USAID
FROM THE AMERICAN PEOPLE

FACT SHEET

Climate Change Information Fact Sheet SOUTHERN AFRICA

Definitions
Ensemble: A collection of model simulations characterizing a climate prediction or projection. [IPCC AR5]
Representative Concentration Pathway (RCP): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover. RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios. [IPCC AR5]
RCP8.5: Generally, high emissions. One high pathway for which radiative forcing reaches >8.5 W m^{-2} by 2100 and continues to rise for some amount of time. [IPCC AR5]
RCP4.5: Generally, moderate emissions. One of two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W m^{-2} after 2100. [IPCC AR5]

Southern Africa includes 10 countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe. **These countries span four climate zones**: Southwestern, dry climates; Central/Southeastern, warm temperate with dry winters and hot summers; Tropical Savannah, tropical; Coastal, coastal climates.

CLIMATE IMPACTS AND VULNERABILITIES

REGION: SOUTHWESTERN

TEMPERATURE

Current (based on historical climate conditions and recent trends, generally over the past few decades)
This climate zone roughly comprises the southwestern countries of Southern Africa: central and southwestern Botswana, Namibia (except Northeastern), and southwestern South Africa, with climates ranging from hot summers, arid steppe in the east, to arid desert to the west. Mean annual temperatures are generally above 18°C for this sub region, exceptions being the interior of South Africa, and parts of the coast. [KG] Extreme heat days have increased in frequency, while extreme cool days have decreased in frequency over the same period [IPCC AR5]. In South Africa, mean annual temperatures have increased at least 1.5 times the observed global average increase of 0.65°C during the last 50 years. [LTAS]. A study of the Limpopo Province of South Africa showed an increase of 0.12°C/decade in the mean annual temperature. While annual mean annual temperature shows an increasing trend across the whole region, particularly large rates of increase have occurred in Namibia and Angola [PCE].

Future: 2030 (generally 2020-2049)
Projected increases in mean annual temperature for the southern African region are 0.8°C, 0.9°C, and 1.00°C by

2035 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. There is high confidence for these projections [IPCC AR5, Ch. 14].

Future: 2050 (generally 2040-2059)

The majority of southwestern Africa is expected to experience an increase in annual average temperature of 1.5 to 2°C by midcentury under the B1 scenario and the A2 scenarios (compared to the 1961 to 1990 baseline), respectively. High rates of near-surface warming are projected for semi-arid regions in the southwestern subregion in the latter portion of this century under multiple scenarios. Projected increases in mean annual temperature for the southern African region are 1.5°C, 1.7°C, and 2.1°C by 2065 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. Under RCP8.5, the region is very likely to exceed the 1986 to 2005 baseline by 3 to 6°C by the end of the century [IPCC AR5, Ch. 14]. Projections show that temperature changes will not be uniform over the region; the central, southern land mass extending over Botswana, parts of north-western South Africa, Namibia and Zimbabwe are likely to experience the greatest warming of 0.2–0.5°C per decade [PCE].

REGION: CENTRAL, SOUTHEASTERN

TEMPERATURE

Current (based on historical climate conditions and recent trends, generally over the past few decades)

The sub region includes southern Angola, northeastern Namibia, Zambia, northern and eastern Botswana, Zimbabwe, western Malawi, Lesotho, Swaziland, and the eastern half of South Africa. This sub-region is comprised of relatively warm temperate climates (whereby the temperature of the hottest month is greater than 10°C, and the temperature of the coldest month is greater than 0°C and less than 18°C). The region is characterized by predominantly warm/hot summers [KG]. Mean annual temperatures have increased by 0.76° C between 1970-2001 in Lesotho [CCKP].

Future: 2030 (generally 2020-2049)

Projected increases in mean annual temperature for the southern African region are 0.8°C, 0.9°C, and to 1.00°C by 2035 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. There is high confidence for these projections [IPCC AR5, Ch. 14].

Future: 2050 (generally 2040-2059)

The majority of southeastern Africa is expected to experience an increase in annual average temperature of 1.5 to 2°C by 2050 under the B1 and A2 scenarios (compared to the 1961 to 1990 baseline), respectively. [CW] Projected increases in mean annual temperature for the southern African region are 1.5°C, 1.7°C, and to 2.1°C by 2065 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. Under RCP8.5, the region is very likely to exceed the 1986 to 2005 baseline by 3 to 6°C by centuries end [IPCC AR5, Ch. 14]. By mid-century, projections indicate 1 to 4 fewer days below freezing during each winter month. During each summer month, South Africa could experience 8 to 9 additional hot days [CCKP].

