# ZAMBIA CLIMATE CHANGE BRIEFING

## Overview

Zambia has a tropical climate, although temperatures remain relatively cool, due to the high East African Plateau. There are three seasons: a cool, dry winter from May to September; a hot, dry season in October and November; and a rainy season, which is even hotter, from December to April. The annual rainfall averages between 700 mm in the south and 1,400 mm in the north. Zambia has extensive water resources, the sum of which far exceeds the consumptive use - even in a drought year. However, there are significant variations across the country, and a strong seasonal distribution leading to water deficits.

### Temperature

The mean temperature is predicted to increase in Zambia with a greater frequency of 'Hot' days and nights and very few 'Cold' days or nights

### Rainfall

Changes in rainfall are less certain, but rainfall is expected to decrease especially in the winter season, and increase in intensity – increasing water scarcity

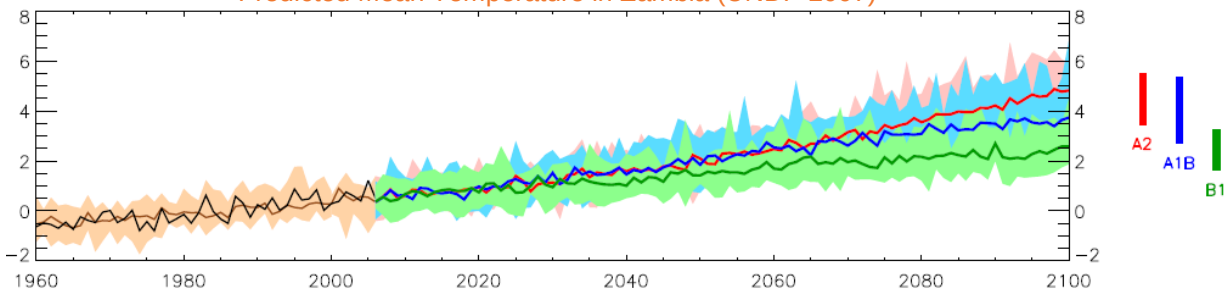
### Extreme Events

An expected increase in the frequency and intensity of extreme events, primarily droughts and floods. Expect extreme events to occur in new locations and a shorter growing season in some regions

## Climate Change

Observational evidence from all continents and most oceans show that many natural systems are being affected by climate change, particularly temperature increases. The mean temperature in Zambia has steadily increased over the last 40 years, as shown on the graph below. The graph also synthesises the mean temperature predicted by 22 global climate models, their range is indicated by the shading and the lines refer to three emissions scenarios A2 (high), A1B (medium) and B1 (low) (describe future economic growth and energy). The change in climate between 1960 and 2003 and the climate changes predicted by 2060 and 2090 are summarised in the table below.

Predicted Mean Temperature in Zambia (UNDP 2007)




| | Observed (between 1960 and 2003) | Changes Predicted by Global Climate Models by 2060 | 2090 |
|---|---|---|---|
| Temperature Rise[1] | 1.3°C (0.29 per decade) | 1.2 - 3.4°C | 1.6 - 5.5°C[2] |
| Frequency '*Hot' Days*[3] (% of days) | 12% of days | 15 - 29% | 16 - 49% |
| Frequency of '*Hot' Days* based on current climate (% of days) | N/A | | 22 - 80% |
| Frequency '*Hot' Nights* (% of days) | 17% of days | 26 - 54% | 30 - 80% |
| Frequency of '*Hot' Nights* based on current climate (% of days) | N/A | | 30 - 99% |
| Frequency '*Cold' Days*[4] (% of days) | -6% (22 days) | 1 - 4% | 0 |
| Frequency '*Cold' Nights* (% of days) | -10% (35 day) | 1 - 4% | 0 |
| Precipitation | -1.9mm per month (2.3% per decade)[5] | No large changes | |
| Heavy Rainfall Events[6] | Possible decrease (not statically significant) | Increase annually, but mainly in rainy season | |
| Maximum 1- and 5-day rainfalls | Possible decrease (not statically significant) | Increase in magnitude in rainy season | |

