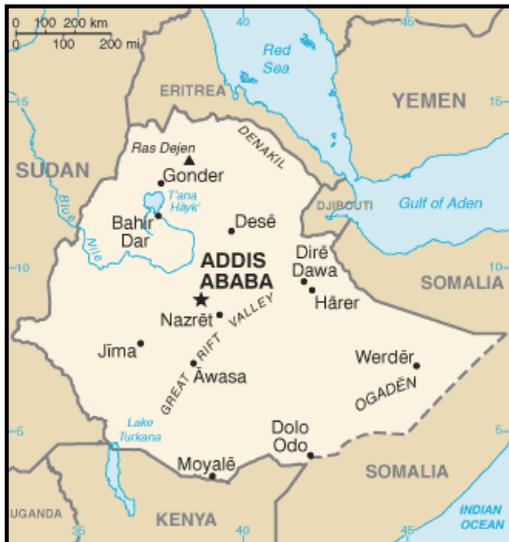




Ethiopia



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General Climate¹

Ethiopia makes up the greater part of the East African 'Horn of Africa'. At latitudes of 4 to 15°N, Ethiopia's climate is typically tropical in the south-eastern and north-eastern lowland regions, but much cooler in the large central highland regions of the country. Mean annual temperatures are around 15-20°C in these high altitude regions, whilst 25-30°C in the lowlands.

Seasonal rainfall in Ethiopia is driven mainly by the migration of the tropical rain belt, the Inter-Tropical Convergence Zone (ITCZ). The exact position of the ITCZ changes over the course of the year, migrating across the equator from its northern most position over northern Ethiopia in July and August, to its southern most position over southern Kenya in January and February. Most of Ethiopia experiences one main wet season, of up to 350mm per month in the wettest regions, when the ITCZ is at its northernmost position. This season (known also as the 'Kiremt' rains or the 'Meher' rains) occurs from mid-June, through July and August, to mid-September. Parts of northern and central Ethiopia also have a secondary wet season of sporadic, and considerably lesser, rainfall from February, through to May (called the 'Belg'). The southern regions of Ethiopia

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

experience two distinct wet seasons which occur as the ITCZ passes through this more southern position. The March to May 'Belg' season is the main rainfall season yielding 100-200mm per month, followed by a lesser rainfall season (around 100mm per month) in October to December called 'Bega'. The eastern most corner of Ethiopia receives very little rainfall at any time of year.

The movements of the ITCZ are sensitive to variations in Indian Ocean sea surface temperatures and vary from year to year, hence the onset and duration of the rainfall seasons vary considerably interannually, causing frequent drought. The most well documented cause of this variability is the El Niño Southern Oscillation (ENSO). Warm phases of ENSO (El Niño) have been associated with reduced rainfall in the main wet season in north and central Ethiopia, causing severe drought and famine, but also with enhanced rainfalls in the earlier February to April rainfall season which mainly affects southern Ethiopia.

Key climate vulnerabilities: Drought; food security; flooding; infectious disease epidemics; terrestrial ecosystem, wildlife and biodiversity

Observed Climate Changes²

Temperature

- Mean annual temperature has increased by 1.3°C between 1960 and 2006, an average rate of 0.28°C per decade. The increase in temperature in Ethiopia has been most rapid in across July, August and September ('JAS') at a rate of 0.32°C per decade.
- Observations show that over the same period, there has been an increase in the number days and nights in a year that are classed as 'hot'³, increasing by 20 percent and 38 percent respectively. The rate of increase is seen most strongly in June, July and August ('JJA') when the average has increased by 32 percent and 59 percent respectively.
- The frequency of cold⁴ days per year has decreased on average by 6 percent, and a decrease is found in all seasons except December-January-February ('DJF'). The frequency of cold nights per year has decreased more rapidly (by 11 percent), and a decrease is consistent across all seasons.

Precipitation

- The strong interannual and inter-decadal variability in Ethiopia's rainfall makes it difficult to detect long-term trends. There is not a statistically significant trend in observed mean rainfall in any season in Ethiopia between 1960 and 2006. Decreases in JAS rainfall observed in the 1980s have shown recovery in the 1990s and 2000s.
- There are insufficient daily rainfall records available to identify trends in daily rainfall variability.

