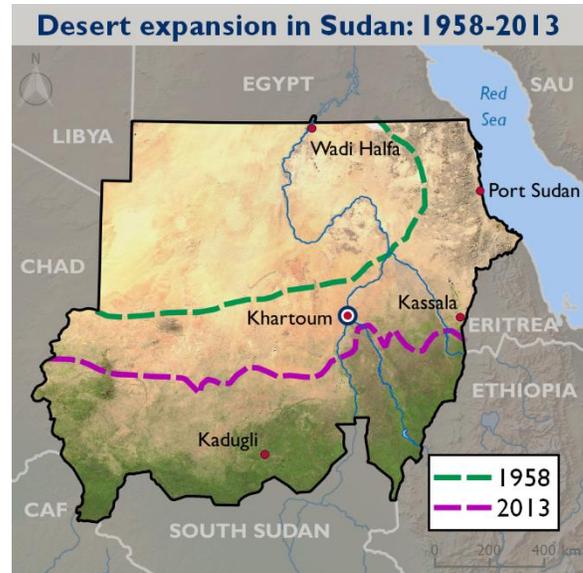




CLIMATE CHANGE RISK PROFILE SUDAN

COUNTRY OVERVIEW

Several vulnerability indices rank Sudan among the most vulnerable countries in the world to climate variability and change. Increased frequency of droughts and high rainfall variability over the past few decades have already put stress on the region's rainfed agriculture and pastoralist systems, the dominant livelihoods in rural areas. In North Darfur, reduction of rainfall, in combination with increased water demand and land use change, has contributed to desertification of millions of hectares and depletion of water sources over the past few decades. In addition to unstable crop production and shrinking productive land and water resources, ongoing conflicts in the region have displaced 2.5 million people, who live under conditions of persistent food insecurity and high rates of poverty. High population growth adds pressure to an already strained natural resource base. Oil production drove most of Sudan's post-2000 growth but the secession of South Sudan and subsequent loss of oil revenues increase the importance of agriculture and livestock (which currently contribute 29 percent to GDP) to Sudan's economic growth. Climate change is increasingly putting all of these sectors at risk. (2, 7, 8, 13)



CLIMATE PROJECTIONS



0.5°–3° C increase in average temperatures by 2050



Increased unpredictability of seasonal rains



Increased incidence of drought



Rising sea levels, higher storm surges

KEY CLIMATE IMPACTS

Agriculture & Pastoralism



Reduced pasture and water for livestock
Loss of arable land and reduced crop yields
Increased rural to urban migration

Water Resources



Reduced water supply
Increased conflict over access to water resources

Coastal Zones



Loss of key ecosystems and species
Intensification of storm surges and cyclones
Damage to coastal infrastructure

Energy



Reduced hydropower potential

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CLIMATE SUMMARY

Sudan has a variable climate ranging from desert and semi-desert areas in the north to arid savannah in the east, west and south, with seasonal rains in central areas between El Obeid and Atbara. Mean annual temperatures vary between 26°C and 32°C across the country. The most extreme temperatures are found in the far north, where summer temperatures can often exceed 43°C and sandstorms blow across the Sahara Desert from April to September. The main rainy season is from May to October, with precipitation ranging between less than 50 mm in the extreme north to more than 1500 mm in the extreme south. (5)

HISTORICAL CLIMATE

Historical climate trends include:

- Steady rise of temperatures between 0.2°C and 0.4°C per decade from 1960–2009.
- Increase in annual dry season rainfall totals by 20–30 mm per decade in the extreme north and south.
- Decrease in annual rainy season rainfall totals by 10–30 mm per decade, primarily in the west.
- Increase in year-to-year variability in the amount and timing of rainfall.
- Increase in the frequency of extreme climatic events, particularly drought in Kordofan and Darfur, as well as in part of central Sudan.
- While highly unpredictable, the frequency of floods increased noticeably.
- Rise in Red Sea levels over the past century, between 10–20 cm. (3, 5)

