

Chad



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General Climate¹

Chad is located in central northern Africa at 7-23° north of the equator, straddling the sub-tropical climate band called the Sahel. The north of Chad extends well into the arid Sahara, with 63 percent of the country classed as desert (CCNUCC, 2001). In contrast, the south has a much wetter, and typically tropical, climate.

The northern, desert regions of Chad receive very little rainfall all year round. The southern, tropical savannah regions of Chad experience a wet season between May and October (receiving 150-300mm per month), whilst the central sub-tropical regions have a shorter wet season between June and September (receiving 50-150 mm per month). In the dry months between November and March, almost no rain falls at all. These seasonal rainfalls are controlled by the movement of the tropical rain belt (also known as the Inter-Tropical Convergence Zone, or ITCZ), which migrates between the northern and southern tropics over the course of a year.

¹ McSweeney, C. *et al.* (2008) unless otherwise stated

Variations in the north-south movements of the ITCZ from one year to another cause large inter-annual and decadal variability in wet season rainfall.

Annually, mean temperatures are similar across most of the country at 25-30°C, and only differ substantially in the cooler mountainous regions of the north at 15-25°C. However, seasonal variations are large, and differ in their patterns for different parts of the country. In the north and central regions, summer and winter temperatures are distinct at 27- 35°C in summer and 20-27°C in winter (these temperatures are 5-10°C lower, year-round, in the northernmost mountainous regions). In the south, less seasonal variation is evident, but the summer months (July-August-September, or JAS) are the coolest (22-25°C) due to the cooling effects of rain at this time of year.

Key climate vulnerabilities: Flooding; drought; food security; infectious disease epidemics; desertification; locust infestations

Observed Climate Changes²

Temperature

- Mean annual temperature has increased by 0.7°C since 1960, an average rate of 0.16°C per decade.
- The rate of increase is most rapid in the wettest season, JAS, at 0.36°C per decade, but there is no evidence of a warming trend in the driest season, January-February-March ('JFM').
- There is insufficient daily observed data to identify trends in daily temperature extremes for most seasons, but hot nights are observed to increase by 11 days per year per decade.
- Cold nights are observed to decrease in all seasons where data are available, by 1 day fewer per month per decade.

Precipitation

- Mean annual rainfall over Chad has not changed with any distinct trend since 1960. Some unusually high rainfalls have occurred in the dry season in the very recent years (2000- 2006), but this has not been a consistent trend.
- There is not sufficient daily precipitation data available to determine trends in the daily variability of rainfall.

Current Climate Vulnerability

Table 1 below shows the natural hazards that have occurred in Chad over the past 20 years. Chad's key vulnerabilities from the climate are related to water. Chad suffers from both shortages of water resources and from flooding. Drought is possibly the largest threat to Chad, where access to clean water is poor and many rely on rain-fed agriculture for food and income. With substantial surface and groundwater resources, particularly in the south, Chad does in fact have sufficient renewable water resources for its needs. However, these resources are distributed unevenly across the country, and are highly variable and vulnerable (ADF, 2006).

As of 2006, only 34 percent of the rural population had access to drinking water, and less than 10 percent had access to modern latrines (ibid). Lack of clean water and suitable sanitation is the main cause of health problems in Chad, reducing life expectancy and reducing productivity. The most common diseases in children under five, for example, are malaria, diarrhea, measles, whooping cough, and cholera (ibid). In 2000, Chad had the ninth highest mortality rate from malaria, with 207 deaths per 100,000 people (Globalis, undated). Outbreaks of Cholera, diarrhea and Hepatitis E commonly occur as a result of flooding and the lack of suitable sanitation. Flooding is an almost annual occurrence during Chad's rainy season, with major floods being recorded in Chad in 2001, 2004, 2005 and 2007 in the 21st century (BBC, 2005).

Food security is heavily affected by rainfall variability, regular droughts and locust infestations. Chad has suffered from poor harvests in recent growing seasons (2006/07 and 2007/08); the result is reduced incomes at a time when food shortages cause food prices to increase substantially. The price of a kilogram of sorghum in Goz Beida in June 2008 was 60 percent higher than at the same time in 2007, four percent higher than

² McSweeney, C. *et al.* (2008) unless otherwise stated

June prices in the midst of the 2004/05 crisis, and 54 percent above the five-year average (ReliefWeb, 2008). Swarms of desert locusts can follow periods of rain when there is sufficient vegetation for newly-hatched locusts to feed. Locusts will eat virtually any crops and vegetation, and swarms can consume many thousands of tonnes of vegetation every day (Haskell, 1992).

