

A Mini-Review on Zambia's Water Governance in a Changing Climate

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Received: March 3, 2015; Published: September 14, 2015

Abstract

This study carried out a mini review on Zambia's water and climate change governance and made recommendations for sustainable adaptation strategies and improved river basin management planning. Agriculture and Hydropower development are sectors which have felt and are more likely to experience the worst impacts of climate change in Zambia. Since these are the major drivers of the nation's economy a lot has to be put in place to minimize impacts. The current national water and climate change governance were assessed and show that Zambia is on the right track in the governance of Climate change impacts on water resources. However, the study reviewed that the current water and climate change governance may not be robust enough to cope with all potential impacts. In many parts of the nation, water management cannot sufficiently cope with all observed impacts, such that large flood and drought damages occur. That is, water and climate governance in Zambia has not reached a stage where it can adequately improve access to water and prevent pollution and depletion of water resources. Luckily, there are enough opportunities for integrating climate change adaptation and mitigation measures in river basin management planning. All water related projects (e.g. Hydropower generation and Irrigated agriculture) need to take into consideration climate change impacts on water resources to enable sufficient and stable future water supply. The nation's major hindrance to fully adapting to climate change is the absence of implementation of the water law, policy and strategies worsened by cross-cutting factors such as: corruption, (political) cowardice, tribalism, greediness, nepotism, and HIV/AIDS, as well as poverty and Lack of education. Data and many studies on emergency events in Zambia suggest a drastic increase mainly in the flood events. However, they do not vividly show whether this trend is due to an increase in precipitation or whether underlying sensitivity factors such as changes in land-use patterns (e.g. cultivation of flood-prone land, deforestation, etc.) play a more significant role. Lack of continuous data in the water sector is a big hindrance to reliable information on how climate change will affect Zambia's water resources. There is need to fully operationalize IWRM principles, improve the hydrological network, and for flexible solutions.

Keywords: *Climate change impacts; Water governance; Climate change governance; Water related problems; Policy responses; Integrated water resources management*

Introduction

"If the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin." Charles Darwin. In addition, it is often claimed that clean water tends to gravitate towards the rich and wastewater towards the poor. According to WWDR2, [1], lack of basic services in many nations, is often due to mismanagement, corruption, lack of appropriate institutions, bureaucratic inertia and a shortage of new investments in building human capacity, as well as physical infrastructure.

Climate change impacts are a great challenge to Zambia and water-related vulnerability occurs through many ways and linkages, i.e. health, food security and energy, as well as physical and economic vulnerabilities. If the current trend continues extreme cases may result in famine and loss of key assets and lives. The nation needs to constantly update and implement its nation adaptation strategies while devising more mechanisms and procedures for climate screening and proofing in the water and related sectors. There is a great need for

Citation: Stephen Siwila. "A Mini-Review on Zambia's Water Governance in a Changing Climate". *EC Agriculture* 2.2 (2015): 285-299.

public awareness on Climate change impacts on water. Lack of continuous data in the water sector is a big hindrance to reliable information on how climate change will affect Zambia's water resources [2]. "Water is the primary way that climate change will impact people, society and ecosystems" [3].

Many studies have clearly shown that it is an un-disputable that climate change impacts will exacerbate deadly events e.g. extreme floods. Therefore for everyone concerned with future water supply and use, whether as municipal utility officials or as developers, real estate professionals, water resources engineers, environment engineers, politicians and citizens at large, there is high need to pay close attention to climate change projections and their potential impacts on the water sector [4].

Data and studies on emergency events in Zambia suggest a drastic increase mainly in the flood events. However, they do not vividly show whether this trend is due to an increase in precipitation or whether underlying sensitivity factors such as changes in land-use patterns (e.g. cultivation of flood-prone land, deforestation, etc.) play a much more significant role. Water availability and poor water management are already at the root of vulnerability for Zambia and this is likely to worsen with future climate changes, having adverse impacts on development progress and achievement of MDGs [2]; hence, adaptation strategies are urgently needed. Future hydropower projects need to take into consideration climate scenarios to allow hydropower plants to have sufficient and stable water supply in the future. The study among other things reviewed water governance in relation to such critical issues and contributed to national river basin management planning strategies in a climate changing scenario.

Study area Description

Zambia is a landlocked country in south central Africa between latitudes 8 degrees and 18 degrees south, and longitudes 22 degrees and 33 degrees east and covers an area of approximately 752160 Km². Zambia is bordered by 8 countries, in the south by Namibia, Botswana and Zimbabwe, in the east by Zimbabwe, Mozambique, Malawi and Tanzania, in the north by the Democratic Republic of Congo and Tanzania and in the west by Angola. About 75% of Zambia lies in the Zambezi River basin and 25% in the Congo River basin in the north. Zambia sits on the high plateau of Central Africa at an average altitude of about 1,200 meters, and enjoys a mild, subtropical climate [5].



Figure 1: Map of Zambia indicating the neighboring countries (source: <http://www.yourchildlearns.com/online-atlas/zambia-map.htm>).

