ZIMBABWE

AFRICAN DEVELOPMENT BANK

NATIONAL CLIMATE CHANGE PROFILE

PRODUCED IN COLLABORATION WITH:
African Climate & Development Initiative, University of Cape Town;
Climate Systems Analysis Group, University of Cape Town;
Energy Research Centre, University of Cape Town; Cirrus Group.

October 2018

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENT

This national climate change profile, one in a series of 25 national-level assessments, is the product of the African Development Bank-led project "Enhancing the capacity of African countries to use climate information to inform decision-making and implement NDCs", sponsored by the Africa Climate Change Fund (bit.ly/AfDB-ACCF). The profiles were developed by a diverse group of experts from the University of Cape Town including the African Climate & Development Initiative (www.acdi.uct.ac.za), the Climate System Analysis Group (www.csag.uct.ac.za) and the Energy Research Centre (www.erc.uct.ac.za)) and the Cirrus Group. In addition, these profiles have benefited from the suggestions and inputs of multiple reviewers over the course of project development, and we would like to recognize and appreciate their efforts.

1. BACKGROUND

1.1. Geographic and socio-economic context

The People's Republic of Zimbabwe (henceforth 'Zimbabwe', shown below in Figure 1-1) is a landlocked country in Southern Africa, bordered by Botswana, South Africa, Mozambique and Zambia. Zimbabwe has a population of ~15.6 million people, ~69% of whom are rural and are reliant on smallholder subsistence farming and livestock.

Zimbabwe's economy, GDP currently estimated at ~USD 16.3 billion per year, was severely impacted by several years of consecutive recession within a series of political and financial crises in the period from 2000 – present. As a result of unprecedented hyper-inflation and shortages of cash currency, food and fuel, economically important sectors such as agriculture and industry declined in productivity and GDP per capita decreased by ~40% between 2000–2007. Zimbabwe subsequently discontinued the use of the Zimbabwean dollar in favour of international currency standards and initiated a series of structural reforms under a government of national unity in the period 2009 onwards, which supported a period of positive economic growth and increased foreign exchange earnings. In the subsequent period since 2013, economic growth has since stagnated amid renewed economic uncertainty and introduction of ambitious indigenisation policies. Reported poverty levels and rates of employment in the formal sector vary widely between sources, where it is estimated that up to 90% of working age Zimbabweans are unemployed.

The mining and mineral processing sector, based on diverse natural resources including coal, gold, platinum, copper, nickel, tin, iron and diamonds, is the largest contributor to Zimbabwe's formal economy and export earnings. Agricultural exports of cash crops, particularly tobacco, continue to provide an important contribution to foreign exchange earnings although several other commercial cash crop sectors (inter alia coffee, cut flowers, peanuts and sugarcane) have not recovered to historic levels of productivity. In addition, remittances sent by expatriated Zimbabweans working abroad contributes an estimated ~USD 780 – 980 million per annum. As a result of the large rural population, the majority of whom are partially reliant on crop and livestock-based agriculture, the negative effects of climate-related risks have the potential to effect large numbers of people. In terms of total numbers of people affected by drought, it is estimated that the effects of drought in Zimbabwe impacted about ~16.3 million people in the country during the period 1996-2016. The country is also vulnerable to flood events with ~344,000 people being affected in the same period. The ND-GAIN index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. Zimbabwe's ND-GAIN index is 36.8. This value is composed from a low readiness score and a high vulnerability score and indicates that the country has both a great need for investment and innovations to improve readiness and a great urgency for action. Other key socio-economic and demographic indicators for Zimbabwe are summarised in Table 1-1, overleaf.

Figure 1-1: Map of Zimbabwe

Table 1-1: Socio-Economic Context of Zimbabwe (reference year ranges from 2014 - 2017)

VARIABLE	SCORE/TOTAL	UNIT	RANK (IN AFRICA)
Geography, Socio-Economy and Demographics			
Population 1	15,555,989	people	23
Population growth rate[1]	2.3	% population .yr-1	35
Population density[1]	42	People/km2	34
Land area[1]	387,151	km2	26
% Urban population[1]	30.6	% population	40
% Urbanisation rate[2]	2.0	% population .yr-1	46
Economy: total GDP[2]	16.3	USD billions .yr-1	18
Economy: GDP by PPP[2]	32	billion international dollars .yr-1	24
Economy: GDP/capita[2]	1,009	USD per capita/yr	25
Population below the poverty line[3]	21.4	% below USD 1.90 per day	37
Gender Inequality Index[4]	50.4		31
GINI co-efficient[3]	43.2		25
HDI[5]	0.52		24
Access to electricity[6]	32.3	% population	31
Summary indicators of climate change vulnerability			
Workforce in agriculture[6]	67.2	% workforce	12
Population undernourished[7]	33.4	% population	5
Number of people affected by drought[8]	16,322,618	people	7
Number of people affected by flood events[8]	344,150	people	25
Population living in slums[6]	25.1	% urban population	43
Incidence of malaria[7]	114	cases per 1000 population at risk	29
ND-Gain Vulnerability Index[9] Total	36.8		38
Readiness	0.25		48
Vulnerability	0.52		36

1 Derived from 2012 Census, published in 2017 Inter-Censal Demographic Survey, Zimbabwe National Statistics Agency, www.zimstat.co.za

2. CLIMATE AND WEATHER

The climate of Zimbabwe varies markedly due to topography being humid subtropical over the Highveld to semi-arid over the lower elevation areas along the Zambezi and especially Limpopo River valleys. Rainfall occurs in a single rainy season during austral summer and there is a clearly defined dry season during winter. The rainfall regions or river catchments of Zimbabwe extend far beyond the country's borders; The Zambezi catchment extends into Zambia and eastern Angola where the rainfall is generally higher, especially over the northern parts. The other major catchment is the Limpopo catchment which extends into the Limpopo province of South Africa and eastern Botswana where rainfall is generally lower than over Zimbabwe itself.

Climate variations within the full region are large and therefore five sub-regions are distinguished here. Three of these regions fall fully within the borders of Zimbabwe while the other two partly or fully outside the country. The Zimbabwe regions are illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

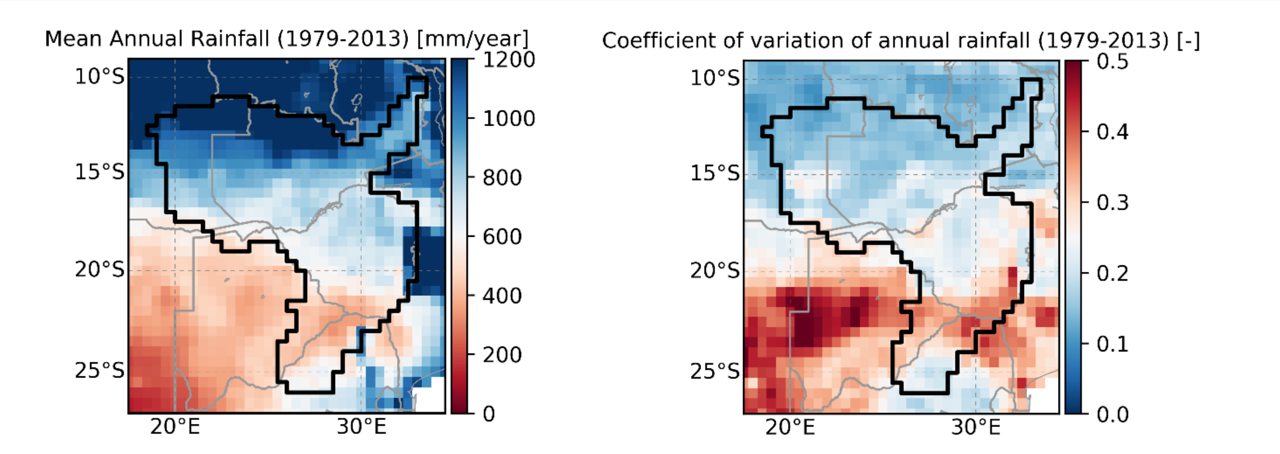
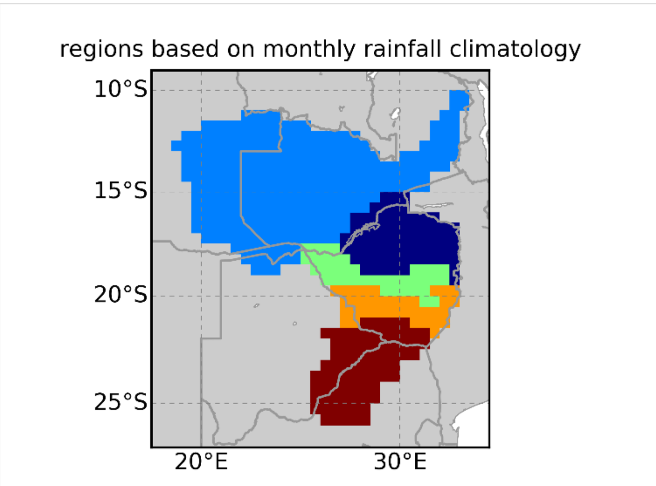


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Zimbabwe and its region



Coloured regions on the map (above) correspond to the colours used in rainfall and temperature graphs (below)