Heavy rainfall events cause damage to homes and other buildings; in August 2009, many homes in the capital, N'djamena, were damaged after 100mm of rain fell in just a few hours (IRIN, 2009). Despite the installation of guttering on houses, and a pump station, many houses were inundated with water, leading to the Prime Minister to declare that these recent improvements were not sufficient (ibid).

Hazard	Number of Events	Deaths	Total of Population Affected
Drought	4	-	3,456,000
<i>Average per event</i>		-	864,000
Epidemic (bacterial)	9	3,071	32,715
<i>Average per event</i>		341	3,635
Epidemic (viral)	4	260	9,298
<i>Average per event</i>		65	2,324
Flood (unspecified)	2	2	81,831
<i>Average per event</i>		1	40,843
Flood (flash)	2	100	349,269
<i>Average per event</i>		50	174,635
Flood (general)	8	112	200,379
<i>Average per event</i>		27	25,047
Storm	1	14	145
<i>Average per event</i>		14	145
Locust Infestation	1	-	-
<i>Average per event</i>		-	-

Table 1 – Natural Hazards in Chad (1991-2010) (CRED, 2010)

Climate Change Projections³

Temperature

- The mean annual temperature is projected to increase by 1.9 to 2.8°C by the 2060s, and 2.4 to 4.8°C by the 2090s. Maximum increases in mean temperature are projected to be 3.4°C and 5.4°C for the 2060s and 2090s respectively.
- The projected rate of warming is similar in all seasons and regions of Chad (see Figure 1).
- All projections indicate substantial increases in the frequency of days and nights that are considered 'hot'⁴ in current climate. Annually, projections indicate that 'hot' days are projected to occur on up to 36 percent of days by the 2060s, and up to 54 percent of days by the 2090s. Days considered 'hot' by current climate standards for their season are projected to increase most rapidly in the JAS wet season, occurring on up to 84 percent of days of the season by the 2090s (see Figure 2).
- Nights that are considered 'hot' are projected to occur on up to half of all nights by the 2060s and up to 63 percent of nights by the 2090s. This increase is most rapid in the JAS season, occurring on up to 95 percent of nights in that season by the 2090s.
- All projections indicate decreases in the frequency of days and nights that are considered 'cold'⁵ in current climate, and in much of the country, do not occur at all by the 2090s.

³ McSweeney, C. *et al.* (2008) unless otherwise stated

⁴ 'Hot' day or 'hot' night is defined by the temperature exceeded on 10% of days or nights in current climate of that region and season.

⁵ 'Cold' days or 'cold' nights are defined as the temperature below which 10% of days or nights are recorded in current climate of that region or season.