[1] The projected rate of warming is a little more rapid in the southern and western regions of Zambia than the northern and eastern regions
[2] The maximum temperature range for any of the models is no more than 1.5- 2.5°C for each emission scenario
[3] 'Hot' day or 'Hot' night is defined by the temperature exceeded on 10% of days or nights in the current climate of that region (average)
[4] 'Cold' days or 'Cold' nights are defined as the temperature for the coldest 10% of days or nights (average)
[5] This annual decrease is largely due to decreases in the rainy season, which has decreased by 7.1mm per month (3.5%) per decade
[6] A 'Heavy' event is defined as a daily rainfall total which exceeds the threshold that is exceeded on 5% of rainy days in the current climate of that region

Cranfield UNIVERSITY
WSUP Water & Sanitation for the Urban Poor

# MAIN IMPACTS OF CLIMATE CHANGE

The consequences of climate change are likely to increase the number of forced migrations (due to undermined livelihoods – primarily due to food insecurities). The migrations will typically be to urban areas, where the migrants are often more rather than less vulnerable to certain climate-related impacts. The increased populations in urban area will increase competition over natural resources and the likelihood of conflict. In addition, resource scarcity can lead to increased capture of resources by elites exacerbating existing inequalities.

| | Droughts | Floods | Extreme Heat | Shorter Rainy Season |
|---|---|---|---|---|
| Water | • Water scarcity<br>• Reduced water quality (reduced dilution of contaminants)<br>• Lower ground water<br>• Sewage in rivers less dilute | • Contamination of drinking water (in particular cholera)°<br>• Ingress of groundwater into pipes | • Reduced water quality<br>• Higher water temperatures exacerbate water pollution | • Lower water levels |
| Food | • Crop damage/loss leading to food scarcity and hunger$^{\Sigma}$<br>• Decrease in cattle population<br>• Decreased nutrients reduce fish stocks (commercial species in particular – breams and sardines most vulnerable)$^{+}$<br>• Increased soil erosion and decreased soil fertility<br>• Increased honey and wild flower production (if drought is not too severe)$^{\Omega}$<br>• Drying and desertification<br>• Degradation of grasslands | • Crop damage/loss, leading to food scarcity and hunger$^{\Sigma}$<br>• Loss of crop land and grazing ground $^{\Sigma}$<br>• Life loss (humans and livestock) | • Loss of life (animals and humans)<br>• Crop damage/loss$^{\Sigma}$<br>• Decreased nutrients reduce fish stocks (commercial species in particular) $^{+}$<br>• Decreased livestock feed | • Increase in risk of crop failure$^{\Sigma}$<br>• Crop damage/loss<br>• Crop seeds do not reach maturity (which negatively affects the next crop generation)<br>• Maize won't mature (It is the main crop for 80% of the population) |
| Infrastructure | • Insufficient water for hydroelectric$^{\Pi}$ - power shortages<br>• Increased energy demand for cooling | • Destruction of infrastructure (houses, roads, water facilities)<br>• Interference with energy production due to change in water flows | • Insufficient water for hydroelectric - power shortages$^{\Pi}$<br>• Exaggerated heat island effect (i.e. increased temperature in urban areas) | |
| Health | • Increase in diseases (affecting humans and animals)<br>• Less water for hygiene and cleaning | • Loss of life<br>• Increase in diseases (malaria, dysentery, cholera, etc.) | • Loss of life<br>• Increase in diseases affecting animals, crops and humans (potential decrease in malaria)<br>• Decreased human capacity to do work<br>• Worsening air quality | |
| Income | • Income Loss<br>• Women and children use more time for chores<br>• Reduction in *Moimbo* woodland* regeneration<br>• Animal migration and stress | • Income Loss<br>• Disruption of communities | • Income Loss<br>• Forest Fires<br>• Reduction in *Miombo* woodland* regeneration<br>• *Kalahari* woodland$^{¥}$ destroyed<br>• Animal migration and stress | • Decreased income from crop selling for those with reduced production |

**Miombo* woodland cover 60% of the land and provides fuel and charcoal for 80% of households, equivalent to 4.3 million tonnes of wood, providing 70% of the nations energy needs

$^{+}$ Zambia holds 40% of the water in the South African Development Community region, which many communities across the nation depend on for fishing & livelihoods

°The 2005 flood resulted in 5,000 recorded cases of chorea in Lusaka

$^{¥}$*Kalahari* Woodland (deciduous trees and short grasses on sand) is present in western area and is used by Angolan immigrants who rely on it for cultivation of cassava