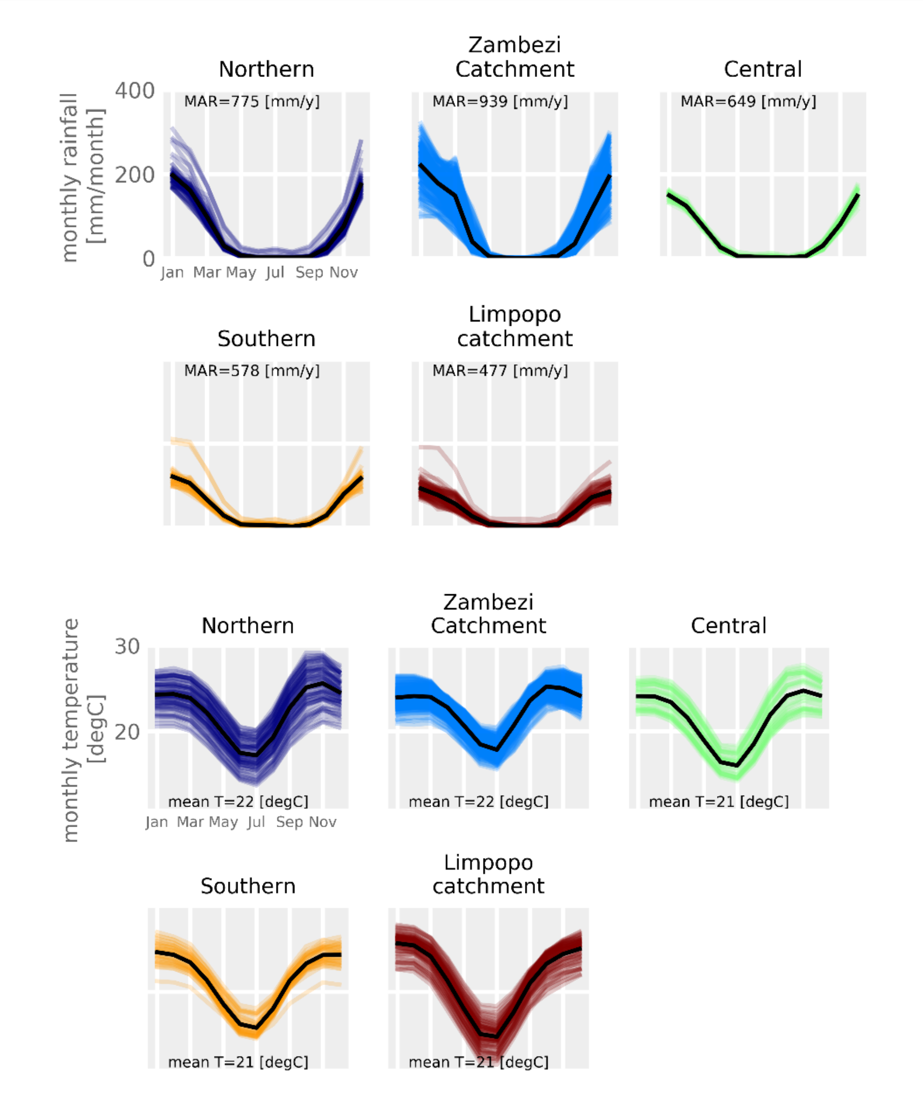


Figure 2-2: Rainfall regions of Zimbabwe based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main characteristics of rainfall of Zimbabwe region

ZAMBEZI CATCHMENT	A large heterogeneous rainfall region with a mean annual total rainfall of 940 mm/year. Rainfall is generally higher over the northern parts and decreases to the south. Interannual or year to year variability is relatively low to the north becoming more moderate to the south. Rainfall generally occurs during austral summer (November – March) peaking at 200 mm/month during January, however some locations show a later peak during March. A clear dry season occurs from May to September. Daily mean temperature averages 22° C with a seasonal cycle of around 8° C with coolest temperatures during June-July and warmest temperatures in October-November (just before the start of the rainy season).
NORTHERN	A moderate rainfall region with a mean annual total of 780 mm/year. Rainfall is generally highest over the higher elevation areas and especially over the mountains in the far east of the country. Interannual rainfall variability is generally moderate, but higher over the more eastern facing catchments. Rainfall generally occurs during austral summer (November – May) peaking at 200 mm/month during January. A clear dry season occurs from May to September. Daily mean temperature averages 22° C with a seasonal cycle of around 9° C with coolest temperatures during June-July and warmest temperatures in October-November (just before the start of the rainy season).
CENTRAL	A rainfall region which runs along the watershed between the Limpopo and Zambezi River catchments and has a mean annual total rainfall of 650 mm/year. Little spatial variability in rainfall is evident, but it is generally higher over the higher elevation and lowest over the far west. Interannual variability is moderate over the central parts, but higher over the eastern and western part. Rainfall occurs during austral summer (November – March) peaking at around 180 mm/month during December and January. A clear dry season occurs from May to September. Daily mean temperature averages 21° C with a seasonal cycle of around 8° C, with coolest temperatures during June-July and warmest temperatures in October-November (just before the start of the rainy season).
SOUTHERN	A rainfall region with a mean annual total rainfall of 580 mm/year. Rainfall is similar across the region with generally high interannual variability over the eastern half and more moderate variability over the west. Rainfall occurs during austral summer (November – February) peaking at around 150 mm/month during December to February. A clear dry season occurs from May to September. Daily mean temperature averages 21° C with a seasonal cycle of around 9° C. with coolest temperatures during June-July and warmest temperatures in October-November (just before the start of the rainy season).
LIMPOPO CATCHMENT	A semi-arid region with a mean annual total rainfall of 480 mm/year. Rainfall is lowest over the lower elevation of the Limpopo River valley and slightly higher over the higher elevation to the north and south. Interannual variability is high, especially along the Limpopo River Valley. Rainfall occurs during austral summer (November – March) peaking at around 100 mm/month in January. A clear dry season occurs from May to September. Daily mean temperature averages 21° C with a seasonal cycle of around 10° C. with coolest temperatures during June-July and warmest temperatures from October to February.

2.1. Observed historical climate variations and climate change trends

The majority of Zimbabwe experiences **moderate rainfall variability** on an inter-annual basis, however the lower elevation areas, especially those along the Limpopo River catchment show high interannual rainfall variability. The more northern parts of the Zambezi River catchment have lower interannual variability associated with the higher rainfall. On **decadal time scales** all the Zimbabwe regions experience **significant variability** with some periods being relatively drier or wetter than others. This variability can be seen in the supporting evidence plots provided in the supplementary Appendix **(Figures A-1 to A-4).**

Long term trends across the region show **increasing temperatures** over the period 1979 – 2015, although the trends appear to be weaker in the second half of that period. Long term trends in total annual rainfall are either not evident or upward for the regions, with only the Zambezi Catchment region showing a statistically significant increase. No trend is generally seen in the frequency of rain events however extreme rainfall events do show an upward trend especially in the Zambezi Catchment region. Long term trends and variability in the Zimbabwe regions are summarized in **Table 2-2** below and illustrated further in the supplementary Appendix **(Figures A-1 to A-4).**

Table 2-2: Summary of trends in rainfall and temperature attributes in Zimbabwe

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Zambezi Catchment	**+0.17**	**+42.2**	upward	**+2.85**
Northern	**+0.24**	upward	not evident	+3.25
Central	**+0.25**	+28.3	not evident	+3.91
Southern	**+0.17**	not evident	not evident	+2.49
Limpopo catchment	**+0.23**	not evident	not evident	slight upward

2.2. Projected (future) climate change trends, including temperature, precipitation and seasonality

Projected changes in main attributes of climate for the Zimbabwe region are summarized in Table 2-3, below, and described in Sections 2.2.1 and 2.2.1. Additional analysis and visualisation of projections be found in Figures A-5 to A-8 in the supplementary Appendix.

2.1.1 PROJECTED CHANGES IN PRECIPITATION FROM PRESENT TO 2100

Rainfall projections across the Zimbabwe regions show a pattern of rainfall remaining within the historical range or potentially decreasing emerging from as early as the 2020s. That pattern appears to be consistent across the regions. Relative magnitudes of potential decreases could be as much as 15% to 30% less than the baseline normal. A strong decrease in the frequency of rainfall events is projected for all regions, but generally no consistent message is found in extreme rainfall frequency. It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics.

2.1.2 PROJECTED CHANGES IN TEMPERATURE FROM PRESENT TO 2100

Air temperature is projected to be about 1.5°C and 3.5°C warmer over the Zimbabwe regions by the 2050s. By 2100 the range of projected temperatures are greater ranging between 3°C to 7°C.