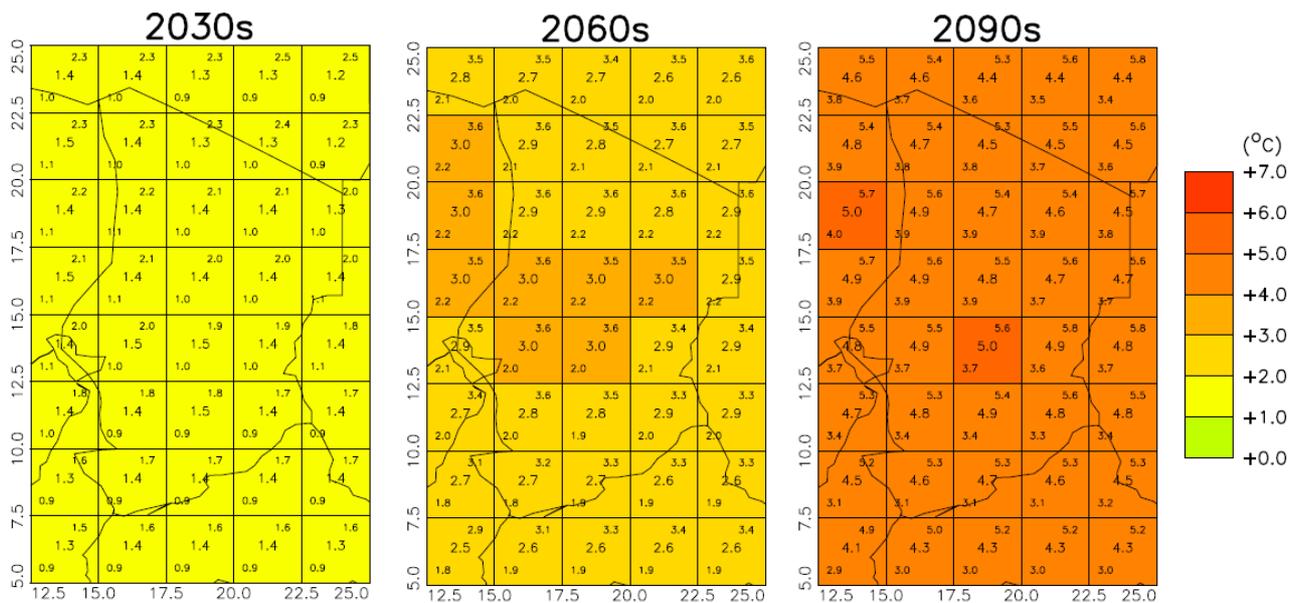


Figure 1 – Projections of mean annual temperature for Chad for the 2030s, 2060s and 2090s (the central value in each grid box gives the central estimate of the model projections, and the values in the upper and lower corners give the maximum and minimum) (McSweeney *et al.*, 2008). See 'A note on the projections' at the end of this document for more information on these maps.

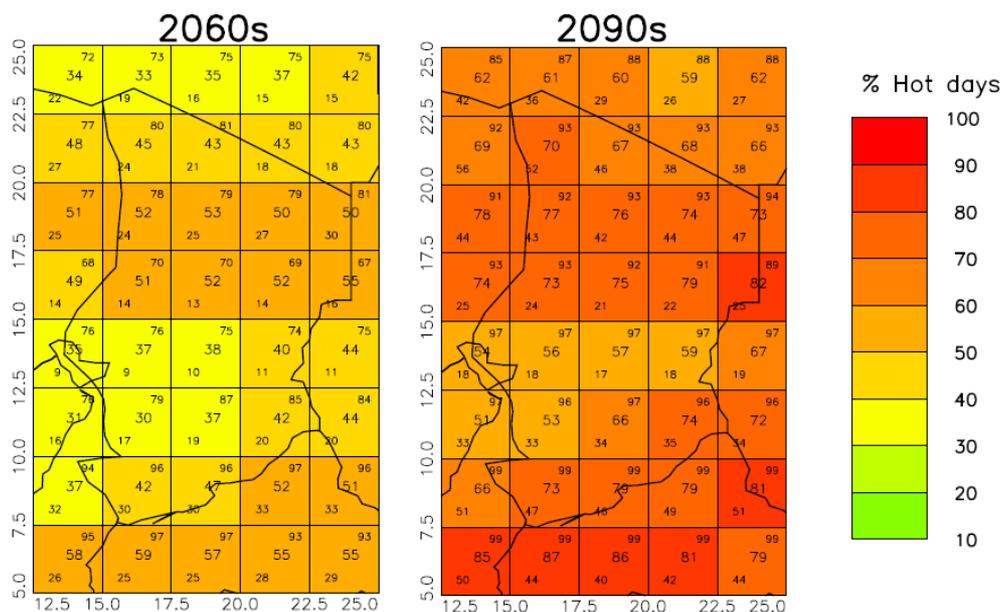


Figure 2 – Projections of percentage changes in frequency of 'hot' days in the JAS season for Chad for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

Precipitation

- Projections of mean rainfall indicate only small changes for the year as a whole, but larger seasonal changes. The projections indicate small decreases during JFM and AMJ rainfall, balanced by increases in JAS and October-November-December ('OND') rainfall.
- The increases in JAS are the most substantial of any season, with projections showing an additional 3 to 6mm of rainfall per month in that season by the 2090s, up to a maximum of 27mm. Increases are most prominent in the south of the country (see Figure 3).
- Whilst the range of projections across different climate models is large, the regional changes in rainfall more consistently indicate rainfall increases in JAS in the south of the country.

- The proportion of total rainfall that falls in heavy⁶ events is projected to increase in the south of the country, but to decrease in the north (see Figure 4).
- Projections indicate that maximum 1- and 5-day rainfalls may increase in magnitude in the south of the country.

