Climate Change Profile

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Zambia

Contents

General Climate[1]

At 8-17° south of the equator in central southern Africa, Zambia experiences a tropical climate. However, the high altitudes of the East African plateau keep temperatures relatively cool throughout the year. The highest seasonal temperatures are reached in the hot, dry season of September-October-November ('SON') (22-27°C), and coolest in the winter months June-July-August ('JJA') (15-20°C).

The hot summer months are very dry, receiving almost no rainfall between June and August. The wet season rainfalls are controlled by the passage of the tropical rain belt (also known as the Inter-Tropical Conversion Zone, or ITCZ). The ITCZ oscillates between the northern and southern tropics over the course of a year, bringing rain between October and April of 150-300mm per month. Variations in the movements of the ITCZ can cause large variations in the rainfall received from one year to the next. Rainfall in Zambia is also strongly influenced by the El Niño-Southern Oscillation (ENSO), which causes further inter-annual variability. El Niño conditions (warm phase) bring drier than average conditions in the wet summer months of December-

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

January-February ('DJF') in the southern half of the country, whilst the north of the country simultaneously experiences significantly wetter-than average conditions. The reverse pattern occurs with La Niña (cold phase) episodes, with dry conditions in the north and wet conditions in the south.

Key climate vulnerabilities: Flooding; drought; infectious disease epidemics

Observed Climate Changes[2]

Temperature

- Mean annual temperature has increased by 1.3°C since 1960, an average rate of 0.29°C per decade. This is more rapid than the global average rate of warming. The rate of increase is most rapid in the winter (JJA), at 0.34°C per decade, but is similar across the different regions of the country.
- Daily temperature observations show increasing trends in the frequency hot days[3] and nights in all seasons. In each decade since 1960, on average, the country has experienced an additional 10 days in every year that are classed as 'hot'. This increase is seen most strongly in March-April-May (MAM).
- Hot nights have also increased in frequency by an additional 10 hot nights in each year every decade. This trend is the strongest in summer (DJF), and slowest in winter (JJA).
- The frequency of cold days[4] and nights has decreased since 1960 in all seasons. In each decade since 1960, on average, the country has experienced 5 fewer days in every year that are classed as 'cold'. This rate of decrease is most rapid in MAM and least rapid in SON.
- Cold nights have decreased in frequency by 8 nights per year per decade. This rate of decrease is most rapid in MAM and least rapid in SON.

Precipitation

- Mean annual rainfall over Zambia has decreased by an average 1.9mm per month (2.3 percent) per decade since 1960. This annual decrease is largely due to decreases in DJF rainfall, which has decreased by 7.1mm per month (3.5 percent) per decade.
- Daily precipitation observations show some indication of reductions in the contribution of heavy[5] events to total rainfall, and the magnitude of maximum 1- and 5-day total rainfall.

Current Climate Vulnerability

Table 1 shows the natural hazards that have occurred in Zambia in the past 20 years. The figures show that Zambia has been particularly affected by flooding and disease outbreaks, but that drought – though less frequent – affects a greater proportion of the population when it occurs. Drought has consequences for food security; between 1986 and 1996, for example, drought-induced crop failures occurred in six out of ten growing seasons in Zambia (allAfrica, 2007).

Flooding causes loss of life, crops and livestock, and damage to homes, schools, medical centres and transport infrastructure. Flooding is a major factor in disease epidemics, particularly in highly-populated urban areas with poor drainage and sanitation systems. The floods in February and March 2010, for example, affected 11 districts across Zambia, including in the capital, Lusaka. Over 120 families had to be relocated into the city's sports stadium as slum areas were submerged by water (ZRCS, 2010). The floods also triggered disease outbreaks, resulting in over 2500 cases of cholera and 41 deaths in Lusaka, with slum areas the worst affected (ACT, 2010).

The impact of El Niño event can vary within the country itself; in the 1997/98 El Niño event, for example, Zambia suffered flooding caused by abnormally persistent and heavy rainfall in the north, yet near-drought

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[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.

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

conditions in the south. In addition to loss of life, flooding washes away crops and homes, hindering food security, development and the economy.