ZIMBABWE

Table 2-3: Summary of projected climate changes across regions of Zimbabwe for key climate variables

REGION	AVERAGE TEMPERATURE [°C]	TOTAL ANNUAL RAINFALL [MM/YEAR]	NUMBER OF HEAVY RAINFALL [DAYS/YEAR]	RAINY DAYS [DAYS/YEAR]
Zambezi Catchment	**Increasing** +1.5°C to +3.5°C by 2050s but changes evident in next decades	**Normal to decreasing,** ranging from no change or nominal decreases to clear decrease (15% drier by 2100). Change could become evident from 2050s.	**Normal to increasing,** ranging from no change to an increase in frequency of up to 40% by 2100. Change could become evident from 2040s.	**Decreasing,** ranging from non-significant to strong decrease of up to 20% by 2100. Change could become evident from 2040s.
Northern	**Increasing** +1.5°C to +3.5°C by 2050s but changes evident in next decades	**Normal to decreasing,** no consensus by 2050, but ranging from no change or nominal decreases to clear decrease (30%) by 2015. Change could become evident from 2020s.	**No consistent message,** model projections range from decrease to strong increase by 2100.	**Decreasing,** ranging from non-significant to strong decrease of up to 30% by 2100. Change could become evident from 2040s.
Central	**Increasing** +1.5°C to +3°C by 2050s but changes evident in next decades	**Normal to decreasing,** most models show no change into the future, with the exception of a few models that show decreasing rainfall of up to 30% by 2100. Change may become evident from 2020s.	**No consistent message,** model projections range from decrease to strong increase by 2100	**Decreasing,** ranging from non-significant to strong decrease of up to 30% by 2100. Change could become evident from 2020s.
Southern	**Increasing** +1.5°C to +3°C by 2050s but changes evident in next decades	**Normal to decreasing,** most models show no change into the future, with the exception of a few models that show decreasing rainfall of up to 30% by 2100. Change may become evident from 2020s.	**No consistent message,** model projections range from decrease to strong increase by 2100	**Decreasing,** ranging from non-significant to strong decrease of up to 25% by 2100. Change could become evident from 2040s.
Limpopo catchment	**Increasing** +1.5°C to +3.5°C by 2050s but changes evident in next decades	**Normal to decreasing,** most models show no change into the future, with the exception of a few models that show decreasing rainfall of up to 30% by 2100. Change may become evident from 2040s.	**Normal,** no change from natural variability into the future, with the exception of a few models that show some wetting.	**Decreasing,** ranging from non-significant to strong decrease of up to 20% by 2100. Change could become evident from 2040s.

2.3. Expected climate vulnerabilities

NOTE: Determining vulnerability of different sectors to climate variations or change is extremely challenging as there are many factors involved in vulnerability and different approaches can yield different results. The vulnerabilities presented here are based on UNFCCC reporting documents such as national communications or national adaptation plans of action where available, and other literature where UNFCCC documents are not available 2.

In landlocked and natural resource rich Zimbabwe increasing temperatures coupled with indications that annual rainfall may be normal to decreasing into the future could put stress on water resources, and strain water supplies which are heavily reliant on surface water. This could also have implications for hydro-power plants, whose limited capacity is already a constraint to the economy. Agriculture, whose irrigation efficiencies rate poorly, is a large water user. While an important contributor to the economy, agriculture, through subsistence farming and livestock further sustains the majority of the rural population, deeming both households and the economy vulnerable to increasing temperatures and possible rainfall changes. The Zimbabwean economy has in recent years been impacted by recession and political and financial crisis, and while numbers vary it has been indicated that unemployment among the working age Zimbabweans could be as high as 90%. High unemployment and massive dependence on agricultural subsistence thus implies that a large portion of the population has limited adaptive capacity and is greatly sensitive to increasing temperatures and potentially increasing water scarcity.

Table 2-4: Broad scale sectoral vulnerabilities and potential climate change impacts in Zimbabwe

SECTOR	IMPACTS
Agriculture	- Reduced rainfall, reduced yields from rainfed agriculture - Increased soil degradation, reduced soil fertility - Increased incidence of crop and livestock pests/diseases - Damage and crop loss from floods and extreme rainfall - Reduced quality and availability of forage for livestock
Fisheries	- Increased severity of wildfires - Changes in composition, density and distribution of plant and wildlife - Loss of forest cover
Water resources	- Reduced river flows and fresh water storage, owing to increased evaporation and reduced infiltration of groundwater - Reduced water quality due to siltation - Increased cost of groundwater abstraction - Increased uncertainty of river flows, owing to changing rainfall - Water-related effects on health sector
Built infrastructure and human settlements	- **Damage to or destruction of outdated infrastructure, owing to extreme events**

2 Also includes Zimbabwe's National Climate Change Response Strategy, http://www4.unfccc.int/sites/nama/_layouts/UN/FCCC/NAMA/Download.aspx?ListName=NAMA&Id=165&FileName=Climate%20Change%20Response%20Strategy.pdf

SECTOR	IMPACTS
Human health	- Changes in the geographic distribution of vector-borne diseases such as malaria, owing to changes in temperatures and precipitation - Increased prevalence of diseases such as diarrhoea, cholera, typhoid, guinea worms and dysentery, owing to reduced availability of safe water - Increased general health risks owing to intensified or altered flood patterns - **Increased prevalence of water-borne diseases, such as cholera, typhoid and bilharzia, owing to intensified flooding** - Enhanced spread of meningitis, owing to increased temperatures

3. CLIMATE CHANGE MITIGATION, GREENHOUSE GAS EMISSIONS AND ENERGY USE

The major carriers of Zimbabwe's energy mix, and the energy demands of major economic sectors, are summarised in Section 3.1, below. The major sources of GHG emissions, described by fuel source and sector, are described in Section 3.2. The latter section also includes summarised statistics on Zimbabwe's agriculture sector, historical land use change and vegetation cover Zimbabwe's national energy consumption and resultant GHG emissions includes multiple sectors, of which the most important sources of Zimbabwe's GHG emissions are related to secondary emissions resulting from diverse practices and activities in the industrial, waste management, agriculture and forestry sectors, contributing ~48 MT CO_2e out of a total of ~63.5 MT CO_2e (see 3.2.2, below).

3.1. National energy production and consumption

Zimbabwe's energy sector, and the resultant distribution of GHG emissions is largely characterised by a split between three major users and fuel sources: i) the manufacturing, industrial and mining sector activities which demand electricity, coal and diesel to support extraction, processing and transport of commodities; ii) grid-connected electricity users, primarily comprising urban households and commercial enterprises, generated by hydropower and coal; and iii) the use of biomass fuel by impoverished rural and urban households to meet domestic energy needs, including both firewood as well as charcoal (the latter particularly in urban areas).

Zimbabwe's national energy production, totally 11.5 MTOE per annum, is primarily supplied by biomass energy (~7.3 MTOE), local coal deposits (~3.7 MTOE) and hydroelectricity (0.5 MTOE). Hydroelectricity facilities generate ~54% of national electricity supply, with the remainder contributed by coal (~44%) and a small share from oil (0.5%) and renewables (1.4%).

Of the various contributing sources, the consumption of biomass fuel accounts for the majority of national energy consumption (7.3 MTOE or ~79% of total), followed by oil (~1.2 MTOE), electricity (0.7 MTOE) and coal (0.3 MTOE). The residential sector accounts for the largest share of Zimbabwe's national energy consumption (~7 out of a total of 9.2 MTOE) (Table 3-3), which is likely to include a large proportion of the total 7.3 MTOE biomass energy produced as well as a share of the 0.7 MTOE electricity generated. The transport sector, primarily comprising road transport, accounts for consumption of ~0.9 MTOE of Zimbabwe's energy, while demands for energy from the industrial and manufacturing sectors (including energy-intensive applications related to smelting, processing and purification of metals) have slowed as a result of decreased production and economic activity to consume ~0.7 MTOE energy per annum.

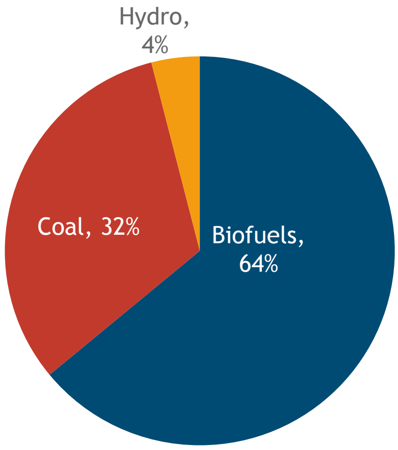


Figure 3-1: Distribution of Zimbabwe's national energy production between major energy carriers

Table 3-1: National energy and electricity production in Zimbabwe

NATIONAL ENERGY PRODUCTION		
Source	**Total (MTOE)[3]**	**% of total energy production**
Coal[10]	3.7	32.4
Hydro[10]	0.5	4.1
Biofuels[10]	7.3	63.6
Total national energy production	11.5	
Electricity[12]	Hydro	54.2
	Non-Hydro renewable	1.4
	Coal	43.9
	Oil	0.5

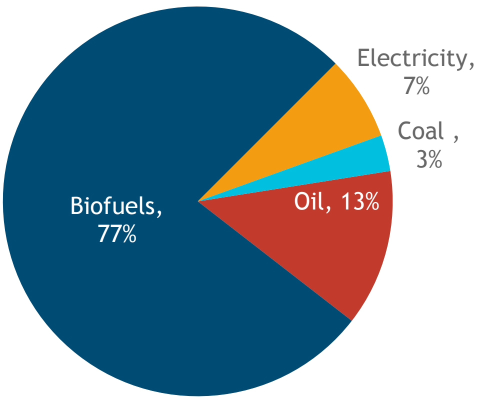


Figure 3-2: Distribution of Zimbabwe's national energy consumption by major energy carriers

Table 3-2: Zimbabwe's national energy consumption by energy source

CONSUMPTION BY ENERGY SOURCE[10]	
Source	**Total (MTOE)**
Coal	0.3
Oil	1.2
Biofuels	7.3
Electricity	0.7
Total national energy consumption by source	9.4

