



# Malawi



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## General Climate

Malawi experiences a mild tropical climate with an average annual temperature of around 24°C and an annual rainfall of between 600 and 2500mm (Jury & Mwafulirwa, 2002). 95 percent of this rainfall occurs in the single rainy season in the summer, from November through to April. This warm, wet season is followed by a dry winter from May through to August, which is dominated by high pressure (ibid). This is followed by a short spring from September to October, which is also dry, but also typically very warm with temperatures exceeding 30°C (ibid). Rainfall is highest along the eastern edge of the country, on the shores of Lake Malawi; temperatures are warmest towards the east, but also towards the southern shores of the Lake.

Rainfall over Malawi is driven predominantly by the movement of the Inter-Tropical Convergence Zone (ITCZ). The ITCZ is the point of convergence of the easterly trade winds from the northern hemisphere (north-east trades) and the southern hemisphere (south-east trades) in a band of low pressure (Godwin, 2005). During the course of a year, the ITCZ migrates between the northern and southern tropics, bringing rain to the countries over which it passes (Marchant *et al.*, 2007). Malawi is at the southern extent of the ITCZ's passage, so the end of the movement south and beginning of the return north occurs within the country's boundary, resulting in a single (unimodal) pattern of rainfall (Beuning *et al.*, 2010). The timing of this single rainy season varies down the length of the country, with the southern areas experiencing a rainy season between November and February, but for northern areas the rainy season can continue into April as the ITCZ migrates north (McSweeney *et al.*, 2008).

The ITCZ is predominantly an oceanic feature and its position changes with the warmest sea surface temperatures (SSTs) (Marchant *et al.*, 2007). It is thus affected by variations in both the Pacific and Indian Oceans, which in turn are affected by the ocean-atmosphere phenomena of the El Niño-Southern Oscillation

(ENSO) and the Indian Ocean Dipole (IOD) respectively (Tierney *et al.*, 2008). ENSO is the collective term for the coupled ocean-atmosphere phenomenon of El Niño and the Southern Oscillation Index (SOI). Warm ENSO events ('El Niños') are identified by a reversal in prevailing trade winds in the Pacific Ocean and warm SSTs off the coast of Peru and Ecuador. The warm phase of ENSO (El Niño) is associated with drier conditions in Malawi (Mason, 2001). The opposite cool phase of ENSO (La Niña) does appear to bring increased rainfall in the rainy season (Nicholson & Selato, 2000; Rocha & Simmonds, 1997).

**Key climate vulnerabilities:** Drought; flooding; food security; infectious disease epidemics

## Observed Climate Changes<sup>1</sup>

### Temperature

- Mean annual temperature has increased by 0.9°C between 1960 and 2003; this increase in temperature has been most rapid in summer (December-January-February, or 'DJF').
- Daily temperature observations show increasing trends in the number of hot<sup>2</sup> days and nights, increasing by 31 days (equivalent to +8 percent) and 41 nights (equivalent to +11 percent). These increases are seen most strongly in DJF.
- The frequency of cold<sup>3</sup> days and nights has decreased in all seasons except September- October- November ('SON'). The rate of decrease is most rapid in March-April-May ('MAM').

### Precipitation

- Rainfall over Malawi has a high interannual variability and observed records show no long-term trend.
- There is no significant trend in the proportion of rainfall occurring in heavy events<sup>4</sup>.

## Current Climate Vulnerability

Table 1 lists the natural hazards that have affected Malawi over the past 20 years. Drought and flooding are the key problems for Malawi, as they affect the population both directly and indirectly through public health, agriculture and food security. With over 90 percent of the population reliant on rain-fed agriculture for livelihood, there is substantial vulnerability to the highly variable rainfall that Malawi receives (EAD, 2006).

In 2005, for example, drought hit southern Africa, with Malawi as one of the worst affected countries – the World Food Programme (WFP) announced that the maize harvest was the lowest since 1992 and could only cover 37 percent of average national consumption (BBC, 2005). Maize is the most important of Malawi's staple crops, accounting for 90 percent of the cultivated land, and 80 percent of daily food calories consumed (EAD, 2002).