REGION: TROPICAL SAVANNAH

TEMPERATURE

Current (based on historical climate conditions and recent trends, generally over the past few decades)

This sub region is characterized by a tropical climate, and includes northern Angola, eastern Malawi, and eastern Mozambique. The temperature of the coldest month in this region is greater than 18°C. [KG] In Mozambique (between 1960 and 2003), the average number of hot days per year increased by 25; and average annual temperature increased by .6°C [UNDP].

Future: 2030 (generally 2020-2049)

Projected increases in mean annual temperature for the southern African region are 0.8°C, 0.9°C, and to 1.00°C by 2035 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. There is high confidence for these projections [IPCC AR5, Ch. 14].

Future: 2050 (generally 2040-2059)
The majority of the tropical Savannah region is expected to experience an increase in annual average temperature of 1.5 to 2°C by 2050 under the B1 and A2 scenarios (compared to the 1961 to 1990 baseline), respectively. [CW] Projected increases in mean annual temperature for the southern African region are 1.5°C, 1.7°C, and to 2.1°C by 2065 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles [IPCC AR5, Ch. 14].

REGION: TROPICAL SAVANNAH

TEMPERATURE

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Oceans play an important role in the region's climate. The east coast is influenced by the southward-flowing Mozambique current, which brings warm water and humid air from the Equator and creates a humid, warm climate. In contrast, the west coast is influenced by the cold Benguela current from the Atlantic Ocean, which produces a drier, cooler climate. [SARVA] Parts of the Southern Namibian Coast and Northern South African coast have mean annual temperatures of less than 18°C [KG].

Future: 2030 (generally 2020-2049)
Projected mean annual temperature increases are slightly less on the Indian Ocean coastline (~0.6°C) versus the Atlantic Ocean coastline (~0.7°C) for the RCP4.5 and 8.5 scenarios. RCP8.5 projections are slightly higher than RCP4.5. There is a slight gradient of increasing temperature projections moving from the southern Cape to northern Angolan coast [CCKP].

Future: 2050 (generally 2040-2059)
The Indian Ocean coastal regions are projected to experience warming, though slightly less than in the interior, about 1.0 to 1.5°C by mid-century under the B1 and A2 median scenarios [CW].

REGION: SOUTHWESTERN

PRECIPITATION AND FLOODING

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Almost everywhere in the region, seasonal rainfall commences around September, October, or November, and ceases around March, April, or May. December-February is the peak of the rainfall season, while June, July, and August are typically dry (less than 1 mm day). [KNMI] The southwestern Cape is an exception, as it is a winter rainfall region that receives the bulk of its annual rainfall in the form of frontal rain May-September. Parts of the region (Botswana, Namibia, South Africa) have a low rainfall index and a variability that exceeds that of the Sahel [UNEP]. This sub-region is comprised of relatively dry winters. The western portion of the region is generally more arid than other regions. [KG] Much of Namibia and Botswana receive less than 100 mm of rain each year. Many areas have seen slight decreases in precipitation since the middle of the 20th Century. Decreasing rainfall trends in Malawi for annual, seasonal, monthly rainfall were deemed non-significant [PCE].

Future: 2030 (generally 2020-2049)
Projected reductions in mean annual rainfall for the southern African region are -5%,-2%, and 0% by 2035 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. [IPCC AR5, Ch. 14] Uncertainty for precipitation projections is high [CCKP and IPCC AR5].

Future: 2050 (generally 2040-2059)
Under the B1 and A2 median scenarios, areas of the southwestern portion of the region - in western South Africa and western Namibia - are projected to experience overall reductions in mean annual rainfall by mid-century [CW]. Projections have shown that, the arid and semi-arid areas are likely to get drier due to climate change than more humid areas. [PCE] This reduction in rainfall is particularly pronounced in the austral winter months, and

more pervasive throughout the region. Although overall precipitation is projected to decrease in these areas, the amount of rain to fall during any particular event is projected to be heavier than the historical average. Uncertainty for precipitation projections is high [CCKP and IPCC AR5]. Evidence points to an increased inter-annual variability, with extremely wet periods in different countries in future [PCE].

REGION: CENTRAL, SOUTHEASTERN

PRECIPITATION AND FLOODING

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Almost everywhere in the region, seasonal rainfall commences around September, October, or November, and ceases around March, April, or May. December-February is the peak of the rainfall season, while June, July, and August are typically dry (less than 1 mm day). [KNMI] Statistically-significant trends within annual averages have not been observed. There has been a significant increase in the frequency of very heavy rainfall events in eastern South Africa from 1906 to 1997; an increase in the intensity of events has also been observed. In almost all hydrological zones of the South Africa the number of rain days has decreased significantly over the last 50 years [LTAS]. Decreasing rainfall trends have been observed in southern Zambia after 1975. Rainfall in Zimbabwe has high inter-annual variability, and currently any change due to global warming is not yet statistically detectable [PCE].