Current Climate Vulnerability

A World Bank study on Natural Disaster Hotspots reveals that 69 percent of Ethiopians are at risk of mortality from two or more hazards – the highest percent of all countries in the world (Dilley *et al.*, 2005). Ethiopia is most at risk from drought, the natural hazard that affects more of the population than any other (see Table 1), and results in loss of life, crops and animals, as well as migration of people. In 2009, for example, Ethiopia experienced a delay in the main rainy season, particularly in northeastern areas, resulting in only 50-70 percent of agricultural land being sown for cropping (IRIN, 2009). As Ethiopia produces 90-95 percent of its total cereal output during this season, any variability in the rainfall received has substantial implications for crop yield (ibid).

Flooding also has very serious implications for Ethiopia, causing loss of life and property; flooding of the Tekezie River in 2006, for example, killed several hundred and displaced over 10,000 (BBC, 2006). Ethiopia has experienced major floods in 1988, 1993, 1994, 1995, 1996 and 2006 (Tadege, 2007).

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

³ '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.

⁴ '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.

Hazard	Number of Events	Deaths	Total of Population Affected
Drought <i>Average per event</i>	12	402,367 33,531	54,936,200 4,578,017
Earthquake <i>Average per event</i>	7	24 3	585 84
Epidemic (unspecified) <i>Average per event</i>	4	429 107	32,948 8,237
Epidemic (bacterial) <i>Average per event</i>	14	10,968 783	130,728 9,338
Epidemic (viral) <i>Average per event</i>	1	157 157	25,000 25,000
Epidemic (parasitic) <i>Average per event</i>	2	46 23	531 266
Flood (unspecified) <i>Average per event</i>	13	136 11	195,240 15,019
Flood (flash) <i>Average per event</i>	6	735 123	436,278 72,713
Flood (general) <i>Average per event</i>	28	1,086 39	1,637,578 58,485
Landslide <i>Average per event</i>	3	39 13	194 65
Volcanic Eruption <i>Average per event</i>	3	69 23	11,000 3,667
Forest Fire <i>Average per event</i>	1	- -	5 5
Locust Infestation <i>Average per event</i>	4	- -	- -

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

Climate Change Projections⁵

Temperature

- Central estimates of mean annual temperature show increases of between 1.8 and 2.7°C by the 2060s, and of 2.3 to 4.2°C by the 2090s (see Figure 1). Maximum increases in mean temperature are projected to be 3.1°C and 5.1°C for the 2060s and 2090s respectively.
- All projections indicate substantial increases in the frequency of days and nights that are considered 'hot' in current climate.
- Annually, projections indicate that 'hot' days will occur on up to 40 percent of days by the 2060s, and up to 69 percent of days by the 2090s. The most rapid increases are projected for JAS (see Figure 2).
- Nights that are considered 'hot' are projected to increase more quickly than hot days, occurring on up to 66 percent of nights by the 2060s and up to 87 percent of nights by the 2090s. Nights that are considered 'hot' for their season are also projected to increase the most rapidly in JAS.
- All projections indicate decreases in the frequency of days and nights that are considered 'cold' in current climate. Cold nights decrease in frequency more rapidly than cold days, not occurring at all in most model projections by the 2090s under the highest emissions scenario.

⁵ McSweeney, C. *et al.* (2008) unless otherwise stated. All projections are stated with reference to a 1970-99 baseline.