[3] *Energy is expressed in 'Megatonnes of Oil Equivalent', where 1 Tonne Oil Equivalent = 11,630 KiloWatt hours (KWh)*

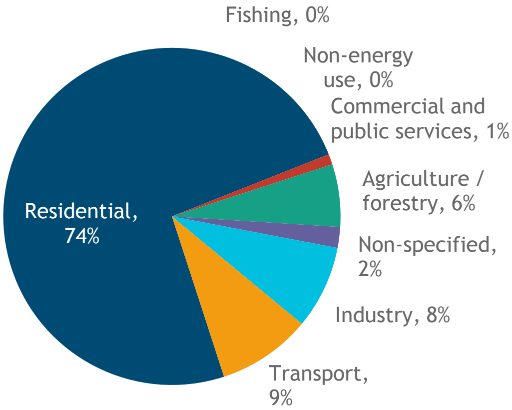


Figure 3-3: Distribution of Zimbabwe's national energy consumption by sector

Table 3-3: Zimbabwe's national energy consumption by sector

CONSUMPTION BY SECTOR[10]	
Source	**Total (MTOE)**
Industry	0.7
Transport	0.9
Residential	7.0
Commercial and public services	0.1
Agriculture / forestry	0.6
Non-specified	0.1
Non-energy use	0.0
Total national energy consumption by sector	9.4

Table 3-4: Zimbabwe's national total primary energy supply

TOTAL PRIMARY ENERGY SUPPLY[10]	
Source	**Total (MTOE)**
Coal	2.0
Oil	1.3
Hydro	0.5
Biofuels	7.3
Electricity	-0.01
Total primary energy supply	11.1

3.2. National greenhouse gas emissions by source and sector

Section 3.2.1, below, describes GHG emissions from fuel combustion – these figures include direct combustion of fuels as a primary energy carrier as well as conversion to other forms of energy (e.g. as electricity). The latter figures are based on statistics from the International Energy Agency (IEA). Section 3.2.2, further below, describes GHG emissions from all sectors of national energy consumption, which therefore includes emissions from fuel combustion, industrial/manufacturing processes, household-level energy consumption and AFOLU (Agriculture, Forestry and Other Land Use). The latter figures are compiled by the World Resources Institute's Climate Access Indicator Tools (CAIT), which employs different methodologies and reporting standards to the IEA. Therefore, while there is some resultant duplication between the two datasets, each provides slightly different approaches to categorisation of major GHG emitting sectors and are both included for consideration. Section 3.2.3 provides additional details on Zimbabwe's Land Use and Land Use Change sector, including detailed summaries of emissions from the agriculture sector and historical land use changes.

3.2.1. GHG EMISSIONS FROM FUEL COMBUSTION, BY SOURCE AND SECTOR

The two largest contributors to Zimbabwe's GHG emissions from fuel combustion in the energy sector (totalling 13.5 MT CO2e) can be attributed to coal (9.2 MT CO2e) and oil (4.2 MT CO2e) (Table 3-5). The applications and activities which account for the largest proportion of emissions from energy use include production of electricity and heat (~4 – 6.8 MT CO2e) (Tables 3-5 and 3-6), supplying residential as well as commercial and industrial users. The non-residential sector accounts for the largest share of other emissions (4.1 MT CO2e) which is likely to include industrial processes such as smelting, purifying and forging of metals and minerals. The transport sector contributes ~2.8 MT CO2e to total annual GHG emissions, 2.6 MT CO2e of which is estimated to be attributable to road transport. Manufacturing industries and the construction industry, which are presently undermined by slow economic growth and are operating at a small fraction of historic productivity, contribute ~1–2.4 MT CO2e or up to ~18% to total national GHG emissions from fuel combustion.

Table 3-5: Zimbabwe's national greenhouse gas emissions from fuel combustion

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR [11]		
Source / Sector		**Total emissions (MT CO_2e)**
Coal		9.2
Oil		4.2
Total fuel source emissions		13.5
Electricity and heat production		4.0
Other energy industry own use*		0.1
Manufacturing industries and construction		2.4
Transport	Road	2.6
	Other	0.2
	Total	2.8
Other	Residential	0.1
	Non-residential	4.1
	Total	4.2
Total sector emissions		13.5

** Includes emissions from own use in petroleum refining, the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries.*

3.2.2. GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION, BY SOURCE AND SECTOR

As described in Section 3.2.1, above, Zimbabwe's emissions from primary energy consumption are estimated to be ~13 –15 MT CO_2e, of which the electricity, heat and 'other fuel combustion' sectors account for the largest proportion of emissions from energy consumption. However, despite the significant emissions of GHGs from the latter sources by direct consumption of primary energy, the largest sources of Zimbabwe's GHG emissions are related to secondary emissions resulting from diverse practices and activities in the agriculture and forestry sectors (and to a lesser degree from the industrial and waste management sectors), totalling ~46.5 – 48.5 MT CO_2e (Tables 3-6 & 3-7). The two largest sources of emissions from these sectors, and the largest sources of Zimbabwe's GHG emissions overall, are the sectors of agriculture (contributing ~10 MT CO_2e or ~21% of total national emissions) and land use change/forestry (which contributes ~36.1 MT CO_2e or ~74% of total national GHG emissions). Several activities which drive emissions from this sector include clearance of savanna and woodland to establish crop agriculture, burning of rangelands to encourage regrowth of grazing for livestock, and removal of wood for fuel (including firewood used by rural households as well as for production of charcoal to supply urban households). These activities are described and quantified further in Section 3.2.3, below. Including direct and indirect emissions, Zimbabwe's total annual GHG emissions are estimated to be ~63.5 MT CO_2e.

.

Table 3-6: Zimbabwe's national greenhouse gas emissions from primary energy consumption

NATIONAL GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION BY SOURCE AND SECTOR [12]		
Source / Sector		Total emissions (MT CO_2e)
Energy	Electricity and heat	6.8
	Manufacturing and construction	1.0
	Transport	2.9
	Other fuel combustion	4.2
	Fugitive emissions	0.2
	Energy sub-total	15.1
Industrial processes		1.6
Agriculture		10.0
Waste		0.7
Land use change and forestry (LUCF)		36.1
Total emissions (including LUCF)		63.5

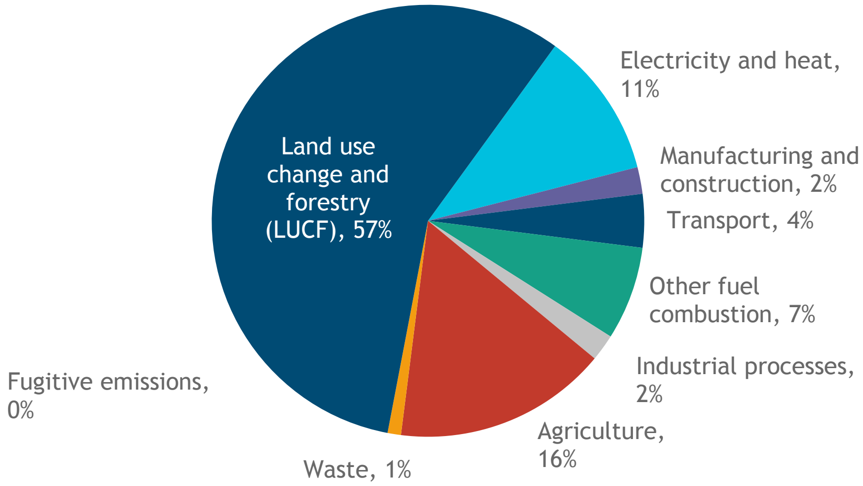


Figure 3-4: Distribution of Zimbabwe's GHG emissions by major sectors

3.2.3. GHG EMISSIONS FROM AGRICULTURAL PRACTICES

As detailed above in Section 3.2.2, Zimbabwe's agriculture, land use change and forestry sectors contribute the largest proportion of national GHG emissions. Emissions from the agriculture sector, which contribute ~10.4 MT CO_2e, are driven by multiple factors including burning of savanna grasslands (~2.1 MT CO_2e), application of synthetic fertilisers (0.6 MT CO_2e) and management of crop residues (collectively ~0.3 MT CO_2e). However, livestock husbandry and particularly the practices for management of livestock manure are the largest contributors to agricultural GHG emissions, accounting for emission of ~7.3 MT CO_2e per annum (Table 3-7).

With respect to emissions from land use change in forest and woodland areas, forest lands are estimated to be the source of at least 36 MT CO_2e GHGs per annum (Table 3-7), which includes emissions from clearance of vegetation and resultant loss of labile organic carbon (e.g. emission of CO_2 from degraded soils) as well as subsequent combustion of woodfuels. The activities driving the emissions from land use change may include multiple factors, including the removal of high-value timber for export, the clearance of new land for agriculture, and the increasing demand for firewood to cure the valuable export tobacco crops.