Flooding is a regular occurrence in Malawi and affects crops, livestock, housing, infrastructure and health. Flooding during the 2001-2002 rainy season, for example, was a contributing factor to Malawi's worst outbreak of cholera, affecting 26 out of 27 districts, with over 33,000 cases and over 900 deaths (WHO, 2008). Heavy rains are also associated with outbreaks of malaria, which is endemic across all of Malawi (WHO, 2005). Annually, cases of malaria run into the millions, and deaths into the thousands; malaria accounts for around a third of all outpatient visits and is the number one cause of hospital admissions in children under five (PMI, 2010).

Hazard	Number of Events	Deaths	Total of Population Affected
Drought	4	500	15,449,435
<i>Average per event</i>		125	3,862,359
Earthquake	2	4	20,736
<i>Average per event</i>		2	10,368

<sup>1</sup> McSweeney, C. *et al.* (2008) unless otherwise stated

<sup>2</sup> '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.

<sup>3</sup> '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.

<sup>4</sup> 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.

Hazard	Number of Events	Deaths	Total of Population Affected
Epidemic (unspecified)	2	175	-
<i>Average per event</i>		88	-
Epidemic (bacterial)	9	1,398	51,105
<i>Average per event</i>		155	5,678
Flood (unspecified)	7	9	280,390
<i>Average per event</i>		1	40,056
Flood (flash)	4	481	339,246
<i>Average per event</i>		120	84,812
Flood (general)	9	11	658,099
<i>Average per event</i>		1	73,122
Storm	1	11	8
<i>Average per event</i>		11	8

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

## Climate Change Projections<sup>5</sup>

### Temperature

- The mean annual temperature is projected to increase by 1.9 to 2.5°C by the 2060s, and 2.2 to 4.3°C by the 2090s. Increases are projected to be slightly larger in the west (Figure 1).
- Projected rates of warming are greatest in the warmest season, SON, increasing by 2.3 to 4.4°C by the 2090s, with the maximum projection of 6.0°C.
- All projections indicate 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 32 percent of days by the 2060s, and up to 53 percent of days by the 2090s.
- ‘Hot’ nights are projected to increase more quickly than hot days, occurring on up to 53 percent of nights by the 2060s and up to 72 percent of nights by the 2090s. The increase in DJF is the most rapid of the seasons, occurring on up to 99 percent of nights by the 2090s.
- All projections indicate decreases in the frequency of days and nights that are considered ‘cold’ in current climate. These events are expected to become exceedingly rare, and do not occur at all by the 2090s in any projections under some climate change scenarios.

