The Social and Economic Value of Water in Zambia

Summary of Key Narratives

Developed by: PEGASYS CHANGING LIVES CHANGING WORLDS

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FOREWORD

Water resources play a critical part in the economy of Zambia. As water underpins all three pillars of sustainable development, namely the economy, society and the environment, water challenges become an important aspect of the long-term economic growth and social upliftment of Zambia. Water resources, and the essential services they provide, are critical to achieving poverty reduction, inclusive growth, public health, food security, human dignity for all, as well as long-lasting harmony with Earth. Meeting the needs of this development places significant pressure on water resources, as sectors such as agriculture, energy, and industries are dependent on water resources; sectors also influence the use, impacts and governance of water resources and the livelihoods of the population of Zambia.

Zambia achieved Gross Domestic Product (GDP) growth of over 6% between 2010 and 2014, which was driven primarily by high global copper prices and robust investments in sectors such as construction, telecommunications, retail, and manufacturing. More recently, however, GDP growth is estimated to have slowed to 3.2% in 2015, with real economic growth falling to its lowest in 15 years. This was driven largely by a decrease in the price of copper, and the decline in agricultural output (due to poor rains). The 2016 agricultural season was also impacted by the El Niño weather effects. In addition, the electricity supply deficit (due to low water levels) caused slow economic growth, which is projected to continue.

This necessitates the understanding of the role that water plays in the economy, as well as the risks and opportunities that are offered by climate change, changes in water availability and quality, and cross-sectoral linkages. This includes the linkages with society and the environment, as well as the risks to continued economic development and social upliftment.

This report, which was led by Zambia Breweries, WWF Zambia and the Water Resources Management Authority (WARMA), aims to inspire water resource management and protection through strategies, policies and collective action. The report appeals to government leaders, the private sector, civil society and all members of society, to join forces to protect and share our most precious resource, and to build a more sustainable future for all.

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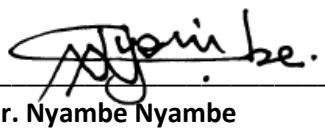

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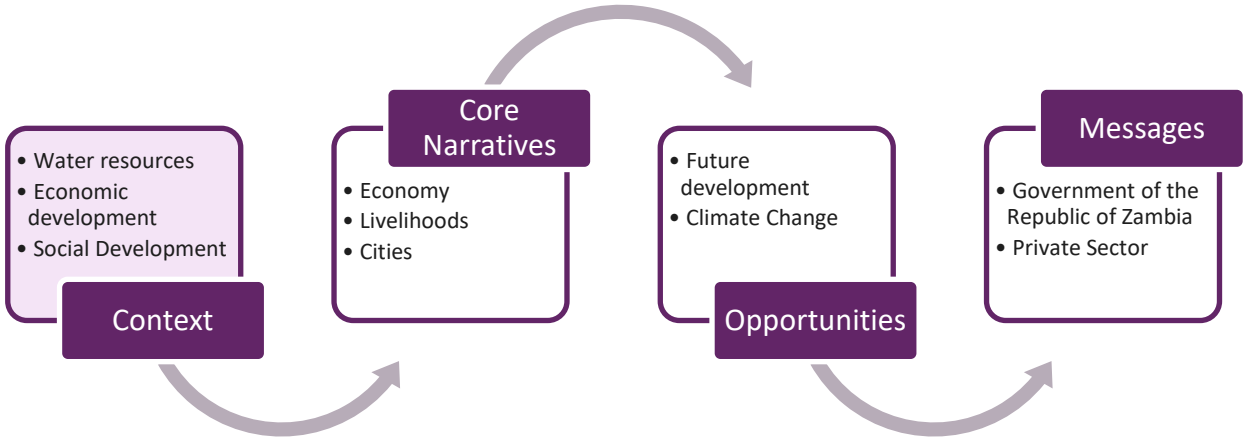
Executive Summary

The importance of water resources as a catalyst to support the Vision 2030 of Zambia, to become a "prosperous middle-income nation by 2030" is evident in documents such as national development plans. However, the practicality of implementing policies and activities in this regard is yet to be determined. There is an opportunity for Zambia, to leverage their comparative advantage with water resources, to drive sustainable development in the economy. There is an important role for the Zambian Government to play in this regard. However, there is also an important role for the Private Sector to play too.

The purpose of this document is to provide a high-level overview of emerging narratives regarding the role of water for the economy and society within Zambia. These narratives have been created following detailed research, coupled with a series of visits to Zambia by the project team, in collaboration with Zambia Breweries, WWF Zambia and the Water Resources Management Authority (WARMA) of Zambia.

The document begins with an overview of the various ways that water supports the social and economic areas of Zambia. Thereafter, the narratives associated with core challenges and opportunities in Zambia are introduced. These are loosely grouped into narratives about the economy, livelihoods and cities within Zambia. Thereafter long-term opportunities for water are explored within the context of the future of Zambia. This is both in terms of the future climate projections for Zambia in addition to the future development trajectory for Zambia. Finally, the document concludes with key messages for the various players in the economy of Zambia.



The Zambian Government already recognizes the fundamental role that water plays in the economy of Zambia through its national development plans. However, this needs to be given effect by continued strengthening and implementation of the governance mechanisms within the country. There is also a role for the private sector to play as they are fundamental to socio-economic development. Business leaders need to come together in understanding their role in supporting the government in addressing to water risks and opportunities in Zambia.

1. Social and Economic Value of Water in Zambia

Vision 2030 states the Zambian people's vision to become "A Prosperous Middle Income Nation by 2030".[1] Water underpins many of the sectors of the Zambian economy, and therefore needs to be considered in the development trajectory of Zambia. The development trajectory associated with this vision will have significant environmental and water impacts. Effective and efficient water resources management is essential for Zambia to achieve the objectives outlined in Vision 2030.

Between 2000 and 2014, Zambia achieved Gross Domestic Product (GDP) growth of over 6%, which was higher than the overall growth rate of sub-Saharan Africa, making Zambia one of the ten fastest growing economies in Africa at the time.[2] This positive growth has been driven primarily by high global copper prices and robust investments in sectors such as construction, telecommunications, retail, and manufacturing.[3] More recently, however, GDP growth is estimated to have slowed to 3.2% in 2015, with real economic growth falling to its lowest in 15 years. In addition to challenges in the mining sector (copper prices declined by 28% while mining output remained roughly the same as in 2014), maize output declined by 22% due to poor rains, among other factors. Slow economic growth is projected for the medium term as the electricity supply deficit continues (due to low water levels) and Zambia continues to import electricity from neighbouring countries. The 2016 agricultural season was also impacted by the El Niño weather effects.

The fall in commodity prices and the impact on the Zambian economy has been aptly summarised as follows: "**Zambia is facing its worst economic crisis in more than ten years, with falling copper prices, pressure on the government's operating and investment budget, and electricity supply shortages, affecting the real economy."**[4] As a result of the fluctuating economy, there are concerns whether the investment into infrastructure to enable access to resources such as water and electricity is keeping up with the longer-term demands on the economy.

Each of the sectors mentioned, which drive the economy of Zambia, are wholly reliant upon stable water supply. Mining is reliant upon hydropower to drive electricity needs, while agriculture is reliant upon water for irrigation. Therefore, it is evident that water plays a critical role underpinning the sustainable development (i.e. economic, social and environmental) of Zambia. Water resources, and the essential services they provide, are critical to achieving poverty reduction, inclusive growth, public health, food security, and livelihoods, as well as promoting environmental sustainability.[5] Water is a fundamental aspect of the long-term social and economic growth of Zambia.

The misconception of abundant water resource availability in Zambia is not helpful in supporting a strategic and integrated water resources management paradigm in the country. At a mathematical level, Zambia is perceived to be well endowed with water resources. This is because, according to the definition in the FAO Aquastat, "water stress starts when the water available in a country drops below 1 700 m^3/year per person".[6] But, Zambia's total renewable water resources[7] are estimated at 163.4 km^3 per year, which equates to an estimated renewable water

[1] Embassy of the Republic of China in the Republic of Zambia: http://zm2.mofcom.gov.cn/article/hostcountry/economyhost/201103/20110307477126.shtml
[2] AfDB: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Development_Effectiveness_Review_2013_ZAMBIA.pdf
[3] World Bank, 2015. Zambia Economic Brief.
[4] AfDB: https://www.afdb.org/en/countries/southern-africa/zambia/zambia-economic-outlook/
[5] WWAP, 2015. The United Nations World Water Development Report 2015: Water for a Sustainable World. WWAP (United Nations World Water Assessment Programme). Paris, UNESCO.
[6] FAO: http://www.fao.org/nr/water/aquastat/didyouknow/index2.stm
[7] Natural renewable water resources are the total amount of a country's water resources (internal and external resources), both surface water and groundwater, which is generated through the hydrological cycle. (http://www.fao.org/docrep/005/y4473e/y4473e06.htm)

resource per capita of 8 700 m^3 per year.[8] However, these figures hide the temporal and spatial difference in water resource abundance and availability in the different agro-ecological zones and catchments within Zambia. For instance, the Zambezi Catchment, on the Western part of Zambia represents 60% of the total runoff in Zambia. In a high rainfall hydrological year, the annual runoff can be as high as 130 km^3 per year. On the other hand, it can be as low as 68 km^3 in a severe drought year. Therefore, the perceived abundance of water resources is impacted significantly by inter-annual variability. This is indicated by the maps below, where it is evident that water resources are also not spatially distributed equally in Zambia.

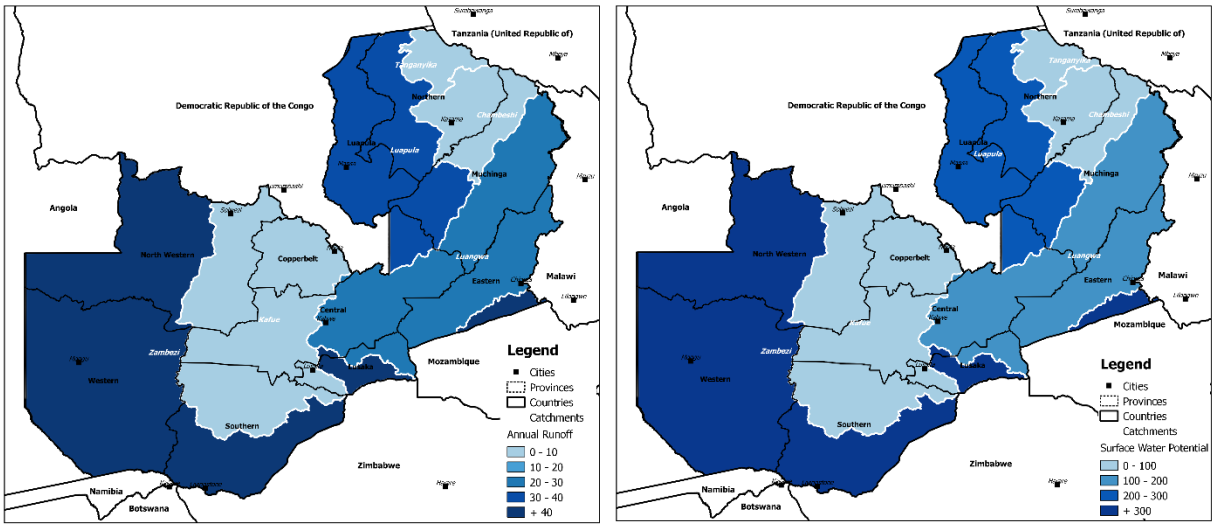


Figure 1: Annual Runoff (km^3) and Surface Water Potential in Zambia (million m^3)

In summary, at a national level, Zambia is not water stressed. However, in specific regions and areas, water scarcity is a challenge. For instance, in the Kafue, the economic heartland in Zambia, water allocation needs to be balanced among several sectors, namely irrigation (the majority of all Zambia's irrigation is used in the Kafue), hydropower (50% of hydropower is generated in the catchment), mining, conservation (the basin is home to the Kafue Flats Ramsar site) and water supply for the capital city (50% of Lusaka's water is piped from the Kafue basin, and this is set to grow to approximately 75% after completion of ongoing works). Therefore, water is becoming a contentious issue in the basin. This is likely to increase as the country continues on its growing development trajectory.