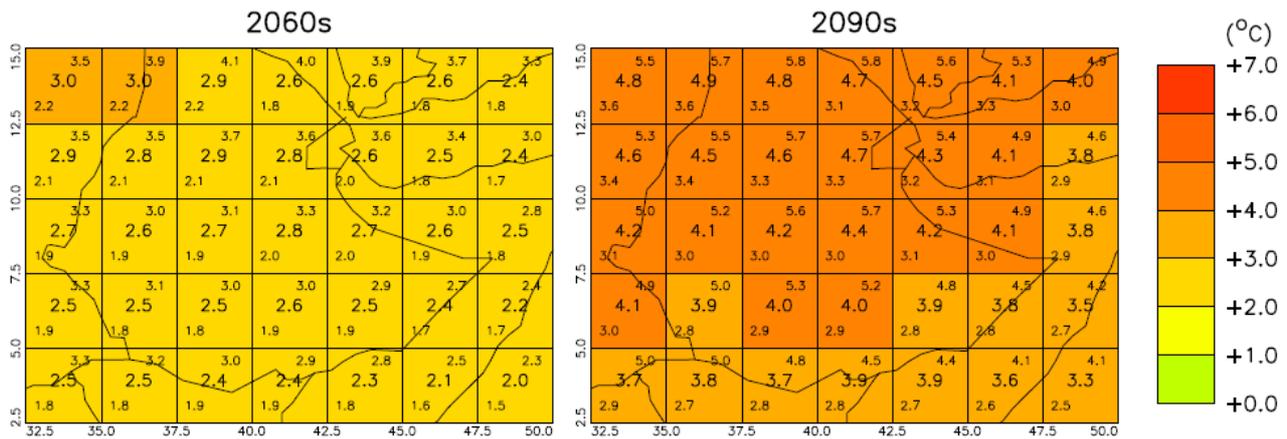


Figure 1 – Projections of mean annual temperature for Ethiopia for the 2060s and 2090s (the central value in each grid box gives the central estimate of the model projections, and the values in the upper and lower corners give the maximum and minimum) (McSweeney *et al.*, 2008). See ‘A note on the projections’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

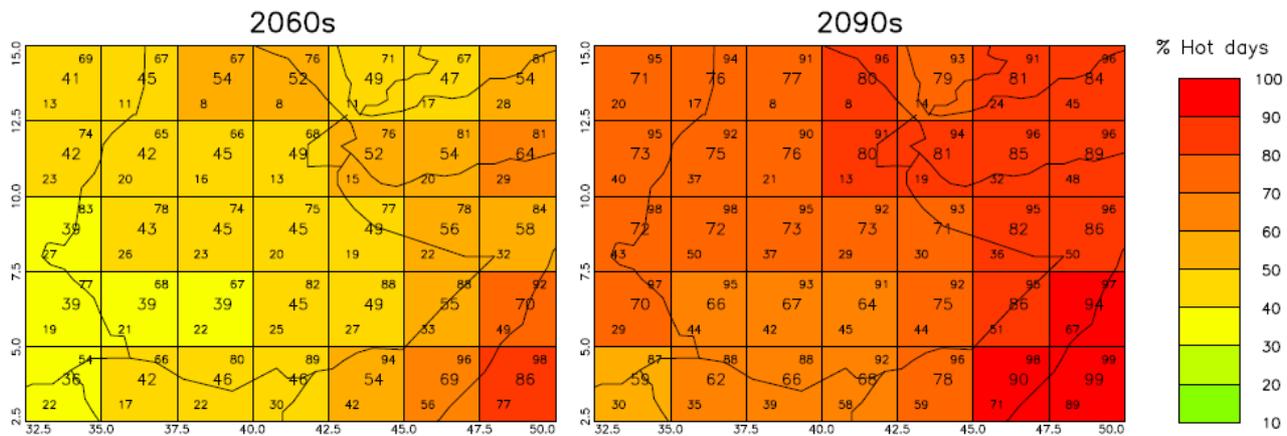


Figure 2 – Projections of percentage changes in frequency of ‘hot’ days in the JAS season for Ethiopia for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