Water Resources Availability in Zambia

The nation generates an estimated 100 billion m³ per year of surface water-with the Zambezi River contributing over 60% of the runoff-and an estimated annual renewable groundwater potential of 49.6 billion m³ per year (estimated annual groundwater potential is based on an estimated annual recharge with very little variations from year to year) [5,6]. Much of surface water is poorly distributed

while groundwater is fairly well distributed. However, most of this water needs to be developed to meet present and future demand for many uses e.g. irrigation, domestic water supply and hydropower generation (MEWD, 2010). Zambia has sufficient water resources but success in addressing water related problems largely depends on how plans and strategies for water resources and environmental management are implemented [5].

Surface Water Situation in Zambia

In most cases the surface water trends follow the rainfall trends because of quick response to seasonal rainfall pattern by surface waters and in normal hydrological years Zambia generates enough surface water to meet current demand [6]. The spatial distribution over the seasons is however very poor, especially, in the southern parts of Zambia where drought frequency is highest. Most of the surface water is confined to the major rivers and lakes including: the Zambezi, Luapula, Chambeshi, Luangwa, Kafue, and Tanganyika and surprisingly enough, the southern part of the nation has more surface water flows only because of the presence of large rivers like Zambezi, Kafue and Luangwa rivers [6].

Ground Water Situation in Zambia

There is availability of good quantity and well distributed groundwater resources in the nation. However, these resources are not fully developed to meet the ever increasing water demands. Currently, ground water is the most reliable source for drinking, domestic and other uses, particularly in rural areas [6]. It is the major resource, especially during the dry season and sustains stream flow during the dry season for perennial rivers and streams contributing about 30 to 90% of the total flows [6]. At the moment, there is inadequate data to make accurate assessments of groundwater resource availability while the unregulated exploitation of groundwater and exposure to pollution is a big threat to this important source of water [6].

Water Demand and Use in Zambia

Water demand is basically the quantity of water of a specified quality required to meet a user requirement. In Zambia, water is used for consumptive uses including: agriculture, industry and municipal water supply, which includes drinking water supply. Like in any other country, water is indeed everyone's business and an essential resource to all aspects of society. Hydropower generation (a non-consumptive use) is by far the largest user of water and uses about 94% while agriculture uses about 5% and only about 1% goes to domestic and industrial water supply [5]. Of about 38.5 billion m³ of overall water withdrawal, 36.3 billion m³ is used to generate electricity for internal use and export to neighbouring countries while about 70% of the country's hydropower potential awaits development [5].

Institutional Set Up For Zambia's Water Sector

The water sector consists of two sub-sectors namely, Water Resources Management and Development (WRMD) and Water Supply and Sanitation (WSS). Key sectors e.g. mining, industry, agriculture, housing and energy need enough water for development. Developments in these sectors impact on quality and quantity of available water resources, hence, the need to protect the resource by effectively coordinating and regulating sectoral activities. Table 1 gives a summary of major players in Zambia's water sector and their Roles.

Water Resources Management and Development (WRMD) Sector

This sector falls under the Department of Water Affairs (DWA) and is responsible for sustainable management and development of water resources in order to secure provision of quality water to meet socioeconomic requirements of Zambia. The Ministry of Energy and Water Development (MEWD) is responsible for initiating national water management policies and setting national standards and priorities for water development and management. MEWD is also responsible for planning and construction of wells, dams and boreholes to promote irrigation and mitigate effects of droughts, floods and related emergencies [7].

Ministry of Energy & Water Development (MEWD), Water Resources Management Authority (WARMA)	National water policy
	National water policy
	Management and development of water resources
	Regulate water resources and hydropower generation
MLGH (Ministry of Local Government and Department of Infrastructure and overseeing Support Services (DISS))	WSS sub-sector policy, strategy elaboration and hous- ing), service provision to urban and rural areas by local authorities and the commercial water utilities
	Resource mobilization
Department of Agriculture, MLGH and Ministry of Health	Strategy elaboration (i.e. irrigation policy), sanitation and hygiene promotion
Statutory Bodies: NWASCO, Water Development Board, Environment Management Agency)	Advisory and regulatory roles
	Pollution Control (Zambia Environment Management Agency)
Commercial Utilities (CUs)	Service provision
Local Authorities	Service provision in rural and urban areas; in urban areas service provision is delegated to Commercial Utilities (CUs)
Training and research Institutions e.g. University of Zambia, NISIR and Copperbelt University (CBU)	Human resource training
	Research
Cooperating partners and NGOs	Provision of capital funds
	Execution of WSS programmes and projects by NGOs
Private Sector	Participation in financing and management of WSS
	Consulting services
	Construction of WSS facilities
Community and CBOs	Beneficiary of WSS services
	Maintenance of sources

Table 1: Major players in Zambia's Water Sector and their Roles (Source: GRZ, 2006).

