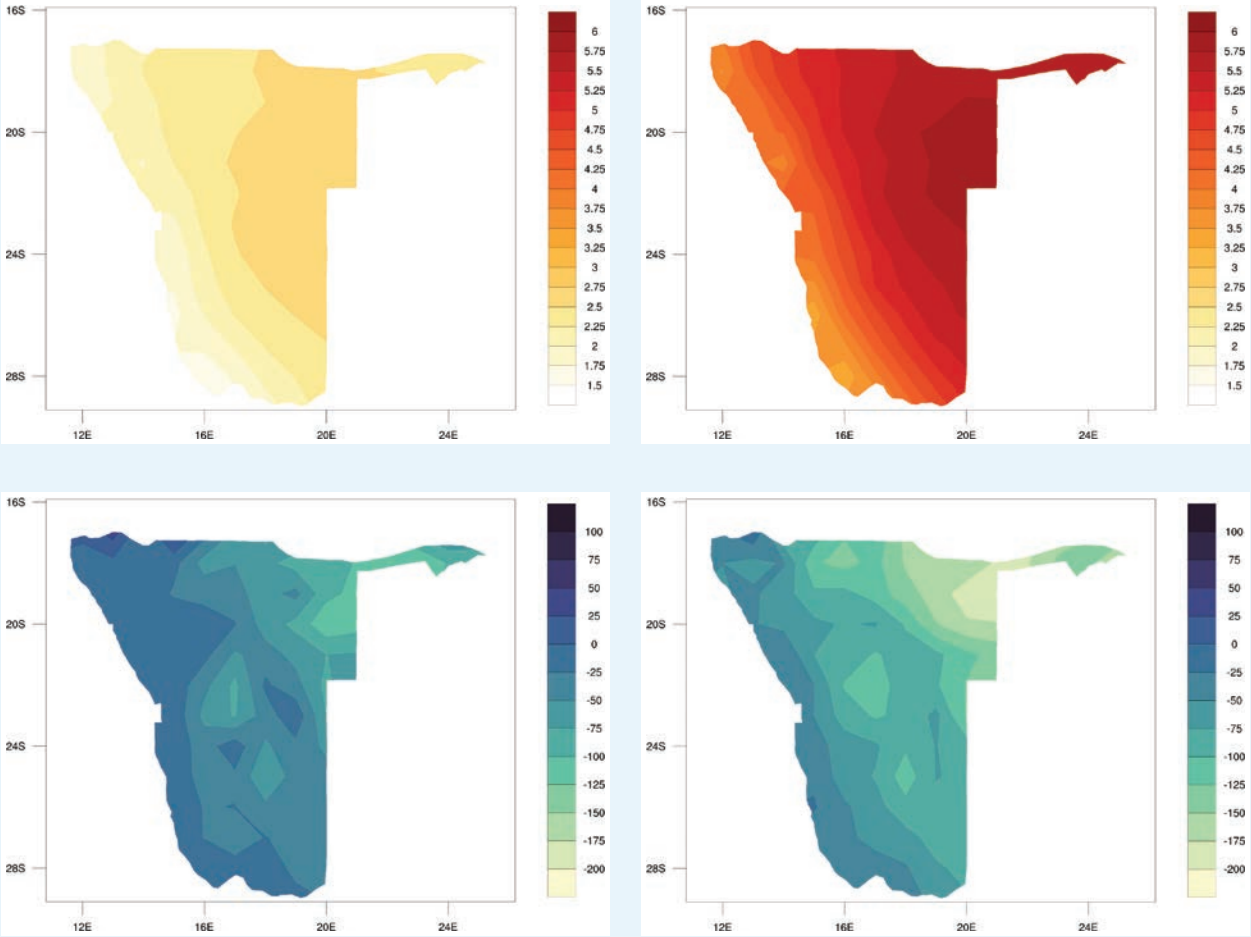
CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Average Temperature Anomaly (°C)	**+0.6°C to +1.8°C** (+1.2°C)	**+1.5°C to +2.9°C** (+2.1°C)	**+2.5°C to +4.5°C** (+3.2°C)	**+3.3°C to +6.0°C** (+4.3°C)
Annual Precipitation Anomaly (mm)	**–11.8 to +10.2** (–1.2 mm)	**–15.7 to +6.9** (–3.4 mm)	**–17.7 to +5.9** (–4.3 mm)	**–21.3 to +5.2** (–6.1 mm)

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

[27] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

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

FIGURE 6. Multi-Model (CMIP5) Ensemble Projected Changes (32 GCMs) in Annual Temperature (top) and Precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), Relative to 1986–2005 Baseline under RCP8.5[29]



Key Trends

Temperature

Temperature is projected to increase progressively in Namibia throughout the end of the century and will increase across the whole country. The greatest increases being projected for inland regions, while increase in coastal temperatures will be moderated by the ocean. The greatest increase in temperatures will be over the period September–October–November. The seasons with the smallest projected increase in temperature are December–January–February and March–April–May.[30]

[29] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Projected Future Climate. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-projections

[30] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

According to analysis from the German Climate Service Center (GERICS) of 32 Global Climate Models (GCMs), temperatures across Namibia are expected to increase by 1.7°C to 5.4°C by the 2080s. Maximum temperatures are expected to increase by 2.0°C to as much a 5.4°C. with minimum (nighttime) temperatures are expected to increase from 1.5°C to 4.9°C by the end of the century. The duration of heat waves is expected to increase by 6 to 29 days by the 2080s; the number of cold days will significantly reduce.[31]

Across all emission scenarios, temperature increase for Namibia will continue to rise throughout the end of the century. As seen in **Figure 7**, under a high-emission scenario, average temperatures are expected to increase rapidly by mid-century. Temperatures are expected to increase throughout the end of the century. Across the seasonal cycle, temperature is supposed to increase throughout the year. Increased heat and extreme heat conditions will result in significant implications for human and animal health, agriculture, and ecosystems. **Figure 8**, shows the change in the number of days with temperatures over 25°C, with the greatest increase projected for April to October.

FIGURE 7. Projected Average Temperature for Namibia (Reference Period, 1986–2005)

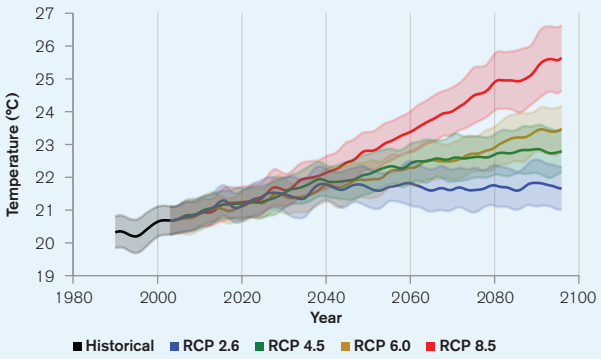
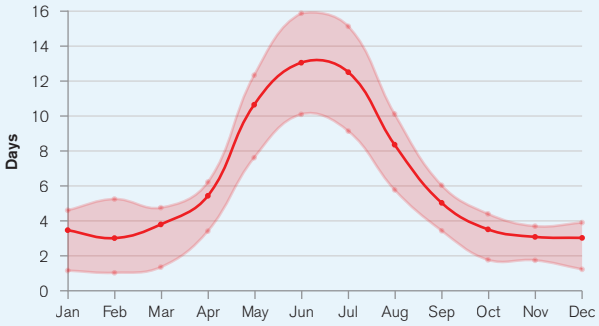


FIGURE 8. Projected Change in Summer Days (Tmax >25°C) (RCP8.5, Reference Period, 1986–2005)[32]



Precipitation

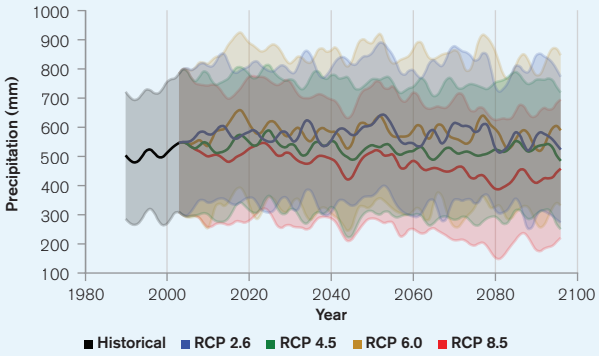
While changing rainfall trends in Namibia is highly variable, GERICS analysis indicates total precipitation rates are likely to reduce by as much as 19% by the 2080s. The largest decrease is projected for the typical dry season, April to October, with likely reductions from 5% to as much as 65%. The country's typical wet season, November to March, are expected to receive a small increase in precipitation.[33] The greatest reduction for the interior of the country will occur from December to February.[34] Other projections indicate that the northern and central parts of the country where most of the population is found, may experience a decline in rainfall to a more significant degree than other parts of the country.[35] Similarly, seasonal precipitation trends are expected to alter over the coming

[31] GERICS (2015). Climate-Fact-Sheet, Namibia.
[32] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Climate Data – Projections. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=NAM&period=2080-2099
[33] GERICS (2015). Climate-Fact-Sheet, Namibia.
[34] Namibia (2016). Nationally Determined Contributions. URL: http://www.met.gov.na/files/files/Intended%20Nationally%20Determined%20Contributions%20(INDC)%20of%20Namibia%20to%20the%20UNFCCC%202015.pdf
[35] Wingate, V. Phin, S. and Kuhn, N. (2019). Mapping precipitation-corrected NDVI trends across Namibia. *Science of the Total Environment*. 684. pp. 96–112. DOI: https://doi.org/10.1016/j.scitotenv.2019.05.158

century and there will likely be an increase in rainfall over the periods September-October-November and March–April–May; occurring at the end of the usual rainy season.[36]

Figure 9 shows the change in the projected annual average precipitation for Namibia. At a nationally aggregated scale, annual average precipitation is expected to remain similar to historical observations, but under the highest emissions scenario, RCP8.5, will decrease the most drastically. Water routing, storage and other management options can be highly varied depending if the precipitation input comes frequently or with long periods of aridity in between rainfall.[37]

FIGURE 9. Projected Annual Average Precipitation in Namibia (Reference Period, 1986–2005)[38]



CLIMATE-RELATED NATURAL HAZARDS

Overview

Namibia is highly vulnerable to natural disasters such as droughts, flooding, water scarcity, extreme heat, and wildfires.[39] The population is at most at risk from floods, drought, and disease outbreaks. Namibia is prone to recurrent drought conditions and wildfires due to its hot and dry climate and erratic rains. It is most prone to flooding along its international border where perennial rivers are located.[40] In Namibia, flooding is an annually recurring event which is worsening each year, with the northern and northeastern regions being the worst affected. Given Namibia's relative high degree of aridity, increased dryness and/or changing rainfall patterns can be particularly devastating. The 2013 drought in Namibia was so severe that it affected approximately 37% of the population and was declared a national disaster.[41] Forest and wildfires are common, especially in the north-eastern part of the country.