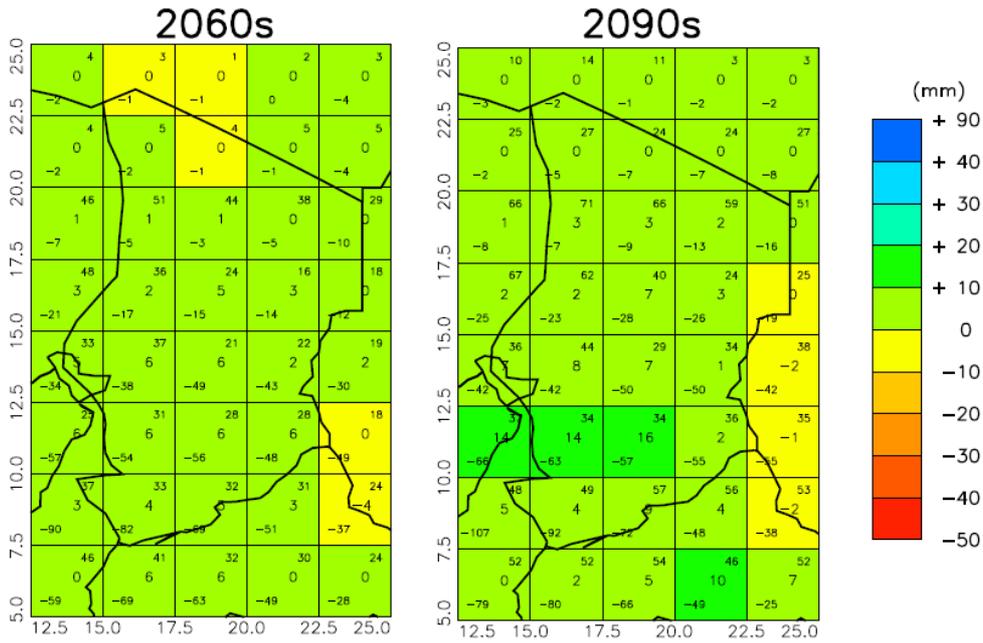


Figure 3 - Projections of percentage changes in JAS rainfall for Chad for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

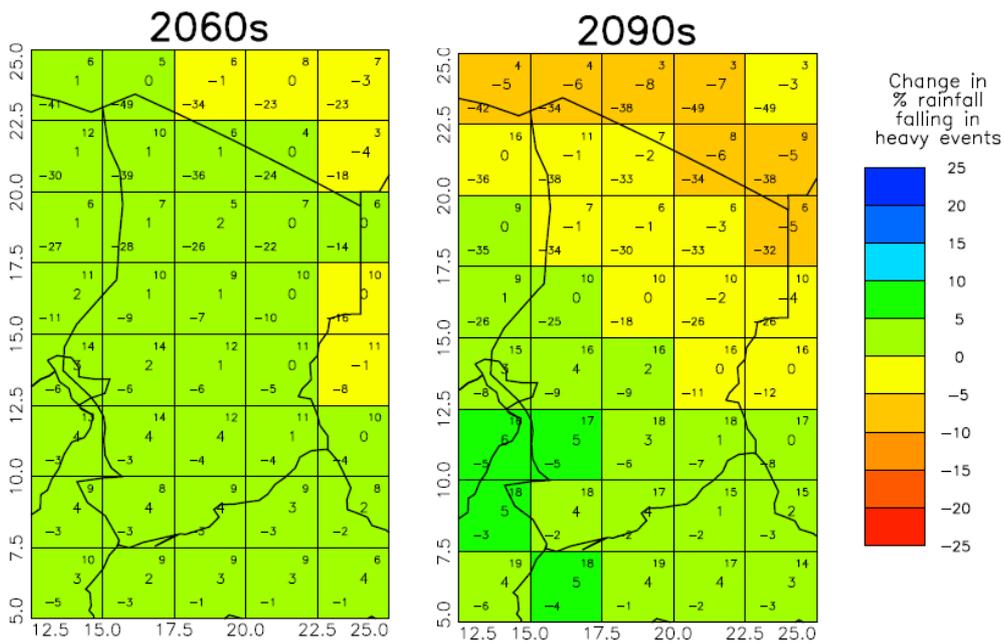


Figure 4 - Projections of percentage changes in the amount of annual rainfall falling in 'heavy' events for Chad for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

⁶ A 'Heavy' event is defined as a daily rainfall total which exceeds the threshold of the top 5% of rainy days in current the climate of that region and season.

Climate Change Impacts

Flooding

The projected increase in short-term heavy rainfall events for the south will increase the risk of flooding in the wet season. This will have knock-on effects across the country, increasing exposure to infectious diseases, and causing an increase in morbidity and mortality. Greater flood risk puts homes and agriculture at higher risk of damage, with consequences for food security and the economy.