In Zambia, there are linkages between agriculture, fisheries, tourism, mining, and energy. All these sectors are underpinned by a dependence on water resources. Figure 5 provides an illustrative framework which is used in this report to communicate the different ways that water is integrated into the economy and society of Zambia. As depicted, there are three distinct lenses through which water is critical in Zambia. The first is for the entire economy. As a

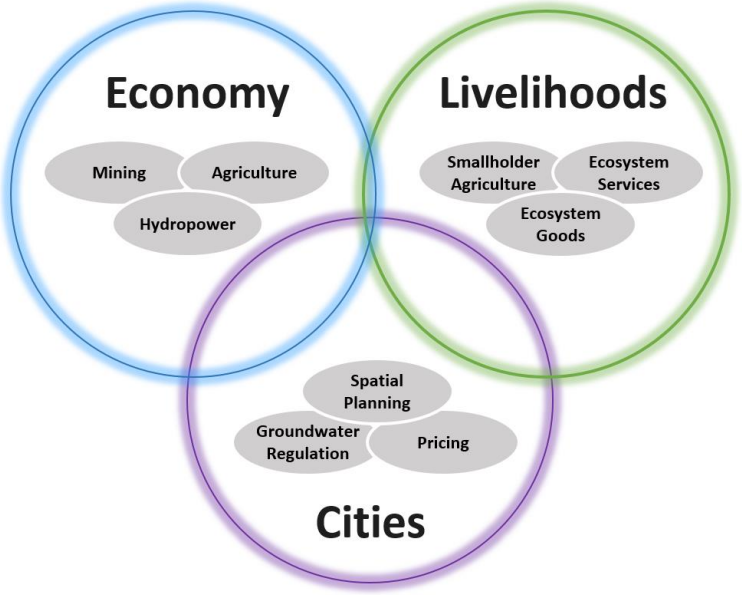


Figure 2: Framing of the role of water for the economy and society of Zambia

[8] AgWater, 2009. Zambia Situation Analysis. Agricultural Water Management National Situation Analysis Brief.

natural resource-based economy, Zambia is wholly dependent upon water resources for its economic growth. Secondly, water is critical for livelihoods in Zambia. This is true not only for smallholder agriculture, but also for the ecosystem goods and services that are provided to the 60% of people in Zambia that live in rural areas[9]. The same is true for the urban areas, and therefore, the third area where water underpins the economy and society of Zambia is through cities. Water in cities is at risk due to the high population growth rate, climate impacts on urban environments, inadequate spatial planning, as well as poor pricing of water to support infrastructure maintenance and capital investments.

These inter-linkages and dependencies represent an economy that is reliant on water, and a foreign exchange that is dependent upon produce that is not possible without water. For instance, approximately 77% of all exports from Zambia are through copper.[10] Copper mining in Zambia is not possible without the electricity generated through hydropower. Therefore, even the mining industry is reliant upon virtual water through hydropower. Locally, food production to feed the nation is obviously dependent upon water. This is of critical importance both in the rural areas, as well as in the cities of Zambia. This is the water-energy-food nexus currently under active discussion.

Water resources challenges are further compounded by an inadequate capacity to regulate and police water resources. Following the enactment of the Water Resources Management Act No 21 of 2011, and the subsequent establishment of the Water Resources Management Authority (WARMA), the regulation of water resources in the country is now well defined, and incorporates critical aspects such as groundwater and boreholes (which were not regulated under the repealed 1949 Water Act).

2. As a natural resource-based economy, Zambia is fundamentally dependent upon water resources

The first premise regarding the role of water in the economy and society of Zambia is centred upon the importance of water for enabling production that earns foreign exchange and results in positive GDP growth. Interestingly, many of the key products with the potential to be traded in foreign markets and generate foreign exchange are sensitive to global price fluctuations, particularly Zambia's major exports (i.e. sugar and copper). This makes Zambia's economy highly sensitive to the global economic shifts. This is supported by the following quote from World Bank (2016): *"In 2015, the Zambian economy experienced three simultaneous shocks to domestic output (poor harvest, power crisis, and sharply falling copper prices) which combined to place significant downward pressure on the exchange rate, upward pressure on domestic prices, and created further fiscal pressures. These*

[9] Trading Economics: http://www.tradingeconomics.com/zambia/rural-population-percent-of-total-population-wb-data.html
[10] World Bank, 2015. Zambia Economic Brief.

effects, in turn, combined to reduce investor confidence and further weaken the economy. The kwacha lost 41.6% of its value in just 12 months, while domestic prices rose by an average of 10.9% on an annual basis, and ended the year 21.1% higher than in December 2014."[11]

Of utmost importance when providing water for the economy, is sufficient water resource storage capacity to overcome variability of supply. This is especially true in sectors such as agriculture. However, this physical infrastructure that enables water supply should be supported by green infrastructure, such as wetlands and urban forests, and healthy ecosystems, such as freshwater and forest ecosystems.

Since the bulk of electricity produced in Zambia is hydropower, a prudent development trajectory would be, for example, an energy policy that reduces Zambia's reliance on water for energy. Although Zambia has a comparative advantage in terms of hydropower resources, it would be further supported by alternative renewable energy options and off-grid solutions, especially in the rural areas. Balanced development that provides stability of inputs such as water and energy will enable a fully functioning economy, that earns foreign exchange and results in positive GDP growth. This development needs to be underpinned by a functioning ecosystem.

Mining, as the cornerstone of Zambia's economy, represents significant embedded water

Mining is central to the economy of Zambia for both GDP (12% GDP) and foreign exchange earnings[12]. Copper is the most important export commodity for the country, representing 77% of total exports (Figure 3). Zambia is the second largest copper producer in Africa and the seventh largest in the world. It is also the world's second largest producer of cobalt, producing 19.7% of total global supply.[13] Therefore, the economy of Zambia and the mining and quarrying industry are closely interlinked.

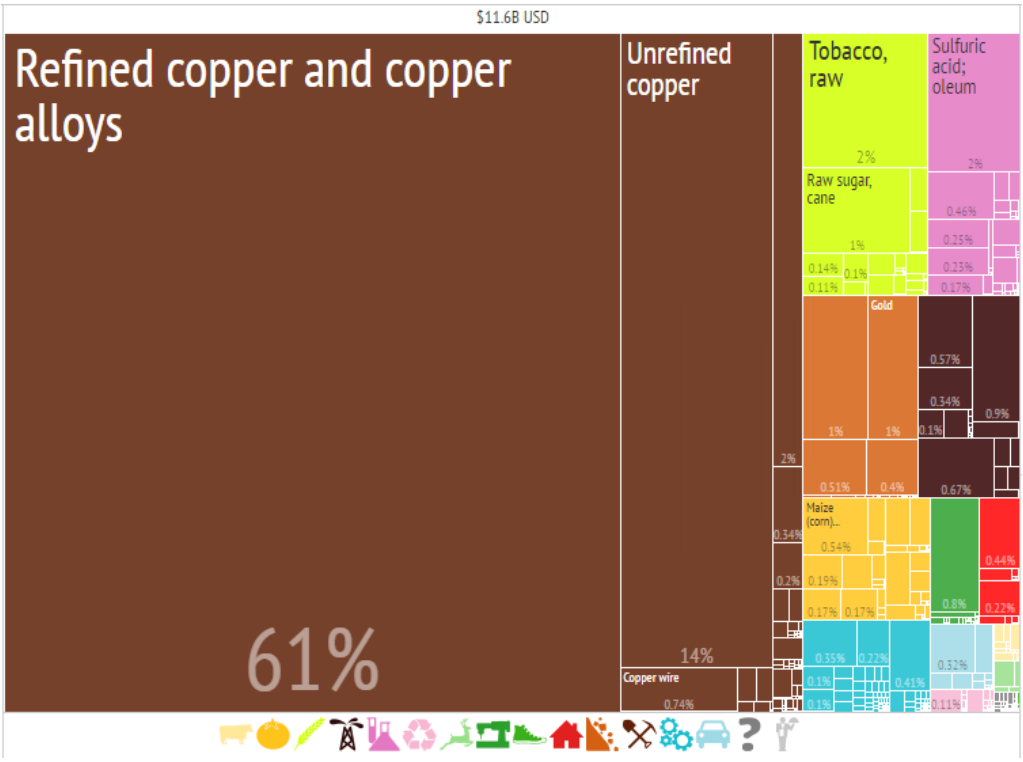


Figure 3: Zambian exports (2014)[14]

[11] World Bank: http://documents.worldbank.org/curated/en/858561475214134326/pdf/108615-WP-P157243-PUBLIC.pdf
[12] World Bank, 2016: http://www.worldbank.org/en/news/feature/2016/07/18/how-can-zambia-benefit-more-from-mining
[13] Sutton J and Langmead G, 2013. An Enterprise Map of Zambia
[14] Center of International Development, University of Havard: http://atlas.cid.harvard.edu/explore/tree_map/export/zmb/all/show/2014/

Zambia experienced a ten-year period of high real economic growth between 2004 and 2014, supported by a strong performance in the mining sector (real growth in the mining sector averaged 20.9% per annum), on account of rising copper prices and increased output (Figure 4). Growth levels were relatively lower between 2011 and 2014 as the copper price started to fall, but nonetheless still averaged 5.8% per annum.[15] The growth in the mining sector, and its contribution to Zambia's GDP, has also been decreasing since 2010 (Figure 4).

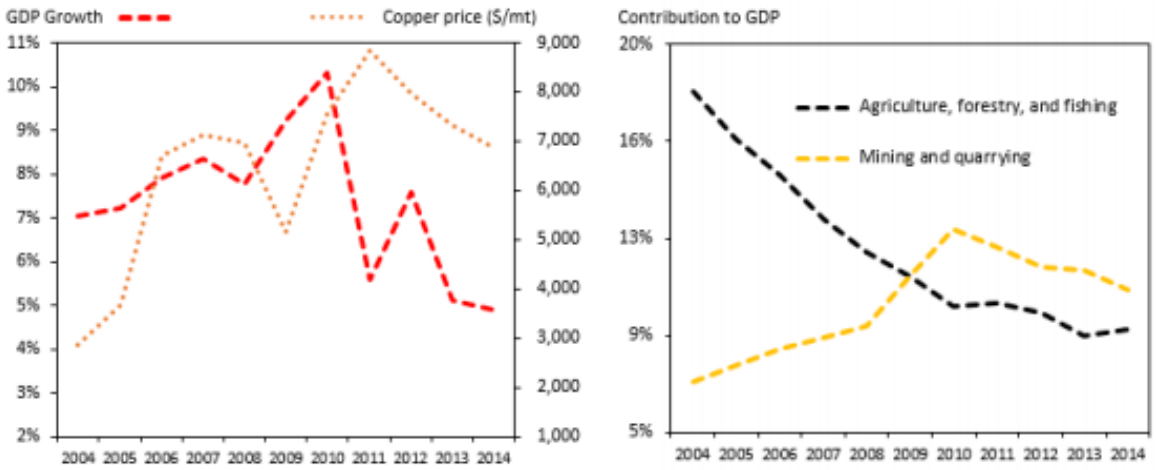


Figure 4: Zambia Growth in GDP 2004 – 2014 (left) and Contribution to GDP (right) (Source: WDI in World Bank, 2016)[16]

Copper prices fell sharply in 2015, losing almost 30% of its value over the course of a year. "Zambia's copper production was also affected by uncertainty over the mining tax and royalty regime, and the power shortages, leading to mine closures (7,700 jobs lost) and delayed investments. Overall, the value of copper exports fell by US$2.4 billion or 31% in 2015, contributing to a current account deficit of 3.5% of GDP. Given that copper accounts for over two-thirds of Zambia's exports, this decline created significant depreciation pressures on the kwacha."[17] The risk of high dependence upon mining in the Zambian economy is recognised by the President of Zambia: "Zambia possesses higher comparative advantages in mining, which has to be diversified away from copper to other precious minerals to include oil and gas exploration so as to mitigate against the changes in the prices of copper."[18]

Mining represented 57% of the total electricity consumption in 2015. And, since hydropower represents 95% of total electricity generation, mining is completely dependent upon the embedded water in power supply.