[36] Namibia (2015). Third National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/namnc3.pdf

[37] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[38] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Water Portlet. URL: https://climatedata.worldbank.org/CRMePortal/web/water/land-use-/-watershed-management?country=NAM&period=2080-2099

[39] GFDRR (2018). Namibia Hazard Report. URL: http://thinkhazard.org/en/report/172-namibia/

[40] Amadhila, E., Shaamhula, L., Van Rooy, G. & Siyambango, N. (2013). Disaster risk reduction in the Omusati and Oshana regions of Namibia, Jàmbá: Journal of Disaster Risk Studies 5(1). URL: http://dspace.nwu.ac.za/bitstream/handle/10394/9099/Jamba_v5%281%292013_Amadhila_E_et_al.pdf?sequence=1

[41] Kapolo, I.N. (2015). Drought conditions and management strategies in Namibia. Namibia Meteorological Services, Windhoek, Namibia. URL: http://www.ais.unwater.org/ais/pluginfile.php/601/mod_page/content/27/Namibia.pdf

It is estimated that fires damaged between 3 and 7 million hectares of land annually. Weather and climate related hazards have significant impacts on incomes, livelihoods and the economy through the devastation of important sectors like agriculture (including fisheries and forestry), water, transport and communication and tourism.[42] Climate change, deforestation, land use, urbanization, and settlements into flood-prone areas have exacerbated issues and impacts from flooding and droughts and have also increased the risk of wildfires. Heavy rainfall can trigger riverine and flash floods. Additionally, water stress during dry periods is likely to be further exacerbated with competing demands from household consumption and agriculture.

In Namibia, flooding is the most regularly occurring hazard. Documented flood events have affected over 1 million people and is estimated to have potential economic damage for the country up to approximately $100 million per year.[43] Worst affected areas include the northcentral regions of Oshikoto, Omusati, Ohangwena, and Oshana, and the northeastern regions of Kavango and Caprivi. These regions lie in the Cuvelai river basin shared with Angola.[44] The climate conditions in neighboring countries to the north affect the flood hazard in the northern region of the country. During 2008/2009, heavy rains in the north and northeastern parts of the country were exacerbated by the rainfall received in the neighboring countries of Angola and Zambia, leading to severe flooding. Floods commonly damage infrastructure and crops, and hamper patients' access to health care and children's access to schools.

Data from the EM-Dat database,[45] presented in **Table 4**, shows the country has endured various natural hazards, including droughts, floods, landslides, epidemics, and storms.

TABLE 4. Natural Disasters in Namibia, 1900–2020

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	8	0	2,143,200	175,000
Epidemic	Bacterial Disease	4	47	1,029	0
	Parasitic Disease	2	234	12,098	0
	Viral Disease	1	10	47	0
Flood	Flash Flood	1	2	12,000	20,490
	Riverine Flood	11	262	1,082,450	20,490

[42] UNISDR (2018). Disaster Risk Profile – Namibia. URL: https://www.unisdr.org/we/inform/publications/63278
[43] UNISDR (2018). Disaster Risk Profile – Namibia. URL: https://www.unisdr.org/we/inform/publications/63278
[44] Amadhila, E., Shaamhula, L., Van Rooy, G. & Siyambango, N. (2013). Disaster risk reduction in the Omusati and Oshana regions of Namibia, *Jàmbá: Journal of Disaster Risk Studies* 5(1): URL: http://dspace.nwu.ac.za/bitstream/handle/10394/9099/Jamba_v5%281%292013_Amadhila_E_et_al.pdf?sequence=1
[45] EM-DAT: The Emergency Events Database – Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/

Key Trends

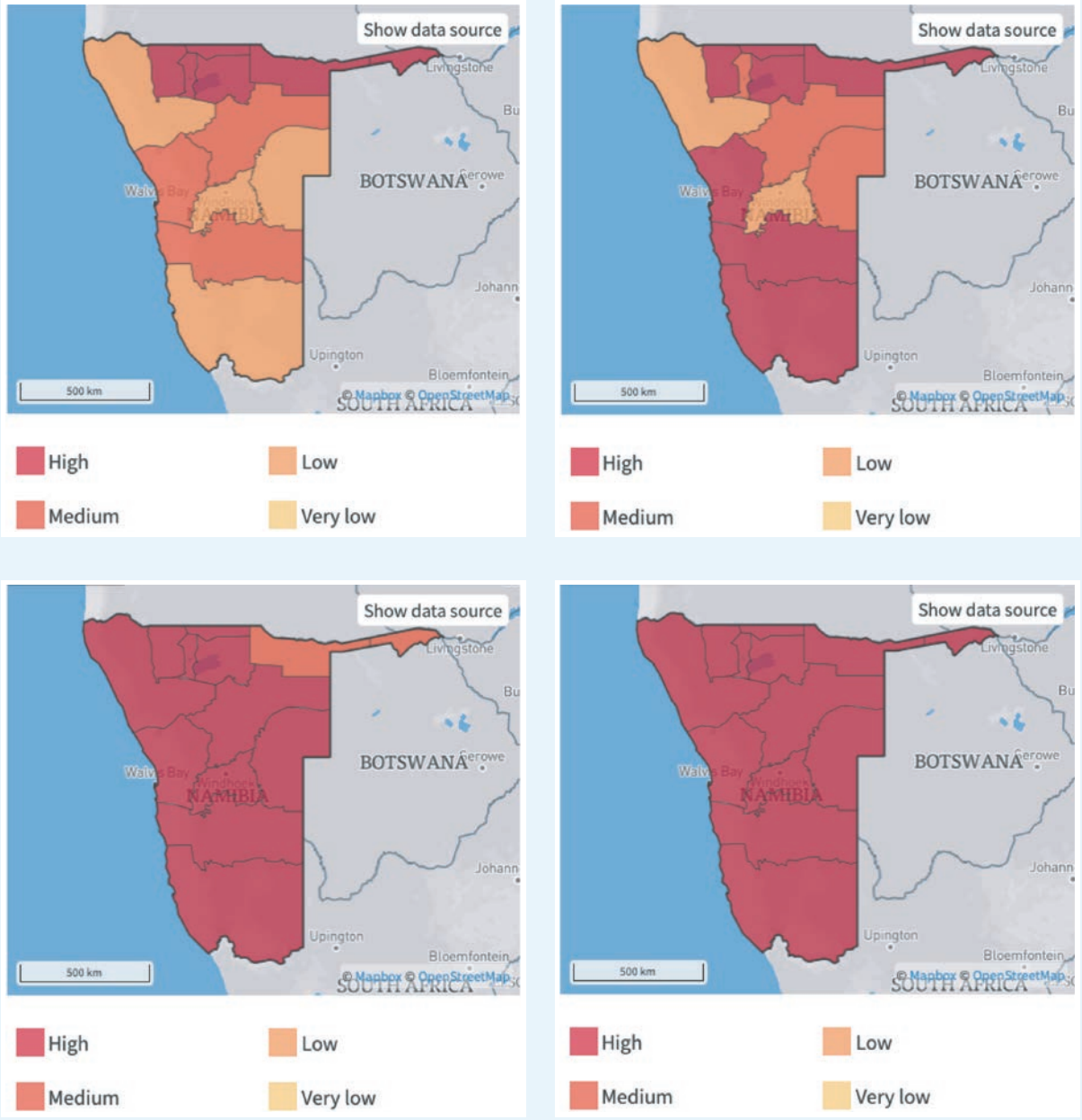
Climate change trends in Namibia are expected to increase the risk and intensity of extreme events and natural hazards, such as heat waves, droughts, floods, and wildfires.[46] It is likely that climate change trends will lead to an increase in drought frequency and intensity as well as an increase in the physical area of drought proneness in Namibia; this will likely impact water scarcity.[47] The incidence of wildfires is also likely to increase as the climate changes, largely due to the rising temperatures and erratic rainfall. The country's fire season is likely to increase in duration and include a greater number of days with weather that could support fire spread because of longer periods without rain during fire seasons. Climate projections indicate also that there could also be an increase in the severity of fire.[48]

While flooding is the most common, drought is the most devastating hazard for Namibia in terms of total people affected and total cost of damage. Over 2 million people are affected and previous droughts have cost the country an estimated $175 million per year; in regards to economic output of impacted areas economic impacts are estimated at reaching $3.6 billion per year.[49] Between 2000 and 2007, the country experienced at least five crippling droughts which affected between 300,000 to 700,000 people. The 2012/13 rainy season was the driest in 30 years, affecting all of the 13 regions of the country. In the western and southern parts of the country the rainfall season practically failed. Out of the population of 2.1 million, 778,504 people were affected, especially those who relied on livestock and crop production for food security and livelihoods. A national state of emergency was declared.[50] Flooding frequency has also increased in recent years and is estimated to impact 70,000 people annually.[51]

Weather-related disease outbreaks are common in Namibia, with many past events requiring state intervention. Epidemic prone diseases in Namibia include Malaria, Dysentery, and Cholera. During the 2008 flood disaster, 1,415 suspected cholera cases were recorded with 19 confirmed cholera deaths. In Namibia, 3.5 to 7 million hectares of forest and grasslands burn every year. In 2001 and 2002, total land area burnt was 3.7 and 5 million hectares respectively. Generally, fires are concentrated in Caprivi, Kavango, Otjozondjupa, Omaheke Khomas, Oshana, Omusati and Kunene regions.[52] The wildfires come with significant environmental and economic impacts, through the destruction of biodiversity, forests, and pasture lands.[53] Increased aridity and temperatures are expected to significantly increase these risks. **Figure 10** show risks for Namibia for river and urban flooding, water scarcity and wild fires.

