GOVERNMENT OF ZIMBABWE

Zimbabwe

Baseline Report on Climate Change and Development

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Foreword

Climate change poses new risks to the existing challenges of tackling poverty and promoting economic growth and human development in Zimbabwe. In order to simultaneously address these triple challenges posed by climate change, there is need for Zimbabwe to develop a coordinated and effective climate change policy and institutional framework that cut across the different sectors of the economy and society. The development of such a policy and institutional framework on climate change and development must be based on sound analysis of the existing evidence of the effects of climate change on key sectors of the economy, which should, in turn, guide the designing and implementation of climate change compatible policies that contribute to sustainable economic growth and poverty eradication in Zimbabwe. This Baseline Report on Climate Change and Development seeks to achieve this, by providing a preliminary analysis of the likely effects of climate change on various sectors of the economy. It provides not only an analysis of the challenges that climate change poses to socio-economic development trajectory of Zimbabwe, but also of opportunities for climate change mitigation and adaptation in all sectors.

Importantly, this Baseline Report sets out the foundation for contributing to the development of a coordinated National Climate Change and Development Strategy that is in line with the broad policy objectives on economic growth and poverty reduction outlined in the Medium Term Plan 2011 – 2015. Specifically, one of the key objectives of the Medium Term Plan 2011 – 2015, is to promote climate change mitigation and adaptation strategies in social and economic development at national and sectoral level. This Baseline Report is an important first step in contributing to the achievement of this MTP objective, both at practical and policy level.

The priorities for technical assistance, research and policy implementation identified in the Report should form a basis for further discussion among key stakeholders with the view of obtaining broad based participation in the prioritisation and implementation of agreed policy objectives and programmes. The Ministry of Environment and Natural Resources Management, Ministry of Economic Planning and Investment Promotion, and the National Climate Change Task Team in collaboration with other Government agencies will use this document in the development and implementation of relevant policies and programmes on climate change and development.

The process of researching and writing of this Baseline Report was both inclusive and participatory, as government officials and representatives from the research and academic institutions, civil society and non-governmental sector were involved. As such, the process created space for fruitful collaboration on climate change and development between Government agencies, civil society, NGOs, academic and research institutions, and well recognised international institutions working on development policy and practice. At national level, all our people should take ownership of the recommendations and suggestions outlined in this Report, and participate in drawing a future programme of action on climate change and development.

As Zimbabweans, we have a rich history of victories achieved by pulling together our collective strength and working together to overcome challenges that threaten us. The effects of climate change on our collective development is no different, and we look forward to working together as Zimbabweans, in collaboration with our international partners, in building a climate-resilient economy that is both globally competitive and lifts people out of poverty.

Honourable, Dr. Francis Nhema (MP) Minister of Environment and Natural Resources Management

Signature:
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1. Executive Summary

Since political settlement in 2009 and the establishment of the Government of National Unity, Zimbabwe's future once again looks bright. The economy experienced a strong positive growth as witnessed by the real GDP growth rates of 5.9% in 2009, 8.1% in 2010, 9.3% in 2011, and in 2012 a 9.4% is anticipated (Ministry of Economic Planning and Investment Promotion, 2012). But climate change offers real and severe threats to poverty reduction and prosperity. Higher temperatures, increasingly variable rainfall and more extreme events will change agro-ecological zones, alter households' livelihood portfolios and threaten the considerable forward and backward linkages from the agricultural sector and other industries. Moreover, climate impacts threaten to dry out Zimbabwe's forests, reduce available water from dams by 30 to 40 percent, hamper efficient mining, and threaten energy and transport infrastructure.

Current political and policy processes offer a discrete window of opportunity to integrate climate and development policy for the benefit of all citizens. The current Medium Term Plan Targets – a National Climate Change Strategy by December 2013, and Mitigation and Adaptation Policies December 2012 – alongside the Second Communication on Climate Change to the UNFCCC, the new National Task Team on Climate Change, and calls for proactive, home-grown climate policy illustrate this considerable momentum.

The foundation of integrating climate and development policy rests on, first, adequate science, second, the translation of scientific findings into plausible, politically savvy, policy, third, institutional support and adequate financing, and fourth, robust and rapid implementation. There is every reason to think these preconditions can be met in Zimbabwe within the span of the current five-year plan.

Whilst the quality of climate science in Zimbabwe has declined since the 1990s, the country maintains a critical mass of internationally-renowned scientists. In addition to providing modellers and meteorologists with the resources to upgrade and downscale projections, there is an urgent need to harness existing talent for more 'creative' interactions with user communities, policymakers and development agencies. The emergent recent literature on climate impacts in Zimbabwe is yet to be packaged into accessible products with precise recommendations for policymakers.

Key to this endeavour is the completion of the Second Communication on Climate Change by the Climate Change Office (CCO). There is a need to provide the CCO with recurrent funding to enable

it to fulfil its mandate, expand, allow decentralisation to provincial levels, and seek statutory powers to enforce submission of returns to track GHG inventories.

But the CCO in its present form has a narrow focus on mitigation, not Zimbabwe's top priority: adaptation. As climate adaptation needs to be driven by impacts, the CCO's mandate should be expanded to explicitly include oversight and strategic management of adaptation plans and programming through including a 'climate change desk' in each relevant ministry. The recently appointed National Task Team on Climate Change provides not only a high-level organ for the CCO to liaise and consult with, but the necessary political clout to push legislation, policy and budget reforms through. In a similar vein, the CCO should continue to be supported by an expanded National Steering Committee on Climate Change, to which the CCO should also be held accountable.

Decentralising some functions of the CCO to provincial level, perhaps through extending the mandate of the District Environmental Committees, will help to overcome a considerable lack of vertical co-ordination between local and national levels. Such a move would also increase the geographical representation within the National Steering Committee on Climate Change. An enhanced, decentralised CCO with statutory powers and the support of the NTTCC could provide the necessary leadership and guidance to ensure sectoral priorities are pushed through budgets, medium term expenditure frameworks and into programming.

Political challenges remain within government largely attributed to lack of role clarity and coordination between government agencies, and between government, on the one hand, and NGOs, researchers and international agencies on the other. However, there is sufficient political support and momentum across the board that should allow the policy progress to be made on climate change and development linked to the medium-term perspective on reconstruction and growth.

Our review of sectoral impacts highlighted the numerous priorities for adaptation research and technical assistance. Within agriculture, these include allowing meteorologists to work more closely with SADC systems to improve early warning systems, and to further support the development of drought-tolerant varieties of staple grains. In the water sector, they include strengthening catchment-based water resources management, irrigation development, improved irrigation technology, increasing efficiency through recycling water, multiple-use water schemes and water pricing schedules. Key priorities regarding extreme events are to ensure the new Environmental Protection and Disaster Management Act incorporates adaptation priorities, and developing greater links between the CCO and Civil Protection Department. Technical assistance can also help to

finalise the new Urban Development Policy and the preparation of city-level disaster preparedness studies by local authorities. Overall, Environmental Impact Assessments, the key tool for adherence to environmental standards, should be amended and utilised to create a knowledge base in the CCO of adaptation and disaster risk requirements and possible mitigation opportunities.

Our review also highlighted priorities for mitigation research and technical assistance. In the forestry sector, technical assistance can facilitate Zimbabwe's application to the UN-REDD secretariat, to update the national inventory, and launch baseline surveys for REDD+ sites. In the mining sector, technical assistance is require for the implementation of energy efficiency improvements, process changes, waste recycling and technology upgrades. Similarly, in the energy sector, technical assistance could help to realise 20-30% energy efficiency savings through industrial energy management, and package up coal-based emission reductions into offset projects. Research is required to further understand the links between land reform and land degradation, whilst technical assistance is required to reduce the impact of small-scale tobacco production on deforestation, and the conversion of timber concessions into farms. Overall, there is need for technical assistance to help convert feasible offset opportunities into carbon credits.

The current climate regime also offers many opportunities for Zimbabwe to benefit from adaptation and mitigation funding. Realising these opportunities will assist the country in ensuring climate change doesn't undermine poverty reduction and Zimbabwe's future prosperity.

2. PART A – Introduction

This Baseline Report presents a preliminary analysis of climate change and development in Zimbabwe. It is in response to the request by the Government of Zimbabwe, through the Ministry of Economic Planning and Investment Promotion to the Climate and Development Knowledge Network for technical assistance in the development of a National Climate Change and Development Strategy within the context of the Medium Term Plan 2011- 2015. As such, the report examines climate change vulnerabilities and impacts on key sectors of the economy, the current policy and institutional framework governing a particular sector, and the challenges and opportunities for climate change adaptation and mitigation. The purpose of the report is to contribute to the design and implementation of climate compatible development and economic growth strategy across all sectors through a coordinated policy and institutional framework. This Report seeks to achieve this through an evidence-based approach to policy and programming.

In Zimbabwe, there is an increasing realisation that climate change threatens social and economic development. Climate change will exacerbate droughts, floods and extreme weather events, which could contribute to food shortages, damage infrastructure and degrade the natural resources on which local livelihoods and the national economy is based. Consequently, climate change can undermine past development gains and make it more difficult to attain development objectives outlined in the Medium Term Plan 2011-2015. Responding to the impacts of climate change is therefore critical. One way of doing this is to ensure that climate change risks and impacts are considered systematically in national development policies and programmes with the view to making social and economic development resilient to a changing climate. 'Development as usual' without consideration of climate risks and opportunities will not allow national development strategies to confront climate challenges.

In view of the above, it is imperative for Zimbabwe to develop an evidence-based understanding of climate change risks and impacts on key sectors of the economy with the view to develop informed policy responses. Such a policy response should enable Zimbabwe to adapt to the effects of, and mitigate her contributions to, climate change and move to a lower carbon economy, while at the same time maintaining the growth rates needed for sustained poverty reduction and economic growth. Such a delicate balance is crucial. Robust national development planning for the short and long term should take the uncertainty associated with climate change into account, and embed adaptation and mitigation strategies in policy frameworks. It is of crucial importance that climate

policy and strategy must go beyond an environmental focus, to include social, political and economic dimensions.

The report aims to identify policy and institutional challenges within a sector and suggest adaptation and mitigation strategies which can be integrated into a coherent national policy. Further, this report explores the legislative framework governing different sectors. The report observes that at present climate legislation and policy is uncoordinated, and sometimes, unenforceable. Nonetheless, if the various pieces of legislation and policy can be brought into a coherent framework, they do constitute a basis for an effective legislative framework.

This Baseline Report is organised as follows:

Following this brief introduction,

- Part A: Provides a brief overview Zimbabwe's economy and natural resources.
- Part B Summarises the evidence of climate variability and change, and the institutional and policy frameworks.
- Part C: Provides a sectoral analysis of agriculture land use, forestry, water and disaster management.
- Part D: Provides a sectoral analysis of mining, energy, urban infrastructure and transport.
- Annex I: Details the legislative framework governing most of the above sectors.

Methodologically, the report is based on a review of primary and secondary literature combined with key informant interviews (conducted with key stakeholders based in Harare). One obvious limitation of the methods used is that it does not provide a detailed and nuanced picture of climate change impacts as well as adaptation and mitigation activities at the local level. Nonetheless, it provides a coherent summary of the national and sector level, and should be used as a tool to foster a useful and constructive debate on climate and development.

3. Overview of Zimbabwe's Economy and Natural Resources

3.1 Zimbabwe's Economy

Zimbabwe has a relatively well-developed economy based on agriculture, mining, manufacturing, and tourism, and a large informal sector in rural and urban areas. From 1980 to the present day, the structure of Zimbabwe's economy has undergone radical transformation and change. Four distinct phases can be identified. The first phase, from 1980 to 1990, was characterized by strong state intervention. The second phase, from 1990 to 1998, was defined by the adoption of structural adjustment programmes. The decade-long economic crisis from 1998 to 2008 represents the third phase. And the fourth phase, from 2009 to the present, is marked by economic recovery, reconstruction and growth, associated with the political settlement and the subsequent establishment of the Government of National Unity. The four phases display dramatic changes in key economic and social indicators.

The current phase 2009 to present, has witnessed a marked growth in the economy mainly due to political stability attributed to the formation of the Government of National Unity (GNU) and economic reforms implemented since then. Real GDP growth has increased from 5.4% in 2009 to 9.3% in 2011 (Ministry of Finance, 2011). This growth is impressive given that real GDP growth was minus 3.7% in 2007, and minus 17.7% in 2008.

The increase in real GDP growth is based on the significant growth in mining and agricultural production over the past three years. Real GDP and sector growth for 2009 onwards is presented in Table 1 below.

Mining grew by 47% growth due to rising prices of mineral and metals on the world market (African Development Bank, 2011:4). In addition, agricultural output increased by 34% as a result of higher output of tobacco, sugar, maize and cotton (ibid) supported by firm prices for these commodities. Locally, the increased use of sugarcane for biofuel production partly explains the increase in the price of sugar. Globally, the demand for grain, especially maize, in bio-fuel production, can also be attributed to increased maize production in response to better prices offered for maize. It is important to note the agricultural sector was adversely affected by the land reform programme, poor rainfall patterns, delays in the distribution of inputs, and late payment to farmers for deliveries. The sector's current growth, particularly improved agricultural production among some beneficiaries of the land reform programme, suggests a long-awaited recovery.

Table 1 - GDP Growth by Sector 2009 - 2012

GDP by Sector (%)	2009	2010	2011 (est)
Real GDP	5.4	8.1	9.3
Agriculture, Hunting and Fishing	14.9	33.9	19.3
Mining & Quarrying	8.5	47	44
Electricity & Water	1.9	1.5	2.5
Construction	2.1	1.5	1
Finance & Insurance	4.5	0.5	2
Real Estate	2	0.9	1
Distribution & Hotels	6.5	0.5	2
Transportation	2.2	0.1	5.5

Source: Ministry of Finance Website, 2011

It is apparent from Table 1 above that real GDP growth is on an upward trajectory, increasing from 5.4% in 2009 to an estimated 9.3% in 2011. A further indication of continued recovery include a decline in inflation from 238% in 2006 to 6% at the end of 2009, mainly as a result of adopting foreign currencies (US$ and South African Rand) in business and trade. The graph below shows the trend of inflation from 2009 to 2012.

Moreover, the increase in the utilisation of manufacturing capacity from 25% in January 2009 to 40 - 50% in 2011 suggests a considerable rebound. However, the manufacturing sector has yet to fully recover as it is adversely affected by lack of credit, power shortages, and uncertainty in some key policies that are of concern to some investors. The latter has led to minimum external investment in the manufacturing sector.

This progress largely rests on the political settlement reached between the main political parties in Zimbabwe (marking a cessation of political violence, and a concerted effort to embark on economic recovery). Two policy documents, the Short Term Economic Recovery Programme and Medium Term Economic Recovery Programme, outline in detail the programmes the coalition government put in place to ensure stability, growth, reconstruction and recovery. Improved revenue collection by the Zimbabwe Revenue Authority and cash-budgeting by the Ministry of Finance has resulted in improved Government finances. Total revenue increased from US$933.6m in 2009 to US$2.34 billion in 2010 (AfDB, 2011), and an estimated $2.75 in 2011 (Ministry of Finance, 2011). The

major sources of government revenue are value-added tax (32%), Pay as You Earn (20%) Customs (12%), Excise duty (10%) and corporate taxes (10%) (ibid.). However, employment costs consumes approximately 63% of government revenue resulting in little revenue to fund social and development programmes, including work on climate change and development.

Two key points are evident from the above. First, is the link between agricultural production and economic growth in Zimbabwe. Despite a diversified economy, the substantial forward and backward linkages between the agricultural sector and the rest of the economy ensure that disruption in agriculture by climatic shocks may lead to economic decline. As such, the likely effects of climate change on agriculture must be curtailed to sustain the sector's contribution to GDP. The prominent contribution of mining, which is less vulnerable to the impacts of climate change, could act as a buffer against the adverse effects of climate change on agriculture and its contribution to the national economy. Second, that despite a tumultuous recent past, Zimbabwe's future once again looks bright.

3.2 Key Sectors of the Economy

3.2.1 Agriculture

The agricultural sector provides livelihoods to over 70% of the population, and currently contributes about 17% of export earnings (Ministry of Economic Planning and Investment Promotion, 2012). From 1980 to 1998, agriculture contributed more than 60 percent of the country's foreign exchange earnings, and between 15 and 19 percent of the Gross Domestic Product. Between 1998 and 2008, the agricultural sector contracted rapidly due to rainfall variability (for example, the drought from 2000 to 2002) foreign exchange shortages, and the political crisis associated with the Fast Track Land Reform Programme (AfDB/OECD 2003: 356).

Despite the significant decline in the agricultural sector in the past decade, agriculture continues to play an important role in Zimbabwe's development. It continues to provide employment for the majority of the population during the current economic recovery. The allocation of land to a significant number of small- and medium-scale farmers under the land resettlement programme coupled with the envisaged irrigation development programme aimed at putting 240 000 hectares land under irrigation by 2015 suggests substantial future growth (especially if agricultural prices remain favourable). Furthermore, it is vital to note the agricultural sector has strong forward and backward links with the manufacturing sector.

3.2.2 Mining

The mining sector accounts for around 4% of the GDP, 5% of formal sector employment, and at least 50% of foreign exchange earnings (Ministry of Economic Planning and Investment Promotion, 2012). Major mining products include gold, platinum, nickel, diamonds, ferro-alloys, and coal, which are invariably exported. The anticipated growth in the mining sector has important implications for climate change given the complex links between climate change and mining. Mining contributes to climate change due greenhouse gas emissions associated with the sector (as it is dependent on thermal power), while on the other hand, climate change affects mining operations. For example, extreme weather events may disrupt power supplies, and changes in water availability may threaten water-reliant production and processing techniques.

3.2.3 Manufacturing

Zimbabwe's manufacturing sector, both formal and informal, is highly diversified absorbing much of the agricultural and mining output. The main sub-sectors are agro-processing, beverages, metal products, chemicals and petroleum products, and textiles. Manufactured exports, which include semi-processed minerals and agricultural products, such as ferrochrome and cotton respectively, are estimated to have accounted for 33 per cent of merchandise exports in the 1990s. Manufacturing contributes a significant share of the GDP, export earnings, and employment in Zimbabwe

Manufacturing sector's share of the GDP averaged 25% in the 1980s. However, its contribution fell to less than 14% in the 1990s partly as a result of the deindustrialisation associated with structural adjustment programs, and an influx of cheap imported goods. The decline continued into the 2000s, as its contribution to the economy fell from about 19 percent of GDP in 2001 to 16 percent in 2003 and an estimated 15 percent by 2006.

From 2009 onwards, the manufacturing sector was starting to grow through improved capacity utilisation partly as a result of the dollarization. This resolved the acute foreign currency shortages and inflation of the Zimbabwean dollar. The manufacturing sector was estimated to grow by 5.7% in 2011 due to improved credit support and better energy supply.[2] As current utilisation of capacity is only around 50%, it is likely the sector will grow rapidly in coming years due to the measures Government has proposed through the MTP and the Industrial Development Policy.

[2] http://dailynews.co.zw/index.php/business/35-business/2315-zim-manufacturing-sector-to-grow-6.html

As manufacturing grows, there is need to examine demand for energy, water resources and contribution to greenhouse gas emissions. It is vital that a potential climate change and development policy takes clear account of the sectors contribution to climate change, as well as impacts of changing climatic conditions on industry. As such, potential climate change policy should strike a balance between embarking on a low-carbon trajectory for the sector, and the sector's contribution to national economic growth and poverty reduction. In other words, the challenge for Government is to ensure that the sector is assessed for greenhouse gas emissions and energy efficiency. Further, government should ensure a regulatory framework is put in place to enforce government policy, and allows the sector to be efficient and competitive at the regional and global level.

3.2.4 Energy

Zimbabwe's energy sector is dominated by conventional energy sources: coal, hydropower, petroleum, biomass, ethanol and liquid gas. Zimbabwe relies mainly on coal for its energy, obtained from four thermal power stations, namely Hwange, Munyati, Harare and Bulawayo. The reliance on coal is set to continue as the country has proven reserves of half a billion tonnes (and possible reserves of up to 30 billion tonnes) (GoZ, 2008). There are plans to expand Hwange Thermal Power Station by 600MW, and to develop the Gokwe North Thermal Power Station, which has the potential to generate 1400MW. Such reserves and the continued threat of drought halting hydro-electric power, indicates thermal power will continue to meet Zimbabwe's energy needs in the short and medium term. Both technology transfer within coal-fired power stations, and hydro-electric and renewable energy sources, offer potential for generating offset credits for Zimbabwe through the CDM and other markets.

With reference to hydro-electric power, the country depends on the Kariba Hydro-Power Station, which generates 1266MW shared between Zimbabwe (750MW) and Zambia. However, the country has significant potential for hydropower generation along the Zambezi River and on some rivers in Eastern Highlands. For instance, there is a planned development of a hydropower facility on the Batoka Gorge, which could generate 1600MW (half of which will accrue to Zimbabwe). More recently, on 3 May 2010, Government signed a $400million agreement with China's Sinohydro to expand Kariba hydropower with the view to increase generating capacity by an additional 300MW. This expansion will not add to available energy but will enable the plant to meet peaking power. According to Mungwena (2002), eight further dams have potential for generating hydropower in

Zimbabwe. Small hydro plants can also be installed on smaller dams provided there is sufficient flow.

Biomass also constitutes a major source of energy, especially for rural and low-income urban population. Of the country's total land area of 39 million hectares, 20.5 million hectares are under indigenous forest while 140 000 hectares are under commercial forest plantations. For energy purposes, only the indigenous forests in communal land areas can be considered as major resource. Total forest cover in the accessible areas is estimated to be 8.4 million hectares. However, forest regeneration in communal lands is very low, only 0.94 tonnes/ha/year (GoZ, 1998). Loss of natural forest continues especially near urban centres and some rural districts. However, both afforestation and reduced deforestation hold potential for carbon offset schemes (the former through both the CDM and voluntary markets, and the latter through only voluntary markets at present).

Energy consumption in Zimbabwe is drawn from different sources, mainly wood used by households, accounting for 47%, coal and coke, 21%, motor fuels 20% and electricity 12% (AfDB, 2011). With specific reference to energy consumption by sector, the residential sector consumes 47%, followed by industry (19%), transport (15%), agriculture (11%), commerce (4%), mining (3%) and others (1%). There is paucity of data on future energy consumption by sector, but it is not farfetched to state that as population increase and key sectors of the economy continue to recover and grow, demand for energy will also increase. Also, the success of the Rural Electrification Programme has led to increased consumption of electricity in rural areas (See Box 1, below).

Box 1: Rural Electrification Programme

The Rural Electrification Programme was launched in 2001 after the creation of the Rural Electrification Agency with the aim of providing electricity to 10 000 rural public institutions such as schools, rural health centres, extension offices and farming communities. The programme promoted the economic use of electricity in rural areas through the development of energy intensive irrigation schemes, cottage and agro-industries. By October 2010, REA provided electricity to 608 rural centres across the country, including 39% of all primary schools in rural areas, 70% of all rural secondary schools, and 65% of rural health centres in the country. In addition, 222 mini grid solar systems had been installed at remote schools and clinics.

(Source: African Development Bank (Chapter 8) 2011:14)

Zimbabwe has had significant experience with promotion of renewable energy for household use. Solar water heaters, solar photovoltaic power for lighting, efficient wood stoves and solar cookers

have all had government, NGO and private sector support since the early 1980's. However, the market has not grown to contribute significantly to the national energy balance. The solar photovoltaic market continues to exist at a low level as those able to pay can buy small panels to power radios and some lights. Large systems are still rare.

Although not widely recognized, biofuels have a long history in Zimbabwe. Ethanol production from sugarcane was conducted at Triangle Limited producing 20% of motor fuel requirements. However, production ceased in 1992 as unblended petrol became cheaper than blended fuel. Due to high oil prices and fuel shortages, ethanol production resumed in 2008. More significantly, a new ethanol plant has been constructed at Chisumbanje by government in partnership with Green Fuel. Sugarcane ethanol production has important implications for climate change and development policy. It has some potential to reduce emissions of GHGs (dependent on the input intensity of feedstock production, and land-use changes). If sugarcane production involves small-scale farmers, including A1[3] and A2[4] farmers, and focuses partly on local consumption of energy and other related products, then there could be considerable poverty co-benefits. These objectives need to be integrated into national policy frameworks on climate change and development.

3.2.5 Services

The services sector played a vital role in the economy during the 1990s, contributing more than 58 percent of GDP in 1998 mostly as a result of increased spending on education and health, and an expansion of tourism. Indeed, Figure 1 shows the stability of growth in services during this period. However, the contribution of services to GDP has fallen rapidly from 2002 onwards. For example, the value added from social services dropped from 10.8 percent of GDP in 2001 to an estimated 7.0 percent in 2006. The tourism sector, which was the fastest growing sector during the 1990s, experienced profound decline since 2000 due to the deepening economic crisis, limited airline accessibility and the perceived unstable political climate. For instance, visitor arrivals in the first half of 2002 were 739 000 compared with 1.45 million in the same period of 2001 (AfDB/OECD, 2004). However, tourist arrivals began to increase from 2003 onwards. For example, total tourist arrivals in the first quarter of 2003, at just over one million, were 47 per cent higher than in the first quarter of 2002 (*ibid*.).

[3] Newly resettled smallholder farmers living in a villagised or self contained manner

[4] Newly resettled farmers on individual plots of land that are classified as small, medium and large scale commercial schemes

Although the services sector is not a heavy emitter of GHGs, the sector can contribute to climate mitigation through changes in energy use, building equipment, appliances, as well as fuel use for transportation. Further, climate change can adversely affect service sector industries and enterprises. Extreme weather-related events, like flooding, may lead to physical damage to property, energy infrastructure, loss of revenue in the aftermath of floods, and higher insurance premiums. Adverse impacts of climate change on water resources and biodiversity may affect tourism.

3.3 Social and Economic Conditions

3.3.1 Poverty and Employment

Currently, the Poverty Headcount Ratio at national poverty line is estimated at 72%. This significant proportion of people in poverty is largely due to the cumulative effect of both the adverse impact of the economic structural adjustment programme implemented in the 1990s and the post-2000 drastic decline in economic performance and well-being associated with the political and economic crisis of the past decade. It is important to note that a key feature of poverty in Zimbabwe is that it is predominantly rural and female, reflecting, in part, the marginal and unproductive nature of land in many communal areas, and the powerlessness of women in accessing productive resources for their livelihoods.

Employment rates sharply deteriorated from 1998 to present. In 2003, structural unemployment was recorded at 63%, with current rates estimated at over 80% (GoZ & UNDP, 2010). However, these figures do not take into consideration the informal sector, which is mainly comprised of informal trading, informal manufacturing, carpentry, motor mechanics, and the informal transport sector.

3.3.2 Population

Zimbabwe's population has increased from 7.5 million in 1982 to 13.1 million in 2006. It is projected to increase to 15.5million by 2020 (UN Data, 2012[5]). Despite the increases in total population, the average rate of population growth was only 0.6% between 2000 and 2005, which is a significant decrease from the 3% experienced in the 1980s. This can be partly explained by the outmigration during the period of economic contraction. In 2003, approximately 3% of the population was over 65 years, and 44% of the population was under 15 years of age. According to the Zimbabwe Demographic and Health Survey (2006), the proportion of people living in urban

[5] http://data.un.org/Search.aspx?q=Zimbabwe

areas increased from 33.0 percent in 1998 to 34.5 percent in 2002, then fell to 31.6 percent in 2006/07.

3.4 Natural Resources in Zimbabwe

Zimbabwe has rich biological diversity, which provides ecosystem services such as food, medicine, energy sources, building and craft materials as well as spiritual, cultural and aesthetic services (Millenium Assessment 2005*)*. Vegetation is mainly savannah woodland interspersed with open grassed drainage lines or *dambos* (wetlands) (GOZ 1987). However, human activities and fires have altered the climax ecosystem, displacing much of the indigenous woodland (Moyo et al. 1991). In communal areas, most indigenous vegetation has been cleared for arable farming, especially in higher rainfall regions with high population densities. Apart from providing commercial timber, forests contribute resources to meet the subsistence needs of rural people (Nhira et al, 1998). Many indigenous species have medicinal properties and contribute to indigenous knowledge systems. Introduced flora includes pines, eucalyptus and wattle. Many food plants, notably maize, which is now the staple, have also been introduced.[6]

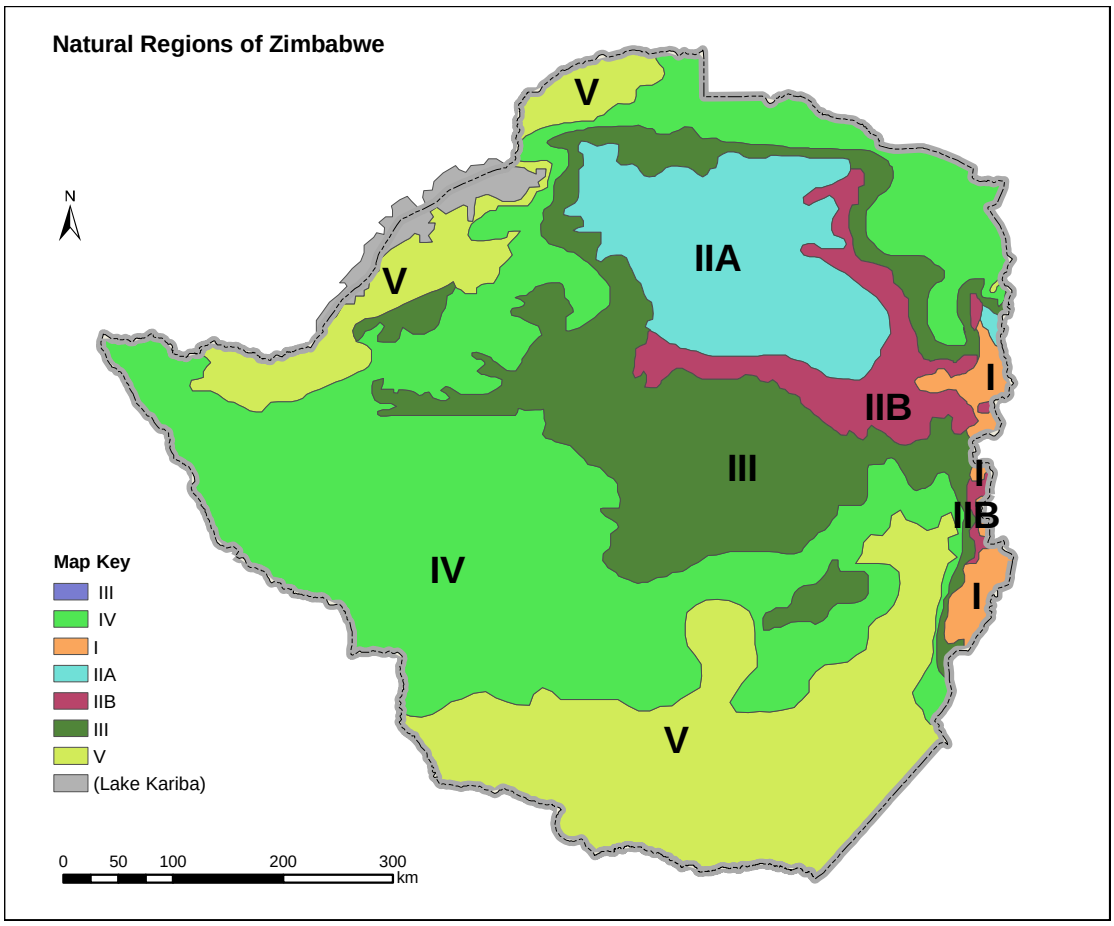
Zimbabwe has abundant and diverse tropical animals including bird species, mammals, reptiles, amphibians and fish species (GOZ, 2010). Wildlife is regarded as a lucrative renewable resource and contributes to the economy through tourism, hunting safaris, hide processing and ivory carving (GOZ 1992). Organised sustainable management of wildlife extends beyond the protected areas and national parks ranging from large-scale commercial game ranches and conservancies to community based Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) programmes. Many of these activities occur in drier agro-ecological regions four and five where game is more profitable than cattle ranching (Moyo et al. 1991).

Zimbabwe's biodiversity is found in gazetted forests areas, national parks, safari areas, sanctuaries, botanical reserves, recreational parks and non-protected areas such as conservancies and communal lands. The main problem affecting biodiversity conservation and management relates to loss of biodiversity particularly in non-protected areas, such as communal and resettlement areas. The recurrent droughts affecting Zimbabwe have also resulted in loss in numbers of certain species, both plant and animal (Ministry of Environment and Tourism 2008).

[6] One poisonous (to livestock) alien species, Lantana camara is particularly invasive and problematic.

Geographically, Zimbabwe is divided into five agro-ecological regions on the basis of climatic conditions, farming potential and, to certain extent water resources (see Figure 1 and Table 2, below).

Figure 1 Natural Regions in Zimbabwe



Source: Mtisi, 2008

Table 2: Brief Descriptions of Agro-Ecological Regions of Zimbabwe

Agro-ecological Zone	**Brief Description of Key Characteristics**
Natural Region I	Constitutes 1.6% of the country, receives an annual rainfall of more than 1,050 mm. It is suitable for a broad range of agricultural activities such as dairying, tea, coffee and intensive livestock production. The region is well endowed with rivers
Natural Region II	Annual rainfall in Natural Region II ranges from 700 to 1,050 mm, and supports significant agricultural production of tobacco, maize, cotton and horticultural crops. The region also possesses a significant level of water resources.
Natural Region III	Natural Region III receives an annual rainfall of between 500 and 700 mm, and is subject to periodic seasonal droughts, and prolonged mid-season dry spells. Agriculturally, it is a semi-intensive farming region where maize and drought-resistant crops such as cotton and sorghum are grown. Irrigation is required for other crops.
Natural Region IV	Rainfall of between 450 and 600 mm per annum are experienced in Natural Region IV, which is suitable for cattle ranching (rain-fed agriculture is risky). Drought-resistant crops such as millet and sorghum can be grown. The region is less endowed with water resources.
Natural Region V	Natural Region V is less endowed with water resources. Rainfall is normally less than 450 mm per annum and largely erratic. It is largely described as too dry for successful crop production without irrigation but suitable for cattle ranching and wildlife.

Surface water contributes over 90% to the country's water supply. Most of the rivers and streams, especially those in the drier areas, are seasonal. Dams have been constructed to store water for agricultural, industrial and domestic purposes. There are 140 large dams with a capacity greater than one million cubic metres and nearly 11,000 small dams. High siltation rates are a major problem (reducing the life span of small dams - ENDA-ZERO, 1992. Because of recurrent droughts, over-exploitation, poor management and ecological degradation, freshwater is increasingly becoming a scarce resource.

Zimbabwe has a number of wetlands (*vleis)*, including dambos, which are grass covered treeless valleys that are periodically inundated with water. Dambos are of great importance as they are intensely used for cattle grazing, dry season agriculture and water supply for domestic purposes. Unfortunately, many dambos have been severely degraded by inappropriate and excessive use (Chenje et al. 1998). Ground water is also used with wells and boreholes and is particularly important in the drier parts of the country.

To a large extent, the soils of Zimbabwe are related to the nature of the underlying geology. About 50% of Zimbabwe is underlain by granite which generally gives rise to sandy soils, regosols, which are susceptible to soil erosion (Murphree and Mazambani 2001). They are of low nutrient content, requiring large quantities of fertiliser and manure in order to produce good yields. These soils occur predominantly in communal areas and smallholder farming regions where the limited resource base is a major socio-economic constraint. There are numerous other types of soil with varying degrees of fertility. Of particular note are the more fertile fersiallitic groups derived from basic dolerites,

sandstones and quartzites that occur in Zimbabwe's maize belt where large-scale commercial farms predominate (Moyo et al. 1991).

3.5 Summary

Zimbabwe faces a number of challenges in reducing poverty and in promoting sustainable social and economic development. The political and economic challenges of the past decade between 1998 and 2008 led to significant declines in all indices of social and economic progress. Such challenges are exacerbated by the threats posed by climate change, particularly on agricultural systems. Three severe droughts in 2002, 2005, and 2007 occurred when the country was already suffering from considerable political and economic challenges. The recent resurgence of agriculture and mining, and the important contributions that the two sectors are making to GDP, employment and poverty reduction must be noted. However, Zimbabwe needs to simultaneously respond to the challenges posed by climate change and to devise a development strategy that ensures economic recovery, social development and poverty reduction that takes into account the effects of climate change.

Part B – Climate Science, Institutions and Policy

4. Climate variability and change in Zimbabwe

Zimbabwe is wholly tropical but enjoys subtropical conditions because of its high average elevation. The whole country is influenced by the Inter Tropical Convergence Zone (ITCZ), the influence from which reaches a peak in January. In years when the ITCZ is poorly defined, there is a tendency towards below average rainfall and a likelihood of serious drought in the country. When the ITCZ is well defined then rainfall is average or well above average. Zimbabwe's national average annual rainfall ranges from 500 to 750 mm, and diurnal average surface temperature varies from 15°C in July to 22°C in January. There is growing evidence to indicate that the country's climate has been undergoing dramatic changes in recent years. Zimbabwe is strongly influenced by fluctuations in rainfall. An improvement in the water balance as a result of climate change would be a great benefit; increased water stress, on the other hand, would be a development challenge.

4.1 Introduction

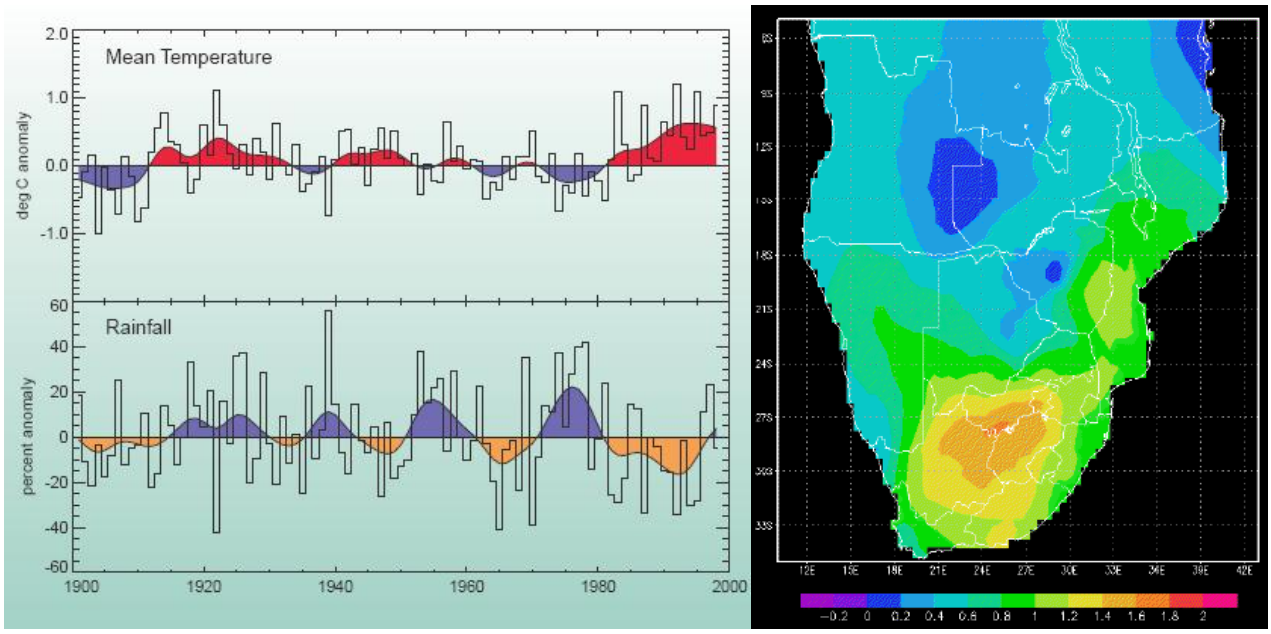
Zimbabwe faces a number of risks related to climate variability and change. The country is prone to droughts, periodic floods and shifting rainfall patterns. The country's primary and secondary industries including urban centres face ongoing water constraints. Widespread and severe climate change impacts are likely to worsen these challenges. Success in minimizing the potential economic, environmental and social dislocation caused by climate variability and change – and in capturing new opportunities for productivity growth inherent in emission reduction and adaptation – will require greater scientific understanding. Policymakers and development practitioners must know how and why the climate has been changing in the past, how and why it will change into the future, and how those changes are likely to affect various sectors and the country's socio-economic status. This section presents the evidence on climate change in Zimbabwe, the status of climate modelling and research (including the availability of relevant scientific data), management of information on climate change, and the national framework for climate sciences. The section also identifies priority areas for research and technical assistance.

4.2 Historic Changes in Temperature and Precipitation

4.2.1 Temperature

In Zimbabwe, temperature records began in 1897 at Harare and Bulawayo. For the entire country, reliable surface temperature records began in July 1923 when thermometer shelters were replaced by the conventional Stevenson's screen. A number of research reports show that Zimbabwe is experiencing more hot and fewer cold days than earlier last century.[7] The country's annual mean surface temperature has warmed by about 0.4ºC from 1900 to 2000 (Figure 3). National average maximum temperature has warmed by about 1ºC over the same period. The period from 1980 to date has been the warmest on record.

Figure 3 - Changes in mean annual temperature for Zimbabwe between 1900-1998 and early temperature trends across southern Africa between 1901-2002



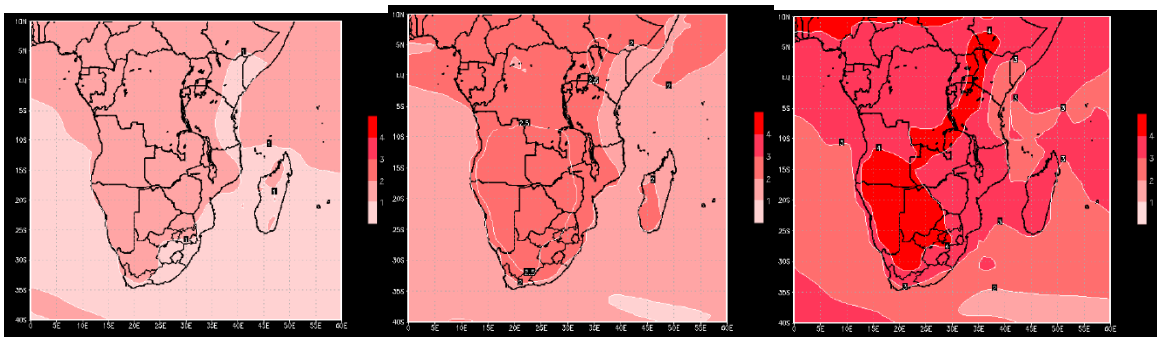
Source: Hulme and Sneard, 1999; CRU

[7] **Aguilar, E., et al. (2009),** Changes in temperature and precipitation extremes in western central Africa, Guinea Conakry, and Zimbabwe, 1955–2006, *J. Geophys. Res.*, 114, D02115.

4.2.2 Projected Changes in Temperature

Future climate scenarios for Zimbabwe and the southern Africa region have been produced from a number of models (KNMI, 2006; Engelbrecht et al., 2009) for periods up to 2100. All cited studies conclude that Zimbabwe's climate will be warmer than the 1961-1990 baseline. More specifically, warming rates of 0.5 to 2°C by 2030, 1 to 3.5°C by 2070, and 3 to 4°C by 2100 over baseline are projected assuming an A2 greenhouse gas emissions pathway (see Figure 4). These scenarios suggest a warming rate of just below 0.2°C per decade to over 0.5°C per decade.

Figure 4 - Projected change in annual average temperature (a) 2011-2040, (b) 2041-2070, and (c) 2071-2100 from the 1961-1990 baseline.



Source: Engelbrecht et al., 2009

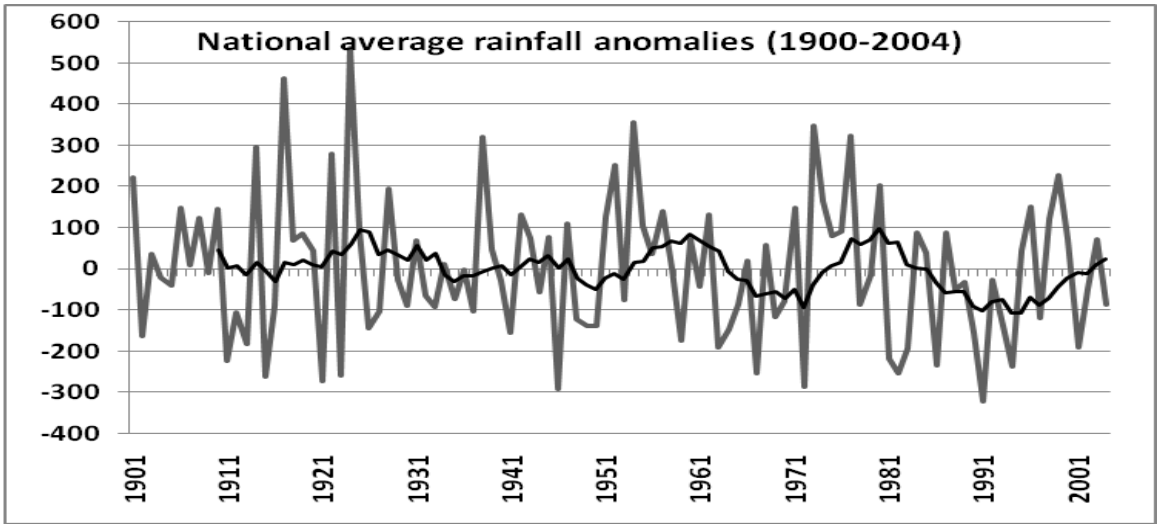
The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007a) indicates that climate model projections for the period between 2001 and 2100 suggest an increase in global average surface temperature of between 1.1°C and 6.4°C. The range depends largely on the scale of fossil-fuel burning within the period and on the different assumptions within the models used. Since the first IPCC report in 1990, assessed projections have suggested global average temperature increases between about 0.15°C and 0.3°C per decade for 1990 to 2005. This can now be compared with observed values of about 0.2°C per decade, strengthening confidence in near-term projections (IPCC, 2007a).