According to the Millennium Challenge Corporation (2013), hydropower generation 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.[19]

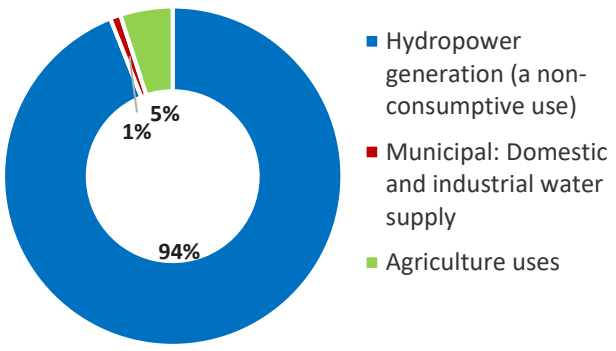


Figure 5: Water use per sector

[15] World Bank: http://documents.worldbank.org/curated/en/858561475214134326/pdf/108615-WP-P157243-PUBLIC.pdf
[16] World Bank: http://documents.worldbank.org/curated/en/858561475214134326/pdf/108615-WP-P157243-PUBLIC.pdf
[17] h World Bank: ttp://documents.worldbank.org/curated/en/858561475214134326/pdf/108615-WP-P157243-PUBLIC.pdf
[18] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.
[19] MCC, 2013. Business Opportunities in Zambia's Water Sector

Indirectly, mining also plays an important role in the flow of water in the Kafue. In the Upper Kafue, the mining industry currently impacts on water resources through water return flows (i.e. dewatering) and quality impacts. For instance, the Konkola Copper Mine, considered the world's wettest mine, discharges some 300 000 m^3 per day into the Kafue River.[20]

> ***"In mining, 1 ton of ore creates 3 tons of water. We need to be storing this resource."***
>
> ***Mine employee***

In Kabwe, lead smelting was largely unregulated in the past, leading to lead poisoning through contaminated dust. Although the smelting activities have now stopped, artisanal mining continues and still affects people in the area. The government has made attempts to clean up the area but many soils are still polluted and pose an acute health hazard. The remediation and restoration of Kabwe has been especially expensive for the Government of Zambia. It is important that we do not allow history to repeat itself in Kitwe and Ndola.

The majority of mining takes place in the Copperbelt and North-Western Provinces. However, in the long-term, as mines in the Copperbelt reach the end of their life-cycle, the mining activities are likely to move to the North-Western Province. This has important economic and water-related ramifications. A shift in mining from Upper Kafue to Upper Zambezi will create an increase in the population of the region. This will have a direct impact on the water and energy demands and use of the basin.

Due to an increasing population, as well as the increase in mining activity, upstream degradation of wetlands, such as the Barotse Plains, is a high likelihood. This will have a downstream impact on hydropower generated in Lake Kariba, which represents 50% of all hydropower produced in Zambia. Therefore, there are important trade-offs (i.e. mining, water, and energy) that need to be realized. With the potential increase in development aimed at growing the economy (e.g. hydropower and mining), there is a high likelihood of people-economy-food trade-offs (e.g. impacts on the agriculture).

In the "new Copperbelt" (i.e. the North-Western Province), opencast mining will be practised, instead of the historical pit mining. Unlike in pit mining, opencast mines are not "producers" of water through dewatering. Instead, open cast mines require water to carry out processing. Therefore, it is assumed that mining in the "new Copperbelt" will have high water demand. As the mining industry moves from the "old" to the "new Copperbelt", due to past experiences and lessons learnt, there some areas of concern, and also some areas of inspiration. "It is important that we do not repeat the Copperbelt situation" (Zambian Wildlife Authority, ZAWA).

> ***"The new mines in the north bring money. But they also will bring more people, who will impact on the forests. This will reduce the water in the Zambezi. We need to understand the impacts."***
>
> ***Honorary Wildlife Officer***

[20] WaterWiki: http://waterwiki.net/index.php?title=Facing_Water_Challenges_in_Zambia

The negative water quality impacts of mining have been addressed through improved regulation. However, implementation remains poor. Kitwe and Kabwe provide examples of where negative health and water quality impacts are associated with mining. However, it is not the mines, but the Zambian Government that is forced to bear the brunt of these costs.

"Many of the mines are listed. These are big capital investments. We want to do the right thing."

Mine employee

It is important for mining companies in the Upper Zambezi and Kafue Basins to realise that they do not operate in silos, and need to reduce the impact they have on the environment. Companies globally are beginning to recognize that water risks are real and require actions, not only within internal value chains, but also within the communities they are situated in or at basin scale. They are increasingly contributing to responsible, sustainable management of freshwater resources by looking outside of individual water use statistics and considering the broader system of the catchment.[21] "Not all the mines are bad. When mines are investing in the areas they operate, they help both the community and the environment in some places. They have even been involved in establishing some parks" (Zambian Wildlife Authority, ZAWA).

Agriculture in Zambia would not be as productive as it is without water

The high dependency of the economic system on climatic factors has resulted in a history of erratic economic growth. Some of the more substantial declines in economic growth over the last three decades have occurred during major drought years. Climate variability is especially important for Zambia's agricultural sector, which, like in many African countries, depends heavily on rainfall due to limited irrigation capacity. For instance, during 1992 to 1994, the value generated by agriculture per m^3 of water increased by 18% annually, while during 1994 to 2000 this value increased only by 6% annually.[22] This coincided with a reduction in annual rainfall.

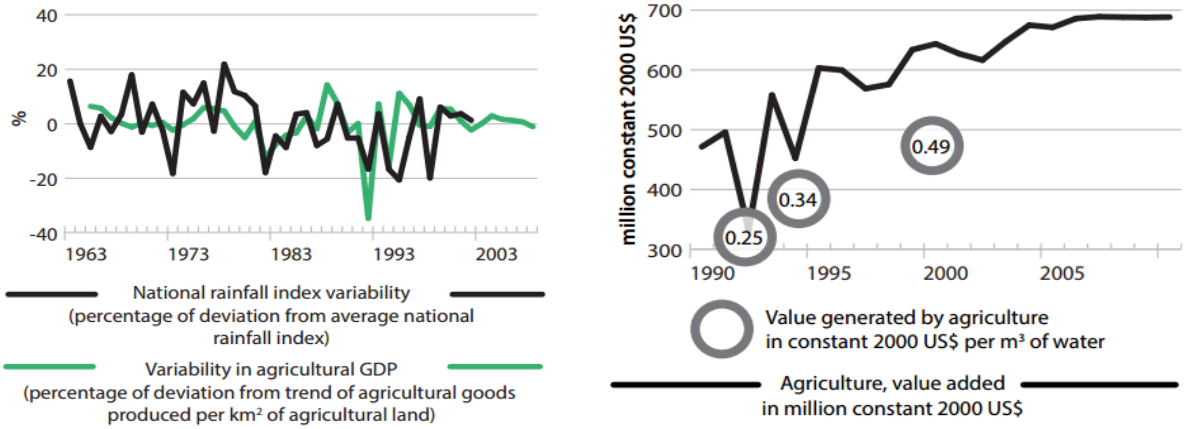


Figure 6: Rainfall Variability and Agricultural GDP[23]

Across the 2014-15 agricultural season (October to March), lower than average rainfall led to reduced agricultural output in 2015 relative to 2014, which in turn increased domestic food prices. Agricultural output fell by 8% in real terms in 2015, while food prices, which account for 54% of the consumer price index basket, rose by 11.2% in 2015. However, agriculture in Zambia is projected to increase by 61 000 ha, which represents an 82% increase in currently

[21] WWF, 2016. Kafue Flats, Zambia: Water in the Economy
[22] UNWater: http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/ZMB_pagebypage.pdf
[23] UNWater: http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/ZMB_pagebypage.pdf

irrigated area.[24] The impact of additional irrigated agriculture on the water demand and water quality are likely to be substantial, especially when imposed on the development plans in Zambia and the broader Zambezi Basin.[25]

Virtual water, through hydroelectric generation, is "powering" the Zambian economy

Competition for water is likely to increase going forward. For instance, hydropower currently accounts for approximately 94% of Zambia's water use (Figure 5). With agriculture using about 5%, and only about 1% attributed to domestic and industrial water supply, this creates a persistent supply problem for many sectors, including the mining sector. For instance, the rainy season in Zambia, and the height of electricity generation, occurs during the first half of the year, while the mining sector is most productive during the second half of the year, when hydropower generation is lower. Over-reliance on hydropower puts the country at risk in the event of drought.[26] Hydropower generation has already been impacted by climatic shocks such as drought, which have a double-edged effect, through the reduction of water supply itself and the reduction of water to generate hydropower.

In recent years, generation capacity has become insufficient to meet consumer demand. The low rainfall in 2015 exacerbated the existing power deficit by contributing to lower water levels in the reservoirs. The deficit is estimated at 40-50% of the base electricity needs in Zambia, necessitating considerable daily load management.[27] At a national level, to meet increased demand, power is imported from both South Africa and Mozambique. As indicated in Figure 7, the imports of power increased from the middle of July as a direct result of the dry period. These imports are a significant cost to the Zambian economy.

"Load shedding costs us thousands of extra dollars due to the need for diesel to run generators"

Zambia Breweries

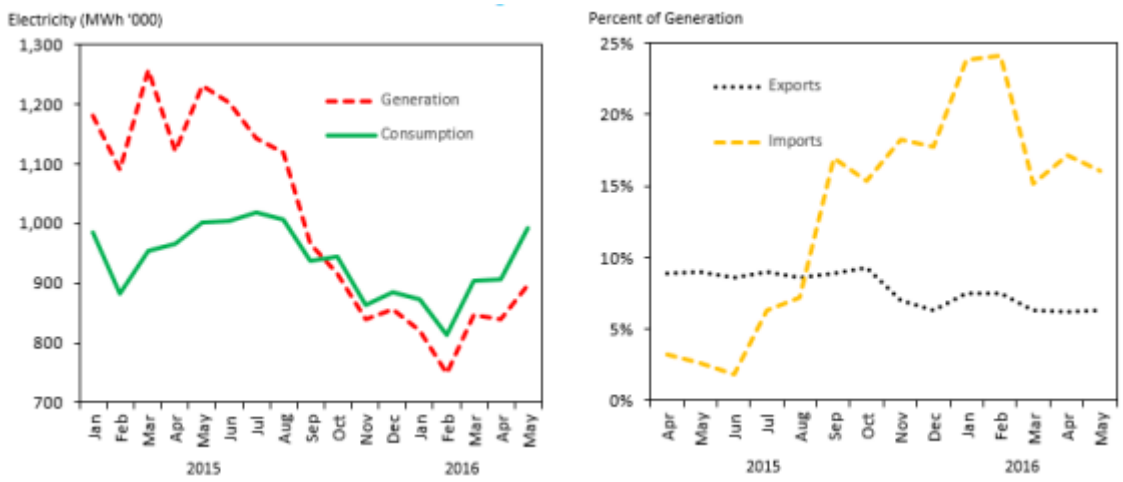


Figure 7: Power in Zamia (Source: Ministry of Finance in World Bank, 2016)[28]

At a company level, water and power shortages translate to increased running costs. This increases the cost of doing business and, therefore, reduces the competitiveness of companies – for example, pricing is likely to be higher than that of competitors due to increased input costs. For instance, during the droughts of 2015, the majority of consumers experienced extensive power shortages (at least 8 hours per day on a rotational basis), which in turn increased the cost of doing business. Many firms have had to invest in diesel generators, and this increase in costs

[24] The World Bank. http://siteresources.worldbank.org/INTAFRICA/Resources/Zambezi_MSIOA_-_Vol_1_-_Summary_Report.pdf
[25] The World Bank. http://siteresources.worldbank.org/INTAFRICA/Resources/Zambezi_MSIOA_-_Vol_1_-_Summary_Report.pdf
[26] World Bank, 2015. Zambia Economic Brief.
[27] AfDB: https://www.afdb.org/en/countries/southern-africa/zambia/zambia-economic-outlook/
[28] World Bank: http://documents.worldbank.org/curated/en/858561475214134326/pdf/108615-WP-P157243-PUBLIC.pdf

has been passed on to consumers.[29] A recent study by Samboko et al. (2016), suggests that in 2015, the losses to the agriculture sector arising from the power shortages amounted to 1.6% of GDP.[30]

The shortfalls in energy production have been recognised by the government; "Public investments in energy projects at the Kafue Gorge Lower, Lusiwasi, Chishimba, and Kariba North Bank are on course and are expected to be completed on schedule. Partners in the private sector have responded positively to the new policy environment. Over the next three years, investors, such as the Ndola Energy Company, EMCO Energy Zambia and Maamba Collieries will provide an additional 655 megawatts to the national grid." It is important that these developments in hydropower take into account their ecosystem impact collectively, rather than purely on an individual project basis; a study such as a Strategic Environmental Assessment (SEA) for hydropower provides a broad perspective of risk and opportunities, particularly in the face of climate change.