[46] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf
[47] GFDRR (2018). Think Hazard Report – Namibia. URL: http://thinkhazard.org/en/report/172-namibia/
[48] MET (2012). National disaster risk management plan. URL: http://extwprlegs1.fao.org/docs/pdf/nam169289.pdf
[49] UNISDR (2018). Disaster Risk Profile – Namibia. URL: https://www.unisdr.org/we/inform/publications/63278
[50] Kapolo (2014). Drought conditions and management strategies in Namibia. National Meteorological Services. Windhoek. Namibia. URL; http://www.droughtmanagement.info/literature/UNW-DPC_NDMP_Country_Report_Namibia_2014.pdf
[51] Kapuka, A. and Hlasny, T (2020). Social Vulnerability to Natural Hazards in Namibia: A District-Based Analysis. *Sustainability* 12(12). DOI: https://doi.org/10.3390/su12124910
[52] MET (2012): National disaster risk management plan. URL: http://extwprlegs1.fao.org/docs/pdf/nam169289.pdf
[53] UNISDR (2018). Disaster Risk Profile – Namibia. URL: https://www.unisdr.org/we/inform/publications/63278

FIGURE 10. Risk of River Flood (upper left); Risk of Urban Flood (upper right);[54] Risk of Water Scarcity (lower left); Risk of Wildfires (lower right)[55]



[54] ThinkHazard! (2020). Namibia Urban Flood. URL: http://thinkhazard.org/en/report/172-namibia/UF
[55] ThinkHazard! (2020). Namibia Urban Flood. URL: http://thinkhazard.org/en/report/172-namibia/WF

Implications for DRM

Namibia is working to advance its disaster risk management (DRM) capacity and increase its resilience to natural hazards exacerbated by climate change. In 2009, the Government of Namibia approved the National Disaster Risk Management Policy. The policy prioritizes the improvement of the capacity of Namibia's early warning system as well as the tracking, monitoring, and disseminating of information on phenomena that can lead to disasters. Namibia also has in place its National Disaster Risk Management Plan (NDRMP) as well as established Emergency Management Operational Procedures, which support NDRMP and actions in dealing with disaster management and relief. NDRMP was established to provide guidance on disaster management to national, regional, local governments, business and community leaders, and civil society organizations with tools to standardize and regulate the practice and management of disaster prevention, preparedness, response, and recovery operations at all scales.[56] The country's Climate Change Strategy and Action Plan (CCSAP) for the implementation of the national climate change policy (NCCP), also emphasizes improvements in disaster forecasting and early warning systems. In addition, the strategy recommends better disaster preparedness and recovery, and the institutionalization of disaster risk management capacities as key action points.[57]

CLIMATE CHANGE IMPACTS TO KEY SECTORS

Namibia is highly vulnerable to seasonal variability and long-term climate change. Increasing vulnerability is expected to result in cumulative impacts across the country's social, economic, and environmental structures. Changing rainfall patterns and floods in particular are likely to have significant consequences on the environment, society, food security situation, as well as the wider economy. Significant impacts are also expected for the country's water resources, agriculture, coastal areas, and health sectors. Increased temperatures, flooding, increased aridity, and soil erosion puts both urban and rural communities at risk, particularly for poor and vulnerable groups. Environmental degradation, impacted water resources, and loss of biodiversity and ecosystem services constitute serious obstacles to the country's continued development and responsible management of its natural resources, which is also likely to impact the country's tourism sector. Environmental pollution is a serious challenge, especially for major urban areas.[58] Projected trends of climate variability and longer-term change are likely to exacerbate these concerns, as the majority of agricultural and livestock production is rainfed, and provides livelihoods for the majority of the population and may trigger increased internal migration and urbanization. More extreme weather events such as intense rainfall after prolonged dry spells can lead to erosion and flash flooding, damaging roads and infrastructure, destroying crops, and put additional lives at risk.[59]

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[56] Namibia (2011). National Disaster Risk Management Plan. URL: https://www.ifrc.org/docs/IDRL/NATIONAL_DISASTER_RISK_MANAGEMENT_PLAN_2011.pdf

[57] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[58] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[59] Namibia (2018). Third Biennial Update Report to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Namibia%20BUR3%20FINAL.pdf

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management, and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use, access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[60]

Agriculture

Overview

The agricultural sector is critical to Namibia's economy and the overall food security and contributes approximately 7%–10% of the country's GDP.[61] Agriculture impacts directly on the livelihoods of 70% of the population which is largely dependent on rain-fed crop production, with nearly 48% of Namibia's rural households dependent on subsistence agriculture. The majority of rural communities, particularly in the higher rainfall areas of the North, depend directly on forest resources for use as fuel wood, building materials, fodder, food, and medicine. It is necessary to ensure the systematic management and sustainability of forest resources. Crop production is second to livestock rearing in importance due to low rainfall that favors the predominant presence of perennial grass species, which are more resistant to moisture stress. Only 2% of the country's total surface area is arable and 46% is appropriate for perennial natural pasture.[62] Agriculture exports (mainly livestock, meat and grapes) form a key part of the country's trade portfolio.[63]

The production of white maize, wheat, pearl millet, and livestock including cattle, goat, and sheep is divided in the intensive commercial production units and the extensive communal production systems. The commercial sector though occupying 44% of land involves only 10% of population while the communal sector occupies 41% of the land and involves 60% of the population. Agriculture is the primary user of water in Namibia, taking up about 75% of all water, especially under the commercial subsector, which is well developed, capital intensive, and export-oriented.[64] There is also a reliance on fish resources, both coastal and inland. Namibia has one of the most productive marine fishing grounds in the world, which it owes largely to the Benguela Current System, a circulation system that occurs in the southeast Atlantic.[65]

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[60] World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: http://documents1.worldbank.org/curated/en/820851467992505410/pdf/102114-REVISED-PUBLIC-WBG-Gender-Strategy.pdf

[61] World Bank Open Data (World Bank, 2018). URL: https://data.worldbank.org/

[62] Namibia (2015). Third National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/namnc3.pdf

[63] Simasiku, C. and Sheefeni, J. (2017). Agricultural Exports and Economic Growth in Namibia. *European Journal of Basic and Applied Sciences*. 4(1). URL: https://www.idpublications.org/wp-content/uploads/2016/12/Full-Paper-AGRICULTURAL-EXPORTS-AND-ECONOMIC-GROWTH-IN-NAMIBIA.pdf

[64] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[65] Zinyengere N. (2016): Climate Change Impacts, Adaptation and Policies for Agriculture in African Small State. Small states economic review and basic statistics, Volume 19. URL: https://www.oecd-ilibrary.org/docserver/00202df5-en.pdf?expires=1544449205&id=id&accname=ocid195787&checksum=01F1729AEB7E4646E3D3B94412EB5377

Climate Change Impacts

Projected climate variability and climate change trends for Namibia such as rising temperatures, changing seasonal rainfall patterns, increased duration of dry spells, and increased aridity and drought threaten the country's agricultural sector. In Namibia, agriculture (crop production, livestock rearing, and fisheries) is highly sensitive to climate conditions. Temperatures are projected to increase across the country by an average of up to 3.8°C–5.1°C. The number of extremely hot days is also likely to increase. While rainfall projections are uncertain about the direction and magnitude of change, there are projections of changes in seasonality and intensity or rainfall. Combined, these conditions and emerging extreme climates will have significant impacts on crops, livestock, and fisheries. Climate change could have significant impacts on agriculture and by extension GDP and it is likely that climate change will negatively affect cereal crop production, livestock production, and fisheries. The combined effect of the negative impacts could lead to losses of hundreds of Namibian thousands of dollars.[66]

The effect of temperature increase and rainfall changes in Namibia will have immense implications for cereal crops. Even favored heat-tolerant crops such as millet are likely to be negatively affected by climate change in drought-prone areas of Namibia. Cereal crop yields are estimated to decline by up to 20% in the northeastern region and by 50% in the northcentral region under rainfed conditions. In the central savannah and woodland areas, concerns are that rainfed crop production could cease entirely as cereal crop farming becomes futile.[67] However legumes, such as Bambara groundnut could benefit from a future climate too severe for traditional cereals. Bambara groundnut yields could increase by up to 30% more by the mid-century in the Caprivi area, due to the benefits of CO_2 fertilization and their tolerance of heat, thus offering options for supplementing food crops.[68]

European breeds of cattle are favored in some parts of the Namibia due to their higher market value, however, they are likely to suffer from reduced thermoregulatory capacity as breeds are ill-adapted to high temperatures.[69] Heat and water stress on such livestock are likely to lead to decreases in feed intake, milk production, and rates of reproduction. Furthermore, changes in climate may affect the distribution of livestock diseases as well as the timing of their outbreaks or their intensity. This can be through affecting pathogens of diseases such as Anthrax and Blackleg, and the moisture-dependent survival of the agents of Dermatophilosis (a fungus), or Haemonchosis (worms) for which Namibia is already prone to.[70] The potential decline in livestock carrying capacity under climate change across the country is estimated to range from 10% in the northeastern region, through 15%–30% in the northcentral region,

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[66] Spear, D. et al. (2018). Vulnerability and responses to climate change in drylands: The case of Namibia. CARIAA-ASSAR Working Paper. University of Cape Town, Cape Town, South Africa. URL: https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/58630/IDL-58630.pdf?sequence=2

[67] Reid, H, L Sahlén, J Stage and J MacGregor (2008): Climate change impacts on Namibia's natural resources and economy', Climate Policy, Vol. 8, pp. 452–66. URL: http://pubs.iied.org/pdfs/15509IIED.pdf