4.2.3 Rainfall

Zimbabwe does not show any aggregate long-term trends in levels of precipitation (see Figure 5 below, and Figure 4 above). However, it does appear that the timing and amount of rainfall received in any given season is becoming increasingly uncertain. In addition, from 1950 to 2010, the length and frequency of dry spells during the rainfall season has been increasing while the frequency of

rain days has been reducing (Tandross et al, 2009). It has been generally observed that competing responses (such as increasing number of dry days, coupled with increases in rainfall intensity), working at different timescales, tends to mask climate change signals in time-averaged total rainfall across the country.

Figure 5: Time series of Zimbabwe national average rainfall anomalies from 1900 to 2004

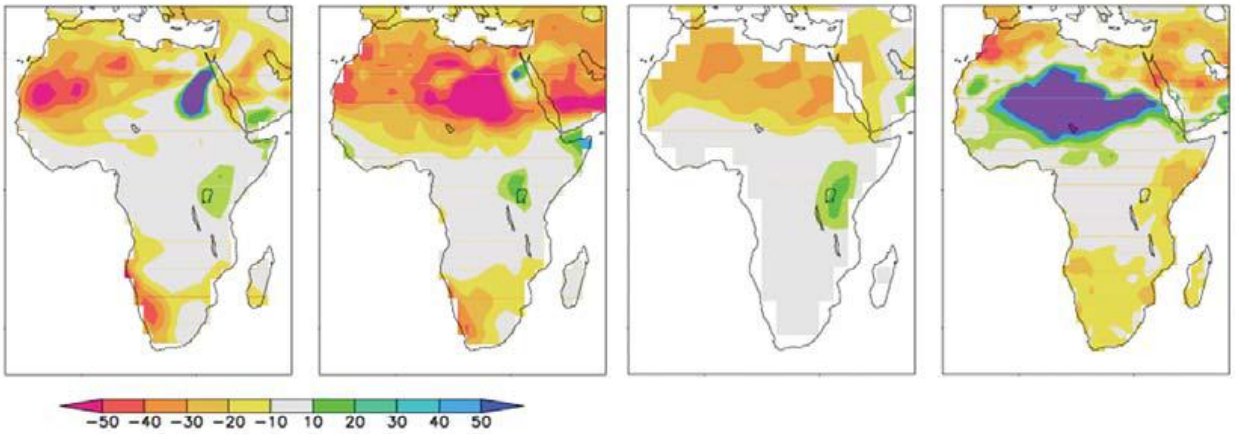


Source: Zimbabwe Meteorological Services Department

4.2.4 Projected Changes in Precipitation

Considerable uncertainty exists in relation to precipitation changes simulated by Global Climate Models for Zimbabwe and Africa. Some GCMs suggest wetting whilst a few suggest drying by as much as 10-20% of a baseline (Figure 5). Downscaled model outputs for selected river basins in Zimbabwe also show little evidence of significant changes in total precipitation across the country, but do show substantial temperature increases leading to greater evapotranspiration and possible water stress (Boxes 2 and 3).

Figure 6 - Percentage change in annual mean precipitation around 2050 compared with 1971–2000 in selected climate models, from left to right: GFDL (CM2.0 & CM2.1), CCCMA, CGCM3.1 and HadGEM1



Box 2: Save River Basin Future Climate Change Scenarios

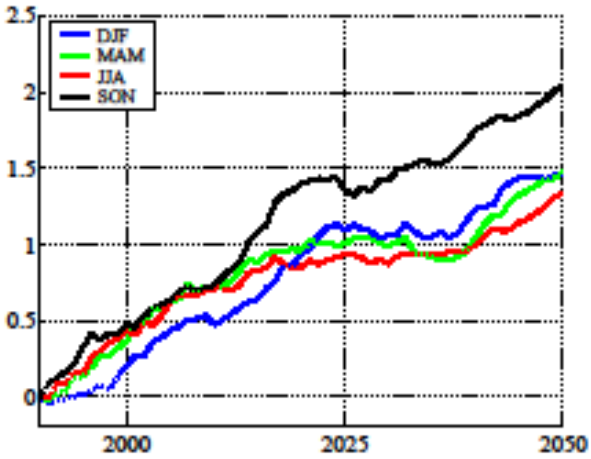
The EMA-UNDP/GEF Coping with Drought and Climate Change project used data from a sample of ten global climate models to produce downscaled future climate change scenarios for the Save Basin in southeast Zimbabwe for the periods 2046-2065 and 2081-2100. The downscaled data predict a temperature increase of 1.5-3.5°C across the basin by 2046-2065 for the A2 (high emissions combined with high sensitivity) greenhouse gas emission pathway. Rainfall predictions for the same period from the median model output do not show significant changes in total rainfall amount, save for some slight decrease during February. Scenarios of rising temperatures across the Save Basin imply increased water loss through evapotranspiration which could lead to some water balance problems if water supply and management practices do not change.

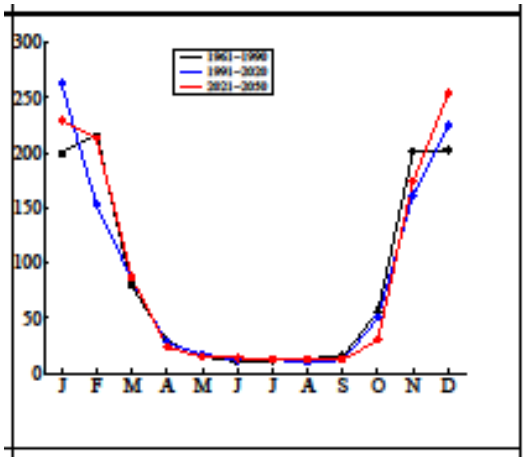
Source: GoZ-UNDP/GEF Coping with Drought and Climate Change project (2009).

Box 3: Pungwe river basin climate change scenarios

Sweden's Meteorological and Hydrological Institute (SMHI. 2006) used a regional climate model to simulate temperature and rainfall over the Pungwe Basin for two periods 1991-2020 and 2021-2050 assuming the A2 greenhouse gas emissions pathway. A general feature of the scenario simulations is a significant increase in temperature in all seasons across the Pungwe river basin. Taken as an average the increase in temperature is between 1.5 and 2.2 C for all seasons (see Figure7 below). For precipitation none of the simulations gave changes larger than ± 5% in total precipitation for the period December through May, while they give decreases of 10-20% between June and November. For the Pungwe River Basin models show a clear delay in the onset of the rains. The climate change signal is stronger in the second period 2021-2050

Figure 7[8] and 8 – (a) 30-year running means of simulated seasonal temperatures in the Pungwe river basin; (b) Simulated mean monthly precipitation for 1961-1990 (black), 1991-2020 (blue), and 2021-2050 (red).





Source: SMHI (2006)

[8] *DJF – represents December, January and February; MAM – March, April & May; JJA – June, July & August; SON – September, October and November.*

4.2.5 Weather Extremes

Extreme weather events include spells of very high or low temperature, torrential rains and droughts. Changes in extreme events may be the first indication that the climate is changing. Change can occur in both mean climate parameters and the frequency of extreme weather events. Prolonged anomalous periods – such as the five-year duration (1990-1995) of El Niño conditions – can destabilize agriculture. Altered weather patterns can increase crop vulnerability to infection, and weed/pest infestations. Sequential extremes, along with altered timing of seasons, can decouple long-evolved relationships among species (e.g., predator/prey) essential for controlling pests, pathogens, and populations of plant pollinators (Rosenzweig, et al., 2001).

Trends temperature and precipitation extremes have indicated that between 1955 and 2003: [9]

- The occurrence of extreme cold days and nights has decreased by -3.7 and -6.0 days/decade, respectively.
- The occurrence of extreme hot days and nights has increased by 8.2 and 8.6 days/decade, respectively.
- The average duration of warm days has increased by 2.4 days/decade.
- The Diurnal Temperature Range shows consistent increases
- There has been a significant increase in regionally-averaged daily rainfall intensity and dry spell duration. However these trends ar not mirrored in Zimbabwe.
- There are increasing trends in regionally averaged rainfall on extreme precipitation days and in maximum annual 5-day and 1-day rainfall, but only trends for the latter are statistically significant.

Trends in synoptic systems (e.g. tropical cyclones) are more difficult to assess, because of difficulties in monitoring these systems consistently over several decades, and difficulties in modelling and understanding them. The strongest evidence that extremes are changing is the significant difference between the 1980s and the late 1990s and early 2000s in the frequency of these climatic shocks.

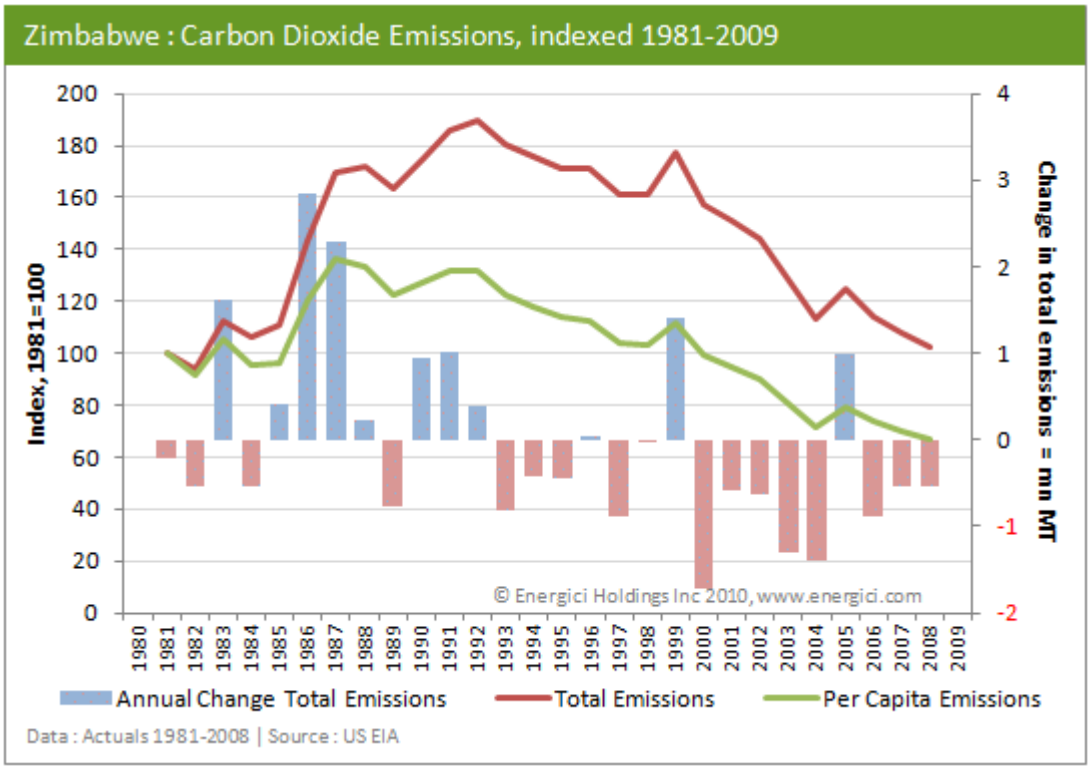
[9] New et al., 2006; Mazvimavi, 2008; Aguilar et al., 2009; Tadross et al., 2009.

4.2.6 Carbon Dioxide Emissions

Current CO_2 emissions, from anthropogenic sources mainly fossil fuel burning, and land use change, and their resultant concentration in the atmosphere is central to future climatic changes. Of significance to note is the fact that projected CO_2 emissions shape policy options for climate change mitigations. It is in this context that we focus on trends of CO_2 emissions in Zimbabwe. Figure 9 below shows CO_2 emission trend from 1980 to 2009. Important to note is the fact that CO_2 emissions in Zimbabwe have been decreasing for the past decade. In 2008, total CO_2 emission had reached 8.96 million metric tonnes (mn MT), a compound decrease of minus 2.04% between 2003 and 2008 (Energici Holdings 2010).

Zimbabwe's total represented 0.78% of total regional emissions and 0.03% of total world emissions. On a per capita basis meanwhile, Zimbabwe was ranked at number 154 worldwide in 2007, with per capita emissions 8.17million metric tonnes (ibid.). With the economic recovery of the past three years, and increased agricultural production, it is expected that CO_2 emissions will increase, but from a very low base to extent that the resultant increased CO_2 emissions will not significantly alter the country's contribution s to regional and global emissions.

Figure 9: Zimbabwe: Carbon Dioxide Emissions, Indexed 1981 - 2009



4.3 State of Climate Science in Zimbabwe

Although the climate system can only be understood if it is analyzed on a global scale, it is also true that Zimbabwe's climate has some unique characteristics influenced by a distinct set of climate drivers. There is a need to promote local climate research to produce information needed to understand climate change relevant to local needs and to inform effective policy responses appropriate. In the 1990s, Zimbabwe contributed to climate science as demonstrated by a wide range of peer-reviewed papers in international journals and high-level climate change impact assessments provided to government via the National Climate Change Office. During the same period Zimbabwe was also an active participant in IPCC Working Groups, the International Geosphere-Biosphere Programme and the World Climate Research Programme. But current climate science has not maintained this quality, and is mostly based on empirical studies not modelling.

In this regard the country is yet to develop world-class climate change science capabilities. A skills shortage in science agencies is developing. Better career paths are required to address this. Part of the solution must be to improve cooperation between Zimbabwe's research institutions and international climate change experts. Zimbabwean universities also need to increase their climate science capacity. Government may also need to consider targeted investment to provide the necessary capability in infrastructure, people and climate observing capacity.

4.4 Knowledge Management of Climatic Data

User communities are seeking efficient and effective mechanisms to access climate change information to underpin their policies and decision-making processes. Leveraging climatic data to manage climate change is therefore an essential component of any mitigation and adaptation effort. Improving our ability to collect, aggregate, and share accurate data and make it broadly accessible would significantly improve our capabilities for responding to climate change. Currently, the Meteorological Services Department manages a central database of historic climate data but has nothing on future climate impacts. A national node for knowledge management on climate change, and vulnerability of systems and sectors at various spatial and temporal scales, may be necessary to support mitigation and adaptation programmes.

4.5 National Framework for Climate Change Science

This sub-section assesses some of the challenges for Zimbabwe's climate change science agenda and identifies areas where climate change science will need to deliver information that will inform important decisions over the next decade.

4.5.1 Capability

i. Climate observations

Long-term, consistent records of the behaviour of the climate system underpin climate change detection and attribution, provide vital information with which to test models, and support the development of adaptation and mitigation responses. The Meteorological Services Department is the primary institution for gathering meteorological data and production of weather forecasts in Zimbabwe. The network coverage is about 65 meteorological sites and around 400 rainfall stations (having declined from 1400 in 2001). Priority data streams include:

- annual assessments of temperature and precipitation change;
- records of greenhouse gas emissions, particularly CO_2;
- observed changes in extreme weather events, such as the frequency and intensity of tropical cyclones, dry spells, heat waves, thunderstorms, heavy rain and hail.

ii. Climate Process Studies

Process studies lead directly to improvements in climate system information and predictability. Elements of the climate system affecting Zimbabwe that require attention via process studies include cloud dynamics and feedbacks, aerosol (air pollution, dust, and smoke) effects, tropical convection, ocean interaction, land surface-atmosphere exchange and the dynamic role of vegetation interacting with changing climate. Currently there is no evidence of local capacity to undertake such vital process studies.

iii. Predicting future climate

Zimbabwe needs climate information at time scales of days, months, years, and decades and across a range of spatial scales. The country currently has capacity to provide daily forecasts and some limited information about seasonal climate (3–9 month forecasts) with moderate accuracy. The

country's capacity to provide information on the 10-30 year time scale of interest to many decision makers for adaptation programming is almost non-existent.

iv. Linking Climate with Social and Economic Systems

While there are some joint activities to enhance risk-reduction activities, there is still little active engagement between communities that are essentially researching similar themes. The need exists, therefore, to enhance efforts on the coupling and drawing together of disaster risk-reduction activities, vulnerability assessments, and climate change and variability assessments. There is also a need to improve and continue to assess the means (including the institutional design and requirements) by which scientific knowledge and advanced technological products (e.g., early warning systems, seasonal forecasts) could be used to enhance the resilience of vulnerable communities.

4.5.2 People and Infrastructure

Appropriate skills, infrastructure and communication mechanisms are fundamental to an effective national climate change science effort to deliver the information needed by the adaptation and mitigation communities. Skilled Zimbabwe scientists are distributed across several local and foreign institutions, including academic and research organisations, and some government agencies. The challenge is to develop an effective mechanism to coordinate climate science work across these institutions to:

- harness the best available science talent to work on national climate change science priorities;
- use scarce resources, large-scale infrastructure and data more efficiently; and
- foster the development of new talent.

Much of the research on climate has been driven by the atmospheric sciences community, including, more recently, greater interaction with biophysical scientists. However, there is much to be gained from an approach which includes those working in the social sciences and public policy. Moreover, the growing interest in partnerships, both public and private, as well as the inclusion of large corporations, formal and informal business, and wider civic society requires more inclusive processes and activities. For this reason, more 'creative' interactions (e.g., greater interactions

between users and producers of science as well as policymakers and development agencies) will be required.

4.5.3 Future Research Directions

The IPCC Fourth Assessment Report has identified a number of knowledge gaps for Africa, most of which are relevant for Zimbabwe. Notwithstanding the marked progress made in recent years, particularly with model assessments, the climate in many areas of Zimbabwe is still not fully understood. Climate scenarios developed from GCMs are very general and do not adequately capture important local variations. The need therefore exists to further develop regional climate models and sub-regional models at a scale that would be meaningful to decision-makers and to include stakeholders in framing some of the issues that require more investigation.

A further need is an improved understanding of climate variability, including an adequate representation of the climate system and the role of regional oceans. Improved seasonal forecast systems are expected to play an increasingly important role in strengthening adaptation strategies in the country.

Research on agro-ecological zones so far has been conducted assuming these zones are stable. However, since agro-ecological zones are by definition a function of climate, their geographical extend or characteristics may shift or change as the climate changes. Future research should attempt to estimate the impact of climate change on Zimbabwe's agro-ecological zones. If there are any shifts in agro-ecological regions, these need to be carefully understood and their implications for local economies and livelihoods mapped out. Knowing more about these potential aspects of climate change is essential to social and economic policy in Zimbabwe.

5. Institutional and Policy Framework for Climate Change

There are several formal and informal institutions that deal with climate change issues in Zimbabwe. These include public institutions (mainly, government agencies), civil society organisations, NGOs, community-based organisations, private sector organisations, and informal institutions (e.g., traditional authorities).

This section presents an analysis of institutions and policies that govern climate issues, with a view to examine the strengths and limitations of the current institutional arrangements and policies. More importantly, the analysis explores the extent to which prevailing institutional arrangements and policy frameworks can serve as a basis for a coordinated approach to the development of national adaptation and mitigation strategies.

5.1 Public Institutions

5.1.1 Ministry of Environment and Natural Resources Management

There are a number of public institutions that deal with climate change issues, the most important of which is the Ministry of Environment and Natural Resource Management (MENRM), the national focal point for climate change (providing an administrative coordination structure for climate change policy and programmes). It is the lead ministry for the development and implementation of environmental policy, and coordinates with all other ministries and agencies on environmental matters. The Ministry derives its mandate from four principle pieces of legislation, namely, the Environmental Management Act (Chapter 20:27) of 2002. The policymaking and coordinating unit for the Ministry is at head office in Harare and its mandate is executed via its parastatals: namely, the Environmental Management Agency (EMA), the National Parks and Wildlife Management Authority and the Forestry Commission.

MENRM manages the implementation of Multilateral Environmental Agreements in Zimbabwe. Zimbabwe was amongst more than 150 countries that signed and ratified the three Rio Conventions, including the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. In 1997 Zimbabwe signed the Kyoto Protocol, and this was ratified by both houses of the Zimbabwe Parliament in 2008. Within the ministry, the Climate Change Office is mandated to deal with climate change issues.

5.1.2 The Climate Change Office

The Climate Change Office was established in the Ministry of Environment and Tourism in 1996 to administer the implementation of the UNFCCC and the Kyoto Protocol. The Climate Change Office hosts the UNDP/GEF project on capacity building in sub-Saharan Africa. This project is still underway and is commissioning studies designed to update the GHG inventories.

The staff of the Climate Change Office currently consists of a coordinator and a secretary. An officer in the Environment Division of the Ministry is also assigned to the Office. It is mainly externally funded, with government providing in-kind support such as office space, furniture and recurrent costs. The coordinator participates in international climate change negotiations and UNFCCC conferences. The office's work is guided by a multi-sectoral National Climate Change Steering Committee.

5.1.3 National Climate Change Steering Committee

The Ministry of Environment is supported in its administration and implementation of the UNFCCC by a multi-sectoral National Climate Change Steering Committee (Ministry of Environment and Tourism, 2008a). The Committee was originally established under the United Nations Institute for Training and Research (UNITR) project, with representation from various other national institutions, universities, research organisations, industry associations and NGOs, to provide technical input. Currently, the committee meets annually and is primarily for information sharing regarding the international UNFCCC negotiations', thus ensuring information is disseminated to all relevant stakeholders.

The National Climate Change Steering Committee currently consists of:

- The Permanent Secretary of Ministry of Environment and Natural Resources Management, who chairs the meetings;
- The Climate Change Office which is the Secretariat, sending invitations and recording minutes;
- Members of line ministries and parastatals: Agriculture, Health, Science and Technology, Foreign Affairs, Water, Industry and Commerce, Finance, Labour and Social Services, Transport (which includes the Meteorology Department), the Attorney General's Office, Environmental Management Agency, Forestry Commission;

- Project leader of the Coping with Drought and Climate Change project;
- The Standards Association of Zimbabwe;
- UNDP, Harare Office;
- Global Environmental Facility (GEF), Small Grants Programme;
- The Ozone Office;
- ZERO (a regional NGO);
- Southern Centre for Energy and Environment (a regional NGO);
- World Wide Fund for Nature (WWF) (an international NGO).

5.1.4 The National Designated Authority (NDA) Board

Under the Kyoto Protocol, developing countries have access to funds for investment in environmentally sound technologies under the Clean Development Mechanism (CDM). Zimbabwe is in the process of establishing a National Designated Authority (NDA), the mechanism required to examine project proposals and access CDM funding. The framework for the establishment of the NDA is still under review at the Attorney General's Office, however it's expected to consist of line ministries and be chaired by the Ministry of Environment. A Statutory Instrument is being developed, with terms of reference to guide the operations of the NDA. Five project proposals have been developed so far, mainly related to energy, but these have not been adopted as no funds have yet been received.

5.1.5 The Department of Meteorological Services

As discussed above, climate monitoring falls under the responsibility of the Department of Meteorological Services, in the Ministry of Transport. Although the Department of Meteorological Services does not have any climate change programmes, they do participate in climate change initiatives. For example, the department has a Memorandum of Understanding with ICRISAT on a climate change programme which involves the provision of data for a weather insurance index.

5.1.6 Zimbabwe National Statistics Agency (ZIMSTAT)

ZIMSTAT (formerly the Central Statistics Office) compiles national Environmental Statistics Reports. Reports have been produced in 1994, 2000, 2004 and 2010. The objective of the report is

to identify national environmental concerns, and gaps. The 2010 Report contains a section on climate change that gives a historical overview of drought and rainfall patterns in southern Africa from 1800 to 2007 (ZIMSTAT, 2010). The Report also contains information on rainfall, water resources and deforestation.

5.1.7 The Environmental Management Agency (EMA)

EMA, a parastatal under the Ministry of Environment and Natural Resources Management, is responsible for the promotion of standards for environmental quality, including air, and to provide information on the environment. It oversees implementation of the United Nations Convention to Combat Desertification which involves a National Action Plan and implements a number of pilot projects dealing with adaptation by vulnerable communities.

5.1.8 The Forestry Commission

The Forestry Commission, a parastatal under the Ministry of Environment and Natural Resources Management, monitors the extent of forests and deforestation in the country, and promotes rural afforestation. It carries out studies for the Climate Change Office on the Land Use Change and Forestry (LUCF) initiative.

5.1.9 Ministry of Water Resources, Development and Management

Hydrological observations fall under the responsibility of the Zimbabwe National Water Authority (ZINWA) a parastatal in the Ministry of Water Resources, Development and Management. ZINWA is central in the production of water statistics and has the mandate to collect data on river flows and dam levels, run-off in selected rivers, ground water level, siltation of water bodies and rainfall and evaporation (CSO, 2009).

5.1.10 The Ministry of Agriculture, Mechanisation and Irrigation Development

The Ministry, in collaboration with research institutions including the University of Zimbabwe and Chinhoyi University of Technology, is carrying out research with smallholder farmers on adaptation and piloting best practices.

5.1.11 The Department of Disaster Management and Resettlement (Ministry of Local Government)

Natural disasters in Zimbabwe are predominantly climatic or meteorological in origin, namely droughts and floods, but also include wild bush fires which are primarily anthropogenic in origin. Zimbabwe has a policy on disaster risk reduction which provides local structures for disaster and risk management. The policy is being revised in view of climate change. Policy implementation is coordinated by the Department of Disaster Management and Resettlement (formerly Department of Civil Protection), under the Ministry of Local Government, which is responsible for coordinating and handling natural disasters.

The Department of Disaster Management and Resettlement collates data on natural disasters, including incidence of droughts, landslides and floods, runoff, and disease outbreaks. Data is collected from the Department of Meteorological Services, Ministry of Health and Child Welfare, Local Authorities, ZINWA and SIRDC. The Ministry of Health and Child Welfare has a Disease Surveillance Unit. The Department of Disaster Management and Resettlement has structures at national, provincial and district levels. At the national level, the Climate Change Coordinator is a member of the Disaster Management Committee

5.1.12 Local Authorities

There approximately 52 local authorities in Zimbabwe. Local authorities are mandated to carry out air quality monitoring, but have little capacity and equipment for this. Harare City Council carries out air pollution monitoring, but not on a regular basis.

5.2 Non-Governmental Organisations (NGOs)

Many national and international NGOs are involved in climate change activities, including mitigation, adaptation, capacity building, and awareness-raising. According to the National Association of NGOs (NANGO), there are over 180 organisations working on climate change and the environment (mainly on resource management in communal areas). It is important to note that

ZERO and the Southern Centre for Energy and Environment are members of the National Steering Committee for Climate Change.[10]

5.2.1 The Climate Change Working Group

The Climate Change Working Group consists of organisations interested in climate change in Zimbabwe. The Working Group is chaired by ZERO, which also provides the secretariat. The Working Group implements programmes that aim to influence government policy. There are a number of thematic sub-committees in the working group dealing with a wide range of climate change issues. Strategic thematic foci for the Working Group are:

- Advocacy for climate change policy;
- Facilitating and promoting research;
- Strengthening education, awareness and capacity development;
- Promoting climate change adaptations and mitigation strategies;
- Developing communication strategies.

5.2.2 Community-Based Institutions

A number of *ad hoc* institutions have been formed in communities dealing with climate change, primarily adaptation. They are largely uncoordinated and formed around a specific issue. They are mainly based on their legitimate claim to represent a local concern that is not adequately represented elsewhere in policy process, but is of crucial importance to the local community. For instance, the Tongwe Community Group is an example of a community-based institution that was established to address loss of its irrigation infrastructure. To prepare for coping with increased water shortages, the community group decided to diversify income-generating activities and switched from growing maize to drought-tolerant and pest resistant sorghum seed.

[10] Some of the NGOs include, Zimbabwe Regional Environmental Organisation (ZERO), Southern Centre for Energy and Environment, Practical Action, Oxfam, Care International, World Vision, Zimbabwe Environmental Law Association, Development Reality Institute, and Save the Children.

5.3 Academic and Research Institutions

A number of institutions of higher learning are involved in climate issues across various disciplines. Table 3 below provides an overview of the key institutions and their respective work on climate change.

Table 3 - Examples of Academic and Research Institutions working on climate change in Zimbabwe

Institution	Activities on Climate Change
Department of Geography and Environmental Sciences, University of Zimbabwe	Teaches a course on Climate Change and Development for undergraduate and post-graduate students; Contributed vulnerability and adaptation studies to the Second National Communication; and Participates in the National Capacity and Self Assessment study
Faculty of Agriculture, University of Zimbabwe	The Faculty has a number of projects on resilience of smallholder farmers to the effects of climate change.
Chinhoyi University of Technology	CUT has a project on climate change and education and awareness focusing on agricultural extension officers.
Midlands State University	MSU has a DFID/IDRC funded project on building adaptive capacity to cope with increasing vulnerability due to climatic change with communities in southern Zimbabwe.
Scientific and Industrial Research and Development Centre (SIRDC)	SIRDC has a component on climate change under the Cleaner Production Initiative.
The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	ICRISAT is a research organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).
Institute of Environmental Studies (IES), University of Zimbabwe	IES conducts environmental research on ecological, social and economic consequences of environmental change. IES is tasked with providing three services: Research and Development; Education and Training; and Information, Consultancy and Networking
Institute of Development Studies, University of Zimbabwe	IDS conducts research on development policy and practice in Zimbabwe
Southern Centre for Energy and Environment (SCEE)	SCEE conducts policy and technical studies to support the introduction of sustainable environmental practices, and providing support for renewable energy and cleaner production technologies, activities which are relevant to climate change
Centre for Social Studies (Trust)	Conducts policy research on climate change and development, particularly effects on local livelihoods. Works with the Ministry of Agriculture on FAO-funded nationwide vulnerability assessments

5.4 International Agencies

The past decade has witnessed a significant withdrawal of international agencies working in Zimbabwe. In this context a significant amount of funding by international and donor agencies were channeled towards work on governance and humanitarian assistance. However, some organizations, such UNESCO, UNDP, World Bank, WWF, DfID and the British Council supported work on climate change.[11]

Although the work of international agencies is commendable, budget allocated to climate change activities in Zimbabwe have been low. In some instances, climate change budgets were withdrawn or reduced (as is the case with the British Council). These developments coupled with the political crisis of the past decade make it extremely challenging for international agencies to significantly fund climate activities in Zimbabwe. A thawing of the diplomatic tensions from 2009 onwards has seen an increased innovation in funding for climate change work, and importantly a return of some international agencies, such as the Danish International Development Agency (DANIDA), which might lead to increased budgetary support on climate change. The increased and active role that the Australian Agency for International Development (AusAid) is expected to take in contributing to development in Zimbabwe, and Sub-Saharan Africa more generally, might result in increased funding on climate change. Although this positive trend is encouraging, the impact of global financial crisis on future flows of funding to climate change work in Zimbabwe is yet to emerge.

5.5 Links to Research and Policy

A preliminary analysis of the climate change activities by the aforementioned institutions indicates there is limited coordination of research and practice to influence national policy processes. First, although there is an emerging body of literature on various aspects of climate change, such studies are still to be translated and packaged into accessible, meaningful and practical recommendations

[11] First, the British Council and UNESCO are implementing a project called 'Our Climate, our Future, which seeks to raise awareness on the effects of climate change in Zimbabwe. Also, under the Development Partnerships in Higher Education (DelPHE) programme, the British Council, together with University of Zimbabwe's Institute of Environmental Studies (IES), Department of Civil Engineering, and University of Zimbabwe is implementing a project that is incorporating climate change in the integrated water resources management Master's Programme. This project seeks to mainstream climate change issues in postgraduate curricular. Second, in 2011, DFID funded ZERO to commission research under the 'Meeting Information and Advocacy Needs for Adaptation to Climate Change in Zimbabwe' initiative. Thirdly, the Global Environment Facility Small Grants Programme has funded more than 20 small projects on climate change in Zimbabwe since 1993. These projects have supported activities that contribute to the reduction of GHGs while contributing to local development.

which can be taken up by policy and decision makers and inform the policy process. Secondly, political tensions of the past decade between researchers, NGOs, international agencies on the one hand, and policymakers on the other, still characterise the relationship between these stakeholders. Consequently, there is limited space for researchers and NGO staff to engage in a constructive debate with policymakers with the view to develop a coordinated response to climate change and development. In sum, the use of research to inform a climate change policy will depend on the *improvement of relations* between researchers, NGOs and policymakers, which might be driven by the need for different stakeholders finding a common ground to do work that benefit the nation.

It is important to note that the Climate Change Office has prepared proposals for, and conducted studies specifically on climate change and climate-related issues which have influenced the policy process.[12] All these studies are meant to help Zimbabwe identify and prioritize the climate change initiatives it should undertake. Further, the Climate Change Office is currently finalising the Second National Communication to the UNFCCC which is coordinated by the Ministry of Environment and Natural Resources Management. The report highlights measures that could be used to reduce greenhouse gas emissions: for example, catchment area rehabilitation through agro-forestry, industrial energy management, development of projects for the Clean Development Mechanism and wider use of renewable energy. The Climate Change Coordinator is currently developing a proposal for the Third National Communication.

Although these reports are important, it is clear that the project-by-project potential for emission reductions in Africa is generally small. Investors would therefore not achieve short payback periods they require. The carbon market is therefore a higher cost option for Zimbabwe than would be the case if there was a flourishing African or even Southern African carbon market. In addition, the CDM process is complex and there are limited skills in Africa to ensure conception, design and implementation and certification of a CDM project.

Some progress has also been made linking up the work done by the Climate Change Office to national policymakers as climate change is now being debated in Parliament. In 2010, the Climate Change Coordinator was called to the Parliamentary Committee for Environment and Natural Resources to answer questions by Parliamentarians on climate change issues.

[12] Among these are: the Strategy for Zimbabwe with respect to Activities Implemented Jointly (AIJ) and the Clean Development Mechanism (CDM) sponsored by the World Bank, the Vulnerability and Adaptation of Maize Production to Climate Change in Zimbabwe (2004), Climate Change Mitigation Studies in Zimbabwe (2004), the National Capacity Self-assessment for Climate Change, Biodiversity and Land Degradation in Zimbabwe (2008a), and the Technology Transfer Needs Assessment Report for Zimbabwe (2008b)

In addition to the above, broader research on different aspects of climate change have been carried out in Zimbabwe recently (see Boxes 4 to 8 below). A key study on the impacts of climate change on agriculture is being conducted by the Environmental Management Agency (EMA**),** in collaboration with the United Nations Development Programme (UNDP) and with funding from the Global Environment Facility Special Climate Change Fund. See Boxes below.

Box 4 – University of Zimbabwe

Ongoing research and field trials are being carried out on various water harvesting technologies to improve crop yields in dry regions. For example, in the semi-arid districts of Mudzi, Chivi and Mutoko dead contour water management technology and *Fanya juus* are being used in conjunction with appropriate soil-water management techniques and drought tolerant seed varieties of crops such as rapoko, sorghum and finger millet. *Fanya juus* are the opposite of contour ridges where the soil is heaped down slope and the resultant ridge has the effect of keeping water within the levelled field so as to facilitate infiltration for the benefit of crops. With both technologies yields of three tonnes per hectare of the drought tolerant crops have been achieved compared to around one tonne per hectare under dry farming (Feresu 2010).

Box 5 - IDRC

The IDRC's Climate Change Adaptation in Africa (CCAA) research and capacity development program and the START African Climate Change Fellowship programme supports African countries in their efforts to increase their knowledge, capabilities and experience for advancing climate change adaptation in Africa. A number of Zimbabwe researchers have produced research products through these programmes.

For example, the University of Zimbabwe is implementing the project 'The Lack of Resilience in African Smallholder Farming: Exploring Measures to Enhance the Adaptive Capacity of Local Communities to Pressures of Climate Change' in Rusape and Wedza. The project aims to assess the vulnerability of smallholder farming communities to the effects of climate change and variability on agricultural productivity and livelihoods and identify opportunities for enhancing the adaptive capacity of different households and communities with particular focus on integrated soil fertility management.

Box 6 – GEF Mitigation Projects

The Global Environment Facility have been a key partner in supporting mitigation projects in Zimbabwe. For example, the country benefited from the pilot phase of a GEF Photovoltaic Project with a total budget of US$7 million over five years. The project was designed to have long-term mitigatory effects by removing barriers to energy conservation and energy efficiency. Zimbabwe was also of one of the four countries (together with Ghana, Kenya and Mali) in sub-Saharan Africa that in 1996 participated in the two-year GEF Pilot Phase project entitled "Capacity Building in Sub-Saharan Africa to respond to the UNFCCC" implemented by UNDP.

A UNEP/GEF supported technology transfer needs assessment was conducted in 2004 covering the Agriculture, Industry/Mining, and Energy sectors[1]. The purpose of the assessment was to establish technology needs to reduce greenhouse gas emissions from those sectors as an enabling activity for concrete technology transfer projects development. Moreover, a UNEP/GEF supported capacity needs self assessment for the implementation of the Multilateral Environmental Agreements was conducted in 2006.[1]

Box 7 – Early Warning Systems

Climate information can be used to improve early warning systems and their application may reduce vulnerability to change. Zimbabwe participates in the SADC regional early warning systems and hosted the SADC Drought Monitoring Centre during 1991 to 2008 (Feresu 2010). The Centre monitors near real-time climatic trends and generates long-range climate outlook products on monthly and seasonal time-scales. These outlook products are disseminated to the regional community to afford greater opportunity to decision-makers to develop strategic plans in dealing with adverse climatic conditions.

The country also participates in the activities of the SADC Regional Early Warning System and the Famine Early Warning System that provide advisory services on the food security situation in the region. In addition, Zimbabwe is a member of the Southern Africa Regional Climate Outlook Forum, a network that meets regularly to interpret global and regional climate signals and also provide seasonal rainfall forecasts to the region.

Box 7 – Adaptation - Coping with Drought

The Environmental Management Agency in collaboration with the UNDP and with financial support from the GEF Special Climate Change Fund has been implementing a 5-year (2008-2012) pilot project "Coping with Drought and Climate Change". The goal of the project is to enhance the capacity of agricultural and pastoral systems in Zimbabwe to adapt to climate variability and change. This project seeks to develop and pilot a range of long-term adaptation measures in the agriculture sector to reduce the vulnerability of small-holder farmers and pastoralists in rural Zimbabwe to current and future climate change related shocks. The primary focus of the project is Chiredzi District in Masvingo province. The project has been designed around four outcomes to address the barriers hampering long-term adaptation to climate change in the agriculture sector in Zimbabwe with special reference to agro-pastoralists in the semi-arid regions of the country. The outcomes are: (i) Developing the capacity of National institutions to facilitate climate change adaptation by improving their knowledge base (ii) promoting sustainable livelihoods for drylands, (iii) enhancing use of early warning systems, and (iv) Up-scaling adaptation lessons learned outwards to other geographic areas and upwards to national policy level.

5.6 Assessment of Existing Institutional Architecture to Deliver and Implement Effective Climate Change and Development Policy

To reiterate, one of the negative effects of the political crisis was it created political tensions between Government and other stakeholders, such as civil society organisations, the NGO sector, and donor agencies. Consequently, there has been little or coordination between Government and other stakeholders on climate change and development. To this end, policy responses to climate change have been fragmented.

The above observations are supported by findings from the National Capacity Self-Assessment process which looked at the ability to implement three UNCED conventions, including the UNFCCC. This study concluded that although some institutional arrangements for UNFCCC implementation do exist, more needs to be done to formalise institutions and improve mandates (Ministry of Environment and Tourism 2008a).The report further noted that the functions and responsibilities for climate change were not clearly allocated.

Six key capacity constraints were identified:

- The current legislation is based on 'command and control' rather than being based on incentives and penalties. There is a need to enhance the capacity of institutions to formulate evidence-based policies;
- There is low awareness of the existence of climate change and its causes and possible redress mechanisms, due to inadequate communication and dissemination of information about climate change;
- There are insufficient project proposals being developed on climate change for local situations. There is need to stream-line the process and provide technical assistance for proposal development;
- There is a lack of climate change-related research in Zimbabwe and there is need to strengthen research and development capacity of local scientists and research institutions.
- Environmental education is limited and needs to be promoted at all levels;
- There is lack of capacity for systematic inventorying of GHGs and obtaining reliable information is a problem.

A key reason for the lack of user uptake of climate knowledge has been that the Climate Change Office lacks long-term funding, resulting in a significant amount of time is spent trying to secure funding through projects.

In addition, a project by the Zimbabwe National Statistics Agency (ZIMSTAT) reviewed the capacities of institutions to deliver information used to formulate climate change policy (CSO 2009). This found that the country is not collecting quality or reliable data regarding air and climate indicators (CSO 2009). There are gaps in data on GHGs in Zimbabwe. The relevant institutions do not have the required equipment and skilled personnel to capture data on air pollution.

Similarly, the Department of Meteorological Services has faced a number of problems with respect to instruments for measuring climatic data. Over the past ten years, many of the rain gauges have been vandalised, or information and returns not submitted, either through lack of commitment or lack of sufficient knowledge to make the required measurements (CSO 2009). Some of the evaporation pans in remote areas have been destroyed by animals. Also, the automatic weather observing equipment is malfunctioning and obsolete (CSO 2009). As a result the Meteorological Department is now failing to collect relevant climatic information to inform users, and more importantly, to make day-to-day decisions.

The reliability of Zimbabwe's air and climate statistics provided by the Meteorological Department is further compromised by the gaps in geographical locations (CSO 2009). Much of the data is not captured due to malfunctioning or absence of equipment. The Department has a lack of computer capacity for climate modelling for production of local scenarios. These problems need to be addressed if climatic data is going to be used to understand climate change and feed into national policy processes.

The Climate Change Office collects data on GHG emissions through commissioning studies by consultants. Under the obligations of the UNFCCC, Zimbabwe is required to collect data and report on GHG emissions every five years. The last report was in 1998 and the Climate Change office is currently working on the latest National Communication Report. There is no systematic emissions inventory for the country except that compiled on GHGs as part of the Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) (Ministry of Environment and Tourism 2008a). Although the Climate Change Office adheres to quality control techniques developed by the Inter-Governmental Panel on Climate Change (IPCC) and its reports are subjected to external validation, it does not have the resources to verify data submitted (CSO 2009). Therefore, if the data could be correctly verified, this will improve the quality of the statistics produced.

Presently, the Climate Change Office is not able to deliver effectively because of: its weak mandate, small size and limited structure; and limited funding. The Climate Change Office does not have statutory powers to enforce compliance in submission of returns. The Office only operates at national level, as such there are no lower level structures, making vertical coordination problematic.

5.7 Challenges and Opportunities for Institutional Coordination on Climate Change and Development

A number of potential challenges to effective institutional coordination, as well as opportunities for improved and enhanced coordination of climate and development in Zimbabwe have been identified.

5.7.1 Climate Change Office: Challenges and Opportunities

Foremost amongst the threats is the limited capacity and mandate of the Climate Change Office, which is geared to serve the international agenda on climate change. Perhaps, the fact that the Climate Change Office is funded by the United Nations Environment Programme, might place

emphasis on UN processes on climate change which tend to emphasise mitigation and carbon trading. One of the key activities of the Climate Change Office is compiling the national Communication Frameworks, such as the Second Communication. Although important, such policy documents are primarily for the UN. In view of this, there is need for the Climate Change Office to focus more on the national agenda vis-à-vis climate change, specifically the effects of climate change on Zimbabwe's social and economic development, which, in turn, should inform the country's policy positions on climate change that take cognisance of Zimbabwe's development trajectory. One way of achieving that is for the Climate Change Office to pay more focus to climate change adaptation issues in Zimbabwe, which are Zimbabwe's priority under the UNFCCC (Ministry of Environment and Tourism 2008a), and to champion these at national and international level.

The lack of a comprehensive climate change policy makes it difficult to mobilise funds. A welcome development is that in 2011 the Government of Zimbabwe allocated funds to the Ministry of Environment and Natural Resources Management that were earmarked for climate change activities.

The existence of a well-established Climate Change Office, albeit small, with an experienced Climate Change Coordinator, together with the high level of experienced technical expertise in the country, has the potential to lead to a vibrant and effective institution for leading all aspects of climate change and development in Zimbabwe. The Office has robust linkages with major stakeholders and institutions on climate change, both government and civil society, as well as with the private sector and academia. With more resources, the Climate Change Office could be transformed into a fully-fledged department with sections dealing with specific issues. The National Capacity Self-Assessment corroborates this as one of the priority needs under the UNFCCC (Ministry of Environment and Tourism, 2008a).

5.7.2 The National Steering Committee on Climate Change: A Multi-sector Institution

The existence of a multi-stakeholder National Steering Committee on Climate Change is an excellent opportunity to permeate all areas of development and coordinate across sectors. However, at present, although representing a wide range of sectors, the National Steering Committee is more of a platform for sharing information on international climate change events than for addressing national climate change issues from a multi-sectoral developmental perspective. The meetings are

infrequent and there is no mechanism for coordination of policies and implementation of climate change activities. Consequently this reduces its impact for driving sustainable development and climate change issues.

The national importance and cross-cutting nature of climate change and development issues has been recognised and the matter is currently being addressed at the level of the Office of the President and Cabinet. A National Task Team on Climate Change is being established which will provide overall policy guidance on climate change issues in the country and will assist in mobilising all the relevant Ministries and other stakeholders to participate. The advantage of such a high-level committee is that it will have the authority to carry out its mandate and insist on compliance. The Task Team would be able to instruct institutions to provide data and information on climate change. Furthermore, the multi-sector Task Team will ensure that decisions taken regarding climate change and development by various sectors are compatible and comply with the overall national development policy. Such consultation will avoid conflicts between targets set for national appropriate mitigation actions under the multilateral agreements and national industrial development. A strong multi-disciplinary institution would enable the country to plan in a coordinated manner for the worst case scenarios. It is envisaged that technical committees with operational mandates will be established under the National Task Team to handle the various issues. Due to the need for a coordination mechanism and structures that will ensure systematic identification, coordination and monitoring of climate change policies and activities in each sector, one solution could be a 'climate change desk' in each relevant Ministry.