Water Resources

The Intergovernmental Panel on Climate Change (IPCC) reported in 2001 that the total available water in Africa's large catchment basins of Niger, Lake Chad and Senegal, had already decreased by 40-60 percent (McCarthy *et al.*, 2001). Chad's water resources rely heavily on surface sources such as Lake Chad, and decreasing availability of water will put further pressure on these resources. A combination of reduced rainfall and damming of feed-in rivers has resulted in a 90 percent reduction in size of Lake Chad (from 25,000 km² to less than 1500 km²) over the past forty years, and is at risk from drying up completely within 20 years (UN, 2009; BBC, 2007).

With the onset of climate change, water-stressed areas will find it increasingly difficult to find sufficient water. For Chad, and its neighbouring countries, this is a very real problem. Access to water is likely to be one of the main causes of conflict and migration resulting from climate changes. Chad has borders with six countries, and as such could be at risk from an influx of people seeking water.

Agriculture & Food Security

The impact on agriculture and food security is inextricably linked to water supply and flood risk, particularly in the southern part of the country. Over 80 percent of Chadians rely on subsistence farming and raising livestock for a living, and so will be at particular risk from changes in rainfall patterns (CIA, 2007). Key crops include sorghum and millet, which grow most successfully in the southern, more fertile area of Chad. One of the chief agricultural exports is cotton, with around 400,000 farmers producing the crop. Cotton is a water and fertiliser-intensive crop and as a result, harvests and exports vary considerably with rainfall (e.g. 282,000 tons in 1997/1998 and 161,000 tons in 1998/1999) (CCNUCC, 2001). Crop yields may increase under small increases in temperatures, but are likely to decrease under large changes in temperature. Fish catch from Lake Chad is also an important source of food and revenue, yet size of catch has been decreasing with the size of the lake. In the past forty years the daily fish catch in Lake Chad has diminished from around 230,000 tonnes to barely 50,000 tonnes (BBC, 2007).

Public Health

Incidence of infectious disease is likely to increase in Chad under the impact of climate change. With increases of flood events, exposure to diseases such as cholera, typhoid and Hepatitis E will increase, putting more people in danger at a time when access for aid and medical supplies is compromised. Rising temperatures will also increase the habitat of mosquitoes, thus increasing the population at risk from malaria.

Housing & Communities

The more erratic rainfall patterns brought about by climate change will increase the frequency of the flood events that damage houses and communities periodically in Chad. The projections show that such events will worsen in the south of the country.

Chad has seen many thousands of refugees migrate over to Chad to escape war and drought in Sudan. With increased pressure on resources across the semi-arid belt across Africa, migration caused by climate change is likely to affect much of Africa. Chad could experience an influx of migrants, as seen from Sudan, or an exodus of people in search of water, food and shelter in the event of future climate disasters.

Biodiversity & Conservation

Decreased soil moisture from lower rainfall and higher temperatures will put the drier areas of Chad at an increased risk of soil erosion and desertification, including the continuing encroachment of the Sahara desert.

Livelihoods

The Chadian economy has experienced substantial growth since the country began to export oil. In 2004, for example, a combination of foreign direct investment and exports via the Chad-Cameroon pipeline was

largely responsible for a 30 percent increase in GDP (EIA, 2007). Chad's GDP has continued to grow on the back on increasing oil prices. While additional investment in Chad's oil production is expected in coming years, its contribution to Chad's economy may be hindered by both further civil unrest, and climate change. The latter will affect the industry through increased risk of damage to oil infrastructure from flooding. While agricultural exports will also be strongly affected by changing rainfall patterns.

Energy

Chad became a net exporter of oil after the Chad-Cameroon pipeline came online in 2003; however, as Chad lacks the capacity for refining oil, it imports 100 all of its petroleum product requirement from Cameroon and Nigeria (EIA, 2007). Thus delivery interruptions can leave the country short of petroleum.

Work has started on a new 185-mile Chinese-funded pipeline to take oil from the Koudalwa oilfields in the south to a new refinery to the north of N'djamena (BBC, 2009). There is concern that that this project, like the World Bank-funded Chad-Cameroon pipeline, will displace dozens of villages and hundreds of people (Schwartz & Nodem, 2009).

The increased risk of flooding from climate change will put the oil infrastructure, and delivery networks, at increasing risk of damage. This has the risk of interrupting delivery of imports and exports. Only 2 percent of the country has access to electricity, the majority of the population rely on biomass such as wood and animal dung for fuel (ibid).

Transport

The majority of Chad is not connected by paved roads, thus flooding seriously impedes attempts to bring aid and medical attention to those in need.