Water Supply and Sanitation (WSS) Sector

This sector caters for the following [7]:

- a. Services for human consumption, industrial, agricultural, mining and other uses for urban towns and centers. WSS is currently managed by ten commercial water utilities in the country.
- b. Provision and maintenance of adequate supply of water for human consumption and domestic use in rural areas. Water supply sources include boreholes, shallow water wells and springs. Sanitation aspects include promotion of hygiene education in rural communities and schools. Rural water supply and sanitation (RWSS) falls under Department of Infrastructure and Support Services (DISS) of Ministry of Local Government and Housing (MLGH), and implementation is decentralized to local authorities. The most significant strategy for RWSS is the Water Sanitation and Health Education (WASHE) adopted in 1996 with a goal of promoting integrated development of water, sanitation and health education enhancing impact of WSS on health and promoting community management to ensure sustainability of services through better financial support, operation and maintenance [7].

Water Supply and Sanitation (WSS) Sector

The principal Act presently governing the administration of water is the Water Act (cap.198) of the Laws of Zambia. The current Water Act is over 50years old and was enacted in 1949 and has since under gone very few amendments. It is restrictive in nature as its jurisdiction is limited to consideration, issuing and monitoring of water rights [6]. The act does not deal with shared water courses

or ground water management and does not reflect all issues of reasonableness and equity [6]. Besides, the current Water Act does not apply to:

1. The Western Province
2. The Zambezi River
3. The Luapula River
4. That portion of the Luangwa River which constitutes the boundary between Zambia and
5. Mozambique.

The current Water Act is inadequate in many ways and does not provide for [6]:

1. Clear principles for WRM
2. Equitable and reasonable principles for water allocation
3. Management of international waters
4. Development, management and utilization of groundwater
5. Involvement of stakeholders at lowest appropriate level in decision making
6. Harmonization in WRM at institutional level
7. Adequate involvement of traditional authorities in management of water resources.

Hence, the current Act has many limitations which have highly hindered sustainable use of water resources and negatively impacted on the control, quality and availability of water. Additionally, the legal framework for water management and development is complemented by various Acts of parliament which include the once in table 2 [6]:

The Constitution of Zambia	The Forestry Act No. 7 of 1999
The Local Government Act Cap 281(enacted in 1991)	The Public Health Act Cap 295
The Water Supply and Sanitation Act No. 28 of 1997	The Zambezi River Authority Act Cap 467
The Energy Regulation Act. Cap 436 (enacted in 1995)	The Town and Country Planning Act Cap 283
The Fisheries Act Cap 200 (enacted in 1974)	The Mines and Minerals Development Act No.7 of 2008
The Tourism and Hospitality Act No.23 of 2007	The Inland Water Shipping Act Cap 466 (enacted in 1961)
The Environmental Protection and Pollution Control Act Cap 204	The Lands Act Cap184 (enacted in 1995)
The Zambia Wildlife Act No. 12 of 1998	The Citizens Economic Empowerment Act; and
The National Heritage Conservation Act Chapter 173	The Zambia Development Agency Act

Table 2: *Complementing Acts to the Water Act (MEWD, 2010).*

Zambia’s 2010 Revised Water Policy and Implementation Framework

The GRZ recently adopted a new water policy namely the 2010 Water Policy. The water policy provides the overall policy framework for the water sector. It covers WRM, urban WSS (water quality and quantity, water tariffs) and RWSS. The seven key principles which guide the water policy are as follows [6]:

1. Separation of WRM from WSS
2. Separation of regulatory and executive functions in the WSS sector
3. Devolution of authority from central government to local authorities and private sector
4. Achievement of full cost recovery for WSS services through user charges in the long run
5. Human resources development leading to more effective institutions
6. The use of more appropriate technologies for local conditions and
7. Increasing government spending priority and budget spending to the water sector.

Institutional Arrangement and Coordination of the Water Sector

The Ministry responsible for water, as lead institution in the water sector, has been mandated to carry out the following responsibilities [6]:

1. In consultation with other stakeholders promulgate a National WRM strategy and plan to facilitate the proper management, development and utilization of the resource in accordance with the provisions of the Policy
2. Ensuring effective implementation of the National Water Policy
3. Coordinating of all policy implementation functions of a sector and cross sector nature
4. Ensuring the monitoring and evaluation of the implementation of the water Policy through collaborative and consultative arrangements
5. Coordinating the Water Sector Advisory group and
6. Monitoring and coordinating cross-sector issues and their implementation.

Recognizing that coordination was weak among sectors of Government, the government in 2003 introduced Sector Advisory Groups (SAGs) as a vehicle for contributing to the process of planning, implementation, monitoring and evaluation of poverty reduction programmes in the implementation of the Fifth National Development Plan [6]. The Water Sector Advisory Group (WSAG) has been organized into four strategic inter-sectoral sub-committees which include

1. Water Resources Management
2. Water Resources Infrastructure Development
3. WSS
4. Monitoring, Evaluation and Capacity Building. The SAGs act as government advisors on sector policy issues on budget consolidation in line with national priorities and implementation of programmes [6].