FUTURE CLIMATE

Projected changes in climate include:

- Rising temperatures, by 0.5°C to as much as 3°C by 2050, with a more extreme temperature rise in the north.
- Temperature increases will intensify the impacts of drought through increased evapotranspiration and reduced soil moisture.
- Slight increases in rainfall (4 percent per decade), coupled with increased variability.
- The Sahara Desert is advancing at an estimated rate of 1.5 kilometers a year, and if current rainfall trends continue, the desert will continue to advance southward.
- Continuing rising levels of the Red Sea, between 30–50 cm by 2050, depending on the increase in temperature. (3, 8, 10, 12)

SECTOR IMPACTS AND VULNERABILITIES

WATER RESOURCES

Climate change, combined with increased water consumption driven by agricultural development and population growth, could contribute to a water crisis for Sudan, particularly in the desert north. With half of Sudan’s population living on only 15 percent of the country’s land area, all near the Nile River, water resources are extremely important to Sudan’s continued economic development and social cohesion. The Nile is the main source of water supply (67 percent) for Sudan, followed by *wadis* or seasonal riverbeds (20 percent) and groundwater (13 percent). Irrigation accounts for 94 percent of water demand and projected increases in agricultural development, even without climate change, will cause demand to far outpace supply by 2030. Climate change impacts are expected to exacerbate this issue. (5) Three decades of increased rainfall variability, combined with episodic and severe drought, have increased disputes over water resources. Water rights continue to be a source of tension between Sudan and neighboring

Climate Stressors and Climate Risks WATER RESOURCES	
Stressors	Risks
Increased temperatures	Increased evaporation from water storage facilities, reducing water supply
Increased rainfall variability	Decreased river flows from the Nile (20-30 percent by 2090), leading to reduced availability of water for irrigation, drinking and sanitation
Drought	Increased conflict over rights and access to water at the local, national and regional levels

countries (particularly South Sudan). Across the region, access to water from the Nile has sparked conflict between states and there is concern that climate change may adversely impact Sudan’s stability. (4, 8)

AGRICULTURE AND PASTORALISM

Already plagued by poor soil conditions and limited access to agricultural inputs, Sudan's low-performing, rainfed agriculture sector will be further constrained by increased drought and rainfall variability. Humid agro-climate zones are projected to shift southward, rendering areas of the north increasingly unsuitable for agriculture. For example, in Kordofan, both millet and sorghum production are predicted to decrease by 2060 due to increased temperatures and more variable rainfall. Food shortages accumulating from consecutive years of drought have already created recurring food emergencies and famine across the country. In addition, drought and reduced rainfall have reduced available grazing lands. Crop failure and high livestock mortality increase rural to urban migration, which expands slums and exacerbates health and sanitation concerns. Mounting evidence suggests that drought has been a stress factor on pastoralist communities – particularly in Darfur and Kordofan – and has contributed to regional conflict. (5, 6, 7, 8, 9)

COASTAL ZONES

Climate change threatens the development and biodiversity of Sudan's coastal zones, negatively impacting livelihoods and economic opportunities dependent on coastal resources. Sudan's coastal zones are experiencing rapid growth in infrastructure development, industrial activity and population, yet they are vulnerable to multiple climate change risks such as sea level rise, which can damage infrastructure and increase salinity of freshwater aquifers. Increased risk of damages due to climate change will increase the cost of development along important industrial coastal zones and ports. Changes in surface temperature and salinity could also negatively impact Sudan's Red Sea shoreline of diverse and relatively undisturbed ecosystems, which include coral reefs, mangroves, sea grass beds and important feeding and nesting sites for a range of bird species. (5)

ENERGY

Hydroelectricity is Sudan's largest source of power, accounting for 68 percent of output in 2011, followed by diesel, heavy fuel oil and biomass. This is a large increase from 2008, when hydropower accounted for only 27 percent of the power supply. Climate change threatens Sudan's hydropower development through its predicted impact on water resources. (5, 11)

