Climate Centre

جمعية الهلال الأحمر السوداني
Sudanese Red Crescent Society

Climate fact sheet | 2024

Sudan

This climate fact sheet summarizes the available information on the climate of Sudan and the impact of climate change on humanitarian activities in-country. Each fact sheet in the series was written using information from peer-reviewed academic papers, government publications, and other documentation from international non-governmental organizations.

1. Climate overview

Average annual temperature: Mean annual temperatures vary between 23–32°C across the country, with summer temperatures in the north often exceeding 43°C.

Average annual rainfall: Annual rainfall is unreliable and varies across the country. The northern part of Sudan receives mean annual rainfall of 100mm/year. The southern part of the country experiences higher mean annual rainfall totals of 700–1,200 mm/year.

Short overview

The climate of Sudan varies from north to south. The northern part of Sudan is a desert climate, receiving little rainfall, shifting to semi-arid and then tropical savannah towards the south. The climate in Sudan is determined by the combined effects of the Intertropical Convergence Zone (ITCZ) as well as its diverse biogeographic features, including the coastline of the Red Sea, inland catchment and plains of the Nile River, savanna woodlands in the south and extensive semi-desert and desert in the central and northern interior (AfDB, 2018).

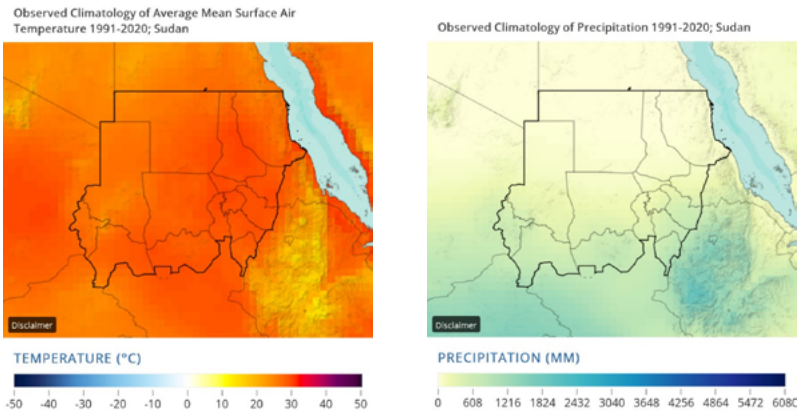

Figure 1. Observed climatology of (left to right) mean temperature and annual mean total precipitation 1991-2020 (from World Bank, 2022).

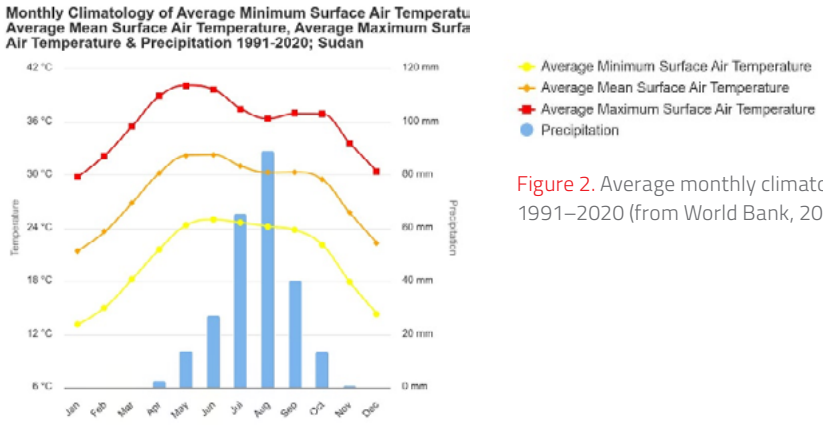

Figure 2. Average monthly climatology over 1991–2020 (from World Bank, 2022).

The total yearly rainfall comes in extremely heavy rainfall events that dump large amounts of water at once. These are infrequent, happening only a few times per year (Salih *et al.*, 2018). Temperatures are highest at the beginning and end of the wet season. During this hot season, temperatures can range from more than 20°C at night to over 40°C during the day. The coldest months of December and January can see nighttime temperatures drop below 20°C. The rainy season is short; occurring primarily between June and September.

The El Niño–Southern Oscillation (ENSO) creates irregular periodic variation in the temperature as well as sea surface temperature, thus influencing year-to-year variability and extreme weather events such as droughts, floods and heatwaves. During El Niño periods, parts of Sudan typically experience drier than normal conditions and during La Niña periods, wetter than usual conditions typically occur.