[68] Karunaratne, AS, S Walker and AC Ruane (2015): Modelling Bambara groundnut yield in southern Africa: towards a climate-resilient future. *Climate Research.* 65 (193–203). URL: https://www.researchgate.net/publication/275254156_Modelling_bambara_groundnut_in_Southern_Africa_towards_a_climate_resilient_future

[69] Newsham, AJ, and DSG Thomas (2011): Knowing, farming and climate change adaptation in 110 Small States: Economic Review and Basic Statistics North-Central Namibia. *Global Environmental Change* 21 (761–70). URL: https://www.sciencedirect.com/science/article/pii/S0959378010001160

[70] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008): Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

to 35% in the central region. These changes will intensify pressures on grazing lands and livestock management systems. As a result of declining carrying capacity, it is estimated that cattle numbers could fall to about 51% of present numbers by 2080.[71]

Namibia has one of the most productive fishing grounds in the world, primarily due to the presence of the Benguela current. The up-welling caused by the current brings nutrient-rich waters up from the depths, which stimulate the growth of microscopic marine organisms. These in turn support rich populations of fish, which form the basis of the marine fisheries sector. As is the case in other up-welling systems, relatively few species dominate and their abundance can vary greatly in response to changing environmental conditions. Over 20 commercially important fish species are landed using various fishing methods. Since independence in 1990, the fishing industry has grown to become one of the pillars of the Namibian economy. The commercial fishing and fish processing sectors significantly contribute to the economy in terms of employment, export earnings, and contribution to GDP. The fishery sector contributed 4.6% in 2009, compared to 3.7% in 2010, representing a 20% reduction. The country's fisheries sector is also a substantial export earner and more than 85% of Namibian fish output are destined for international markets.[72] The nature of the impacts of climate change on fisheries in Namibia are highly uncertain. Valuable fish stocks could be reduced by lower coastal upwelling and increased frequency of Benguela Nino events, which weaken the Benguela current system responsible for the productive fishing along the coast. However, increased mean summer winds as temperatures rise may lead to both increase and decrease in fish stocks, depending on intensity. A best-case scenario sees climate change potentially increasing the productivity of the Benguela ecosystem, which would lead to the recovery of some fish stocks, such as pelagic stocks in the northern Benguela system. In-shore fisheries that support subsistence populations could suffer from damage caused to wetlands by climate change.[73]

Figure 11 shows the projected change in average daily max-temperature across the seasonal cycle. Temperature thresholds for agriculture and livestock are important as temperature changes, and in particular extreme heat, it can cause damage to plants and affect the health of livestock as well as farm workers. Crops are known to have specific temperature windows for optimal growth and yield. Cold temperatures and frost can affect the early growth, but high temperatures above crop-specific thresholds rapidly reduce the yield. **Figure 12** presents the increased change in consecutive dry days (a day without any meaningful rain meaning a threshold below 0.1 mm) also has important implications for agriculture as it directly impacts crop growth and impacts soil moisture. As climate warms, one of the signals is the increase in contrast: when it rains, it might rain harder, but when its dry it might get drier. The trend toward more consecutive dry days and higher temperatures will increase evaporation and add stress to limited water resources, affecting irrigation and other water uses. Long periods of consecutive days with little or no precipitation also can lead to drought.

[71] Turpie, J, G Midgley, C Brown, J Barnes, J Pallett, P Desmet and P Tarr (2010): Climate Change Vulnerability and Adaptation Assessment for Namibia's Biodiversity and Protected Area System. Namibia Nature Foundation, Windhoek.

[72] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[73] Reid, H, L Sahlén, J Stage and J MacGregor (2008): Climate change impacts on Namibia's natural resources and economy', Climate Policy, Vol. 8, pp. 452–66. URL: http://pubs.iied.org/pdfs/15509IIED.pdf

FIGURE 11. Projected Change in Average Daily Max Temperature for Namibia (RCP8.5, Reference Period, 1986–2005)[74]

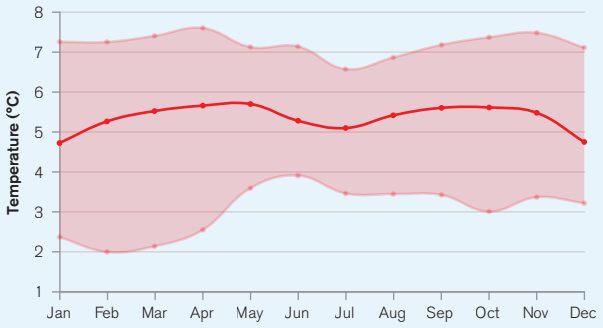
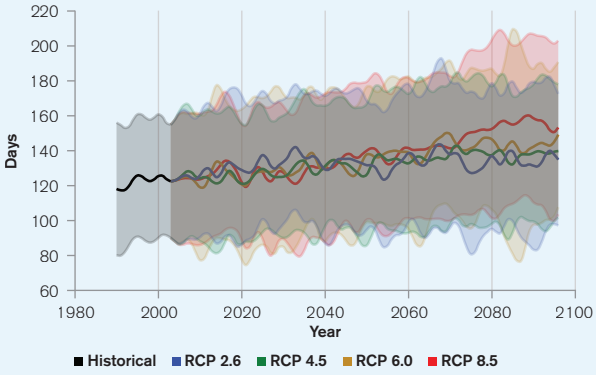


FIGURE 12. Projected Number of Consecutive Dry Days (Reference Period, 1986–2005)[75]



Adaptation Options

Both the sensitivity of the agricultural sector to the climate and the high reliance of this sector on rainfall and water resources have important implications for Namibia's farmers and wider economy. Key adaptation strategies have been identified to increase sectoral productivity, which include, expanding and optimizing irrigation infrastructure with national investment schemes and private sector companies taking a lead on procurement opportunities, introducing drought-tolerant and early maturing crop varieties, increasing and upgrading the country's storage facilities to reduce loss and increase the country's food security, providing agricultural insurance and enhancing the country's agricultural extension services, and promoting alternatives to livestock production.[76]

Adaptation presents Namibia with the opportunity to reduce the negative impacts of climate change on agriculture and take advantage of any benefits that could accrue from it. As such, the Government of Namibia has expressed agricultural adaptation intent in key policy and strategic documents, such as the Agricultural Policy, the National Policy on Climate Change, its NDC, and National Communications. It also intends to solidify these intentions through a National Adaptation Plan (NAP). Agricultural adaptation strategies identified include, (i) coordinating the timing of ploughing and crop planting with rainfall events, (ii) using drought-resistant crop varieties and livestock breeds, (iii) implementing soil and water conservation policies and practices, (iv) fostering year-long food production through irrigation, water harvesting, and conservation agriculture, (v) increased access to seed and fertilizer (incorporating organic fertilizers), (vi) improving early warning systems and drought mitigation measures, and (vii) restoration of rangelands and improved livestock management strategies (e.g. shifting livestock to alternative grazing areas). In support of its national adaptation

[74] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Agriculture Dashboard. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-sector-agriculture

[75] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Agriculture. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-sector-agriculture

[76] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

strategies and efforts, Namibia has committed to adopt improved agricultural systems for both crops and livestock, this includes: diversify livestock and improve range management; increase access to drought resistant crops and livestock feeds; and adopt better soil management practices.[77]

Water

Overview

Namibia is the driest country in Southern Africa, with water scarcity being one of the major primary limiting factors to development in the country. The effects of climate change, rapid population growth, and rural exodus pose additional challenges and threaten people's livelihoods as well as the balance of the ecosystems. Namibia's rainfall is skewed, with the northeast receiving greater precipitation than the west and southwestern parts of the country. Of the water that Namibia receives as precipitation, it is estimated that only 2% ends up as surface run-off and just 1% becomes available to recharge groundwater. The balance of 97% is lost through direct evaporation (83%) and evapotranspiration (14%). Rainfall often evaporates before it reaches the ground. Another source of moisture comes from fog in the cooler coastal regions where it is an extremely valuable source of moisture to desert animals and plants. The primary sources of water supply are perennial rivers, surface and groundwater (alluvial) storage on ephemeral rivers, and groundwater aquifers in various parent rocks. Additionally, unconventional water sources have been adopted to augment the limited traditional sources. About 45% of Namibia's water comes from groundwater sources, 33% from the Border Rivers, mainly in the north, and about 22% from impoundments on ephemeral river.[78]

Water is of primary importance in economic sectors, such as agriculture, livestock, fishing, mining, and manufacturing. Despite its low contribution to GDP, agriculture uses up to 75% of the total water production in Namibia. Commercial agriculture is the largest sub-sector through irrigation, while communal farmers are the least consumptive. Water productivity in the agriculture sector is, however, far below average. Households make use of about 12% of the total available water, of which urban areas use about 3 times more than rural areas. The remainder is split between services, manufacturing, and mining.[79] Access to clean water in Namibia is much better than most countries in Africa. Only an average of 20% of the country's population do not have access to safe drinking water, with strong disparities between the urban and rural areas. About 37% of rural residents do not have access to safe drinking water, while only about 2% or urban residents do not have access to clean water.[80] The northern regions (especially Zambezi, Kavango East and West, Ohangwena and Omusati) also have the highest figures for lack of access to safe water. **Figure 13** shows the hydrography of Namibia and its perennial rivers.