Table 3-7: National annual greenhouse gas emissions from agricultural practices, forestry and other land use in Zimbabwe (estimated for 2015)

VARIABLE	ZIMBABWE	ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [13]	Burning - crop residues	0.1
	Burning - savanna	2.1
	Crop residues	0.2
	Enteric fermentation	4.0
	Manure management	0.3
	Manure applied to soils	0.1
	Manure left on pasture	3.0
	Rice cultivation	0.0
	Synthetic fertilizers	0.6
	Sub-total (Agricultural practices)	10.4
Annual GHG emission from land use change[13]	Forest land	36.0
	Burning biomass	0.0
	Sub-total (Land use change)	36.1
Total emissions		46.5

As described in Table 3-8 (below), 16.6 million hectares (~42% of total land area) is characterised by woody vegetation cover of density at least ~10-30% canopy cover, which is a major labile sink for Zimbabwe's GHG emissions. Estimated deforestation rates range from 0.1% up to 1.7% (for the densest forest class of '50-100% canopy cover). At present, Global Forest Watch estimates that Zimbabwe's forests and woodlands contain an estimated ~452 million tonnes of carbon as biomass.

Table 3-8: Vegetation cover and land use change in Zimbabwe

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [14]	10-30% canopy cover	16,618,688	42.53	% of total land area
	30-50% canopy cover	1,038,077	2.7	
	50-100% canopy cover	206,174	0.5	
	Total	17,862,939	45.7	
Land use change and agricultural expansion	Historical annual rate of deforestation[15]	10-30% canopy cover	0.1	% of previous year
		30-50% canopy cover	0.4	
		50-100% canopy cover	1.7	
	Historical annual area converted to agricultural land[16]	16,486,164	42.2	% of previous year

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Zimbabwe's main priority actions related to climate change are described in the country's submissions to the UNFCCC through the Intended Nationally Determined Contributions (INDC) document. This document includes detailed descriptions of Zimbabwe's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to adaptation, derived from the Climate Response Strategy and draft National Adaptation Plan (NAP) (Table 4-3, further below).

"The Mitigation Contribution for Zimbabwe is given as 33% below the projected Business As Usual energy emissions per capita by 2030. This is a contribution target subject to the following conditions as a minimum: 1. "Full implementation by developed countries of their commitments relating to finance, technology and capacity pursuant to Article 4 of the Convention"; 2. Full, effective and sustained implementation of the Convention; 3. A post-2020 agreement addressing all elements set out in paragraph 5 of decision 1/CP.17 in a balanced and comprehensive manner; 4. Receiving contributions by developed countries on "all elements set out in paragraph 5 of decision 1/CP.17" relating to mitigation, adaptation, finance, technology development and transfer, and capacity-building in the context of a global and comprehensive agreement for the period beyond 2020."

Zimbabwe's INDC notes that investments of up to USD 35 billion will be needed by 2030 for actions related to climate change adaptation in the agriculture sector, which is anticipated to include domestic contributions of ~USD 8.725 billion and therefore requires additional international support of ~USD 26.175 billion by 2030. Further, the INDC notes that additional conditional actions will be implemented subject to availability of other factors inter alia affordable international financial support, investment, technology development and transfer and capacity development etc.

Table 4-1, below, gives details on Zimbabwe's GHG reduction targets outlined in the country's INDC, with information on target gases and sectors, the use of international markets in achieving targets (e.g. the use of carbon credits), and accounting methods used to quantify GHG emissions (e.g. inclusion of land use and land use change).

Table 4-1: Summary of Zimbabwe's INDC commitments for reduction of GHG emissions

GHG EMISSIONS REPORTED IN INDC (MT CO_2E/YR)	BASE LEVEL	REDUCTION TARGET	TARGET YEAR	SECTORS AND GASES	USE OF INTERNATIONAL MARKETS	LAND-USE INCLUSION / ACCOUNTING METHOD
62.93	BAU	33 percent (per-capita) (conditional)	2030	CO_2, CH_4, N_2O; Energy	Not mentioned	Land-sector excluded

4.1. National priorities for climate change mitigation

Zimbabwe's INDC identifies several themes and areas of action related to mitigation of GHGs, including sectors such as energy, transport, waste management and AFOLU (agriculture, forest and other land use). Of the aforementioned sectors, Zimbabwe's priority mitigation actions for the energy sector are comparatively detailed and extensive, including actions to increase the production of energy using renewable or low-emission technologies as well as several measures to increase the efficiency of energy use and distribution.

In particular, examples of GHG-mitigation actions in Zimbabwe's INDC priorities for the energy sector include measures to increase the role of solar power for water heaters and off-grid electrification, increased use of hydro-electricity (including through small-scale hydroelectricity facilities operated by independent power producers) and biogas digesters (aiming to establish ~1,250 digesters by 2030). Measures to increase energy efficiency and reduce demand include upgrades to existing thermal power station technologies, nation-wide efforts to substitute incandescent lightbulbs with compact fluorescent bulbs and promoting increased use of LPG in the energy mix as a substitute or supplement to grid electricity.

By comparison, the list of priority actions and measures identified for Zimbabwe's AFOLU sector are less detailed than the energy sector. In recognition of the large consumption of firewood by the tobacco industry (particularly to supply the energy-intensive tobacco-curing process), Zimbabwe's INDC notes the need to investigate and promote alternative energy systems for tobacco curing. The main priority noted for the AFOLU sector, however, is the implementation of the integrated set of AFOLU actions identified in Zimbabwe's draft national REDD+ programme, which already includes several pilot-scale initiatives focused on integrated landscape-level approaches to reducing emissions (combining agriculture, forestry, livelihood diversification, and investments in local infrastructure such as roads and boreholes). Priorities related to mitigation of GHGs in Zimbabwe's transport sector do not include detailed descriptions, only citing the need to review Zimbabwe's transport system (where opportunities for emissions reductions may include *inter alia* increased use of biofuels, enhancement of public transport, and upgrades to existing railway network as an alternative to road transport. The waste sector (which contributes ~0.7 MT CO_2e or ~1% of total national GHG emissions) is also identified as a sector to be included in GHG mitigation actions, however no details are provided of what actions will be implemented in Zimbabwe's waste management sector.

Proposed activities and investments within each sector are categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for mitigation projects (key for technology types provided below Table 4-2).

Table 4-2: Mitigation priorities in Zimbabwe's INDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE* [4]
Energy	Solar water heaters	1
	Energy efficiency improvement	1, 6
	Increasing hydro in the energy mix	1
	Refurbishment and Electrification of the rail system	1, 5
	Coal-bed methane (CBM) power	1
	Solar powered off-grids	1
	Changing thermal power station technologies	1
	Replacing more than a million incandescent bulbs with compact fluorescent lamps (CFLs) to more than 164,654 houses saving 42 MW	1, 3
	Recognising and rewarding companies making efforts in the area of energy efficiency and carbon footprint as a way of promoting good behaviour	1, 5
	Stepwise increase in Kariba Power Station (hydro power plant) from 666 to 750 MW and then 1050MW. Work on this plant is underway	1
	Promoting the use of liquefied petroleum gas (LPG) as the substitute for or alternative to grid electricity.	1
	Constructing institutional biogas digesters (50 to 80m3 in size) in all provinces with a target of at least 1,250 digesters by 2030	1, 6
	Mini-hydros are already being constructed by Independent Power Producers (IPPs) and the mini-hydro installed capacity and is expected to rise to 27 MW early 2016	1, 6
	Solar energy, which has a huge potential of reducing especially if combined with hydro -power is already under consideration	1
Transport	Reviewing the transport system	2
AFOLU	REDD+ implementation	4, 5
	Sustainable Energy Alternatives of curing tobacco	4
Waste	Integrated waste management	4

[4] **GCF Technology Type Key (derived from GCF's Results Framework for mitigation)*

1. Reduced emissions through increased lower emission energy access and power generation.

2. Reduced emissions through increased access to low-emission transport.

3. Reduced emissions from buildings, cities, industries and appliances.

4. Reduced emissions from land use, deforestation, forest degradation, and through sustainable management of forests and conservation and enhancement of forest carbon stocks.

5. Strengthened institutional and regulatory systems for low-emission planning and development.

6. Increased number of small, medium and large low-emission power suppliers.

7. Lower energy intensity of buildings, cities, industries, and appliances.

8. Increased use of low-carbon transport.

9. Improved management of land or forest areas contributing to emissions reductions.

4.2. National priorities for climate change adaptation

The major adaptation priorities noted in Zimbabwe's INDC are summarised in Table 4-3, below, reflecting potential adaptation measures and actions for sectors including energy, AFOLU, water, human health and institutional capacity. These proposed activities and investments related to adaptation are further categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for adaptation projects (key for technology types provided below Table 4-3). As a particularly drought-prone country, Zimbabwe has already been affected by the impacts of drought and rainfall variability (see Sections 1-1 and 2), which results in constraints to fresh drinking water, negative effects on agricultural productivity and reduced generation of hydroelectricity due to decreased water flow. In consequence, Zimbabwe's adaptation priorities include multiple detailed actions to reduce the negative impacts of climate change on the water sector, such as promotion of water harvesting, construction and/or rehabilitation of water storage infrastructure, development and maintenance of surface and groundwater resources, and measures to promote integrated management of water resources and sustainable management of biodiverse water catchment areas. Zimbabwe's INDC also identifies adaptation priorities for the energy sector to address the threat of reduced rainfall to generation of hydroelectricity, particularly the implementation of management practices that enhance capacity of power generation of hydropower stations in situations of limited water availability due to reduced rainfall.