"With load shedding, we are only supplying water for 19 hours a day. This means we sell less volume, which impacts our finances. Water and energy are connected"

Commercial Utility

Zambia is experiencing challenges in managing competing needs of the food, energy and water nexus

The water-energy-food nexus is of interest due to the country's dependence on the mining and industrial sectors for economic growth. In the Upper Kafue region, for instance, mining and industrial sectors impact on water quantity and quality. Mining and industry are highly dependent on energy, which is produced from the water resources of the Kafue and Zambezi through hydropower. Therefore, the mining sector is a significant user of water as well as embedded virtual water in electricity. Energy and water are completely interconnected in this case. Furthermore, the migration of people, attracted to economic opportunities associated with the mining sector, is also responsible for increasing water and energy demands in the region. This increases the impact on energy (e.g. wood) and water resources. The additional migration to the region also places a demand on food. The agriculture associated with feeding the additional people also represents increased irrigation, and therefore stress on the catchment. Across Zambia, there are examples where growth in the mining sector, has resulted in an increase in water, energy and food demands. However, the management of the increasing demands on water, energy and food are often not managed in an integrated manner. For instance, allocations for irrigation, domestic use and industrial use are often not aligned. Integrated and coordinated planning and management of natural resources (i.e. water, land) are key to sustainable development.

Likewise, the Lower Kafue has many competing demands. For instance, the existing Lower Kafue Gorge Dam produces approximately half of the hydropower in Zambia. In light of the shortages of energy in the country, there is potential for future hydropower expansion. However, the region is vulnerable to the impacts of climate change, high experiences high competition, such as providing 50% of the water supplied to Lusaka, and the majority of irrigation taking place in the country.[31] This is likely to increase to approximately 75% after the completion of Lower Kafue Gorge II project. In addition, the Kafue Flats wetland itself is home to a diverse range of wildlife and supports livelihoods for a significant number of people, through fisheries and livestock. This is an example of energy, water and food demands on a single water body.

Competing demands for water from the Kafue Flats include irrigation for crops (such as sugar), the domestic water demand for towns (such as Kafue), the supply of 50% of the total water demand in Lusaka, and generating 50% of the total hydropower in Zambia.

[29] AfDB: https://www.afdb.org/en/countries/southern-africa/zambia/zambia-economic-outlook/
[30] Samboko et al., 2016: http://fsg.afre.msu.edu/zambia/wp105.pdf
[31] WWF Kafue Flats Water in the Economy Report, 2015.

There are potential trade-offs between fisheries and coal mining going forward. Lake Kariba is home to a significant fisheries industry that is important for food security in the country. Mining is projected to increase as the bulk of coal comes from the open-cast Maamba coal mine near Lake Kariba. With the energy deficit in the country, coal mining is projected to expand. This will create an increase in the population of the region, with an increase in food and water demand. In addition, potential long-term trade-offs, such as water quality impacts from increased mining may potentially impact environmental resources, including fisheries along the Zambezi Basin.[32]

More generally in Zambia, trade-offs between natural resources and the growing economy and population are evident. The growing population results in an increase in the competition for resources, and may result in an impact on natural resources. For instance, particular sectors, such as agriculture, have specifically been highlighted for growth in terms of diversification of the economy. This is supported by a recent address from the President of Zambia: "the agriculture sector, fisheries and livestock will be the main focus around which other sectors will be developed in an integrated manner under the seventh national development plan. Agriculture will, therefore, be the major priority of our economic diversification agenda."[33]

"Due to large numbers of people netting, there are no fish left. That means people are left poorer. We need better implementation of regulation."

Tourism developer

However, in growing the agricultural sector, there are likely to be environmental impacts (such as increased clearing of land), environmental degradation through habitat conversion, and additional water consumption for irrigation. This may have a negative impact on high-value conservation areas (such as critical freshwater habitats) and tourism (such as the national parks and the Victoria Falls). Tourism requires intact environments to thrive, while agricultural activities only require a functioning system. Therefore, tourism, especially nature-based tourism, and agriculture need to be managed appropriately considering the development objectives of the country. "Habitat loss due to unplanned settlements or the conversion to agricultural land is a major risk. This together with poaching will destroy our tourism" (Zambia Wildlife Authority, ZAWA).

Development in Zambia also needs to be aware of the high percentage of livelihoods (60% of the total Zambian population) that are directly dependent on ecosystem goods and services. The high dependency on natural ecosystems is due to the high dependence on subsistence agriculture in Zambia.

Almost 90% of Zambians living below the extreme poverty line are concentrated in rural areas.[34] Nationally, the proportion of the population living below the poverty line was 54.4% in 2014, with 76,6% residing in rural areas, and 23,4% in urban areas.[35]Therefore, the poverty gap index (a measure of how far average incomes fall below the poverty line) is far higher for the rural population than their urban counterparts).[36]

[32] Mhlanga et al., 2014. Fragmentation of Natural Resources Management: Experiences from Lake Kariba. Volume 2.
[33] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.
[34] World Bank: https://www.scribd.com/document/213369833/The-World-Bank-Zambia-Overview
[35] CSO, 2015. The 2014 Living Conditions Monitoring Survey
[36] World Bank: https://www.scribd.com/document/213369833/The-World-Bank-Zambia-Overview

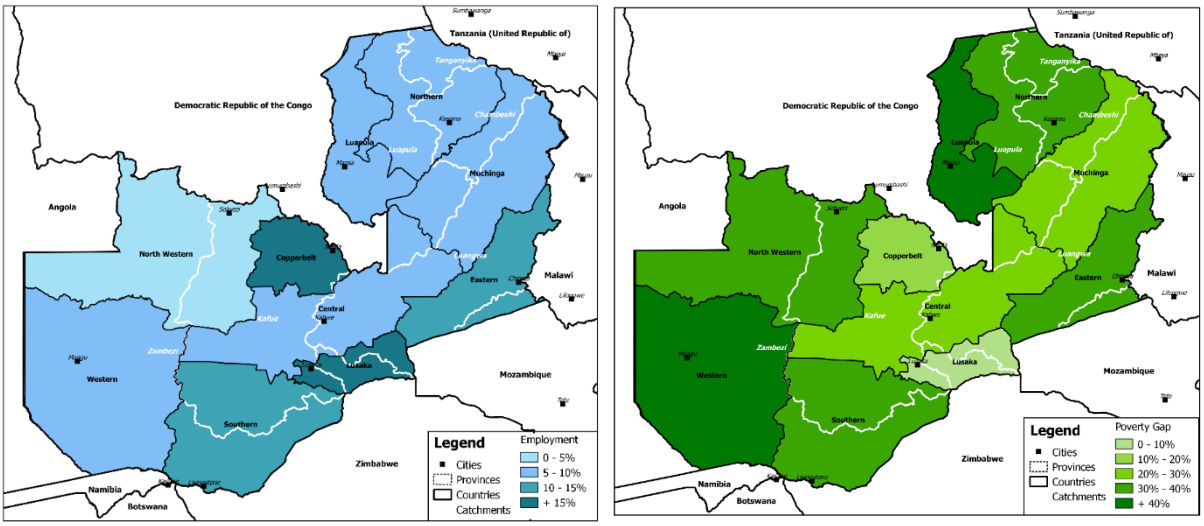


Figure 8: Employed Population (%) and the Poverty Gap (%) for 2010 (Data Source: CSO)

The vulnerability of the rural population of Zambia will result in two possible outcomes as the impacts of climate change become more severe. Some climate projections indicate that increased rainfall and high-temperature patterns may become favourable for certain crops, thus increasing crop production.

Other projections show that droughts may become longer and extreme events more variable. This will result in subsistence farmers needing to rely more heavily on ecosystem services other than fertile soils to supplement their diets, as their crops fail. This may continue for some time, until even the natural ecosystems cannot sustain these livelihoods longer. As living conditions deteriorate, livelihoods will be threatened. To ensure food security, people may be forced to migrate to cities, which, as indicated in the following chapter, are already under pressure. Both of these two outcomes are likely. It is this very uncertainty, of differing impacts and outcomes that make adaptation for agriculture, and building resilient rural communities a challenge in Zambia.

"When the water level in the Zambezi is too low, we cannot pump water to irrigate. We are then low on production. In the future this will get worse."

Farmer

The resilience of subsistence farmers is closely linked with the availability of water

In Zambia, smallholder farmers are traditional farmers that cultivate <5 ha each and consume most of their produce. Of Zambia's estimated 8 million people living in rural areas, 96% are smallholders cultivating 76% of the total cropped area. Most female farmers fall within this category. Medium-scale farmers cultivate 5-20 ha each and sell most of their crop. Large-scale and commercial farmers cultivate >20 ha each and sell most of their produce.[37] Zambia's farming sector is dominated by small-scale – mono-cropping farmers (as 82% of the country's small-scale farmers grow maize) and 72.7% of these small-scale farming households cultivate less than two hectares of crops.[38]

In Zambia, agriculture remains the leading sector in terms of food security, economic growth and poverty reduction. The country is highly dependent on rain-fed agriculture and suffers from reduced crop yields when droughts occur. In 2012, women accounted for 46% of the economically active population in agriculture.[39] Around 50% of the Zambian labour force is employed in the agriculture sector, and the sector accounts for 22% of the Zambian GDP.[40]

[37] AgWater, 2009. Zambia Situation Analysis. Agricultural Water Management National Situation Analysis Brief.
[38] UNDP, 2013. Zambia Agriculture Investment Opportunities Brief. CAADP Investment Facilitation Programme.
[39] UNWater, 2013. Zambia Country Brief: http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/ZMB_pagebypage.pdf
[40] UNDP, 2013. Zambia Agriculture Investment Opportunities Brief. CAADP Investment Facilitation Programme.

The different agricultural-ecological zones are an important consideration for future climate and rural livelihoods. Poverty is highest in rural areas, where, on average, about 80% of the incomes is derived from agriculture. As shown below, poverty rates are high in all five of the rural zones. However, there is some variation, with poverty lowest in Zone IIa2 (mostly Eastern Province) and highest in Zone IIb (mostly Western Province). The former includes many cotton farmers, whose rising incomes were instrumental in reducing rural poverty in Zambia during the mid-1990s. However, while per capita incomes are highest in Zone IIa1, poverty rates in this zone are still high at 79%. This reflects Zambia's high-income inequality, with the relatively few households located closest to large urban centres and major transport routes having a considerably lower incidence of poverty.

	Population (1000)		Households (1000)		Per capita expenditure		Poverty rate
	Total	Poor	Total	Size	Kw 1000	$US	(%)
All households	10,986	7,461	2,089	5.26	1,861	417	67.9
Urban households	4,298	2,271	814	5.28	3,242	726	52.8
Non-farm	3,075	1,484	619	4.97	3,625	812	48.3
Farm	1,223	793	195	6.26	2,281	511	64.8
Rural households	6,687	5,192	1,275	5.24	974	218	77.6
Non-farm	722	540	171	4.22	1,320	296	74.8
Farm	5,965	4,653	1,104	5.40	932	209	78.0
Zone I	814	657	144	5.64	754	169	80.8
Zone IIa1	1,258	991	215	5.86	1,564	350	78.8
Zone IIa2	1,074	790	198	5.42	859	192	73.6
Zone IIb	383	321	75	5.08	648	145	84.0
Zone III	2,437	1,892	471	5.17	793	178	77.6

Sources: 2006 SAM of Zambia and LCMS4.