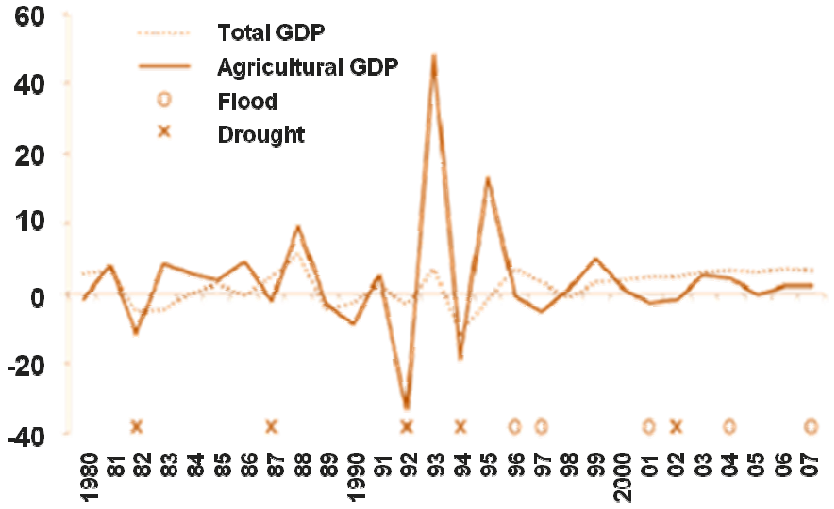
$^{\Pi}$Hydroelectricity contributes 14% of total energy use, but represent 92% of installed capacity and accounts for 99 of electricity production, key for industry and mining

$^{\Sigma}$The area suitable for maize production in the North and centre is likely to decrease by 80%, while maize yields with decrease by 66% (16% irrigated land – 5%)

$^{\Omega}$Honey production is expected to be a significant growth sector in the economy

# Importance of Climate

The variability of weather has a large effect upon Zambia's GDP. The graph opposite illustrates the impact of floods and droughts upon the GDP. For example during the droughts of 2004/05 1.2 million people were in need of food assistance, while during the flood of 2006/07 400,000 people needed food aid for a period of 8 months. The relationship is due to Zambia's dependence on rain fed agriculture – primarily maize. A model was developed by the International Food Policy Research Institute (2009) assessing the impact of climate variability and changing climate on crop yields. The work highlighted that climate variability has a very significant role for economic development. For example the model estimated that during a severe drought (such as the 92/93 drought) GDP is reduced by US$ 2.6 billion and absolute poverty increases by 836,000, while a severe flood (such as the 06/07) reduces GDP by US$ 0.9 and increases absolute poverty by 273,000. The study concluded climate change may further exacerbate the negative consequences of climate variability, but the impacts of climate variability will dominate until 2025. Highlighting the need to invest in irrigation and water management practices, which mitigate the adverse impacts of climate change.




Zambia has **abundant water resources** (the highest in the region), but seasonal and temporal rainfall patterns and limited investment in infrastructure means the country still experiences **water scarcity and severe floods**. The main challenges of climate change are the reduction in *Miombo* woodland and maize yields, which will exacerbated by the high levels of poverty in the country

# Vulnerability

A range of global and regional studies have assessed Zambia's vulnerability to climate change using global datasets[1,2,3,4,5] producing Indices for each country to enable simple comparison. The table below presents the scores (measure of vulnerability) for Zambia for 9 global indices. The indexes which assess the impact of climate change on water resource indicate that Zambia has a very low vulnerability; this is due to Zambia's relative abundance of water resources. However, when social factors are assessed (including Zambia's level of economic growth and governance) Zambia comes out with a medium vulnerability. This is due its limited adaptive capacity and widespread poverty in the country.