Zimbabwe's adaptation priorities for the AFOLU sector recognise the strong dependence of the majority of rural populations on agriculture, livestock and various natural resources and forest products as a source of livelihood and emphasise adaptation practices such as the promotion of non-timber forest products and sustainable agro-forestry practices to enhance forest-based adaptation. Additional INDC priorities for adaptation in the agriculture sector include: i) Strengthening capacities to generate new forms of empirical knowledge, technologies (including conservation agriculture) and agricultural support services that meet climate challenges; and ii) promoting the use of indigenous and scientific knowledge on drought tolerant crop types and varieties and indigenous livestock that are resilient to changes in temperatures and rainfall. At an institutional level, Zimbabwe's adaptation priorities note the need to adopt an integrated approach to identifying and reducing impacts of climate change on all aspects of the economy, including a focus on gender-responsive policies and measures to support vulnerable groups. With respect to institutional capacities, adaptation needs noted include: i) strengthening the capacity of the national meteorological and hydrological services to provide climate data timeously; and ii) strengthening early warning systems on climate related agricultural risks.

Table 4-3: Adaptation priorities in Zimbabwe's INDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[5]
Energy	Implementing management practices that enhance capacity of power generation of hydropower stations in situations of limited water availability due to reduced rainfall	1, 5, 7
AFOLU	Promoting non-timber forest products and sustainable agro-forestry practices to enhance forest-based adaptation	1, 4, 8
	Promoting the use of indigenous and scientific knowledge on drought tolerant crop types and varieties and indigenous livestock that are resilient to changes in temperatures and rainfall	1, 2, 5
	Developing frameworks for sustainable intensification and commercialization of agriculture at different scales across agro ecologies	1, 5
	Strengthening capacities to generate new forms of empirical knowledge, technologies (including conservation agriculture) and agricultural support services that meet climate challenges	1, 5
Water	Increasing the water-holding capacity of reservoirs in anticipation of increased abstraction and increased evaporation	3, 4
	Promoting and supporting water harvesting as a climate change adaptation strategy	2, 5
	Developing, rehabilitate and maintain surface and groundwater resources	2, 4
	Strengthen and intensify monitoring systems for hydro-meteorological parameters	2, 8
	Promoting efficient water use practices in the economy	1, 2
	Strengthening institutional capacity, research and extension for integrated water resources management	2, 4, 5
	Strengthening biodiversity conservation management and integrity of natural ecosystems to adapt to climate change	2, 4, 5
	Strengthening water and moisture conservation initiatives	2, 4, 5
Community based	Promoting the use of indigenous and scientific knowledge on drought tolerant crop types and varieties and indigenous livestock that are resilient to changes in temperatures and rainfall	1, 5, 8
Institutional	Strengthening early warning systems on climate related agricultural risks	5, 6
	Developing and sustaining an integrated approach in all sectors of the economy to reduce impacts of climate extreme events	4, 5
	Strengthening the capacity of the national meteorological and hydrological services to provide climate data timely	2, 5
	Mainstreaming gender responsive climate policies and emphasise special efforts to support vulnerable groups (women, youth and children) in climate change adaptation efforts within all sectors of the economy	1, 2, 5

[5] **GCF Technology Type Key (derived from GCF's Results Framework for adaptation)*

1. Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions.

2. Increased resilience of health and wellbeing, and food and water security

3. Increased resilience of infrastructure and the built environment to climate change threats

4. Improved resilience of ecosystems and ecosystem services

5. Strengthened institutional and regulatory systems for climate responsive planning and development

6. Increased generation and use of climate information in decision making

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

5. ASSUMPTIONS, GAPS IN INFORMATION AND DATA, DISCLAIMERS

Additional resources to be consulted for updated information on national climate change priorities and strategies include:

Zimbabwe's National Climate Change Response Strategy:

http://www4.unfccc.int/sites/nama/_layouts/UN/FCCC/NAMA/Download.aspx?ListName=NAMA&Id=165&FileName=Climate%20Change%20Response%20Strategy.pdf

Zimbabwe's National Climate Policy (April 2016)

The observed and projected climate trends described in Section 2 'Climate and Weather' are derived from a combination of publicly-available observational data and CMIP5 climate models. Detailed information is included in Section 6. Appendix 1, including '6.1.b. Historical Trends and Variability Analysis' and '6.1.c. Climate Projections Visualisations'.

Unless stated otherwise, all statistics reported in Section 1 ('Geographic and Socio-Economic Context' and Section 3 'Climate change mitigation, greenhouse gas emissions and energy use') are derived from databases of publicly available datasets managed by international or multilateral agencies including inter alia The World Bank Group, the United Nations, World Resources Institute and International Energy Agency.

Unless stated otherwise, all energy and greenhouse gas emission figures are derived from UN Stats (2014); World Energy Council (2016); the World Resources Institute (2013), and the International Energy Agency (2016). Agriculture & forestry-related emissions are also reported from Food and Agriculture Organisation (2014-2017) and Global Forest Watch. (2015-2017). Full references are provided as a supplementary appendix.

As a result of the use of standardised methodologies and data sources across the 25 countries included in this AfDB Climate Change Profile, statistics and estimates reported herein may differ from other publicly available datasets or national estimates. Readers are advised to always check for updated publications and newly released national datasets.

This AfDB Climate Change Profile series is intended to provide a brief touch-stone reference for climate change practitioners, project managers and researchers working in African countries. The figures and estimates provided herein are intended to inform the reader of the main climate-related challenges and priorities, however these should be used to inform a process of additional research and in-country consultations. The University of Cape Town, the African Development Bank and its Boards of Directors do not guarantee the accuracy of figures and statements included in this work and accept no responsibility for any consequences of its use.

6. APPENDIX 1

1.a Supporting evidence

The climate projections detailed in Chapter 2 (above) are supported by rigorous analysis of observed and model projections data. More details of this analysis and supporting figures can be found below.

1.b Historical trends and variability analysis

The analysis of historical trends and variability of key climate variables is presented below. This analysis uses the WATCH Climate Forcing dataset which has been selected as the most broadly representative of station observations across Zimbabwe. Long term (1979 to 2013) trends as well as inter-annual variability (decade to decade) has been analysed for total annual rainfall, number of rainfall days, number of extreme rainfall days, and daily mean temperatures (1979-2014) for each of the five climate regions across Zimbabwe. The plots below detail **inter-annual variability** (dotted lines), **decadal variability** (smooth bold solid curves) and **long term trends** (thin straight lines) for each region and statistic. This allows for comparison of different types of variability against the long term trend. It can be seen that for rainfall statistics, inter-annual and decadal variability are typically fairly large compared to long term trends. For example, for total annual rainfall, the Central region has very high inter-annual (550mm in some years to 950mm in other years) and moderate decadal variability (600mm in some decades to 750mm in other decades). The long term trend is not statistically significant but could be around 90mm over the 30 year period.