5.8 Vertical coordination: Lack of Downward and Upward Linkages

At present, there is a disjuncture in coordination between national and local levels. Although the Environmental Management Agency has officers at the district level, the Climate Change Office does not have any lower level structures. Therefore, coordination of activities country-wide is difficult. Institutions responsible for adaptation at the local level report to different line Ministries (for example, Local Government). Accountability tends to be upwards, rather than downwards, resulting in very little coordination of policies and activities at the lower levels. An opportunity exists in that there is a lot of activity at district and local levels which needs to be coordinated and streamlined. Effective local level coordination can be achieved through strengthening the local level institutions and structures. These in turn can engage with institutions at higher levels.

5.9 Coordination of compliance on Climate Change Policies

The absence of a distinct overarching climate change policy makes it difficult for the Ministry of Environment and Natural Resources Management to insist on compliance and the submission of required data on climate change indicators as it does not have the mandate or authority to be effective across sectors. There are also differences on priority with industry. Climate change issues are not mainstreamed into sector policies, which are often contradictory and non-compliant regarding climate change issues. Furthermore, there are numerous climate change mitigation and adaptation activities that are not coordinated and implemented on an *ad hoc* basis, resulting in overlaps and gaps. A variety of projects and researches are being implemented on climate change issues, with various sources of funding and partnerships. It is not clear how these relate to the national coordinating institutions.

There is need to have a mechanism that will harmonize climate change policy across sector policies as well as harmonize climate change activities, giving a stronger mandate and authority to insist on compliance to the Ministry of Environment and Natural Resources Management. This can be ensured through legislation, such as developing Regulations under the Environmental Management Act and as part of the domestication process involved with ratification of the Kyoto Protocol.

This is now being addressed through the formulation of a comprehensive national Climate Change Strategy which is being initiated by the Ministry of Environment and Natural Resources Management, with funding from UNDP. [13] Zimbabwe's Medium Term Plan for 2011-2015, launched in July 2011, sets a time frame for the development of the National Climate Change Strategy and Policy by the end of 2013 (Government of Zimbabwe 2011).

5.9.1 Role of Civil Society

Although they are undertaking work on climate mitigation and adaptation, especially in rural areas, civil society is not very well organised and the various initiatives are not coordinated. They tend to run parallel systems, being supported by various sources of donor funding. The Civil Society Working Group's strength is that it comprises of organisations with a diverse range of interests in

[13] This was announced at the National Climate Change Conference, November, 2010 by the acting Permanent Secretary, Mr Samuriwo. He indicated that government is working on a climate change policy to guide efforts to reduce the impact of climate change on Zimbabwe's development. The policy will guide ministries in formulating sector specific strategies to combat climate change.

climate change issues. However, the Climate Change Office is not represented in the Working Group, and consequently, links with government are weak. To forge stronger links with government actors, the CCO could be invited to join the Working Group, so that the civil society can benefit from national priorities, policy and practices. This would lead to more effective coordination of climate activities.

5.10 Analysis of Environmental Policy and Strategies and the Integration of Climate Change and Development into National Policy Frameworks

Broadly, the National Environmental Policy and Strategies (NEPS) is the framework policy that provides scope for an integrated approach to sustainable development in Zimbabwe (GOZ 2009). The NEPS provides for a number of National Environmental Policy Objectives. One of the key principles of these objectives is sustainable development with a view to promote equitable access and sustainable use of natural and cultural resources so as to satisfy basic needs, enhancing food security, reducing poverty and satisfying basic needs.

Furthermore, National Environmental Policy Objective 2.3.6 calls for the promotion of national interests by cooperating in the drawing and implementation of international environmental agreements (such as the United Nations Framework Convention on Climate Change – see Box 9).

The main goal of the environmental policy is '*to avoid irreversible environmental damage, maintain essential environmental processes and preserve the broad spectrum of biological diversity so as to sustain the long term ability of natural resources to meet the basic needs of people, enhance food security, reduce poverty, and improve the standard of living of Zimbabweans through long term economic growth and the creation of employment*' (Ministry of Environment and Natural Resource Management, 2009, p. 2).

Following on international and regional natural resource management trends, the policy promotes principles of sustainable management (public participation and partnerships, access and benefit sharing, access to information, polluter pays principle and integrated approach) under sections on environmental rights and general principles presented in Box 9 below.

Box 9 - Environmental rights and general principles guiding environmental management in Zimbabwe

General Environmental Rights: Every person shall have a right to:

1. A clean environment that is not harmful to health
2. Access to environmental information
3. Protect the environment for the benefits of present and future generations and participate in implementation of legislation and policy that prevents pollution and environmental degradation and enhance ecologically sustainable management of natural resources whilst promoting economic and social development.

General Principles

1. All elements of the environment are linked and inter-related, therefore environmental management must be integrated and the best practicable environmental management options must be pursued.
2. Environmental management must place people and their needs at the forefront of its concern.
3. The participation of all interested and affected parties in environmental governance must be promoted and all people must be given an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation.
4. Environmental education, environmental awareness and the sharing of knowledge and experience must be promoted in order to increase the capacity of communities to address environmental issues and engender values, attitudes, skills and behavior consistent with sustainable environmental management.
5. Development must be socially, environmentally and economically sustainable.
6. Anticipated negative impacts on the environment and on people's environmental rights shall be prevented, and where they cannot be altogether prevented be minimized and remedied.
7. Any person who causes pollution or environmental degradation shall meet the costs of preventing, controlling and minimizing further pollution, environmental damage and adverse health effects.
8. Global and international responsibilities relating to the environment must be discharged in the national interest.
9. Sensitive, vulnerable and highly dynamic or stressed ecosystems require specific attention in management or planning procedures, especially where they are subject to significant human resource usage and development pressure.

The Zimbabwe Medium Term Plan 2011-2015, launched by the Ministry of Economic Planning and Investment Promotion on the 7th of July 2011, is a national programme to integrate climate change to all sectors of the economy. The overall goal of the Medium Term Plan is 'to transform the economy, reduce poverty, create jobs, maintain macro-economic stability and restore the economy's capacity to produce goods and services competitively, building upon the gains achieved since the launch of Short Term Economic Recovery Programme (STERP) in March 2009' (GOZ, 2011:1). The Medium Term Plan also states that 'climate change poses a significant and complex challenge to Zimbabwe' (GOZ, 2011:165).To adequately deal with the challenges of climate change, the Medium Term Plan advocates for the development of a Climate Change Strategy and

Policy with the objective of 'promoting climate change mitigation and adaptation strategies in social and economic development at national and sectoral level' (GOZ 2011: 166). The Medium Term Plan's policy targets under climate change are:

a) The development of National Climate Change Strategy and Policy by end of 2013;
b) The development of National Plan for Adaptation and Mitigation by end of 2012; and
c) Increase in the integration of climate change adaptation and mitigation strategies in economic and development activities and policies at national and sectoral level by end of 2012.

The development of a comprehensive climate change strategy and policy is important in a number of ways. First and foremost, the policy will outline the Government of Zimbabwe's intention, vision and strategies with regard to climate change. Secondly, the policy and strategy will lead to a coordinated and harmonised approach. Currently, uncoordinated and fragmented approaches result in conflicts and overlaps between various laws, policies, government departments, wasting human and financial resources. The need for a coordinated and harmonised approach to climate change cannot be over emphasised.

5.10.1 The National Steering Committee on Climate Change: A Multi-sector Institution

The existence of a multi-stakeholder National Steering Committee on Climate Change is an excellent opportunity to permeate all areas of development and coordinate across sectors. However, at present, although representing a wide range of sectors, the National Steering Committee is more of a platform for sharing information on international climate change events than for addressing national climate change issues from a multi-sectoral developmental perspective. The meetings are infrequent and there is no mechanism for coordination of policies and implementation of climate change activities. Consequently this reduces its impact for driving sustainable development and climate change issues.

The national importance and cross-cutting nature of climate change and development issues has been recognised and the matter is currently being addressed at the level of the Office of the President and Cabinet. A National Task Team on Climate Change was established which provides overall policy guidance on climate change issues in the country and will assist in mobilising all the relevant Ministries and other stakeholders to participate. The advantage of such a high-level committee is that it will have the authority to carry out its mandate and insist on compliance. The

Task Team is able to instruct institutions to provide data and information on climate change. Furthermore, the multi-sector Task Team ensures that decisions taken regarding climate change and development by various sectors are compatible and comply with the overall national development policy. Such consultation will avoid conflicts between targets set for national appropriate mitigation actions under the multilateral agreements and national industrial development. A strong multi-disciplinary institution would enable the country to plan in a coordinated manner for the worst case scenarios. It is envisaged that technical committees with operational mandates will be established under the National Task Team to handle the various issues. Due to the need for a coordination mechanism and structures that will ensure systematic identification, coordination and monitoring of climate change policies and activities in each sector, one solution could be a 'climate change desk' in each relevant Ministry.

5.11 Vertical coordination: Lack of Downward and Upward Linkages

At present, there is a disjuncture in coordination between national and local levels. Although the Environmental Management Agency has officers at the district level, the Climate Change Office does not have any lower level structures. Therefore, coordination of activities country-wide is difficult. Institutions responsible for adaptation at the local level report to different line Ministries (for example, Local Government). Accountability tends to be upwards, rather than downwards, resulting in very little coordination of policies and activities at the lower levels. An opportunity exists in that there is a lot of activity at district and local levels which needs to be coordinated and streamlined. Effective local level coordination can be achieved through strengthening the local level institutions and structures. These in turn can engage with institutions at higher levels.

5.12 Coordination of compliance on Climate Change Policies

The absence of a distinct overarching climate change policy makes it difficult for the Ministry of Environment and Natural Resources Management to insist on compliance and the submission of required data on climate change indicators as it does not have the mandate or authority to be effective across sectors. There are also differences on priority with industry. Climate change issues are not mainstreamed into sector policies, which are often contradictory and non-compliant regarding climate change issues. Furthermore, there are numerous climate change mitigation and adaptation activities that are not coordinated and implemented on an *ad hoc* basis, resulting in overlaps and gaps. A variety of projects and researches are being implemented on climate change

issues, with various sources of funding and partnerships. It is not clear how these relate to the national coordinating institutions.

There is need to have a mechanism that will harmonize climate change policy across sector policies as well as harmonize climate change activities, giving a stronger mandate and authority to insist on compliance to the Ministry of Environment and Natural Resources Management. This can be ensured through legislation, such as developing Regulations under the Environmental Management Act and as part of the domestication process involved with ratification of the Kyoto Protocol.

This is now being addressed through the formulation of a comprehensive national Climate Change Strategy which is being initiated by the Ministry of Environment and Natural Resources Management, with funding from UNDP. [14] Zimbabwe's Medium Term Plan for 2011-2015, launched in June 2011, sets a time frame for the development of the National Climate Change Strategy and Policy by the end of 2013 (Government of Zimbabwe 2011).

5.12.1 Role of Civil Society

Although they are undertaking work on climate mitigation and adaptation, especially in rural areas, civil society is not very well organised and the various initiatives are not coordinated. They tend to run parallel systems, being supported by various sources of donor funding. The Civil Society Working Group's strength is that it comprises of organisations with a diverse range of interests in climate change issues. However, the Climate Change Office is not represented in the Working Group, and consequently, links with government are weak. To forge stronger links with government actors, the CCO could be invited to join the Working Group, so that the civil society can benefit from national priorities, policy and practices. This would lead to more effective coordination of climate activities.

5.13 Priority Areas for Technical Assistance

Zimbabwe has limited capacity to effectively address climate change at policy, research and implementation levels. A number of studies have identified and prioritized the most pressing needs: GHG monitoring, and generation of accessible, policy-relevant environmental and climate

[14] This was announced at the National Climate Change Conference, November, 2010 by the acting Permanent Secretary, Mr Samuriwo. He indicated that government is working on a climate change policy to guide efforts to reduce the impact of climate change on Zimbabwe's development. The policy will guide ministries in formulating sector specific strategies to combat climate change.

information. Studies also indicate there is a need to strengthen capacity for policy formulation, analysis and to mainstream climate change in the country's sector policies.

This Baseline Report suggests a number of key priority areas for research and technical assistance, namely:

5.13.1 Support for the formulation of a National Climate Change and Development Policy and Strategy

This should be done through broad-based consultation and participation at all levels and with all sectors. Once the policy is in place, support for its implementation will be needed. There is also a need to support the integration and implementation of climate change and adaptation strategies in economic and development activities at national and sectoral level.

5.13.2 Support for a fully-staffed and resourced Climate Change Office

This is a prerequisite for implementing a Climate Change Policy and Strategy. At implementation level, there is need for better coordination of activities among different ministries and sectors and for resource mobilization (Feresu 2010).

5.13.3 Enhanced Capacity of Local Level Institutions to Adapt to the Impacts of Climate Change

Technical assistance and research should focus on building capacity for adaptation and strengthening local institutions (Ministry of Environment and Tourism 2008a). Support would also be needed to cascade the Climate Change Office through to the provinces. This could be done through extending the mandate of the District Environmental Committees. They are already involved with fire control, prevention of deforestation and pollution.

5.14 Priority Areas for Research

A policy-relevant research programme would help identify appropriate actions as the current state of knowledge evolves. Research needs include understanding the mechanisms responsible for climate variability such as El Niño events and improving forecasting and early warning systems for extreme weather events.

Of paramount importance is research to develop practical and technological innovations for adapting to the impacts of climate change. For example, there is need for research on: crops and livestock that are more tolerant to disease and drought conditions; short-season, high-yielding crop varieties and livestock breeds; effective storage systems for agricultural products; and water harvesting. The cost-effectiveness of adaptation options is needed, so that informed decisions can be made.

5.15 Summary

There is an urgent need for a climate change policy to provide the framework in which development actors across all sectors can operate. At present there are fragments of policies spread across various sectors that need to be streamlined and harmonised into a distinct comprehensive climate change policy, with strategies for implementation. The development of the policy should be informed by research findings and experiences regarding climate change in Zimbabwe.

Key institutions dealing with climate change issues are in place and these need to be strengthened so as to be fully functional. There is an urgent need for the provision of necessary resources to enable the government structures involved in climate change to operate effectively. The Climate Change Office forms the core of climate change activities in Zimbabwe and needs to be fully resourced to become a decentralised hub of climate activities in Zimbabwe.

Part C – Sectoral Analysis

6. Climate Change and Agriculture

Increases in temperature, more frequent extreme weather events, and greater variability of rainfall are projected to increase the occurrence of crop failures, pests, crop disease, and the degradation of land and water resources. These impacts will adversely affect Zimbabwe's agricultural sector as the country seeks to increase agricultural production to support a growing population and national economy. It is also important to note that agriculture contributes to anthropogenic emissions of greenhouse gases, and thus has a key role to play in mitigation strategies. This section focuses on the threats and opportunities from climate change in the agriculture sector.

6.1 Overview of Agricultural Sector

The agricultural sector is highly diversified, producing tobacco, wheat, tea, coffee, maize, cotton, beef, and dairy and horticultural products. Agriculture provides livelihoods to over 70% of the population and currently contributes 20.4% to the GDP (Global Finance, 2012) Between 1998-2008, the agricultural sector contracted rapidly due to a combination of factors, including frequent droughts (for example, the drought from 2000 to 2002) foreign exchange shortages, and the political crisis associated with the Fast Track Land Reform Programme (AfDB/OECD 2003: 356). Some analysts point out that sanctions and restrictive measures on some of the political elite have had the broad effect of limiting lines of credits to the sector, therefore have contributed to the decline in agricultural production.

Despite the significant decline in the agricultural sector in the past decade, agriculture continues to play an important role in Zimbabwe's development. It continues to provide employment for the majority of the population during the current economic recovery. The allocation of land to a significant number of small- and medium-scale farmers under the land resettlement programme coupled with the envisaged irrigation development programme aimed at putting 240 000 hectares land under irrigation by 2015 suggests substantial future growth (especially if agricultural prices remain favourable).

Furthermore, it is vital to note the agricultural sector has strong forward and backward links with the manufacturing sector. At least 60% of agricultural produce finds its way into local manufacturing industries, while 20% of manufacturing output is absorbed by agriculture (AfDB/OECD 2003).

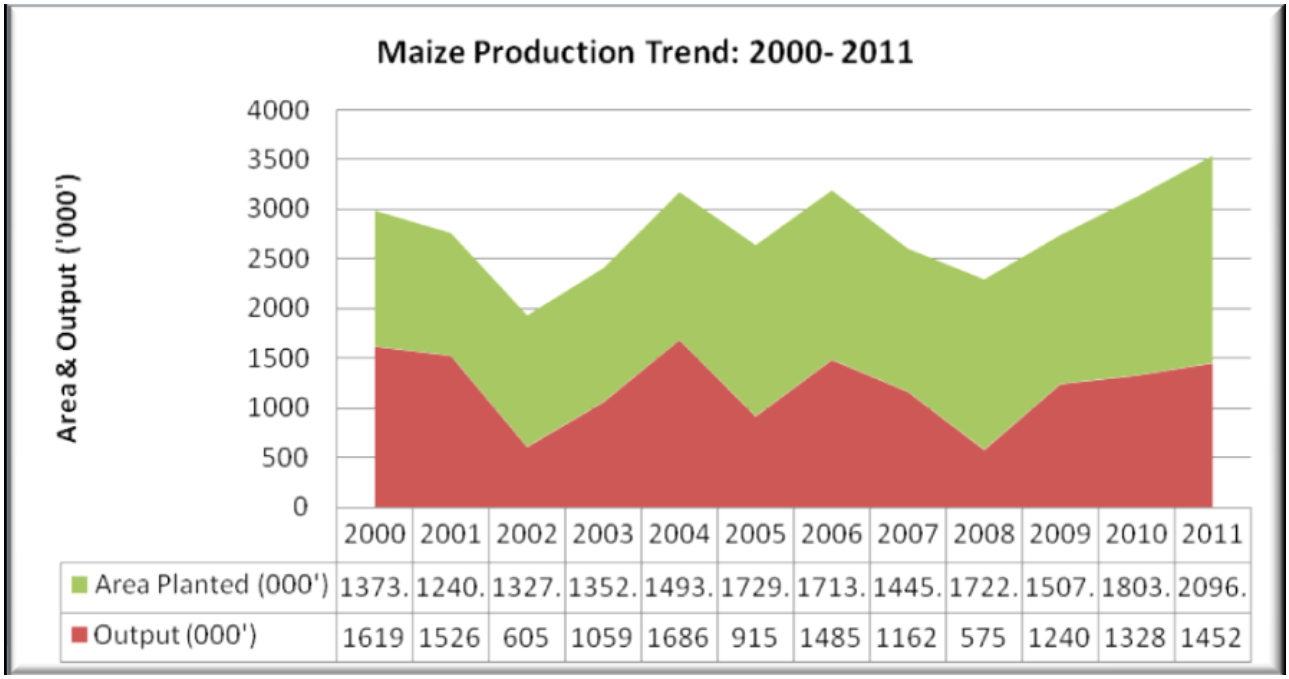
For many decades, there was sustained public investment in maize, tobacco and cotton seed leading to great improvements in yield. These crops are widely grown by smallholders. Maize production on communal land increased rapidly in the 1980s and 1990s, and declined between 2002 and 2008. Between 2009 and 2011, maize production increased across all farming sectors, with communal farmers accounting for the largest share of 43%, while large commercial and A2 farmers accounted for 4% and 20% respectively (Government of Zimbabwe, 2011). According to Table 4 below, A1 farmers contributed 20% of the increase in maize production, while old resettled farmers contributed 5%, small-scale commercial farmers, 2%, and peri-urban farming 4% (ibid.).

Table 4: Sector Contribution to Maize Production 2009 – 2011

Sector	2009/2010 Season	2010/2011 Season	2011 Proportion of Contribution (%)	Yield Change (%)
Communal Areas	536 051	627 210	43	17
A1	296 964	357 408	24	20.4
A2	259 668	285 443	20	9.9
Old Resettlement	133 740	69 603	5	minus 48
Small-Scale Commercial Farming Areas	40 454	29 909	2	minus 26.1
Peri-Urban	60 695	56 704	4	6.6
Total	1 327 572	1 457 799	100	9.8

(Source: Ministry of Finance, 2011)

Figure 9: Maize Production from 2000 - 2011



(Source: Ministry of Finance 2011: 19)

Although maize production has increased between 2009 and 2011, the total output it is still inadequate to meet the total national maize requirement of 1.8million tonnes. The significant declines in old resettlement schemes and small-scale commercial farms need to be addressed as part of a broad strategy to produce sufficient maize to meet national requirements. It is vital to note the pivotal role communal areas play in maize production. Yet, invariably all communal areas are located on marginal lands in Natural Regions 4 and 5, regions that are prone to droughts. As such, the frequency and intensity of droughts associated with climate change are likely to adversely affect maize production in communal areas.

Cotton in many ways mirrors the development of maize production in Zimbabwe, with a highly successful local breeding programme and successful integrated pest management techniques. The cotton marketing system in Zimbabwe has been described as a 'single channel operation'. This system ensured high-quality produce and input provision, and paid highly competitive prices to growers (Tschirley et al 2006). However, cotton production has been declining, a decline associated to the decrease in average yield per hectare from 2009 to 2011. Specifically, average yield per hectare declined from 0.7 in 2010 to 0.58 tonnes per hectare in 2011 (Ministry of Finance, 2011). Paradoxically, the decline in average yield was accompanied by the increase in the area under crop production, which increased from 338 270 ha in 2010 to 379 689 ha in 2011 (ibid.).

Zimbabwe mainly grows and exports flue-cured Virginia tobacco. Tobacco used to be Zimbabwe's main foreign exchange earner and main national industry, contributing between twenty five and thirty percent of total earnings, and at least six percent of total national employment (Woelk et al 2001). Since 2000 production has collapsed mainly as a consequence of the implementation of the Fast Track Land Reform Programme, which led to the acquisition and redistribution of some of the large-scale commercial farms where tobacco was grown. Annual production decreased from over 200,000 tonnes to less than 50,000 tonnes in the early 2000s. However, in 2010 Zimbabwe produced over 118,000 tons of flue-cured tobacco, more than doubling the previous years' crop. This increase in production is not based on large-scale estate production, but smallholders, who grew around 70 percent of this crop.

Flue-cured Virginia tobacco is a capital-intensive crop, due mainly the curing requirements of heating the reaped tobacco leaf in large barns ensuring that smoke does not impart any flavour into the leaf. The labour required for flue-cured tobacco is highly concentrated in a small period of time: not only are large quantities of fertiliser applied in a single dose, but leaves must be reaped quickly before they mature too fully. These agronomic characteristics have contributed to flue-cured tobacco being grown using direct wage labour, and not estate tenants or out-growers.

The production and export of horticultural goods such as fresh vegetables, fruit and cut flowers has expanded rapidly in the 1980s and 1990s. Zimbabwe was one of the few countries able to exploit international horticultural markets – mainly cut flowers, baby vegetables, mangetout, sweetcorn, and chillies. These crops were mainly flown to the UK. By the middle of the 1990s, over 140 smallholder schemes were growing over 8,000 hectares of horticultural crops. By the end of the decade, around 10% of fresh produce for export came from smallholder farms (Masakure et al 2005).

Crops such as finger millet and groundnuts have witnessed a revival in the past three years, as their production has significantly increased. Table 7 below provides details on increased production of the two crops between 2009 and 2011.

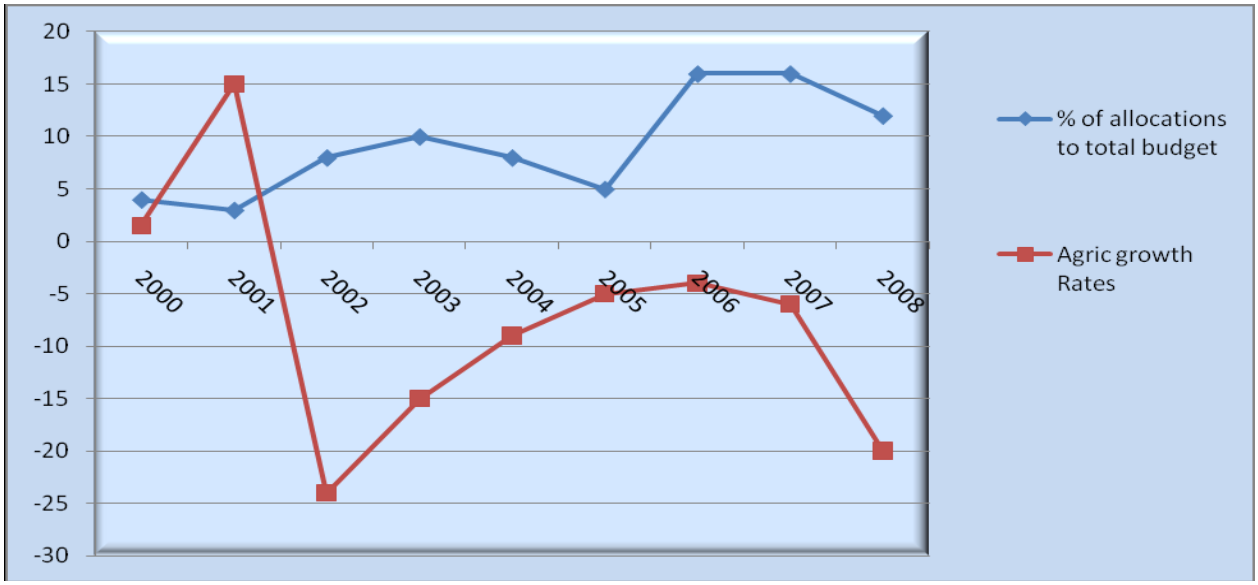
Table 7: Production of Finger Millet and Groundnuts from 2009 – 2011

Crop	Production in Tonnes		Percentage Change
	2009/2010 season	2010/2011 season	
Finger millet	12 403	16 627	34%
Groundnuts	186 214	230 475	24%

(Source: Ministry of Finance 2011)

Despite the significance of the sector to the national economy, government support to agriculture has been falling far short of the 10% of national budget as recommended by the Africa Union Maputo Declaration of 2003. For the period between 1995 and 2008, budgetary allocation has varied from a minimum of 2% to a maximum of 7.5% of the total budget. Figure 10 below shows the continued low trend in budgetary allocation to agriculture and agricultural growth rates from 2000 to 2008. However, it is important to note that between 2009 and 2011, international partners and private financiers provided US$1.4billion to the agricultural sector, with the government providing US$552.

Figure 10: Trends in Budgetary Allocations to Agriculture and Agricultural Growth Rates 2000 - 2008



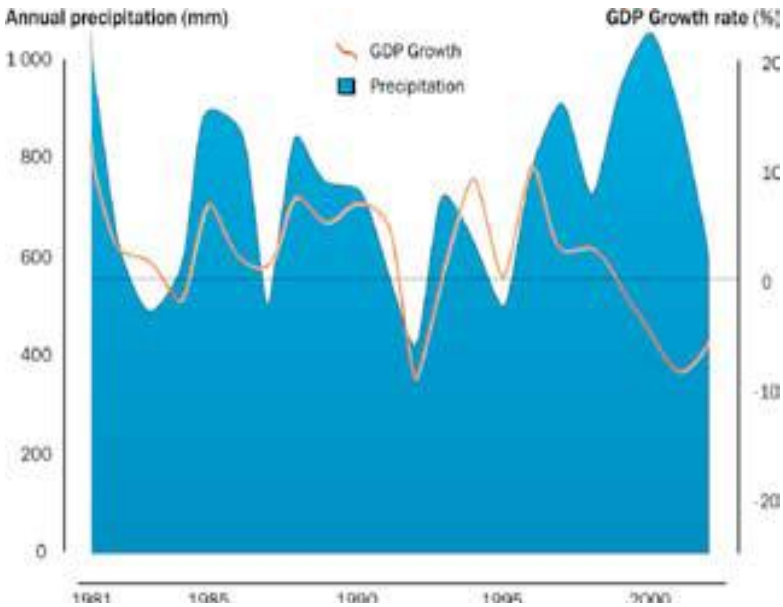
(Source: Ministry of Finance, 2011)

In the context of the Medium Term Plan, the agriculture sector is projected to grow by 14.8% in 2012, 8.8% in 2013, 7% in 2014 and 5.9% in 2015 (Government of Zimbabwe, 2011). Such projected growth are expected to ensure that agriculture plays its part in contributing to economic growth and poverty reduction as well as enabling the country to be food self-sufficient. Important to note is that the growth in agriculture is premised upon maize, sugarcane, tobacco, cotton and beef production coupled with increase in irrigation development. This has implications on policy options for climate change adaptation and mitigation strategies, and will be discussed in the relevant sections of this chapter.

6.2 Climate Change Vulnerabilities and Opportunities

Zimbabwe's agriculture is largely dependent on rainfall which constitutes the most important climatic factor affecting crop production (Makhado et al 2006). As Zimbabwe gets warmer and rainfall becomes more variable, the sector's output will be strongly influenced by weather patterns. Trends in economic performance are closely linked to rainfall variability (see Figure. 11).

Figure 11 – Influence of rainfall on GDP growth



Vulnerabilities associated with climate change have been characterised by changing seasonal characteristics, especially the onset and cessation of rainfall, and increasingly intense mid-season dry spells. There have also been notable shifts in the frequency of heavy rainfall events and tropical

cyclones. The onset of the rain season has shifted from the end of October to end of November (Press et al 1993). The sequence of rainfall events leading to the start of the rainy season as understood by smallholders in communal and resettlement areas has almost disappeared. This traditional pattern had guided local farmers on when to prepare their fields for the coming season. This pattern had indigenous names according to the period in which they occurred. There used to be the "*madzura chando*" (the winter rains in June), followed by the "*gukurahundi*" (the rain in August), the "*bumharutsva*" (the rain in September), and "*kutemera gwati"* in mid November which indicated the start of the actual rain season. However, such defining characteristics are no longer found in intra-seasonal rainfall pattersn. Average temperature has increased, impacting both negatively and positively on crop grain yields (Dimes et al 2009).

The changing rainfall and temperature patterns have affected the country's agro-ecological regions which were classified in the 1960s (see Figure 3). For instance, agro-ecological regions which were classified as high rainfall areas are no longer experiencing rainfall to suit such classification. For example Chinhoyi, Chibero and the surrounding areas, which were formerly classified as Natural Region II with high rainfall, have assummed rainfall characteristics of Natural Region III, marked with low annual rainfall. Kwekwe, which, in the 1960s, was classified as region III has now acquired Natural Region IV climate characteristics. On the other hand, Natural Region I, characterised by high rainfall, is reported to be shrinking fast. Thus, agro-ecological regions suitable for rainfed farming are decreasing. It is evident that the potential changes in these key climatic variables will result in less agricultural productivity, declines in crop yields, pasture growth and livestock production. These impacts are not going to be uniform throughout the country's agriculture systems, but differentiated by farming sector.

The categorisation of farmers as smallholder and large scale farmers translates into varied agricultural productivity across communal, resettlement and large scale commercial farms. For instance, Mudhara (2004) noted that there were low yields and agricultural productivity in the communal areas as compared to large-scale farms. Thus, as an illustration, communal area farmers were achieving maize yields of some 800 kilograms per hectare compared to 4 000 kilograms per hectare that the large scale commercial farmers were achieving (Mudhara 2004). Nationally, maize yields declined from a peak of 1 653 kg per ha in 1993, to a low 455 kg per ha in 2002, before rising to 659 kg per ha in 2007 (Government of Zimbabwe, Draft Agricultural Policy, n.d). In this context, UNDP (2008) estimates that maize production in Zimbabwe currently averages about a third of the 1998 levels. At its peak in the 1980s smallholder agriculture in Zimbabwe contributed to an increase in maize production.

Broadly, agriculture in Zimbabwe can be classified into smallholder agriculture in communal and A1 resettlement areas and commercial agriculture in A2 schemes and old large scale commercial farms. Table 6 below summarizes the frequently observed vulnerabilities within the country's farming sectors. A2 and old large-scale commercial farmers are mostly located in areas with high rainfall and good soils, and rely on the intensive use of technologies such as improved seeds, fertilizers and mechanization. As a result this farming category obtains higher yields per hectare for most crops (see Mudhara 2004). Commercial farmers, both A2 and old large-scale farmers, are highly literate and use information productively. Farming for this group is significantly shaped by the performance of commodity markets, access to finance and seasonal forecasts. In contrast, smallholder farmers in communal and A1 resettlement schemes a limited asset base compared to their A2 counterparts. Many smallholder farmers are poor and have limited literacy. Invariably, communal and resettlement farmers are located in regions that have low rainfall and poor soils. As such they are more vulnerable and less equipped to understand the nature and extent of climate change and, more importantly to adapt to dramatic changes related. Against a background where climate change is taking its toll on the agricultural sector, declining agricultural productivity, especially amongst smallholders, remains a major cause of concern.

Table 6 - Climatic and Non-Climatic Determinants of Vulnerabilities to Climate Change across Zimbabwe's Agricultural Systems.

Farming Sector	Examples of manifestation of vulnerability	Climatic drivers of vulnerability	Non-climatic drivers of vulnerability
Communal Areas (smallholder farmers)	- Poor soils - Famine and chronic food shortages - Increased poverty	- Increased incidence of climate extremes (droughts and floods) - Increased aridity - Changes in average climate and shifts in rain season	- Land degradation - Poor rural infrastructure - Limited off-farm livelihoods - High dependence on a small number of crop varieties - Less educated - lack of social safety nets and lack of access to credit
A 1 resettlement (smallholder)	Declining incomes and increasing poverty	- Increased incidence of climate extremes - Shifting seasons - Deteriorating agro-ecological conditions	- Unstable cash prices, and rising input costs - Insufficient agricultural management skills - Poor infrastructure
A2 (commercial farmers)	Declining or more variable net income Decreased crop and livestock quality	- Increased incidence of climate extremes - Shifting seasons - Deteriorating agro-ecological conditions	- Non climate factors buffered by: - on-farm dams - better farming infrastructure, good access to resources, credit and finance - better quality farm products

Source: Constructed from various sources

Changing rainfall patterns have altered the character of the country's agro-ecological regions, but non-climatic factors have also, and will continue, to play an important role. These include land and agricultural policy, institutional reforms, technical support, markets for agricultural produce and infrastructure.

6.3Agriculture and Climate Mitigation

Agricultural systems contribute to carbon emissions through cultivation of soils resulting in the loss of soil organic matter, clearing of forests to create new cropland, direct use of fossil fuels in farm operations, and indirect use of embodied energy in manufacturing processes that are energy-intensive. Sustainable agricultural practices are therefore essential for implementation of forest restoration projects. Sustainable agriculture in developing countries can lead to a decreased need for additional forest clearing, particularly those that lead to improvements in soil fertility (Sanchez & Jama 2000). Usually, agriculture releases significant amounts of GHGs into the atmosphere, which include carbon dioxide, methane and nitrous oxide (see Table 7 below).

Table 7 - Main GHGs Emitted in Agriculture

GHG	Agricultural Source
Carbon Dioxide (CO_2),	Released largely from microbial decay or burning of plant litter and soil organic matter
Methane (CH_4)	Produced when organic materials decompose in oxygen-deprived conditions, e.g., fermentative digestion of ruminant livestock and stored manures
Nitrous oxide (N_2O).	Generated by microbial transformation of nitrogen in soils and manure, especially under wet conditions

Source: IPCCC Report 2007: 501

GHG emissions from agriculture are expected to increase due to the greater area of land under agriculture, increasing use of fertilisers, escalating demand for meat products, greater demand to for energy to power agricultural equipment ranging, as well as the manufacture of fertiliser.[15]

A variety of options exist for mitigation of GHG emissions in agriculture. Key options include improving crop and grazing land management, restoration of degraded lands, improved water management, agro-forestry, and improved livestock and manure management (IPCC Report, 2007). Whilst Zimbabwe enjoys considerable ecological space vis-a-vis high- and middle-income countries, it shares the common responsibility of all countries to reduce emissions. In this respect, mitigation efforts should be grounded in a strategy for developing viable offset projects through the CDM or other market channels.

Agriculture can sequester carbon when organic matter accumulates in the soil, or in above ground woody biomass used in agro-forestry systems, or for production of biomass for energy sources that substitute fossil fuels. Soil organic matter, and thus carbon, can be increased to a new higher equilibrium with sustainable management practices. The greatest dividend comes from conversion of annual crops to agro-forests systems, and accumulation of carbon in woody biomass. Grasslands within rotations, zero-tillage (or no-till) farming, green manures and cover crops, and high amendments of straw and manures to the soil, also lead to substantial carbon sequestration.

[15] As Zimbabwe's economy recovers, it is envisaged that this will be accompanied by a growing demand for meat, which may result in further changes in land use from forestland to grassland to provide pasture for livestock. This will lead to increased CO2 emissions. In addition, larger herds of beef cattle will cause increased emissions of methane and livestock manure.

Zimbabwe has been one of the lead proponents of conservation and zero tillage agriculture. These practices reduce the use of energy in the agricultural sector, and can increase carbon storage in soils. Whilst such agricultural practices have the potential to form offset projects, such as through voluntary carbon markets, no such projects have been proposed for the agricultural sector. The reasons for non participation, which were cited by the Climate Change Office which is responsible for co-ordianting offset projects are:

- lack of domestic legal / institutional framework (e.g. lack of title to emission rights);
- lack of local/regional financing sources to execute offset projects;
- limited capacity among various stakeholders to formulate and develop offset projects, especially for the CDM; and
- limited understanding of the opportunities that offset projects represent for the country.

Implementing mitigation measures in the sector should shape policy and practice of Zimbabwe's national development priorities. Balancing the trade-offs between mitigation, adaptation and poverty reduction measures in the sector is vital for a successful climate change and development policy.

6.4 Agriculture and Adaptation

Several adaptation options can be pursued in the agricultural sector (see Table 8 below). One of the major adaptation strategies is the development of irrigation schemes. With only about 2 000 hectares of the country's 119 000 hectares of irrigated land under smallholder control (Makadho et al 2006), communal and resettlement agriculture remains the most vulnerable to drought. Furthermore, some of the irrigation schemes are non-functional for various reasons.[16] Irrigation development, therefore, provides an opportunity for the agricultural sector to adapt to the increased variability of rainfall.

Agricultural research in Zimbabwe is quite advanced and the country has a long history of successfully adopting innovative approaches in agricultural production. For example, the Zimbabwe

[16] Available data shows that the problem of non-functioning irrigation schemes is widespread. For instance, in Kadoma district, 4 of the 8 irrigation schemes are not functioning while in Cheguto 4 out of 7 irrigation schemes are not working. In Bubi district (Matebeleland North), 6 out of 9 schemes are not functioning (Government Records, July 2011). Reasons include pump breakdowns and inadequate water supply.

branch of the International Maize and Wheat Improvement Center (CIMMYT) developed, released and successfully tested productive maize varieties that mature early or are tolerant to drought and various other stresses such as nitrogen deficiency and pests. These may play a substantial role in responding to climate change in the future.

In addition, the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) introduced Conservation Agriculture in late 2008. FAO,GTZ, DfID and Practical Action have together run pilots in conservation farming and zero tillage in numerous villages throughout the country.

The broad suite of adaptation measures contained in the National Communication of 1998 include:

- Introduction of livestock and dairy production in areas where maize production becomes uneconomical;
- Promotion of drought-tolerant crops;
- Improvement of irrigation techniques and promotion of agricultural diversification;
- Adjustment of the timing of the of farming operations and changing planting density;
- Installation of medium to large dams throughout the country for the developement of irrigation projects; and
- Shifting from subsistance to cash-crop economy to boost rural income.

Despite the seemingly progressive intentions, there is no clear evidence to suggest widespread adoption of such measures. As government appears not to have a clear strategy on climate adaptation in agriculture, most adaptation work in agriculture is being led by NGOs and other developemt agencies, especially the UN. For example, on-going initiatives which are contributing to adaptation, although originally conceived to address a range of productivity challenges, include rainwater harvesting and integrated water resource management.

Table 8 - Climate Risks, Effects on Agriculture and Potential Adaptation Options

Climatic Risk	Effects on Agriculture	Adaptation Options
Decline in preciptation **Increase in temperature**	Decrease in optimal farming conditions for some areas	- Livelihood diversification - Strengthen local farming capacity to reduce sensitivity to climate change - Changing cultivation practices - Increased irrigation of key crops
	Crop area changes and decreased crop productivity	- Changes in crops and cropping patterns - Increased input of agro-chemicals to mantain yields - Advisory services for farmers on adapted farming practices and on new crops - Crop planting diversification - Agricultural insurance
	Loss of soil water retention capacity	- Irrigation - Create/ restore wetlands - Water retention technologies
	Land Abandonment	- Design regional adaptation plans - Livelihood diversification
	Increased erosion	- Better and new agricultural practices that reduce erosion - Change fallow and mulching practices to retain moisture and organic matter
Increase in extreme weather events	Droughts and Floods	- Increase rainfall interception capacity - Reduce grazing pressures to protect against soil erosion from flash flooding - Contour ploughing - Increase drainage - Insurance for crop damage and farm infrastructure
Frequent droughts	Reduced water availability	- Invest in irrigation development - Improvements in irrigation technology – trickle irrigation, - New irrigation practices, e.g., irrigating during the night - Installation of small-scale wayet reservoirs on farms - Improve field drainage and soil absorption capacity - Improved water management e.g., water audits, water charging to promote efficient water use; recreate wetlands
	Deteriorating conditions for livestock	- Livestock breeding and introduction of heat tolerant breeds - Supplemental feeding - Match stokcing densities to forage production

6.5 Food Security and Climate Change

Food security is a broad concept which encapsulates availability, access and utilisation of foodstuffs (Falco et al, 2011). As such, food security can be achieved through production or trade (i.e., local, regional and international). This section focuses exclusively on food availability through national production.

The impact of higher levels of carbon dioxide, higher temperatures and more varied precipitation on staple food crops is mixed. On the one hand, research suggests that increased carbon dioxide concentrations and higher temperatures can have positive effects on crop yields. Studies by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) and evidence from Hadley M2 General Circulation Models indicate that crop yield will increase, partly due to:

i. Positive physiological effects of increased CO_2 concentrations which result in increased photosynthetic rates and water-use efficiencies of vegetation and crops, which will result in increased rate of plant growth. This will increase in organic matter supplies to soils which vital for plant growth;

ii. Minor increases in soil temperatures and extended periods in which soils are warm enough for microbial activity tends to increase the quantity of plant nutrients cycling through soil organisms. The increased production of root material tends to raise soil organic matter content, which also entails the temporary immobilization and cycling of greater quantities of plant nutrients in the soil (Brinkman and Sobrel, 2000);

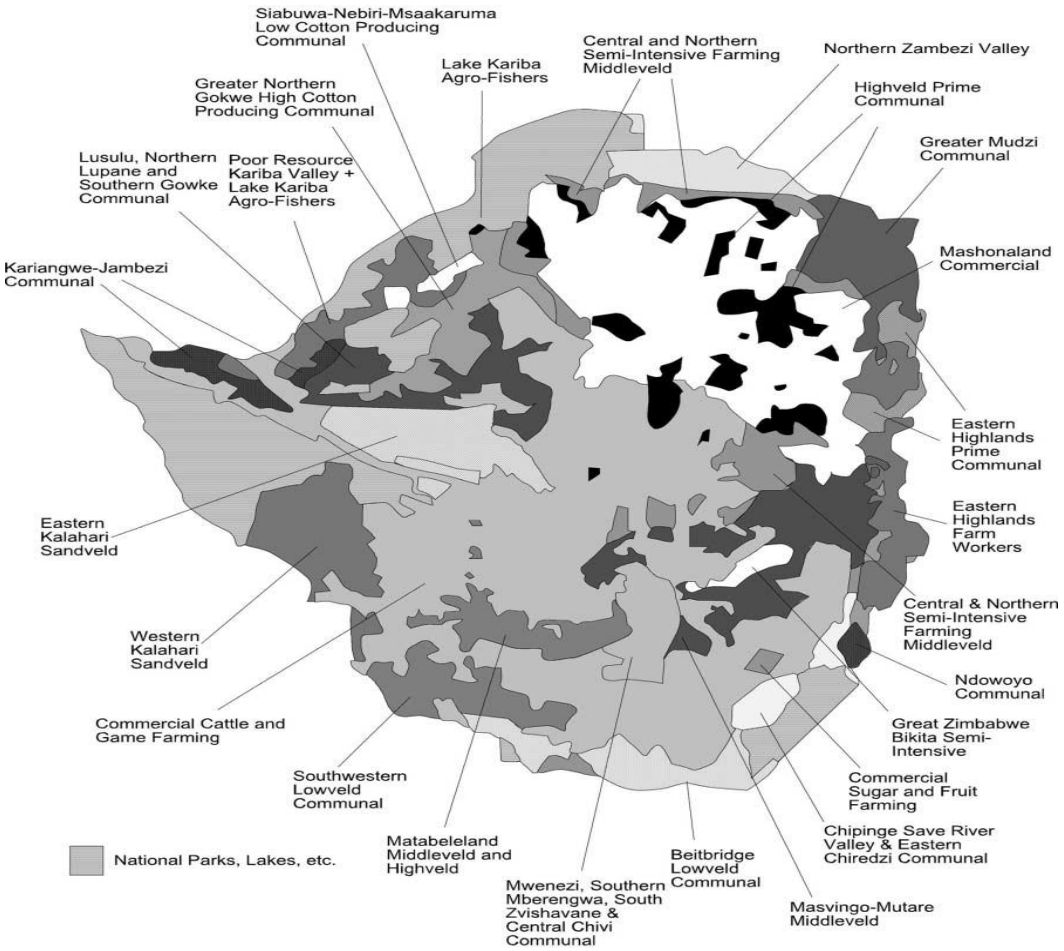
iii. Lengthened growing season and amelioration of cold temperature effects on plant growth. In Zimbabwe, increased temperatures will be conducive for crops affected by frost especially in the Eastern highlands, and thus provide regimes more conducive to greater crop productivity.