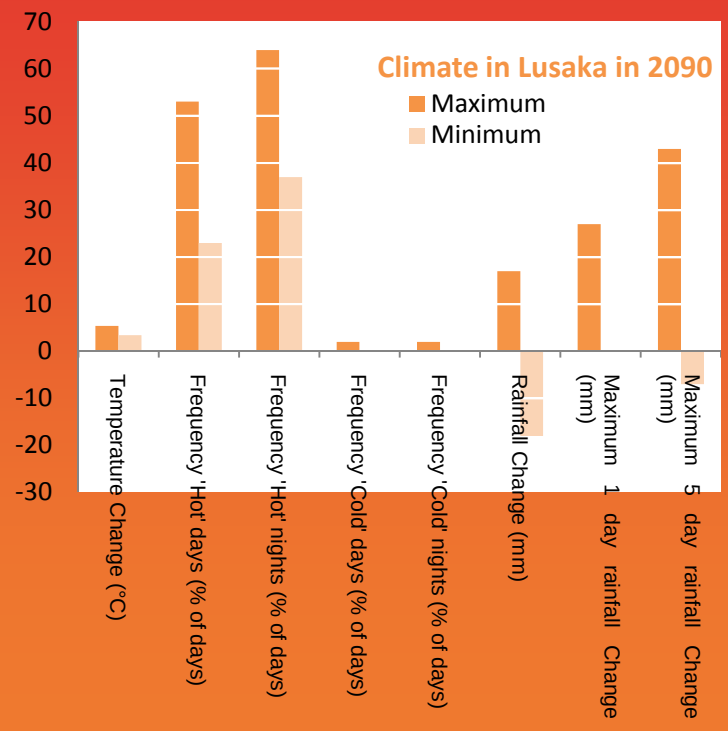
| Index | Score | Vulnerability | How it's calculated |
|---|---|---|---|
| **Water Resources** | | | |
| Water Scarcity Index (2004)[1] | 0.0027 | Very low (Abundant) | Water extracted from rivers divided by the low flow (q90). E.G If ≥ 1 then consumption exceeds supply |
| Ground Water Dependence (2004)[1] | 0.0402 | Very low (Abundant) | Ground water withdrawn as a fraction of total water withdrawn in region |
| Total freshwater withdrawal as percentage of total renewable freshwater resources (2009)[2] | 1.7% | Very Low | Total freshwater withdrawn in a given year, expressed in percentage of the total actual renewable water resources It is an indication of the pressure on the renewable freshwater resources. (data from 1998-2002) |
| Annual Renewable Water Supply per Person (Projections for 2025)[2] | >4000 $m^3$pp | Abundant supply | Runoff (data from 1950-2000) divided by Population (2025) (prediction from UN population division |
| **Social Vulnerability** | | | |
| Human Vulnerability (2007)[3] | 0.597 | 29th /49 (Africa) | Social vulnerability to climate change (the Index consists of 5 weighted factors, each of which is scored). The factors are: economic well being and stability (20%), demographic structure (20%), global interconnectivity (10%) and dependence on natural resources (10%); HVB also includes institutional stability and infrastructure (40%) – corruption |
| Human Vulnerability (including corruption) (2007)[3] | 0.631 | 42nd / 49 (Africa) | |
| Sensitivity and Adaptability (2007)[4] | 0.481 | 164th / 182 (global) | Human Development Index (used as generic indicator for adaptive capacity) |
| Sensitivity Index (2004)[1] | 2.33 | Low | Combination of Water Scarcity Index, GW Dependence and Sensitivity and Adaptability Index |
| Climate Vulnerability Index (2007)[5] | - | Medium | The index links water resources modeling with human vulnerability assessments to contribute to a meaningful assessment for generic use |

[1] Petra Döll (2009) Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment. *Environmental Res. Letters* 4 (3)
[2] World Business Council for Sustainable development Global Water Tool (2009) www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MeuId=MTUxNQ&doOpen=1&ClickMenu=LeftMenu
[3] Vincent, K. (2004) Creating an index of social vulnerability to climate change for Africa, Tyndall Centre Working Paper 56
[4] Human Development Index (2009) http://hdr.undp.org/en/statistics
[5] Centre for Ecology and Hydrology (2007) Oxford Centre for Water Resources. The Climate Vulnerability Index. http://ocwr.ouce.ox.ac.uk/research/wmpg/cvi/

# Climate Impacts: Lusaka

Lusaka has a population of 2 million (2005) with a growth rate of 3.6%, 40% of residents live in informal areas – these unplanned areas have an estimated growth rate of 12%. Lusaka is in the central part of the country, which is the most populous zone and has the highest agricultural potential. The figure opposite overviews the changes to climate predicted to occur by 2090. The predictions show similar trends to the national predictions with rising temperatures, an increasing number of 'Hot' days and uncertain rainfall changes. Notwithstanding this, there is an anticipated decrease in volume of rainfall, and an increase in intensity.