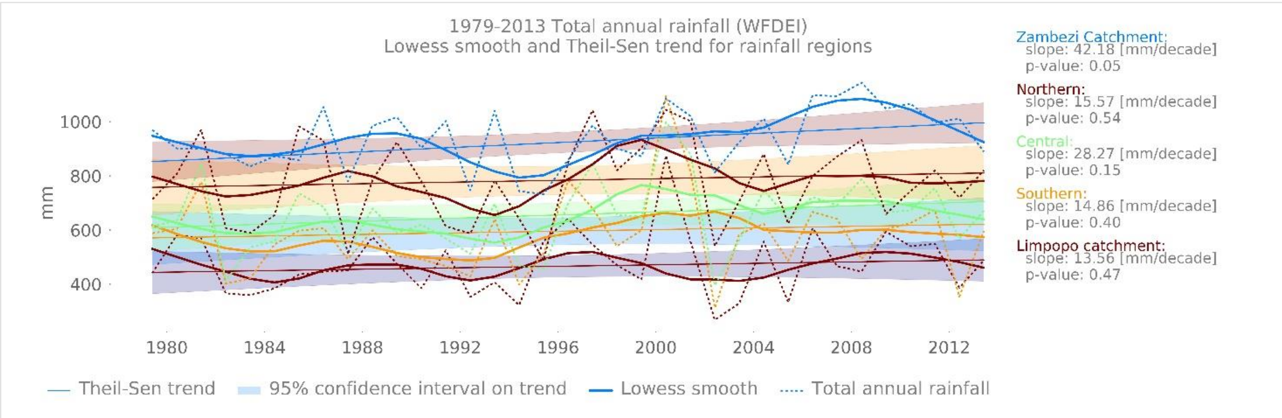


Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

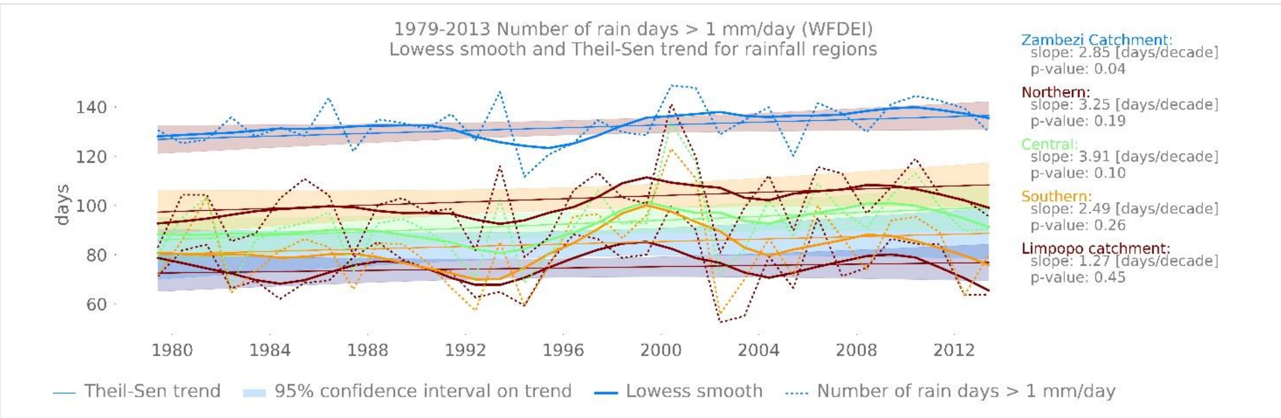


Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

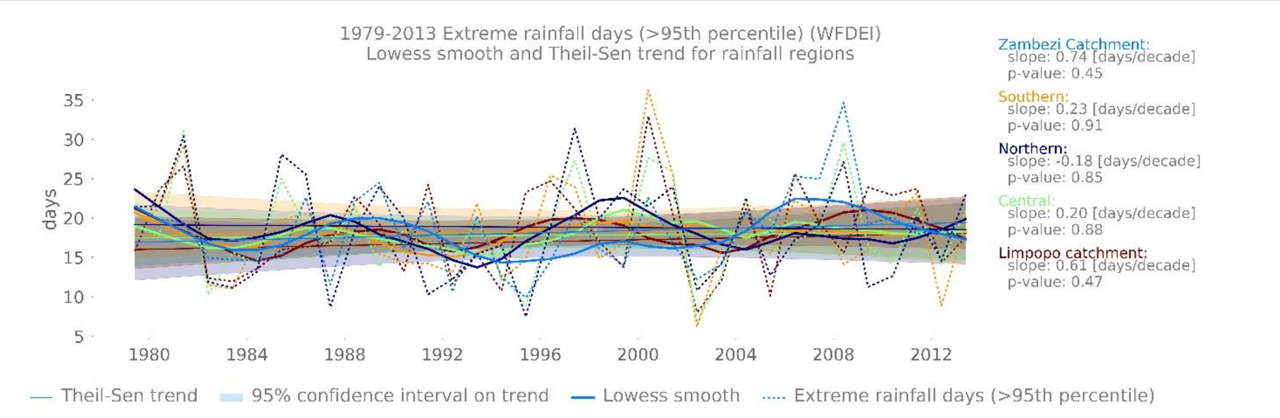


Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

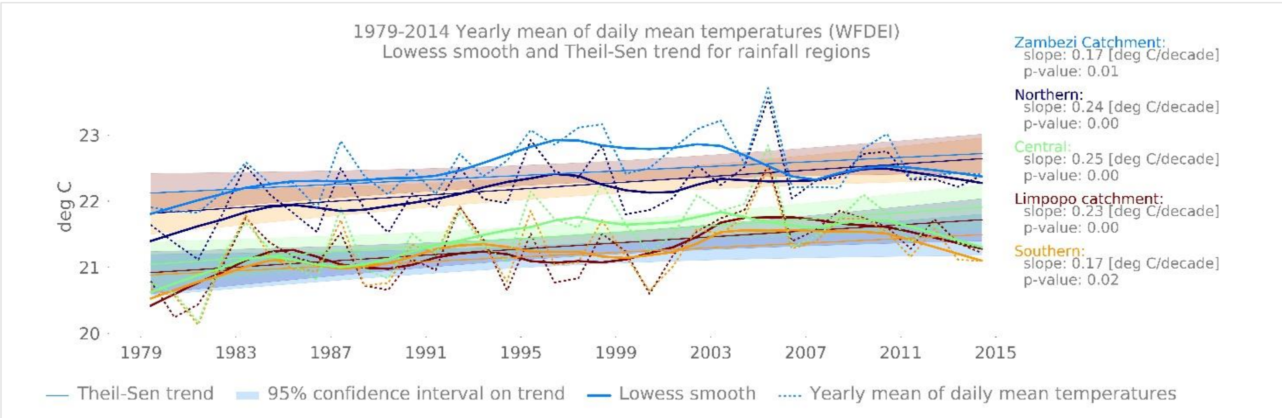


Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

1.c Climate projections visualisations

The plots below (Figures A-5 – A-8) are called plume plots and they are used to represent the different long term projections across the multiple climate models in the CMIP5 model archive used to inform the IPCC AR5 report. The plots show projected variations in different variables averaged over the climate regions. The blue colours indicate variations that would be considered within the range of natural variability, so in other words, not necessarily the result of climate change. The orange colours indicate projection time series where the changes would be considered outside of the range of natural variability and so likely a response to climate change. It is important to note that these are global climate model projections and so likely do not capture local scale features such as topography and land ocean boundary dynamics. They also may not capture small scale features such as severe thunderstorms that can have important societal impacts. Finally, these projections are averages over relatively large spatial areas and it is possible that different messages would be obtained at small spatial scales and if various forms of downscaling are performed.