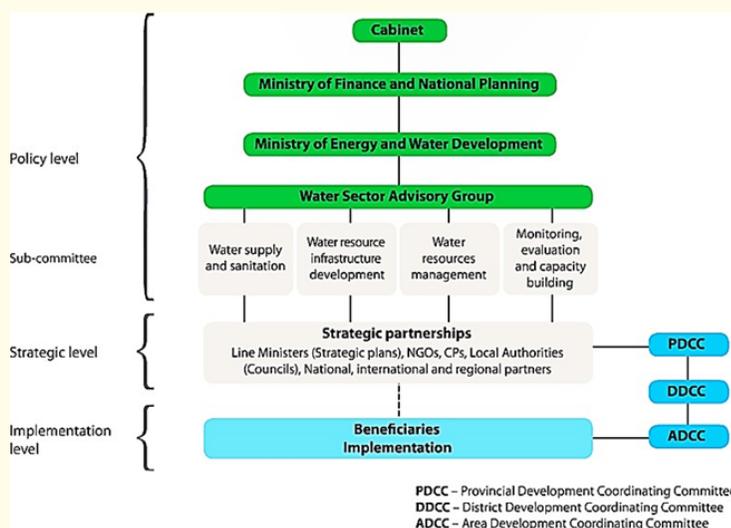


Figure 2: Water sector Coordination arrangements in Zambia (IWRM plan, 2007-2030).

The Water SAG is operational and provides useful technical advice and direction for the sector and is chaired by MEWD. Stakeholders represented in the Water SAG include: line ministries, statutory institutions, cooperating partners, academic and research institutions, civil society and NGOs and membership is open to any organization interested in the sector [6].

Decentralization: The new focus in WRM is using the river basin as the management unit. The approach seeks to empower stakeholders in a particular locality with the ability and responsibility to make decisions regarding WRM in a specific basin. RBM of water resources will transcend provincial and district boundaries. The approach will be boosted by the decentralization Policy whose goal is to empower local communities by devolving decision making authority, functions and resources from the center to lower levels (district and provincial levels). The national water policy and decentralization policy have a direct link between them though the former takes administrative boundaries as the management unit [6].

Monitoring and Evaluation: The MEWD in collaboration with stakeholders has sought to develop verifiable indicators for the purpose of ensuring that the objectives of the water Policy are achieved in line with implementation plans.

Water and Climate Change Policy Framework

The vision for the water sector is “a Zambia where all users have access to water and sanitation and utilize them in an efficient and sustainable manner for wealth creation and improved livelihood by 2030 and beyond” [8]. The IWRM/Water efficiency (WE) implementation plan developed in 2007 highly assisted in implementing water programmes in the fifth national development plan (FNDP) (2006-2010) and is now assisting implementation of the sixth national development plan (SNDP) (2011-2015). Full implementation of this plan may increase RBM capacity in a changing climate and raise adaptive potential for Zambia.

Zambia's National Water Policy on Climate Change

In the current 2010 water policy Climate change is considered as one of the serious threats to sustainable development, due to its potential adverse effects. The water policy states that the incidences of drought and floods the nation is experiencing are increasingly being attributed to a changing climate regime [6]. The policy further states that these extreme hydrological events have negatively affected the socio- economic development process and that a lot of resources meant for other development programmes have been diverted to solve these climatic eventualities [6]. Hence, the policy fully recognizes the fact that the nation needs to be prepared to address the growing challenges of climate change.

In order to address challenges of climate change, the national water policy has to this regard outlined the following measures to be implemented [6]:

1. Conducting public awareness to enlighten all citizens on climate change issues, including mitigation and adaptation measures
2. Assessing and monitoring the potential impact of climate change on natural resources especially woodlands, forests and wetlands
3. Investing in irrigation systems
4. Supplying clean and safe water to communities to prevent water borne diseases that come with floods/droughts
5. Developing and promoting alternative energy sources and technologies in order to reduce wood-fuel usage so as to protect woodlands, forests and wetlands
6. Strengthening the national hydro-meteorological databases plus monitoring networks.

Zambia's Climate Change Policy and Legislation

Climate Change Policy: Zambia has various policies related to impacts of climate change on water e.g. the National Policy on Environment (NPE) launched in July 2009; the National Forest Policy of 1998; the Policy for National Parks and Wildlife 1998 and the National Energy Policy 1994. The NPE has direct reference to climate change; while the other policies have provisions that have indirect bearing to climate change such as the National Energy Policy 1994 provision to “overcome the constraints preventing wider use of new and renewable sources of energy” has a bearing on climate change mitigation as most renewable energy is carbon neutral [9]. The NPE addresses climate change by addressing the four basic natural resources- climate, land, water and biological diversity, and key economic sectors which impact on environmental resources-agriculture, tourism, fisheries, forest, wildlife, mining, water, energy, industrial and commercial plus heritage sectors [9].

One of objectives of NPE is to minimize adverse impact of climate change and reduce air pollution and GHG emissions and states that “GHG emissions must be reduced; sinks enhanced and localized air pollution controlled especially in the urban environment”. The major weakness with the NPE is that it emphasizes more on climate change mitigation but inadequately covers adaptation. This is despite the fact that adaptation is a key developmental challenge for a developing country like Zambia. Hence, it can be justifiably concluded that there is currently no proper policy framework in Zambia to address climate change [9].