The main water provider is Lusaka Water and Sewage Company (LWSC) (producing 94 million $m^3$ per day). Half the water is extracted from the Kafue River and the other half from groundwater, which is over extracted, increasingly polluted and boreholes are increasing drying up during droughts. 55% of the water from LWSC is unaccounted for and only 30% of consumers have piped sewers. In the informal areas there is indiscriminate groundwater extraction. WSUP target areas are Chanzanga and Kanyama, where water is provided directly by LWSC and through Water Trusts alongside private and NGO supplies.




- **Chazanga** (population approximately 35,000) is located on hilly terrain and is drained by three rivers. It can be divided into the new (planned and relatively spacious) and old (unplanned) areas. It is supplied by 4 boreholes (the water table is between 40-60m), which are operated by electric and hand pumps. There are also shallow wells which are not used for drinking
- **Kanyama** (population approximately 96,000) is located on an old wetland in a depression of flat hard rock (difficult to dig - constrains pit latrines), with a relatively high water table (6m) supplying 2 boreholes

| | Chazanga | Kanyama | Predicted Impacts of Climate Change |
|---|---|---|---|
| **Waste Management** | Relatively clean, working waste management scheme. However, Lusaka waste dump is within 50 m of the 2 main boreholes | Poorly functioning waste management scheme. Households burn waste or dispose in pits (which collect water in the rainy season) | Flooding will spread waste and increase the risk of disease |
| **Drainage** | Good drainage and clear roads, but threatened by expansion | Poor drainage, drains blocked by housing, leads to water logging | Intense rainfall will increase severity of floods. A lower water table will improve drainage |
| **Sanitation** | Pit latrines*, spacious, some latrines within 30 m of boreholes | Pit latrines*, unlined, regularly flood when full | Flooding will lead to contamination of latrines and water supplies |
| **Water Kiosks** | 27 water kiosks, majority leak or waste water and have no meter | 112 Kiosks metered and well managed | Flooding damages facilities, during drought expect water scarcity[¥], this is likely to increase prices leading to vandalism and corruption |
| **Water Quality** | Tube wells reasonable quality but some are compromised by pollutants | Borehole meets WHO guidelines on drinking water quality. Shallow wells are contaminated, 40% population uses these for drinking water | Floods will contaminate source, droughts will increase water scarcity. Potentially higher water tables in winter lead to ingress of groundwater in pipe networks |

*When the latrines are full, new latrines are dug. When there is no space occupants empty latrines onto road or next to latrine and wait for next flood to wash away pile

[¥] Chazanga will suffer from greater water scarcity due to the limited capacity of infrastructure and low yielding boreholes

## Key References:


- **DFiD Guidance Sheets on Climate Change (2010 - Draft):** *Key sheets that summarise the existing guidance available on the implications of climate change for various strategic, sectoral and thematic policy issues (prepared by Cranfield University and the University of Sussex)*
- **IFPRI Paper 00890 (2009)**: The Impact of Climate Variability and Change on Economic Growth and Poverty in Zambia Available at: www.reliefweb.int/rw/RWFiles2009.nsf/FilesByRWDocUnidFilename/VDUX-7WDTAM-full_report.pdf/$File/full_report.pdf
- **IPCC**: **Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability**: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Available at: *www.ipcc.ch/publications_and_data/ar4/wg2/en/ch9.htm*
- **IMF Zambia Poverty Reduction Strategy Paper (2002):** Available at: www.imf.org/external/np/prsp/2002/zmb/01/
- **UNDP Climate Change Country profiles (2010):** Analyses of up-to-date observed data and multi-model scenario-based projections. Providing observed and IPCC AR4 model data based on data from 23 different GCMs. Available at: country-profiles.geog.ox.ac.uk
- **Zambia. Initial national communication under United Nations Framework Convention on Climate Change (2004).** Ministry of Tourism Environment and Natural Resources. Available at:www.adaptationlearning.net/sites/default/files/zambia_inc.pdf
- **Zambia: National Adaption Plan for Action (2007**): UN supported process to identify priority activities and immediate needs with regard to adaptation to climate change. Available at: www.preventionweb.net/files/8581_zmb01.pdf


Tom Heath 2010 Cranfield University t.t.heath@cranfield.ac.uk