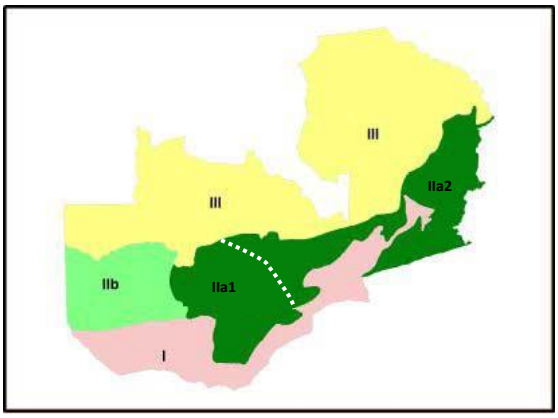


Figure 9: Household income and poverty characteristics per Agro-zone[41]

The importance of supporting rural livelihoods to further develop the resilience of Zambia is recognised by the President of Zambia in the following quote: "the rural population, in particular, derives its livelihood on and off the land. It is from agriculture that school fees are paid, health bills are met, and it is agriculture that puts food on the table. Agriculture is, therefore, a key lever for improving rural livelihoods. To this end, we will focus on boosting agricultural production, enhancing productivity and increasing earnings for our farmers. We have to make agriculture a real business venture even for small-scale and peasant farmers."[42]

Ecosystem goods and services support a large number of livelihoods in Zambia

Despite its rich agricultural resources, Zambia has continued to experience chronic food and nutrition security problems. According to the Rural Agricultural Livelihoods Survey (RALS) conducted between May 2011 and April 2012, 42% of rural households experienced food shortages during that time. Of the 42%, the average number of months that they went without sufficient food access was 3.2 months.[43] Most household food deficits in rural Zambia occur during the months of December, January, and February. This suggests that food security in rural Zambia has a distinctly seasonal dimension, which coincides with Zambia's production and marketing season. Between December and February, food stocks from agricultural household's own production begin to diminish, while at the same time the prices of food in retail market begin to rise. As a result, many rural households are forced to forego meals or decrease the quantities of food served per meal.[44] Other alternatives include harvesting from natural ecosystems for goods such as firewood, fruit, tubers, fish and other resources.

[41] Thurlow, J. et al. 2009. Climate change, economic growth and poverty in Zambia.
[42] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.
[43] Government of Zambia, 2013. Zambia: National Agriculture Investment Plan (NAIP) 2014-2018. Ministry of Agriculture and Livestock.
[44] Government of Zambia, 2013. Zambia: National Agriculture Investment Plan (NAIP) 2014-2018. Ministry of Agriculture and Livestock.

Furthermore, inequality in Zambia in terms of income, assets, and social services is on the rise. Recent data shows that the Gini coefficient (a measure of inequality in income distribution), in the country increased to 0.65 in 2010 from 0.60 in 2006. Similarly, due to limited job opportunities, the rate of unemployment worsened to 28% in 2010 from 22% in 2005. Even among the employed, 95% are estimated to be in vulnerable work, mostly in low productive informal activities.[45]

Zambia did not attain the Millenium Development Goal targets on a number of indicators, including: literacy rates, child mortality, maternal health, and access to safe water and basic sanitation, which remain below target.[46] However, the Zambia - United Nations Sustainable Development Partnership Framework (2016-2021), provides a platform for collaboration to ensure realisation of the SDGs. Zambia's Vision 2030 articulates its aspiration to become "a prosperous middle-income nation" by 2030, the same time frame as the SDGs. It is expected that a lot of work will be required to achieve these two ambitious targets by 2030.[47]

Therefore, to promote food and income security, Zambia's grasslands and forests are of ecological, economic, and social importance, especially for rural populations. They provide food, fodder, fuel, and medicinal products to communities dependent on them for their health and livelihoods. About 100 000 ha of dambos or inland valley bottoms (wetlands) are utilized for crop production by small-scale farmers.[48] Studies have estimated that forest products, including timber and non-timber, represent 20.6 and 29.6% of total household income respectively.[49] However, trade-offs between natural resources and the growing economy/population are evident. The increasing population results in an increase in the competition for resources, and may result in an impact on natural resources.

In terms of energy use, the Living Conditions Monitoring Survey (2010) provides the following statistics (Figure 10):

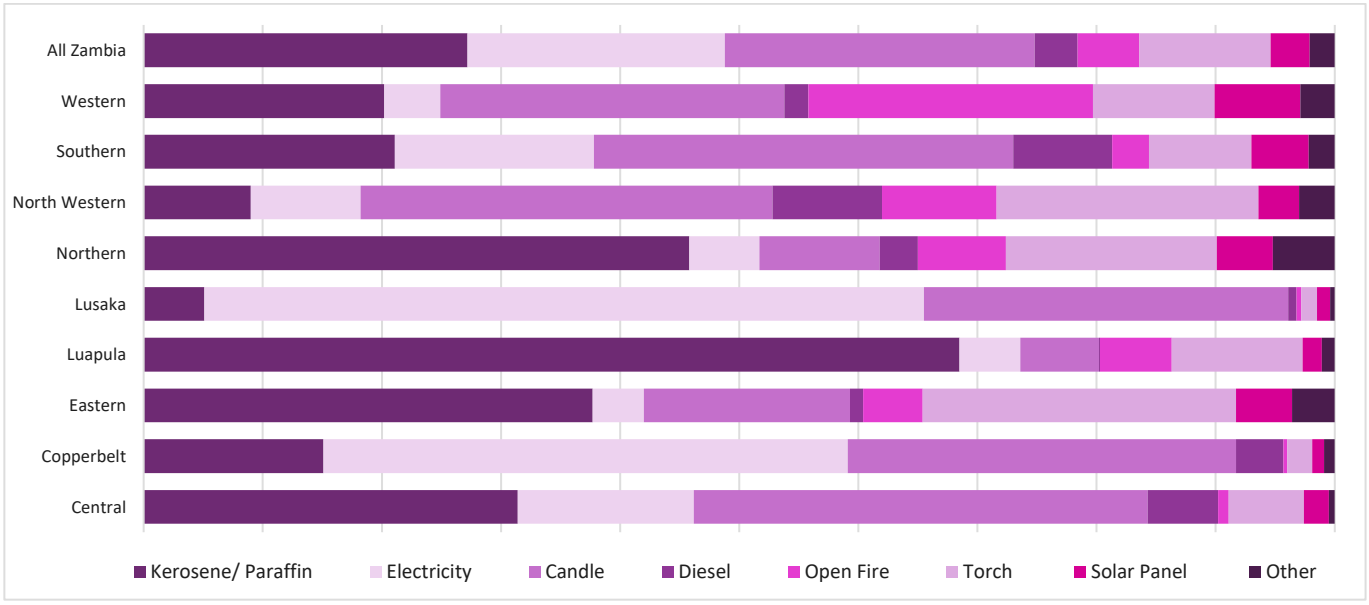


Figure 10: Percentage Distribution of Households by Main Type of Lighting Energy (2010) (Data Source: CSO)

For lighting energy in Zambia, the majority of households (about 27%) used kerosene/paraffin, while 26% used candles. Electricity is used by 26% of the total households. In rural areas, the majority of households (37%) used

[45] UNDP, 2013. Zambia Agriculture Investment Opportunities Brief. CAADP Investment Facilitation Programme.
[46] Rasmussen, P.E., 2015. Zambia 2015. African Economic Outlook.
[47] Daily Mail: https://www.daily-mail.co.zm/?p=86176
[48] FAO: http://www.fao.org/nr/water/aquastat/countries_regions/ZMB/
[49] Samboko et al., 2016: http://fsg.afre.msu.edu/zambia/ps_46.pdf

kerosene/paraffin, compared with only 10% of urban households. The highest proportion in urban areas used electricity (with 53%), and the utilization of electricity for lighting was highest in Lusaka and Copperbelt Provinces with 60 and 44%, respectively.

For cooking needs, only 16.8% of the households used electricity. On the other hand, 79% of the rural households use firewood, compared with 4% of the urban households. However, the dependence on natural ecosystems also exists in urban areas, as charcoal is used by 51% of urban households, followed by electricity (43%).

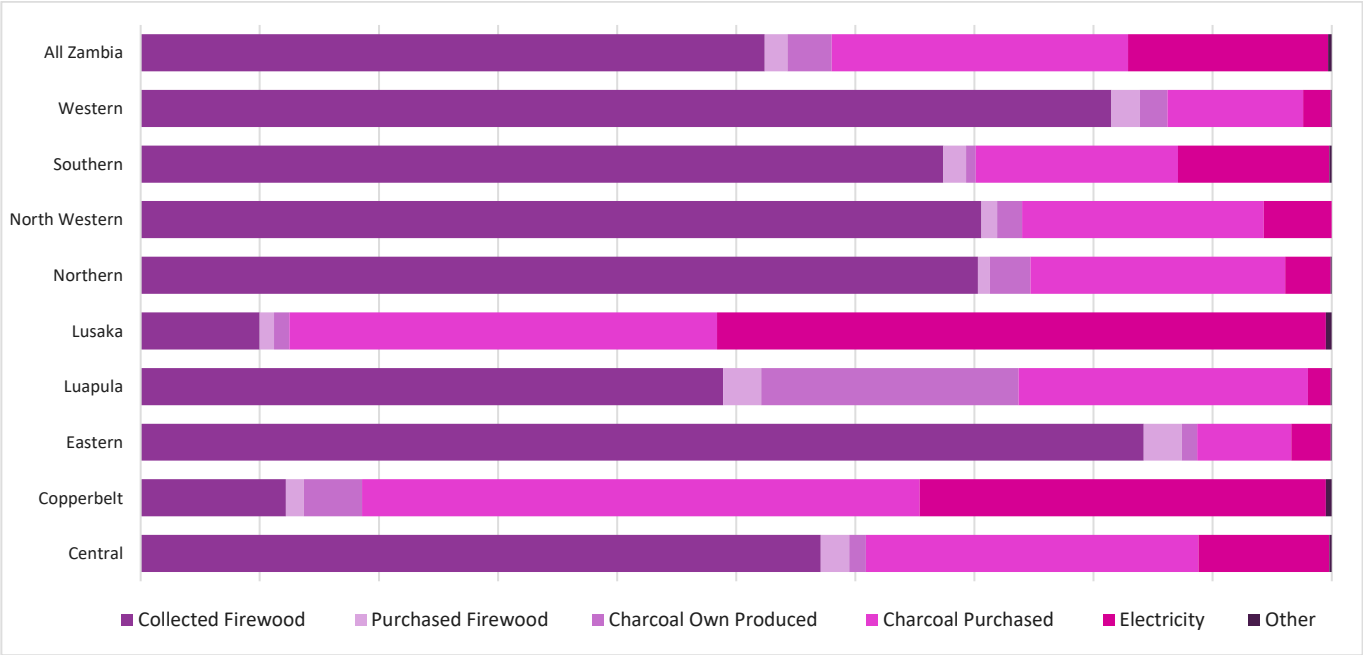


Figure 11: Percentage Distribution of Households by Main Type of Cooking Energy (2010) (Data Source: CSO)

As shown in the figure above, 52% of all households in Zambia are reliant upon collecting firewood for their cooking energy. This represents a reliance on ecosystem services that may not be sustainable in the future. Urban household electrification reduces charcoal consumption to between 1.5 and 3 times.[50] Sustainable forestry and catchment management (i.e. preventing deforestation) is essential for preventing degradation. This is because of catchment degradation taking place upstream of hydropower plants may result in decreased river flow and limited capacity generation. The hydropower sector should become more proactive in supporting reforestation, and also improve the rate of electrification so that catchment restoration and conservation can be promoted. Although this has an element of long-term thinking, recognition of this opportunity by the hydropower sector could help reduce the significant backlog in rural electrification currently in Zambia. Therefore, an important policy response to sustainable energy supply, reduced deforestation and catchment degradation, is to rapidly increase the electrification of both rural and urban areas across Zambia, and promote off-grid options and improved access to alternative energy options.