The diverse and varied geography of Sudan means that it is exposed to a broad array of environmental hazards (hydrometeorological as well as geophysical) which are directly impacted and exacerbated by the impacts of climate change across the country. Sudan is one of the most vulnerable countries to humanitarian crises, ranked 15th out of 191 countries by the 2022 Inform Risk Index (DRMKC, 2022).

1.2 Climate change in Sudan

Historical climate change	Projected climate change
Temperature	
▪ The mean annual temperature over Sudan increased at a rate of approximately 0.3°C/decade in 1961–2015 (Gutiérrez *et al.*, 2021). ▪ The frequency and intensity of hot extremes have increased, and cold extremes have decreased (Seneviratne *et al.*, 2021).	▪ Mean temperatures over the region are projected to rise until 2050 by at least 2–3°C for a high greenhouse gas concentration scenario (SSP5–8.5) and by 1.5–2°C for a low greenhouse gas concentration scenario (SSP2–4.5) (AfDB, 2018; Gutiérrez *et al.*, 2021). ▪ Maximum and minimum temperature will increase, and heatwaves will intensify in duration and peak temperatures for every increase in global warming levels above the pre-industrial values. In line with rising mean annual temperatures, the annual number of very hot days (days with daily maximum temperature above 35°C) is projected to rise and with high certainty (Gutiérrez *et al.*, 2021; Ranasinghe *et al.*, 2021; Seneviratne *et al.*, 2021)
Precipitation	
▪ There were mixed trends in rainfall by seasonality in recent decades. Dry season rainfall totals have increased by 20–30mm per decade in the extreme north and south. Wet season rainfall total have decreased by 10–30mm per decade, primarily in the west. This points to overall trends of increased year-to-year rainfall variability (USAID, 2016).	▪ Mid-century (2040–2060) estimates of annual precipitation changes over Sudan under a low emission scenario (SSP2–4.5) and a high emissions scenario (SSP5–8.5) are projected to increase by around 10–25 per cent coupled with increased variability and a lack of predictability for seasonal rains (USAID, 2016; AfDB, 2018; Gutiérrez *et al.*, 2021). ▪ The frequency and intensity of heavy precipitation events are projected to increase with potential impacts on levels of flooding and soil erosion (Seneviratne *et al.*, 2021).

2. Priorities of the Red Cross Red Crescent Movement under climate change

2.1 Scale up climate-smart disaster risk reduction (DRR), early action and preparedness

Existing hydrometeorological hazard	Projected risks
Floods	
Both riverine and flash flooding pose a threat to Sudan. Riverine flooding occurs along the River Nile (including the White and Blue Nile tributaries) and is caused by runoff into rivers from rainfall within Sudan and neighbouring countries of Ethiopia and South Sudan. Communities in the Blue Nile, White Nile, Sennar, Gezira, Kassala and Khartoum states are affected the most regularly. Flash flooding impacts low-lying areas that are dry for most of the year and can cause significant damage and loss of life (Save the Children, 2022).	As the frequency and intensity of heavy rainfall events are projected to increase, Sudan is likely to continue to see floods pose a high risk for communities across the country.
Droughts	
Sudan is part of the Sahel belt region, which has been exposed to a series of recurring dry years and droughts in recent times (Government of Sudan, 2021). The most severe droughts in recent history occurred in 1967–1973 and 1980–1984. Successive years of drought between 1985–1993 led to severe food shortages and had impacts on lives and livelihoods. EM-DAT data shows in the past fifty years (1970–2020) droughts affected over 27 million people in Sudan (Government of Sudan, 2021).	Haile *et al.* (2020) project that drought event duration, frequency and intensity will increase by the end of the 21st century under all scenarios. The area under drought will increase by 16 per cent, 36 per cent and 54 per cent under increasing Representative Concentration Pathways (RCPs) (2.6, 4.6, 8.5 respectively).

It is important to note that many of these hazards are interrelated and produce compound risks in the same areas and communities. In addition, risk must be understood as the interplay between hazard, exposure and vulnerability which makes certain individuals, communities and sectors more impacted by the hazards. All project design should take such compounding risks into account.

Disaster risk management strategies

Currently, Sudan does not have a comprehensive law or management strategy outlined to govern DRR activities. Twenty-five sectoral laws and the Civil Defence Act of 2005 are the main entities in-country and DRR is dispersed among all of these (Government of Sudan, 2021b). The Voluntary and Humanitarian Work Act (2006) functions to streamline humanitarian activities to address the needs of citizens affected by natural and manmade disasters. In the absence of a legally binding framework, overlap in responsibilities and weak coordination are challenges. The updated Nationally Determined Contribution mentions putting measures in place to prevent future flood risk across the country (Government of Sudan, 2021b).