However, these positive effects are subject to a 'hill function': that the effects of higher temperatures and CO_2 levels on crop yields reach an inflection point after which further increases in temperature reduce yields. Such thresholds differ across species and landscapes, with, for example, maize yields being particularly sensitive to increases in temperature, because maize does not utilise higher CO_2 levels effectively. The Climate Change Office indicated that areas like Karoi which fall in Natural Region II will have a maize yield reduction as a result of rising temperatures. Maize production requires 26.5 degrees Celsius and an increase by 2 degrees reduces yields considerably given that the average summer temperature for Karoi is 23 degrees Celsius. This would affect national food production since Mashonaland West province, part of the country's bread basket.

In addition, livestock production could also be also affected, as the scarcity of pasture and water results in the deterioration of livestock condition and a decline in the price of livestock on the market. Thus climatic variations could lead to greater food insecurity resulting from both agricultural production and lack of income or financial resources to purchase food from the market.

In other words, climate change could increase food insecurity for both farming households (especially subsistence farmers in communal and A1 resettlement schemes) and those employed in non-agricultural sector. Such changes could translate into a shift in livelihood zones. Such changes could translate into a shift in livelihood zones. As such, Earl and Moseley's (1996) 25 food economy zones have possibly moved in relation to the shifting agro-ecological zones (see Figure 12 below).

Figure 12 - Food Economy Zones in Zimbabwe



Source: Earl and Moseley's (1996)

Food security issues in the country are region specific and vary from one group of farmers to another. As such there is need for the policy on food security to recognise farmers are a diverse group, and thus disaggregate the needs of different farmers located in different agro-ecological regions. For instance, there is need to do more research on goat production as it is a source of livelihood for many households in the drier regions. In addition, distribution of seed packs should take into account the suitability of the seeds in different agro-ecological regions.

At the national level, the Zimbabwe Vulnerability Assessments (ZIMVAC) and the Early Warning Systems were put in place to enhance national preparedness to deal with food insecurity. Through the FAO-led Agriculture Coordination Working Group, appropriate national institutions like the Meteorological Services Department and the National Early Warning Unit have played a key role in generating appropriate information for use in making relevant decisions pertaining to the national food situation in the country.

However, national early warning system tends to focus on cereal production and the impact of hazards, primarily drought. While this may be sufficient to warn of impending food shortages, in most cases the information and analysis is insufficient to actually guide planning (Mano et al, 2003). Jayne et al (2006) also pointed out that the use and effectiveness of early warning systems unit needs to be effectively empowered to the extent that their findings are not overruled by politicians. Despite timely early warnings in Zimbabwe, government is generally slow to acknowledge the impending production shortfalls and in launching an official appeal for assistance.

6.6 Research and Technical Assistance

Studies on climate change and agriculture in Zimbabwe remain grossly inadequate. For the few studies that have been done, only a limited number of crops, especially cereals, feature prominently. Yet adaptation strategies require a diversified cropping system. Given that the country's agro-ecological regions have been shifting over the years, there is need to reanalyse existing regions of their suitability for a range of crops. As such, the reconfigured agro-ecological regions need to be supported by new cropping regimes.

While it has been proven that crop yields are sensitive to variations of climate (e.g. the onset of rainfall, temperature trends), there has been no systematic analysis of locally available information in order to present empirical evidence to farming communities on the localised effects of climate change. In general, such information largely remains in its crude form (i.e. unanalysed) in various offices. More importantly, the information has not been used in any meaningful way to improve the adaptation strategies of farmers. There is need for more analytical work on adaptation strategies by individual households. Gwimbi (2005:89) makes reference to preferred adaptation strategies by farmers, but concluded that "no evidence was however found that supported the view that farmers

were implementing any adaptation on the ground, despite the farmers highlighting their preferred coping strategies to climate change."

In addition to examining the role of greater and more resilient production in the new food security/livelihood zones in the light of the changing agro-ecological regions, studies are also required to establish the appropriate role of trade in ensuring food security. There is also a need for a comprehensive framework for collating statistics on food security, including production estimates, market prices, ratio of local '*ganyu*' wages to food prices, incidences of coping strategies and nutritional indicators, building on the data provided by FEWS-Net.

6.7 Summary

Several key issues emerge from the analysis above, which include;

Budgetary support - Government will take the lead in supporting farmer adaptation strategies as defined in the National Communication Strategy of 1998. This will require the National Budget to adhere to the Maputo Declaration which stipulates that regional governments need to increase the proportion of national budget to the agricultural sector to 10% of total budget. In view of this, the Ministry of Finance may need to prioritise budget allocation to the agriculture, particularly to support climate change adaptation in the sector.

Increase collaboration among local institutions, as well as with international and regional centres (e.g., SADC Drought Monitoring Centre) in the collection, analysis and dissemination of weather information to guide farmers' agricultural practices. In this regard close collaboration is needed between the Meteorological Department and Agricultural Extension Services (AGRITEX) for more effective use of climate information. AGRITEX needs support in terms of human resources, funds and know-how in order to provide better services to farmers. There is also need for enhanced collaboration between AGRITEX, NGOs and community based organisations (CBOs) in using agricultural information to guide farmers' practice.

Developing improved seed varieties – There is need to improve research, development and adoption of improved seed varieties that effectively respond to the challenges posed by climate change in the agricultural sector. For instance, drought tolerant varieties of maize, millet and sorghum developed by CIMMYT and ICRISAT should be widely promoted.

Expanding irrigation development and schemes is advisable as an adaptation strategy but should be placed within the context of increased competition for water with other sectors at a time when water availability is declining. This means that technologies that allow economical use of water should be given priority. An integrated approach which combines large and small water storage options including water from natural wetlands, water stored in the soil, groundwater beneath the earth surface and water collected in tanks, reservoirs should be pursued for communal and A1 farmers.

Re-classification of Zimbabwe's agro ecological regions – there is need for an assessment of the emerging agro-ecological zones and suitability of particular crops. This is because the traditional crop type for a particular region may already be unsuitable as the rainfall patterns have shifted.

Linking agricultural policy and climate change – although the agriculture policy is in place and addresses important issues in the sector, it makes no direct reference to climate change and does not clearly state the role of the agriculture sector in climate change. This needs to be addressed as a matter of urgency. More research on climate change and agriculture is required to guide interventions in the agricultural sector. The outputs of research work will also be critical in preparing farmers to understand the impacts of climate change, as well as informing farmer adaptation strategies.

7. Land Use, Land-Use Change and Climate Change

Land-use and land-cover are linked to climate change and weather in diverse and complex ways. These links include the exchange of GHGs (such as water vapour, carbon dioxide, methane, and nitrous oxide) between the land surface and the atmosphere, the radiation (both solar and longwave) balance of the land surface, the exchange of sensible heat between the land surface and the atmosphere, and the roughness of the land surface and its uptake of momentum from the atmosphere (CCSP, 2003). Because of these strong links between land cover and climate, changes in land use and land cover can be important contributors to climate variability and change. Land cover characteristics are important inputs to climate models.

Land-use, land-use change and climate change can be viewed in two ways. On the one hand, land-use change is often a driver of environmental and climatic changes. Land-use change can be due to demographic factors, such as population size and distribution, expansion and growth of agriculture, economic and technological development. On the other hand, a changing climate can affect land use and land cover. As average annual temperature increase and average rainfall decline, some areas may switch from particular crops. In short, climate change alters land-use practices.

This section predominantly focuses on land-use changes brought about by the land reform and seeks to establish the interface between land reform, and their effect on land use changes and implications for climate change. Changes in land use as a result of urbanisation and forestry are discussed in the sections on forestry and urbanisation.

7.1 Overview of Land Reform and Land-Use Changes 1980 – 2010

Zimbabwe's land reform program started at independence in 1980. The period 1980-2000 saw 3.5 million hectares of large scale commercial farms settled under the land reform programme. This represents 9% of the country's total land area. Fast track land reform, launched in 2000, distributed 4.1 million hectares as smallholder plots (A1 model) and 3.5 million hectares as small-, medium- and large-scale commercial farms. This represents 11% and 9% of the country's total area respectively (Moyo 2009). Given the redistributive focus of the land reform programme, a new category of farmer has emerged from the process. An estimated 76 000 households were allocated land in the first phase of land reform (1980-2000). In addition, some 146 000 smallholder farmers

(A1) and 16 000 A2 commercial farmers (A2) have benefitted from the post-2000 land reform. Fast Track Land Reform distributed over 80% of large-scale commercial farms (LSCFs), a confirmation that the redistributive component is coming to an end. What has changed with land reform include, *inter alia*, land-uses, farm size structures, tenure rights, management and utilization of land, access to and management of water resources, productivity and production technologies and the character of beneficiaries. The task then is to establish the interface between the said land reform induced changes and climate change.

Unlike in the past, the post-2000 land reform targeted all forms of land-uses for resettlement. In this context, land under timber plantations and wildlife was also redistributed. New evidence is showing that maize production is the dominant land-use by new beneficiaries (Moyo et al 2009). Further to this, maize production has expanded into new areas in the dry regions that previously did not cultivate the crop. This represents the changing face of land-use patterns.

7.2 Land Use, Policy and Climate Change

There are two important issues that directly link Zimbabwe's land reform programme and the land use policy on one hand and climate change on the other hand. Firstly, there is the changing agrarian structure which is characterized by the conversion of formerly large scale commercial farms into small-holder plots and farms. Secondly, the distribution of land is accompanied by changing land-use patterns, a process that is dominated by the clearing of vegetation, especially trees, to make way for crop-based production. This reduces the area of forests that act as carbon sinks.

In 2000, the Government of Zimbabwe introduced a new policy, the Rural Land (Farm Sizes) Regulations S1 288 which set the parameters for subdividing rural land for distribution under the land reform programme. The regulations set the maximum farm sizes for each of the country's agro-ecological regions 1-5, across A1 and A2 farms (see Table 9). This essentially led to the division of farms into small scale, medium scale, large scale and peri-urban commercial farms. Subdivision of land for the different land-use patterns, including timber production were expected to respect the maximum farm sizes. Suffice to mention that the new farm size structure has implications on the type of land uses that can be supported on such plots.

Table 9 - Policy Determinants of the New Agrarian Structure (in hectares)

Agro-Ecological Zone	A1 Plots			A2 Farms			Peri-Urban Commercial Farms
	Arable	Grazing	Total	Small-Scale	Medium-Scale	Large-Scale	
I	5	7	12	20	100	250	2 - 50
IIa	5	10	15	30	200	350	
IIb	5	15	20	40	250	400	
III	10	20	30	60	300	500	
IV	10	30	40	120	700	1500	
V	10	60	70	240	1000	2000	

Source: Government of Zimbabwe Documents 2001

Yet, Zimbabwe's land reform programme has changed the tenure arrangements governing the ownership of rural land. Existing tenure arrangements for resettled land range from permits (especially for A1 smallholder farmers), 'offer letters,' and 99-year leases, which are not widely viewed as providing security of tenure for new farmers (Richardson, 2005; Marongwe, 2009). The processing of new tenure rights for land reform beneficiaries will take time given the complexities of the process and the institutional constraints that confront land administration institutions. It remains to be seen how the tenure arrangements will evolve.

Zimbabwe's land reform programme has resulted in significant change of land use. The clearing of forests and other vegetation to make way for crop production is accepted in policy and practice as an integral part of the programme. Thus, of the 8 million hectares of land that was distributed in the post-2000 period, a significant proportion of this has already been cleared. Moyo et al (2009) makes reference to land utilization levels of between 0 and 80%. Scoones et al (2009) noted that farmers in their study sample had used between 2.8 and 56% of their plot sizes. It is apparent that land reform beneficiaries have been working on their land, clearing forests and other vegetation for crop production.

Traditionally, the exotic timber plantations sector supplied most of the country's timber needs. Before Fast Track Land Reform, it was estimated that Zimbabwe's exotic timber plantations occupied some 119 000 hectares of land out of the estimated 140 000 to 170 000ha of forests in the country, with 90% of the timber plantations located in Manicaland province. The Rural Land (Farm

Sizes) Regulations of 2001 stipulate that timber plantations should be subdivided into maximum farm sizes of 250 hectares. This was criticized as being unresponsive to the uniqueness of the timber industry, forcing the setting up of a specific technical team to deal with the settlement of timber plantations. As such, the technical team recommended appropriate technicalities in the redistribution of timber plantations in Manicaland province. The maximum farm sizes were to be 500ha, supporting the recommendations of the influential Utete Report of 2003.

The growing cycles for the different types of timber range from 7-10 years for eucalyptus light poles and pulpwood to 25 years for pine. Investment in timber production therefore does not yield immediate and seasonal benefits within the initial 7-10 years. This situation is particularly relevant when implementing a timber based land reform policy. New settlers who start timber production would therefore not expect to realize any revenue for at least 7 years. This has important implications on the willingness of land reform beneficiaries to continue with timber plantations, and thereby directly impacting on the functioning of forests as carbon sinks. Ideally, this requires that beneficiaries be well-resourced farmers who can rely on other sources of income before any profit could be realized from the timber ventures. Accordingly, economic characteristics of new settlers who were allocated land with timber is a critical variable in the discussion on whether or not they will be in a position to continue with timber plantations as a land-use. The important question to ask is: how prepared (psychologically, technically and financially) are beneficiaries of timber plantations to continue with forest as a land use?

In essence, the forest based land reform policy is anchored on the continuation of timber plantations as the main form of land-use. The approach is therefore to consolidate timber plantations as the main form of land use while at the same time developing strategies for ensuring that the participation of indigenous populations in timber production is enhanced. However, anecdotal data seem to indicate that events on the ground have actually been contrary to these intended policy provisions, making the policy intentions almost inoperable in certain areas without major reversals and regularization. Indeed, interviews with relevant officials show that some of the new farmers are replacing timber plantations with crop based land use systems. In this regard, the conversion of timber plantations into crop based production systems has negative consequences on climate mitigation. What needs to be thought through is how the seemingly conflicting demands of land reform and the role of forests as a climate change mitigation strategy have to be negotiated.

Shifting away from the exotic timber plantations, trends elsewhere have confirmed the clearing of forests and other vegetation cover to make way for crops. The Zimbabwe Environmental

Assessment Report (UNDP, 2003) analyzed (using LAND SAT imagery) land-use or cover changes in various study sites namely the districts of Chipinge, Mazowe, Makoni, Goromonzi, Zvimba, Umguza and Marondera as well as Harare Province. Focusing on the period 1998-2002, the assessment found out that in Marondera there was a 3.2% increase in the area under cultivation and this was linked to the Fast Track resettlement. An increase in area under cultivation was also noticed in Mazowe district, Makoni district and Goromonzi district. Minimal afforestation was recorded in Chipinge and Zvimba districts.

7.3 Land Use and Mitigation

A small range of mitigation options exist regarding land-use change:

- Maintaining and expanding sinks by protecting and practicing agro-forestry and other plantation activities
- Creating a system of credits and debits wherein emission or sequestration of carbon in the biosphere is equated with emission of carbon fossil fuels
- Restoration of degraded lands
- Reduction of emissions through positive changes in the agricultural system, such as increased cropping
- Promoting land-use planning practices that reduce the demand for energy and transportation services
- Changing cattle feed to reduce methane emitted and utilising methane produced

However, the scope for climate change mitigation is not that broad in the land reform and land-use sector. Rather, the discussion is best placed in other subsectors, especially agriculture, forestry and water. The land policy provisions that call for the continuation of forest-based land uses represent the clearest examples that link land reform and land use patterns to climate change mitigation strategies. The proposals outlined in the forest-based land reform policy form the basis for implementing climate change mitigation strategies through the promotion of forests as a land-use.

7.4 Land Use and Climate Change Adaptation

Climate change adaptation strategies in the field of land-use and land cover change can be conceived as being located in the land-use planning and disaster management arena. This calls for the analysis of risk and vulnerability of places by land-use practice. Within the framework of existing land-use practices and proposed land-use changes, risk and vulnerability assessment can provide information on how land-use practices are prone to climate change extremes like droughts and flooding. According to EMA (2002), the following are climate change adaptation strategies in the land use planning arena:

- Restricting or prohibiting development in high-risk areas through zoning and other forms of development control;
- Restricting or limiting the types of development in high to moderate risk areas for recreation or other forms of public use reducing the potential impacts of natural hazard events; and
- Applying appropriate development controls in moderate and lower risk areas such as minimum elevations, setbacks and plot sizes, as well as maximum densities and site coverage.

Other important strategies include the development of model household and community land-use plans which will act as a guide to how community effect land-use and land cover change. This will be supported by policies and standards that regulate the clearing of land. In addition, it is important to develop a data and knowledge base that assists households (as land-users) to adapt to climate change in local contexts.

7.5 Research and Technical Assistance

The argument so far has been that land reform is an important contributor to anthropogenic climate change. Overall, there is need for;

— An analysis of the effects of land reform on land-use change and the implications these changes have on climate change. Such an analysis will inform national climate change adaptation and mitigation strategies

- An analysis of the links between deforestation and tobacco production, especially the use of wood fuel in curing tobacco. This will enable development of alternative methods of tobacco curing.
- . Studies to examine changes in the exotic timber plantations that were redistributed under the land reform programme. Thus, whilst policy provisions call for new farm size structures of not less than 500 ha and that new beneficiaries should continue with forest based land uses, research is yet to establish the consistency between policy prescriptions and local evidence on policy implementation. It remains appropriate for studies to identify key success (and failure) factors that determine the outcomes of forest based land reform.
- Detailed studies on how land-use changes associated with land reform impacts on processes such as soil erosion, 'desertification,' and deforestation. How the outcomes of such processes impact on household livelihoods is another important point for research.

Relevant government and academic institutions require technical assistance to assist in the tracking of land uses changes and measuring critical variables that include albedo of different land surfaces as induced by land-use change and the associated changes in the water cycle. This should include access to satellite imagery equipment and appropriate equipment for measuring area at the farm level. The development of an information management system will assist in capturing and monitoring land use changes. A full set of indicators will need to be developed to guide data collection. Partnerships with appropriate university institutions will allow the participation of students in the data collection process.

7.6 Summary

Land use patterns in the country are in the process of transformation as a direct outcome of the land reform programme. Whilst it is evident that the changing land uses have a direct impact on climate change, the nature and extent of the change is less understood. In addition, there are other parameters that have changed as a result of the land reform programme, including types of beneficiaries (or famers), farm sizes, tenure arrangements and even productivity. Again, the nature of the relationship between such attributes and climate change is not articulated in policy. Some policy provisions, especially the forest-based land reform policies, have a direct impact on climate

change adaptation and mitigation strategies. The existence of the forest-based land reform policy is important as it provides the basis upon which other activities can build on.

The inherent conflict between land reform and the central role of forests as carbon sinks has been noted. Whilst the situation is very apparent, land policy has neither acknowledged this nor highlighted any strategies of resolving the situation. In addition, a system of tracking land uses changes is required in the country. Such monitoring work needs to emphasize both the clearing of forests and afforestation initiatives at the farm level. Policy guidelines are required for balancing crop-based production and forest based land uses.

8. Forestry and Climate Change

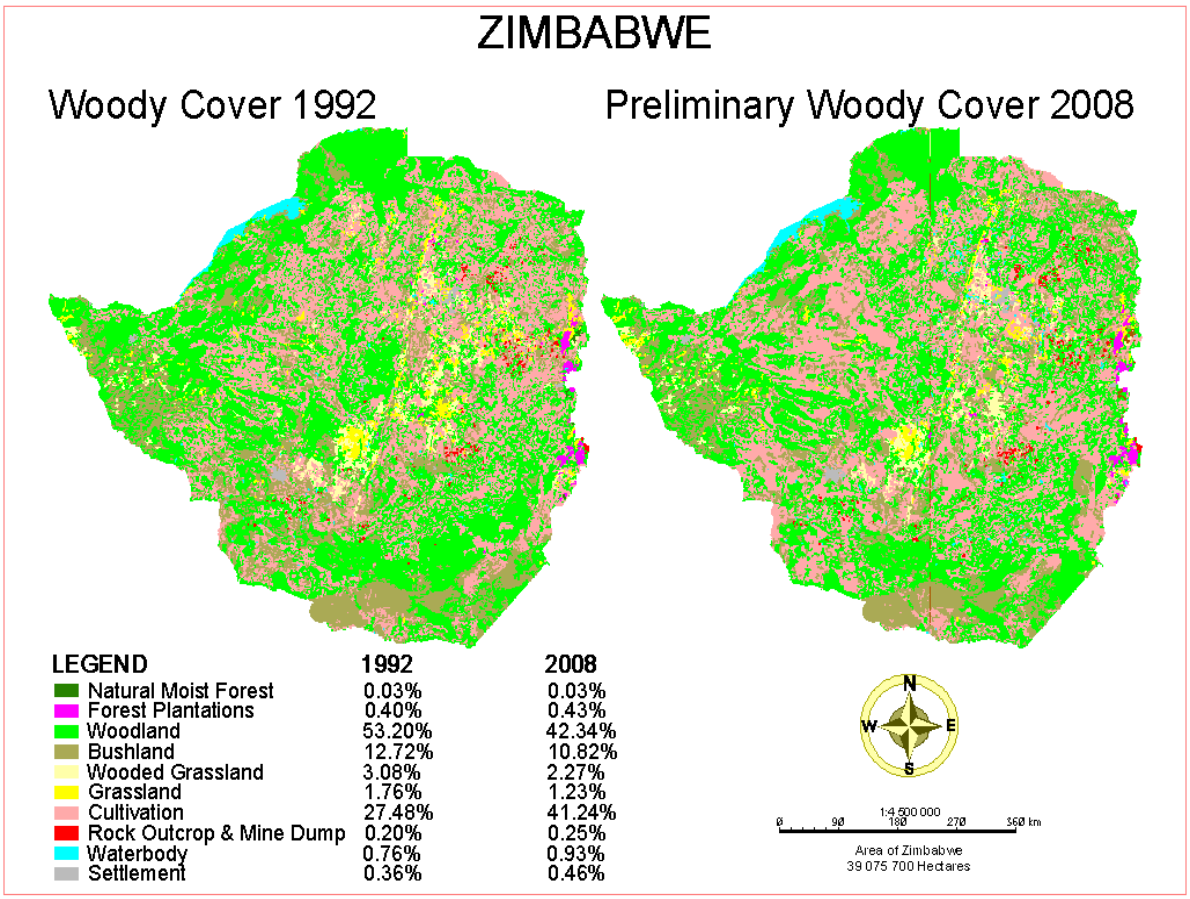
This chapter presents the results of an assessment of the Zimbabwe's forest sector and climate change. The chapter starts with an overview of the forestry sector in Zimbabwe, followed by climate change vulnerabilities and opportunities, mitigation options, and a discussion of REDD. The chapter ends by highlighting priority areas for research and technical assistance in relation to key issues discussed.

8.1 Overview of the Forestry Sector

Zimbabwe's forestry resources cover approximately 56% of the total land area (218, 295km^2), and generate a wide range of products (both timber and non-timber) and ecosystem services. The products include: fuel wood (for various purposes including charcoal making), sawn timber, pulpwood, building materials, wood for crafts, fodder, fruits, honey, mushrooms, bark for rope, medicines, leaf litter, game meat, gum and resins. The services include: watershed management, carbon sequestration, micro-climate stabilization, and the provision of windbreaks, shade, soil stability and wildlife habitat. Given the extensive woodland cover across the country, Zimbabwe's forests have the potential to be a carbon sink, but current pressures for settlement and agricultural land and for fuel wood (for various purposes, including tobacco curing), make this scenario unlikely (Shumba, 2001). Forestry in Zimbabwe is divided into two sectors - the indigenous (i.e. naturally occurring) forestry sector and the plantation forestry sector.

The indigenous forests consist of natural forests, woodlands, bush lands and wooded grasslands that make up about 22 million hectares according to the 2008 statistics from the Forestry Commission (Refer to Figure 13 below). Indigenous forests are divided into five woodland types: Miombo, Teak, Mopane, Acacia and the Terminalia/ Combretum woodlands. Woodland degradation has been triggered by over-exploitation of open access common property, fires, disease and browsing by wildlife (especially elephants) and the opening up of forest land for agriculture expansion after the formalization of the Fast Track Land Reform Programme in 2000.

Figure 13: Map showing the changes in forest cover from 1992 to 2008



It is worth noting that the 2008 satellite data have yet to be verified through field sampling and inventory. The changes that occurred to Zimbabwe's forestry resources are depicted in Table 11 below. Results indicate that only the area of natural moist forests has not significantly changed since 1992, while all the other woodland types have decreased. For the most part, this can be attributed to the practice of opening up forests for cultivation purposes. Forest plantations have increased by a very small margin.

Table 11 - Percentage of the total area covered by various land uses (including forests) in Zimbabwe

Class	Cover Type	1992 **(ha)**	%	2008 **(ha)**	**%**
1	Natural Moist Forest	11477	0.03	11508	0.03
2	Forest Plantation	155297	0.40	168581	0.43
3	Woodland	**20790234**	**53.20**	**16544210**	**42.34**
4	Bush land	**4972071**	**12.72**	**4228547**	**10.82**
5	Wooded grassland	1204666	3.08	888463	2.27
6	Grassland	689186	1.76	479883	1.23
7	Cultivation	**10738945**	**27.48**	**16113866**	**41.24**
8	Rock	78707	0.20	97720	0.25
9	Water body	298089	0.76	364331	0.93
10	Settlement	139341	0.36	180904	0.46
	Total	**39078013**	**100**	**39078013**	**100**

Source: Forestry Commission Mapping and Inventory (2010).

8.1.1 Commercial Plantations in Zimbabwe

Zimbabwe's well established plantation forest resource base covered an area of 89,862 ha in 2009 (TPF, 2009). However, when considering all small eucalyptus plantations in communal, resettlement areas and commercial farms this forest resource covers a total of 168,581ha. About 90% of the plantations are located in the eastern highlands, an area characterized by high altitudes (700 – 2,200m) and high rainfall (average of 1, 000 mm/annum). Major plantation forest species include: *Pinus patula, P. elliottii, P. taeda, Eucalyptus grandis, E. camaldulensis* and *Acacia mearnsii*. Pine species (*Pinus patula*) are mainly used for structural timber, pulp and paper, and Gum trees (*eucalyptus species*) are used for poles, pulp and paper. Wattle (*Acacia mearnsii*) is used for the production of tannin and high quality charcoal.

Between 2000 and 2009, there has been a steady decrease in commercial forest plantation area, from 118,621ha in 1999 to 89,862ha in 2009 (see Table 12 below), a decrease which can be attributed to resettlement losses, fire losses and clear felling without corresponding afforestation. It is important to note also that this Timber Producers Federation (TPF) (1999-2009) data only covers

plantations that are in the Mutare area, Eastern Zimbabwe, while the area data above covers plantations across the country, including the small eucalyptus woodlots in communal and resettlement areas.

Table 12: Commercial Forest Plantation Land Area (ha)

Year	Pine (ha)	Eucalyptus (ha)	Wattle (ha)	Others[17] (ha)	Total Area (ha)
1999	80 989	23 910	13 434	288	118 621
2000	79 082	29 036	11 789	275	120 182
2001	78 007	29 314	11 529	280	119 130
2006	68,550	26,010	10,039	106	104,705
2007	70,946	26,654	9,906	134	107,641
2008	69,140	19,350	9,782	46	98,318
2009	57,637	22,375	9,799	51	89,862

Source: Timber Producers Federation 1999 – 2009

Zimbabwe's Ministry of Environment and Natural Resources is a major player in forest biodiversity management through its two departments, the Forestry Commission and the Department of National Parks and Wildlife Management. Several other sectors such as agriculture, construction and water have direct and indirect impacts on forest resources. There is currently, however, no formal cooperation mechanism between the institutions governing forestry and other sectors.

8.2 Climate Change Vulnerabilities and Opportunities

Forests thrive in various climatic conditions the world over, ranging from wet tropical forests to the forests of dry boreal (high-latitude) regions (Sedjo and Sohngen 1998). Depending on prevailing

[17] *This include species such as poplus, auricaria species, acacia melunoxylon, crytomeria japonica and cuppressus species*)

moisture conditions, vegetative transition from deserts to grasslands to forests, and vice versa, may occur. In extreme dry conditions, forests can be replaced by grasslands. Changes in temperature and precipitation brought about by climate variability and change will therefore affect forests in different regions differently. Climate change impacts will affect forests through changes in their physiology, structure, range, species composition and health. Increased temperatures and drought will lead to more frequent outbreaks of pest infestations, more forest fires and increasing alterations in populations of plant and animal species, thereby severely affecting forest health and productivity. In some regions, climate change may bring about positive effects through increased forest productivity, but this increase in productivity will depend to a large extent on the availability of precipitation and nutrients that are necessary for growth. In Zimbabwe, forests thrive under varying ecological conditions ranging from very dry to very wet conditions see, Table 13. The tree species in the different eco-regions are different (Table 13).

Table 13: Vegetation found in Zimbabwe's Eco-regions

Eco-region	Corresponding Natural Region	Altitude (m)	Mean Annual Rainfall (mm)	Dominant Vegetation type
Kalahari	IV and V	1030	560	*Colophospermum mopane* and *Baikieaa*
Central	II and III	1300	620	*Brachystegia spiciformis-julbernadia globiflora*
Zambezi	IV	1080	650	*Colophospermum mopane*
Save Limpopo	IV and V	687	400	*Tree Savanna, Acacia*
Eastern Highland	1	1500	740	*Themeda-exotheca Loudetia grasslands* and *brachystegia speiformis, Julbenadia globiflora woodlands*

Source: Ministry of Environment and Natural Resources Management, 2010

Forest ecosystems do not only cut across other livelihood sub-sectors, they safeguard other ecosystems while providing physical buffers against desertification, drought, high temperatures, land degradation and flash floods which are common expressions of climate impacts in Africa. Some identified direct and indirect impacts of climate change on forests include the following:

- A changing climate could directly affect availability (positively or negatively depending on the change) of products from forest ecosystems especially high temperatures and low rainfall;
- A negative impact of climate change on agricultural production is likely to increase the reliance that rural communities place on forest ecosystems as alternative sources of food, medicine, fibre and income. The majority of Zimbabwe's population live in the rural areas and their livelihoods are dependent on agriculture;
- An increasing market demand for forest products or their alternative uses (like high demand for fuel wood) could have a synergetic negative impact on the availability of other forest products;
- Other effects of environmental degradation indirectly resulting from climate change impact (such as drought and bushfires) can affect the forest's ability to regenerate.

In view of the above discussion of likely climate impacts on temperature and precipitation, studies have been undertaken, using the Holdridge Life Zone and the Goddard Institute of Space Studies (GISS) methods, to examine the impact of climate change on forest distribution in Zimbabwe (see Table 14).

Under the GISS scenario there is a climate shift towards more variable annual precipitation (rainfall) and high ambient temperatures. According to Matarira and Mwamuka, (1996) north-eastern Zimbabwe, for example becomes more suitable for vegetation found in the subtropical moist forest conditions in the GISS climate change scenario as opposed to the warm temperate moist forest which exists under current climate conditions (Table 14).[18]

[18] Under the current climate conditions Zimbabwe contains 5 Holdridge life zones: subtropical dry forest, subtropical thorn woodland, tropical very dry forest, subtropical moist forest and the warm temperate moist forest (Matarira and Mwamuka, 1996). The subtropical dry forest covers the largest area in Zimbabwe (68.7% by area and corresponds to the miombo woodland and savanna, mopane woodland and savanna, terminalia-combretum woodland, Zambezi teak woodland and Acacia woodland according to historic vegetation classification system (Matarira and Mwamuka, 1996)

Table 14 – Selected Holdridge forest life zone classes in Zimbabwe comparing current climate conditions and under GISS climate change.

Life zone classes	Forest area (km^2) under current climate conditions	Forest area (km^2) under GISS climate change	Change (km^2)	% Change
Subtropical dry forest	264 056	175 179	- 88 877	-33.66
Subtropical thorn woodland	83 725	9 016	- 74 709	-89.23
Tropical very dry forest	21 253	157 790	+ 136 537	642.44
Subtropical moist forest	10 304	1 223	- 9 081	-88.13

Source: Matarira and Mwamuka, (1996)

8.3 Opportunities for Mitigation

Forests act as carbon sinks, removing CO_2 from the atmosphere and sequestering carbon in biomass, woody stems and the soil. However, when they are cleared or degraded, the carbon is released into the atmosphere as carbon dioxide. The largest source of greenhouse gas emissions in most tropical countries is from deforestation and degradation, which collectively account for nearly 20% of global GHG emissions. However, in Zimbabwe, research to quantify the existing carbon stocks in the different forests has yet to be undertaken. This research however will be crucial, if the country is to benefit from existing carbon markets and related mechanisms.

Many land-based opportunities to increase carbon stocks or avoid carbon emissions exist in Zimbabwe. For forests, this can be achieved by:

- protecting secondary and other degraded forests to allow them to regenerate naturally;
- restoring native forests through assisted and natural regeneration;
- maintaining existing forest-carbon stocks and sink processes by avoiding deforestation and forest degradation;
- establishing plantations on non-forested lands; and
- managing forests sustainably to provide services, such as biomass for energy.

8.3.1 Reducing Emissions from Deforestation and Degradation

Global climate initiatives such as Reducing Emissions from Deforestation and Forest Degradation in developing countries (REDD) are being developed to address these emissions such that developing countries can actively contribute to greenhouse gas mitigation and benefit from conservation, sustainable management of forests and the enhancement of forest carbon stocks. The 13th Conference of the Parties (COP 13) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2007 laid the foundation to develop a post- 2012 climate change agreement that would include REDD in developing countries. Since that time, the REDD mechanism has been expanded to include the role of conservation, sustainable management of forests, and the enhancement of forest carbon stocks (REDD+). The mechanism, although still being negotiated, offers a unique opportunity for developing countries to benefit from activities, while contributing to global mitigation of greenhouse gases.

REDD can be a relatively cost-effective climate change mitigation strategy, and can create additional socio-economic benefits to local communities through helping to conserve forest biodiversity. A REDD mechanism with robust environmental and social safeguards could offer an effective climate abatement strategy, provided it is linked to a post-2012 climate agreement with strong binding CO_2 emission reduction targets for industrialized nations. The key challenges for Zimbabwe's REDD policy process include:

- Zimbabwe has not yet joined other developing countries in participating in the UN-REDD programme (a multilateral initiative to support developing countries 'readiness' to avail of a REDD+ mechanism) although pilot projects have been run in neighbouring Zambia and in Tanzania. To participate in this programme Zimbabwe needs to apply to the UN REDD Secretariat asking for their participation as a partner country;
- There is currently no climate change policy or strategy in place;
- Need for political will and commitment to manage forests sustainably – for instance, a process to tackle the practical challenges between forestry policy and the land-reform program;
- Issues of tenure – communities may be unwilling to invest their time in managing forests and land for which they do not have tenure or land rights;
- If financial or policy incentives for sustainably managing forests – are not sufficient, it will be difficult to convince communities to manage forests;

- Effective forest governance systems do not exist at the local level – without transparent, accountable local level institutions, it will be difficult to manage forest sustainably, avoid deforestation, and thereby benefit from a REDD mechanism;
- There is currently no updated forest inventory at the national level, which is necessary to establish a forest reference emissions level (which is pre-requisite for entry into the REDD+ mechanism) and the technical capacity to develop such a system is lacking in Zimbabwe.

8.4 Research and Technical Assistance

- Research to understand local-level drivers of deforestation (especially tobacco production)
- Baseline surveys for areas where the REDD+ projects could be implemented as a sub-national strategy
- A detailed analysis of the specific financial and technical support needed to enable the government to prepare to enter the REDD+ mechanism.
- Feasibility studies on community's willingness to conserve and sustainably manage forests, and what additional measures are needed to avoid deforestation (i.e. what is needed to address the drivers of deforestation, which often times is poverty). How to enable and reward communities participating in the REDD programmes? How best to ensure that environmental and social safeguards are met?
- Technical assistance to learn lessons from existing Community-Based Natural Resource Management

8.5 Summary

The crucial role that forestry plays in climate change mitigation and adaptation is apparent yet, Zimbabwe's forests are under tremendous pressure due to increased demand for new land for agricultural production, curing of tobacco in the context of increased tobacco production among resettled farmers, and fuel demands in both urban and rural areas. This has been exacerbated by an absence of policy and institutional coordination across the different sectors that have an implication on forestry. As such there is need for inter-sectoral platforms around forestry that brings together land, agriculture, finance, environment, national parks, and climate change to guide forestry policy.

From the analysis above, it is clear that the role of Zimbabwe's forestry as a carbon sink and its potential role in carbon markets are less well articulated. Therefore, there is need to assess, quantify and monitor existing carbon stocks in the country's forests. One way of achieving this, is for Zimbabwe to apply to become a partner country in the UN-REDD programme. This will ensure that the country obtains UN support and assistance in developing analyses and guidelines on measurement, reporting and verification of carbon emissions and flows, and more importantly, ensuring that forests continue to provide multiple benefits for livelihoods, economic growth and the environment. Such membership can be used to develop local policies and programmes that take into account not only the role of forestry in climate change mitigation and adaptation but also its links to land reform, agricultural production, ecosystems services with the broad context of national social and economic development.

9. Water Resources, Climate Change and Development

Climate change and variability have a significant impact on water resources mainly through changes in the amount and patterns of precipitation, and occurrence of extreme hydrological events. These changes will alter both the supply and demand of water resources, as well as its quality. This section reviews climate related impacts on water resources in Zimbabwe, and examines their likely effects on social and economic development. It concludes by suggesting mitigation and adaptation strategies for the sector that ensure it continues to play a critical role in poverty reduction and national economic growth.

9.1 Overview of Water Sector

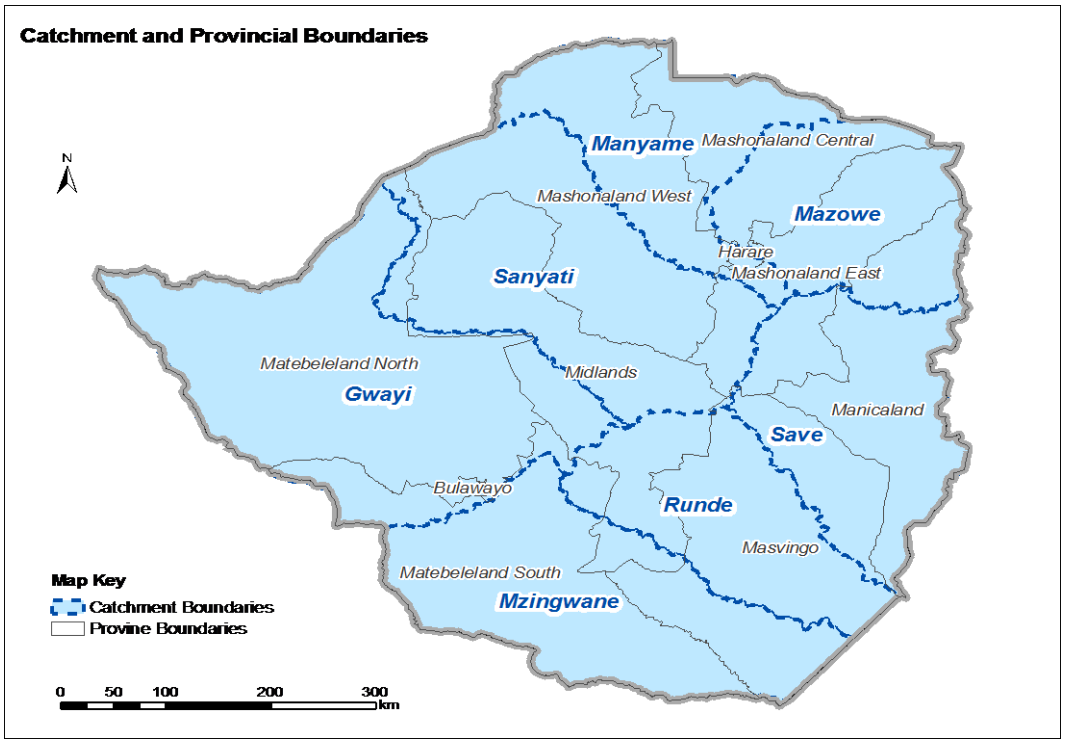
There exists great variation in the spatial and temporal distribution of water resources in Zimbabwe. The country has one rainy season (November to March), with an average annual rainfall of 657 mm. Spatially, annual rainfall varies from 1,000mm per year in the Eastern Highlands to 400mm/year in the lowveld. Net annual pen evaporation ranges from 1,400 mm in the high rainfall areas to 2,200 mm in the low lying areas. Zimbabwe's rainfall pattern can be best described as erratic, unreliable, and insufficient and only 37 percent of the country receives adequate rainfall for agriculture. Trends over the years have shown that the majority of Zimbabwe's wet seasons are often punctuated by mid-season droughts which affect crops resulting in poor harvests (Gumbo, 2006).

Zimbabwe's surface water resources (mostly rivers) are estimated to account for 90 percent of the country's water supply, with a supplement from dams. In 2000, agricultural water use was estimated at 71 percent of total withdrawals, rising to 78.9 percent in 2002. There are seven internal river basins in Zimbabwe whose watersheds yield 11.26 km^3 of freshwater per year. The basins are Gwayi, Manyame, Mazowe, Mzingwane, Runde, Sanyati and Save (Figure 14). In addition, the country has 1 to 2 km^3 of ground water per year located in four aquifers, namely, Lomagundi dolomite, Nyamandhlovu forest sandstone, Kalahari sands and Save alluvial deposits. Underground water is tapped mainly through boreholes and records show that there are over 16,000 boreholes scattered across the country but other experts believe that they could very well be in excess of 50,000. The total annual abstraction of ground water for the rural communities is estimated at 35 x 106 m^3 while that for the agricultural sector is estimated at 350 x 106 m^3. Groundwater is also being

drawn for several Growth Points and Rural Service Centres (e.g., Nyamandhlovu, Gokwe), Urban Centres (e.g., Bulawayo), and Rural Institutions (e.g., schools, health centres). Overall, groundwater presently contributes not more than 10% to the total water use in Zimbabwe (Gumbo, 2006).

Thus, the country has 12.26 km^3 of water available per year. Much of the surface water (circa 45%) is stored in government dams and the other 55% in some 5, 700 dams found in former large-scale commercial farming areas, mines, and plantation estates.

Figure 14: Major catchment areas of Zimbabwe



Source: Mtisi, 2008.

The estimated exploitable yield of Zimbabwe's fresh water resources is 8.5 km^3/year, of which 56% is already committed leaving 3.7 km^3/year for irrigation and other sectors. Close to 550,000 hectares of land in Zimbabwe is irrigable using internal water resources and not considering water resources from trans-boundary rivers such as Limpopo and Zambezi. However, only 33.6% (200,000 ha) of the irrigable land has been developed. Of this potential over 100 000 ha can be immediately developed using water from (i) existing under-utilised dams, (ii) newly constructed dams and (iii) dams currently under construction. The non-availability of funding and the high investment costs for irrigation have retarded development of new irrigation facilities (National Investment Brief, 2008). Of the total irrigated area in Zimbabwe it was estimated in 1999 that approximately 114 000 ha was under sprinkler irrigation (including centre pivots), 47 000 ha under

surface irrigation and 14 000 ha under localized irrigation (ibid.). Out of this area, approximately 102 000 ha are operational and 73 000 ha (i.e., 43 percent) is equipped but not functional because the equipment was damaged during the land redistribution exercise and during the floods induced by Cyclone Eline. All require rehabilitation.

Because of its informal nature, dambo (wetland) cultivation is not usually included in official estimates of the total irrigation area. It is estimated that the total size of dambos in Zimbabwe vary from 20 000 to about 50 000 ha.

It is within this context of available water resources in Zimbabwe that anticipated increase in demand due to population growth, urbanisation and growth in the industrial, mining and agricultural sectors, that there is need for proper assessment, planning, development and management of water resources to avoid over-exploitation and degradation of its quality. Currently, there are problems which affect water resources, such as siltation of dams resulting in short life spans for dams, leakages in urban areas, loss of capacity of ground water recharge due to soil compaction and algal capping, and inefficient irrigation technologies. These factors combine to reduce the availability of water resources. Climate change will invariably affect water withdrawals especially against the predicted decreasing precipitation trend (1mm to almost 15 mm per decade) and the 2°C and 3°C increase in temperature which will also mean higher crop evaporative demand (Gumbo, 2006).

9.2 Key Organisations in the Water Sector

Table 15 below provides an overview of the key organisations involved in water resources management in Zimbabwe.

Table 15 - Zimbabwe Water Sector: Institutions and Roles

Institution	Role in water sector
Ministry of Water Resources, Development and Management	Formulate and implement sustainable policies on the development, utilization and management of water resources; Responsible for the overall/national planning, management, regulation and standardization of irrigation development and adoption of appropriate technology
Ministry of Agriculture and Rural Development	Overall development and implementation of the government's policy on agriculture and irrigation.
Department of Research and Extension Services	A functional arm under the Ministry of Agriculture and Rural development which provides extension services to irrigators, soil surveys and irrigation development.
Agricultural and Rural Development Authority	Quasi-government agency responsible for the operation of government-owned irrigated estates and farms.
Department of Irrigation	As specialist department under the Ministry of Agriculture and Rural Development responsible for irrigation planning, identification of schemes, designing, construction, operation and management of existing and new schemes.
Department of Water Development	A specialist department under the Ministry of Water Development with the main task of formulation of national policies and standards for planning, management and development of the nation's water resources.
Zimbabwe National Water Authority	Water planning quasi-government agency advising Catchment Councils and Sub-catchment Councils. A key role in the management of the water permit system and the operationalization of water pricing systems, planning, coordination, management of water resources and the delivery of water.
Catchment Councils – Linked to ZINWA	Prepare outline plans, determine applications and grant permits for water withdrawals and use, regulate and supervise exercise of water rights and supervise performance of sub-catchment councils. Day to-day water management is carried out by sub-catchment councils.
District Development Fund	Tillage services to irrigators, maintains infrastructure e.g., boreholes and small dams. Plans and constructs small irrigation schemes.
Ministry of Local Government, Public Works and National Housing	Working through the Rural District Councils to mobilize the local community, farmer selection and irrigation plot allocation in smallholder irrigation development.
Environment Development Agency under the Ministry of Environment and Tourism	Environmental impact assessments for new irrigation schemes and dams, pollution abatement, environmentally healthy catchments, water quality.