"Deforestation is taking place to supply wood for cooking or for curios to sell. This impacts upon on our water supply. People do not see the connection"

Honorary Wildlife Officer

A healthy functioning Zambezi River requires a fluctuating, seasonal hydrology. The fluctuating hydrology of the Zambezi is a key factor in supporting livelihoods that depend on the different seasons and levels of the river. Changes in water resource availability will have a direct impact on livelihoods, through agriculture and access to

[50] USAID: http://pdf.usaid.gov/pdf_docs/pnadm063.pdf

water or goods and services from the river. The Zambezi is said to be the bloodline of Zambia. It is fundamental not only in terms of economic use, such as hydropower generation, but also culturally. The river fluctuation levels are also a particular risk for the many cultural ceremonies that are dependent on the Zambezi. For instance, there is the Ku-omboka Ceremony where thousands of inhabitants move annually to higher ground as the Zambezi floods into the low-lying plains of Western Province.[51] The festival celebrates the move of the Litunga, king of the Lozi people, from his compound at Lealui in the Barotse Floodplain of the Zambezi River to Limulunga on higher ground. When the flows are not adequate in the Zambezi, this ceremony is unable to take place. This has an impact on the psyche of the Lozi community, who have practised the ceremony for over 300 years. In addition, there is likely to be a potential impact on tourism to the region, as this ceremony attracts thousands of people from all over the world every year.

What remains to be investigated, is the impact of degraded natural infrastructure on rural livelihoods in Zambia. As 60% of Zambians live in rural areas[52], where will the approximately 8 million vulnerable people obtain their food in the absence of functioning ecosystems (e.g. forests or rivers)? What will happen to cultural practices that are reliant upon functioning ecosystems? Many projections indicate higher rural to urban migration, leading to additional complications with regards to employment and access to basic services across Zambia.

Ecosystem services need to be included in the valuation of natural infrastructure to balance the competing development objectives appropriately

Zambia is well endowed with vast natural resources. These resources (i.e. land, wildlife, forest, minerals, natural heritage and wetlands) need to be well managed to be available for and to benefit future generations.

Wetlands, including dambos, swamps and floodplains, play an important role in providing stable water supply to the rivers in Zambia.[53] Through Ramsar, some of these wetlands are protected. Zambia currently has 8 sites designated as Wetlands of International Importance (Ramsar Sites), with a surface area of 4 030 500 hectares (4.03 million ha). [54] These areas are all or mostly parts of National Parks and Game Management Areas, and are home to an incredible array of mammals, birds, and fish; some of them rare or vulnerable and some of them endemic.[55] As these wetlands are a source of livelihood for the majority of the rural population in Zambia, it is important to understand what the value of their protection is, and what is the opportunity cost of not having these wetlands.

[51] Zambia Tourism: http://www.zambiatourism.com/destinations/rivers/zambezi
[52] Wold Bank: http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS
[53] USAID, 2012. Climate Change Adaptation in Zambia. Fact Sheet.
[54] Ramsar: Zambia. http://www.ramsar.org/wetland/zambia
[55] Ramsar: Zambia. http://www.ramsar.org/wetland/zambia

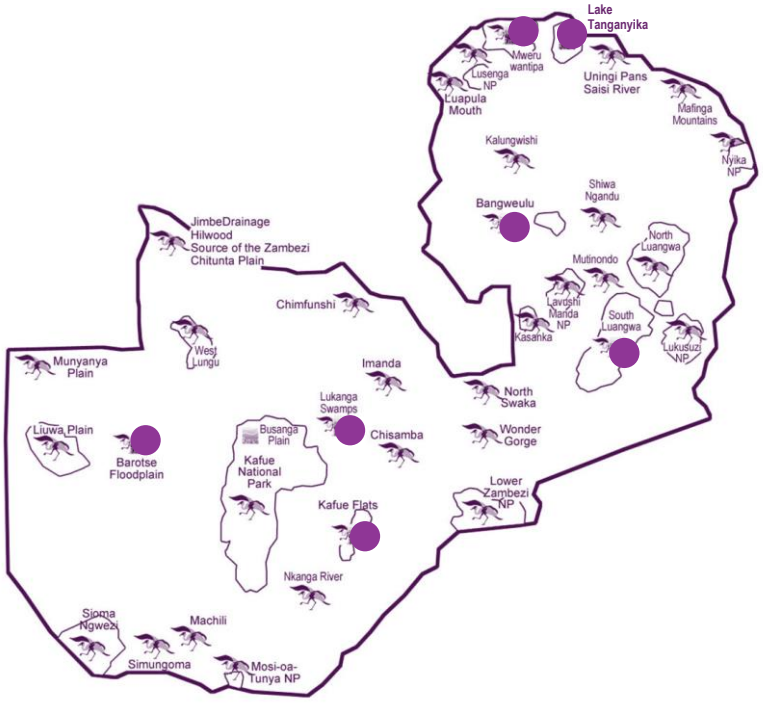


Figure 12: Sites identified as Ramsar Sites and Important Bird Areas (IBAs) in Zambia

The Bangweulu Swamps are a Ramsar site, providing a breeding ground for birds, fishes and wildlife. The swamp is a natural flood control system and is important for groundwater recharge and water quality control. Because of the Bangweulu swamps, which is the largest swamp in the country, the Lake Bangweulu is a hub of bird life. In addition, the lake has remarkable white sandy beaches. However, the Lake Bangweulu is exploited more as a fish source than for its tourist potential. The main catches in the Lake are Cychlids (bream, tigerfish, yellow belly) and catfish. About 57 000 metric tons of fish are harvested from the Lake each year. Although fish stocks are not in danger, catches are declining and the favoured species are becoming more scarce.[56]

The main question that needs to be asked about Lake Bangweulu is: What is the opportunity cost of not managing this resource well? This includes possible challenges such as plans for upstream irrigation, which will likely divert flow from the wetland. Increased irrigation needs to be considered alongside the balance of functioning ecosystems, livelihoods supported by fisheries and the potential value of future tourism. In other words, what is the potential future opportunity cost for tourism (or other sectors) that will not succeed because of a degraded ecosystem?

The negative quality impacts of the Kafue Basin are negated by the ecosystem function of the Lukanga Swamps.

The Lukanga Swamps clean the impacted water as it flows from the North (Upper Kafue), and are the reason why mining-related water quality challenges are contained within the Upper Kafue. "Some of the ecosystem services provided by Lukanga Swamps include groundwater recharge, flood control, sediment trapping, waste water treatment, detoxification, nutrient retention, ecosystem support and water transport. These functions provide benefits not only to the environment, but also to the local communities who depend on the swamps for food, water and other resources."[57]

As stated above, the Lukanga Swamps, which cover 2 600 km^2, play a role in attenuating mining pollution in the Kafue River.[58,59] The Nature Conservancy suggest that this is a basis to engage mining houses and Zambia Electricity Supply Corporation (ZESCO) in payment for ecosystem services (PES) schemes to help support management of the Lukanga Swamps and its watershed. This would ensure the Lukanga Swamps continue to provide vital ecosystem services, such as water purification. In addition to their important role in helping to treat polluted mine water, the Lukanga Swamps are important for livelihoods. The swamps are the fifth largest wetland in Zambia, and directly

[56] Zambia Tourism: http://www.zambiatourism.com/destinations/lakes/bangweulu
[57] Kachali R.N., Lund Univerity: http://www.lumes.lu.se/sites/lumes.lu.se/files/rhoda_kachali.pdf
[58] FutureWater: http://www.futurewater.eu/projects/ecosystem-zambia-en/
[59] Ramsar: Zambia: Lukanga Swamps. https://rsis.ramsar.org/ris/1580

support a population of 250 000 people.[60] However, if you include indirect ecosystem functions of the swamps, they indirectly support a population of 6.1 million people in Lusaka, Central and the Copperbelt provinces, through the provision of fish, agricultural produce, livestock grazing, fuelwood and charcoal.[61]

An important question in relation to the Lukanga Swamps is: What is the value that they provide through passive treatment of mine dewatering taking place in the Upper Kafue catchment. If the Lukanga was not functioning, what would be the cost of poor quality water resources to the economy and livelihoods dependent on the river? How will hydropower generation be impacted by changes in the water recharge and flood retention functions of the swamps?

Another important ecosystem is that of the Barotse Floodplain, which is the second largest wetland in Zambia after the Lake Bangweulu system. It differs from other wetlands in Zambia as it has a large permanent lake and swamps, and a much smaller area; the plains area approximately 550,000 hectares, and the total wetland cover is some 1.2 million hectares,[62] The plains dry out annually, and act as a critical regulator of flow and retainer of floods. This is because the Kalahari sands that cover the plains act like a huge sponge, absorbing water and rainfall. Therefore, the plains flood from December to June, lagging behind the annual rainy season (November to April).[63] However, the plains often experience high rates of evaporation.[64]

"The Barotse Floodplains can be seen as the largest form of storage regulating the flow of the Zambezi River"

WWF

These floods dominate the natural environment and the lives, society and culture of the inhabitants and those of other smaller, floodplains throughout the country.[65] The Barotse Plains provide livelihoods to local communities and support various social and cultural activities. The goods and services provided by the wetland system are the basis for the livelihoods that are dependent on the region. An evaluation done on the economic value of the ecosystem goods and services provided by the Barotse has found that at the household level, wetlands generate an average net financial return of $405 a year. Home consumption and subsistence materials represent 83%. By far the most valuable products were found to be fish (43% of the total, and 73% of household cash income), floodplain grazing (29% of the total income) and crop production (22% of the total income).[66]

"The Barotse is a National Monument. But there is not enough sensitisation among the community regarding what this (declaration of a Ramsar site) actually means."

Zambian Conservationist

However, the Barotse Plains are being degraded through uncontrolled activities. This will have an impact on the water resources and economies that are dependent on the plains. The plains and the upper Zambezi catchments are especially vulnerable to deforestation (i.e. of the Miombo Woodlands). "This will have a detrimental impact upon the flow for the Zambezi" (WWF).

Zambia is one of the top ten GHG emitting countries due to deforestation and degradation.[67] Wood fuel production is the primary driver of this deforestation in Zambia, which is quoted at a rate of 250 000 to 300 000 ha per year.[68] This equates to almost half a percent of the total area of Zambia every year. Deforestation has escalated due to overexploitation through logging for wood fuel or charcoal, encroachment for "slash and burn" agriculture and

[60] Kachali R.N., Lund Univerity: http://www.lumes.lu.se/sites/lumes.lu.se/files/rhoda_kachali.pdf
[61] Kachali R.N., Lund Univerity: http://www.lumes.lu.se/sites/lumes.lu.se/files/rhoda_kachali.pdf
[62] IUCN, 2013. Barotse Floodplain, Zambia: local economic dependence on wetland resources. Case Studies in Wetland Valuation, No. 2.
[63] InAction: http://www.inaction.co.za/africa_zambia.html
[64] The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis
[65] InAction: http://www.inaction.co.za/africa_zambia.html
[66] IUCN, 2013. Barotse Floodplain, Zambia: local economic dependence on wetland resources. Case Studies in Wetland Valuation, No. 2.
[67] WISDOM Zambia Inception Workshop, Lusaka 15 November 2016
[68] Musambachime, M.C. The impact of Deforestation in Zambia: A Gradual Process towards Desertification

human settlements. It has resulted in localized flooding, increased erosion and siltation, reduction in surface and groundwater availability and loss of aquatic life.

Zambia is one of the largest consumers of charcoal in the region and charcoal production provides livelihoods for a substantial number of people, employing an estimated 40,000 people.[69] The fast rate of deforestation is not only a challenge because it hinders ecosystem services such as quality improvement or flow attenuation, but there are also major social challenges associated with migration. Large-scale "charcoal production results in a migratory pattern where workers will move to a woodland area, buy trees (~USD 0.28/tree), burn them into charcoal, sell the charcoal, and finally move to a new area when the trees are gone. Charcoal producers are not necessarily the recipients of miombo ecosystem services, so there is little incentive to harvest in a sustainable manner."[70] Therefore, there are limited incentives by the major deforestation culprits to engage in ecosystem services payment schemes to incentivise better practices. This is a challenge across Zambia, but of particular importance in the Miombo ecoregion, which is particularly important for catchment systems in Zambia.