Disaster risk management law and policies

- The Khartoum Risk Reduction Action Plan (2019-2023) aims to enhance the capabilities of Khartoum State and prepare for an effective disaster response.

2.2 Reduce health impacts of climate change

Frequent droughts, floods and rising temperatures resulting from climate change threaten clean air, the supply of safe drinking water and food, and safe shelter, which ultimately threatens human health and wellbeing in Sudan (WHO, 2022).

Flooding, especially annual floods along the Nile River and flash floods from seasonal water courses, is becoming more frequent (UNICEF, 2021). Consequently, communities are exposed to increased risks of water- and vector-borne diseases such as dengue fever, chikungunya and malaria (Fong *et al.*, 2020; UNICEF, 2021). In Sudan, the incidence of severe malaria cases tends to increase following flood events (Elsanousi *et al.*, 2018).

Additionally, warming temperatures across the country create a conducive environmental for the rise and spread of disease vectors. For example, an invasive malaria vector, *Anopheles stephensi*, has spread throughout Sudan, with numbers expected to increase as warmer temperatures in the country create a more suitable breeding ground for the vector (Abubakr *et al.*, 2022).

Epidemic outbreaks of diseases such as cholera, Rift Valley fever and yellow fever due to temperature rise, floods and droughts are also expected to increase in number and in terms of additional burdens on the country's healthcare system (Fong *et al.*, 2020; Gaythorpe *et al.*, 2020; WHO, 2022). In 2020 and 2021, the Sudan floods also caused damage to healthcare facilities and sanitation infrastructure which has elevated the risk of various infections owing to an already weakened public health system (Fong *et al.*, 2020; IFRC, 2022).

2.3 Ensure sustainable water supplies

Water, Sanitation and Hygiene (WASH)

The projected increase in evaporation rates due to climate-related intense droughts and rising temperature will reduce water availability for domestic use and irrigation, especially in the northern part of the country (Elsheikn & Nasreldin, 2022). Agriculture accounts for 94 per cent of all water withdrawals in Sudan, and with increased evaporation from storage facilities and water bodies, reductions in agricultural water supply are expected (USAID, 2016). Increased droughts and reduced rainfall also lead to decreased groundwater recharge and exacerbated stress on this critical resource (Shilenje & Rehmani, 2014). Water access challenges will likely increase in the direr parts of the country (Osman & Ali, 2021).

Climate change will exacerbate the existing water and sanitation challenges in Sudan. Two-thirds of households currently do not have access to proper sanitation, and 32 per cent do not have access to improved drinking water (UNICEF, n.d.). Poor WASH services are responsible for over 11 per cent of child mortality in the country (UNICEF, n.d.). There are also significant inequalities in access to water and sanitation services in Sudan (Cha *et al.*, 2021). Climate change will reinforce these WASH inequalities by reducing available water supplies and increasing contamination rates (*ibid*).

Infrastructure and electricity

Water and sanitation systems will need to account for potential seasonal ups and downs in water availability in riverbeds, because climate change is likely to alter the timing and distribution of rainfall. In some years this could increase the availability of water, while in others this could result in prolonged dry spells. Water harvesting is a concrete climate change adaptation strategy that has been promoted in Sudan along with tapping groundwater (Siddig *et al.* 2020). At least half of Sudan's power supply is derived from hydropower, which can be affected by increased evaporation and changes in water availability with climate change (USAID, 2016).

Climate change will increase heat stress in Sudan, especially in the built environment. Studies project that appropriate building design combined with active air-conditioning is going to be critical in many buildings in Khartoum to manage heat stress by the end of the century (Osman & Sevinc, 2019). Traditional Sudanese architecture includes many strategies to manage heat stress in buildings, including roofs that shade themselves, natural ventilation and mixed open and closed areas. Additional cooling strategies include the shading of windows during the hottest parts of the day, dehumidification and air-conditioning. Because much of Sudan is very dry, innovative techniques for cooling buildings, such as two-stage evaporative cooling and solar chimneys, can be low-cost and effective. Covering roofs with reflective paint or material can also reduce the heating of buildings from the sun (Osman & Sevinc, 2019).

2.4 Enable climate-resilient livelihoods and economic security

Agriculture (crop and livestock farming) is the main economic activity in Sudan, employing about 75 per cent of the labour force (Osman *et al.,* 2021; Siddig *et al.*, 2020). Rising temperatures along with more frequent and intense floods and droughts are putting the livelihoods of the many people who depend on the sector at increasing risk (Fong *et al.*, 202).