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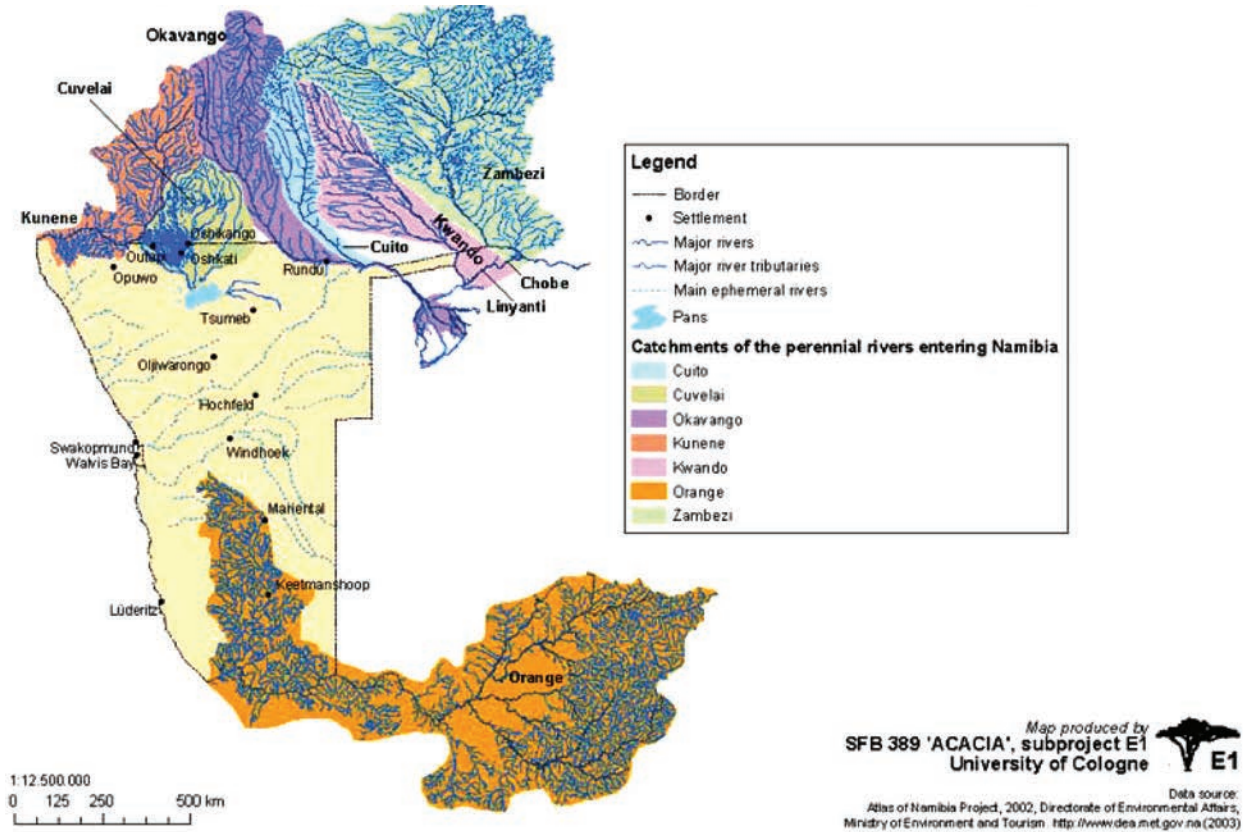
[77] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[78] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[79] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008). Climate change vulnerability and adaptation assessment Namibia. *Final Report. March*. URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[80] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

FIGURE 13. Hydrography of Namibia: Perennial Rivers and the Cuvelai System[81]



Climate Change Impacts

Changes in patterns of rainfall over Angola and in particular western Zambia are expected to impact stream flow in perennial rivers along Namibia's northern border, in particular in the Caprivi.[82] Projected changes in rainfall over Angola and Zambia of up to between 10–20% by 2050 will likely lead to reduction of 20–30% in runoff and drainage of perennial rivers in northern Namibia. Ephemeral rivers in the interior of the country may be similarly affected. Projections also indicate that by 2065, changes to rainfall patterns over the catchments of the Zambezi, Kavango, Cuvelai, and Kunene rivers are likely to lead to a 25% reduction of runoff and drainage in these river systems. The lower runoff of the northern region river basins is particularly concerning because they are located in the regions where the lowest water access rates are found. Reduction in runoff and drainage will make them even more sensitive to access to safe drinking water, as many rural residents rely on naturally occurring water sources. Furthermore, the main irrigation projects in the country are located on the perennial northern rivers along the

[81] Directorate of Environmental Affairs (2003). Atlas of Namibia Project. URL: http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/e1_download_physical_geography_e.htm#top

[82] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008). Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

borders (mainly Okavango and Kunene). Declining runoff for these rivers will present a threat to irrigation expansion for increased food production as planned by the Namibian government.[83]

As temperature rise increases begin to surpass 3°C, a marked increase in evaporation of 5%–15% is expected, thereby leaving even less water available for discharge and storage. As shown in **Figure 11**, daily maximum temperatures are projected to increase 5°C to 6°C by the end of the century. This will also reduce the length of inundation of seasonally flooded wetlands. Smaller and more shallow floodplains would dry out more quickly and this could disrupt the seasonal breeding of many invertebrates and fish.[84] An estimated 60% of Namibia's population resides near major wetlands and relies on them for resources. Drying of these wetlands will spell drastic impacts for these people who are already largely poor. Furthermore, drying will likely increase the salt content of pans and pools, making them less suitable for human and animal consumption. Rainfall is, however, expected to increase over the southern regions of the country which could result in increased dam yields, though further research is needed.[85]

As groundwater abstraction is greater than the recharge rate in many places, groundwater resources in the country are already vulnerable to the vagaries of climate. Overall, it is estimated that the country will incur a reduction of groundwater recharge, thereby making the ground water situation in the country dire.[86] Namibia's groundwater, usually provides a buffer against droughts in many regions, however, persistent future droughts will likely result in falling groundwater tables and reduced surface water flows. This can lead to wells drying up, extending distances for water collection, and increasing water source pollution. The poor will be affected the most.[87] Sea level rise will likely also affect ground water as coastal aquifers become more and more susceptible to salt water intrusions. This will affect water supply to coastal cities especially Walvis Bay. The coastal aquifers which supply water to the town are susceptible to salt intrusion.[88]

Changes in precipitation patterns will impact river flow, irrigation, water management, and flooding. This can be seen through both the supply as well as demand. Greater periods of enhanced drought will be exacerbated by higher temperatures, and thus stronger evapotranspiration. Projected climate change trends for Namibia are therefore expected to enhance the contrast between wet and dry and thus might change the dynamics around

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[83] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[84] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008): Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[85] Mapaure I. (2013): Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

[86] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008): Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[87] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[88] Mapaure I. (2013): Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

the balance between availability and use of water. Higher intensity rain and enhanced droughts pose significant challenges to water supply infrastructure and water quality. **Figure 14** shows the projected annual Standardized Precipitation Evapotranspiration Index (SPEI) through the end of the century. SPEI is an index which represents the measure of the given water deficit in a specific location (–2 indicates severe drought); accounting for contributions of temperature-dependent evapotranspiration. Across a nationally aggregated scale, Namibia's mean SPEI by end of the century is projected at –2.11, however, areas of the country will experience varying degrees of drought and rainfall. This is an important understanding for the water sector (as well as energy) as it provides insight into increasing or decreasing pressure on water resources. **Figure 15** shows the spatial variation for SPEI across the country for the periods 2040–2059 and 2080–2099, under RCP8.

FIGURE 14. Projected Annual SPEI Drought Index, Namibia (Reference Period, 1986–2005)[89]

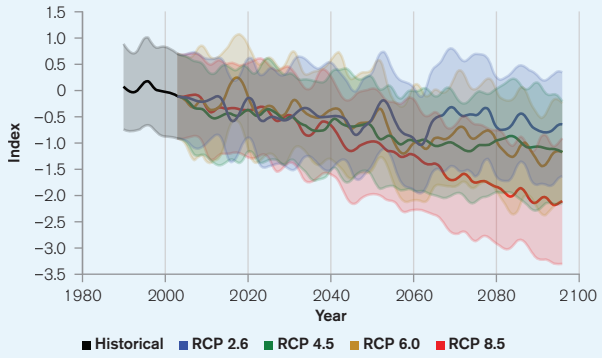
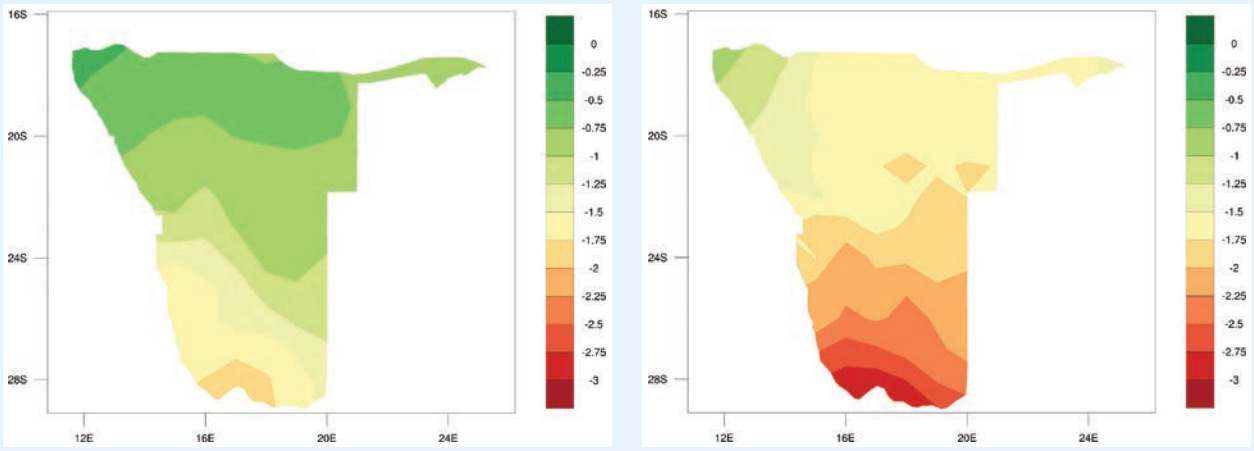


FIGURE 15. Projected SPEI in Namibia for the Periods 2040–2059 (left) and 2080–2099 (right) (RCP8.5, Reference Period, 1986–2005)[90]



[89] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Water Dashboard. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-sector-water