(Source: Gumbo, 2006)

The Ministry of Water Resources, Development and Management, which is responsible for policy formulation, is at the apex of water management while the Zimbabwe National Water Authority is the implementing agency. For more efficient and effective water management, the country has been

divided into seven catchments based on the major river systems in Zimbabwe. These catchments are managed by the catchment councils. A catchment council is in charge of water affairs in its respective catchment and it consists of elected representatives of the various water users within the catchment which include farmers.

In terms of water policy, Zimbabwe has been guided by the framework document *Towards Integrated Water Resources Management: Water resources strategy for Zimbabwe* developed in the late 1990s. The document also guided the framing of the 1998 Water Act. This policy document makes specific reference to the adoption of the Integrated Water Resources Management (IWRM) strategy which is embodied in the Water Act (1998). The IWRM strategy provides a good platform for Water Demand Management (WDM) implementation. The strategy has led to the implementation of market-based interventions in water resources management (e.g., paying for water, effluent charges, and the 'polluter pays principle') technological interventions (loss reduction and recycling), special measures for irrigation, mandatory measures and raising public awareness. Zimbabwe's national water policy does provide an effective policy and institutional framework for water resources management, but the policy needs to make specific references to climate change to ensure coordinated plans and programmes.

9.3 Water Policy and its Relevance to Climate Change

Zimbabwe's water policy enshrined in the Water Act of 1998 (see Box 10), founded on IWRM principles, provides a basis for water sector response to climate change. Importantly, the current water policy was partly a response to the devastating drought of 1992 which provided the impetus for policymakers to respond to such challenges. To this end, the water policy was a response to the effects of climate variability and change.

Zimbabwe's water policy provides a good water management framework and policy that is essential to adapt and mitigate the effects of climate change on water resources. IWRM can be used to analyse scenarios for climate change, and projected effects on water demand for irrigation, domestic water supply, industrial water supply and environmental requirements. Such an analysis can be used to establish the availability of water as well as its spatial distribution and variation over time. Consequently, projected future demands are checked against projected available future resources within a river basin or river catchment. In case of imbalance, water resources management strategies are designed to improve the situation. Finally, the performance of the strategies, in terms of impacts on the water resources system, the socio-economic system and the environment, is assessed (CRWC, n.d.).

Box 10: Provisions of the 1998 Water Act

- All water (surface and underground) is owned by the State and all water use except primary requires state approval
- Unit of management for water – catchment councils
- Time bound water permits (subject to application and intended use) issued by the Catchment Councils as against water rights held in perpetuity
- Priority date system replaced with proportional water allocation
- Polluter pays principle recognised and water treated as an economic good
- Water is allocated for environmental purposes and linked to drought preparedness and degradation of catchments
- Setting up a national water authority

9.4 Climate Change Vulnerabilities and Opportunities

Climate change projections for Zimbabwe provide ample evidence that water resources will be significantly affected by climate change, with wide range consequences for social and economic development. Observed changes in the country's climate include higher temperatures which affect soil moisture content, rates of evapo-transpiration, changes in the intensity and timing of rainfall, and the occurrence of extreme weather events. Broadly, these changes will alter not only the supply and demand of water resources, but also its quality.

9.4.1 Rainfall Patterns and Run-off

Model experiments suggest that annual rainfall will become more variable across Zimbabwe in the future. This variability occurs in all seasons, but is more conclusive for the early and late rains than for the main rainy season months of December to February. As a result of more variability in rainfall, drought events have become more frequent in recent years. Many of the serious droughts that Zimbabwe has experienced have coincided with an El Niño event (for example, 1982-83 and 1991-92), reducing total rainfall to as little as 30 percent of the annual average (Orlove & Tosteson,

1999). In contrast, Zimbabwe often experiences extreme rainfall events and flooding, which are related to La Niña events. The 2007 floods are a case in point, which resulted in extensive flooding in some parts of Zimbabwe as well as other southern African countries (allAfrica, 2007).

As rainfall becomes more unreliable and temperatures increase, availability of fresh water will decrease. The majority of Zimbabwe's water is taken from dams, particularly for urban centres and large-scale irrigation schemes. According to the National Communication on Climate Change (MOMET, 1998) the yield from these dams could be reduced by 30-40 percent as a result of climate change. One of Zimbabwe's main water supply reservoirs, Umzingwane near Bulawayo for example, has been declining since 1977. In rural areas, where water supply is less secure, there will be an increased risk of shortages of water for agriculture and domestic consumption.

9.4.2 Surface Water Resources

Evapo-transpiration under climate change is predicted to increase by between 4 and 25 percent in the river basins, and runoff has been projected to decline by up to 40 percent, with the Zambezi Basin being the worst affected (Chagutah, 2010). Water available for storage from runoff varies between seasons. The estimated long-term mean is 20 billion m^3 per annum, excluding the flow of the Limpopo and Zambezi Rivers

A sensitivity analysis of water storage in Zimbabwe's main reservoirs during the 1991–92 drought cycle indicated that with a 2°C mean temperature increase and a potential evaporation exceeding the long-term average by 30 to 90 percent, the water level dwindled to 10 percent of capacity. In 2007, most of Zimbabwe's dams had extremely low water levels due to high evaporation, resulting in some of them being decommissioned. The last six years have been the warmest of the last fifteen and evaporation has increased. Due to the reduced water levels, many rural wells and boreholes have dried up, urban water supplies have been severely limited throughout the country, and hydroelectric power generation has gradually fallen, threatening several industries.

9.4.3 Groundwater Availability

The current and projected long term variation in rainfall in Zimbabwe will adversely affect groundwater recharge and levels of groundwater tables. This will negatively affect water supply from groundwater sources for agriculture and domestic purposes. An instructive case is the 1992

drought, which adversely affected groundwater resources. As rainfall in 1992 fell to just 30% of normal, it was observed that the water table in some areas dropped by 100-200 metres, traditional shallow wells and boreholes dried up, and a number rivers, reservoirs, and their related ecosystems disappeared (Gumbo, 2006). This had great consequences for rural households which relied on groundwater for domestic water supply. It is important to note that knowledge of current groundwater recharge and levels in Zimbabwe is poor, and there has been little research on the impact of climate change on groundwater resources. Such information and knowledge is vital in planning on the future use of groundwater in the country.

In summary, more variable rainfall, surface water resources and groundwater will impact agriculture, industry, energy production and ecosystems (as detailed in relevant sections of the report). It will also impact on domestic water use. The 1991/92 and 2007 droughts provide an illustrative case of the effects of climate change on domestic water supply. Due to these droughts, supply of water for domestic purposes was frequently cut and water rationing measures have been put in place for many urban areas as was rationing of power, commonly referred to as 'power cuts'.

For Bulawayo such measures have become normal. This is mainly because its dams are located in drought prone areas and the rainfall in the catchment areas of these dams has been decreasing over the years. In November 2007 the City of Bulawayo had to decommission three of its five supply dams namely Lower Ncema, Upper Ncema and Umzingwane. This was mainly because no significant inflows took place during the rainy season. As a result, Bulawayo has for years been putting in place water rationing measures which usually see residents receiving water once or twice a week. Consequently, the impact of climate change on water supply is likely to undermine improved access to water and sanitation for the population with negative consequences on human health and socio-economic development.

9.5 Mitigation in the Water Sector

The relationship between water resources and climate change mitigation measures is both complex and dynamic, as one aspect feeds into the other. Put simply, mitigation measures in other sectors can influence water resources, while measures for water resources management influence greenhouse gas emissions.

Water management activities that influence GHG emissions include the construction of water reservoirs, which, in turn, emit small amounts of GHG as water conveys carbon in the natural carbon cycle. On the other hand, water reservoirs absorb carbon dioxide at their surface. The extent

to which water reservoirs in Zimbabwe emit and absorb GHGs has not yet been studied. Expanding the area for irrigation, as is planned in Zimbabwe, and the use of more effective irrigation techniques, can enhance carbon storage through yields and residue returns.

Mitigation practices in other sectors such as land use management and forestry impacts on water resources. Reduced tillage, afforestation, re-afforestation, and greater use of perennial crops, which are aimed at improved land use management and soil carbon conversation, improve the supply and quality of water resources, such as groundwater.

9.6 Adaptation in the Water Sector

To adapt to the increasing impacts of climate change on water resources, water managers and policymakers need to address supply and demand aspects of water. With reference to supply side, the following adaptation strategies that can be implemented within the water sector, and these include:

- Protecting extraction of groundwater resources through the issuing of permits and instituting fees for groundwater extraction
- Increasing storage capacity by building reservoirs and dams to manage variability of water resources, flood regulation
- Working on maintenance, major rehabilitation, and re-engineering of existing systems including dams, irrigation systems, canals, pumps, rivers and wetlands; and
- Development and implementation of rain-water harvesting and storage techniques (see Box 9)

On the demand side, the following strategies can be considered, namely:

- Improvement of water-use efficiency by recycling water and providing multiple-use water schemes;
- Changing the cropping calendar, crop mix, and areas planted to reduce the demand for water;
- Improve efficiency of irrigation technology to deliver more crops per drop; drip irrigation, wastewater reuse and recycling of water
- Promotion of indigenous practices for sustainable water use e.g. dambo cultivation; and
- Expanded use of economic incentives including metering and pricing to encourage water conversation.

Box 11 – Rainwater Harvesting

There are current initiatives to encourage local communities and households to embark on rainwater harvesting for domestic and productive purposes. This would allow communities to capture water resources when it rains or when there are floods and the harvested water would be used during dry spells or after the rain season. Organisations such as the Zvishavane Water Project has been promoting rainwater harvesting for schools, communities and household in Zvishavane and Chivi districts. The project has enabled households, schools and communities to have access to water for domestic purposes as well as for nutrition gardens.

It is important to remember that the water sector is governed by a policy and legislation framework inspired by the concept of integrated water resources management. As such, the water policy provides an instrument that can contribute to adaptation measures as issues pertaining to coordinated management of land and water resources, water metering and pricing, effective systems of water allocation and the need for resolving conflicts between competing water uses, are already embedded in national policy framework. In short, the policy framework should incorporate climate change adaptation within the governance of water resources to the extent that it speaks directly to climate change issues. This will then provide a more effective basis for climate change adaptation in the water sector. For effective adaptation, water management institutions should be strengthened at all levels and capacities built for holistic water management in the context of climate change.

9.7 Priority Areas for Research and Technical Assistance

The following areas should be prioritised for research and technical assistance:

- Assessments of the impact of climate change on surface and ground water resources;
- Efficient utilisation and management of surface and ground water resources under changing climatic conditions;
- The use of indigenous knowledge systems in forecasting and management of water resources as well as in mitigation and adaptation strategies;
- Impact evaluations of adaptation initiatives in the water sector, such as multiple-use schemes and rainwater harvesting
- Review of the water policy to take into account climate change; and

- Strengthening ZINWA, Catchment and Sub-Catchment Councils through funding and capacity building so as to effectively deliver their water resources management functions in the context of climate change. This include developing and updating catchment and sub-catchment water demand needs, projecting future water demands and developing appropriate water allocation mechanisms that supports poverty reduction, livelihood improvement and economic development goals.

9.8 Summary

Improving water availability and irrigation systems: In the light of decreasing rainfall due to climate change, there is a need to ensure water availability for productive purposes through water development, particularly stored water, and irrigation. There is also a need to ensure water for irrigation is used in an efficient manner. This would mean, in part, the introduction of technologies such as drip irrigation. The development of appropriate irrigation systems will need to involve the farmers in the planning, implementation and management process.

***Groundwater resources*:** There is need to understand the reserves of groundwater available in the country. Such information will then help in planning how ground water can be obtained and allocated for both domestic and productive purposes.

Micro hydro-electric schemes: Investment in micro hydro-electric project will reduce pressure on the energy supply from the Kariba dam. Such schemes allow communities to be partners in the generation and management of their electricity needs.

Institutional Strengthening: Key institutions of water development and management must be supported through the capacity building and improved funding for them to effectively deliver on their mandates.

***Revision of the Water Policy*:** The Water Act and the Zimbabwe National Water Authority Act should be revised to take into account the changed landscape of water users and likely impacts of climate change on water resources taking cognisance of the important role water plays in agricultural production, industrial development and human health.

10. Disaster Preparedness and Response and Climate Change

This section first presents an overview of hydrological hazards, their frequency and impacts on social and economic development. The second section examines the current disaster management efforts by the government through the Civil Protection Department and the enabling policy and institutional framework. Recommendations on reducing climate change risk through disaster risk reduction and the enhancing technical assistance and research requirements are provided in the last section.

10.1 Overview of Climate-Related Disasters in Zimbabwe

Zimbabwe has witnessed an increasing number of weather related hazards, namely droughts, floods and more recently tropical cyclones, which have adversely affected people's livelihoods and undermined the country's economic development. Data on natural disasters from EMDAT is presented in Table 16. Drought is the most common disaster and its frequency per decade is increasing. Floods are also common.

Table 16 - Top 10 natural disasters in Zimbabwe for the period 1980 to 2011 sorted by (a) number of total people affected (b) economic damage cost

Disaster	Year	No Total Affected
Drought	1982	700 000
Drought	1992	5 000 000
Drought	1998	55000
Drought	2001	6 000 000
Drought	2007	2 100 000
Drought	2010	1 680 000
Epidemic	1996	500 000
Epidemic	2008	98 349
Flood	2000	2 000 000
Flood	2001	30 000

Disaster	Year	Damage (000 US$)
Drought	1982	2 500 000
Drought	1991	50 000
Flood	2000	72 900
Flood	2001	3 600
Flood	2003	200 000
Storm	2007	1 200

Source: EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université Catholique de Louvain - Brussels - BelgiumDate accessed 24/07/2011

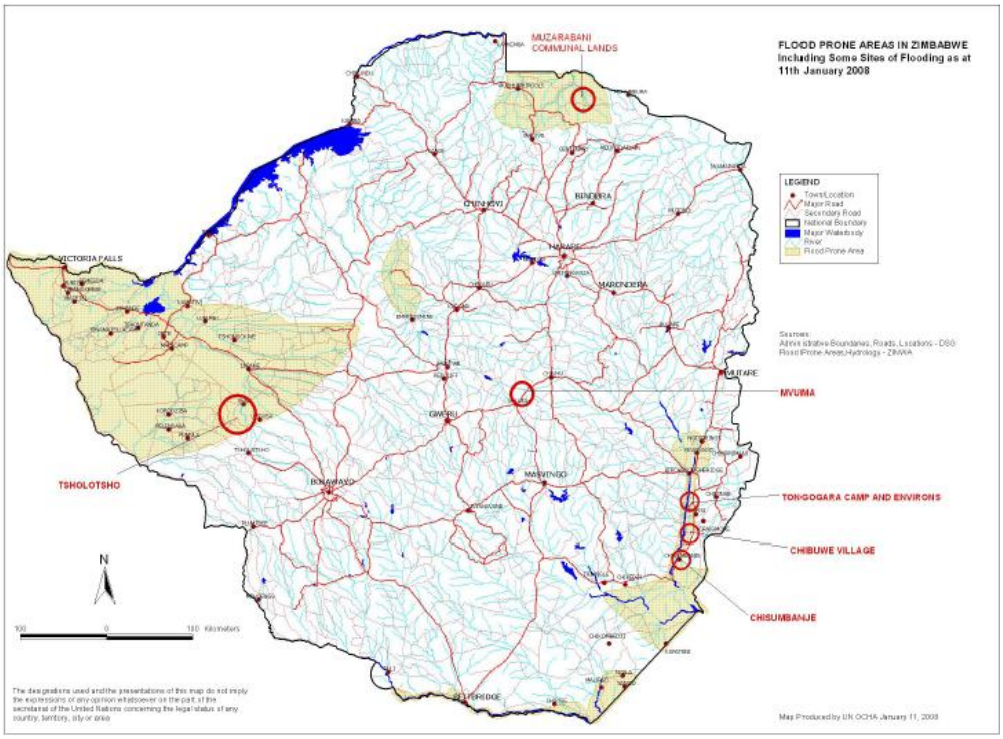
Table 17 - Drought occurrence according to intensity for the period 1950 to 2000

Mild	Moderate	Severe	Extreme	
1963/64	1959/60	1982/83	1946/47	1964/65
	1983/84	1986/87	1967/68	
1981/82			1972/73	
			1991/92	

Source: Adapted from Manatsa et al., 2009

Source: EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université Catholique de Louvain - Brussels - BelgiumDate accessed 24/07/2011

Figure 15 - Flood prone areas of Zimbabwe



Source: OCHA website[19]

Floods are often caused by tropical cyclones from the Indian Ocean. These often result in structural damage from the accompanying high winds as they track inland from the Mozambique coast. Figure 15 above shows areas in Zimbabwe that are prone to floods. Floods often cause damage to infrastructure, crops and livestock, and result in loss of life. For instance, in 1999 Cyclone Eline which sustained winds of up to 120km/hr claimed more than 70 lives, livestock, crops and infrastructure were extensively damaged as the cyclone swept across the eastern parts of the

[19] http://reliefweb.int/sites/reliefweb.int/files/resources/ocha_FL_zwe080111.pdf

country. Up to 70% of the crops in the affected region were destroyed, leaving approximately one million people in need of food, shelter and drinking water. Figure 15 above shows the areas that are prone to floods in Zimbabwe.

The disaster profile of Zimbabwe is characterized by a vulnerable population, superimposed on a predominantly agro-based economy that is very susceptible to the variability of the climate. In this context, risks and vulnerabilities are exacerbated by many rural households' minimal coping capacities. The country has minimum resources to invest in disaster risk reduction and minimum fiscal space to cater for relief and recovery efforts after a major disaster. It is quite evident that the recovery processes after the Cyclone Eline floods in 1999/2000 and the 1991/92 drought were so underfunded that even today the country has not fully recovered. Critical infrastructure, such as roads and dams, are still damaged. In sum, climate change is predicted to increase the risk of rainfall variability, drought, the frequency of tropical cyclones and floods in Zimbabwe. This will place added pressure on disaster risk management and response.

10.2 The Civil Protection Policy and Institutional Framework in Zimbabwe

Disaster management in Zimbabwe operates under the legal and institutional framework of the Civil Protection Act No.5 of 1989. It is coordinated by the Department of Civil Protection in the Ministry of Local Government, Public Works and National Housing. The system is such that the central government initiates disaster preparedness programs through the appropriate sector ministries with the local administration taking the responsibility for implementing and maintaining its effectiveness. As such the Civil Protection Department has only seven full time members including the director, the deputy director and five operational officers who are all located at headquarters.

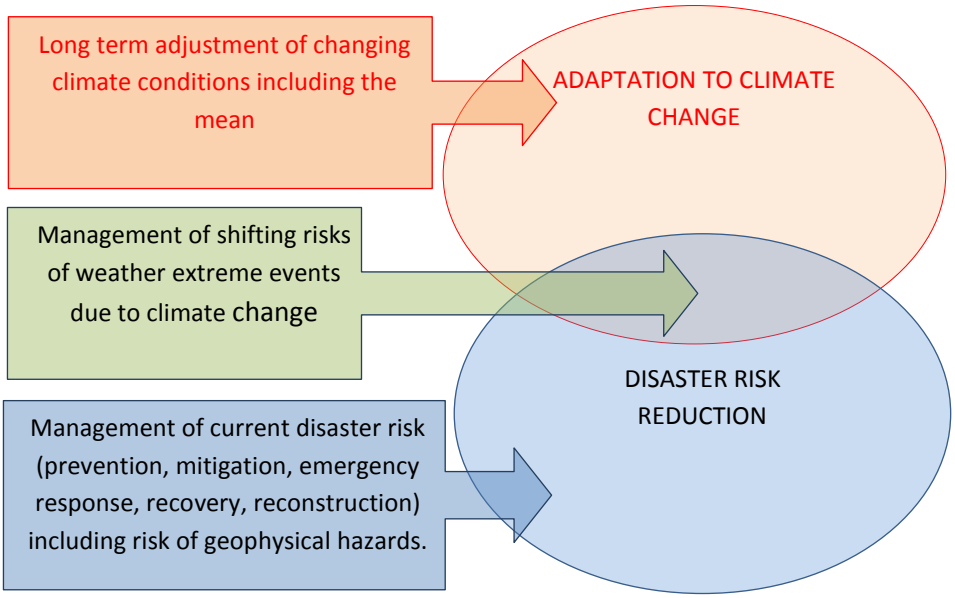
The National Civil Protection Coordination Committee (NCPCC) whose membership is derived from senior officers of selected ministries/departments, parastatals and NGOs directs most of the national disaster management agenda. Other members, especially from the private sector, are co-opted when necessary. At the provincial level the committee is known as Provincial Civil Protection Coordination Committee (PCPCC) and at the district level the District Civil Protection Coordination Committee (DCPCC). The Department is mostly state funded through the Disaster Fund. This money is only released after the declaration of a state of disaster by the President. In the event of major disasters, where more resources are required, the enabling legislation has the provision through which the treasury can inject additional funding. However the funding is usually

less than the amount needed to successfully manage the disaster. This has left the department to rely also on development partners (like UN agencies and NGOs) to fund some of its disaster management initiatives. But with the country's impasse with the international community, such funding has gradually dried up.

10.3 Disaster Management and Climate Change

It is critical for disaster risk management to become a central component in all national climate change adaptation strategies. Climate change increases the frequency and intensity of hydro-meteorological hazards such as floods, droughts and cyclones. As such, efforts for disaster risk management aimed at reducing vulnerabilities to extreme weather events dovetails with efforts to promote climate change adaptation. Figure 16 below illustrates the links between disaster management and climate change adaptation. It is apparent that the inter-linkage between disaster risk management and climate change adaptation include management of extreme weather events, which can be broadened to cover the generation and communication of climate risk and vulnerability information, institutional capacity and coordination, community level activities and financing of disaster risk reduction and adaptation to climate change.

Figure 16 - The overlapping agendas of climate change adaptation and disaster risk reduction.



Source: World Bank, 2010a

A key entry point in establishing an effective legislative and policy framework is replacing the Disaster Management Act of 1989 with the proposed Emergency Preparedness and Disaster Management Act (currently being drafted). The Act should no longer be focused on relief and rehabilitation efforts, but should lay the legal framework to address pre-disaster prevention and preparedness, as well as post disaster issues of response, recovery and reconstruction. This may open avenues for climate adaptation to be incorporated in the legislation.

The Act could be used as a vehicle for:

- Mainstreaming risk management in climate sensitive sectors including agriculture, fisheries, water, infrastructure and health;
- Introducing disaster risk management operations across administrative levels, from ward to national level;
- Enhancing linkages and synergies between the humanitarian and rural communities who are most vulnerable;
- Renewing interest in preparedness and contingency planning to prepare for more frequent and less predictable multiple hazards; and
- Accessing new or additional financial instruments from the regional and international community.

There are many regional and international players who aim to reduce climate change vulnerability. The Civil Protection Department should foster links with established international and sub-regional programs to enhance capacity. The sub-regional networks can also be used for information and knowledge sharing, especially regarding methods and technologies.

10.4 Current Initiatives

Successive climate related disasters and global movements since the 1990s have triggered a paradigm shift in disaster management leading to a host of new initiatives to reduce the risks of disasters. For example the SADC Hydrological Cycle Observing System (SADC-HYCOS) project which is a regional component of the World Meteorological Organisation (WMO) installed five data collection platforms along major rivers in Zimbabwe to assist in flood early warning, monitoring and water resource management.

The Meteorological Department also acquired and installed automatic weather stations in major cities increasing continuous data collection of weather elements that are needed in atmospheric research. In the area of disaster risk reduction, the Civil Protection Department with the assistance of UNDP managed to develop a Disaster Risk Reduction Resource Book which is now being used as a reference book for Zimbabwe hazards and disasters by education instructors in schools and tertiary institutions across Zimbabwe.

10.5 Priority Areas for Research and Technical Assistance

The generation and provision of reliable and appropriate information on present and future climate risks is a key component of adaptation. Improvement of data sources and modelling capacity is an adaptation in itself and a resource in which to base adaptive decisions and actions. However, the understanding of implications of national climate change at local level is severely limited as the collection of data of sufficiently high resolution and continuity remains a fundamental problem. Low resolution data has insufficient temporal and spatial coverage hence is unable to detect crucial local climate change trends as well as validating projections of regional climate models. In view of this, priority areas for research and technical assistance include;

- Collection of data for hazard monitoring
- Establishing hydro-meteorological early warning systems at national, provincial and district level
- Provision of resources (i.e., technology and funding) to hydro-meteorological monitoring departments of Zimbabwe National Water Authority and Meteorological Department to improve hazard monitoring, assessment and reporting
- Capacity building of staff in relevant government agencies, at national and sub-national level, to enable them, to monitor and respond to weather-related disasters.
- Restoring recording stations and data collection platforms for hydrological monitoring which are managed by ZINWA and the Meteorological Department, including those installed by SADC HYCOS; and
- Promoting inter-sectoral coordination and collaboration

Technical assistance is needed from regional and international disaster reduction agencies to assist education and training, including public awareness programs. There should be a systematic approach to mainstreaming disaster risk management training and capacity building that emphasizes climate change adaptation through formal education in schools, colleges, universities and other technical or professional training institutions.

It is apparent that the existence of an effective disaster database for management of all disasters at all levels, be it national, provincial, district or ward level is long overdue. Currently the nation relies on international organizations such as EMDAT for its own national disaster statistics. Although the data is better than nothing, its reliability is often questionable. As such inadequacy of data and lack of readily available national disaster information leads to poor planning, lack of institutional memory and lack of effective monitoring and evaluation of trend analysis and forecasts. The database would enable continuous monitoring of events and facilitates evaluation analysis, research, storage and application to new project plans.

Research is needed to develop a hazard diagnosis tool to assist in identifying areas of high vulnerability to different hazards throughout the country. The mapping should take into consideration social and economic aspects of the population vulnerability and the vulnerability of the infrastructure, with the capacity to be update to reflect the changing climate as well as the socioeconomic patterns.

10.6 Summary

Considering the projected impact of climate change over the country, the reduction of current and future vulnerabilities should build on expanding existing disaster risk management efforts. This is because climate change adaptation and disaster risk reduction are closely linked. Adapting to climate change requires both preparing for long term changes in average climatic conditions and addressing short to medium term impacts of climate variability and extreme events. In Figure 16, the overlapping agenda for climate change and disaster risk reduction are illustrated. A close collaborative framework between the Climate Change Office (which is responsible for coordinating national climate change activities) and the Civil Protection Department should be fostered (not least as they rely on the same source of baseline information, such as hydro-meteorological data to be used in early warning systems and for long term climate predictions).

Currently, disaster management and climate adaptation fall within different ministries, and are addressed at the national level under different policy frameworks. Consequently they are managed through different line departments that often have no cross sectorial coordination. Compounding this, the location of the Climate Change Office within the Ministry of Environment and Natural Resources Management tends to isolate it institutionally from the development agenda where most adaptation activities are located.

There are some persistent gaps between the production of climate risk information and the ability of the decision makers and vulnerable stakeholders to interpret and react to such information. The uptake of climate information is also hampered by lack of trust and may require concerted efforts for ‘bridge building’ between scientists and stakeholders within implementing institutions.

Part D – Sectoral Analysis 2

11.Mining and Climate Change

Mining contributes to climate change while at the same time it is vulnerable to its impacts. Mining by its nature is inherently destructive of the environment. Open cast mining for example, results in the clearing of forests which are major carbon sinks. Blasting results in the emission of gases into atmosphere which may contribute to climate change. Coal dumps which are not rehabilitated timely may result in spontaneous fires which results in the emission of greenhouse gases (GHGs). On the other hand, both underground and open cast mining are vulnerable to the impacts of climate change. Climate change can result in flooding, water and energy shortages and, to some extent, shortages of raw materials.

11.1 Overview of Mining Sector

The mining sector accounts for around 4% of the GDP, 5% of formal sector employment, and at least 30% of foreign exchange earnings. Major mining products include gold, platinum, nickel, diamonds, ferro-alloys, and coal, which are invariably exported. Mining output declined by 14% in 2000 as a result of mine closures, power shortages, and depressed international prices of minerals. This declining trend in the formal mining sector continued up to 2008. For instance, gold production – accounting for about half of total value of the mining sector – declined to 18.04 tonnes in 2001 from 22.07 tonnes in 2000 (AfDB/OECD 2003:358). In contrast, artisanal mining underwent a boom during the period of economic contraction.

Despite the decline in the mining sector at this time, the sector's relative importance in economy increased from 3.8% in 2001 to 6.4% by 2006. Recent years have seen resurgence in the mining sector, with increased production in key minerals, such as gold, coal, platinum and diamonds. The table below highlights the increased production of key minerals from 2009 to 2011.

Table 17: Mineral Production from 2009 to 2011

Mineral	Total Production			
	2009	**2010**	**June 2011**	**Projected Total 2011**
Gold/kg	4966	9620	5 521.3	13000
Nickel/t	4857.5	6133	3858.4	8 400
Coal/t	1 606 315	2 668 183	1 018 543	3 000 000
Chrome/t	201 000	516 776	241 371	61 000
Platinum/kg	6848	8 639	5305.3	12 000
Diamond/carat	1 305 692.9	8 435 584	2 329 441.2	8 200 000

(Source: Ministry of Finance, 2011)

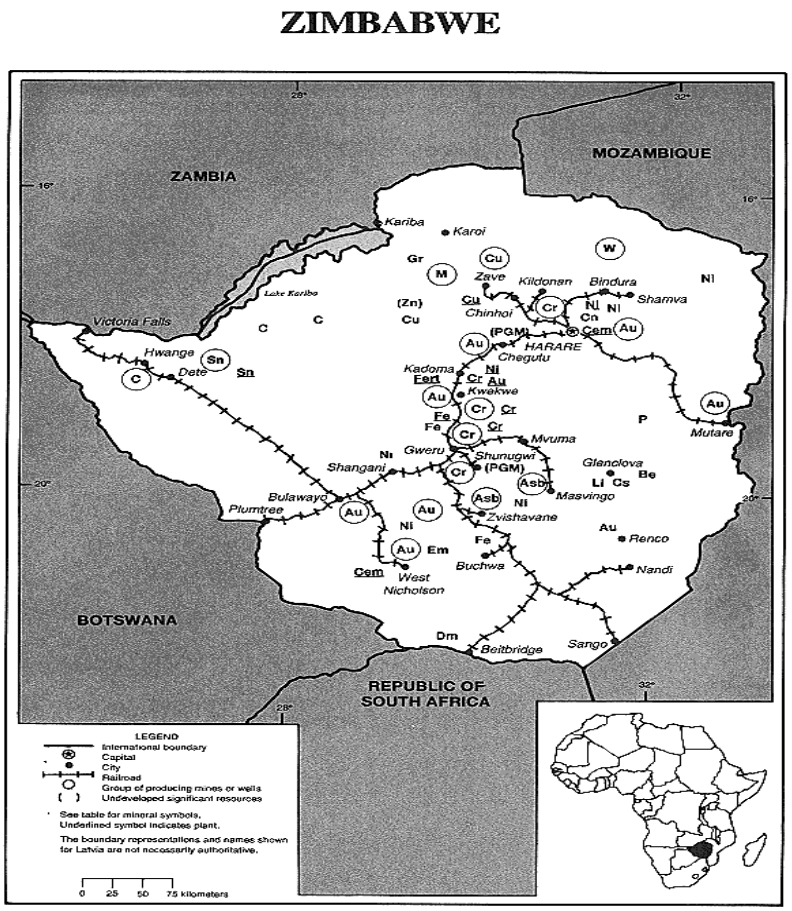
It is apparent from the above table that there is significant growth in the mining sector fuelled by buoyant international prices for minerals and improved supply of electricity, and making the sector a key contributor to GDP. Growth in the sector is projected to continue to grow in the next ten years. For instance, in 1999 gold production was 27 tonnes per year, and projections are that in 2015 it will be 50 tonnes per year. Platinum was being mined at 170 000 ounces per year but is projected to reach 1 million ounces with further development in the next ten years. Coal is mostly used for electricity production and industrial uses. The Hwange Power Plant takes about 2.5 million tonnes of coal per year at peak production. At peak Hwange Colliery was producing about 6 million tonnes of coal per year but this has since reduced to less than 3 million tonnes per year in the recent past. Recently there have been new coal mines opened around the country but production figures are not readily available. Most new mines are producing coal for the metal industry, especially chrome smelting. Increased output would be inevitable with revitalization of other productive sectors. It is anticipated that coal liquefaction may be adopted for a liquid fuel supply (see Table 16 for a breakdown of mineral production capacity).

The resuscitation of iron and steel processing in Kwekwe (which is under new management), will result in significant production of iron and steel as well as coal. Alluvial diamond mining in Marange, which is considered one of richest diamond fields in the world, has also led to tremendous

growth in the sector. Given the huge coal reserves in Zimbabwe, coal mining is poised for considerable growth.[20] There is a significant amount of coal bed methane estimated at 33 terra cubic feet. Minerals are concentrated on the Great Dyke (Figure 17 shows the location of formal large-scale mines). Large mines are located along the main rail links.

The anticipated growth in the mining sector has important implications for climate change given the complex links between climate change and mining. Mining contributes to climate change due greenhouse gas emissions associated with the sector (as it is dependent on thermal power), while on the other hand, climate change affects mining operations. For example, extreme weather events may disrupt power supplies, and changes in water availability may threaten water-reliant production and processing techniques.

Figure 17 - Mines in Zimbabwe



[20] http://www.nationsencyclopedia.com/Africa/Zimbabwe-ENERGY-AND-POWER.html

11.2 Mining Policy

Mining policy can be used to reduce the contribution of mining to climate change while at the same time reducing its vulnerability from it. The Mines and Minerals Act (Chapter 21:05) is the principal legal instrument governing mining in Zimbabwe. However, this is a very old Act which was passed in 1961 well before climate change began to receive international attention. To that extent, any reference to climate change in the Mines and Minerals Act is implicit rather than explicit. Climate change related issues resulting from mining are addressed by the Environmental Management Act (Chapter 20:27) and regulations made under it and the Mines and Minerals Amendment Bill of 2007.

The Mines and Minerals Amendment realises forests are an important component of the sustainable management of natural resources. In terms of section 36(1), the Mines and Minerals Act states that;

> *Every owner or occupier of private land may apply for and shall be granted by the mining commissioner a reservation against the cutting or the taking by prospectors or miners of fifty per centum of such indigenous wood or timber as is existing on his land at the time of his application for the reservation.*

This can be interpreted as a realisation on the need to ensure that trees or forests are not wantonly cut during exploration and mining operations. Furthermore, the mining commissioner may through a notice authorised by the Minister reserve the cutting down of specified indigenous wood or timber by a holder of a prospecting licence or a special grant in terms of section 37(1). These provisions maybe interpreted as having some relevance to climate change. While the reservations do not have the effect of stopping the prospecting or actual mining activities, its usefulness is that it ensures that they are done in a sustainable manner. However, it is important to note that these reservations are only applicable to indigenous wood or timber.

In terms of section 257 B, large scale mining companies are required to establish environmental rehabilitation funds. These environmental rehabilitation funds will be used for:

a) quittance work or other work that will be required upon the cessation of mining operations in the mining lease or mining locations; and
b) any other work required, whether under this Act or any other enactment, to protect or to restore the environment from the consequences of the miner's mining operations.

The establishment of an environmental rehabilitation fund is to be done within twelve months of commencing mining operations. The environmental rehabilitation funds can be used to carry out activities that have direct implications on climate change. For example, rehabilitation may entail growing of trees which will act as carbon sinks. Availability of rehabilitation funds will result in timely rehabilitation of mined out areas in the case of coal mining thereby mitigating against the outbreak of spontaneous fires which are a major source of air pollution which causes climate change.

In terms of section 97 of EMA, mining is one of the activities listed in the First Schedule which must not be undertaken before an EIA is carried out. If the EIA shows that the proposed mining activity will contribute to GHG emissions, there are strong grounds to apply technological processes to mitigate and package the project up as an offset credit.

The Environmental Management (Atmospheric Pollution Control) Regulations, Statutory Instrument 72 of 2009 has provisions that are applicable to mining. Air pollution contributes to climate change and these regulations can be used as mitigation measures against climate change. Section 3 of the regulations sets objectives to prevent air pollution and to set emission standards for certain activities. These include the burning of waste at landfill, the burning of vehicle tyres, the burning of bitumen, the burning of metallic wire coated with any material, the burning of oil in the open air, the operation on an incinerator and any activity that causes the emission of a pollutant into the atmosphere.

Further, the regulations make it an offence for an owner or occupier of land or premises with a disturbed surface area to cause or allow fugitive dust to be emitted in to the atmosphere as a result of activities on the disturbed surface area in excess of the prescribed amount in the Third Schedule. Mining activities leads to the emission of fugitive dust into the atmosphere. These provisions compliment section 63 of the Environmental Management Act on air quality standards.

Some wastes from mining activities like open cast mining of coal can result in spontaneous fires if they are not timely rehabilitated. These spontaneous fires results in air pollution which contributes to climate change. Section 24 (1) of the Environmental Management (Effluent and Solid Waste Disposal) Regulations, Statutory Instrument 6 of 2007 regulates the management of mining waste. The regulations state that any person who is authorised to carry out any type of mining activities in accordance with the Mines and Minerals Act shall do so in a manner that does not negatively impact on the environment. Furthermore, the person is required to rehabilitate the land to the satisfaction of the Environmental Management Agency within 12 months on cessation of

operations. This provision has direct implications on climate change. Delays in carrying out timely rehabilitation can again result in spontaneous fires and air pollution.

The generation and management of waste has direct implications on greenhouse gas emissions through the production on methane and carbon dioxide. Mining equipment can also contribute to climate change if it contains ozone depleting substances. Environmental and Natural Resources Management (Prohibition and Control of Ozone Depleting Substances and Ozone Depleting and Ozone Depleting Substances Dependent Equipment) Regulations , Statutory Instrument 2 of 2011's objective is to regulate the import, export, installation , decommissioning and destruction of ozone depleting substances and ozone depleting substances dependent equipment. These regulations ensure that ozone depleting and dependent equipment is handled in a sustainable manner that does not have negative impacts of the environment including climate change.

11.3 Climate Change Vulnerabilities and Opportunities

Some of the impacts of mining on climate change include;

i. GHG emissions from mineral handling and processing ; and

ii. Loss of vegetation through clearing land for open cast mining, construction of mine plant build and other related infrastructure such as roads and civil works.

Mines are located on the basis of availability of resources and not on climate factors and suitability of the lands to withstand climate impacts. Coal mines are situated at Hwange and Gokwe where they constantly threaten the Zambezi River, and gold mines are dotted all over the country even in places where water scarcity threatens survival (despite gold mining having potential highly detrimental impacts on water). Small-scale miners pose a unique threat on the environment. They exploit mostly alluvial gold and have no capacity to mitigate environmental damage. In addition small-scale miners lack the skills necessary for efficient mineral extraction hence they achieve low yields. The motivation for small-scale miners is poor opportunities elsewhere in the economy. Gold panners are particularly motivated by the poor performance in agriculture due to droughts. The damage caused by poor mining methods by panners and small-scale miners threatens surface water resources and flooding is exacerbated by deforestation and siltation of water courses.

As already stated, both underground and open cast mining are vulnerable to the impacts of climate change. Flooding, water and energy shortages and, to some extent, shortages of raw materials, can hinder and hamper the proper functioning of mines and ancillary activities.

Climate change also offers important opportunities for the mining sector to reduce their emissions and trade their carbon credits on the international carbon market. Put simply, mines that can install clean technology such as for capturing and storing carbon, and hold carbon credits issued by government, can trade their surplus credits on the international market. However, Zimbabwe is yet to put in place a framework for carbon markets.

11.4 Mitigation in the Mining Sector

One important way of reducing emissions in the sector is to increase the energy efficiency of mining operations. Zimbabwe is facing a critical shortage of electricity, affecting the operations of mining and industry. Most private investors are seeking ways to alleviate the electricity shortages. The Business Council for Sustainable Development in Zimbabwe has been working with various partners to encourage their members to adopt energy efficient production methods. These include electricity production and use as well as improved energy management. In the first National Communication to the UNFCCC, Zimbabwe presented opportunities for carbon emission reductions that included mineral beneficiation processes. Energy audits carried out in mines and mineral processing plants showed simple measures such as lamp replacement, process tank insulation, staff training and compressed air pipe repair as having a significant potential for reducing energy use. The following table summarizes some of the opportunities for carbon emission reduction in mining.

Table 18 - Options for Reduction of Carbon Emission in the Mining Sector

Option	**Description**
Energy efficiency improvement	— Adoption of practices that reduce energy consumption per unit of mineral produced including technology and management options
Process Changes	— Redesign production processes to reduce the carbon intensity of production (mixing technologies from compressed air to mechanical stirrers, maintaining material temperature when transferring between processes)
Waste recycling or reuse	— Import of waste from other facilities and blending with product to reduce energy intensity and carbon intensity of product (cement blending with blast furnace slag, coal fines mixed in brick clay, coal ash used for cement blending, recycling glass and steel)
Technology upgrades	— Changing technology to enable better processing and finer control of product quality as a way of increasing value and reducing demand (clinker mills to enable high blending ratios, waste dump reprocessing for chrome and gold extraction)
Use of Clean technology especially in coal mining	— Use of carbon capture and storage technologies; — pollution control devices - like advanced scrubbers - that clean pollutants from flue gases before they exit a plant's smokestack; Chemical looping combustion technology to concentrate CO2 levels in exhaust; — Production of ultra clean coal which reduces ash from the coal allowing it to be directly fired in gas turbines at higher efficiency and lower greenhouse gas emissions; — Coal Gasification including underground gasification in situ; Capture and utilisation of fugitive emissions from coal mines

Low-carbon opportunities tend to favour the larger production houses. Despite their impacts on carbon sinks and inefficient production methods, there are fewer opportunities with small-scale miners. The challenge of poor regulation and monitoring of small-scale miners is therefore a barrier to sustainable development. Delegation of regulation and supervision of small-scale miners to local authorities may serve to improve the situation.[21] Moreover, stimulating a vibrant agricultural sector may well reduce the number of small-scale miners.

[21] Small Scale mining and alluvial gold panning in the Zambezi basin: an ecological time bomb and tinderbox for future conflict among riparian states, Dennis S.M. Shoko.

11.5 Adaptation in the Mining Sector

Higher temperatures, more variable rainfall and a greater frequency of extreme events suggest that mining companies need to strengthen safety procedures, pump capacity and contingency plans. There could also be important spill-over effects from adaptation in the mining sector. For example, improved water use efficiency in mines could help to release water for agricultural applications. In this respect, mining companies should benefit from, and be party to, climate projections, policy and programming as facilitated by the CCO.

When mines are closed there is usually no initiative to modify the water supply system for continued use. Pumps and power transformers are abandoned underground and water storage facilities such as dams are left without maintenance. Some mine infrastructure is handed over to local authorities who have no capacity to operate and maintain the infrastructure. A strategy to improve the utility of the infrastructure would be to introduce options for long term usage towards the end of the mine life.

Waste material from mines is often considered a hazard. Mine dumps pose a landslide hazard and some of the minerals left in the dump decompose and form acidic or alkaline run-off which is detrimental to soils and surface water. Some rocks which appear suitable for construction have high sulphides or other compounds which make them unsuitable for making building aggregate. There is however some mine waste that can be used for construction especially road stabilization and rock filling of dam walls. Granite and limestone quarries offer such materials.

The presence of mines increases the available skills in remote districts. In Gokwe the communities have a problem of soil erosion due to the prevalence of sodic soils in the district. A mining company has previously offered to provide skills and equipment to help in recovering some of the gulleys. The mine also offered to provide advisory services to the communities through the Global Environment Facility Small Grants Program. It is also common for mining companies to maintain local roads as a community service, especially in areas where access is difficult.

Due to their reliance on local labour, mines naturally integrate local communities into their beneficiaries for social services. The larger mining companies provide the municipal services as well as health and education facilities. Hwange Colliery and ZISCO are examples of such mines. Given the prevalence of malaria in the two districts there is a natural linkage between mining company health services and malaria prevention.

Mines are also a natural partner in disaster management. Basic services such as fire fighting, search and rescue as well as accident response and recovery are included in mining activities and are also a requirement for communities to survive extreme events. There is need to consolidate the collaboration between mines and local authorities so the services can be wider reaching and more efficient.

In view of the above, Government must provide a regulatory framework that encourages the mining sector to mitigate its GHG emissions through the use of clean technologies, particularly in coal mining activities, as well as to support climate change adaptation activities in communities where minerals are mined. With regards to GHG emissions, carbon capture and storage can be regulated to form an integral part of mining plans before a new mine is commissioned. With regards to adaptation, perhaps, a proportion of funds contributed by mining firms to Community Trust Funds can be used to support community-wide climate change adaptation activities.

11.6 Summary

The importance of mining to economic recovery and growth in Zimbabwe has been underscored by the tremendous performance of the sector in the past three years, with important links to GDP growth and employment. Given the contribution of mining to climate change there is need for mining companies to use clean technologies and energy efficient methods in the production and processing of minerals. A climate changed focused regulatory framework is needed from Government to provide a legal basis for steering the mining sector towards low-carbon production and processing activities.

Research, capacity building activities and funding needs to be provided to technical colleges and universities to build the critical skills need to develop the required technologies, monitor and assess GHG emissions, enforce government regulations, and more broadly, to foster a transition to a low carbon production of minerals.