Future: 2030 (generally 2020-2049)
Projected reductions in mean annual rainfall for the southern African region are -5%,-2%, and 0% by 2035 for the RCP4.5 mean model ensembles 25th, 50th, and 75th percentiles. [IPCC AR5, Ch. 14] Uncertainty for precipitation projections is high [CCKP and IPCC AR5].

Future: 2050 (generally 2040-2059)
Under the A2 and B1 median scenarios under mid-century, mean annual rainfall is projected to increase in parts of southeastern South Africa, Northern Zambia, and northern Angola [CW]. The central and eastern plateau of South Africa, as well as the Drakensburg Mountains could see possible increases in austral summer rainfall [USAID citing Hewitson and Crane, 2006]. Many models project that by 2050 the interior of southern Africa will experience decreased rainfall during the growing season due to reductions in soil moisture and runoff. The general conclusion from most studies is that streamflow is projected to decrease by 2050 [PCE].

REGION: COASTAL

PRECIPITATION AND FLOODING

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Almost everywhere along the Atlantic and Indian Ocean coastlines, seasonal rainfall commences around September, October, or November, and ceases around March, April, or May. December-February is the peak of the rainfall season, while June, July, and August are typically dry (less than 1 mm day) [KNMI]. The southwestern Cape is an exception, as it is a winter rainfall region that receives the bulk of its annual rainfall in the form of frontal rain May-September. Oceans play an important role in the region's climate. The east coast is influenced by the southward-flowing Mozambique current, which brings warm water and humid air from the Equator and creates a humid, warm climate. In contrast the west coast is influenced by the cold Benguela current from the Atlantic Ocean, which produces a drier climate.

Future: 2030 (generally 2020-2049)
Under the RCP4.5 and 8.5 median scenarios at 2030, some models project increases in annual average rainfall along the northwestern Atlantic coast and southeastern Indian Ocean coast, with drying over the Atlantic coast of South Africa and up through the coast of Namibia. Uncertainty for precipitation projections is high [CCKP and IPCC AR5].

Future: 2050 (generally 2040-2059)

Under the B1 and A2 median scenarios at mid-century, the northwestern Atlantic coast and southeastern Indian Ocean coast are projected to see increases in annual average rainfall, which is most pronounced in the austral summer months. A strong drying trend over the Atlantic coast of South Africa is projected, which is particularly pronounced in the austral winter, when it extends up through the coast of Namibia. Uncertainty for precipitation projections is high [CCKP and IPCC AR5].

ALL REGIONS

DROUGHT

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Disaggregated information for this climate condition in the region is sparse. The years 1973, 1982, 1983 and 1992 were particularly dry in southern parts of the region, and the 1991/1992 drought was the most severe in the last century [UNEP]. Western portions of the region have been affected during the second half of the century due to an upward trend in Indian Ocean sea surface temperatures (SSTs). Dry spells have been occurring with increasing frequency [IPCC AR5]. A drying trend has been observed for many countries in the region. A number of countries have been experiencing more frequent and intense drought events in the last few decades (since 1979). Lesotho and Malawi, in particular, have seen more severe droughts than expected, historically [USAID citing Conway, 2009 and Kandji et al., 2006]. Some evidence suggests a spatially coherent increase in consecutive dry days over much of southern Africa in the last decades of the twentieth century [PCE].

Future: 2030 (generally 2020-2049)
Evidence points to an increased inter-annual variability, with more intense droughts in different countries in future. Changes in rainfall timing, intensity and frequency, may result in more droughts, and longer periods between rainfalls [IPCC AR5].

Future: 2050 (generally 2040-2059)
There is medium confidence that droughts will intensify in the 21st century in some seasons, due to reduced precipitation and/or increased evapotranspiration in southern Africa [IPCC AR5]. Over southern Africa, CMIP3 GCM projections show a drying signal in the annual mean over the climatologically dry southwest, extending northeastward from the desert areas in Namibia and Botswana. During the austral summer months, dry conditions are projected in the southwest. Consistent with the AR4, drier winters are projected over a large area in southern Africa by the end of the century. Rainfall decreases are also projected during austral spring months, implying a delay in the onset of seasonal rains over a large part of the summer rainfall region of southern Africa [IPCC AR5]. Evidence points to an increased inter-annual variability, with more intense droughts in different countries in future. Besides volumes, rainfall patterns are also expected to change in intensity and frequency, resulting in more extreme events and longer periods between rainfalls. River runoff and water availability are projected to decrease by 10–30% in the dry tropics [PCE].