[90] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=NAM&period=2080-2099

Adaptation Options

Namibia needs to enhance and scale up its integrated water resource management which includes the increased conservation and management of watersheds and catchment areas, promotion of integrated development and water resource management, conservation and sustainable utilization of water resources, improved trans-boundary cooperation regarding water resources and access, and improved institutional and human capacity in water resource management and more efficient use.[91] The country has committed to adaptation in the water sector in various policies and plans. Primary identified actions include (i) measures to reduce evaporation and to enhance the efficiency of the utilization of water resources, (ii) water reclamation, artificial recharge of aquifers and desalination of both saline inland resources and seawater, (iii) actions to optimize use of existing resources through conjunctive use of surface and ground water and improved water demand management.[92] These actions would specifically seek among other things to: protect surface and groundwater resources from pollution through regulating discharges, prioritize the development of the Ohangwena II aquifer to supply the Cuvelai, prioritize seawater desalination to augment supply to the Central Namib area and new Uranium Mines, use water only for irrigation of high value crops, and to institutionalize efficient irrigation practices. The change of enhanced storage of water in reservoirs can support vegetating the wetlands and increase water use efficiency. The recycling of waste water can improve agriculture in peri-urban areas, especially in drier areas.[93]

Energy

Overview

Namibia's top energy sources are petroleum, hydropower, imported electricity, and imported coal. The country's own internal resources supply less than one-third of its needed energy requirements. Namibia currently has three electricity power stations: the Ruacana hydroelectric power station, which depends on the in-flow of rainfall from the catchment areas in Angola; the Van Eck coal power station using coal imports from South Africa; and the Paratus diesel plant. Namibia imports more than 50% of its electricity from neighboring countries, South Africa, Zambia, and Zimbabwe, as well as from the Southern African Power Pool.[94] A special arrangement between the Namibian power utility, NamPower, and Eskom, the South African Power utility, enables Namibia to buy and utilize the surplus energy from South Africa at affordable rates, with Zambia providing most of the remaining balance. NamPower also imports on a smaller scale from Zambia for supply to the Caprivi region and exports on a small scale to Angola and Botswana.[95] It is estimated that less than 10% of rural households have access to electricity, either through the electrical grid or via local power generation.[96]

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[91] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[92] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[93] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008). Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[94] REEEP (2018). Energy regulation framework in Namibia. URL: https://www.reeep.org/projects/energy-regulatory-framework-namibia

[95] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

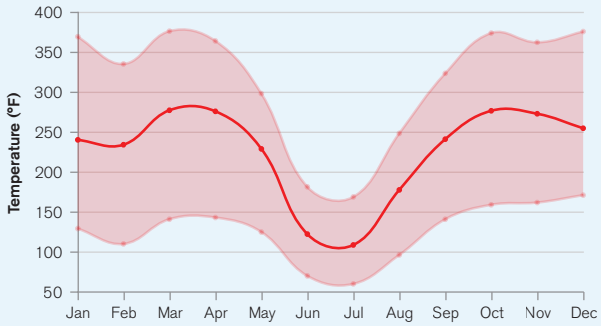
[96] Sendegeya, A. and Chiguvare, Z. (2016). The role of academia in capacity building for sustainable energy development: The case of Namibia. Energy Procedia. 93. pp. 218–222. DOI: https://doi.org/10.1016/j.egypro.2016.07.173

Climate Change Impacts

Namibia has high potential for solar, wind, and biomass generation. Brush is widely spread in the country's northern areas, which allows a large-scale bioenergy-based production capacity. Off-grid renewable energy projects include the small/micro wind energy installations used for water pumping that are very common in Namibia, especially on farms. This technology has been used successfully for decades, with approximately 30,000 wind-driven water pumps installed as of 2005; however, the current trend is to replace these with solar energy sources. Namibia is at risk to disrupted and/or limited power supply due to climate change trends of reduced precipitation, reduced river flow, and thus decreased hydropower generation. As Namibia is dependent upon energy supply from southern Africa, regional trends can be highly impactful. A projected reduction in rainfall may lead to reduced runoff and surface water availability. Increase evaporation rates for water storage facilities will impact production costs and increase prices for consumers. Increasing temperatures are likely to increase demand for energy for cooling with increase peak loads during hotter periods, with an overall net increase in electricity usage. The increased variability of river flows will impact hydropower generation plant, with potential for undersupply of expected energy outputs.[97]

Increased temperatures are likely to increase energy demand, especially during peak heat periods. The relationship of daily heat with the demand for electricity can be estimated through Cooling Degree Days (**Figure 16**). This quantity accumulates the temperatures above 18°C threshold, which broadly represents a comfortable living environment. Cooling Degree Days capture the amount of heat that society would like to get rid of by period through some form of active cooling, be it through air conditioning or through evaporative processes that generally require pumps for water. The monthly changes provide insight into potentially extended seasons of power demand for cooling, or highlighting when during the year likely power demand increases might occur. The figure below shows the increase in cooling days across the seasonal cycle. Sharp increases in temperature are expected during the country's typical hot-seasons across all RCP scenarios.

FIGURE 16. Projected Cooling Degree Days (65°F) in Namibia for the Period 2040–2059 (RCP8.5, Reference Period, 1986–2005)[98]



Adaptation Options

The Namibian government has made addressing the need to increase access to energy however a significant share of current energy demand remains unmet. The current grid is unable to reliably serve the existing industrial and urban customer base. The country has committed to improving its energy situation by increasing the share of renewable energy (hydro, solar, wind, and biomass) in electricity production from 33% in 2010 to approximately 70% in 2030; implementing an energy efficiency program to reduce consumption by 10% in 2030; commissioning a mass transport system in city of Windhoek to reduce number of cars (taxis and private) by about 40%; implementing

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

[98] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia – Energy. URL: https://climatedata.worldbank.org/CRMePortal/web/energy/oil-gas-and-coal-mining?country=NAM&period=2080-2099

a car pooling system to reduce fossil fuel consumption; and improving freight transportation through bulking to reduce the number of light load vehicles by about 20%.[99]

Health

Overview

Namibia's health services are shared between the public and the private sector. Infant and child mortality is comparatively low, but the maternal mortality ratio has increased, despite the fact that over 70% of births are delivered in hospitals. General life expectancy has not improved, partly due to the HIV/AIDS epidemic. Malnutrition levels in children under the age of five years are as high as 38% in some regions. The five leading causes of inpatient deaths (all age groups) are HIV/AIDS, diarrhea, tuberculosis, pneumonia, and malaria. Malaria is one of the major health problems. However, year-on-year incidences of malaria are highly variable, and closely correlated with the prevailing temperature, rainfall, and humidity. Malaria is endemic in parts of the northcentral and northeastern regions. In contrast, in northwestern and parts of central Namibia, malaria transmission is seasonal and follows the onset of rains; these unstable occurrences increase the risk of malaria epidemics. Approximately 15% of the total Namibian population aged 15–49 is living with HIV/AIDS, but the infection level appears to have stabilized. Seven per cent of all people living with HIV/AIDS are under the age of 15, and 60% are women. The very high incidence of tuberculosis in Namibia is fueled by the HIV/AIDS epidemic, which has reduced life expectancy from 62 years in 1991 to 62 years (2015).[100]

Climate Change Impacts

Namibia is highly vulnerable to the adverse health implications from projected future climates for the country, including increased temperatures, more intense and frequent extreme weather events, and increased duration and severity of aridity and drought. These trends are likely to result in increased water and food insecurity, higher exposure to heat stress and ultraviolet radiation, and changes in infectious and vector borne disease transmission patterns. The leading causes of death in Namibia, including respiratory illnesses, have strong links to climatic factors. As such, climate change may pose a threat to health in Namibia. Climate change may have direct and indirect impacts on human health through impacts on water quality and availability, extreme climatic events, nutrition status of humans, and distribution and abundance of vector organisms due to changing temperature and rainfall patterns.[101] Heat stress is likely to increase in Namibia owing to projected increases in extremely hot days. Increasing incidences of heat stress, increased dehydration, and a reduction in the ability to cope with other stressors and/or diseases (pre-existing disease burdens) are likely to be the main effects that Namibians will suffer due to an increase in future temperatures. The young and the elderly, especially in rural areas of north and central Namibia, which are the most populous but where populations may also have less access to advanced medical facilities are likely to be most affected.[102]

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[99] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[100] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[101] von Oertzen, D. (2010). Impact Of Climate Change On Human Health In Namibia. Review and Update of the National Circumstances. URL: https://www.voconsulting.net/pdf/environment/Impact%20of%20climate%20change%20on%20human%20health%20in%20Namibia%20-%20VO%20CONSULTING.pdf

[102] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

Extreme events such as floods in northern Namibia have been linked to outbreaks of cholera. Flood plain regions of the north such as Zambezi, Omusati, Oshikoto, Kavango, and Ohangwena will be particularly prone to increased future flooding. This will add additional pressures to the social environment that is, in many cases, already burdened by poverty and health challenges such as the HIV/AIDS pandemic, tuberculosis, malaria, and malnutrition among others.[103] Flooding and drought will also pose health threats through the destruction of available sanitation facilities and shortages of water. Schools and crowded inner cities in Namibia are particularly prone to such events and outbreaks. The changes in extreme climate events are strongly linked to vector borne diseases in Namibia. Floods will likely increase the disease burden from water borne diseases (cholera, typhoid, leptospirosis, E. coli, and hepatitis A) in the northern parts of Namibia, while also presenting challenges for accessing treatments through destroying roads and cutting off communities, and temporary migrations (both forced and voluntary). This is particularly concerning for Namibia because of the large proportions of the population who are on HIV/AIDS and TB treatment who could be affected by such events. Intense rainfall events and water runoff are projected to increase in Namibia, enhancing the chances of formation of open waters, presenting more breeding grounds for some vector borne diseases and insects (such as malaria and dengue fever). Areas previously marginal to malaria could become more prone due to prevailing temperature regimes and emerging rainfall patterns. Malaria prevalent areas are predicted to expand southwards into the central inlands. Such a shift may already be occurring.[104] Projections suggest there could be an incursion of some vector borne diseases which have not been a problem in Namibia in the past, such as lymphatic filariasis (elephantiasis), dengue fever, and yellow fever in the northern regions from neighboring countries as climate conditions change. On the other hand, other vector borne diseases like sleeping sickness, carried by the tsetse fly, which are not currently present in Namibia (although the cattle version (nagana) occurs in eastern Caprivi), will likely not take hold under future climates because of a reduction in habitat availability for the tsetse fly.