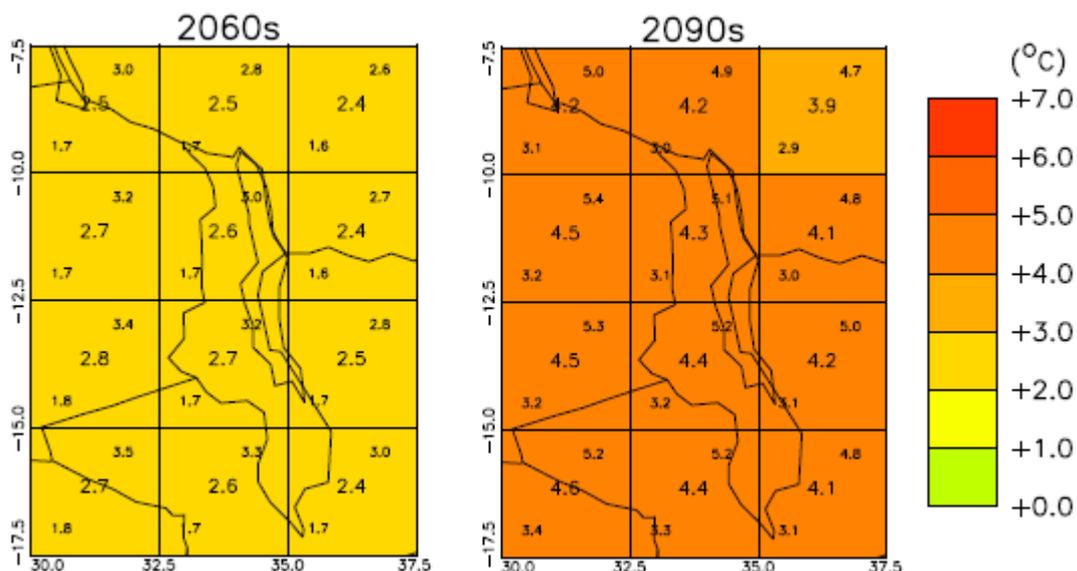


Figure1 – Projections of mean annual temperature for Malawi for the 2060s and 2090s (the central value in each grid box gives the central estimate of the model projections, and the values in the upper and lower corners give the maximum and minimum) (McSweeney *et al.*, 2008). See ‘A note on the projections’ at the end of this document for more information on these maps.

<sup>5</sup> McSweeney, C. *et al.* (2008) unless otherwise stated

## Precipitation

- Projections of mean rainfall show small changes in annual rainfall, but larger changes in seasonal rainfall – indicating a trend towards decreases in dry season rainfall (JJA and SON) and increases in wet season rainfall (DJF and MAM).
- The largest increase in rainfall is projected for DJF, with increases of 2 to 5 percent (equivalent to 5 to 11 mm per month) and 4 to 11 percent (12 to 25mm per month) for the 2060s and 2090s respectively. The upper end of the projections show maximum increases of 25 percent by the 2090s, equivalent to 55mm per month of extra rainfall. Increases are largest towards the east (Figure 2).
- The most substantial reduction in rainfall is projected for the SON season. Decreases are projected for the 2060s and 2090s of -7 to -16 percent (equivalent to -3 to -7 mm per month) and -4 to -11 percent (-7 to -21mm per month) respectively. The maximum projected reduction in rainfall is -27 to -63 percent, equivalent to -15 to -26mm less rainfall per month. Decreases are largest towards the southeast (Figure 3).
- The proportion of rainfall that falls in heavy events is projected to increase, from 3 to 7 percent in annual rainfall by the 2090s, to a maximum of 19 percent (Figure 4).
- Maximum 1- and 5-day rainfall totals are projected to increase in DJF and MAM; by up to 26mm in 1-day events, and up to 39mm in 5-day events by the 2090s.

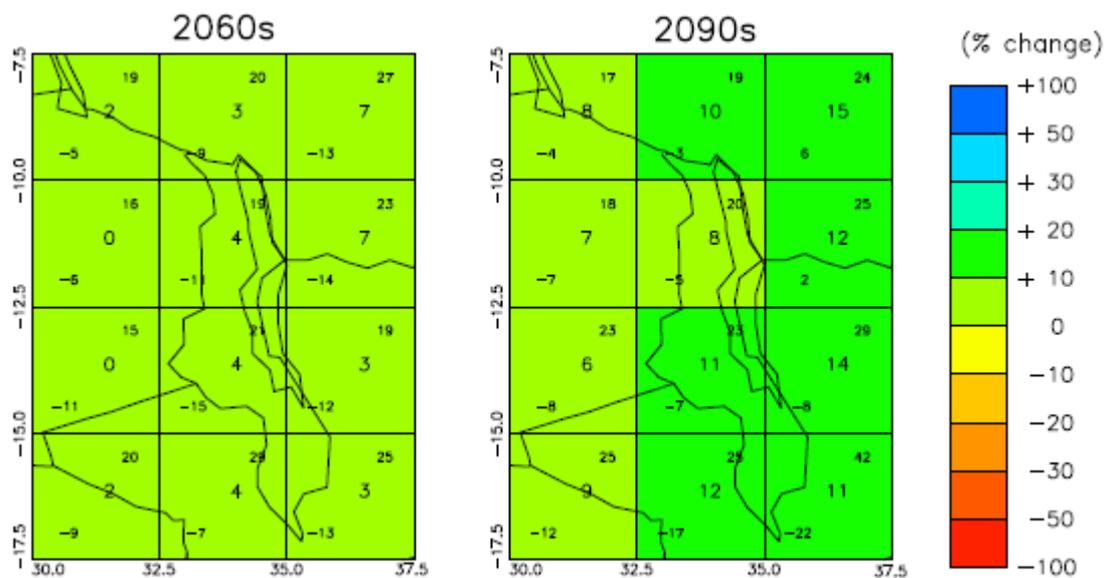


Figure 2 – Projections of percentage changes in DJF rainfall for Malawi for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