REGION: COASTAL

SEA LEVEL RISE AND STORM SURGE

Current (based on historical climate conditions and recent trends, generally over the past few decades)
Mozambique has 3,114 km of coastline; South Africa 3,079 km; Angola 1,712 km; and Namibia 1,520 km. Along the eastern coastal region, frequent storms originating in the Indian Ocean and Pacific have an impact on storm surge and wave heights [USAID]. Coastal areas of South Africa, particularly the Cape Peninsula, have been impacted by heavy waves and storm surge during violent coastal storms. However, such events have not been severe enough to limit development and trends have not been increasing. Regarding sea level rise, significant increases beyond global average have not been observed, although average annual SST in the Indian Ocean has shown significant increases since 1950 of about 1°C [USAID citing IPCC AR4].

Future: 2030 (generally 2020-2049)
A linear interpolation of end of century global sea level estimations indicates that sea level could rise by 0.13 meters [RCP4.5] up to 0.4 meters [RCP8.5] by 2030 (from a reference time period of 1971-2010). [IPCC

WG1AR5, Ch. 13] Cyclone-induced storm surges are likely to be exacerbated by a potential rise in sea level [CCKP].

Future: 2050 (generally 2040-2059)

A linear interpolation of end of century global sea level estimations indicates that sea level could rise by 0.20 meters [RCP4.5] up to 0.58 meters [RCP8.5] by 2050 (from a reference time period of 1971-2010). [IPCC WG1AR5, Ch. 13] According to an analysis of sea level rise in Cape Town which considered local conditions and IPCC projections, 2.5 to 6.5-meter sea level rise scenarios were deemed plausible during the 21st Century. If a storm were to occur during high tide, surge could be significantly greater than this. [Cape Town] Cyclone-induced storm surges are likely to be exacerbated by a potential rise in sea level [CCKP].

ALL REGIONS

WINDS AND OTHER STORMS

Current (based on historical climate conditions and recent trends, generally over the past few decades)

Disaggregated information for this climate condition in the region is sparse. Cut-off lows and tropical cyclones do occasionally affect southeastern portions of the region, but not routinely. However, many tropical cyclones affect eastern Mozambique, particularly during the months of October to April [USAID]. Mozambique is already prone to annual flooding due to the convergence of storm surge and river basin drainage [CCKP].

Future: 2030 (generally 2020-2049)

Large uncertainties surround projected changes in tropical cyclone landfall from the southwest Indian Ocean that have resulted in intense floods during the 20th century [IPCC AR5].

Future: 2050 (generally 2040-2059)

The Indian Ocean High that is southeast of the African continent is projected to strengthen, on average, during this century. This strengthening displaces tropical lows in a northward direction. This could be responsible for a portion of the projected increase in heavy rainfall events, but heavy winds do not appear to be of particular significance [LTAS]. Large uncertainties surround projected changes in tropical cyclone landfall from the southwest Indian Ocean that have resulted in intense floods during the 20th century [IPCC AR5].

Climate information sources	CCKP = World Bank Climate Change Knowledge Portal (CCKP)
	CSAG Climate Tool = http://cip.csag.uct.ac.za/webclient2/app/#datasets (Provides detailed historical and projected climate information -downscaled at stations throughout South Africa)
	CW = Climate Wizard
	IPCC AR5 = Niang et al., 2014. WGII Ch22 Africa
	IPCC AR5, Ch. 14 = Christensen, J.H., et al., 2013. WGI Ch 14 Climate Phenomena and their Relevance for Future Regional Climate Change
	KG = Kottek, Markus, Jürgen Grieser, Christoph Beck, Bruno Rudolf, and Franz Rubel, 2006. World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift, Vol. 15, No. 3, 259-263 (June 2006)
	KNMI = Shongwe et al., 2009. Projected Changes in Mean and Extreme Precipitation in Africa under Global Warming. Part I: Southern Africa. Royal Netherlands Meteorological Institute (KNMI)
	Koppen Geiger Climate Zones = http://koeppen-geiger.vu-wien.ac.at/pdf/kottek_et_al_2006_A4.pdf
	LTAS = Republic of South Africa Department of Environmental Affairs, 2013. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa

	PCE = Kusangaya, Samuel, Michele L. Warburton, Emma Archer van Garderen, Graham P.W. Jewitt, 2013. Impacts of climate change on water resources in southern Africa: A review. Physics of Chemistry and Earth. 2013.
	USAID = USAID, 2012. Climate Change Adaptation in Southern Africa