The effect of a changing climate on food crops as indicated under the agriculture section is likely to lead to a reduction in food security, which in turn has important negative effects on nutrition. High levels of food insecurity are already experienced in parts of the north of Namibia, including Omusati, Kavango, Otjozondjupa, Omaheke, Kunene, and Erongo. These same regions are projected to face increasing food security challenges. Mothers, child bearing women, children, and adolescents will be most prone to malnutrition.[105] With rising malnutrition, communities are likely to be more vulnerable to water and vector-borne diseases, especially in the northern regions of the country where incidences of water-borne diseases could increase.

[103] von Oertzen, D. (2010): Impact Of Climate Change On Human Health In Namibia. Review and Update of the National Circumstances. URL: https://www.voconsulting.net/pdf/environment/Impact%20of%20climate%20change%20on%20human%20health%20in%20Namibia%20-%20VO%20CONSULTING.pdf

[104] Dirkx, E., Hager, C., Tadross, M., Bethune, S., & Curtis, B. (2008): Climate change vulnerability and adaptation assessment Namibia. *Final Report. March.* URL: http://www.landscapesnamibia.org/mudumu/sites/default/files/resources/Namibia%20Climate%20Change%20Vulnerability%20and%20Adaptation%20Assessment.pdf

[105] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

In Namibia, the annual distribution of days and nights with high temperatures can provide insight into the health hazard of heat. Increased night temperatures can result in decreased opportunity for natural cooling. Increased health threats can be projected and monitored through the frequency of tropical nights (>20°C). Tropical Nights (**Figure 17**) represents the projected increase in tropical nights for different emission scenarios (CMIP5 ensemble) to demonstrate the difference in expected numbers of tropical nights. As seen in the figure below, tropical nights are projected to be minimally increased, except for the sharp increase expected under the high emission scenario. **Figure 18** shows the spatial variation for 'hot days', temperatures reaching over 35°C for the period 2040–2059 and 2080–2099, under RCP8.5. The areas experiencing the largest increase in hot days will also experience some of the largest reductions in precipitation, with the country's interior experiencing a significant increase, as compared to coastal areas.

FIGURE 17. Projected Number of Tropical Nights (Tmin >20°C) (Reference Period, 1986–2005)[106]

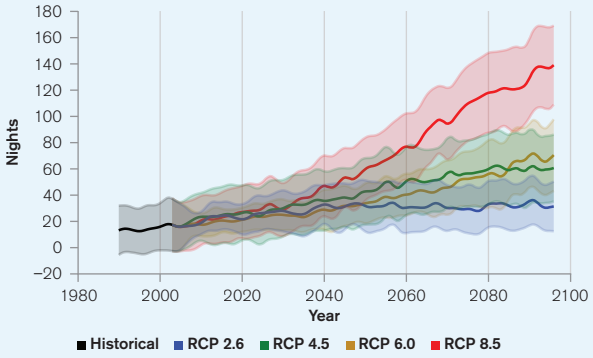
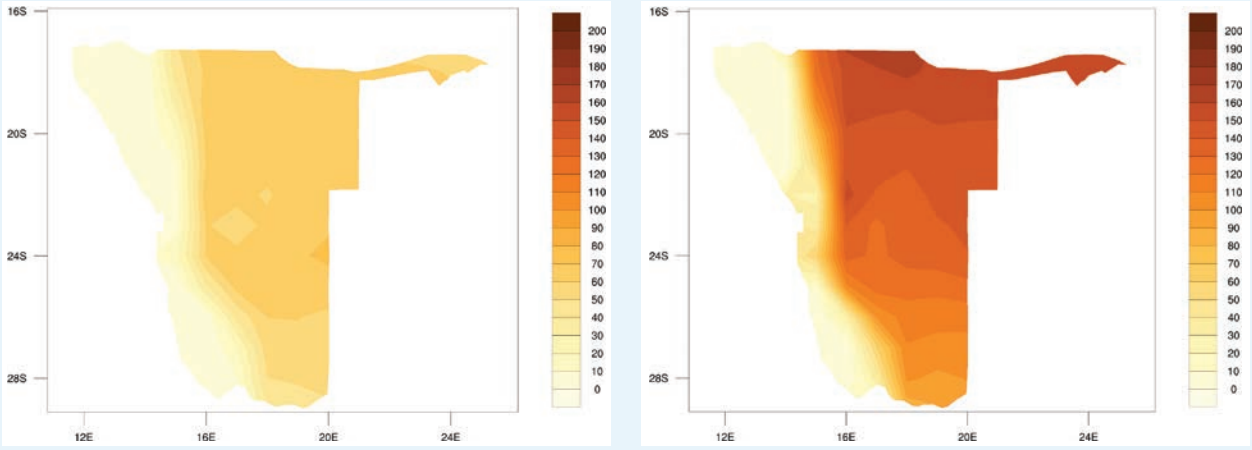


FIGURE 18. Projected Number of Hot Days (Tmax >35°C) in Namibia for 2040–2059 (left) and 2080–2099 (right) (RCP8.5, Reference Period, 1986–2005)[107]



[106] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Health Sector. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-sector-health

[107] WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Health Sector. URL: https://climateknowledgeportal.worldbank.org/country/namibia/climate-sector-health

Adaptation Options

While Namibia remains committed to improving its healthcare system, service delivery, and resilience to climate change, it is likely that without an added focus on health and health-related developments, the Namibian population will be exposed to new or intensified disease burdens, as a consequence of the direct and indirect impacts of climate change. Future challenges to the health system could include an increase in local or even national epidemics, and a variety of small and larger scale outbreaks diseases, all of which will impose added demands on the existing health infrastructure. There is, therefore, an urgent need to adapt and strengthen the resilience of the health system in the country. The country is committed to focusing on disaster risk management and preparedness, proactive management of forced migrations, improved cholera outbreak and malaria control, and improvement in nutrition. These are to be achieved party through increasing nutrition surveillance and improved staff trainings for malnutrition prevention and treatment. Additional training is needed for community health workers to provide emergency support as well as to strengthen transport and communication systems between health facilities. Improvements to water and sanitation systems is imperative as is improved data collection and management for preparing for climate induced events and changes.[108]

Biodiversity and Tourism

Overview

Namibia holds a remarkable variety of species, habitats, and ecosystems ranging from deserts to subtropical wetlands and savannas. Namibia is one of the few countries in Africa as an internationally-recognized "biodiversity hotspot". Namibia's most significant "biodiversity hotspot" is the Sperrgebiet, which is the restricted diamond mining area in the Succulent Karoo floral kingdom, shared with South Africa. The Succulent Karoo is the world's only arid hotspot. It constitutes a refuge for an exceptional level of succulent plant diversity, shaped by the winter rainfall and fog of the Southern Namib Desert. Namibia's unique landscapes and biodiversity support a rapidly developing tourism sector. Tourism is one of the fastest growing sectors in Namibia. In 2011, tourism contributed 3.9% and 15.7%, directly and indirectly to national GDP respectively, and 5.3% and 19.7% to employment.[109] In 2014, tourism directly and indirectly contributed 14.2% to Namibia's GDP.[110] Nature landscapes, wildlife, and increasing interest in culture dominate the Namibian tourism product. The Namibian landscape supports a remarkable biodiversity, especially its plant species. More than 4,500 plant taxa have been recorded, almost 700 of which are endemic to the country, and a further 275 of which are Namib Desert endemics. Other areas of concentrated endemic plant species are the Kaokoveld in the northwest, the Otavi highland in the Kalahari basin, the Kavango region in the northeast, the Auas Mountains on the western edge of the central plateau, and the southern Namib.[111] The Etosha National Park is the most visited National Park, with 22% of all tourists travelling there, and 53% of all holiday tourists.

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[108] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[109] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[110] MET (2011). National Policy on Climate Change. URL: https://adaptation-undp.org/sites/default/files/downloads/namibia_nationalclimatechangepolicyfornamib.pdf

[111] Mapaure I. (2013). Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

Climate Change Impacts

Climate is a principal resource in tourism in Namibia and determines activities and suitability for tourist activities. In addition, tourism tends to be seasonal depending on climate conditions. Therefore, climate change can have an impact on the viability of the tourism industry in the country. There are very limited assessments of the implications of climate change on Namibia's tourism industry. The few studies that have been carried out indicate that the impacts projection for the tourism sector are largely still uncertain and are largely based on an understanding of how climate change will affect biodiversity in the country. Overall, considering exposure to climate hazards, sensitivity and adaptive capacity of tourism resources in Namibia, it is tourism in the regions in the northern parts of the country that is most vulnerable to climate change. The most vulnerable regions include Kavango, Kunene, Zambezi, Omaheke, and Omusati. Kavango and Kunene will see a particular increase in vulnerability of their tourism sector to climate change relative to the present.

Projections of the impacts of climate change on biodiversity indicate a reduction in vegetation cover over the central highlands by the 2050s, with further reductions towards the 2080s. Overall, projections show species loss of 40%–50% in 2050 and 50% and 60% by the 2080s. The patterns of loss will vary considerably spatially. The greatest absolute plant biodiversity cover reductions are projected for the Kaokoveld region in the extreme north-west and in the Kalahari basin in the south-east, with less significant reductions recorded at higher altitudes in the central highlands.[112] Projections also indicate that some portions of non-arid lands in Namibia could become more arid. Desert and arid-land shrubs or grasslands are likely to take over parts of the grassy and mixed savannah areas in the country. Arid vegetation is projected to increase by almost 20% by 2050, and up to 43% by 2080, under non-CO_2 fertilization scenarios. However, with a CO_2 fertilization effect, the expansion will only be a little less than 30% by 2080. The reductions in the savannah grasslands for arid grasslands are likely to be more prevalent in the central highlands and north-east plains of Namibia. The frequency of forest fires is likely to increase in Namibia owing to rising average and extreme temperatures, thereby affecting biodiversity.[113]

In the desert areas, the impacts of climate change on plant species also vary considerably. Local plant extinctions of up to 80% (without migrations) are projected for parts of the north-eastern and northern Kalahari, while extinctions of only 20% are projected in the coastal dessert zones regions. High species turnover is likely in the north-eastern regions of the country, with reductions in species losses towards the west and southwestern parts of the country. Endemic plant species which are more adapted to the arid and dessert environment conditions in Namibia will be less impacted by climate change relative to the exotic species, with projected losses of no more than 19% by 2080.[114]

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[112] Midgley, G., G. Hughes, W. Thuiller, G. Drew, W. Foden. (2005). *Assessment of potential climate change impacts on Namibia's floristic diversity, ecosystem structure and function.* Cape Town. South African National Biodiversity Institute (SANBI), Climate Change Research Group for the Namibian National Biodiversity Programme. URL: http://www4.nau.edu/direnet/publications/publications_m/files/midgley-2005.