Climate Change Legislation: Though Zambia has no specific law on climate change, there are a number of sectoral laws which indirectly address aspects of climate change. These include the Water Act of 1948; the Wildlife Act of 1998; the Forest Act, No. 7 of 1999; the Energy Regulation Act of 1995. Zambia has embarked on strengthening international provisions to adequately provide for climate change adaptation and mitigation measures as agreed in the UNFCCC and Kyoto Protocol while reflecting the reality on ground. Besides, Zambia has no single institution with a clear mandate to coordinate climate change activities [9].

Zambia has a Disaster Management (DM) Act of 13th of April 2010 which created Disaster management and mitigation unit (DMMU) with legal authority for guiding DM, risk reduction and other DM operations. The Act has provisions aimed at mitigating climate disasters like need for “early warning systems covering all sectors”, and the “formulation of disaster prevention, mitigation and preparedness to meet all foreseeable requirements in consultation” with state and non-state actors. Aside that, the Environmental Protection and Pollution Control Act has provisions for minimizing impacts of climate change and reduce GHG emissions [9].

Existing and Planned National Adaptation Measures and Response Strategies As Relates To Climate Change Impacts on Water

It is highly important worldwide that responses to climate change must focus on water. That is, addressing water management is recognized as a priority, and is an inescapable part of reducing vulnerability and promoting adaptation to climate change [5].

National Response Options

The government of Zambia has responded to natural disasters resulting from climate change and has formulated the National DM Policy with legal framework for management and responding to natural disasters such as floods and droughts. The formulation of the National Adaptation Programme of Action to deal with climate change related issues was recently completed and is expected to be fully operational [10]. Agriculture is the main sector requiring the largest percentage of consumptive water use and hence a primary area for development of adaptation strategies. The main focus of the recently formulated national irrigation plan (NIP), is to make agriculture less dependent on rain, and provides for intensive exploitation of water resources for irrigation. However, national capacity on flood and drought forecasting is still very weak [10]. Conservation farming and the growing of drought resistant crops to support food security is still very low this needs to be fully promoted.

National Adaptation Programme of Action (NAPA)

Goal of the NAPA: The primary goal of the NAPA process is to broadly communicate to the international community priority activities that address Zambia's urgent needs for adapting to adverse impacts of climate change [10].

NAPA Specific Objectives: The NAPA process is a consultative, participatory and team building effort. Its main objective is to develop a plan of action for addressing concerns of the impacts of climate change in Zambia. Essentially, the NAPA contributes to [10]:

1. Adaptation strategies to identified adverse impacts of climate change as a road map
2. National objectives of poverty reduction through sustained economic growth, employment creation and enhancement of food security
3. Achievement of the MDGs
4. Public awareness of the urgency to adapt to adverse effects of extreme weather events
5. Capacity building to address vulnerabilities to climate change and climate variability.

The Human Adaptive Capacity and Adaptation Strategies amongst Zambian Communities

Strategies to deal with increased CCIs on water are very similar amongst communities and include the ones given in table 3. Source of income and diversification capacity is the major difference amongst Zambian communities [10]. Some communities have access to more natural resources (wild foods, non-timber forest products, fish, etc.) while others have a higher level of specialization, education, expertise (e.g. specialized charcoal makers), coordination and institutional support than other communities, enhancing their adaptive capacity [10]. Besides, there are major differences in the extent of agricultural knowledge and adaptation strategies associated to crop management (crop rotations, intercropping, mulching, etc.). It is clear that some adaptation to climate change impacts on water is taking place, as shown by the existing and proposed coping strategies undertaken by Zambian communities (table 3) however, these strategies may not be sufficient to effectively deal with all present and future climate change impacts.

Droughts	Floods	Shorter Rainy Season
Income diversification (charcoal making, fishing, honey and beer production, selling grass and livestock, casual labor) to buy food	Income diversification (charcoal, crafts, mats and beer making, fishing, grass selling, casual labor) to buy food	Using medicinal plants to treat diseases
Trading other commodities for food	Trading other commodities for food	Boiling water or treating it with chlorine to prevent diseases
Gathering and selling wild food	Gathering and selling wild food	Going to the medical clinic
Food rationing	Shifting agricultural production, livestock and houses to higher lands	Buying and using mosquito nets
Selling less crops to keep more for household consumption	Using medicinal plants to treat diseases	Working earlier in the morning
Shifting agricultural production from highlands to lower lands	Boiling water or treating it with chlorine to prevent diseases	Buying medicines for cattle
Earlier crop planting	Bury ditches to prevent waterborne diseases Early evacuation when water levels increase	Income diversification (e.g. agricultural production to cope with decreased fish stocks; charcoal production to cope with crop loss)
Growing more drought resistant crops (e.g. cassava)	Improve drainage around houses	Trading other commodities for food Earlier crop planting
Incorporation of crop residues instead of burning	Putting plastic on top of houses	Taking animals out early in the morning
Crop rotations, intercropping, and cover cropping	If houses are destroyed, build temporary shelters or live temporarily with neighbors	Using zero-grazing for some animals
Irrigation (practiced by very few)		Income diversification (selling charcoal, livestock or grass; casual labor)
Sinking wells		Selling less crops to keep more for household Consumption
Walking longer distances to get water		Gathering wild food
Using medicinal plants to treat diseases		Buying seeds for the next growing season
Going to medical clinics		Exchanging crop seeds between community members or villages
Boiling water or treating it with chlorine		
Getting support from NGOs and the govt.		