Government Response

The Ministry of the Environment and Water was responsible for the signing of the UN Framework Convention on Climate change. It was signed on 7th June 1992, and ratified on 30th April 1993. Chad presented its initial national communication in Morocco in November 2001. Arrangements are in place for the second communication. However, Chad has not yet completed a National Adaptation Programmes of Action (NAPA) for assessing options for climate change adaptation.

Action on climate change is restricted by the pressing needs already affecting the country's population. Civil unrest and rebel attacks have continued to upset Chad's progress and development. As the 8th poorest nation in the world (UNDP, 2008), Chad is not well placed to invest in climate change adaptation, despite being at high risk from its impacts. With increased revenues from oil exports there is potential for investment to address many of Chad's needs, conditions of World Bank loan programme require the government to spend at least 70 percent (previously 80 percent) of oil revenues on development. However, it is essential that climate change adaptation is mainstreamed in any such programmes, to ensure maximum benefit is realised and that efforts are not wasted.

Desertification is a major challenge; the government, with the assistance of the World Bank and UNDP has developed a National Environmental Action Plan (NEAP) which defines the broad principles for management of fragile ecosystems. Implementation of these plans needs strengthening through additional resources and institutional arrangements. The government has also signed a 'National Action Program for the Fight against Desertification' (NAP-FAD), but its implementation has been delayed by a lack of resources. The World Bank, through the Global Environment Facility has been funding some programmes in this area, including a 'Community-based ecosystem management project'.

Likely Adaptation Options

Many of the issues affecting Chad are chronic without the addition of climate change. Therefore, it is essential that where projects are put in place to improve access to water, prevent loss from flooding, improve public health or build infrastructure, that climate change forms an integral part of any project. Most importantly, access to clean water is required in much of the population (particularly in rural areas). Chad has considerable groundwater resources that could be made use of, while surface storage is also important in a future where rainfall will become more unpredictable.

Water availability is also critical for agriculture, which will be adversely affected by changing rainfall patterns. Farmers in Chad may no longer be able to rely on rainfall alone for their crops and so irrigation may be required to prevent crop failures. Irrigation using re-used water should be encouraged, in addition to efficient techniques such as drip or bubble irrigation. Irrigation will require sufficient storage of water,

which has a cost implication, but can be made more cost-effective where many farmers in a catchment can work together. Other options for agriculture and food security include careful conservation of soils and switching to more drought-resistant crops.

The increased risk from infectious diseases requires a combination of education in hygiene routines, and investment in modern latrines. Such programmes will become more pressing as climate change puts water resources under more strain, and an increasing population at risk from flooding.

Useful Websites

- UNDP Climate Change Country Profiles: <http://country-profiles.geog.ox.ac.uk/>
- UNFCCC NAPAs from Non-Annex I Countries: http://unfccc.int/national_reports/napa/items/2719.php
- UNFCCC First Communications on Climate Change for Non-Annex I Countries: http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php
- Adaptation Learning Mechanism: <http://www.adaptationlearning.net/>
- IPCC Reports: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm

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A note on the projections...

The climate change projections used in this profile were developed as part of a UNDP project, carried out by McSweeney *et al.* (2008), to produce a series of climate change projections for individual developing countries. The study uses a collection, or 'ensemble', of 15 General Circulation Model (GCM) runs to produce projections of climate change for three of the SRES emissions scenarios (see Nakićenović & Swart

(2000) for more details on emission scenarios). The three emissions scenarios used in the study were 'A2', 'A1B' and 'B1', which can be broadly described as 'High', 'Medium' and 'Low' respectively (McSweeney *et al.*, 2010).

The figures quoted here refer to the 'central estimates' (i.e. the median results) from the 15 GCMs across the 3 emissions scenarios. Where maximum figures are also quoted, they refer to the 'High' (A2) scenario model results. The maps shown are for just the 'High' scenario. Both figures and maps are described for two future 'timeslices' – i.e. decadal averages for the 2060s and 2090s.

For a more detailed description of the UNDP Climate Change Country Profiles, please see McSweeney *et al.* (2010). Complete projections (with maps, plots, supporting text and data files) for all 52 countries are available to download via the website at <http://country-profiles.geog.ox.ac.uk/>.

Note: This profile is designed to give a brief, non-technical overview of the current and future climatic conditions of Chad. The key climate impacts are summarised by sector; however, this should not be taken as an exhaustive list, and the corresponding list of adaptation options are as a guide of likely or possible strategies.



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