Precipitation

- Projections from different climate models are broadly consistent in indicating increases in annual rainfall in Ethiopia. These increases are largely a result of increasing rainfall in the ‘short’ rainfall season (October-November-December, of ‘OND’) in southern Ethiopia.
- Central estimates of annual changes in precipitation show increases of 3 to 9 percent by the 2090s for Ethiopia as a whole, but the upper end of the projections show this increase could be as much as 42 percent (see Figure 3).
- Central estimates for rainfall in the OND season show increases of 17 to 36 percent by the 2090s, but up to 70 percent at the upper end of the projections. Percentage increases in OND rainfall in the driest, eastern most parts of Ethiopia are large (see Figure 4).
- Projections of change in the rainy seasons AMJ (April-May-June) and JAS, which affect the larger portions of Ethiopia, are more mixed, but tend towards slight increases in the south west and decreases in the north east.
- Projections show an increase in the amount of rain falling in ‘heavy’⁶ events, with annual increases of up to 18 percent by the 2090s. The largest seasonal changes are seen in JAS and OND, with increases of up to 16 and 25 percent respectively (see Figure 5).

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.

- Projections also show increases in the amount of rainfall in the heaviest 1-day and 5-day rainfall events, particularly in the OND season, with increases of up to 29mm and 20mm respectively for the

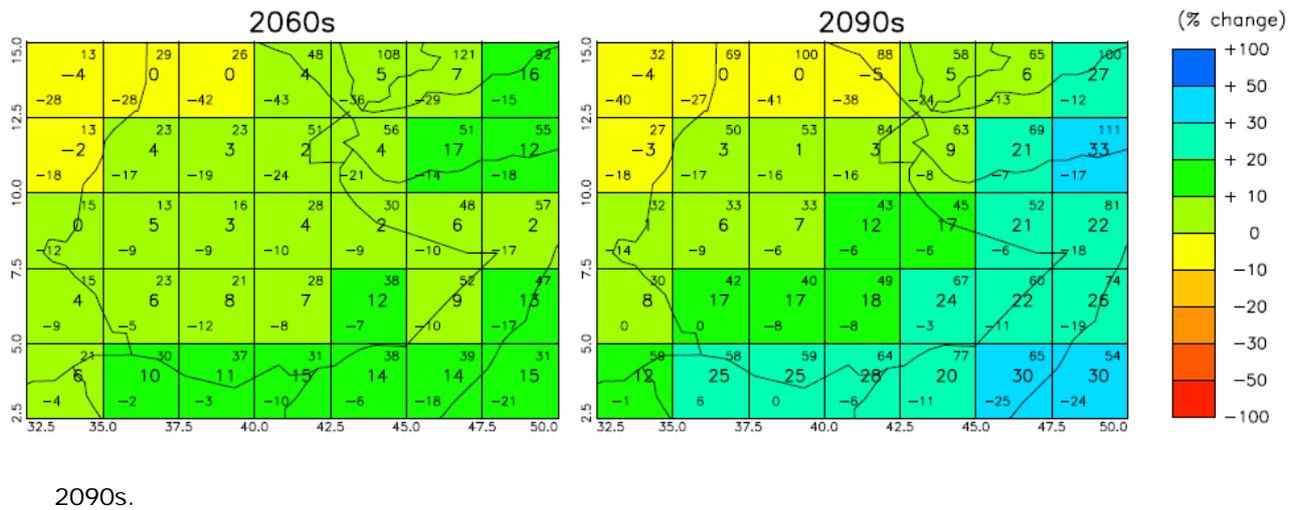


Figure 3 – Projections of percentage changes in annual rainfall for Ethiopia for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