12. Energy

Zimbabwe has a wide range of energy resources which include coal, coal bed methane, hydro power, solar energy, sugar bagasse, wood waste, animal waste, urban waste and crop waste. This section focuses on Zimbabwe's energy sector by examining current and future energy supply, the complex links between energy and climate change, and suggests relevant climate change adaptation and mitigation options.

12.1 Overview of Zimbabwe's Energy Sector

Current energy use is dominated by wood fuel due to its usage in households followed by coal and petroleum fuels. In 2004, fuel-wood resources in accessible woodlands covered about 20 percent of the total land area, representing a stock of 320 million tons, with a sustainable yield of 13 million tons per annum (AfDB, 2011). Total national fuel-wood consumption is estimated at around 9.4 million tons per annum. Consequently, the national demand for fuel-wood can be met by sustainable yield. However, there is an increasing demand fuel-wood in urban areas and fuel-wood deficit rural areas. Recent power outages have also served to increase the demand for fuel wood as some areas experience up to 18 hours of electricity outages per day. In view of this, there is need for planned reforestation and afforestation programmes to meet increased national demand for fuel-wood and maintain area covered by woodland.

Zimbabwe has a significant number of timber plantations, entirely based on plantation timber, whose production was dominated by three large organizations producing about 87% of the national output. In 2002, plantation forests occupied about 0.02% of the total land area of Zimbabwe, comprising 81,000 ha of pine, 24,000 ha of eucalyptus and 13,000 ha of wattle, the majority of which are in the Eastern Highlands. Over 70,000 tons of biomass waste is produced annually from timber plantations, and this waste material has the potential to fuel power plants to create electricity or other forms of energy. Wood waste is generally used in process steam boilers for lumber drying kilns. However, at the largest mills the amount of biomass waste generated on-site could alone yield as much as 4 MW of usable power. As such, biomass waste has the potential to provide sustainable power for local consumption.

Further, biogas offers an additional source of energy for households in Zimbabwe. There are more than 400 biogas digesters have been installed in Zimbabwe, which range in capacity from 3 cubic meters to 16 cubic meters (AfDB, 2011).

Coal is another key source of energy, second in importance after fuel-wood. Zimbabwe's coal reserves are estimated at about 10.6 to 26 billion tons in situ in 21 deposits, of which some 2 billion tons are considered mineable by opencast methods (AfDB, 2011). To date, only 3 million tons per annum of the coal resources are used to generate power at Hwange power plant and the small power plants in Bulawayo, Harare, and Munyati. Hwange Power Station is the main producer of thermal power, and consumes about 2.5 million tonnes of coal per year. At present the power station is operating at about 50% capacity.

Industrial coal is used for steam raising and smelting. The major users of coal are the steel, chrome and cement industry. Since 2000 production in the food and textile industry has fallen with a resultant reduction in coal consumption. Tobacco curing which was another major user of coal is now dependent mostly on fuel wood. The high efficiency tobacco barns that were achieving low coal intensity per unit of tobacco are now less popular with farmers due to their dependence of electricity for driving the air supply and circulation system. Frequent power cuts make the more efficient technology less reliable.

Zimbabwe is also endowed with coal bed methane deposits, which are located at Lupane, Chiredzi, Hwange, and Beitbridge, estimated at more than 600 billion cubic meters. These can also be used for generation of electricity.

Petroleum fuels are an important source of energy in Zimbabwe, especially for the transport sector. Diesel is the main fuel for public road transport, agriculture machinery, rail transport and road freight. Gasoline is used mostly for light passenger vehicles. In 2005 diesel consumption was 900 million litres per year and gasoline was 730 million litres per year. Forty-six percent of fuel is used by transport services, 26% by commerce, 14% by agriculture, 10% for manufacturing and 4% for mining (Reserve Bank of Zimbabwe, Proposal for Fuel Conservation, 2005).

There is significant available renewable energy sources in the country, including hydroelectricity, solar radiation, and wind. Hydropower potential on the Zambezi River is estimated at 37 TWh per annum, of which about 10 TWh per annum have been harnessed (ibid.). The Zambezi river offers opportunities for large-scale hydropower at Batoka Gorge (4370GWh), Devil's Gorge (3000 GWh), Mupata Gorge (3000GWh) and Katambora Gorge (2000GWh). All these sites would be shared with

Zambia as they lie on the border. The Zambezi catchment is vulnerable to droughts even though it covers some of the high rainfall regions of the subcontinent. In 1992 the Kariba dam level reached a low level of 1 meter above the power station intake thereby threatening cessation of hydro power generation.

Potential for small-scale hydropower also exists in Zimbabwe. Because of the terrain and rainfall pattern, the small hydropower potential is mostly concentrated in the Eastern part of the country. Solar radiation is available at an average of 2,000 kW per hour per square kilometre per annum, spread over roughly 3,000 hours per annum. At this rate, photovoltaic cells could generate the current total electrical energy consumption of 10,000 GWh with efficiency of 10 percent and by installations covering 1.3 percent of Zimbabwe's total surface land area. There is also considerable potential for wind energy, particularly for water pumping.

In addition, ethanol is increasing in importance as a source of energy. An ethanol distillation plant was installed at Triangle since the 1980s, and has supplied anhydrous ethanol for the transport sector , blended with gasoline at a rate of up to 13%. The recent construction of the Chisumbanje ethanol plant points to the increasing prominence of ethanol in Zimbabwe's future energy supply. Table 19 below shows energy use in 2005.

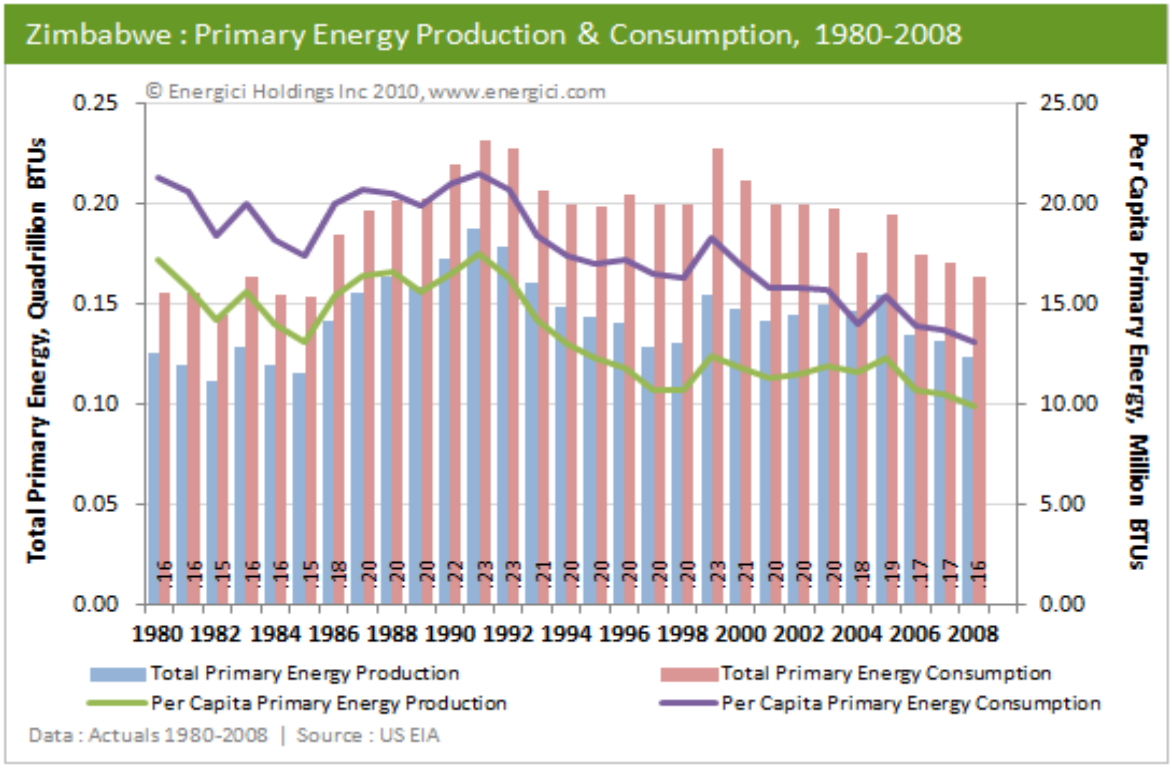
Table 19- Energy Use in Zimbabwe

Energy Source	**Usage in TJ (2005)**	**% of Total**
Fuel wood	170000	41.5
Diesel	39079	9.5
Petrol	17633	4.3
Jet A1	10359	2.5
Coal	129950	31.7
Hydro electricity + imported electricity	42941	10.5
Total	**409962**	**100**

Source: Zimbabwe Energy Resource Assessment Study, 2008

The graph below also illustrates the declining trend of energy consumption from 1980 to 2008, which can be partly explained by the de-industrialisation as a result of the economic structural adjustment programme of the 1990s and the decade long economic crisis from 2000 to 2009 which reduced the capacity of industrial utilisation of energy.

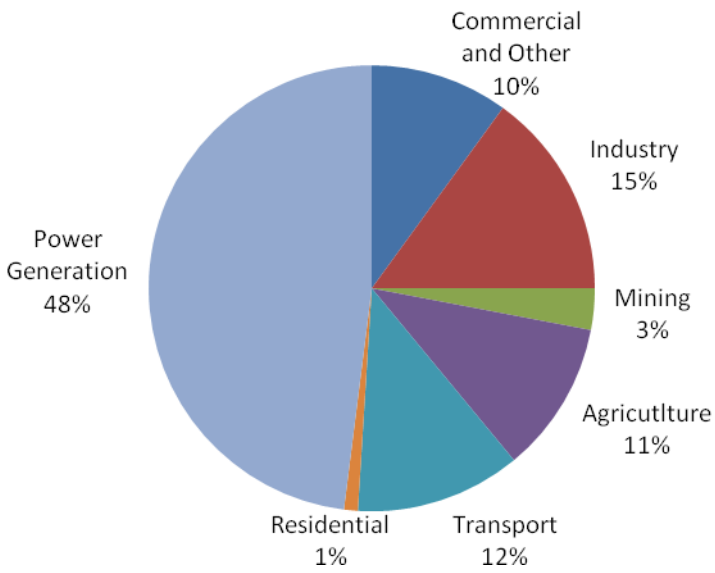
Figure 18: Primary Energy Production and Consumption in Zimbabwe from 1998 - 2008



The energy resource assessment shows that the bulk of the energy resource in Zimbabwe is from renewable energy sources. However energy usage is dominated by fossil fuels and unsustainable firewood harvesting. The 1994 greenhouse gas inventory for Zimbabwe shows the energy sector being responsible for 80% of the greenhouse gases emitted by the country. Energy is mostly based on unsustainable wood fuel, coal and petroleum fuels. Hydro-electricity forms about 50% of local produced grid electricity at present.[22] Importantly, Zimbabwe's first National Communication on Climate Change highlighted how the country is a net sink for greenhouse gases due to absorption of carbon by forests.

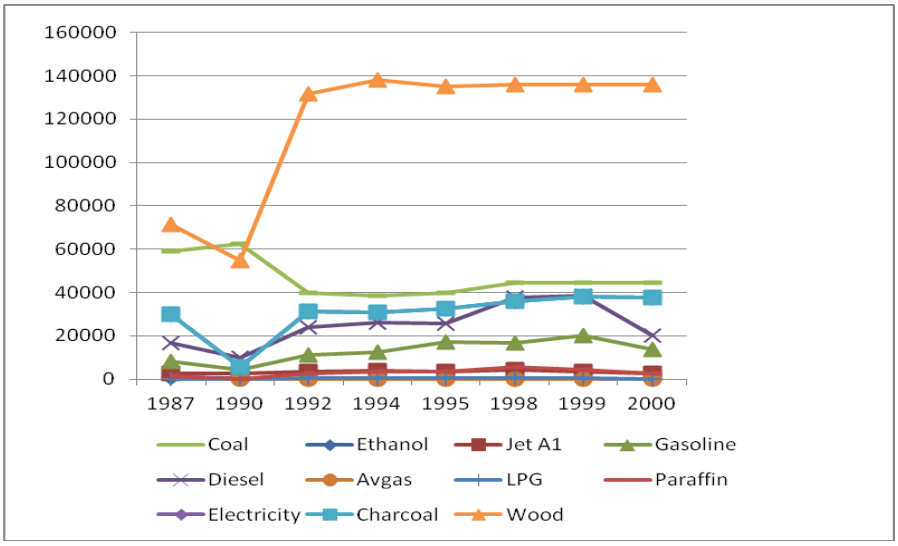
[22] Commercial fuels exclude fire wood and according to the UNFCCC, carbon dioxide emissions from fuel wood are not reported in the national totals.

Figure 19: GHG Emissions from Commercial Energy Use



Source: Zimbabwe First National Communication to UNFCCC.

Figure 20 - Fuel Use Profile[23]



Source: Ministry of Energy and Power Development, Energy Balance.

[23] The graph shows some discontinuities in the early 1990's mostly due to changing methodologies as the energy data base was being established.

12.2 MTP and Energy

The energy section of the Zimbabwe Medium Term Pan (2011 – 2015) focuses on electricity. Electricity supplies are the major source of concern for current energy supply in the country. Installed capacity is performing below potential due to aged equipment and lack of maintenance as shown in Table 20 below. The current electricity demand is outstripping supply due to inadequate capital investment. Electricity use is now mostly for residential customers due to the prevailing reduction in industrial production.

Table 20 - Electricity Production Capacity

Power Station	Type	Name Plate Rating (MW)	Available Capacity (MW)	% Available Capacity
Kariba	Hydro	750	710	95
Hwange	Thermal	920	524	57
Harare	Thermal	100	20	20
Bulawayo	Thermal	90	25	28
Munyati	Thermal	100	40	40

Source: MTP (2011 to 2015)

The energy chapter in the MTP acknowledges the importance of independent power producers (IPPs) and the role that they play in improving the sustainability of the sector.[24] Such producers have an impact on climate change by either increasing emissions or providing the much needed experience with renewable energy. However, are facing the same tariff driven challenges that are being faced by ZESA and would need assistance in refurbishing their equipment.

12.3 Future Sources of Energy

Energy projections in Zimbabwe indicate increasing diversity of sources, with ethanol bio-fuel and thermal power gaining prominence in the country's energy mix. For bio-fuel, projected increase of bio-fuel is mainly based on the revival of ethanol production at Triangle Sugar Estate, and new production at Chisumbanje. Zimbabwe has a long history of ethanol production at Triangle Sugar

[24] Rusitu small hydro has an installed capacity of 750kW, triangle and Hippo Valley sugar Estates have an installed capacity of 20MW each, Border timbers has an installed 400kW and Inyanga hydro has an installed 1000MW. There is a large number of medium size (250kW to 1000kW) diesel generators being used for production.

Estate, and as such have has some experience in ethanol use for power generation and for fuel blending. The current 45 million litres per year capacity for ethanol production at Hippo Valley combined with the potential 45 million litres per year in Chiredzi and the 375 000 litres per day from Chisumbanje. There is also a nascent development in the jatropha-based bio-fuel energy sector. Zimbabwe embarked on a program to encourage the production of jatropha seed by small scale farmers for biodiesel production. By 2009 NOCZIM had contracted 300 small scale farmers and provided them with 30 million seedlings to plant on about 1000 hectares of land. Initial targets were to achieve 10% petroleum diesel displacement by 2017. Current producers in Mtoko and Mudzi are using jatropha as a live fence to control livestock near fields and homesteads. They collect seed for use as household fuel. Some community groups in the districts have acquired oil extraction machines and are producing the oil for use in lighting and in soap production, but there is yet to be a vibrant technology market to use jatropha oil as fuel. In short, production of bio-fuel is focused on increasing national capacity for power generation and reducing the fuel import bill.

With reference to coal, the projections are based on the significant coal reserves that the country possesses. To reiterate, coal reserves are estimated at approximately 10.6 to 26 billion tonnes. There is also an estimated 33 tera cubic feet (900 billion cubic meters) of coal bed methane. This resource needs to be confirmed before extraction can be planned. Discussions have centred on use of the gas for electricity production.

Hydro-power is projected to continue to increase, with improvements in production capacity at Kariba Dam, and the development of new potential sites along the Zambezi River and along rivers in the Eastern Highlands (such as the Pungwe River) and on several dams (such as Osborne Dam). The Zambezi has an additional 3840MW of electricity that can be developed at three gorges upstream from Caborra Bassa dam.

Solar energy is also viewed as a potential resource for energy supply. Zimbabwe has had experience with conversion of solar energy for lighting through the GEF PV pilot project that was implemented from 1995 to 1998. The project was limited to small systems for rural households that were funded through a revolving loan. There continues to be a market for solar PV systems with the demand being for lighting, TV and radio. Importantly many urban centres, like Harare, are increasingly installing solar-powered traffic lights. Some larger installations for mini grids are planned for the next eight years up to 2020. The Rural Electrification Agency installed over 61 solar mini grid systems at various schools and plans are to install a total of 500 such systems nationwide. Stand-alone solar home systems have also been installed in many rural homesteads. The main reason for

using solar mini grids is to avoid grid extension and reduce the cost of rural electrification. Solar water heaters can also be used for preheating water used for industrial processes. There are a few manufacturers of solar water heaters in Zimbabwe. Most of them focus on producing units for use in households. There are also imported units that offer higher quality finishes but at higher prices. Solar energy can also be used for drying agricultural products and for space conditioning in buildings, e.g. as seen in Harare's East Gate shopping.

Wind energy has historically been used for water pumping mainly for livestock watering. The low wind speeds prevailing in Zimbabwe dictated the use of multi-blade low speed machines. Such machines, however, require heavy lifting equipment as well as technical skills to enable the on-going maintenance associated with their operation. It was therefore only the well-established farmers or companies that could own and operate them. In the mid-1990s a project was implemented to determine wind profiles in various parts of the country. The project did not generate sufficient data to enable production of a wind map but enabled the design and production of a wind electric machine able to operate at the low prevailing wind speeds. A company is now manufacturing these machines and exporting them to South Africa and as far afield as USA.

With specific reference to electricity generation, which is the main source of energy for industrial and social development in Zimbabwe, the capacity to generate electricity is projected to grow for both hydro-power and thermal energy (refer to Table 22 below). The growth in power generation is premised on the projected increase in the demand and consumption of electricity.

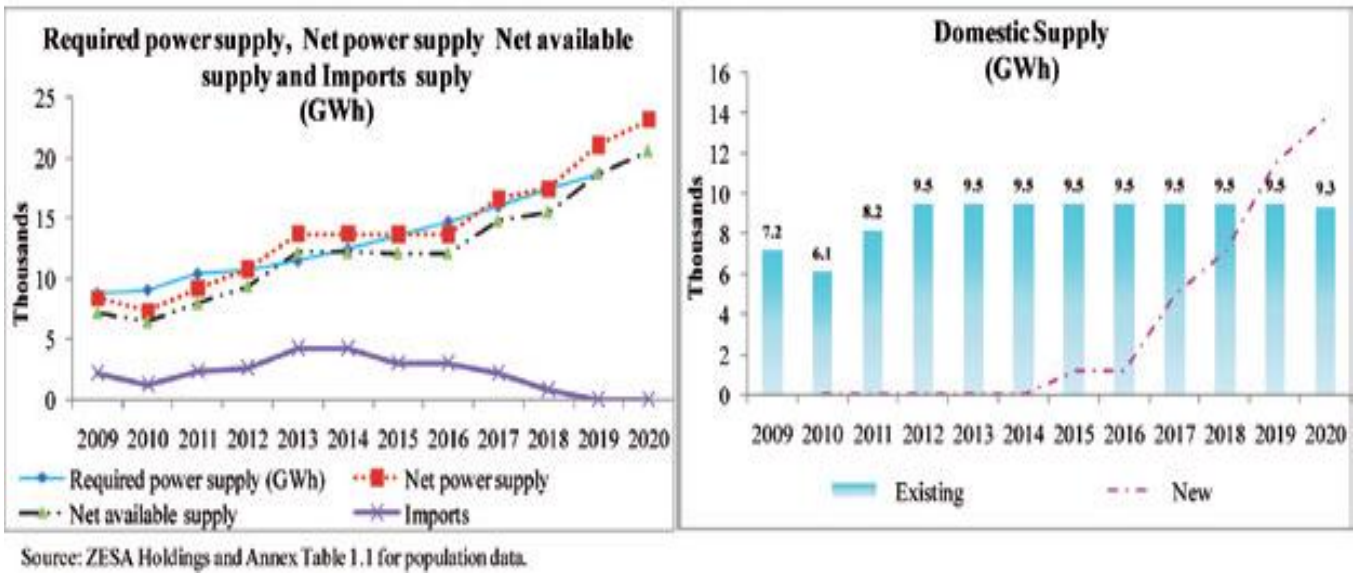
Table 22: Zimbabwe's Capacity for Electricity Generation

Power Station	Production Capacity of Electricity (MW)			
	2012	**2013**	**2014**	**2015**
Kariba	750	1000	1050	1050
Hwange	920	1200	1520	1520
Harare	40	60	100	100
Bulawayo	60	80	90	100
Munyati	60	80	100	100
Total	**1830**	**2420**	**2860**	**2860**

(Source: Government of Zimbabwe, MTP, 2011)

Using the base case scenario, the demand for power is projected to grow at an average rate of approximately 8% per year up to 2020. Figure 20 below shows the projected supply and demand for power from 2009 to 2020.

Figure 20: Projection of Power Demand for the Base Case



(Source: cited in African Development Bank Report, 2011)

From the above, it is apparent that potential exist for embedding climate change mitigation measures, such as clean technologies, within the energy sector in Zimbabwe given the projected growth in production capacity, demand and supply. Mitigation measures should also be focused on thermal energy as it is posed to provide the bulk of electricity in the next ten years. Hydropower, bio-fuels, and solar energy provide a basis for climate change mitigation in the energy sector and their projected growth is likely to be significant as climate change mitigation measures.

12.4 Institutions in the Energy Sector

The energy sector falls under the Ministry of Energy and Power Development (MEPD), which is responsible for policy formulation, performance monitoring and regulation of the energy sector. In addition, the Ministry has the responsibility for promoting new and renewable sources of energy and energy conservation. The Ministry supervises specialised public agencies and parastatals, mainly the Zimbabwe Electricity Supply Authority (ZESA) and the National Oil Company of Zimbabwe (NOCZIM). ZESA was restructured into a holding company through the Electricity Act of 2002, which led to the establishment of four companies, namely,

1. The Zimbabwe Power Company (ZPC) responsible for the all power generating stations
2. The Zimbabwe Electricity Transmission Company (ZETCO) responsible for the supply of power to the transmission grid
3. The Zimbabwe Electricity Distribution Company (ZEDC) responsible for power distribution, and
4. Powertel, responsible for providing communication services to the power companies as well as providing data services to other users

The provision of power to rural areas, especially to schools, health centres, irrigation schemes, government offices, and community initiated projects, falls under the responsibility of the Rural Electrification Agency, created through the Rural Electrification Act of 2001.

ZESA Enterprises, a private sector entity, manufactures equipment used in the power sector for sale to public and private sector organisations, and is also responsibility for maintenance and repair of equipment for power plants.

Restructuring and deregulation of the energy sector has enabled the entry of various private sector entities into the sector, especially for the procurement and delivery of petroleum fuels. The electricity sector has seen a few producers enter the market but mostly for small production facilities.[25]

There are a few Independent Private Producers (IPPs) involved in power generation in Zimbabwe. Most of the power generates is sold to the national grid. The key examples are the Nyamingura IPP (a 1.1MW hydroelectric plant) and the Charter IPP (500MW co-generation plant), and five community-owned small hydro plants in the Eastern highlands. Their capacities range up to 20kW. These were installed by Practical Action Southern Africa mostly with European Union Funding.

The Ministry of Energy and Power Development is working to establish regional representation as opposed to the centralised structure that has existed since 1980. Energy is a service to all other sectors of the economy and representation at the local level has always been through parastatals and other line ministries. This had the shortcoming of lengthening the communication path from implementation to policy making. In most cases, local levels were not aware of the energy policy. Line ministries lack the technical skills to manage energy hence policy decisions were taken at the national level and implementation was inefficient. An example is the use of diesel power for water pumping at irrigation dams where available hydro energy could be used. The limited identification of opportunities could be a direct result of poor interaction with the Ministry of Energy at the local level. The current policy draft addresses this issue by making a commitment to establish Provincial Energy Offices.

12.5 Energy Policy

In 2010 the National Energy Policy was accepted by Cabinet. The current policy was produced through a consultative process supported by technical studies. The key elements are outlined in Box 10, below.

[25] Border Timbers Limited is producing 400kW from sawmill waste at the Charter Sawmill in Chimanimani, Inyanga Hydro in the Eastern Highlands Tea Estate is producing 1 MW, Enda Zimbabwe and a Canadian partner installed a 750kW small hydro plant at Rusitu but is now decommissioned due to operational challenges. The two sugar mills in the country are set to export 5MW each to the grid subject to appropriate tariff agreements and, Green Fuel, a new sugar cane to ethanol plant has been set up and will produce 15MW with about 6MW for the grid.

Box: 10: Key Elements of the National Energy Policy

Energy Goal: The goal of the National Energy Policy is to meet the energy needs of the people of Zimbabwe for social and economic development in a sustainable manner.

Policy Objectives

i. Ensure availability, affordability and accessibility of electricity for all consumers

ii. Stimulating sustainable economic growth and poverty eradication

iii. Provide a platform for adequate and reliable access to electricity to all at competitive prices

iv. Allow access to IPPs and Private-Public Partnerships and other joint ventures

v. Promote the use of modern energy fuels in rural areas especially coal and electricity as the promotion of renewable energy technologies

vi. Improving energy security through diversity in supply

vii. Reduce the negative environmental impact of energy resource exploitation and use

viii. Promote the use of clean energy technologies to mitigate climate change.

Policy Measures

i. Maintain a dynamic system of development planning process

ii. Facilitate efficient use of existing infrastructure

iii. Adopt energy efficiency on the supply side

iv. Observe environmental regulations in all power sectors

v. Develop local capacity for manufacturing of electricity equipment

(Source: GoZ, Final Draft Energy Policy, 2008; AfDB, 2011)

In short, the Ministry of Energy and Power Development, through the energy policy, seeks to increase energy security, diversity energy sources, increase access to modern energy by the poor and reduce the energy import bill.

In addition, the Ministry aims at developing and promoting renewable energy. Cleaner energy technologies are considered a priority in Zimbabwe as demonstrated by the implementation of the Global Environmental Facility Solar Lighting Pilot Project and presence within the Ministry of Energy an active renewable energy and energy conservation unit. Zimbabwe was elected Chair of the UNESCO World Solar Summit Process represented by the President. The need to subsidize renewable energy through donor funding, reduced taxes and duties as well as increasing access to technology has been recognised from the early 1980s.

The energy sector has a history of energy shortage including poor security of supply, wide deforestation which is partly driven by use of fire wood, shortage of foreign exchange which limits the ability of the country to import energy technologies. As a result the energy policy reflects government interest in developing local energy technologies and securing energy supply. The following are some of the more specific policy options that government has adopted;-

- Diversification of sources of supply of energy, through increased production of bio-fuels and promoting the use of solar energy
- improved access to commercial energy for the poor and rural communities through rural electrification programme;
- Cost reflective pricing model for energy through setting tariffs on a cost-plus basis;
- Infrastructure development in the energy sector through expansion of hydro-power generation at Kariba;
- Promote optimal use of infrastructure;
- Promote investment in the energy sector through increased private sector participation;
- Promote regional integration and international cooperation;
- Encourage optimal use of energy resources;
- Promote Information Communication Technologies (ICTs) in the energy sector; and
- Develop a consolidated national database, which is supported by legislation.

12.6 The Medium Term Plan 2011 to 2015

The Medium Term Plan highlights the critical role of energy supply to resuscitation of the economy. The electricity sub-sector is recognised as the most critical component sometimes at the expense of other energy sources. Current policy as stated by the MTP is to:-

A. Restore electricity production capacity to meet demand through:

   i. Restoration of production at Hwange by 2012

   ii. Lease of small thermal plants to private investors

   iii. Installation of prepaid meters to reduce bill collection periods; and

   iv. Institution of demand side management to achieve savings of 300MW

Thermal power plant using old fuel combustion technologies cannot achieve the higher efficiency levels met by Hwange Power Station. The result of leasing old thermals is going to be an increase of higher carbon electricity into the grid. Given the time frames being considered it is unlikely that Hwange will be upgraded to improve its efficiency.

The proposed regulatory measures focus on increasing participation by other investors, enforcing environmental legislation and strengthening the regulator. The regulations are silent on issues of climate change apart from what may be general consideration under environmental impact assessment. Proposed measures do mention low carbon technologies as an objective but do not provide an explicit link between cleaner energy and grid electricity. Reference is made to smaller solar technologies that continue to require reduction of duties and taxes. Large renewable energy projects would fall under national projects that are naturally exempt of duties and taxes. Some of the planned projects do not have clear short-term targets as projects have long lead times. The Batoka Gorge project needs at least six years to develop and most likely 10 years to completion. The MTP indicates implementation of the project without indicating the targets for the period.

The MTP refers to petroleum supply projects and use of biofuels. Institutional issues surrounding NOCZIM as both an importer and distributor are set to be reviewed and use of ethanol biodiesel which imply inclusion of the private sector in the supply chain are also indicated. The production of biodiesel is dependent on availability of oil seed and this is not indicated as an explicit objective. The MTP has prioritised the refurbishment of Feruka Refinery , which if implemented will have an

impact on climate change by localising fuel production emissions and increasing availability of heavy fuel oils that are more polluting. However, the use of the oil pipeline as a regional hub would reduce, if not eliminate, road and rail oil transfer that has a higher emission of greenhouse gases. What is apparent in the planned interventions is the limited linkage between local supply interventions and the prevailing global energy use priorities. Reference to climate change seems coincidental without any specific targets for climate change performance.

12.7 Climate Change Vulnerabilities and Opportunities

The energy sector is vulnerable to the effects of climate change in several ways, as many different aspects of the energy industry are directly affected by environmental and climatic conditions. Some of the key effects of climate change on energy include;

1. Seasonal and daily temperatures and precipitation changes affect the timing of peak electricity demands and the size of these peaks. For instance, the predicted temperature increase for Zimbabwe will likely to result in increased demand for electricity for cooling industrial machines and households

2. Related to the above, changes in temperature and precipitation affect water availability for cooling power generators;

3. Increased occurrence of blackouts may be observed as a result of higher electricity demand for cooling and refrigeration caused by higher temperatures.

4. Changes in cloud cover, temperature and pressure patterns directly affect wind and solar resources (affecting resource availability or productivity);

5. Extended periods of drought lead to reduced water availability for hydropower generation. For instance, the 1992 drought led the electricity sector to curtail demand by about 20% to match available capacity after lake levels in Kariba had dropped to critical levels.

6. Increased intensity and frequency of severe weather events impact on energy infrastructure, for instance power plants, transmission lines, refineries, pipelines and power lines in and around Zimbabwe. Heavy storms and floods pose a significant threat to energy infrastructure as power lines are often pulled down by falling trees

or lightning strikes. In the early part of the rainy season the power utility, ZESA, faces an upsurge in distribution network faults mostly due to water ingress into cables and trees leaning or falling into overhead power lines. These weather-related supply disruptions may result in higher energy prices in the long term; and

7. Increased intensity and frequency of severe weather events impact design and safety requirements of future energy infrastructure. One of the impacts of dry and hot weather is the failure of the safety systems attached to power lines. Under normal circumstances a conductor coming into contact with the ground directly or indirectly causes a fuse to blow or a switch to open. Under very dry conditions low voltage lines tend to fail this safety function as the ground does not conduct enough electricity to cause the fuse to blow. Preventive measures will require utilities to add new protective measures or to bury the existing power lines deeper into the ground where the soil would be moist.

Coal forms a major part of the energy supplies to Zimbabwe. At present coal caters for 756MW of electricity supplied and about 100% of all steam raising in industry. Hwange coal mine has stockpiles of high sulphur coal fines which industry cannot use. These dumps are prone to spontaneous combustion due to high temperatures and methane. If the climate becomes increasingly dry and hot there will be more incidences of coal dump fires. Such fires release more fossil carbon into the atmosphere and also release high levels of sulphur oxides.

In addition, the potential impact of severe weather events can also affect the distribution of petroleum and diesel, which is critical for transport. Severe storms and rains, lead to flooding may make rail and road transportation inaccessible and even deteriorate critical bridges used for fuel transport or distribution. As such, any significant disruption to the transportation infrastructure has serious implications for energy service reliability

12.8 Climate Mitigation in the Energy Sector

Climate change mitigation in Zimbabwe's energy should be focused on reducing energy demands, increasing the efficiency of energy production technology, and shifting to renewable and cleaner energy sources, which, in combination, can lower GHG emissions.

12.8.1 Energy Efficiency

There are opportunities to increase energy efficiency on both the supply and demand side. Supply side energy efficiency can be increased by improving equipment for power generation, transmission and distribution. Since Zimbabwe has committed to undertake a significant programme to rehabilitate both hydro and thermal power stations, there is an opportunity to upgrade these power stations and improve their efficiency in generating and distributing electricity. Cleaner technologies can also be installed in thermal power stations. Reducing transmission losses is cost effective and can lead to significant reductions in carbon emissions.

Demand-side energy efficiency opportunities include improving the energy performance of equipment such as cook stoves, lamps, appliances, boilers, building, and vehicles, and of processes particularly in the energy-intensive industries of cement, chemicals, fertilisers, iron and steel, and paper.

Box 11: Energy Efficiency Projects in Zimbabwe

Energy Efficient Cook stoves: the Department of Energy has been promoting efficient wood stoves, the Chingwa stove, since 1982 with some success. The Chingwa stove consumes less energy and emit lesser amount of CO_2.The Chingwa stove has also been widely promoted by NGOs, which resulted in the installation of 114 000 stoves in the country.

Energy Efficient Bulbs – From 2010, ZESA has been promoting the use of energy efficient bulbs in households. However, it is too early to ascertain the results. Zimbabwe Electricity Supply Authority (ZESA) is planning to hand out compact fluorescent lamps in exchange for less efficient incandescent lamps and is also implementing some investigative projects to improve the market penetration of efficient technologies. A trial efficient lighting project is being implemented in Belvedere in Harare and will use an independent monitor to produce a verification report. The output of the Monitoring and Verification process will be used to assess the possibility of trading the achieved carbon emission reductions.

Fuel Efficient Vehicle – The Ministry of Environment tabled a bill to ban the importation of vehicles that are more than 10 years old as way of introducing fuel efficient vehicles in the country. This bill did not receive public support and was not turned into policy.

12.8.2 Fuel Substitution

There are opportunities to switch to less-carbon-intensive fuels on both the demand and supply sides. The demand-side fuel switching strategies to reduce carbon emissions include the use of ethanol in vehicles and electricity generation. Bio-fuel production at Triangle and Chisumbanje for fuel-blending and for generating electricity can be viewed as climate change mitigation measure.

Examples of supply-side fuel switching include the development of bagasse/biomass/ cogeneration/bioenergy systems; and using mini hydro-power, wind and off-grid solar photovoltaics, and other renewable energy.

Box 12: Fuel Switching Projects in Zimbabwe

Bio-fuel projects – Chisumbanje and Triangle ethanol production for fuel blending and power generation. Sugar mills have expressed interest to generate power for the grid but the challenge remains that of tariffs. An ideal sugar cogeneration plant would have a separate entity supplying steam for sugar processing and using the high pressure steam for power generation. With such an arrangement using 80 ba steam boilers about 100MW could be generated from existing sugar mills in the Chiredzi area.

Wind energy – Use of wind energy in pumping water in rural areas

Mini and micro-hydro power generation – 8 developed and functional micro-hydro-power stations for electricity generation and ten potential mini-hydro-power schemes. The Zimbabwe Power Company is set to invest in small hydro power plant above 10MW in size and the Rural Electrification Agency is set to implement plant including those below 10MW in capacity. Recently they commissioned a 24kW micro hydro plant at Chipendeke in Mutare district to replace the current use of diesel for grain milling, kerosene and candles for lighting.

Solar energy – solar photovoltaic installed in rural areas at schools and health centres

It is important to note that the potential for climate change mitigation in the energy sector has been analysed, and reduction options have been identified and quantified.

Table 23: Proportion of CO_2 Reduction by Option

CO_2 Reduction Option	Reduction (%)
Efficient Boilers	23
Energy saving in the industrial sector	4
Efficient motors and power factor correction	2
Increased Hydropower	5
Efficient furnaces	2
Central Photovoltaic Power	2
Coal for ammonia	1
Total CO2 Reductions	**38**

(Source: UNEP Abatement Studies, cited by Sathaye and Ravindranath, 1998)

12.9 Climate Adaptation in the Energy Sector

Climate change adaptation is currently focussed on rural livelihoods. Industry has not taken up the concept of adapting to climate change (possibly due to the emphasis on climate change mitigation). Electricity plans are, however, sensitive to the possibility of diminishing hydropower resources. The Power System Development Plan has shown this sensitivity especially in the mid-1990s as upgrading of Kariba, construction of Batoka Gorge and expansion of Hwange Coal Power Station took varying levels of priority. Water use efficiency should be seen as a priority, and there is a need for greater coordination of the Zambezi system at least from Victoria Falls (Zambia) to Caborra Bassa.

12.10 Priorities for Research and Technical Assistance

The key priorities for research and technical assistance focused on climate change and energy include;

1. Capacity building for policymakers to enable them to understand and assess the effects of climate change on energy as well as the effects of energy supply on climate change to enable them to develop and implement appropriate policies and programmes that links climate change, energy and development.

2. Development and implementation of energy efficient measures for households and industries. This should be focused on those aspects that hold the greatest prospect of reducing CO2 emission

3. Development and promotion of bio-fuels and renewable energy sources such as solar, wind, hydropower and biogas in rural areas
4. Introduction of more efficient coal-fired industrial furnace
5. Introduction of more efficient and cleaner coal technology for energy production

12.11 Summary

The energy sector in Zimbabwe has the potential to contribute significantly to the reduction in CO2 emissions given the dominance of firewood and thermal energy as well as the continued use of inefficient technology in the energy sector. The national energy policy and the MTP both provide effective policy and institutional framework for Zimbabwe's energy sector to provide low carbon energy, as both policy documents emphasize on developing renewable energy sources and promoting energy efficiency in domestic and industrial processes. However, funding and technical capacity to support the transition into low carbon energy generation and supply as well as in implementing energy efficient options is still lacking. There has been little investment in low carbon energy sources and renewable sources from the private sector, public and donor agencies. This situation is likely to be worsened by limited technical and research capacity within the Ministry of Energy and Power Development to enable to develop effective policy responses that focuses is on energy, climate change and socio-economic development. Despite these challenges, there is an opportunity to embed climate change compatible energy policy and programmes given the significant development and rehabilitation programme that is currently underway in the energy sector as part of broad Government strategy for economic recovery and growth.

13. Climate Change and Urban Infrastructure

13.1 Overview of Zimbabwe's Urban Areas

Urban Infrastructure contributes to climate change while at the same time it is affected by it (United Nations Human Settlements Programme: 2011; ZERO: 2010). Industries, transportation, housing, heating and cooling systems and dump sites are among urban infrastructures that produce GHGs that result in climate change. On the other hand, urban infrastructure like housing and other buildings, bridges, transport and communication systems are vulnerable to climate change. The objective of this section is to show the relationship between urban infrastructure and climate change.

Zimbabwe's urban population stands above 7 million and this excludes at least another 100 000 residents of mining towns and Growth Points, which suggests that more than 50% of the country's 13 million people live in urban areas[26]. At 5-6% the urbanization rate in Zimbabwe is higher than national population growth rate of 4.3%(Government of Zimbabwe 2011). There are thirty two urban settlements (see Table 24) with built-up areas hosting diverse socio-economic activities. Urban activity concentration is supported by social, physical and economic infrastructure and services whose development and maintenance radically transform natural conditions. As Zimbabwe's urban centres increase in number and size environmental transformation and climate implications also rise.

There is inadequate information on the effects of climate change on urban infrastructure in Zimbabwe. The sensitivity of policies and systems is low across key sectors. In recognition of this shortcoming the fourth Zimbabwe-United Nations Development Assistance Framework (ZUNDAF, 2012-2015) proposes to address this issue.

Table 24 - Zimbabwe's Urban Centres

Town/city	Population
1. Beitbridge	40 000*
2. Bindura	40 000
3. Bulawayo	1 500 000
4. Chegutu	120 000
5. Chinhoyi	150 000
6. Chipinge	30 000
7. Chiredzi	35 000
8. Chirundu	5 000*
9. Chitungwiza	1 000 000
10. Epworth	80 000*
11. Gokwe	10 000
12. Gwanda	80 000*
13. Gweru	300 000
14. Harare	2 500 000
15. Hwange	15 000
16. Kadoma	120 000
17. Kariba	34 000
18. Karoi	37 000
19. Kwekwe	120 000
20. Lupane	3 000
21. Marondera	80 000
22. Masvingo	110 000
23. Mutare	300 000
24. Mvurwi	9 000
25. Norton	80 000
26. Plumtree	30 000
27. Redcliff	40 000*
28. Rusape	59 000
29. Ruwa	30 000*
30. Shurugwi	25 000
31. Victoria Falls.	45 000*
32. Zvishavane	40 000
33. TOTAL	7 107 000

[26] According to the African Development Bank (2011).

Urban development in Zimbabwe proceeds within a framework that makes urban areas prone to risks like flooding and excessive moisture in areas with poor drainage (due to the nature of soils and inadequate physical infrastructure), strong winds, cyclones and heat waves. The vulnerability of whole urban areas and sites within them depend on a number of factors. These include topography, quality of available physical infrastructure, community and state institutions, level and distribution of economic development.

Transportation expands with urbanization. Both privately and publicly provided transport services connect residential, industrial, institutional and commercial land-uses. Public transport in urban Zimbabwe is currently based on kombis[27], which lead to high emissions because a significant proportion are second-hand imports which are not fuel efficient.

Rising urban population has placed demand for urban infrastructure expansion in an environment of rising urban poverty (African Development Bank 2011). High rates of urbanization and higher urban poverty strain municipal revenue streams making expansion and maintenance of urban infrastructure difficult. The strain has resulted in a generally negative interaction between the natural and urban systems. Strains are seen in road infrastructure, water and sanitation, housing and the energy sectors. World Bank commissioned and UNICEF coordinated studies on the water and sanitation situation cite low coverage, unreliable services, mechanical and electrical malfunctioning of treatment plants and distribution systems beyond design life (World Bank 2010, UNICEF and Vilens-Evides International 2009). Though urban areas remain generally well planned and well governed (World Bank 2002), the effects of economic strain are visible (African Development Bank 2011).

In terms of climate change, four important dimensions need elaboration. First is the general susceptibility of Zimbabwe's infrastructure to the increasing frequency of extreme weather conditions like flooding. Second is the reality that the ageing and congested industrial, residential and commercial infrastructure is energy inefficient, breaks down frequently and generates waste which reduces urban environmental quality. For Harare, this has often been expressed in relation to the city having lost its sunshine status.[28] Loss of environmental quality has also reduced the quality of life as evidenced by streams of sewer in some residential areas in towns like Kadoma, Chitungwiza and Harare.

Third, information on the extent and implications of urban adaptation is limited; knowledge on the required transformation of physical infrastructure (e.g. housing, industrial and commercial buildings, roads and storm water drains), policies, laws and bylaws, organizational structures and overall urban governance is lacking. General climate change awareness is not supported by critical action to improve relevant policy and practice.

[27] 10-30 seater passenger vehicles mainly imported as second hand units from Japan and other countries.

[28] Used in reference to the cleanliness that the city used to be known for.

13.2 Urban Infrastructure Development Policy and Climate Change

Planning, developing and managing urban areas including the specific infrastructure needs and services are governed by a mosaic of sector-specific laws and policies administered by an equally diverse set of national and sub-national organizations. However, the principal or framing legislation consists of the Regional, Town and Country Planning Act (RTCPA) and the Urban Councils Act (UCA). The RTCPA guides Master and Local Planning while the UCA defines the setting up and functions of local authorities. Subsidiary legislation (Statutory Instruments, Council by-laws, policies and directives) generally flow from these two pieces of legislation. Other allied legislations include laws governing public health, the environment and public finance. The country used to apply a system of rating urban areas based on population, industrial base and municipal financial performance (rates base), which constituted an Urban Development Policy. However, this system has collapsed and efforts at developing a comprehensive Urban Development Policy have not yet borne fruit. Master and local planning under the RTCPA currently lag behind and some smaller Councils lack the capacity to undertake long-term planning.

Deregulation of urban transport under the 1990s economic structural adjustment program (ESAP), which saw the use of 10-16 passenger commuter omnibuses replacing conventional Zimbabwe United Passenger Company (ZUPCO) vehicles, has led to a semi-chaotic urban transport system. This has stressed basic road infrastructure, public facilities (e.g. at bus stands) and exacerbated congestion with implications for pollution and overall urban functionality. An integrated urban transport policy is therefore needed as a starting point for designing and executing climate sensitive transport infrastructure development and maintenance.

Relevant organizations include central government ministries, state-owned enterprises, local authorities, civil society organizations including professional bodies and private sector companies.[29] Central government ministries responsible for local government, transport and communication, energy, water, environment and health are the most critical in terms of determining relevant sector policies, standards and overseeing the activities of state and non-state agencies.