Therefore, the question needs to be asked: What is the value of the Barotse Plains in keeping the flow of the Zambezi River stable? Without the Barotse, what will the flow of the Zambezi be, and how would this impact the fishing and tourism industries, and the 250 000 people living alongside the wetland? What would happen to downstream environments without the flood retention and recharge functions of the floodplains? In addition, what is the impact on hydropower generation or irrigation lower down in the Zambezi catchment?

The Luangwa River is one of the largest unaltered rivers in Southern Africa[71], providing a significant source of uninterrupted runoff to the Lower Zambezi Catchment. It is estimated that in 2016, there were 7,239,708 people in the four provinces covered by the Luangwa Basin. The basin is also home to a number of hydropower and agricultural developments. For instance, the Lunsemfwa Hydropower Company has plans to increase their installed capacity to 500 MW by 2020,[72] and in Lusiwasi, there are two new run-of-the-river schemes that are proposed on the Lusiwasi River Channel. However, the variable hydrological nature of the river could potentially impact the long-term sustainability of these projects.

"Luangwa is like the last dodo of the rivers. We need to make the case for its conservation in real economic terms."

WWF

In addition to hydropower, there are extensive plans for expanding agriculture. For example, a total of 165 potential sites have been identified by the Ministry of Energy and Water Development (MEWD) and stakeholder institutions for construction, more than 70% of the sites are within the Luangwa Basin.[73] There are also a number of planned mining projects in the basin that have not been finalised; however, there is not information available at present. Therefore, the Luangwa Basin currently faces a significant trade-off: to continue providing uninterrupted flow to the Zambezi and being home to National Parks, or to develop its water resources for hydropower, irrigation and the population of the Basin.

In order to fully understand the importance of the Luangwa in its current state, it is proposed that the full value (economic, social, environmental) of having the last unregulated river in southern Africa is determined. It is important that we better understand the direct and indirect risks of developing the Luangwa, compared to keeping the system pristine.

[69] van de Veen, H. & Bureau MO. 2005. Managing the Miombo: Economic Crisis Threatens People and Nature in Zambia's Copperbelt. Gland, Switzerland
[70] USAID: http://pdf.usaid.gov/pdf_docs/pnadm063.pdf
[71] Luangwa Valley: http://www.theluangwavalley.com/about/luangwa-valley/
[72] International Hydropower Association (IHA): www.hydropower.org/companies/lunsemfwa-hydro-power-company
[73] Silembo, O. 2016. Integrated Flow Assessment for the Luangwa River, Zambia: Phase 1. Water resources situation assessment. WARMA.

Healthy watercourses and tourism in Zambia are intertwined

The tourism sector in Zambia has massive potential. This is recognised by the President of Zambia in the following quote: "the potential of the creative and recreation industry such as tourism, arts and culture, have not been fully exploited. We have vast natural resources, and good weather patterns. In addition, we have rich wildlife and attractive fauna and flora, splendid waterfalls and majestic lakes."[74]

The tourism sector in Zambia has experienced rapid growth in recent years, and currently contributes an estimated 3% of national GDP. Zambia has one of the largest protected area systems in Southern Africa.[75] Over 30% of Zambia's land is managed in protected areas, including 19 national parks covering 8% of the country's land area and 34 game management areas covering 22%. The protected areas and the wildlife they support are a major draw for foreign tourism; this is an important source of livelihood and economic growth in the country.[76] Zambia's protected areas, especially national parks, overlap with the majority of the country's major watercourses and remain a key asset for the country's tourism development. This location (along watercourses) has helped to preserve ecosystems (such as wildlife), particularly during times of rainfall shortages.

> ***"It all boils down to value. At the moment, our minerals are valued higher than our wildlife. The value of tourism to Zambia is not appreciated, because we have not used all the potential."***
>
> ***ZAWA***

All National Parks in Zambia are located on or near a major watercourse. Therefore, tourism and water are wholly interdependent. It is important that the cost of degraded watercourses considers the impact on the tourism industry and on its economic multiplying effect.

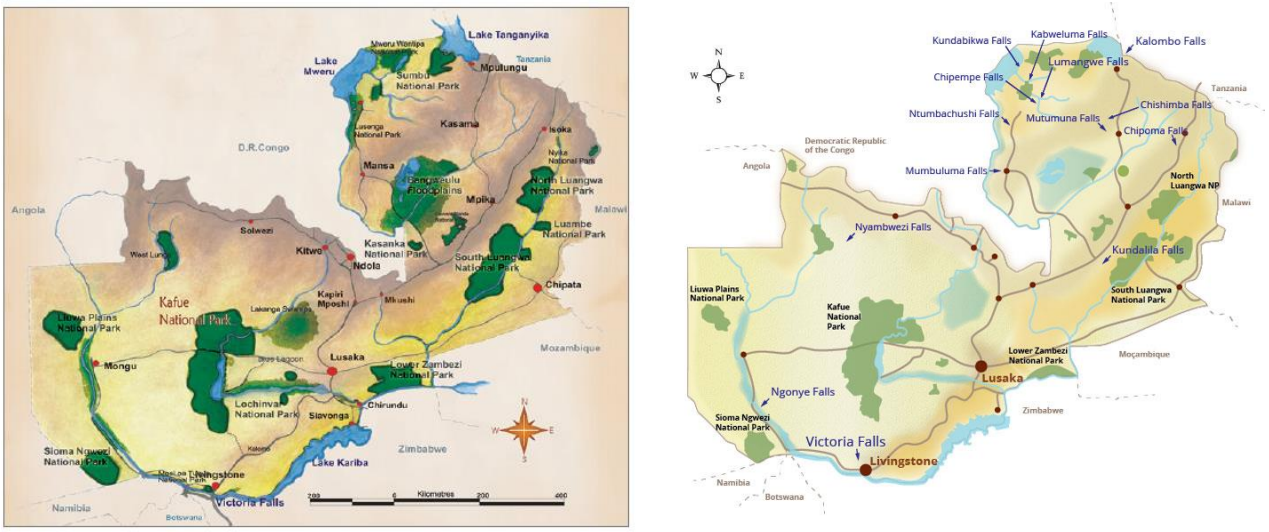


Figure 13: Tourism in Zambia: National Parks[77] and Waterfalls[78]

Livingstone, in the Southern Province, is the heart of tourism for Zambia. Livingstone is home to the great Victoria Falls (known locally as Mosi-oa-Tunya), one of the greatest waterfalls in the world. In addition, Southern Province houses numerous national parks and Lake Kariba, which are key tourist hotspots of Zambia. Therefore, the development of the Greater Livingstone area remains a priority for Zambia's tourism development. The ultimate

[74] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.
[75] Republic of Zambia 2008. Integrated Water Resources Management and Water Efficiency (IWRM/WE)
[76] USAID, 2012. Climate Change Adaptation in Zambia. Fact Sheet.
[77] High Commission of the Republic of Zambia, Pretoria: http://www.zambiapretoria.net/national-parks/
[78] Zambia Tourism: http://www.zambiatourism.com/destinations/waterfalls

goal is to develop the area into a world-class tourism destination through accelerated public and private sector investment so that it has all the necessary amenities such as tourist accommodation, casinos, housing units, shopping facilities, roads, airports and airport infrastructure, water, Information and Communication Technology (ICT) and electricity.

97% of the tourism contributions to GDP are from the Lusaka and Southern Provinces.[79]

There are linkages and trade-offs between energy and tourism. There is a potential win-lose situation, with tourism likely to be the most impacted of the two sectors. For instance, during the dry season, the flow over the Victoria Falls is decreased further due to the diversion of water to the Victoria Falls Hydropower Station. As this reduces the flow, this compromises the tourism potential of the falls. Another example of the trade-offs between tourism and hydropower is the Batoka Gorge. The construction of the Batoka Gorge Dam will increase the energy supply in Zambia. According to the available project information, the Batoka hydropower project will have a 181m high dam wall that will hold back 1,680 million cubic meters of water, covering an area of approximately 26 km^2.[80] The reservoir will be long and narrow, stretching to just about 1km from the plunge pool of the Victoria Falls. The dam will not inundate land since it will be confined to a long narrow gorge, but will flood all the rapids upstream and reduce the riverine natural habitat.[81] For instance, "there will be a negative impact on the Black Eagle and Falcon who nest in the deep gorge" (WWF). In addition, the dam will have a negative impact on the tourism industry, due to the flooding of the rapids for white water rafting.[82] The Victoria Falls rapids represent one of the world's best rafting spots, according to the International Rafting Federation. Water sports such as rafting and jet boating, and land-based tourism to view the gorge scenery and Victoria Falls have created a huge tourism market, contributing to the economies of Zambia and Zimbabwe, as well as creating steady, long-term employment for thousands of local people. It is feared that the reservoir may not create the same amount of tourism-related benefits.[83]

"In Tonga culture, the Nyami-Nyami snake lives in the gorge. This helps to promote conservation. When this is flooded, what will happen to the culture?

Honorary Wildlife Officer

The gorges below Victoria Falls are home to the commercial white water rafting industry, which brings USD 4 million into the Zambian economy annually. The rafting industry will possibly disappear with the development of Batoka Gorge Dam. The question is whether the sustainable benefit of the hydropower took into account the externalities such as the impact on the tourism sector, biodiversity, livelihoods and cultural value along that stretch of the river.

According to International Rivers, "even though the dam is not associated with much human displacement, the social impacts are projected to be significant."[84] For instance, the flooding of the Kariba Falls Gorge will likely impact traditional practices such as the planting of Baobab trees along the top of the gorge; the Baobab trees indicate the presence of shrines below, to enable communities to fish as a source of livelihood. When flooded, these trees cannot be accessed.

[79] Based on data in Tourism Statistical Digest (2014) - Annual Direct Earnings generated from the hospitality industry (per province)
[80] International Rivers: https://www.internationalrivers.org/resources/batoka-gorge-dam-zambezi-river-8291
[81] International Rivers: https://www.internationalrivers.org/resources/batoka-gorge-dam-zambezi-river-8291
[82] Environmental Resources Management (ERM), Batoka Gorge HES Draft Scoping Report.
[83] International Rivers: https://www.internationalrivers.org/resources/batoka-gorge-dam-zambezi-river-8291
[84] International Rivers: https://www.internationalrivers.org/resources/batoka-gorge-dam-zambezi-river-8291

If the development trajectory is followed, it would seem that in the case of Zambia and the current energy deficit, the cost of inadequate electricity outweighs that of the tourism potential lost. However, going forward, these trade-offs are likely to become more complicated, and therefore need to assessed adequately.

In the above-mentioned case, the tourism and hydropower sectors exhibit significant trade-offs. However, it is essential that these major economic sectors of Zambia acknowledge shared risks, and recognise prospects for co-existence (depending on natural resources and socio-economic benefits). This is because it is in both the tourism and hydropower sectors' interests that upstream catchments are kept pristine. It is, therefore, important that these two sectors recognise this alliance, and act upon this impact that could be leveraged.

3. Cities across Zambia are facing a crisis

Cities across Zambia have water, food and energy demands, representing a nexus challenge

There are unique and significant risks being faced in terms of water supply and wastewater treatment in the cities of Zambia. Cities across Zambia face uncertainty regarding the quality of their water supply due to poor regulation, exploitation and exposure to pollution. Uncontrolled development taking place without adequate land-use planning will put current and future cities at major risk in terms of servicing the population. In addition, aquifers, like the Lusaka aquifer, are under serious threats from pollution as they are exposed to seepage from pit latrines, septic tanks and unplanned quarrying for construction materials. This is particularly the case in the Multi – Facility Economic Zone (MFEZ) in Lusaka, which is believed to be situated on an important aquifer recharge zone. New developments taking place in the area need to be carefully planned and monitored, as it is essential to ensure that these activities are not polluting the groundwater supply for the entire city.

> ***"Our malting facility is in the new Lusaka MFEZ. We need to be sure the groundwater is kept pristine"***
>
> ***Zambia Breweries***

There is also a threat of over-pumping aquifers in specific areas such as Lusaka, Ndola and some farming areas. In mining areas, large quantities of groundwater are discharged into the surface water. Although this water may be useful as it augments river flows (such as believed in the Kafue), there are concerns with its quality.[85] There are also major concerns, as the additional returns to the river do not necessarily mimic the natural pulsating flows that are necessary for biodiversity, and therefore, although good for supply, mine-related wastewater returns may not be good for the environment.