Frequent droughts are projected to rise due to climate change and are common in north and western Sudan, Kassala State and some parts of the rainfed central regions (Osman & Ali, 2021). Recurrent droughts and the resulting desertification have considerable effects on agricultural productivity in Sudan, particularly in terms of reducing the water available for agricultural production (Saad *et al.*, 2018). An increase in temperature will also increase evaporation, so that the total amount of available water for irrigated agriculture could decrease (Ahmed, 2020). Drought-related water shortages also increase livestock mortality (USAID, 2016). In this context, desertification is considered Sudan's greatest environmental problem, which will continuously affect agricultural production systems and lead to growing food insecurity (Saad *et al.*, 2018). Similarly, increasing night and day temperatures will reduce yields of major and staple crops, such as wheat, millet and sorghum in the country (Iizumi *et al.*, 2021; Musa *et al.*, 2021; Osman *et al.*, 2021; USAID, 2016).

Ways to improve agricultural productivity include maintenance of irrigation canals and pumps, improved farm machinery, credit, high-yield crop varieties, drought-resistant crop varieties, and weed/pest control. However, any changes to rainfall are only one part of a complex food system, and the evolution of agriculture in Sudan will also be strongly influenced by global geopolitics, including terms of trade and exchange rates. Several scholars have anticipated an increase in potential conflicts over access to water (Siddig *et al.* 2020).

Floods are frequent in areas within the Nile basin and low areas in the extreme south and far north (Osman & Ali, 2021). Flooding not only results in the loss of crops and livestock but also increases the incidence and prevalence of pests, parasites and diseases, most notably Rift Valley fever (Osman & Ali, 2021). Rift Valley fever affects both human health and livestock mortality. In addition, flooding, heavy rains and waterlogging of mud-type soils contributes to breeding grounds for mosquitoes which also transmit Rift Valley fever (Bashir & Hassan, 2019).

Measures that are currently promoted to cope with uncertain water supply in Sudan are characterized in the table, below, by Fadul *et al.* 2019.

Stakeholder	Before flood measures	During flood measures	After flood measures
Farmers	Land preparation before flood, use of shrubs and weeds, pre-tillage practice, make small earth bunds	Use of shrubs and weeds, digging small ditches to distribute waterflow, use lebsha to reduce velocity, use sandbags to close breaches	Sharecropping, cultivate vegetables, increase seeding rate for fodder production, double tillage, wetting seeds, reduction of cultivated area, change crop variety, social system of sharing benefits, delay cropping date, change crop, do not cultivate
Water User Associations (WUAs)	Mesquite clearance, land leasing, pumping groundwater, fixed land system, realignment of field canal	Laying shrubs downstream, field inlets, floodwater spreading at fields, monitoring breaching events, embankment heightening, manage irrigation period between WUAs	Lottery system for field allocation, change field-spur location if needed
Water managers	Embankments heightening, share some of maintenance activities with WUAs, flexible irrigation plan	Flexibility in water allocation period, close monitoring of flooded areas, manual control of intake diversion, delay of maintenance of inaccessible areas	Water pricing based on actual irrigated area at a fixed rate per irrigation unit (*Feddan*)

2.5 Address climate displacement and protection

Current and future displacement challenges

Sudan had 3.6 million internally displaced people (IDPs) at the end of 2022 (IDMC, 2023), and the highest number of IDPs in the world in 2023 (IDMC, 2024), plus 1.1 million refugees, mainly from South Sudan, Eritrea and Ethiopia (UNHCR, 2022). There was a sharp rise (approximately 1 million people) in IDPs in 2021, with more than 80 per cent in Darfur due to increasing violence mainly stemming from intercommunal disputes over land, grazing routes and other resources (IDCM, 2022). In 2020, extreme rainfall triggered flooding and landslides in Sudan which killed 150 people, including IDPs and refugees (UNHCR, 2021), and affected a total of 875,000 people, destroyed 111,000 homes and damaged crops (ReliefWeb, 2020).

Climate-induced displacement and changing migration patterns based on resource un/availability may increase the likelihood of local conflicts in some areas of Sudan (CGIAR, 2023). In one study, net migration was positively associated with the risk of violence in Sudan (McMahon *et al.*, 2021). However, there is no direct causal link between climate change and conflict in East Africa (*ibid*; Owain & Maslin, 2018). As more rural–urban migration occurs in Sudan due to limited agricultural livelihoods and other pressures in rural areas, there is likely to be a rise in urban violence. Correlations between rising temperatures and violence (Maystadt *et al.*, 2015) are stronger in urban areas of Sudan than in rural ones, and extreme weather events are associated with an increase in organized violence (McMahon *et al.*, 2021).