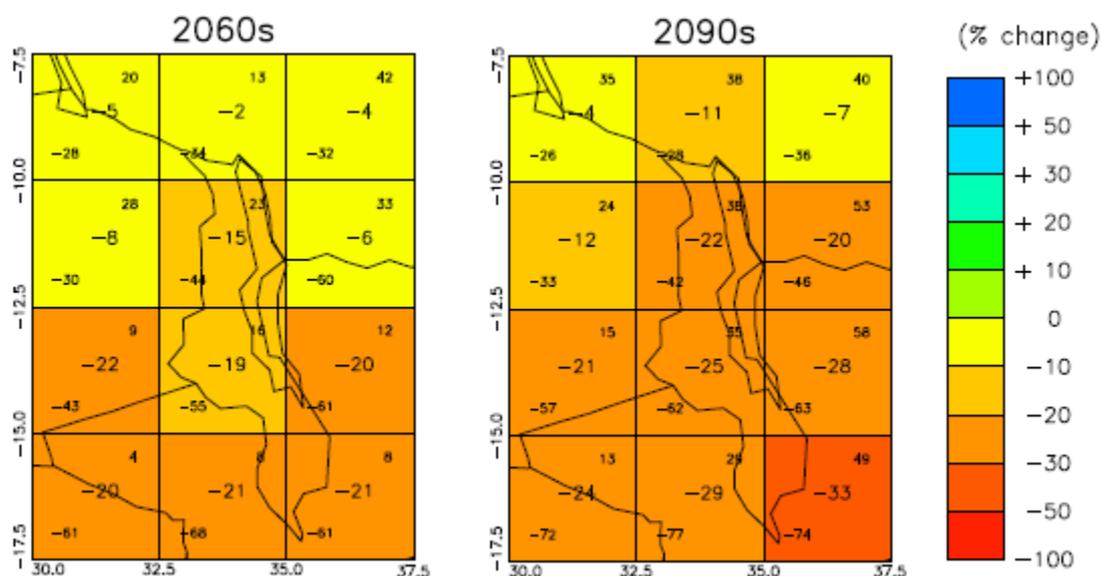


Figure 3 – Projections of percentage changes in SON rainfall for Malawi for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

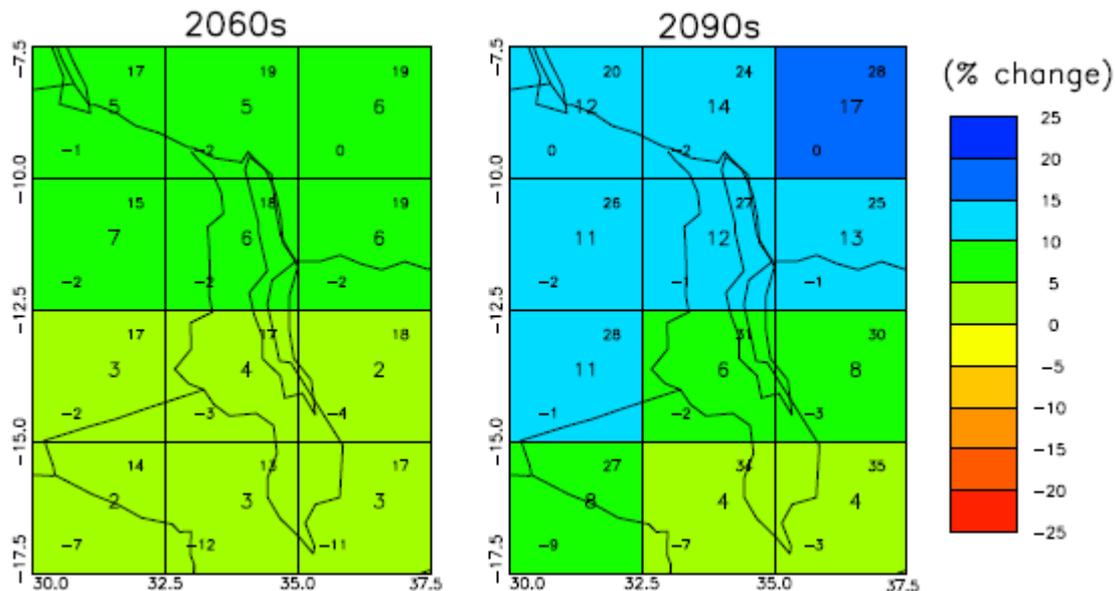


Figure 4 – Projections of percentage changes in the amount of rainfall falling in ‘heavy’ events during the MAM season for Malawi for the 2060s and 2090s (see Figure 1 for details) (McSweeney *et al.*, 2008).