Hazard	Number of Events	Deaths	Total of Population Affected
Drought	3	-	4,173,204
Average per event		-	1,391,068
Epidemic (bacterial)	2	393	11,450
Average per event		197	5,725
Epidemic (viral)	13	713	53,275
Average per event		55	4,098
Flood (unspecified)	2	5	1,917,900
Average per event		3	958,950
Flood (general)	11	55	2,407,483
Average per event		5	218,862

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

Climate Change Projections[6]

Temperature

- Central estimates of mean annual temperature show increases of between 2.0 and 2.8°C by the 2060s, and of 2.4 to 4.5°C by the 2090s. Maximum increases in mean temperature are projected to be 3.4°C and 5.5°C for the 2060s and 2090s respectively. The projected rate of warming is a little more rapid in the southern and western regions of Zambia than the northern and eastern regions (see Figure 1).
- 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 are projected to occur on up to 29 percent of days by the 2060s, and up to 49 percent of days by the 2090s. Seasonal increases are largest for DJF and MAM, with projections of up to 80 percent of days being classed as 'hot' by the 2090s (see Figure 2).
- Projections for increases in 'hot' nights are largest for summer (DJF), with central estimates showing that 78 to 97 percent of all nights will be 'hot' 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, occurring on maximum of 1-4 percent of days in the year, and potentially not at all by the 2090s in many of the projections. Cold nights decrease in frequency more rapidly than cold days.

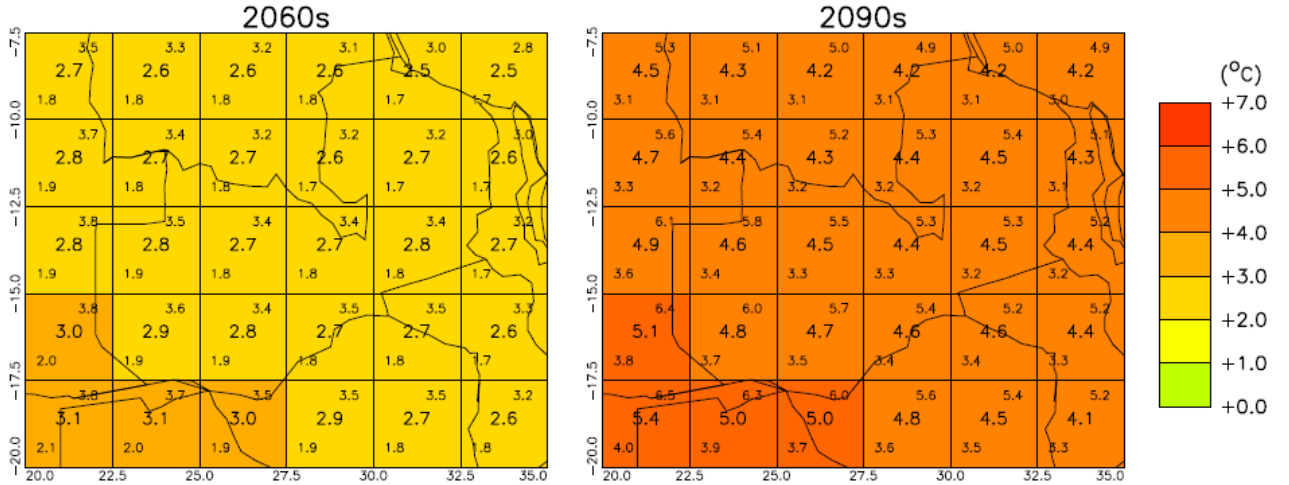

Figure 1 – Projections of mean annual temperature for Zambia for the 2060s and 2090s (the central value in each grid box gives the central estimate of the model projections, and the values in the upper and lower corners give the maximum and minimum) (McSweeney et al., 2008). See 'A note on the projections'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