The heavy reliance of 65 per cent of Sudan's population on agriculture (FAO, 2022) increases the likelihood of migration and displacement due to both lost livelihoods and food insecurity. Poor or failed agricultural production will cause food shortages that increase people's likelihood to migrate to cities, as has occurred previously in Sudan (Nimir & Elgizouli, n.d.).

Potential needs of migrants and displaced people

Displaced people and refugees in Sudan are highly at risk when it comes to the effects of climate change due to a lack of adaptive capacity, assets and resources. In 2020 and 2021, for example, Ethiopian refugees in Sudan faced a number of extreme events, including heavy rains, severe flooding and heatwaves. Over 50 per cent lost their shelter and belongings due to these events, and an ongoing outbreak of hepatitis E started due to lack of proper hygiene and sanitation facilities (Ahmed *et al.* 2021).

Protection

Best practices for working on climate change adaptation in Sudan include structures for conflict resolution and attention to inequalities and exclusions in access to, and control of, water resources. An excerpt from a study on adaptation in Sudan recommends:

1. "Integrating climate change adaptation with wider development and peace-building processes. Technical approaches to environmental security, managed without appreciation of social and political tensions and recognition of the complexity of conflict areas, risk failure, irrelevance or doing harm. This is not least because climate adaptation measures (e.g. migration, expansion of agriculture) employed by, or for one, social group can negatively impact on others.
2. Taking a three-pronged approach to building climate-resilience in conflict areas: (i) facilitating conflict resolution; (ii) managing environmental conditions; and (iii) tackling vulnerability and exclusion." (Bronkhorst, 2011).

Around the world, people in detention frequently have heightened vulnerability to natural disasters due to spatial marginalization resulting from prison locations on hazard-prone land and/or isolation from emergency evacuation services; limited to no connections to social networks, which are crucial aspects to hazard resilience; and political marginalization, including lack of policies and services to prevent disaster impacts on imprisoned populations (Gaillard & Navizet, 2012). These vulnerabilities, coupled with more frequent and intense disasters due to climate change, may leave prison populations in especially precarious positions to hazards such as extreme heat and floods.

2.6 Policy

Relevant information from the Nationally Determined Contribution (NDC) (2021)

Emission target: Sudan sectoral targets on energy, forestry and waste.
Area of focus on adaptation: Food security, agriculture and water as well as coastal areas and health.
Inclusion of DRR: Yes, concrete measures proposed focusing on preparedness, introducing an early warning system and forecasting, but also community health and nature-based solutions.
Next review of the NDC: n/a
National designated entity: Ministry of Environment, Natural Resources and Physical Development of Sudan
Key stakeholders: High Council for Environment & Natural Resources; Council of Ministers; Green Climate Fund (GCF) Preparedness project implemented by the United Nations Development Programme (UNDP); Sudan Meteorological Authority; United Nations Environment Programme (UNEP); REDD+ strategy under validation.

Relevant information from the National Adaptation Plan (NAP) (2018)

Area of focus on adaptation: Agriculture, water, health.

Inclusion of DRR: Yes

Next review of the NAP: n/a

Key stakeholders: Sudan Meteorological Authority; University of Khartoum; Director of Water Harvesting Research Institute; Agriculture Research Corporation; Ministry of Water and Environmental Resources; Ministry of Agriculture; Ministry of Health.

Selected ongoing projects

- Two GCF projects are currently focusing on Sudan 'Gums for Adaptation and Mitigation in Sudan (GAMS): Enhancing adaptive capacity of local communities and restoring carbon sink potential of the Gum Arabic belt, expanding Africa's Great Green Wall – implemented by FAO; and 'Building resilience in the face of climate change within traditional rain fed agricultural and pastoral systems in Sudan' – implemented by UNDP.
- Sudan Sustainable Natural Resources Management Project (World Bank, 2022).
- Environment in Humanitarian Action, including Disaster Waste Management (UNEP, 2022)

Climate finance

National societies cannot apply directly for climate finance from the GCF, but they can be an implementing partner for an accredited entity (Climate Centre, 2022a).

National Societies can explore options for accessing climate funds through smaller funds, such as the GEF's Small Grants Programme or the FFEM's Small Scale Initiatives Program. Other funding from bilateral donors, national climate funds, or multilateral climate funds like the Adaptation Fund, CREWS, or GCCA+ could be explored (Climate Centre, 2022a).

Engaging in national climate adaptation planning is vital for accessing climate finance.

Additional resources

Climate Centre. (2022a). *Factsheet on climate finance.* Red Cross Red Crescent Climate Centre. https://www.climatecentre.org/wp-content/uploads/Fact-Sheet-on-Climate-Finance.pdf

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