Table 3: Adaptation to Climate Change Impacts on Water by Zambian Communities (MTENR, 2007).

National Climate Change Adaptation Strategies for Key Sectors

Water sector: With its natural endowment of renewable freshwater resource of 105.2 billion m³ which amounts to about 8800m³ per capita per annum under normal circumstances, Zambia is classified as a water-rich country [10]. However, climate models indicate that climate change will result in some areas receiving less than normal average precipitation. Additionally, projections show that even for areas where rainfall amount may not change, much of it would fall over a shorter period of time than in the past, creating periods of dry spells. Existing and proposed interventions include in the water sector include [10]:

1. Enhanced investments in water capture and storage/abstraction infrastructure such as dams, strategic boreholes, and tanks to ensure availability of water during dry seasons
2. De-silting of dams to increase their water storage volume
3. Construction/improvement of drainage systems as well as revision of the construction designs of water management infrastructure (drainage, culverts, etc.)
4. Protecting flood prone areas by putting in place adequate hydrometric network and flood warning systems to monitor river flows and flood regimes and construction of dykes
5. Investment in appropriate rainfall measuring equipment and training of personnel to protect watersheds and monitor water quality
6. Construction of inter-basin water transfers (waterways) to channel water from areas with excess water to areas with deficit and protection of wetlands ("dambos")
7. Enforcement and/or enactment of laws and regulations required for efficient WRM and promote full participation of women in implementation of the water policy
8. Protection and conservation of catchments, river- banks, and water bodies from degradation
9. Developing and monitoring artificial re-charging of groundwater for threatened aquifers.

Crop Sub-Sector

Rain-fed agriculture is an important livelihood source and employs over 85% of Zambia's labor force. Existing and proposed adaptation strategies include [9]:

1. Increased support to ZMD's early warning system to facilitate timely dissemination of weather information and enhance preparedness and develop information platforms
2. Enhancing and encouraging crop diversification including the cultivation and consumption of indigenous
3. and more drought tolerant crops e.g. cassava, millet and sweet potatoes
4. Promoting appropriate irrigation technologies suitable for each agro-ecological zone
5. Addressing soil and land degradation by promoting improved soil and land management practices such as conservation agriculture (CA) and agro forestry
6. Diversification of rural economies, e.g. through value addition to agricultural products, livestock keeping and the creation of other ventures e.g. apiculture
7. Enhanced financial and technical support to agricultural sector research and development (R&D), e.g. research that aims to produce drought tolerant varieties
8. Enhanced dissemination of crop varieties able to withstand adverse weather conditions
9. Enhanced investment in water harvesting storage infrastructure for agricultural purposes.

Fisheries Sub-Sector

According to MTENR, 2010, promotion of aquaculture and capture fisheries can enhance the resilience of communities to climatic shocks. However, aquaculture and capture fisheries are also vulnerable to impacts climate change on water. Existing and proposed strategies for both aquaculture and capture fisheries include [9]:

1. Investment in fish hatcheries and water harvesting plus storage
2. Capacity building in water forecasting and utilization in planning aquaculture

3. Promotion of cage fish culture even in dams
4. Research in predation control in line with seasonal variations
5. Promotion of techniques that reduce flood effects and temperature control mechanisms
6. Identification and protection of fish breeding sites in capture fisheries
7. Value addition to fisheries products (e.g. by training fishermen in post-harvest technologies).

Forestry Sector

Forests are very important for IWRM sustainability. Zambia over the past decades, has been losing its massive forest cover at about 30,000 hectares per year due to factors such as clearing forests for settlements and agriculture, illegal logging for commercial purposes, and encroachment into forest reserves. Climate change is likely to increase the pressures that forests are already facing, as tree mortality increases with reduced rainfall, and incidences of pest, diseases and forest fires rise. The existing and proposed strategies include [9]:

1. Intensified and sustained afforestation and reforestation programmes
2. Promoting agroforestry as a way of meeting both food and wood-fuel needs
3. Promoting non-timber livelihood activities e.g. beekeeping to preserve forests
4. Researching and promoting of alternative energy sources, energy conservation initiatives, efficient charcoal production and utilization technologies to reduce wood-fuel consumption
5. Involving forest-dependent rural communities in forests management through an institutional framework that recognizes and defines their role.