Environmental Impact Assessments (EIAs) conducted under the Environmental Management Act constitute the main instrument for ensuring adherence to these principles for all economic development activities including infrastructure development. The legislation also seeks to protect the environment for instance, by prohibiting construction works and cultivation on wetlands and river-banks, providing building lines for on-plot development to allow space for vegetation in built-up areas and instituting a regime of fines to ensure compliance. There are, however, questions about the effectiveness of the 'bureaucratic structures and practice' in the public sector. Additionally, private sector adherence to existing legislation and policy is also questionable. A more comprehensive institutionalization of climate change into the urban governance regime

[29] The key ones include Institutes for Architects, Planners and Engineers.

is needed to guide the proposed development of an Urban Development Policy or at least a transformation of existing policies, legislation and institutional structures.

13.3 Climate Change Vulnerabilities and Opportunities

There are a number of climate change hazards to which Zimbabwe's urban areas are vulnerable. The main ones include storms, localized flooding and water-logging, drought-induced water scarcity and urban warming. Though Zimbabwe's main urban areas were deliberately sited as administrative and commercial centres along the line of rail, and in commercial agricultural areas their infrastructure has become increasingly prone to extreme weather conditions. Additionally, drainage infrastructure in some areas has collapsed due to age (while in others this has been due to over-use).[30] That some of the drainage systems are failing to cope suggests that design specifications for floodwater management used in the past are not suited to current rainwater drainage demands. Increased groundwater extraction has also affected soil stability in some areas, dried some wetlands and affected road foundations resulting in warping of roads and occurrence of potholes.

The serious housing backlog that is estimated to be above 1.3 million units has also resulted in inappropriately-located housing especially on hastily acquired farms where urban authorities were not directly involved in the planning processes. The City of Harare and other urban areas have a number of such housing schemes (Marongwe, Mukoto and Chatiza, 2011). For some of the new schemes tenure insecurity is an issue stalling proper servicing and house development as Councils consider the areas outside their jurisdiction. The net result has been poor access to human settlement services (water, sanitation, energy), which has caused heavy dependence on environmental resources. The 2008 cholera outbreak where at least 4300 Zimbabweans died vividly showed the extent of infrastructure collapse and its implications for urban residents. At the same time, the disaster showed local authority weaknesses. Councils particularly the City of Harare lacked the capacity to ensure access to safe and adequate water. Water and energy scarcity appear to have worsened since 2008 with the water situation only partially resolved through UNICEF support. In other urban areas in Zimbabwe that have sprawling layouts, such as Bulawayo, investment in water, sewer, road and other urban services is expensive.

13.4 Current Initiatives

Since the establishment of the Inclusive Government in 2009, Zimbabwe has hosted a number of studies designed to deepen understanding of institutional recovery. Urban local authorities have also been rehabilitating urban infrastructure using own and some donor funding.

[30] An example is road and drainage damage caused by loaded heavy vehicles navigating through neighborhood roads designed for passenger vehicles (weak traffic management/control).

However, Harare is yet to introduce a park-and-ride system which will reduce inner city congestion and its associated emissions. In a joint venture with Easy Hold of South Africa, Harare is launching an inner-city parking improving program. These initiatives, replicated by other cities to varying degrees have involved urban infrastructure investments and use changes in ways consistent with climate change adaptation and mitigation. To address chronic power shortages plans are underway to resuscitate urban thermal power stations in both Harare and Bulawayo. Such activities will contribute to CO_2 emissions. Small-scale household-level installations of solar lighting and water heating technology are also increasing.

The World Bank coordinated Multi-Donor Trust Fund (MDTF), the European Union, SIDA, Commonwealth Local Government Forum, UNDP, UNICEF and the Government of Zimbabwe have undertaken studies covering urban development and local government. However, no specific and coordinated follow-on action has followed besides investments by agencies like UNICEF in the water sector (urban boreholes, water treatment plant rehabilitation and water purification chemicals). Additionally, none of these studies and investments have been framed as being about climate change adaptation but rather focused on 'recovering institutions'. Their major contribution has been towards policy review and strengthening institutional systems.

At central government level the Zimbabwe United Nations Development Assistance Framework (ZUNDAF) has included relevant priorities. Beyond this, there has been discussion between UN Habitat and the Ministry responsible for local government on an Urban Development Policy. The Ministry responsible for housing has facilitated stakeholder input into a draft National Housing Policy which includes climate issues. The Ministry has a draft infrastructure policy and there have been consultations on regulations governing the importation of used vehicles. Energy sector initiatives have included promotion of solar power and energy-saving appliances including energy efficient light bulbs.

13.5 Priority Areas for Research and Technical Assistance

It is important to support well-funded research to analyze the urban infrastructure-climate change nexus. Key areas of focus include institutional competences or preparedness, policy adequacy and performance management. Such analytical work will guide development of relevant guidelines and policies. [31] Other priority research and policy areas include:

[31] An example is the 1977 Model Building By-Laws, which remain un-adapted even though there have been post-independence debates affecting the essence of some of their provisions.

1. Parameters for a comprehensive Urban Development Policy. The study will inform development and application of climate compliant guidelines on urban planning and land use designs, waste management, urban transport planning and management, energy efficiency and building designs;

2. Research on appropriate building materials, design guidelines and actual model designs for climate resilient basic infrastructure (roads, housing, schools and health facilities);

3. An assessment of city level climate change impacts, preparedness and capacity building focusing on both local authorities and communities. Information dissemination and city-level dialogue on climate change is lacking at present with planning and budgeting processes not taking relevant issues into account. A study of the top six and bottom six urban areas (by population) will help inform the development of an appropriate framework; and

4. A study leading to the development of a sustainable urban infrastructure financing and implementation framework including the necessary incentive-penalty regime.

13.6 Summary

Zimbabwe's urban planning regime does not sufficiently address the challenges for climate planning, engineering, environmental health and the financial architecture for urban infrastructure in the coming decades. Concern can also be raised about the quality and inclusiveness of local governance as well as the extent of community participation and preparedness. Encouragingly, space exists to undertake research and analysis that can guide city level climate change adaptation and mitigation.

14. Climate Change and Transport

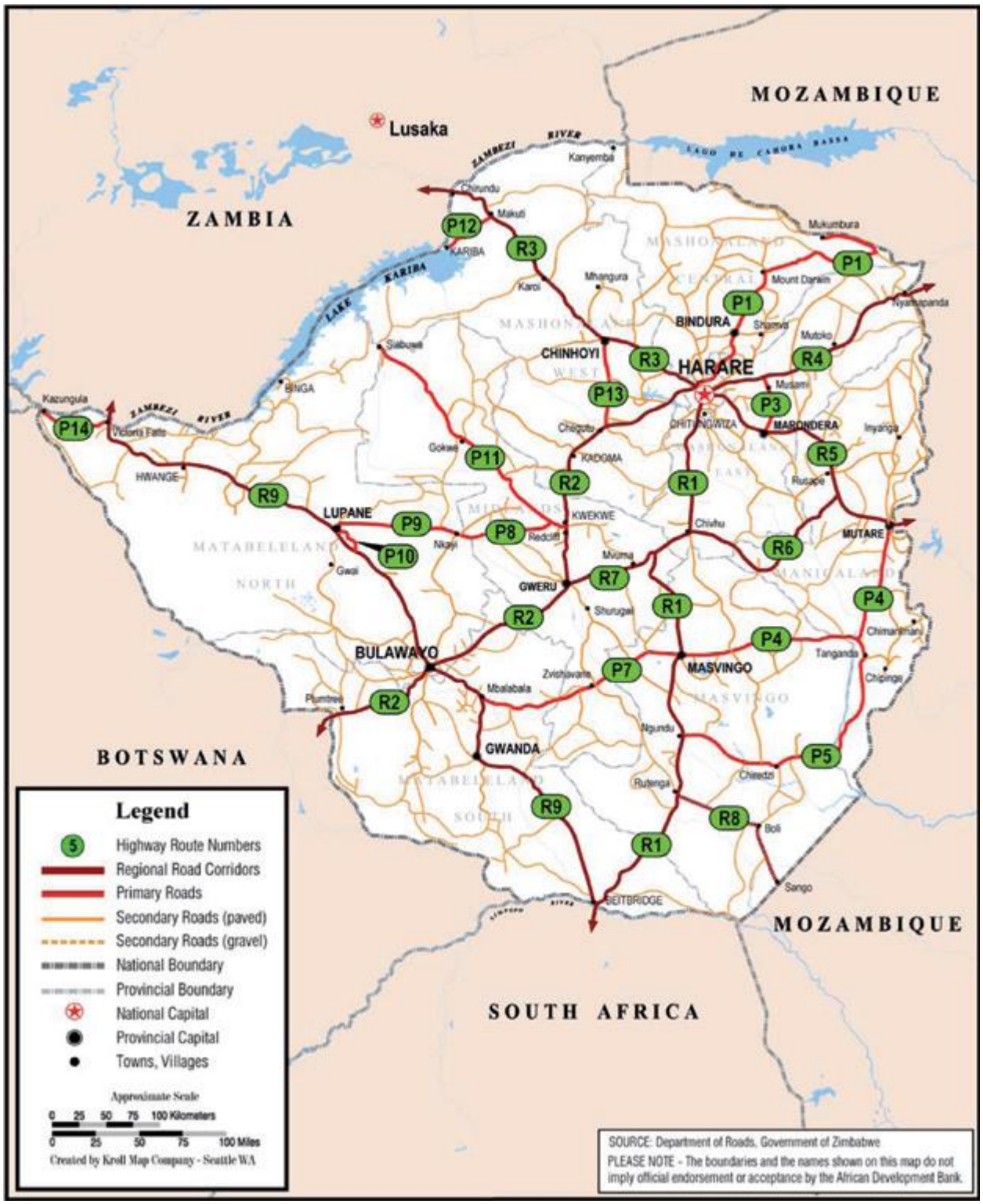
The Zimbabwe transport sector is composed of road, rail, air, and a small navigation service for both passenger and freight on Lake Kariba. The sector mainly relies on fossil fuels which drives road, air and rail transport. As the economy grows and human welfare increases, transport activity will also increase partly due to trade. With increasing incomes associated with economic growth, there is likely to be associated increases in vehicle ownership as more people buy vehicles. However, increased transport activity due to trade and increasing standards of living will result in congestion, air pollution and increased demand of petroleum, which will ultimately lead to increased GHG emissions. It is within this context that this section examines the links between transport and climate change in Zimbabwe. It does so by first presenting an overview of the transport sector in Zimbabwe, the contributions of the transport sector to climate change, likely effects of climate change on the sector and then analyses options for climate change mitigation and adaptation within the sector. It will conclude by outlining priorities for research and technical assistance in Zimbabwe's transport sector.

14.1 Road Network

The road network consists of 88 100km of classified roads, of which 17 400km is paved (AfDB, 2011). According to the African Development Bank (2011), 'approximately 5 percent of the road network is classified as primary roads and has some of the most trafficked arterials that link Zimbabwe with its neighbours which plays a major role in the movement of the country's imports and exports as well as transit freight. Secondary roads, which link the main economic centres within the country, enabling internal movement of people and goods, constitute 14% of the network. About 71% of the network is composed of tertiary feeder and access roads that link rural areas to the secondary road network.

Zimbabwe's road density is about 0.23 km per square kilometre, a figure comparable to that of the high income, non-OECD countries and lower middle-income countries. Both, primary and secondary roads collectively referred to as the trunk road system, carry over 70 percent of the vehicular traffic. This means that a significant number of the population have access to roads.

Figure 22: Road Transport Network of Zimbabwe



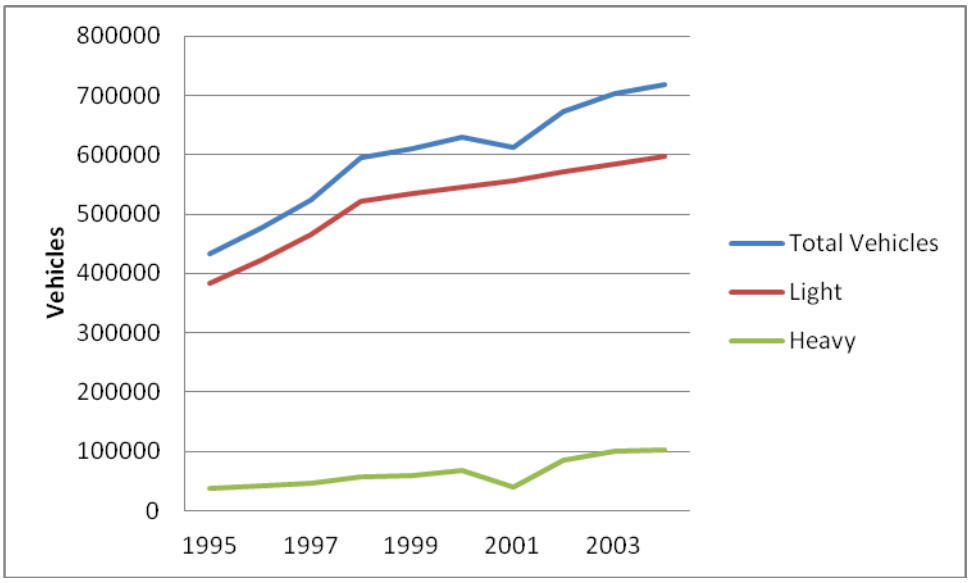
(Source: African Development Bank, 2011:5)

It is important to note that both Further, the road density in Zimbabwe is about 0.23 km per square km. This is high compared with many developing countries; it is comparable to that of the high income, non-OECD countries and lower middle-income countries.

There has been a steady increase in the vehicle population (see Figure 23). The main reason being an increasing number of people buying vehicles given the relatively easy access to low-cost used vehicles. Also, government and company-supported credit schemes have enabled people to buy vehicles from the local car manufacturing plant, Willowvale Mazda Motor Industries. Driving this trend has been an emergent middle class that prefers private transport. The vehicle population in 2009 was 828,395 including 200,000 motor cycles (Central Vehicle Registry). Vehicles per kilometer of road is high and is comparable to middle income countries.[32] The same applies to the road density of 23 km per square km.

Growth has been seen in the heavy freight trucks and passenger transport. The development of road freight is mainly due to private family-led companies that took the opportunity to provide road freight because of the poor condition of the rail system which used to carry a significant portion of the goods.

Figure 23 - Vehicle Population Growth



Source: Reserve Bank of Zimbabwe Monetary Policy (2005)

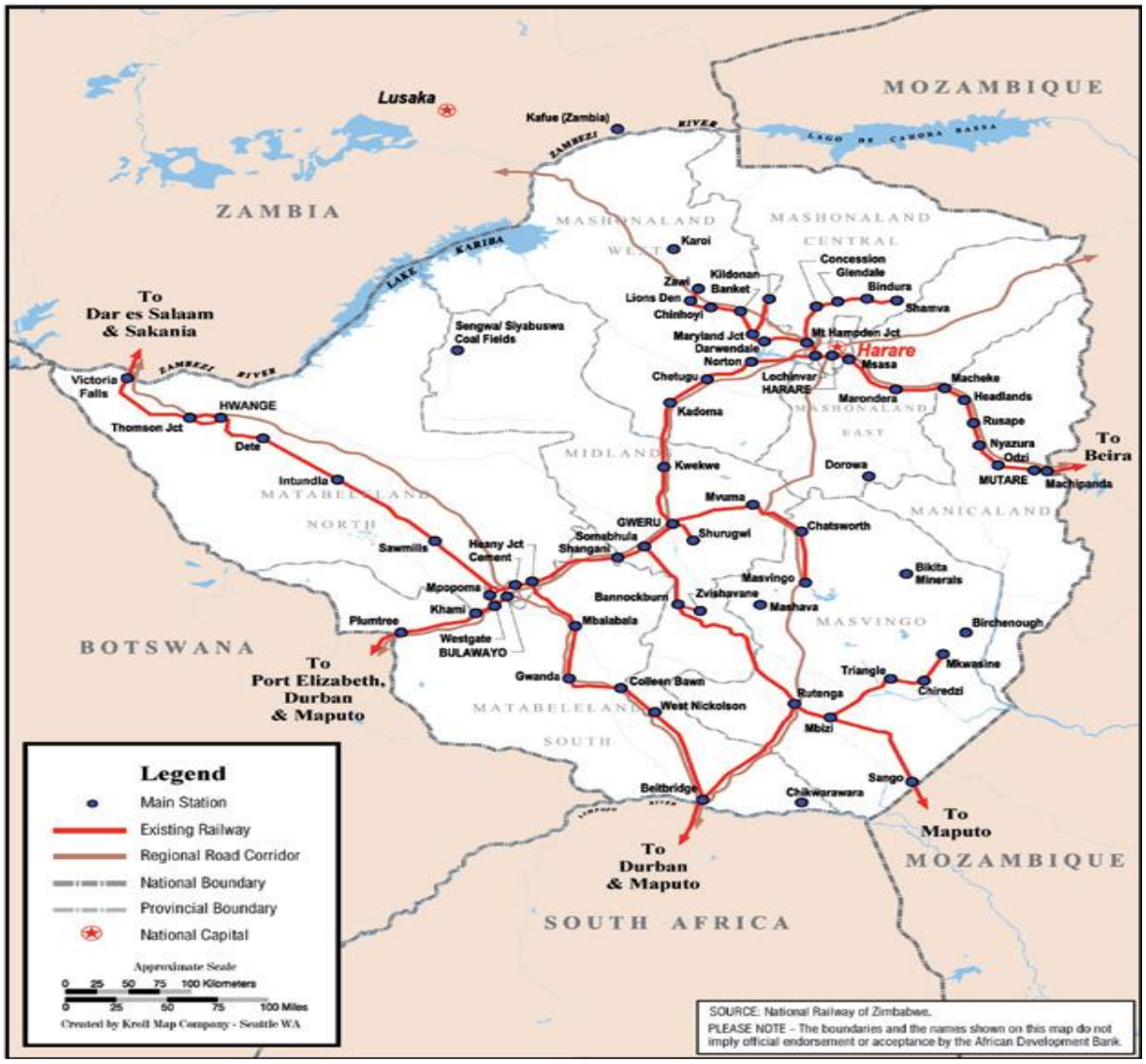
[32] Infrastructure and Growth in Zimbabwe, An Action Plan for Sustained Strong Economic Growth, AfDB, 2011

14.2 Rail Network

The country's rail network covers a total track length of 4,313 km of rail, connecting all major mining, industrial and agricultural centres in Zimbabwe as well as international rail routes linking the DRC, Zambia, Botswana, Mozambique and its ports of Beira and Maputo, and South Africa (See Figure 22 below). Only 313 km of the rail is electrified using a 25 kV overhead system. The total fleet was estimated to be 30 electric locomotives, 87 steam locomotives and over 300 diesel locomotives of all types (Mbohwa n.d.). In the past decades, steam locomotives were scrapped and a few of them are being resuscitated to overcome diesel shortage (ibid.). A study in 2003 indicated that 44% of the fleet had reached their life-span.

The National Railways of Zimbabwe provides suburban commuter services in Harare and Bulawayo, both introduced in 2001, and mainline passenger services between Bulawayo to Harare, Victoria Falls, and Chiredzi, and between Harare to Mutare. The introduction of suburban services in Harare and Bulawayo in 2002, boosted passenger traffic to a peak of 17.4million in 2007. However, the number of passengers declined to about 2 million in 2009 due the unreliability of the services and stiff competition from buses and commuter omnibuses, which are generally faster and more frequent despite having higher fares and overcrowded.

Figure 22: Rail Network of Zimbabwe



(Source: African Development Bank 2011)

For the past ten years, the rail network has suffered major deterioration. Poor capitalization of the rail network is also encouraging use of alternative transport. In 1990 rail freight was about 14.3 million tonnes which was equivalent to 80% of capacity. By 2009 this had reduced to 2.7 million tonnes which equates to 15% of capcity.

In 2004 the network had 149 diesel locomotives, 30 electric and 34 steam. 40% of rail freight is to transport minerals such as coal, chrome ore, iron ore and steel. There is also a rail demand from raw sugar and other agriculture products and supplies, which comprise 33% of freight. Manufactured goods constitute 15% of freight, while transit freight is about 10%. The passenger service operates between the major cities of Bulawayo, Harare, Mutare as well as Victoria Falls.

Zimbabwe also has a private run rail company, the Bulawayo Beitbridge Railway (BBR), which provides rail link between Bulawayo and Beitbridge at the border with South Africa. Prior to its inauguration, rail service between Zimbabwe and South Africa went through Botswana and added an additional 200km to the journey. The new railway line has shortened the time of the journey

between the South African border Bulawayo via Botswana from six days to only nine hours, thus providing seamless rail service from the South African ports to Bulawayo and other destinations along this line[33].

There are plans to extend rail by another 1340km. The route considered most urgent is Lions Den to Chirundu with the possibility to extend to Kafue in Zambia (due to grain transfers on that route). Other projects include the Chitungwiza to Harare commuter rail (26km), Nyazura to Mvuma (210km), Mutare to Mkwasine (215km), Kadoma to Sengwa (180km), Kwe Kwe to Itundla (285km) and Mashava and Bikita Minerals (165km). Rail offers lower fuel cost and carbon intensity per tonne of freight compared to road transport.

14.3 Air Transport

Zimbabwe has a small aviation sector by comparison to other regional countries. The national airline provides the bulk of the passenger and cargo service. Zimbabwe has three major international airports at Harare, Bulawayo and Victoria Falls. There are also airports at Kariba, Hwange and Buffalo Range which are capable of receiving medium size craft for tourist purposes.

The Airforce of Zimbabwe operates a predominantly military fleet but provides search and rescue services in times of emergencies. The Airforce participates in regional rescue missions and was party to the rescue missions in Mozambique during the Cyclone Eline disaster as well as the seasonal flash floods in rural areas of Zimbabwe.

14.4 Pedestrian Traffic

Pedestrian traffic is a major component of transport in Zimbabwe. Infrastructure for pedestrian traffic is however very poor. Cycle tracks are included in a minimal number of road ways and basic pedestrian management systems such as traffic lights, zebra crossings and road guards are in need of major refurbishment. Government removed duty and taxes on bicycles keeping their cost low. However in the absence of infrastructure most commuters prefer motor vehicles.

14.5 Institutional Arrangements Governing the Transport Sector

The institutional and policy framework that governs the transport sector varies from one sub-sector to another, but broadly falls under the Ministry of Transport, Communication and Infrastructure Development. Within the roads sub-sector, the Department of Roads is responsible for the road network with shared responsibility for operation and maintenance with District Development Fund (DDF) for secondary roads and District Councils for feeder roads. Local authorities are responsible for urban road networks. Local authorities receive some grant funding from central government to support infrastructure development but this is seldom enough. DDF and local authorities fall under the Ministry of Local Government Public Works and Urban Development.

Despite the existence of an elaborate institutional framework, there is currently no overarching policy document for the road sector. Nonetheless, three important draft policy documents guide policy in the road.

[33] http://www.nlpi.net/GroupOverview_BBR.html

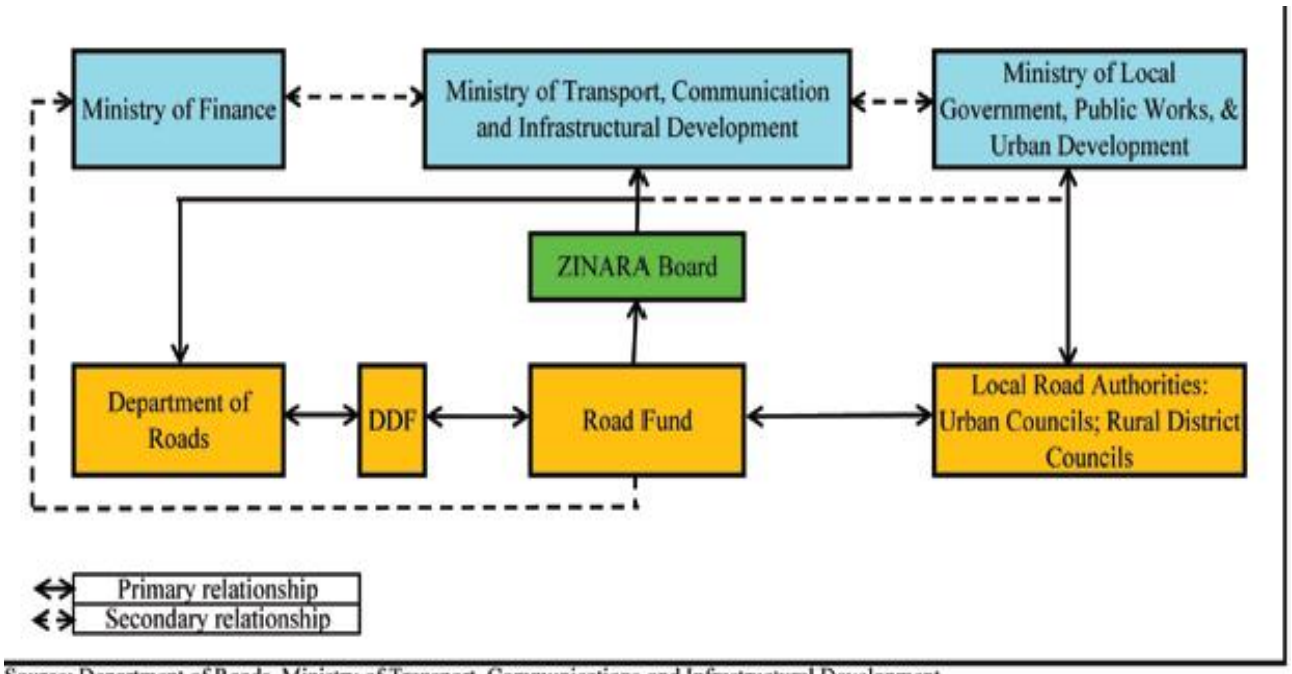
These are namely;

1. the Road Sub-sector Policy Green Paper of March 1999;
2. the "Draft National Transport Policy" of September 2005
3. The Road Act of 2001

The Green Paper is modelled around the Southern African Development Community (SADC) Protocol on Transport, Communications, and Meteorology (1996) which provides a framework for road sector management and financing. On the other hand, the Road Act, established the Zimbabwe National Road Administration (ZINARA) and the Road Fund, and, provides for road authorities and their functions, and for the planning, development, construction, and maintenance of the road network. This includes the regulation of standards, classification of roads, safety and environmental considerations, control of entry upon roads, and the acquisition of land and materials for road works.

The institutions governing the road sector are illustrated in the figure below. Briefly, the management of the primary, secondary and tertiary road network is the responsibility of the Department of Roads. Urban Councils, the Ministry of Local Government, Public Works and Urban Development (MoLGPWUD), are responsible for the management of urban roads, while the unpaved tertiary road network is managed jointly by the DDF and by RDCs under the MoLGPWUD. ZINARA is responsible for fixing road user charges and collect such charges, fuel levies and other revenue for the Road Fund. Ministry of Finance is responsible for providing funds to the Ministry of Transport through budget allocations.

Figure 25: Institutional Relationships for the Roads Sector

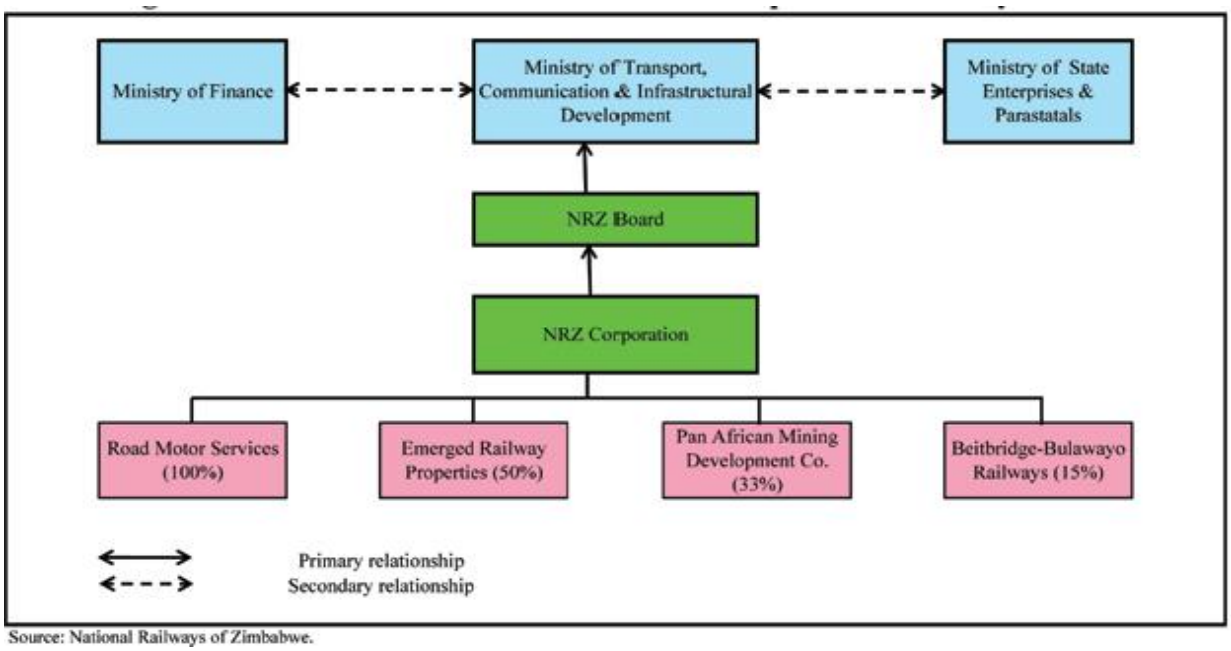


Source: Department of Roads, Ministry of Transport, Communications and Infrastructural Development.

(Cited in African Development Bank, 2011)

The principal public institution that governs the railway sector is the Ministry of Transport Communications, and Infrastructural Development, in conjunction with the Ministry of Finance and the Ministry of State Enterprises and Parastatal Development. The National Railways of Zimbabwe (NRZ), which falls under the Ministry of Transport, operates and manages most railway services in the country. The Beitbridge Bulawayo Railway service is the only privately owned railway service in Zimbabwe, which is premised on a Build-Operate-and-Transfer model. The Railways Act provides the policy and legislative framework for the management of rail network and is geared towards facilitating the transfer of infrastructure assets to Government of Zimbabwe, concessioning of infrastructure and other assets, raising of funds from the private sector, and licensing of more than one operator.

Figure 24: Institutional Relationships for the Railways Sector



Source: National Railways of Zimbabwe.

(Cited in African Development Bank, 2011)

With reference to air transport, the Civil Aviation Authority of Zimbabwe (CAAZ) is responsible for airports and air traffic. It is the main provider of civil aviation services, serving as the regulator of the industry, managing the civil aviation infrastructure, including the main airports, and providing airspace management services. The activities of CAAZ are governed by the Civil Aviation Act of 1998.

In short, there exists a well-established policy and institutional framework that governs the transport sector, and provides a platform for mainstreaming climate change issues into Zimbabwe's transport. A raft of reforms in the transport sector provides opportunities for the participation of private, NGOs and CBOs in policy processes related to transport and climate change. More importantly, the reforms provides for the establishment of regulatory bodies that can implement and enforce key policy decisions within the sector. Further, the introduction of user fees within the sector can provide a basis for revenue collection that can used to fund climate change related activities within the sector. These include carbon tax charged for all fuels, airport tax and toll gate fees.

14.6 Climate Change and the Transport Sector

The link between the transport sector and climate change is mainly through energy use and emissions of GHGs. The transport sector is responsible for about 12% of the greenhouse gas emissions in Zimbabwe (National Communication to UNFCCC, 1998). These figures are expected to increase as the economy recovers and people's disposable income increase. It is widely acknowledged that economic growth increases the demand for transport, while availability of transport stimulates even more development by facilitating trade and services (IPCCC,n.d;329). Further, with increasing incomes, most people will opt to buy personal vehicle, which is both a status symbol and convenient and faster way to travel in Zimbabwe. However, this results in increased consumption of oil-based fuels, mainly petrol and diesel.

Current estimates suggest that Zimbabwe needs over 1 billion litres of diesel and over 730 million litres of petrol per year for transport purposes. This equates to 744 000 tonnes CO_2 from diesel consumption and 543 120 tonnes CO_2 from gasoline combution per year. In addition there will be nitrous oxide, methane and other organic pollutants that are determined by average speed and vehicle technology. High engine temperatures from low speeds yield more nitrous oxide emissions and incomplete combustion from too low or too high speeds yields methane emissions. Fuel leakages also yield greenhouse gases in the form of non-volatile organic pollutants. In sum, current and projected growth in the transport sector will result in increased emissions of GHGs in Zimbabwe.

14.7 The Zimbabwe Medium Term Plan and Transport Sector

The Medium Term Plan lists projects to improve the road transport network. The focus is on improved service provision through:

- Rehabilitation and maintenance of all roads;
- Upgrade of the trunk network;
- Rehabilitation of bridges;
- Promotion of road safety;
- Network expansion into rural areas;
- Promotion of fleet renewal and refurbishment;
- Development of export/import corridors; and

- Construction of tollgates and improvement of revenue management.

Surprisingly, there is no mention of vehicle efficiency improvement. The MTP also lists projects for improvement of the rail system. The projects are focused on rehabilitation and refurbishment of the network and systems as well as improving availability of locomotives. Public private partnerships are mentioned as a way of financing rehabilitation and infrastructure expansion. There is no mention of the commuter service which would be complementary to road transport.

Air transport is mentioned only in terms of improvement of ground and navigation facilities. Aircraft are not mentioned in the plan. This seems to indicate the conservative approach taken for the medium term which seems to focus on returning the available facilities to acceptable service.

In general, the transport fleet is not likely to see vehicle improvement or average age reduction. The sector will continue to follow the natural growth that has seen investors importing second-hand vehicles and longer retention periods. Emissions of carbon per kilometre of travel will therefore continue to grow relative to international trends.

14.8 Vulnerability of the Transport System to Climate Change

Transport infrastructure is vulnerable to climate change, mainly through extreme weather events such as floods and high rainfall events. The fixed nature of transport infrastructure allows it to be affected by floods, storms and extremely high temperatures. Bridge foundations are eroded by increased run-off which affects the integrity and stability of bridges. Roads and small bridges are often washed away by floods. For instance, Cyclone Eline damaged bridges and road infrastructure, some of which remain unrepaired nine years after the event.

Tarred roads are also susceptible to extreme temperatures. In some cases, high temperatures lead to tar melting or softening. It is common during the hottest months in Zimbabwe to see paved road surfaces that have been damaged from softened tar. The road surface exhibits corrugations and ridges. This type of road damage requires frequent maintenance to prevent accidents or subsequent storm damage as water soaks the road bed as the surface becomes permeable.

Concrete surface tend to withstand temperature effects better than bituminous ones. However production of cement is a major source of greenhouse gases. Cement is made from reduction of limestone to lime which yields carbon dioxide as a bi-product. There is an argument that cement reabsorbs carbon dioxide with time but the technical estimates of this are not yet in the UNFCCC methodology.

14.9 Climate Change Mitigation in the Transport Sector

In view of the above discussion, the transport sector can contribute to climate change mitigation through;

1. Use of alternative fuels such as bio-fuels for transport. Given increased production of ethanol in Zimbabwe, there is an opportunity of blending ethanol with petrol and diesel to reduce GHG emissions or to use it in its 'pure' form to reduce dependence on oil-based fuels

2. Improvements in current vehicle technologies by promoting energy efficient vehicles through importing fuel efficient models or through installation of fuel efficient transmission technologies in local car assembly plants such as at Willowvale Motor Industries. Zimbabwe has a significant number of old vehicles. Such vehicles consume more fuel and emit more GHGs than new car models.

3. Reducing the loads on vehicles and thereby reducing the energy required to operate it

4. Developing an efficient public transport system that reduces the increased use of personal vehicles

5. Developing rails services for inter-city and suburban travel which diverts car users to carbon efficient mode of transport which emits less GHGs

6. Promoting cycling and reviving and expanding cycle routes in major urban areas. It is important to note that cycling has experienced a boost in the past decade as a response to fuel shortages or high commuter fares.

7. Improving driving practices such as ensuring proper tyre pressure, reducing maximum speeds, and shutting off when idling. These eco-driving practices can be integrated into the Highway Code and form a core aspect of driving lessons in Zimbabwe and promoted by the Traffic Safety Board of Zimbabwe.

8. Improving land use and transport planning with the view that places of employment and residence are within short distances; and

9. Transport pricing, such as fuel pricing and taxation, vehicle license/registration fees, tolls and road charges, parking charges, can influence travel and fuel demand, which in combination can result in GHG emissions.

14.10 Climate Change Adaptation in the Transport Sector

Climate change adaptation in the transport is focused on the construction of transport infrastructure that can withstand the adverse effects of climate change such as extreme weather events, droughts, floods and higher temperatures. Therefore climate change adaptation in the transport sector must be focused on;

1. Physical changes, for instance, ensuring that surface materials used for tarred roads can withstand high temperatures. In addition, the construction of drains along roads, and bridges at the appropriate height, to reduce the risk of flooding and flood damage

2. Procedural changes, including checking drains in vulnerable areas when heavy rain is forecast. This can be enhanced by mandatory drainage inspection before the rain season commences; and

3. Organisational changes, such as changes in policy, standards, contracts, decision making, and investment. Further, promoting information sharing between the Department of Meteorology and the Department of Roads on weather forecasts to inform preparation when floods are predicted.

Further, the transport sector plays an important role in weather-related disaster preparedness and response. Road, rail and air transport are used for emergency response as well as relief. For example, during the 1992/93 drought Zimbabwe imported over 2.4 million tonnes of food, which relied on coordinated use of road and rail transport to move the large volumes in a short time. Rail transport is used for bulk movement of goods for relief purposes.

Air transport, mainly helicopters, is available for emergencies and rescue missions, especially during floods. For instance, during the floods caused by Cyclone Eline in 2000, helicopters were used to assess the damage caused by the floods, and more importantly, in rescue missions. Six helicopters rescued about 8000 people within a week. Emergency relief is based on dynamic systems that need to be coordinated from a normal production environment to emergency mode.

14.11 Priorities for Research and Technical Assistance

The key priorities for research and technical assistance with the transport sector include;

1. A detailed study that provides an update analysis of the transport sector, its contribution to GHG emissions, the likely effects of climate change on the sector and opportunities for climate change mitigation and adaptation in the sector

2. Mainstreaming climate change issues in various policies and programmes in the transport sector

3. Promoting use of alternative fuels such as bio-fuels for transport.

4. Promoting the installation of fuel efficient transmission technologies

5. Developing an efficient public transport system that reduces the increased use of personal vehicles

6. Encouraging institutional collaboration for integrated planning and information sharing. For instance between the Department of Meteorology and the Department of Roads on weather forecasts to inform preparation when floods are predicted.

14.12 Summary

The transport sector is a major user of energy and hence is a major source of greenhouse gases. Zimbabwe as an importer of transport vehicles has limited influence on the technology but has the opportunity to influence the vehicle mix and average age of the fleet. However, vehicles that are manufactured locally should be equipped with the necessary technologies for fuel efficiency, consumption of blended fuel, and reduction in GHG emissions. Given that transport is a service sector it is paramount that planning be integrated with planning for the productive sectors. Historically the transport sector in Zimbabwe has seen joint planning with the mining sector as well as industry to optimise service provision during peak demand periods.

As a service sector, transport would benefit from integrated planning. The major challenges of poor access to capital, lack of access to technology, poor administrative structures including regulation and lack of suitable financing options could be overcome by integrated planning. In the past the rail network has benefited from finance from mining houses especially for rail wagons. Industry was also involved in logistical planning especially during the peak demand events of 1992. The apparent view that involvement of the public sector will bring more capital needs to be sensitive to the cost of such capital in the absence of other economic measures. Where passenger and freight volumes are low, financiers tend to demand shorter payback periods and higher interest rates.

The transport network imposes a heavy maintenance burden on the national budget, especially from extreme events. Optimised planning and system expansion is therefore essential for cost minimization. In the past a split responsibility between local authorities and central government has seen service levels interrupted through inconsistent maintenance of sections of major roads. It is essential that responsibility for road maintenance be allocated according to national benefits. Such allocation would require studies on the economic value of roads which at present are not done in sufficient detail.

Part D– Legal Section

15. Legislative Framework Governing Climate Change in Zimbabwe

15.1 Introduction

Although an analysis of the links between climate change and the various sectors of the economy, and the opportunities for adaptation and mitigations for each sector, is important, such an analysis is incomplete if it does not pay adequate attention to the legislative framework that provides a legal basis for mainstreaming suggested policy options in national development framework and programmes. It is within this context that this section pays attention to key legislation governing various sectors in Zimbabwe, such as agriculture, biodiversity, energy, forestry, mining and transport, and assesses their relevance to climate change.[34]As such, analysis in this section combines identification and assessment of relevant provisions in law and highlighting the strengths, and weaknesses. Further, this section is aimed at examining how the various legal provisions can be integrated to form overarching and coordinated climate legislation. While the majority of laws do not specifically mention the term 'climate change', there are many instances in which issues relating to climate change can be inferred. In this respect, it can be stated that provisions for climate change related legislation are scattered in various pre-existing legal provisions.

Schematically, this section starts with an analysis of the Environmental Management Act, which is the principal piece of legislation relevant to climate change and development, followed by sector legislation on agriculture, biodiversity, land, forestry, water, disaster management, mining, energy and transport.

15.2 The Environmental Management Act

[34] Legislation or law are "the rules of conduct or action that are laid down and enforced by a government body"(Griffin 1999:14). Law defines rights and responsibilities of the various stakeholders and its most distinctive feature is that its breach attracts sanctions by the state. Apart from penalties for non compliance, laws also provide incentives for compliance. The legislative framework consists of Acts of parliament also known as statutes and subsidiary legislation known as Statutory Instruments or Regulations and by-laws.

Broadly, Environmental Management Act provides the overarching framework for environmental management in Zimbabwe with implications for other sectors. The main objectives of the Act are to provide for the sustainable management of natural resources and protection of the environment , the prevention of pollution and environmental degradation, the preparation of a National Environmental Plan and other plans for the management and protection of the environment. It can be reasonably argued that addressing climate change through mitigation and adaptation is one of the ways of promoting sustainable development as envisaged by EMA. To this end, the Act can be extended to cover legislative issues related to climate change, if the term 'environment' is defined in its broadest sense.

Specifically, Environmental Management Act recognizes the linkages between pollution and environmental degradation. Air pollution contributes to the emissions of GHG gases, thus it is an important factor in climate change debates. Section 4(1) (a) makes provisions for a right to a clean environment that is not harmful to health. Furthermore, Section 4 (2)(g) prescribes that any person who causes pollution, in this case air pollution, shall meet the cost of addressing such pollution or environmental degradation as well as the cost of preventing , controlling or minimising further and environmental damage. These penalties are deterrent to those who carry out activities that result in pollution and environmental degradation that contributes to climate change.

Section 55 makes provisions for the establishment of the Standards Enforcement Committee including air quality. The functions of the Standards Enforcement Quality in terms of section 63 of the Environmental Management Act includes recommending to the Environmental Management Board ambient air quality standards, emission standards for various sources and criteria and guidelines for air pollution control for both mobile and stationary sources. By addressing air pollution which is one of the major causes of climate change, the Act can be argued to be alive to climate change related issues.

Specifically, the Environmental Management (Atmospheric Pollution Control) Regulations, Statutory Instrument 72 of 2009's objective is to prevent air pollution. They forbid the following activities : burning of waste at a landfill, burning of vehicle tyres , burning of bitumen , burning of metallic wire coated with any material, the burning of oil in the open air , the operation of an incinerator and any operation that cause the emission of pollutant into the air. All these activities cause air pollution which can result in climate change. These Regulations compliment Section 63 of the Act.

Section 4(2) (h) of the Environmental Management Act calls for the implementation of global and international responsibilities relating to the environment. These relate to conventions and declarations that Zimbabwe is a signatory to. Some of the conventions and protocols are directly and indirectly linked to climate change.

The Environmental Management Act in section 97 -108 requires project proponents of scheduled projects to undertake Environmental Impact Assessments (EIA) of the project before they commence operations. The projects for which EIA reports and certificates are mandatory are provided for in the First Schedule of the Environmental Management Act. In the energy sector there are several projects for which the Environmental Management Agency requires an EIA before the project commences. Some of the energy sector projects for which an EIA is required include petroleum production, storage and distribution and in particular oil and gas exploration and development projects, pipelines, oil and gas separation, processing, handling and storage facilities and oil refineries. For power generation and transmission projects an Environmental Impact Assessment is required for projects such as thermal power stations, hydro-power stations and high voltage power transmission lines. It is without doubt that the above projects have great implications on climate change as most of them are based on exploitation of fossil fuels whose footprint on climate change is huge.

Lack of environmental education and awareness are some of the major contributory factors to climate change. For this mindset to change there is need for environmental education and awareness raising. Section 4(2) (d) of EMA calls for the promotion of environmental education, environmental awareness and the sharing of knowledge and experience with a view to increasing the capacities of communities to address environmental issues. Environmental issues can be interpreted broadly to include climate change.

In sum, analysis of the Environmental Management Act indicates that there are legal provisions embedded within the Act that constitute the essential elements for governing climate change, particularly on issues pertaining to GHG emissions, climate change education and awareness and the effective adoption of global climate change commitments into national legal frameworks. Although the Environmental Management Act is an important piece of legislation, it is broad and thus does not provide sector specific legal guidance. Consequently, a sector specific analysis of legislative provisions is important to provide clear legal guidance on issues related to climate change. The next section provides an analysis of sector specific legislation.

15.3 Agriculture and Biodiversity Legislation and Its Relevance to Climate Change Activities

Global warming and climate change have direct and indirect negative impacts on agriculture and biodiversity. These range from the loss of traditional varieties of seed and genetic resources to droughts, floods and changing weather patterns. There is, therefore, an urgent need to protect poor people against the vagaries of climate change which lead to loss of livelihoods, food insecurity, loss of biodiversity and agricultural systems, emergence of new disease strains and high levels of poverty. At the policy level, there are several laws and policies in the agriculture sector with implications for climate change. Some of these laws include the Land Acquisition Act, National Biotechnology Authority Act, Plant Breeders Act, Research Act, and the Environmental Management (Access to Genetic Resources and Indigenous Genetic Resource-Based Knowledge) Regulations.