Climate Stressors and Climate Risks AGRICULTURE and PASTORALISM	
Stressors	Risks
Increased minimum temperatures	Loss of productive land, pasture and water due to expanded desertification
	Shortened growing season
Increased variability in onset and length of rainy season	Reduced yields and/or crop failure
	Increased conflict between pastoralists and farmers over limited land and resources
Drought	Increased rural to urban migration due to prolonged droughts and strain on rural livelihoods

Climate Stressors and Climate Risks COASTAL ZONES	
Stressors	Risks
Sea level rise	Intensification of storm surges (20 percent increase) and cyclones, damaging existing infrastructure and impeding future economic development
Changes in seawater temperature and salinity	Irreversible damage to coral reef systems through bleaching
	Damage to mangrove systems, which provide vital ecosystem services and protection against storm surges
Increase in sea-surface temperature	Damage to sea grass and salt marsh ecosystems, which provide habitats for several key species

Climate Stressors and Climate Risks ENERGY	
Stressors	Risks
Increased temperatures	Increased evaporation in water storage areas and reduced river flows, resulting in reduced water availability for hydropower generation
Increased rainfall variability	

POLICY CONTEXT

INSTITUTIONAL FRAMEWORK

Sudan's Higher Council for Environment and Natural Resources (HCENR) serves as both the focal point for the United Nations Framework Convention on Climate Change (UNFCCC) and a coordinating body for development of national environment policies and strategies as well as environmental management.

Other important institutions include the Sudan Meteorological Authority (SMA), which provides short-term weather and climate forecasts for national planning, and the General Directorate for Planning and Agricultural Economics (GDPAE), which is situated within the Ministry of Agriculture and Forestry and produces scientific articles, workshops and seminars on climate change information. The GDPAE is developing a link with the HCENR as the climate change focal point to facilitate better collaboration between the two institutions. In early 2011, the HCENR established a climate change network to focus more attention on adaptation planning, including capacity building, awareness-raising among government institutions, and outreach to media.

NATIONAL STRATEGIES AND PLANS

In addition to submitting national communications to the UNFCCC, Sudan prepared and submitted its National Adaptation Programme of Action (NAPA) in 2007, which identified agriculture/food security and water as key sectors that needed to be addressed. With financial support from the Global Environmental Facility (GEF), implementation of a subset of the highest priority NAPA projects began in 2010. Currently, UNEP is supporting the HCENR to implement a major climate change project aimed at preparing the country's National Adaptation Plan.

The following strategies and plans are available:

- [First National Communication](#) (2003) and [Second National Communication](#) (2013); Ministry of Environment and Physical Development
- [National Adaptation Programme of Action](#) (2007); Ministry of Environment and Physical Development

KEY RESOURCES

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Map source: adapted from Eltoun, M. 2015. The role of ecological factors causing land surface desertification, the case of Sudan. *Journal of Agriculture and Ecology Research International* 4(3): 105-116.

SELECTED ONGOING EXPERIENCES

Selected Program	Amount	Donor	Year	Implementer
Darfur Water Project	\$3.2 million	African Development Bank	2012–unknown	Ministry of Water Resources and Electricity
Sudan Sustainable Natural Resources Management Project (SSNRMP)	\$8.35 million	World Bank	2013–2019	Ministry of Environment, Forestry, and Physical Development
Climate Risk Finance for those Most Vulnerable to Climate Change	\$6.3 million	GEF (LCDF)	2013–2015	UNDP
Building Resilience Against Climate Change	\$2.8 million	CIDA	2013–2016	UNDP
Livestock and Rangeland Resilience Program	\$33 million	GEF	N/A	IFAD
Enhancing the Resilience of Communities Living in Climate Change Vulnerable Areas of Sudan Using Ecosystem Based Approaches to Adaptation (EbA)	\$15.7 million	GEF (LDC Trust Fund)	2014 – unknown	UNEP