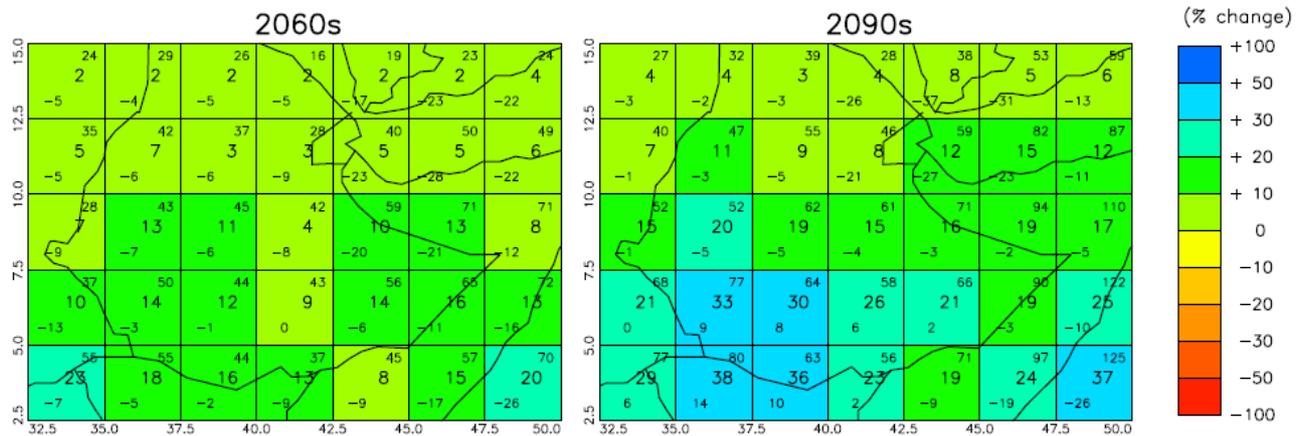


Figure 4 – Projections of percentage changes in OND rainfall for Ethiopia for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

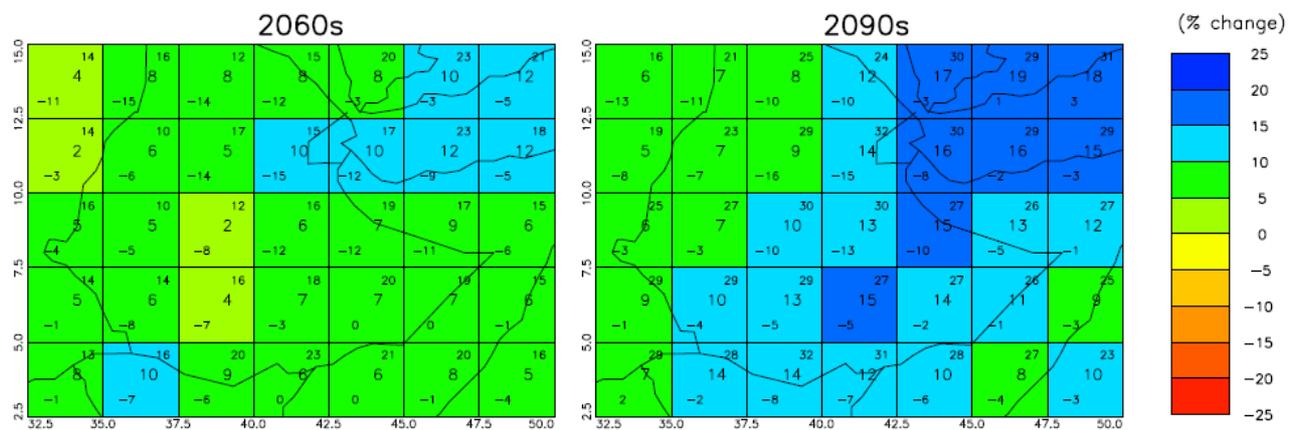


Figure 5 – Projections of percentage changes in the amount of rainfall falling in 'heavy' events during the OND season for Ethiopia for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

Climate Change Impacts

Flooding

Much of Ethiopia suffers from regular seasonal flooding of major rivers such as: (Tadege, 2007).

- The Afar Region along the Awash River;
- The Somali Region along the Wabi Shebele River;
- The Gambela Region along the Baro-Akobo River;
- The Southern Region along the Omo-Gibe River;
- The Bahirdar Zuria and Fogera areas along the Abbay River in the Amhara Region.

Climate change projections show an increasing trend for heavy rainfall events, particularly in the late wet season of OND. Therefore, Ethiopia will be under increasing threat from flooding in the coming decades.