15.3.1 Land Acquisition Act (Chapter 20:10)

The Land Acquisition Act empowers the government to compulsorily acquire land. The Act also sets the procedures for compulsory acquisition of land especially acquisition of agricultural land for resettlement purposes. The implication of the Land Acquisition Act for climate change issues cannot be overemphasized. The Land Act supports the constitutional provisions under which land can be acquired for forestry, environmental and agricultural purposes. Given this position it is possible that land can be acquired for purposes of resettling rural communities who would have been displaced by floods or droughts as a result of climate change (or for other purposes). However, this remains to be seen as the government has mainly been resettling people to address historical imbalances in land ownership.

15.3.2 Agricultural and Rural Development Authority Act (Chapter 18:01)

The Agricultural and Rural Development Authority Act establishes the Agricultural and Rural Development Authority (ARDA). Some of the functions of ARDA that are outlined in Section 18 of the Act that have implications for climate change including the duty to plan, coordinate, implement and promote agricultural development in Zimbabwe. Further, ARDA has a duty to plan and carry out schemes for the development, settlement and utilization of state land. In terms of the First Schedule, which supports Section 21(1) of the Act, ARDA has the power to construct, establish, acquire, maintain and operate dams, reservoirs and irrigation schemes. This will be done with the approval of the Minister of Agriculture. In addition, ARDA has wide powers to operate or establish irrigation schemes and farming of land including ranching, forestry, settlement of farmers on land,

research into agriculture and to supply technical expertise and other assistance and advice and information to farmers.

The above functions of ARDA also places it at the core of ensuring that the agricultural sector adapts to the effects of climate change such as droughts and floods that may affect agricultural activities such as cropping and animal husbandry among other agricultural activities. Some of the functions like promoting land irrigation, resettling farmers, operating dams are important adaptation measures in the agricultural sector.

However, the major problem with the Act is that while it provides wide powers to ARDA the authority is not well resourced to effectively carry out its mandate. Given the increasing adverse impacts of climate change on the agricultural sector – such as the loss of traditional seed varieties and biodiversity – it is not clear whether the authority will be able to respond effectively to these challenges. It should be mentioned that the Act does not contain explicit language on climate change, but contains the general framework within which measures to promote climate change adaptation can be adopted in the agricultural sector.

15.3.3 Agricultural Research Act (Chapter 18:05)

The Agricultural Research Act establishes the Agricultural Research Council. Some of the functions of the Agricultural Research Council have implications for climate change including the promotion of all aspects of agricultural research. In this regard, while the Act does not explicitly mention research on the impact of climate change on the agricultural sector, it is generally permissive since it gives the Agricultural Research Council the duty to carry out agricultural research and the duty to promote all aspects of agricultural research. Agricultural research in the advent of climate change is key to Zimbabwe and this is a function that should be fully pursued by the Agricultural Research Council.

15.3.4 Research Act (Chapter 10:22)

The Research Act establishes the Research Council of Zimbabwe. The Research Council of Zimbabwe is given power in terms of section 16 to promote, direct, supervise and coordinate the research interests of Zimbabwe. The research interests may be pursued in various sectors. However, Section 16 (1) (c) states that the Research Council has a duty to ensure that persons, animals, plants and the environment are generally protected from the effects of potentially harmful research undertakings. Accordingly, the Act provides for the establishment of Safety Boards on potentially

harmful research for purposes of monitoring and supervising potentially harmful research or undertakings.

While the Research Act does not specifically mention climate change research, it has implications on research that may be undertaken by any person to try and promote climate change adaptation or mitigation in Zimbabwe. Evidently, such research will fall within the ambit of the Act and should be undertaken under the monitoring and supervision of the Safety Board that may be established for that purpose especially if the research is potentially harmful to persons, animals, plants and the environment.

15.3.5 National Biotechnology Authority Act (Chapter 14:31)

The National Biotechnology Authority Act was passed in 2006. The Act establishes the National Biotechnology Authority whose function is to support and manage biotechnology research, development and application. The Act defines biotechnology in section 2 as any technique that uses living organisms or parts of organisms to make, modify or improve plants or animals. The Act also provides for the importation, exportation, use, release on the market of any product of biotechnology which is likely to have adverse effect on human health, environment, the economy or national security.

Some of the functions of the National Biotechnology Authority include the development of a policy for safety in biotechnology, review of proposals concerning high risk category organisms and controlled experimental trials and to make decisions on whether to approve or prohibit them. In Section 22 (2) (a) the Act also provides for the development of guidelines and standards on the contents of risk assessments and environmental impact assessment as well as the requirements for the importation or exportation of biotechnology products that are likely to have an adverse effect on human health, the environment and the economy among others.

From the above there are several issues that have implications on the climate change debate. Firstly, it is important to note that the Act has great implications on the agricultural and environmental sector. For the environmental sector it incorporates environmental principles such as Environmental Impact Assessments (EIA) and risk assessments of biotechnology products. This means if any person is developing a biotechnology product he/she is expected to assess the environmental impact of that product on the environment and this may cover the potential impact on climate change or global warming.

Secondly, in the agricultural sector many scientists have been trying to develop new crop (seed) varieties especially genetically modified organisms (GMOs) or seed that are resistant to droughts, plant diseases and pests. GMOs have been touted by others as the panacea to droughts caused by climate change and global warming. Due to the uncertainties around the potential impact of GMOs on the environment, health and safety, the Biotechnology Act states that the Biotechnology Board may prohibit any activity involving genetically modified organism. It is important to note that this provision does not in itself prohibit GMOs, but leaves it upon the Board to make a decision whether to prohibit or allow GMOs or its product.

15.3.6 Access to Genetic Resources and Indigenous Genetic Resource-Based Knowledge Regulations of 2009

Access to Genetic Resources and Indigenous Genetic Resource-Based Knowledge Regulations were passed by the Minister of Environment and Natural Resources in 2009 in terms of the Environmental Management Act (Chapter 20:27). The purpose of the regulations is to protect the rights of communities and local authorities to their genetic material and indigenous genetic resource-based knowledge. In addition, the regulations were meant to promote indigenous genetic resource-based knowledge by conserving and strengthening communal systems of informal knowledge, collective innovation and transmission thereof which do not conform to the notions of private ownership, intellectual property rights or individual privilege over knowledge or innovations. The regulations provides that genetic resources and indigenous genetic resource-based knowledge may be accessed based upon explicit prior informed consent if the community as equitable sharing of benefits.

Access to Genetic Resources and Indigenous Genetic Resource-Based Knowledge Regulations have many implications for climate change, especially regarding communal farming. The genetic resources and knowledge being referred to in the regulations basically includes the plants or crops that have been grown by communities since time immemorial and which have been in many cases freely saved and exchanged amongst people from season to season. The knowledge being referred to in the regulations is the knowledge amongst the people on how to plant particular crops, and cropping times. The connection with climate change is that there are some crops or seed varieties that are threatened by climate change, and that climate change is negatively affecting agricultural cropping systems. Accordingly, in order to protect genetic resources, Section 5 (2) (h) provides for the establishment of a Genetic Resources and Indigenous Genetic Resource-based Knowledge Protection Committee whose functions include monitoring the causes of the loss or scarcity of genetic resources. This function may be used as an opportunity by the Committee to understand and monitor how climate change is leading to the loss of genetic resources in communal lands around Zimbabwe.

Another important aspect on the debate on climate change is that communities should continue adapting to climatic changes as they have been doing over the years, albeit in ways that is appropriate to the scale of the threat climate change poses. Accordingly, the regulations gives communities the right to continue saving and exchanging genetic resources such as seed from year to year than relying on GMOs or other seeds that are protected by intellectual property rights. The communities can innovate by themselves to cope with changing weather and soil conditions.

However, while the regulations are new they do not specifically mention climate change as one of the major threats to genetic resources and loss of knowledge. The regulations only state the need for the Committee to monitor the causes of loss of genetic resources. Further, the implementation of the regulations may be problematic as they may conflict with other laws that give the state power over communal lands and forests. Further, the regulations have not yet been implemented to merit a thorough assessment of their effectiveness.

The Environmental Management Act also provides for conservation of biological diversity in Section 116. It empowers the Minister to take necessary measures for the conservation of biological diversity of Zimbabwe. Some of the measures that can be taken that are critical for agriculture and climate change adaptation include measures to protect the indigenous property rights of local communities in respect of biological diversity, control or restrict the use, handling, movement, packaging and import and export of genetically modified organisms, prohibition of the importation or introduction into the wild of exotic animal and plant species and establishment and management of germplasm banks, botanical gardens, zoos and animal sanctuaries. These are measures that may serve plant and animal species that are threatened by climate change.

15.3.7 Other Agriculture Related Laws

There are many other laws in the agriculture sector that have implications on climate change. Four key pieces of legislation include the Plant Breeders Rights Act (Chapter 18: 16), Plant Pests and Diseases Act (Chapter 19:08), Seed Act (Chapter 19:13), and Fertilizer, Farm Feeds and Remedies Act (Chapter 18:12).

The Plant Breeders Rights Act provides for the registration of the rights of plant breeders in respect of certain varieties of plants. A breeder is defined in Section 2 of the Act as the person who directed, developed or discovered the new plant variety. Plant breeders' rights are granted for new varieties of plants which have not been offered for sale before and are distinct from any other variety. The variety should also uniform in its relevant characteristic and is stable. The Act seeks to protect the right of the person who is registered as the holder of such rights.

The implication of the Plant Breeders Rights Act is that it seeks to reward people who develop new varieties of crops or plants by granting them intellectual property rights over the plant for a specific period of time to encourage them to develop new varieties. The relevance of the Plant Breeders Rights Act to the climate change debate is that this creates an opportunity for plant breeders to develop new crop varieties that may resist pests and droughts that are caused by climate change. This has been viewed as one way in which the agricultural sector can adapt to climate change and help farmers to grow crops that gives better yields and matures quickly. However, in many cases plant breeders are private companies and not communal farmers who have been saving and exchanging seed since time immemorial. Instead the rights of communal farmers will be protected through the new regulations i.e. Environmental Management (Access to Genetic Resources and Indigenous Genetic Resource-Based Knowledge) Regulations of 2009.

The Plant Pests and Diseases Act provides scope for the eradication and prevention of the spread of plant pests and diseases in Zimbabwe. The Act gives power to the Minister of Agriculture in Section 4 to make regulations, issue an order or notice for the eradication of pests or for the prevention or control of plant attacks by pests or diseases. The Minister can also make an order for the disinfection, treatment and destruction of pests or the host plants. The Act also imposes a duty on the owner of land in section 6 on which pests or plant diseases are found to take reasonable measures to eradicate, reduce or prevent the spread of the pests as may be ordered by an inspector. The Plant Pests and Diseases Act may become vital in the climate change debate in the event of occurrence of crop or plant diseases and pests resulting from the effects of global warming or changing weather patterns. In that regard, the Minister of Agriculture will be expected to make an order or regulations to deal with the new emergency (pests and diseases) while the owner of the land is also required to take appropriate measures.

The third agriculture related legislation that may also have implications on climate change is the Seed Act (Chapter 19:13). The Seed Act provides for the registration of seed and regulates the importation, exportation and sale of seed in Zimbabwe. Those who are engaged in the selling of seeds are required to be registered. It is an offence for any person to make a false or misleading statement or advert on seeds that he/se is offering for sale. The implication of the Seed Act is that it provides scope for the elimination of unregistered seeds and importation of seeds that are not suitable for farmers in Zimbabwe under the pretext that they are varieties that are drought or pest resistant. In many cases farmers living in low rainfall areas where the effects of climate change are evident have been duped by seed sellers who misrepresent that the seeds are resistant to pests and drought.

The Fertilizer, Farm Feeds and Remedies Act (Chapter 18:12) provides for the registration and restrictions on the sale of fertilizers and farm feeds. Fertilizers are used for improving or maintaining the growth of plants or productivity of the soil. The need to increase crop yields in light

of low rainfall due to climate change and changing weather patterns and the application of fertilizers is a key element of the agriculture sector. The Act therefore tries to protect farmers from buying fake fertilizers, farm feeds and remedies for use. The Act also makes it an offence for any person to make misrepresentations and false adverts on farm feeds, fertilizers and remedies.

15.4 Forestry Legislation and Its Relevance to Climate Change Activities

The Forest Act (Chapter 19:05) and the Communal Lands Forest Produce Act (Chapter 19:05) are the two principal legal instruments governing forest management in Zimbabwe. The objectives of the Forest Act include the protection of private forests and trees, the conservation of timber resources, compulsory afforestation, and, regulation and control of the burning of vegetation. The Communal Land Forest Produce Act has among its objectives; regulation of the exploitation of forests, regulation and encouragement for the establishment of plantations within communal land. It is apparent that these legal provisions, contained in the Forest Act and the Communal Forest Product Act, have important implications on climate change.

Trees and forests are major carbon sinks as they absorb carbon dioxide in the air and thereby reducing global warming which results in climate change. In terms of section 14(2) of the Communal Lands Forest Produce Act, the Forestry Commission has the power to establish and control plantations and forest nurseries. With the approval of the local authority, inhabitants, associations and or a group of inhabitants, may establish and control forest nurseries. These plantations and the trees that are planted from the nurseries act as carbon sinks thereby reducing the amount of GHGs in the atmosphere that causes climate change. The Minster may also declare a forest a protected area.

The role and importance of forests in climate change management is also reinforced through the Forest Act. An owner or occupier of land is required to give notice of intention to dispose of indigenous timber and the Minister may give orders to restrict the cutting or removal of indigenous timber in terms of section 55 and 56. While these are restricted to indigenous timber, these provisions prevent the wanton cutting down of trees which may result in deforestation which is a contributor to climate change. The control of fires and burning of vegetation also has linkages to climate change. Burning of vegetation can result in forest fires which destroys forests and cause air pollution.

The Forest Act was put in place during the colonial era and has fundamentally remained unchanged from its original provisions, despite the few amendments that have been made. Formulation of the

Forest Act in Rhodesia was mainly influenced by the Commonwealth Forest Association Conferences debates which endorsed strict conservation of forests based on law enforcement (Brown, 2003). This resulted in the Commonwealth Countries demarcating large tracks of land as protected forests.

The Forestry Act (1) established the Forest Commission for the administration, control and management of state forests in the country; (2) provided for the setting aside of state forests and the protection of private forests, trees and forest produce; (3) established the Mining and Timber Permit Board to control the timber cutting for mining purposes; (4) provided for the conservation of timber resources and compulsory afforestation of private land; (5) regulates and controls trade of forest produce; and (6) regulates and controls the burning of vegetation. The Forestry Commission's duties include the consideration of all matters arising from or relating to the Forest policy in Zimbabwe, and submitting reports and recommendations to the Minister. In addition the Commission is tasked with the control, management and exploitation of state forests, plantations forest nursery's, the establishment, maintenance and improvement of forest plantations and nurseries; surveying the forest resources in Zimbabwe; conducting forest and forest products research; investigating matters related to the use and occupation of forests and advising the President on whether the occupation is legal or not; authorizing the sales and purchases of timber products, and managing protected forests.

The Act forbids cutting of timber from state lands, as well as indigenous trees from privately-owned land, without a permit from the Mining Timber Board. The Act therefore has huge provisions for conserving timber (Nickerson, 1994). Private land holders may also be instructed by the Minister to put in place certain conservation measures.

As already mentioned, the Forest Act remains fundamentally unchanged, and still reflects the thinking and debate of the colonial era, despite the current developments on conservation and forest management. This may be attributed to the exclusionary conservation policies which increasingly result in local hostilities and conflicts as indigenous peoples living around protected areas continue to illegally extract and make use of resources they consider essential for survival (Dzingirai and Breen, 2005; Pimbert and Pretty, 1995; Prabhu, 2003; Hasler, 1996; Duffy, 2000; Gibson, 1999). In many cases, indigenous groups have destroyed infrastructure put in place to protect natural resources (Murombedzi, 1994). In trying to protect natural resources, some governments have developed measures to track and shoot poachers of forest resources and wildlife. Even with such measures in place, many protected areas have continued to be degraded, 'leaving conscientious ecologists and practitioners certain that some other way of doing conservation was needed' (Dzingirai and Breen, 2005).

Thus, over the past decades there has been increased pressure for developing countries to implement decentralised and community-based natural resource management (CBNRM) approaches (Wilshusen et al., 2002; Borinni-Feyerabend, 1996; Dzingirai and Breen, 2005; Leach, 2002). Such projects have taken various forms, and a diversity of names have emerged, including joint forest management, co-management, collaborative management, and shared forest management. This shift has been widely promoted by proponents of participation as the new approaches incorporate views of local communities, where livelihoods depend on the resources in question. Currently, it is now being argued that participation of local communities in management and benefit sharing is probably the most effective incentive and modality for sustainable forest

management. This shift towards participation by local communities was incorporated into the World Conservation Strategy (WCS) in 1980. In regard to Zimbabwe, this aimed to integrate rural development goals with conservation objectives, and to ensure the participation of local people (IUCN, 1980).

Clearly, as it stands now, the Forestry Act does not reflect the environmental rights and guiding principles enshrined in the Zimbabwe environmental policy and strategies, and furthermore does not take into account the current debates on environmental issues or those relating to climate change (e.g. promoting the sustainable management of forests). Although the Act does not recognize participation of local communities in the management of state forests, some pilot resource-sharing projects have been implemented in Mafungautsi State Forests to try and generate lessons to influence policy. Further research was conducted jointly by the Centre for International Forestry Research (CIFOR) and the Forest Commission under the Adaptive Collaborative Management Project [Mutimukuru-Maravanyika T., and Almekinders C., 2010; Mutimukuru-Maravanyika 2010; Mutimukuru-Maravanyika et al. 2008). Despite implementation and lessons learned during the project, the Forestry Act has remained the same up to this present day.

The Forestry Commission is currently engaged in the National Forest Programme, funded by FAO, to develop a new Forest Policy. The NFP is a process of reviewing current practices on the ground to ensure that there are synergies between new forestry policies and practice on the ground. The NFP will also help Zimbabwe's forestry sector to integrate sustainable forest management into poverty reduction strategies and build consensus on how to address forestry issues at the national level. This process provides a unique and timely opportunity for climate change issues to be addressed in the forestry policy.

15.5 Water Legislation and Its Relevance to Climate Change Activities

The water sector in Zimbabwe will be negatively affected by global warming. The main pieces of legislation in the water sector with implications on climate change include the Water Act (Chapter 20:24), the Zimbabwe National Water Authority Act, the Environmental Management Act (Chapter 20:27) and regulations made in terms of the Water Act and the Environmental Management Act.

The Water Act regulates the development and utilization of water resources in Zimbabwe. It establishes the institutional framework for water resources management such as the Zimbabwe National Water Authority, Catchment Council and Sub-catchment councils. The Act also recognizes various uses of water such as primary (domestic) use, agricultural, industrial, electrical and recreational use among others.

The Water Act has various provisions with implications on climate change. In terms of section 6(2)(g) the Minister of Water Resources has a duty to ensure that research is carried out and information

obtained and kept on hydrological and hydro-geological matters such as the quality and quantity of the country's water resources. In the same vein, land may be acquired by the Minister of Water Resources for purposes of constructing hydrological stations which will be used for measuring and monitoring rainfall. Additionally, the Water officers of the Zimbabwe National Water Authority have power to obtain, record information and statistics relating to the hydrological conditions of Zimbabwe in respect of both surface and ground water. The measurement of water availability and rainfall is important in understanding the impact of climate change on water availability and planning.

A key feature of the Water Act is the permit system for water use which is critical during droughts that are induced by global warming. For example while a permit is not required for primary use of water, a Catchment Council in terms of Section 33(1)(a) may limit the quantity of water abstracted for primary purposes to ensure equitable distribution and use of water. The Act further provides for the right to use water when volume is insufficient to satisfy various water demands. The Act states that whenever the volume of water in any river system is insufficient to satisfy demand the Catchment Council may revise, reallocate or reapportion the permits and put in place conditions that ensure equitable distribution and use of the available water. This provision is critical during periods of drought. The power vested in the Catchment Councils is important as a policy decision and adaptation strategy to ensure that all people cope and manage to access water during periods of water shortage.

Further, there are several other climate change related adaptation measures that are implicit in the Water Act that may be invoked to enable people to cope with droughts, floods and other emergencies caused by global warming. For example the Water Act gives power to the Minister in section 57 to issue a notice to reserve any specified quantity of water for future use as well as the power to declare any area as a water restriction area if the use of water in any catchment area is approaching the limit of the potential of the catchment area.. In this respect no permit may be issued for water use except under the authority of the Minister.

In addition, section 61(1) provides for the declaration of water shortage areas. The Act states that if the flow of water in any public stream or water storage works has ceased or the levels have fallen or is likely to fall, the Minister on the recommendation of the Zimbabwe National Water Authority in consultation with the catchment council may declare the area to be a water shortage area. If an area has been declared a water shortage area, the catchment council may do any of the following in terms of section 62; suspend or amend any water use permits, make orders on abstraction, appropriation, control or use of the water, determine the priority in the use of water in the water shortage area. The catchment council may also restrict the sinking of boreholes or wells and may fix the maximum volume of water which may be abstracted from any public stream or water storage works, boreholes or well in a water shortage area in terms of Section 63 and 64. The above provisions provide a legal framework for coping with water shortages during drought periods.

Another important aspect on climate change that is implicit in the Water Act is on the safety of dams. Sections 99-102 makes provision for the safety of dams. The Act prescribes some of the safety requirements for the construction of both small and large dams for water storage in terms of design, plans and specifications. The Act prescribes that the adequacy and safety of every dam has to be certified by an approved civil engineer and that dams have to be periodically inspected. The issue of dam safety is critical in the event of floods that may be a result of heavy rains induced by climate change. In this case the law recognizes the need to ensure that dams are strong to withstand flood waters. The importance of dam safety measures and procedures is that it may also reduce destruction of property, homes and livestock of communities living downstream in situations where dams walls collapse due to floods or other causes. This can be interpreted as a climate change adaptation measure.

Section 109 (1) of the Water specifically relates to floods. Subsection (1) states that if the owner of a dam learns of a flood which may affect the dam, he shall take all reasonable and practical steps for dealing with the flood. In addition, the owner of the dam is required to notify the Secretary in the Ministry of Water Resources and the Zimbabwe National Water Authority (ZINWA) of the flood. The law makes it an offence to fail to take reasonable or practical steps or to notify the Ministry. From the above it is evident that the Water Act provides some safeguards on how climate change induced floods may be handled, although the Act does not explicitly link the floods to climate change. However, these provisions may be adequate for dam owners to respond to climate change related floods.

The Zimbabwe National Water Authority Act establishes the Zimbabwe National Water Authority (ZINWA), which is mandated to carry out several functions that have implications on climate change adaptation in Zimbabwe. One of the critical functions of ZINWA is to advise the Minister of Water Resources on formulation of policies and standards on water resources planning, management, development, hydrology, dam safety as well as protection and conservation of water resources. These functions encompass climate change adaptation related issues such as the monitoring of rainfall (hydrology), the safety of dams against floods that may be induced by climate change and generally the need to conserve water when there are shortages. In addition, ZINWA is mandated to undertake research studies, to develop a database on hydrological issues and to publish the findings, to produce maps, plans and other information necessary for development and exploitation of water resources. These activities may be used to understand how climate change impact on water resources management.

More importantly, ZINWA has the responsibility of advising the Minister on the exploitation, conservation and management of water resources of Zimbabwe with the objective of *taking appropriate measures to minimize the impact of drought, floods or other hazards.* This function places ZINWA at the centre of ensuring that the people of Zimbabwe are not greatly affected by

droughts and floods. Given the legal position it is incumbent upon ZINWA to ensure that the Minister of Water Resources is appropriately advised to adopt measures to adapt and cope with the adverse effects of climate change within the water sector.

ZINWA may be used to promote climate change adaptation include the power to construct, establish, acquire, maintain or operate dams, reservoirs, canals, water distribution works and hydro-electric power stations in any area. These powers are provided in the *Schedule to Section 6* of the Act and places ZINWA at the core of ensuring water availability to water users even during times of shortages due to droughts.

The Water Act provides establishment of Catchment and Sub-Catchment Councils tasked with the responsibility for managing river systems. The key functions of catchment and sub-catchment councils include, preparation and updating outline plans for river systems, deciding and enforcing water allocations and reallocation, work with ZINWA to maintain a database and information system for the catchment, determine application for the use of water and impose conditions that are necessary, monitor activities of subcatchment councils, maintain all registers of permits issued for access by members of the public. In terms of section 12 (1) catchment councils have the following powers; to grant or refuse applications for a provisional permit or temporary permit for use of water, carry out inspections, revise or cancel permits, grant permits for construction of water storage works and ensure compliance with the Water Act. In other words, the functions of catchment and sub-catchment councils provide an institutional framework for the adaptation of the water sector to climate change.

Despite the fact that the legislation governing water has important climate change implications, it was observed that the legislation made no explicit reference to climate change. Further, implementation and enforcement of various pieces of legislation is often hindered by political, economic and social factors. Some of the economic factors include shortages of funds, fuel, transport and equipment. Political factors include government interference in operations of public bodies such as ZINWA and local authorities. On the part, communities lack of knowledge about these laws and how to claim their rights, which also stifle implementation and enforcement of these laws.

15.6 Disaster Management Legislation and Policy

The Disaster Management Act No.5 was enacted in 1989. It should be noted that this legislation was enacted before the establishment of the first global environmental UN agenda (Agenda 21 of 1992 UN Conference of Environment and Development, UNCED). This indicates that the disaster management issues in Zimbabwe have been handled by an outdated legal framework that was enacted before the globally elevated climate change awareness of the UNFCC process. This Act only provides for the Disaster Fund but is silent on resources for prevention and mitigation measures. The Act also does not cater for funding of disaster management authorities at sub national and local levels. The officers in the provinces and districts execute the role of the Civil Protection Department on part time basis without a budget. They depend on funding and instructions from the national headquarters in the capital. The legal framework provides mostly for relief and response efforts. This inclination on relief and response is quite visible in Table 1 which shows line Ministries which are responsible for coordinating the main activities of the Civil Protection. This scenario is a product of the legal framework which does not address the most pertinent issues related to mitigating the climate risks.

Table 1 Functional Sub-committees on Disater Management.

Sub Committee leader	Function
1. Min of Public Services, Labor & Social Welfare	Food Supplies and Food Security
2. Min of Health and Child Welfare	Health, Nutrition and Welfare
3. Zimbabwe Republic Police& Defense Forces	Search, Rescue and Security
4. Min of Finance	International Cooperation and assistance

Response is not designed to address the root causes of disasters, instead is focused on relief with the effect that it perpetuates existing risk and a cycle of recurrent disasters. Thus while it is important to timely respond and provide appropriate humanitarian assistance, it is equally crucial that national efforts are made to deal with the longer term challenges associated with disaster risk reduction. Reducing vulnerability centres on understanding and addressing the underlying problem while building resilience against the same. Consequently in its current state the Civil Protection Department is inadequately equipped with the right strategies and instrument for addressing vulnerability reduction, the key aspect of reducing climate change risks. Without adequate emphasis

for long term preventive measures and mitigation, coupled with a systematic approach through careful planning, the unfolding climate events may soon overwhelm the capacity of the country to cope.

However it is fortunate that the Civil Protection acknowledges that it faces significant governance challenges precipitated by the weak institutional policy framework to effectively respond to disasters and manage the national risk reduction measures. This includes poor staffing levels in both numbers and skills (few of its officers are qualified disaster managers) hence have limited work related analytical skills and implementation capacity. An unclear institutional landscape of addressing disaster risk reduction across various ministries and agencies that it coordinates is evident. An apparent weak partnership exists with other disaster management agencies, academia, Non-Governmental Organisations (NGOs), and private sector. This is evidenced by the lack of an audited account of all the disaster management activities taking place across the country. Thus efforts are already in being initiated to reform the department so as to conform to the international paradigm shift of Disaster Risk Reduction.

15.7 Mining Legislation and Its Relevance to Climate Change Activities

Mining is a major contributor to climate change. Mining is inherently destructive of the environment. Open cast mining for example, results in the clearing of forests which are major carbon sinks (and can release sores of greenhouse gases into the atmosphere). Blasting results in the emission of gases into atmosphere which may contribute to climate change. On the other hand mining, both underground and open cast is vulnerable to the impacts of climate change. Climate change can result in flooding, water and energy shortages and disruption of mining activities.

The Mines and Minerals Act (Chapter 21:05) is the principal legal instrument governing mining in Zimbabwe. However, this is a very old Act which was passed in 1961 well before climate change was an issue. To that extent, any reference to climate change in the Mines and Minerals Act is implicit rather than explicit. Climate change related issues emanating from mining are addressed in the Environmental Management Act and its related regulations, and the Mines and Minerals Amendment Bill of 2007.

As already noted, forests are major carbon sinks. The Mines and Minerals Act seems to realise that forests are an important component of sustainable management of natural resources. In terms of section 36(1), the Mines and Minerals Act states that;

Every owner or occupier of private land may apply for and shall be granted by the mining commissioner a reservation against the cutting or the taking by prospectors or miners of fifty per centum of such indigenous wood or timber as is existing on his land at the time of his application for the reservation

This can be interpreted as a realisation on the need to ensure that trees or forests are not wantonly cut during exploration and mining operations. Furthermore, the mining commissioner may through a notice authorised by the Minister reserve the cutting down of specified indigenous wood or timber by a holder of a prospecting licence or a special grant in terms of section 37(1). These provisions maybe interpreted as having some relevance to climate change. While the reservations do not have the effect of stopping the prospecting or actual mining activities, its usefulness is that it ensures that they are done in a sustainable manner. However, it is important to note that these reservations are only applicable to indigenous wood or timber.

In terms of section 97 of the Environmental Management Act, mining is one of the activities listed in the First Schedule which must not be undertaken before an Environmental Impact Assessment (EIA) is carried out. This can be argued to be an indirect reference to activities that are related to forestry and climate change. If the EIA shows that the proposed mining activity will contribute to significant climate change impacts which will affect sustainable development, this may be grounds for it not to be implemented.

The Environmental Management (Atmospheric Pollution Control) Regulations, Statutory Instrument 72 of 2009 has provisions that are applicable to mining. Air pollution contributes to GHG emissions and these regulations can be used as mitigation measures against climate change. Section 3 of the regulation whose objective is to prevent air pollution, sets emission standards for certain activities. These include the burning of waste at land fill, the burning of vehicle tyres, the burning of bitumen, the burning of metallic wire coated with any material, the burning of oil in the open air, the operation on an incinerator and any activity that causes the emission of a pollutant into the atmosphere.

Further, the regulations makes it an offence for an owner or occupier of land or premises with a disturbed surface area to cause or allow fugitive dust to be emitted in to the atmosphere as a result of activities on the disturbed surface area in excess of the prescribed amount in the Third Schedule. These provisions compliment section 63 of the Environmental Management Act on air quality standards.

Some wastes from mining activities like open cast mining of coal can result in spontaneous fires if they are not timely rehabilitated. These spontaneous fires results in air pollution which contributes

to climate change. The Environmental Management (Environmental Impact and Ecosystems Protection) Regulations, Statutory Instrument 7 of 2007 makes provisions that have direct implications on climate change. Section 15(1) requires land users, land owners and designated authorities to put in place appropriate fire prevention measures on their land while section 15(2) makes it an offence for anyone to deliberately start a fire that they cannot extinguish which can cause damage to the environment. The objective of this Statutory Instrument is to prevent fire outbreaks. Fire outbreaks results in the destruction of the environment which includes trees and forests (major carbon sinks) and also cause air pollution. By preventing fire which destroys carbon sinks and prevents air pollution, these regulations are contributing to climate change mitigation.

Mining equipment can also contribute to climate change if it contains ozone depleting substances. Although ozone depletion is not a major cause of climate change, it never the less has an impact. Environmental and Natural Resources Management (Prohibition and Control of Ozone Depleting Substances and Ozone Depleting and Ozone Depleting Substances Dependent Equipment) Regulations, Statutory Instrument 2 of 2011's objective is to regulate the import, export, installation, decommissioning and destruction of ozone depleting substances and ozone depleting substances dependent equipment. These regulations ensure that ozone depleting and dependent equipment is handled in a sustainable manner.

15.8 Energy Legislation and Its Relevance to Climate Change Activities

The burning of fossil fuels, for example, has been the major contributor to emission of GHGs, while increasing demand for fuel wood is leading to depletion of forests especially in the context of erratic supply of electricity in rural and urban areas. Meeting energy demand in Zimbabwe, requires the country to resort developing thermal power, biofuels, wind and solar energy. According to the Ministry of Energy the country has a target to substitute 10% of the nation's fuel requirements with biofuels by 2015 (Ministry of Energy, 2011). These sources of energy have different implications on climate change.

Energy legislation plays a critical role as it provides scope for the development of standards and benchmarks for emission levels and sets the institutional framework on energy use, distribution and production. In Zimbabwe there are various pieces of legislation that regulate the energy sector and have implications for climate adaptation. These laws include the Energy Regulatory Authority Act of 2010, the Electricity Act (Chapter 13:19), the Rural Electrification Fund Act (Chapter 13:20) and the Petroleum Act (Chapter 13:22).

15.8.1 Energy Regulatory Authority Bill (2010)

The Energy Regulatory Authority Bill of 2010 seeks to establish a single regulatory authority in the country covering both the electricity and petroleum sectors which are currently being regulated by different and separate bodies in terms of the Electricity Act (Chapter 13:19) and the Petroleum Act (Chapter 13:22). What the Bill seeks to do is to consolidate the functions that were being carried out by the Electricity Regulatory Commission and the Petroleum Regulatory Commission and ensure that these will now be carried out by the Energy Regulatory Authority. The Authority will play a critical role in regulating the whole energy sector which encompasses both renewable and non-renewable energy sources.

There are several provisions in the Energy Regulatory Authority Bill with implications on climate change. Firstly, in Section 2 the Bill identifies "energy sources" as any source of renewable or non-renewable energy. More importantly, it defines renewable energy as *energy generated from natural resources such as sunlight, wind, rain, tides, geothermal heat, plants and biomass which are naturally replenished*. This definition squarely falls within the ambit of the ever increasing calls for recognition of the importance of development, production, application and distribution of renewable energy for use as alternative energy sources, than reliance on fossil fuels and non-renewable energy sources most of which are responsible for the current high levels of greenhouse gas emissions. To that extent the law recognizes renewable energy sources as an important source of energy to be produced and supplied to consumers in Zimbabwe.

Secondly, the Bill in Section 7(1) gives power to the Zimbabwe Energy Regulatory Authority Board with the agreement of the Minister of Energy and Power Development and after consultation with stakeholders to declare by notice in a statutory instrument that any specified energy source that is not regulated under any other enactment shall be subject to licensing under the Energy Regulatory Authority Bill. This provision is important in that it provides scope for declaration and licensing of alternative and renewable sources of energy that may be developed and produced in future. These sources of energy may be climate friendly. This means that other sources of energy that are not specifically regulated in terms of any specific law such as bio-fuels in Zimbabwe can be licensed under this Bill. The bio-fuel production projects that are being pursued by government, for instance jatropha and sugar cane projects, are being currently undertaken in the absence of a specific law that regulates them. In that respect, biofuels production will now be regulated and licenced under the proposed Energy Regulatory Authority Act. However, the provisions of this Act are not very specific about the procedures that should be adopted by those involved in the production of fuel from jatropha. In that case there will be need to adopt regulations that specifically apply to biofuel production.

Thirdly, the Energy Regulatory Authority Bill outlines the functions of the Energy Regulatory Authority in Section 4 (1) as *inter alia* to license and regulate energy industries, to identify, promote, and encourage the development of sources of renewable energy, to ensure access to affordable and environmentally sustainable sources of energy to consumers. The above is testimony to the need to ensure that the Authority promotes the development of energy sources that do not contribute to climate change and global warming. This will be achieved through the employment of technologies that eliminate GHG emissions.

The other key function of the Authority in terms of Section 4 (1) (q) is to assess, promote studies and to advice the Minister of Energy and Power Development and licencees on the environmental impact of energy projects before licensing them. This provision clearly offers the prospects for the Authority to carry out or to advise those who are licenced to conduct environmental impact assessments (EIA) before they start operations. This legal position provides the opportunity for the assessment of the potential impact of thermal power stations for example on climate change. Thermal power stations use coal and coal burning has been a major source of GHG. In the above context, it is important to note that Environmental Impact Assessments are an important element in the fight against climate change and environmental degradation as they are meant to identify the environmental risks that may result from the project. In this case an EIA may reveal the potential impact of the project as it may involve direct emission of Green House Gasses or clearing of vast tracks of forests (carbon sinks) in preparation of land for the project. Noteworthy, EIAs are regulated by the Environmental Management Act (Chapter 20:27).

Although the Energy Regulatory Authority Bill has important legal provisions that have implication on climate change, it still lacks legal provisions that can be used to regulate and control the development, production and distribution of specific energy sources such as bio-fuels. It provides a framework within which renewable energy sources can be licensed. In addition, the Bill is too general and falls far short of what such a law may be expected to contain. These shortcomings are exacerbated by the fact that the Bill does not make specific reference to climate change issues in the energy sector. Yet, the Bill was developed at a time when climate change was already a topical issue. Further, it is important to note while the Bill is broadly progressive, lack of funds and human resources may hinder its effective implementation.

15.8.2 Electricity Act (Chapter 13:19)

The Electricity Act is another piece of legislation that deals with the energy sector and has implications on climate change. Although the Act provides for the establishment of the Zimbabwe Electricity Regulatory Commission, the Commission will be replaced by the Energy Regulatory Authority to be established in terms of the Energy Regulatory Authority Bill which will take over

all the functions of the Commission. The Electricity Act provides for the licencing and regulation of the generation, transmission, distribution and supply of electricity.

Some of the functions of the Commission with implications on climate change are stated in section 4 and include licencing and regulating persons engaged in the generation, transmission, distribution and supply of electricity. Any person who intends to generate more than 100 Kilowatts of electricity is required to apply for a licence. The only specific reference to environmental issues is in the Second Schedule of the Act which provides for the compulsory acquisition of land to facilitate the transmission and distribution of electricity. In this case before the servitude is granted the Commission has to consider a report by the Ministry of Environment on the anticipated impact of the works on the environment.

An analysis of the Act indicates that it does not provide any major provisions on how climate related challenges can be handled in power generation. The Act is silent on the implications of electricity generation, production, distribution on climate change. Given that the production of thermal energy is a major source of GHG emission, there is need for legislative guidance on how this will impact on Zimbabwe's commitments to GHG emissions within the UNFCC framework, which the country signed to.

15.8.3 Rural Electrification Fund Act (Chapter 13:20)

The Rural Electrification Fund Act provides for the establishment of the Rural Electrification Fund which is administered by the Rural Electrification Fund Board. The purpose of the Fund is to facilitate rapid and equitable electrification of the rural areas of Zimbabwe, promote rural development and identify rural electrification projects and to act as a centre of information, to carry out research and keep abreast of technological developments in rural electrification world-wide.

The other purpose of the Fund is to give attention to off-grid stand alone technologies for supply of electricity to rural areas. The Rural Electrification Fund Board is responsible for giving financial assistance to rural electrification projects. In Section 2 of the Act the term electrification "project" is defined as a project in a rural area which entails the construction of works for the distribution of electricity and the financing of its end-use infrastructure including the construction of *isolated mini-hydro electricity, solar power and wind generators* for centres away from the national grid.

From the above it is evident that the legislation was formulated with the objective of promoting alternative sources of energy which are renewable like solar, wind and mini-hydro power stations in

rural areas which are not connected to the electricity grid. These projects falls within the ambit of sustainable technologies that are friendly to the environment and do not cause significant GHG emissions. In addition, the fact that the legislation provides for the gathering of information, research and technological advancement entail that the Act was meant to ensure the rural communities also learn from other countries where new renewable electricity generation technologies are being tested and applied to curb GHG emissions and global warming.

In practice, the provisions of the Act have been implemented and applied through the activities of the Rural Electrification Agency (REA) which has been implementing projects in rural areas aimed at promoting alternative and renewable sources of energy such as the provision of solar energy to selected schools, clinics and homesteads of Chiefs. In addition, a 6% levy is being paid by all consumers of electricity to support the rural electrification projects. The effect of rural electrification is reduced reliance on firewood which has been depleting forests that act as carbon sinks.

A key factor that adversely affected the implementation of the provisions of the law on rural electrification projects is limited funding. While a rural electrification levy has been imposed on electricity consumers this has not translated into massive electrification of rural areas. The suppressed economic conditions in the country have adversely affected the implementation of the programme objectives. Further, the sanctions that are imposed on the country has negatively affected the ability of local investors attracting foreign investment and technology required in the sector.

15.8.4 Petroleum Act (Chapter 13:22)

The Petroleum Act provides for the regulation and licensing of the petroleum industry. In Section 2, the Act defines petroleum product as including petrol, diesel fuel, paraffin and liquid petroleum gas among others. Some of the functions of the Petroleum Regulatory Authority that are critical for climate change are stated in Section 4 of the Act. These functions include promotion of the production, procurement and sale of petroleum products and the advancement of technology relating to the petroleum industry. No person is allowed to produce, sale or procure petroleum products without a licence. In Section 5(2)and(3), the Act states that in order to protect consumers of petroleum products the Authority shall fix safety, health and environmental standards that should be adhered to by the licencee. Further, the Authority has power to develop consumer protection standards, while the Minister has power to make regulations.

An analysis of the Act shows that the petroleum industry has great implications on climate change especially the production of petrol and diesel from fossil fuels. Fossil fuels have contributed significantly to global warming. However, there are no specific and clear provisions on this in the Act. However, there are general provisions about development of technology relating to the petroleum industry without stating whether this technology will be new technologies that reduce GHG emissions. The only provision in the Act that remotely seeks to protect the environment deals with the powers of the Authority to put in place safety, environmental and health standards to protect consumers. It is hoped that this can be used by the Authority to put in place measures and standards aimed at making sure that the petroleum industry in Zimbabwe reduces its climate change footprint by adopting cleaner methods and technologies.

However, as stated earlier all projects that relate to the production, storage and distribution of petroleum should be subjected to an Environmental Impact Assessment (EIA) in terms of the Environmental Management Act (Chapter 20:27). This offers some hope that climate change issues may be considered before the commencement of projects aimed at producing petroleum products. A key limitation of the Petroleum Act is that it does not make reference to EIAs. This is problematic as it leaves investors in the petroleum sector with no environmental guidance to their activities. Further, the Petroleum Act does not explicitly mention fuels (petrol and diesel) generated from renewable sources such as bio-diesel. It just generalizes the petroleum products and one cannot avoid the conclusion that the bias is towards fossil fuels.

In the energy sector, while the Energy Regulatory Authority Act provides scope for regulation of the various facets of the energy sector including biofuels and other technologies such as biomass, woodstoves, grate stoves, solar energy and wind energy among others, there is need to develop specific regulations that support the Energy Regulatory Authority Act by setting the explicit procedures and parameters under which these technologies will be promoted in light of the challenges posed by climate change.

15.9 Transport Legislation and Its Relevance to Climate Change Activities

Motor vehicles emit GHGs in the form of carbon monoxide and carbon dioxide which are among the major causes of climate change. It is argued that vehicular emissions are among the largest single source of pollutants of GHGs in Harare (ZERO Regional Environmental Organisation: 2010). In terms of section 68 of EMA, it is an offence for an owner or operator of a transport conveyance to operate it in a manner or way that results in air pollution in violation of the prescribed emission standards. The penalty for causing air pollution includes a fine and a jail sentence depending on whether it is a first or second conviction.

The Environmental Management (Atmospheric Pollution Control) Regulations, Statutory Instrument 72 of 2009 sets emission standards for motor vehicles. The regulation further gives powers to inspectors to test and inspect motor vehicles to determine if they are in compliance with the emission levels, and if not inspectors are empowered to order the car not to be used on any road or to set conditions under which the motor vehicle will be used.

Furthermore, the Government of Zimbabwe is proposing the ban of second hand imported vehicle that are more than 5 years through the Road Traffic (Construction, Equipment and Use) Regulations, Statutory Instrument 154 of 2010. Section 65 of the regulation states that: "No person shall import any motor vehicle for registration and use on any road in Zimbabwe if the year of manufacture from the country of origin is 5 years". This could be interpreted as a measure to combat climate change. There is a correlation between the age of the vehicle and fuel efficiency. Old vehicles results in low fuel conversion efficiency and this causes high emissions due to incomplete combustion of the fuel. Zimbabwe is a significant importer of second hand vehicles.

16. Conclusion

This Baseline Report has noted that there is unequivocal evidence that Zimbabwe is experiencing a changing climate marked by both a decline in annual average rainfall and an increasing average temperature over the past century. These climate change impacts have significant implications for socio-economic development and economic growth in Zimbabwe. They threaten to undermine economic recovery, poverty reduction and the achievement of MDGs through the adverse effects of climate change on key social and economic sectors. However, there is considerable scope for the Government to effectively respond to the challenges that climate change pose on socio-economic development and economic recovery. The Medium Term Plan 2011 – 2015, particularly the policy objectives set out for Climate Change and Development, provide a vital framework for a national response to climate change. In addition, existing policies and programmes across the different ministries provide valuable opportunities to mainstream climate change issues into sector policies and programmes. As such, individual ministries should take a lead in implementing programmes that are climate change compatible both at national and subnational level. However, this Report called for the coordination of this sectoral response into an integrated framework on climate change and development that ensures Zimbabwe's socio-economic development and economic growth is climate resilient.

Advancing this agenda will require clear political support, committed leadership, extensive consultation with, and participation of, a broad range of stakeholders, that seeks to implement the suggestions and recommendations for research, policy and technical assistance highlighted in this Report. Further, this Report calls for a bold vision and identifies a long term agenda for the development of an effective and coordinated framework for a National Climate Change and Development Strategy for Zimbabwe.

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