[6] McSweeney, C. *et al.* (2008) unless otherwise stated

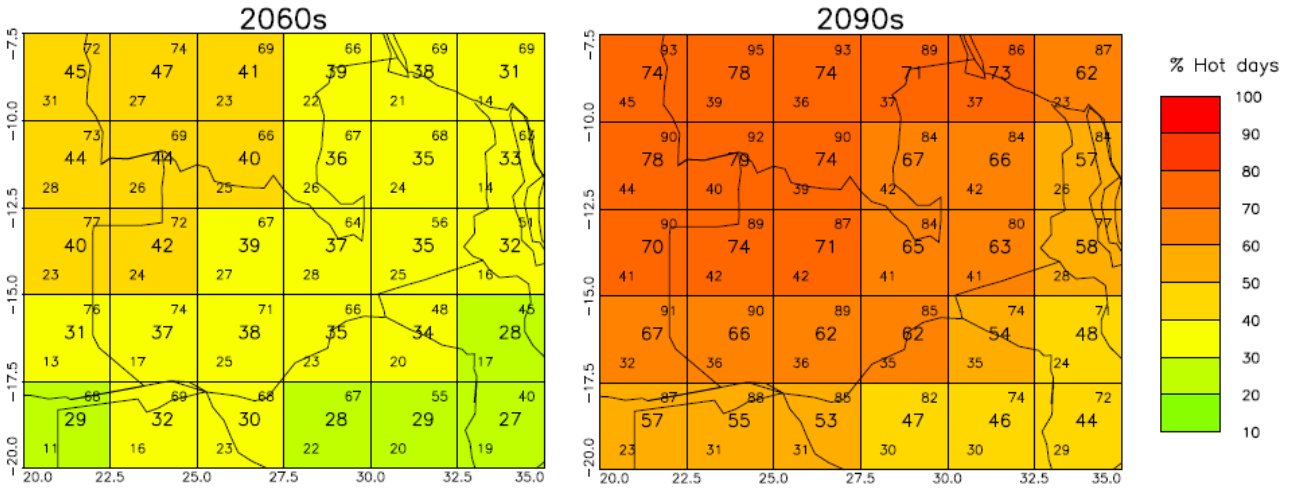

Figure 2 – Projections of percentage changes in frequency of 'hot' days in the JAS season for Zambia for the 2060s and 2090s (see Figure 1 for details) (McSweeney et al., 2008).

Precipitation

- Projections of mean rainfall indicate only small changes for the year as a whole, but larger seasonal changes. The range of projections from different climate models is large, but they indicate small increases in DJF and MAM rainfall, balanced by large decreases in SON rainfall.
- The decreases projected for the SON season are more substantial than any other season; with central estimates showing decreases of between 8 and 12 percent by the 2060s, and 4 and 19 percent for the 2090s (see Figure 3). The upper end of the projections show decreases to a maximum of 32 and 39 percent for the 2060s and 2090s respectively.
- SON decreases are largest towards the south of the country, while the projected smaller increases during DJF and MAM are concentrated in the north-east.
- The proportion of total rainfall that falls in heavy events is projected to increase annually; with increases in DJF and MAM partly offset by small decreases in JJA and SON (see Figure 4). Increases are concentrated in the north-east, and decreases are most evident in southern areas.
- Projections indicate that maximum 1- and 5-day total rainfall may increase in magnitude in DJF and MAM, and on an annual basis as a whole. Small decreases are projected for SON and little or no change is projected for JJA.

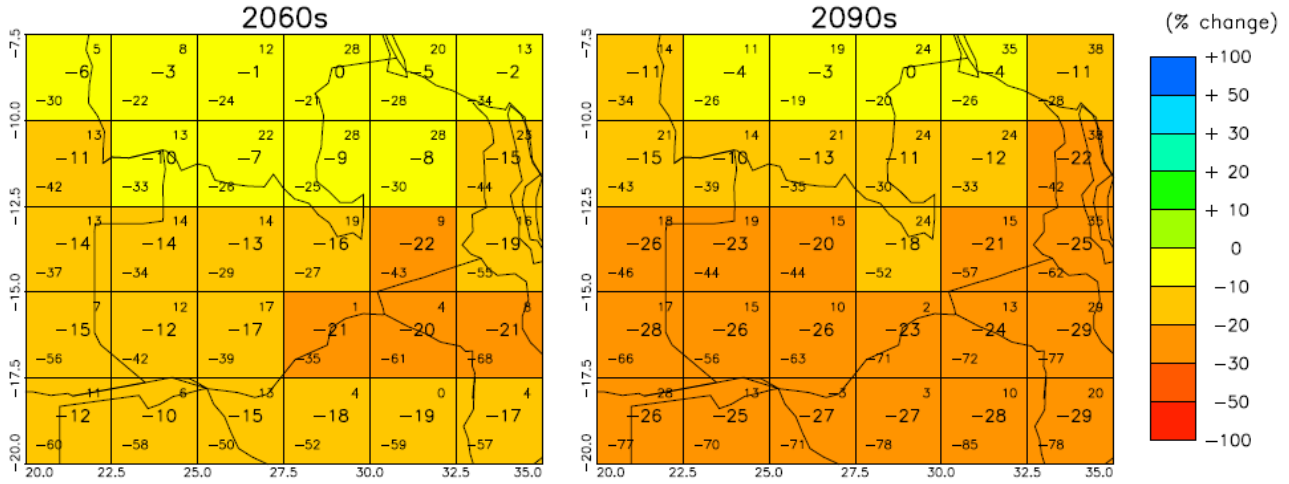

Figure 3 – Projections of percentage changes in SON rainfall for Zambia for the 2060s and 2090s (see Figure 1 for details) (McSweeney et al., 2008).