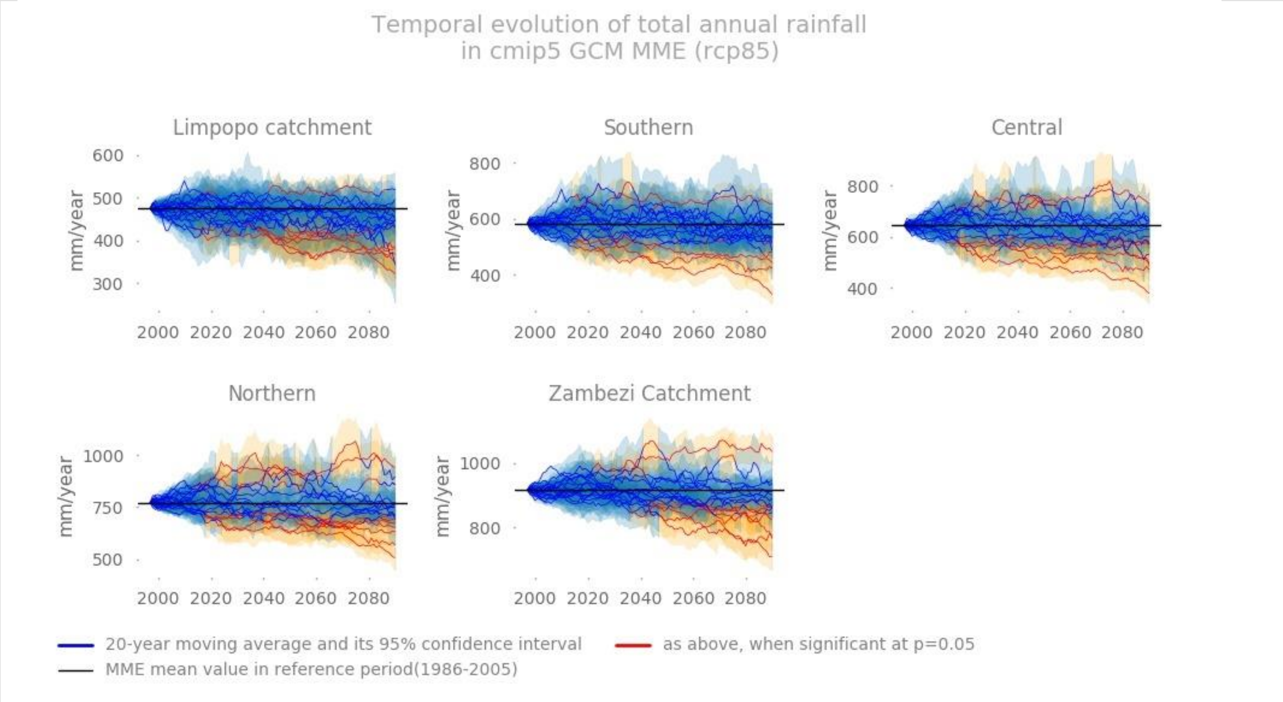


Figure A-5: Projected changes and emergence of changes in total annual rainfall

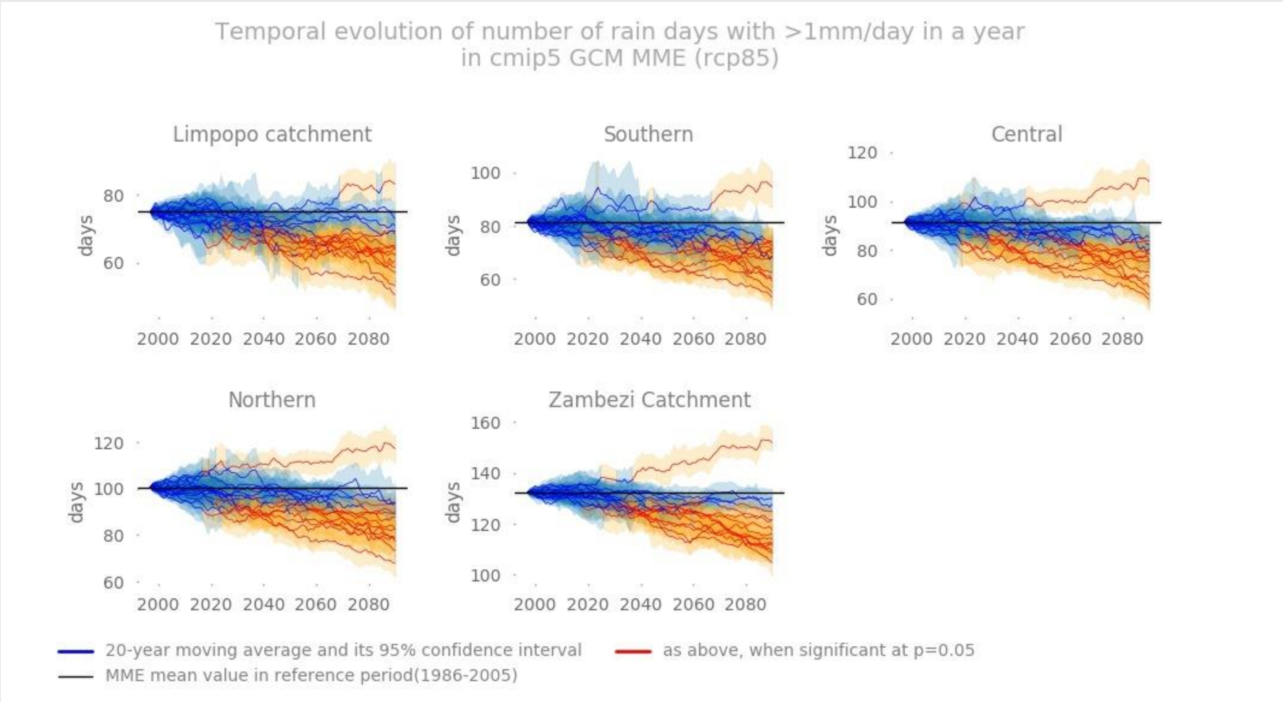


Figure A-6: Projected changes and emergence of changes in number of rain days per year

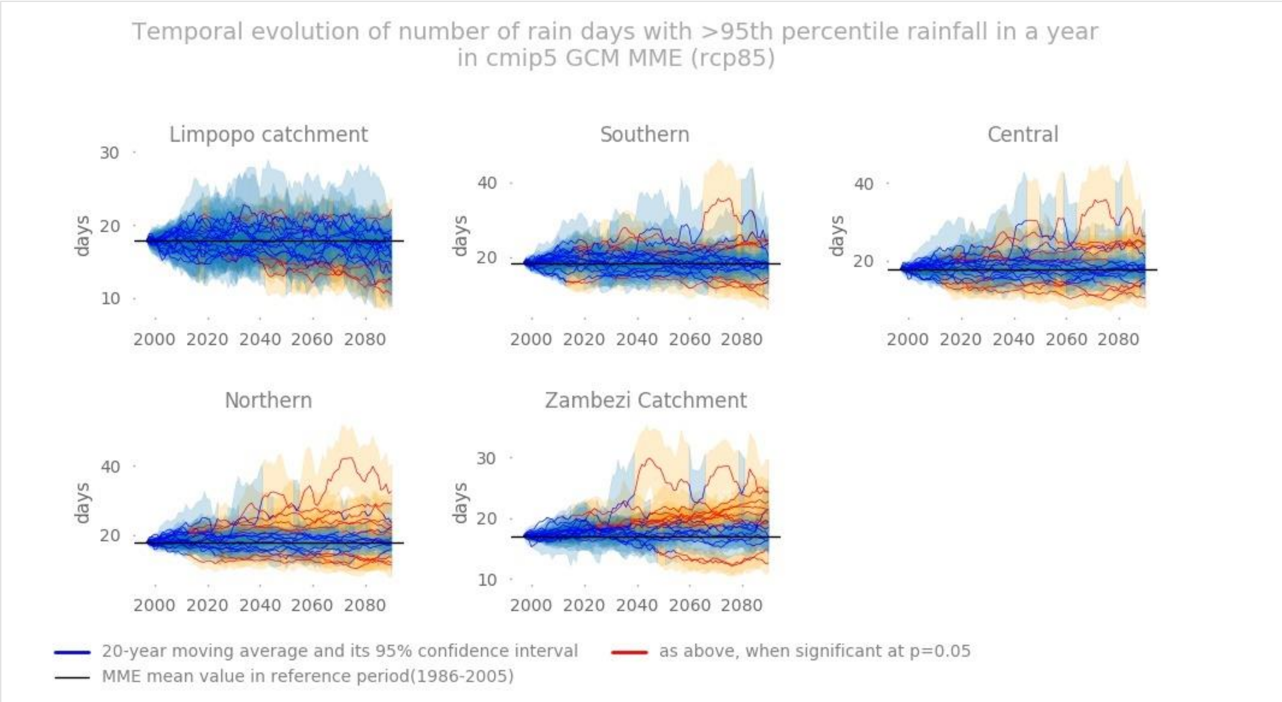


Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

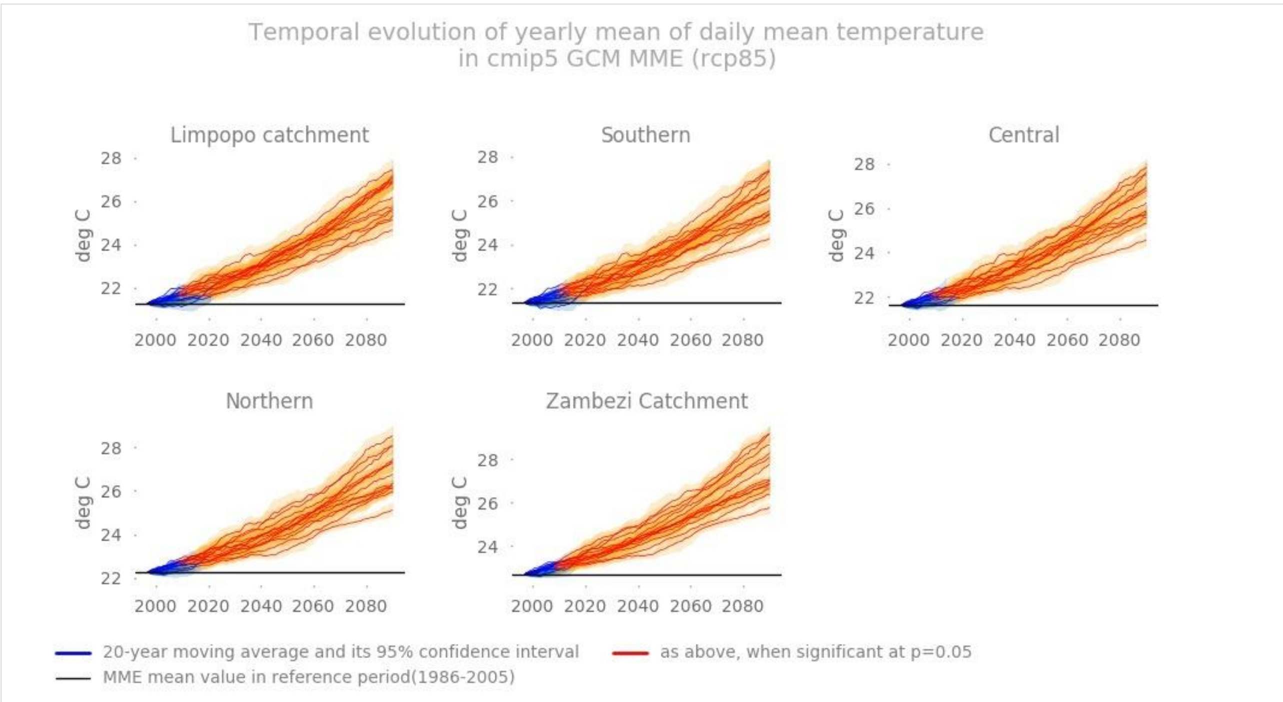


Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

7. REFERENCES

1. Worldometers. (2017). African countries by population. Retrieved from http://www.worldometers.info/population/countries-in-africa-by-population/
2. World Bank. (2016). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
3. African Economic Outlook. (2011). Statistics. Retrieved from http://www.africaneconomicoutlook.org/en/statistics
4. African Economic Outlook. (2014). Statistics. Retrieved from http://www.africaneconomicoutlook.org/en/statistics
5. UNDP. (2016). Human Development Report (Data for 2015). Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf
6. World Bank. (2014). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
7. World Bank. (2015). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
8. Emergency Events Database. (2017). Disaster List (1996-2016). Retrieved from http://emdat.be/emdat_db/
9. ND GAIN. (2015). Country Rankings. Retrieved from http://index.gain.org/ranking
10. International Energy Agency. (2014). Energy balances. Retrieved from www.iea.org/statistics/statisticssearch/
11. International Energy Agency. (2013). CO2 emissions. Retrieved from http://www.iea.org/statistics/topics/CO2emissions/
12. World Resources Institute. (2013). CAIT Climate Data Explorer. Retrieved from http://cait.wri.org/
13. Food and Agriculture Organisation. (2014). FAOSTAT Data. Retrieved from http://www.fao.org/faostat/en/#data
14. Derived from Global Forest Watch. (2017). Country Profiles. Retrieved from http://www.globalforestwatch.org/
15. Derived from Global Forest Watch. (2015). Mean 2001-2014. Retrieved from http://www.globalforestwatch.org/
16. Food and Agriculture Organisation. (2011). FAOSTAT Data. Retrieved from http://www.fao.org/faostat/en/#data