[113] Mapaure I. (2013). Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

[114] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

Namibia's coastline stretches more than 1,500 km long and consists of 78% sandy beaches, 16% rocky shores and 4% mixed sandy and rocky shores, and 2% of the shore backed by lagoons. The coastline is very important for tourism and recreation activities, which contribute significantly to the Namibian economy.[115] There are three significant tourist attractions located along the coasts: Sandwich harbor, the wreck of the skeleton coast, and Walvis bay lagoon. Projected sea level rise and coastal erosion pose a threat to tourist activity along the coast. Projected sea level rise under very conservative scenarios of 0.4 m–1.4 m can lead to erosion of these tourist landmark attractions.[116] For example, Walvis Bay, which is located between 1-3 m above sea level, in a semi-sheltered bay surrounded by an erodible coastline is especially vulnerable and may cease to exist altogether. Even a sea level rise of only 0.3m, regarded as virtually certain, will flood significant areas, and a 1m rise will inundate most of the town during high tide.[117]

Adaptation Options

Given that a large portion of the tourism industry in the country is based on nature and biodiversity, the impacts of climate change as described above will have significant impacts on tourism in Namibia. The Namibian government considers tourism a growth sector and has been proactive in protecting nature and biodiversity. It is the first African country to incorporate protection of the environment in its constitution. The environmental and social components of tourism have been well managed, and Namibia is a model for other destinations in terms of community involvement in the management of nature and biodiversity.[118] The country's National Communication proposes three broad adaptation strategies for the tourism industry: (i) Namibia should take advantage of the growing demand for sustainable tourism to respond to climate change, (ii) the country needs to promote wildlife land use systems to achieve better value for land than could be achieved by other sectors such as agriculture, and (iii) Namibia should improve the national conservancy information system to include information and indicators on biodiversity and nature, which are useful for effective monitoring of climate change adaptation strategies in the tourism sector. The national policy on tourism doesn't adequately address climate change. Therefore, there is need to align the national tourism policy with the national climate change policy. The harmonization will ensure that tourism growth strategies are climate proofed and that development in the sector is sustainable.[119]

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[115] Mapaure I. (2013). Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

[116] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

[117] Mapaure I. (2013). Climate change in Namibia: Projected trends and effects. Environmental Law and Policy in Namibia, Edition: 2, Chapter: 11, Publisher: Orumbonde Press. & Welwitschia Verlag Dr. A. Eckl Essen, Editors: Ruppel O.C., and K. Ruppel-Schlichting, pp. 291–309. URL: https://www.researchgate.net/profile/Isaac_Mapaure/publication/233993490_Climate_change_in_Namibia_Projected_trends_and_effects/links/555b564608aec5ac22322869/Climate-change-in-Namibia-Projected-trends-and-effects.pdf?origin=publication_detail

[118] World Bank (2012). Tourism Growth And Development In Namibia. A Policy Note. Poverty Reduction Economic Management. Southern Africa Africa Region. URL: http://www.the-eis.com/data/literature/Namibia%20WB%20Tourism%20Policy%20Note.pdf

[119] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

Institutional Framework for Adaptation

Namibia's approaches to addressing climate change are focused on ensuring strategies are consistent with national development priorities and the use the energy sector as a key driver for sustainability and economic growth. The Cabinet of Namibia is the Government entity entrusted with the overall responsibility for the development of Policies, including those on climate change. The National Climate Change Committee (NCCC) oversees the implementation of the climate change policy, including the preparation of the reports for submission to the Convention and also plays an advisory role to Government on climate change issues. It comprises representatives of the various ministries and other stakeholders, such as the private sector and NGOs amongst others. The NCCC is chaired by the Ministry of Environment and Tourism (MET) and the deputy chair is the National Meteorological Service of the Ministry of Works and Transport. The NCCC reports to the Permanent Secretary of the MET via the head of the Department of Environmental Affairs. The NCCC established working groups and sub-committees which have been active and very useful for overseeing and providing guidance on the different thematic areas during the preparation of this national communications. MET has embarked on a full exercise of reviewing the existing set-up towards developing and implementing new and more robust institutional arrangements for meeting the enhanced and more frequent reporting obligations. Within the planned institutional arrangements, there will be a sharing of responsibilities with the coordinating body taking on most of the planning, preparation, quality control, archiving, evaluation and validation, and the other stakeholders concentrating on the preparation of the more technical components, including data collection and validation, performing technical tasks like compilation of the GHG inventory, and producing draft reports and documenting these.[120]

Policy Framework for Adaptation

Namibia submitted its Fourth National Communication to the UNFCCC in 2020, its Third Biennial Update Report in 2018, and its Nationally Determined Contributions in 2016; Namibia's Updated Nationally Determined Contribution is expected to be released late 2021. Namibia has identified its commitment to responding to climate change challenges through its National Policy on Climate Change (NPCC). The NPCC was adopted in 2011 and provides a legal framework and overarching national strategy for the development, implementation, and monitoring and evaluation of climate change mitigation and adaptation activities in Namibia. While climate change issues have been mainstreamed across the country's key sectors, such as agriculture, water resources, tourism, and health, these policies do not include concrete actions to mitigate climate change risks.[121] Namibia is currently developing its first Nationally Appropriate Mitigation Action (NAMA) and is working on its National Adaptation Plan (NAP) to better guide the country on its way to mitigate and adapt to climate change. The country is working to develop and enhance both adaptation and mitigation efforts to support the country's development goals and improve its

[120] Namibia (2015). Third National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/resource/docs/natc/namnc3.pdf

[121] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

economy. Continued adaptation efforts are focused on the country's most vulnerable sectors: agriculture, forestry, water resources, and health, and on increasing the country's resilience capabilities, and strengthen the country's social and economic structures against vulnerability.[122]

National Frameworks and Plans

- Fourth National Communication (2020)
- Third Biennial Update Report (2018)
- Second Biennial Update Report (2016)
- First Biennial Update Report (2014)
- Third National Communication (2015)
- Second National Communication (2011)
- First National Communication (2002)
- National Policy on Climate Change (2011)
- Nationally Determined Contributions (2016)
- National Agricultural Policy (2015)
- Water Sanitation and Supply Policy, 2008
- National Policy on Tourism, 2008
- National Health Policy Framework (2010–2020), 2010
- National Disaster Risk Management Policy, 2012
- Climate Change Strategy and Action Plan (CCSAP) (2013–2020), 2013

Recommendations

Research gaps

- Improve, support, and reinforce the teaching of meteorology, climatology, and general hydrology in Namibia, especially within the higher education and university channels of natural sciences and build capacity of hydro-met service staff
- Enhance capabilities for handling climate change data at the national, regional and local levels
- Develop effective early warning system for monitoring, preventing, and effectively responding to the human diseases associated with climate change[123]
- Evaluate needs and develop a national strategy for technology transfer to support NDC adaptation measures
- Undertake research to quantify the potential impacts of climate change at the local, national and regional levels to enable informed decision-making and action
- Monitor ecosystem and biodiversity changes and their impacts
- Improve coordination of climate research to optimize meeting the needs of policy makers
- Undertake research on sea level rise and its impact along Namibia's coast
- Develop and project climate change scenarios at higher resolutions for the different regions of the country

[122] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[123] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

Data and information gaps

- Improve technical capacity to analyze hydro-met data and project impacts across sectors; specifically, regarding health and natural disaster events
- Undertake risk assessment and risk reduction measures to increase the resilience of the transportation and communication sectors[124]
- Establish institutional capacity for providing timely early warning systems to farmers for improved decision making and understanding seasonal variability for key agricultural zones
- Increase understanding of water resource threats and groundwater risks to improve long term management and improve water use efficiency in agriculture and urban management
- Improve regulation and enforcement to protect forests, rainforests, and protected areas
- Strengthen information exchange by enhancing technologies transfer and capacities necessary from national to local levels to promote environment and climate change mitigation and adaptation through education and public awareness development
- Build capacity of media, theatre groups, entertainment, and advertising industries to mobilize their experience in shaping public awareness and increase the active public participation in the climate change adaptation and mitigation debate
- Establish Climate Change Resource Centre and Climate Change database

Institutional gaps

- Increase staff, reduce existing schedules, and stem staff turn overs in key collaborating institutions on climate change
- Institutionalize and strengthen disaster risk management and create mechanism and capacities at all levels of government and communities
- Mainstream climate change in national, local and sector policies
- Strengthen and enhance international collaboration, linkages, and networking among stakeholders involved in environment and climate change related issues
- Review and update existing legislation to reflect climate change issues and develop new sector or national policies that address emerging climate change issues
- Provide support to build capacity of national experts in various state departments for implementation, follow-up, quality control, and reporting
- Establish land-use plans by type of use (road infrastructure, oil and gas distribution, agriculture and animal husbandry, forests, coastal zones, urban spaces etc.)
- Integrate climate change concerns into relevant policies and planning processes at the state and national levels
- Finalize regulations to fund and implement impact studies regarding climate change impacts for the country and key sectors[125]

[124] Republic of Namibia (2016). Nationally-Determined Contributions. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Namibia%20First/INDC%20of%20Namibia%20Final%20pdf.pdf

[125] Namibia (2020). Fourth National Communication to the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Namibia%20-%20NC4%20-%20Final%20signed.pdf

CLIMATE RISK COUNTRY PROFILE

NAMIBIA

WORLD BANK GROUP