Energy Sector: About 75% of Zambia's energy needs is met by biomass energy, mainly being firewood, charcoal and agricultural waste [9]. Most biomass energy is used by rural households, the urban poor and small businesses. Zambia greatly depends on hydropower generation which depends on water resources availability and electricity production in Zambia is 99% hydro based [10]; hence any changes in rainfall can have significant impact on hydropower potential. Additionally, amounts of freshwater required for cooling power plants that use heat to generate electricity are quite high. The strategies include [9]:

1. Promotion of efficient utilization of hydro-schemes' upstream water to enhance or ensure availability of water downstream for hydro-power production
2. Research and feasibility studies into inter-basin water transfer
3. Promoting energy system diversification by:
4. Promoting the use of alternative renewable energy such as solar, biomass, wind, bio-fuels and associated technologies
5. Promote efficient wood-fuel cook stoves, solar, LPG cookers and pre-paid meters.

Mining Sector: The mining industry faces climate change challenges classified as direct (e.g. flooding of mines) or indirect (e.g. inadequate cooling water). Strategies include [9]:

1. Implementation of efficient resources (e.g. water) utilization
2. Investment in dust suppression measures and technologies
3. Appropriate design of tailing lagoons/effluent discharge systems that take into consideration flooding and water scarcity (drought) conditions.

Tourism Sector: Tourism is one of the main foreign exchange earners and largely depends on wildlife, which in turn depends on rangelands. Extended dry periods which periodically affect rangelands could lead to devastating effects on wildlife, and reduce tourism. Existing and proposed adaptation strategies in this sector include [9]:

1. Improving the carrying capacity of rangelands (e.g. through construction of watering-points/dams in parks and animal translocation)
2. Monitoring, management and restoration of degraded rangelands
3. Encouraging participatory approach to rangeland management involving communities living in or around wildlife-protected areas, and whose livelihoods depend on rangeland resources.

Health Sector: Zambia is vulnerable to a number of climate change-sensitive diseases including malaria, cholera, diarrhea, rift valley fever and dengue. The strategies include [9]:

1. Ensuring adequate water supply during droughts (e.g. through adequate water capture infrastructure) so as to reduce water-borne diseases such as sore eyes, scabies, trachoma etc.
2. Introduction of waste management interventions by the provision of approved and appropriate means of health care waste management
3. Improving access to clean water and sanitary facilities to limit outbreaks of waterborne diseases, alongside strong public awareness programmes to promote better hygiene
4. Developing climate resilient national water and sanitation policy
5. Creating 'green spaces' in urban centers, i.e. planting trees in urban centers to moderate temperatures and ensure fresh air for healthy living
6. Promote sustainable medical facilities and practices
7. Renovate and rehabilitate existing health infrastructure to minimum acceptable standards.

Social Infrastructure and Human Settlements: Citizens that will be largely affected by climate change are those residing in peri-urban, slum neighbor hoods and regions prone to drought, floods and geological movements (e.g. landslides). The strategies include [9]:

1. Proper planning of urban settlements e.g. ensuring proper housing structures, adequate waste disposal facilities and piped water supply
2. Relocation of humans e.g. from flood-prone areas to alternative safer areas
3. Developing climate change awareness programmes involving all stakeholders
4. Establishing insurance schemes to make reparations to affected persons and communities
5. Diversifying economic activities to improve resilience to rural communities dependent on climate-sensitive sectors such as agriculture and livestock rearing.

Physical Infrastructure: Climate change is already threatening vital infrastructure such as road and rail networks as well as water and energy systems. Hence, as Zambia expands and modernizes the infrastructure, it is important to introduce measures to ensure resilience of infrastructure over its lifespan, in a changing climate, i.e. climate-proofing the infrastructure. Proposed and existing strategies include the following [9]:

1. Introducing changes infrastructure designs (e.g. enhancement of designs for roads, bridges and drainage systems to suit different climatic scenarios)
2. Revising building codes and factoring in impacts of climate change
3. Creating a strategic fund for responding to damages caused to key infrastructure.

International Water and Climate Change Instruments Ratified by Zambia

Zambia has signed and ratified several international instruments that directly relate to water, biodiversity protection and climate change which include the following:

The United Nations Framework Convention on Climate Change (UNFCCC): The ultimate aim for the convention is stabilization of GHG concentrations to the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This convention was adopted on 9th May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro, Brazil by more than 150 countries. Zambia has started implementing its commitments under the Convention and submitted its Initial National Communication (INC) to the UNFCCC Secretariat in 2004 and second national communication in 2010 [2].

The Kyoto Protocol: This treaty was signed at the 3rd session of the Conference of Parties (COP) in Tokyo, Japan in 1997. Under the Protocol, countries agreed to reduce their anthropogenic GHG emissions by at least 5% below 1990 levels in the period 2008 to 2012. The protocol contains legally binding commitments including the UNFCCC. Zambia has since ratified the UNFCCC and deposited the Kyoto Protocol instruments [2].

The UN Convention on the Law of the Non-Navigational Uses of Shared Watercourses 1997: Though, this framework convention is not yet in full force it provides a sound basis for managing shared watercourses. Zambia was one of the first countries to sign and ratify the convention. The convention is an important framework for cooperation in Shared Watercourses and international waters [6].