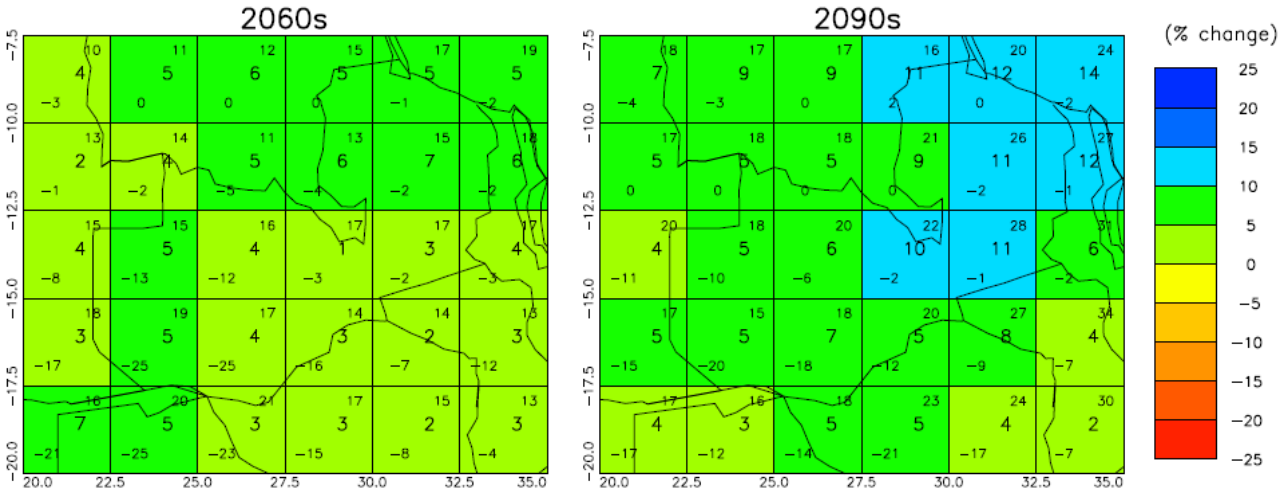

Figure 4 – Projections of percentage changes in the amount of rainfall falling in 'heavy' events during the MAM season for Zambia for the 2060s and 2090s (see Figure 1 for details) (McSweeney et al., 2008).

Climate Change Impacts

Flooding

Zambia already experiences a high incidence of flooding; this is predicted to worsen as rainfall is increasingly likely to fall in heavy events. Within Zambia, flooding causes loss of life and shelter and has knock-on effects on food security, access to clean water, sanitation systems and the spread of infectious disease. Catchments from major rivers such as the Zambezi cross country borders; therefore, the actions in Zambia to divert or store water can affect countries downstream, such as Mozambique. Zambia has many dams for hydro-electricity generation, so discharges from reservoirs can contribute to flooding issues downstream.

Water Resources

In 2006, the proportion of households with access to safe water was 59 percent, this was higher in urban (about 89 percent) than in rural areas (about 43 percent) (CSO, 2006). While changes in total annual rainfall are likely to be small, changes in seasonal rainfall are likely to be more important. Zambia has abundant surface water resources, yet communities living in arid parts of the country's agro-ecological region experience severe water shortages during summer. Moreover, population increases in urban centres have also put pressure on groundwater. Ground water resources are negatively affected by drought resulting in inadequate recharging, lowering of water tables and drying of boreholes and rivers. Water balances between demands and resources for the drought year with a ten-year return period showed that the Southern province is extremely vulnerable and experiences critical shortages during drought conditions (RoZ, 2007).

Agriculture & Food Security

Around 75 percent of Zambia's population is engaged in agriculture, largely subsistence farming, which will be at risk from a changing climate (IMF, 2002). On average, Zambia currently experiences two to three drought years in a decade; severe droughts often cause total crop failures in the southern and western parts of the country (RoZ, 2007). Reductions in crop yields by as much as 30 percent are projected for Zambia's cereals under various climate change projections, even taking into account the benefit to crops of increased atmospheric carbon dioxide (Parry *et al.*, 2004). Key crops for Zambia, such as maize, would not mature due to shortening of the growing season in the agro-ecological regions of southern Zambia, undermining food security (RoZ, 2007). Lack of rainfall would also affect the number of cattle that can be kept, as availability of pastures is directly related to cattle population.