Water Resources

Potentially, Ethiopia has substantial water resources, with 12 drainage basins with a mean annual flow of 111 billion cubic metres (Tadege, 2001), equivalent to 1920 cubic metres of fresh water per year for each Ethiopian (UN Habitat, undated). However, little has been developed for water supply, irrigation or industry. As of 2003, only 34 percent of the population had access to potable water (25 and 85 percent for rural and urban areas respectively), access to adequate sanitation is even more limited (ibid). Climate change will increase the variability in rainfall from year to year, increasing the risk of both drought and flooding. This will be combined with an increased pressure from internal migration towards urban centres, and the associated growth and expansion of those towns and cities. Therefore, where water is does not have a secure supply, in both urban and rural areas, there will be an increased risk of shortages for agriculture and domestic consumption.

Agriculture & Food Security

Ethiopia's agriculture is highly dependent on rain-fed agriculture and is therefore highly vulnerable to climate variability and change. Cropped land for cereals, pulses and oilseeds was estimated in 1994 to cover around 6.9 million hectares; key cereals include teff, maize, barley, wheat and sorghum (Tadege, 2001). Crop yields are therefore very sensitive to temperature and amount of rainfall. The vast majority (94 percent) of food is grown by small-scale farmers, employing traditional farming techniques. Despite large areas of cultivatable land, Ethiopia is a net importer grain and has been since 1981 (ibid).

Livestock is also very important for Ethiopia, which has a total livestock population of around 80 million – the largest in Africa and the tenth largest in the world (Tadege, 2001). Climate change is likely to hinder the quality and quantity of pasture, which in turn will have an impact on livestock productivity, and the distribution and incidence of animal and plant disease. Current climate variability and drought is major challenge for this sector.

The cash crop coffee is also at risk from the impact of climate change. A small black beetle, *Hypothenemus hampei* (or 'Coffee Berry Borer'), causes millions of dollars of damage to coffee producers worldwide – particularly in East Africa. A recent study has shown that rising global temperatures may increase the populations of the beetle, expanding its habitat and putting wider areas of coffee crops in danger (Bosire, 2009).

Public Health

The key risks from climate change for public health in Ethiopia is the increased prevalence of infectious disease. Ethiopia is currently endemic for malaria and dengue fever, with only the highlands areas currently unaffected. However, with increasing temperatures, the habitat for mosquitoes may spread into these highland areas and put more of the population at risk of infection.

Drought and flooding can both be a factor in disease outbreaks, and an increase in the number and severity of flood events will likely also increase the incidence of water-borne disease such as cholera, dysentery and typhoid.

Housing & Communities

With the projected increase in rainfall and heavy rainfall events, Ethiopia's housing will be under increasing risk of damage and destruction. In the floods in April 2005, for example, tens of thousands lost their homes in southeastern area of the country, on the border with Somalia (BBC, 2005).

Biodiversity & Conservation

Ethiopia currently experiences land degradation, soil erosion, deforestation, loss of biodiversity, and desertification (Tadege, 2007). Much of this environmental degradation is a result of expansion of cultivated areas for agriculture, and fuel wood gathering. While at present this issue is largely of socio-economic cause, climate change may exacerbate the problem. Increasing temperatures and more irregular rainfall patterns will worsen soil erosion and accelerate desertification.

Livelihoods

Ethiopia's economy relies heavily on agriculture, which accounts for almost half of GDP, 60 percent of exports, and 80 percent of total employment (CIA, 2008). The economy as a whole is therefore very susceptible to natural hazards; the drought in 2002, for example, caused a 3.3 percent drop in GDP by the following year (CIA, 2008). Key exports include coffee, gold, leather products, and qat (also known as 'khat'). Coffee remains the most important of these, accounting for \$350 million of exports in 2006 (ibid), but is vulnerable to global fluctuations in coffee prices. Climate change is likely to increase the risk of crop yield losses and the livelihoods that depend on them.