The Revised SADC Protocol on Shared Watercourses 2000: The Protocol was greatly influenced by the Helsinki Rules of 1966, the Dublin Principles, Agenda 21, and the UN Convention and is a framework for cooperation on sustainable utilization of shared watercourses in SADC [6]. It has been ratified by Zambia awaiting implementation.

Zambezi River Authority Act, 1987: It is an agreement between Zambia and Zimbabwe for the environmentally sound management of the common Zambezi river system. The Zambezi scheme as defined in the Agreement is "the Kariba complex and any additional dams, reservoirs and installations that may be developed on the Zambezi river" [6].

Millennium Development Goals: Eight United Nations MDGs define the main areas of global concern that affect development and related activities. Three MDG goals of greatest importance to Zambia's water governance include: Goal 1, Eradicate extreme poverty and hunger; Goal 6, Diseases, and; Goal 7, take measures to ensure environmental sustainability. Accordingly, the national water policy embraces the socio- economic issues that impact on water and highly recognizes the role of water in achieving the MDGs [6].

Conclusion and Recommendations

The current national water and climate change governance shows that Zambia is on the right track in the governance of CCIs on water. However, it may not be robust enough to cope with all potential impacts. In many parts of the nation, water management cannot sufficiently cope with all observed impacts, such that large flood and drought damages occur. That is, water and climate governance has not fully succeeded to adequately improve access to water and prevent pollution and depletion of water resources. Luckily, there are enough opportunities for integrating climate change adaptation and mitigation measures in RBMP. Hydropower and Irrigation projects have to take into consideration CCIs on water to enable hydropower plants and irrigation projects to have sufficient and stable future water supply. A guidance document by UNECE published in 2009 states that implementing IWRM will support adaptation to climate change by e.g. planning at basin level, strong inter-sectoral cooperation, public participation and making best use of water resources [11]. Zambia could learn from UNECE, EU and USEPA in terms of IWRM and RBM principles and ensure full implementation of the 2007-2030 IWRM/WE plan [12].

The nation's major hindrance to fully adapting to climate change is the absence of implementation of the water law, policy and strategies worsened by cross-cutting factors such as: corruption, (political) cowardice, tribalism, greediness, nepotism, and HIV/AIDS, as well as poverty and Lack of education. Agriculture and Hydropower development are sectors which have felt and are more likely to experience the worst impacts of climate change. Since these are the major drivers of Zambia's economy a lot has to be put in place to minimize impacts. Currently, only one third of the citizenry has access to electricity which is mainly from hydropower and on average Zambia earns at least US \$10 million per year on electricity exports. The question is what could happen if the current hydropower potential declined? Factors, e.g. population growth and un- sustainable land use could worsen the impacts [13-17].

Recommendations: Actions for Sustainable Adaptation to Climate Change in Zambia

1. Establishing a national water resources authority and developing or adopting a water framework directory to cutter for: surface water, ground water, storm water, drinking water, waste water, marine water, solid and liquid waste management, etc.
2. Taking into consideration different climate scenarios when designing and constructing infrastructure such as dykes, dams, boreholes, canals, bridges, roads, culverts, schools, etc. For instance, dykes, levees and storage dams are particularly dangerous when design thresholds are exceeded in that unexpected failure can result in a rapid rise in water level and make evacuation and emergency protection extremely difficult.
3. Frequent maintenance, optimization and updating of critical infrastructure e.g. water treatment plants, pump stations, hydro-power equipment, roads, bridges, etc.

4. Increased funding by central government into the water sector; re-enforced climate and water policy implementation, filling all vacant posts in the water and related sectors and increased professional capacity building for long term adaptation.
5. Promoting rain-water harvesting and storage infrastructure, water re-use and affordable water treatment and supply technologies plus full implementation of RBM plans.
6. Better demand management e.g. by adoption of sustainable agricultural strategies (organic fertilizers, agro-forestry, water efficient crops, etc.) and cropping patterns and improved water application methods, like drip irrigation promoting water use efficiency.
7. Water governance must be expanded to, and integrated with, non-water sectors and access to technology, science and information should be increased for sound planning.
8. The water and climate policy and legal frameworks need regular reviewing and updating for sector sustainability as well as promoting water engineering and related research.
9. Public awareness and sensitization campaign in climate change impacts: the general public needs to be sensitized on climate change issues and their implications.
10. Some people need to be re-settled to allow for redesign and improvement of drainage systems and there is need for stiff penalties on illegal quarrying and related activities.
11. Strengthening flood forecasting, hydrological networks and early warning systems.
12. Land-use planning at local or municipal level to reduce future flood and drought damages e.g. by integrating land-use planning for flood-prone areas into broader plans for urban and surrounding areas.
13. Though every effort needs to be made to reduce water related disasters through structural and non - structural measures, emphasis should be placed on preparedness with coping mechanisms as an option e.g. rehabilitation of natural drainage systems. That is, methods for coping with floods and droughts have to be encouraged and communities need to be involved in preparing NAPAs for floods and droughts.
14. An integrated approach is needed for water, land and energy management with scientific inputs from local research and academic institutions to enhance IWRM.

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Volume 2 Issue 2 September 2015

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