## Climate Change Impacts

### Flooding

Malawi already suffers substantially from flooding, with substantial flood events an almost yearly occurrence. Flooding can have devastating effects on communities, taking lives, homes, crops and livestock. The projections show that climate change is likely to result in an increase in heavy rainfall events during the rainy season, which is likely to increase the risk of flash floods occurring.

### Water Resources

Historically, Malawi has been vulnerable to changes in rainfall; reductions in rainfall of 40 and 30 percent were the cause of droughts in 1992 and 1994 respectively, contributing to the drying up of the Mulunguzi reservoir in Zomba (Ngongondo, 2006). Declines in rainfall totals in southern Africa since 1980, for example, had been linked with contributing to food insecurity in the region (Funk *et al.*, 2008). Projections show an increasing proportion of rainfall in the rainy season and decreases in the dry. This will affect the flow of rivers in Malawi, most of which are seasonal and dry up in the dry season. Therefore, it will be necessary for Malawi to have sufficient storage for the provision of fresh water all year round.

One major source of water storage is of course Lake Malawi, which itself is highly sensitive to interannual variability of rainfall (Jury & Gwazantini, 2002). The summer rainy season is the main source of recharge yet annual rainfall totals can vary widely; this is the main source in the variability of inflows to the lake (ibid).

### Agriculture & Food Security

Agriculture supports the majority of the population through subsistence farming, primarily through rain-fed agriculture, growing cereals (such as maize and wheat), legumes, vegetables and fruit (EAD, 2002). Drought and flooding can both endanger food security as they did in 2005 after consecutive poor harvests left 4.2 million people short of food (Buerkle, 2005). However, with good rains and a fertiliser subsidy programme, yields in the past five years have produced a surplus of maize, Malawi’s most important crop, even offsetting the reduced yield resulting from the dry spell in southern areas (IRIN, 2010).

Maize yields are likely to experience a mixed response to climate change across the country; with southern areas predicted to experience a slight increase in crop yield, while central areas experiencing a decrease (ibid). However, as irrigation is not widely used, farmers are already at risk from periods of drought, while both crops and livestock are also at risk from damage and destruction from heavy rain and flooding, the risks of which are likely to increase under climate change.

### Public Health

Malaria outbreaks often follow periods of heavy rain that provide standing water in which mosquitoes can breed (van Lieshout *et al.*, 2004). The increasing prevalence of heavy rainfall events that climate change is projected to bring is likely to result in a greater abundance in breeding habitat for mosquitoes (ibid).

Flooding from extreme rainfall is associated with outbreaks of diarrhoeal diseases such as cholera, dysentery and typhoid, which account for over 20,000 deaths a year in Malawi (WHO, 2009).

## Housing & Communities

Traditional rural housing consisting of mud walls and thatched roofs are at risk from being damaged or washed away during flood events. Flash flooding in southern Malawi in January 2007, for example, washed away over 1000 homes and damaged 10 schools, affecting 22,000 households in total (Kubwalo, 2007). With an increase in heavy rainfall, this risk to rural communities will increase with climate change.

## Biodiversity & Conservation

A study of the impact on climate change on two National Parks in Malawi (Lengwe and Nyika) found that increasing temperatures and more variable rainfall would cause a decline in habitat quality, particularly in Lengwe (EAD, 2002). The result would be a decreasing trend in the ability of the park to support large mammal populations, and the study suggested that this impact could be seen across Malawi in general (ibid). Such an impact would be similar to that which was seen in the short-term during the droughts of 1979-80 and 1991-91, which resulted in degradation in vegetation, over-crowding of mammals at watering holes and high mortality of the southern African antelope, the Nyala at Lengwe (ibid).