Energy

Ethiopia's domestic energy demand is met largely by biomass; the result of which is deforestation for fuel wood and production of charcoal. Electricity is generated mostly by hydropower (around 85 percent), and a small amount by oil, though Ethiopia itself has no capacity for refining. There is potential for geothermal power production in the Great Rift Valley, and for an increase in hydropower. Recent environmental policy in Ethiopia sets out a commitment to invest in these two forms of energy, as well as solar power. It has been reported that Ethiopia has some reserves of oil and gas, having similar geology to other oil-producing countries such as Sudan and those on the Arabian Peninsula (EIA, 2008). In 2003, the Ethiopian government signed an oil exploration agreement with Petronas for an area in Gambela in the far West (ibid).

In September 2009, the Ethiopian government announced a plan to build a fourth hydroelectric dam along the Omo River (Ashine, 2009). The 'Gibe 4 dam' will generate 1,400 megawatts of electricity and will be built within five years by the Chinese company Sino-Hydro Corporation Limited; the dam is projected to cost 1.4 billion euros and will be part-financed by loans from China (ibid).

Transport

Ethiopia is landlocked and therefore has to rely on using the ports of Djibouti (Djibouti) and Somalia (Berbera) (CIA, 2008). Much of the road and railway infrastructure is in need of investment and repair, and will be in increasing danger of being damaged by flooding and land subsidence resulting from climate change impacts. For the majority of the population, forms of transport are limited to walking, head loading and use of pack animals.

Government Response

Ethiopia has ratified the United Nations Framework Convention on Climate Change (UNFCCC). Accordingly relevant governmental institutions have been entrusted to discharge responsibilities in the area of environment and development and amongst which, the National Meteorological Services Agency is mandated to deal with climate related affairs.

The Environmental Policy of Ethiopia indicates that environmental sustainability is recognized in policies and strategies as a key prerequisite. In line with this an institution in charge of environmental issues at the federal level, the Environmental Protection Agency (EPA), was established. The EPA mainly assumes a regulatory role and coordinates various activities within line ministries, agencies and nongovernmental institutions. To promote sustainable socio-economic development through sound management and rational use of natural resources and the environment, the Conservation Strategy of Ethiopia has been formulated. The CSE encompasses 10 sectoral and 10 cross-sectoral environmental policies and seeks to integrate into a coherent framework plan, policies and investment related to environmental sustainability (Tadege, 2001).

The Environmental Policy of Ethiopia, an umbrella policy of various environmental policies was formulated and approved by the Ethiopian government in 1997. Included in this is a policy on climate change and pollution, with the overall aims to (Tadege, 2007):

- Promote climate monitoring programmes as the country is sensitive to changes in climate;
- Recognise that a firm and demonstrable commitment to the principle of containing climate change; and
- Foster use hydro, geothermal and solar energy so as to minimise emission of greenhouse gases.

Under the mechanism within the UNFCCC, Ethiopia produced a National Adaptation Programme of Action (NAPA), which was published in 2001. The aim of producing this document is to identify 'immediate and urgent' adaptation activities that address current and anticipated adverse effects of climate change and extreme climate events (Tadege, 2007).

Ethiopia has also produced a National Communications Plan under the UNFCCC mandate. This also covers mitigation of climate change, including an inventory of greenhouse gas emissions and options for further mitigation of carbon emissions.

Likely Adaptation Options

The following broad adaptation options are those which were highlighted in Ethiopia's NAPA, and subsequently prioritised through a multi-criteria analysis (Tadege, 2007):

- Promoting drought/crop insurance programme, including micro-insurance.
- Strengthening/enhancing drought and flood early warning systems.
- Development of small scale irrigation and water harvesting schemes in arid, semi-arid, and dry sub-humid areas.
- Improve or develop water management, including pollution control.
- Improving/enhancing rangeland resource management practices in the pastoral areas.
- Community based sustainable utilization and management of wetlands in selected parts of the country.
- Capacity building programme for climate change adaptation; including pest and disease forecast and control.
- Realising food security through multi-purpose large-scale water development project in Genale–Dawa Basin. Switching to different cultivars, improve and conserve soils.
- Establishment of national research and development (R&D) centre for climate change.
- Strengthening malaria containment programme (MCP) in selected areas.
- Promotion of on farm and homestead forestry and agro-forestry practices in arid, semi-arid and dry-sub humid areas.

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 Ethiopia. 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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