Public Health

Four main areas are highlighted for concern from climate change impacts in Zambia; they include malaria, schistosomiasis (also known as bilharzia), water-borne diseases, and malnutrition (McMichael *et al.*, 2003). An increase in extreme rainfall events will increase the breeding habit for mosquitoes, and an increase in average temperatures may cause an expansion of the area where malaria is a risk (van Lieshout *et al.*,

2004). The prevalence of schistosomiasis may also increase as the average temperatures in previously unaffected areas increases to within the threshold for the schistosomiasis parasite. Prevalence of water-borne diseases and malnutrition would increase as an indirect impact of other hazards such as flooding and drought.

Housing & Communities

Housing infrastructure will be under increasing threat from floods throughout the 21st century, which includes houses constructed from mud, with thatched roofs, in rural areas and shanty housing in urban townships.

Biodiversity & Conservation

Forests are under threat from extended droughts, which lead to land degradation and loss of soil fertility, as well as forest fires. Under excessive rainfall, wetland animals like the Lechwe and Puku would be adversely affected (RoZ, 2007).

Livelihoods

Zambia's economy relies heavily on agricultural exports, which experienced a bumper harvest in 2007, boosting GDP and helping to contain inflation. Despite high levels of poverty, Zambia's economy has strengthened with single-figure inflation, a relatively stable currency, decreasing interest rates, and increasing levels of trade (CIA, 2008). This stability is dependent on continuing strength in the agricultural sector, which is damaged through natural disasters. Therefore, Zambia's economy will be at risk under climate change and more frequent flooding events.

Energy

In 2006, approximately 19 percent of households in the country had access to electricity; urban households were more likely to have access, with 49.3 percent compared to 3.2 percent for rural areas (CSO, 2006). The energy sector generally derives the hydro-electric power from a number of sources, which includes Kariba dam, and Kafue gorge (RoZ, 2007), accounting for around 70 percent of domestic power consumption (STC, 2007). However, this has been negatively affected by the droughts and floods, as extremes in water availability affect the regular discharges needed for power generation. Drought in particular has had devastating effect on the hydropower generation in Zambia with significant economic reduction in the power potential (RoZ, 2007).

Transport

Transport infrastructure will come under increasing threat from flooding throughout the country, this has associated affect in the ability of aid to be delivered to the worst affected areas.

Government Response

The Ministry of tourism, environment and natural resources, in conjunction with the United National Development Programme (UNDP) and the Global Environment Facility (GEF), produced the National Adaptation Programme of Action on Climate Change (NAPA) in September 2007. They have also produced a National Communication on Climate Change, which includes an inventory of greenhouse gas emission and an assessment on potential measures to limit greenhouse gas emissions.

With the help of the UNDP, the government of Zambia established the climate change facilitation Unit (CCFU) in 2009, which has the responsibility of coordinating climate change issues in the country, with a objective of helping to build capacities and institutions required to effectively combat climate change at the national level (UNDP, 2010). In collaboration with GEF's small grants programme, the UNDP has allocated grants $50,000 for non-governmental and community-based organizations for climate change mitigation and adaptation; conservation of biodiversity among others.

The government has increased the amount of subsidised fertilizer to small-scale farmers – from 80,000 to 100,000 tonnes in an attempt to boost production of white maize (Reuters, 2009). This is part of a wider plan to increase harvests of white maize to 5 million tonnes (from 1.3 million in 2007/08 and 1.9 million in 2008/09) and become a major exporter to neighboring countries (ibid). Combined with cheaper seed prices and fixed prices for government purchase, Zambia has moved to become a net exporter of the grain.

Likely Adaptation Options

- With the increased risk to housing from floods, one adaptation option will be to promote the use of concrete for housing where possible. By subsidising the cost of concrete, this could provide more structurally sound buildings that can withstand flood events.
- The high temperatures and reduction in rainfall is likely to reduce the ability of Zambia's forests to regenerate once cleared. As forest are an important source of fuel, for domestic use and charcoal production for example, it will be necessary to reduce the pace of deforestation to allow sufficient re-growth.
- Adaptation of crops (cereals, legumes, root crops, and horticultural crops); including promotion of early maturing and drought-resistant crops.
- Promotion of irrigation and efficient use of water resources, including rainwater harvesting.
- Development of small dams, and other storage facilities, to mitigate droughts and flooding, to harvest water and to initiate community-based fish farming and breeding (RoZ, 2007).
- Targeting afforestation and re-afforestation programmes to control siltation of streams and rivers as well as to provide fuel wood to minimize encroachment of the forests (RoZ, 2007).
- Strengthening of early warning systems and preparedness for drought and flood events.

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 Zambia. 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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We are Christians passionate about the local church bringing justice and transforming lives – overcoming global poverty.