Malawi also has several important wetlands at Lakes Malawi, Chiuta and Chilwa and also Shire River (ibid). These wetlands are of particular importance for their diversity of plant species, animals, fisheries and micro-organisms. Lake Chilwa is particularly at risk from periods of drought, and can dry up completely; climate change is likely to cause more variable rainfall and an increasing likelihood of longer periods without rain during the dry season (ibid).

## Livelihoods

Malawi's economy is largely agriculture-based, being the largest source of formal employment (80 percent), the largest source of export earnings (90 percent) and accounting for 35-40 percent of GDP (EAD, 2002). Cash crops such as tobacco, cotton, tea, sugar and cashew nuts are grown primarily for export (ibid), and tobacco is particularly important as it accounts for over half of export revenues (CIA, 2010). Livelihoods depend strongly on crop yields, and so are at risk from climate change through the changing rainfall patterns and increasing temperatures discussed above.

## Energy

Wood (firewood and charcoal) is the key source of fuel for over 90 percent of the population, but the level of consumption is unsustainable and results in deforestation (EAD, 2002). The primary source of electricity generation is hydropower, generated on the Shire River and accounting for 98 percent of Malawi's generated electricity (EAD, 2006). However, grid electricity is only available to 4 percent of the population and it is instead largely used by industry (EAD, 2002). Hydropower generation is at risk from both too much and too little rainfall, with output declining in dry periods and hydropower installations at risk of damage from flooding. Rainfall variability and extreme events are likely to increase under climate change, increasing the risk to electricity generation.

## Transport

Transport infrastructure will come under increasing threat from flooding throughout the country, with unsurfaced roads particularly at risk from being washed away.

## Government Response

The Malawian government have produced both an Initial National Communication on climate change (EAD, 2002) and a National Adaptation Programme of Action (NAPA) (EAD, 2006) under the United Nations Framework Convention on Climate Change (UNFCCC).

The Malawian government has signed an agreement with the United Nations Development Programme (UNDP) for funding a programme to manage the impacts of climate change (Namadzunda, 2010). The agreement will put 4.2 million USD in place to help the government work with development partners to develop a national framework for helping Malawi deal with the impacts on economic development and food security (ibid).

Following the success of DDT-spraying to reduce cases of malaria in Zambia, Malawi's Ministry of Health are considering introducing the measure for indoor residual spraying (IRS) as part of the 2010 anti-malaria campaign 'Malungo zii' (Kick out malaria) (Nyasa Times, 2010). Malawi is also receiving additional aid to tackle malaria from the US Government under the President's Malaria Initiative (PMI). Beginning in 2006,

this programme has so far committed \$83 million towards providing bed nets, carrying out IRS, and providing drugs and health care workers (PMI, 2010).

## Likely Adaptation Options

As part of producing Malawi's NAPA, the government assessed the impacts of climate change on different sectors and identified different options and strategies for adapting to climate change. The following is the prioritised list of adaptation options, limited to those designated as the most urgent and that could be implemented as a specific NAPA project. (ibid):

- Sustaining life and livelihoods for the most vulnerable communities.
- Enhancing food security and developing community based storage systems for seed and food.
- Improving crop production through the use of appropriate technologies.
- Increasing resilience of food production systems to erratic rains by promoting sustainable dimba production of maize and vegetables in dambos, wetlands and along river valleys.
- Targeting afforestation and re-afforestation programmes to control siltation and the provision of fuel wood, and for their benefits, such as sources of alternative cash income.
- Improving energy access and security in rural areas: e.g. through extension of the rural electrification programme, energy-efficient stoves and development of ethanol-based stoves.
- Improving nutrition among rural communities: e.g. through the promotion of fish farming, rearing of small ruminants and nutritional supplements for children and the sick.
- Disseminating bed nets in high incidence malaria areas.
- Developing food and water reserves for disaster preparedness and response.
- Developing community based wildlife ranching and a breeding programme for Nyala.
- Developing and implementing strategies for drought preparedness, flood zoning and mitigation works.
- Developing small dams, and other storage facilities, to mitigate flooding, to harvest water and to initiate community based fish farming and breeding.

## 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](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](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](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 Malawi. 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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