The challenge in cities is both in terms of water, but also in terms of the complexity relating to the nexus. This is because cities not only face water challenges from a water supply and sanitation perspective, but also because they are domestic service hubs, with an increasing peri-urban population that is serviced out of the city. **Urban growth in Zambia is taking place at a massive rate. "In 2015, urban growth continued at an estimated rate of 42% as people moved to towns in search of jobs and opportunities."**[86] This growth is creating increasing pressures on the urban environment. The growing centres require food and energy

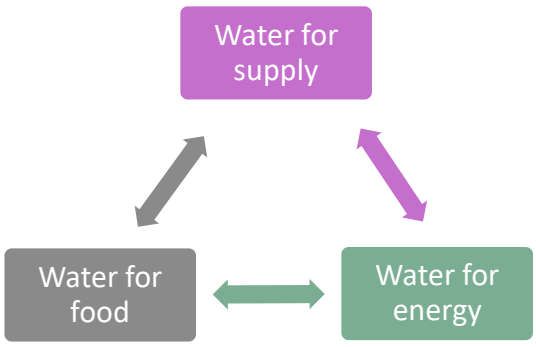


Figure 14: Cities across Zambia have water, energy and food needs. All of which are underpinned by embedded water through the nexus.

[85] Republic of Zambia 2008. Integrated Water Resources Management and Water Efficiency (IWRM/WE)
[86] AfDB: https://www.afdb.org/en/countries/southern-africa/zambia/zambia-economic-outlook/

alongside water to survive. As indicated previously, all these resources are intertwined with water in Zambia. Furthermore, inadequate adaptation of rural livelihoods results in massive migration of vulnerable people to the cities. This migration is adding additional complexity and pressure to the situation.

Each city that is aggressively growing in Zambia is hungry for both food and energy (in addition to water). The need for food to feed a city is closely linked with the availability of water for agriculture. In areas such as Mkushi or Mazabuka, significant amounts of water are used for irrigation to feed the cities such as Lusaka. In addition, cities require electricity to operate productively. Due to the dependence of Zambia on hydropower, the demand for energy represents a demand for embedded water within the cities. Therefore, for each city in Zambia, the demand for water is threefold due to the nexus of water, energy and food needs.

The urban water crisis has far-reaching consequences in Zambia

Across Zambia, there are major gaps in terms of access to water supply and sanitation. This is due to a number of factors. For instance, in Lusaka, there is a high urban population and significant migration is taking place into this region (the district of Lusaka is projected to have an average annual population growth of 3.8% between 2011 and 2020). In Lusaka, more than half of the water supply for the city is pumped from groundwater. However, there is a very small proportion of the population that has access to piped sewerage. As a result, many homes have septic tanks. In addition, due to the karstic nature of the geology in the area and the quick recharge rates, the pollution of groundwater is taking place both from industrial effluent and septic tank seepage. This has a negative impact on the security of groundwater as a water source for consumption.

In Kitwe, the massive growth of the town (projected to be 3% between 2011 and 2020) has led to a lag in water supply and sanitation from the commercial utility (CU). Some residents have mentioned waiting for over a year to receive a connection to piped water and sewerage. In the interim, homes rely on private boreholes and septic tanks for their water and sanitation services.

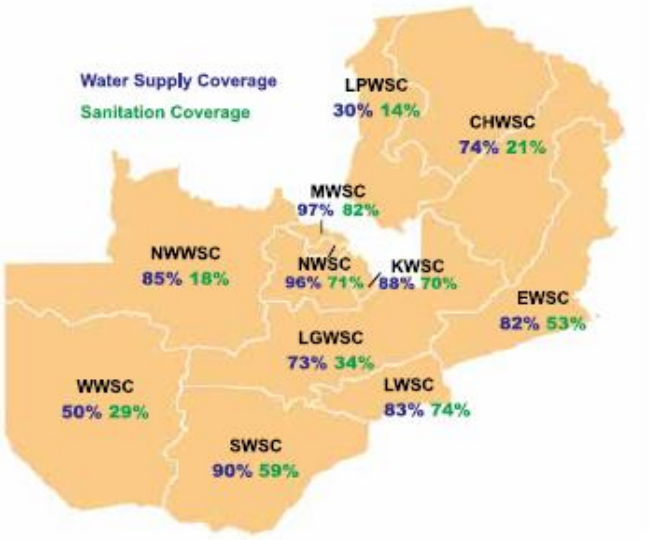


Figure 15: National Urban Water Supply and Sanitation Coverage

In Ndola, the growth in the town (projected to be 1.8% between 2011 and 2020) has led to increasing housing development on important recharge zones for the valuable groundwater resource that services the town. Industries depend upon springs for their water supply. However, in some cases, the understanding of the hydrological relationships between surface and groundwater in the region is lacking. As this is critical to healthy water resouces, the poor quality jeopardises private sector water supply as well as the CU responsible for domestic access to piped water services (due to increasing costs of treating water).

In all of these towns, industries and businesses are finding it difficult to carry out their operations due to inadequate security of water supply and sanitation. This is not always due to unavailability of the resource, but often due to inadequate capacity of the CU responsible for access to water. In such cases, businesses are being forced to make difficult decisions in terms of the siting of their operations. For many of these towns or cities across Zambia, without these industries or businesses, the employment and economic contribution to the region would become further challenged.

"Water quality risks are one of our largest challenges as a brewery"

Zambia Breweries

"We always focus on water. But the challenge of sanitation is a mammoth in Zambia."

WWF

Due to the urban crisis in terms of water supply and sanitation, Zambia is heavily impacted by the low productivity of its labour force, due to its poor health. According to the IWRM Plan for Zambia (2010 – 2016), a high proportion of the Zambian population (47%) have no access to safe drinking water. Between 40-80% of the urban population reside in peri-urban areas and informal settlements. These areas are characterised as being unplanned, making the provision of services difficult. There have been areas with a high incidence of diarrhoeal diseases due to the contamination of water sources.[87] One of the most obvious indicators of health impacts due to inadequate sanitation is the high prevalence of diarrhoea in the age group 0-4 years old, where it accounted for 15.4% of illness.

In 2004, it was estimated that 11.4% of all deaths in Zambia were water, sanitation and hygiene related.[88]

A focus on the rural population's water supply and sanitation challenge: In Zambia, a high proportion of the rural population have no access to safe drinking water. The majority of the rural population access their water from lakes/rivers and unprotected wells, which are not safe. Each year, unsafe water, poor sanitation and hygiene cause several deaths. Rural populations already face a number of challenges and disadvantages, especially over access to basic services. Therefore, the limited access to water is an additional negative impact on their livelihoods. The situation in rural contexts in terms of access to sanitation has only marginally improved, with a very slight increase in the level of access citizens have to sanitation; rising from 28.6% of the population having access in 1990 to a low 33.9% in 2012.[88]

The importance of adequate water and sanitation is recognised by the President of Zambia in his recent address. "Building an integrate multi-sectoral approach to development that enhances inclusiveness in development without leaving anyone behind, entails doing more with less by creating linkages between various sectors and building upon each sectors' comparative advantage. For example, if we improve the water and sanitation system, we will reduce the disease burden arising from water-borne and communicable diseases and spare the resources to be used in other areas of development."[89]

The pricing of water is often seen as an indicator of the value attached to the resource. In Zambia, this indicates a very low valuation of the resource

Economic value is a measure of the benefit provided by a good or service. It is generally measured relative to units of currency, and the interpretation is, therefore, "what is the maximum amount of money a specific actor is willing and able to pay for the good or service"?

[87] Zambia IWRM Plan
[88] VAREN, 2015. The Republic of Zambia - Realising the human right to water and sanitation. Vision Africa Regional Network (VAREN)
[89] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.

While water is provided by nature, there is a real cost for the pipes, pumps, equipment, and people who ensure it is safely delivered to users and returned to the environment. Aging infrastructure, population growth, unplanned development, neglect for the natural infrastructure of the country, strengthened regulations, seismic hazards, and climate change, are driving the need to invest in upgrades and renewal of water supply systems. If we are unable to pay for these essential systems, the health and prosperity of the population will be at risk.[90] Furthermore, the next possible sources of water are always likely to be more expensive than the previous, creating major fiscal challenges if not financed correctly from the start.

"We have losses of over 35%. This makes us even more financially stretched"

Commercial Utility

The fact that groundwater is not paid for by the majority of users in Zambia indicates that it is taken for granted and it is not considered a valuable resource, i.e. it is perceived to be limitless. But, this is not the case, as seen in Lusaka, where shortages and poor quality are becoming a reality.

"The water company has no capacity to expand. I applied for a water connection over a year ago, myself"

Commercial utility employee

Commercial water utilities (CUs) are finding it difficult to invest in water and sanitation infrastructure due to the poor levels of returns gathered through water supply. This is due to a range of issues, including non-revenue water through theft and leakage. However, increased pricing of water must not be to the detriment of the poor, and their ability to access the resource, but it should increase the ability of CUs to invest in improved infrastructure.

Therefore, in addition to improved pricing and collection, improved monitoring and pricing of groundwater use is needed to ensure that the precious resource is managed appropriately.

Poor regulation of groundwater is creating major risks for future water supply

Groundwater is a major source of surface water in many parts of the country. It sustains surface river flows especially during the dry season for perennial rivers and streams, and can contribute to between 30 and over 90% of the total flows.[91] Based on available data, approximately 9% of water usage is from groundwater and groundwater provides 28% of domestic water supply.[92] JICA-MEWD (1995) estimated the average renewable groundwater potential to be 49.6 Km^3. This is based on an average of 8% of the rainfall, which is the main source of renewable water in Zambia at an average annual total rainfall of 1000 mm. However, due to lack of data, it is difficult to accurately assess the groundwater potential of the country.[93]

There has been growing demand on the available water resources in Zambia, and groundwater use is increasing steadily. Groundwater is accessed from a variety of sources: boreholes equipped with electric pumps, hand-pumps, windmills, solar pump, diesel pumps and rope and bucket. The National Water Policy (2010) states that there are no recent statistics on the different pump technologies employed, but a nationwide inventory carried out by the government in 1998 produced an estimated total of 11,000 boreholes (electric and hand pump) and 22,000 protected wells in the country. The resource has greatly suffered from unregulated exploitation and exposure to pollution – aspects that may threaten it as an important source of water in the future.

[90] Value of Water: http://www.valueofwater.ca/
[91] Nyambe I.A. and Feilberg M. 2009. Zambia: National Water Resources Report for WWDR3. Water in a Changing World. Ministry of Energy and Water Development, Republic of Zambia.
[92] Water Aid: www.wateraid.org/~/media/Publications/groundwater-quality-information-zambia.pdf
[93] Nyambe I.A. and Feilberg M. 2009. Zambia: National Water Resources Report for WWDR3. Water in a Changing World. Ministry of Energy and Water Development, Republic of Zambia.

Decreasing groundwater quality, due to increasing industrial and agricultural pollutants and a falling groundwater table, is a growing problem in highly populated urban areas. Sanitation and solid waste management are also major concerns. Waste collection and management are inadequate, posing a serious threat to groundwater quality, particularly in peri-urban areas and informal settlements, where between 40% and 80% of the urban population resides.[94]

> ***"Even us locals treat our water coming from the tap. The quality is not good. We cannot trust the water company"***
>
> ***Livingstone Resident***

Information on the status of groundwater is inadequate due to poor information collection. Although groundwater level measurements are taken automatically at some stations in Lusaka on a daily basis, in other places, these are read fortnightly are not at all. There is no national or regional groundwater quality monitoring, and the lack of regulation of groundwater in the current water legislation has led to inadequate management, which has contributed to decreasing aquifers and the deteriorating quality of groundwater resources.

> ***"The yield of our boreholes is dropping due to the high number of illegal boreholes"***
>
> ***Water utility***

A contributing factor to the urban water crisis is the fact that groundwater abstraction is not regulated. This is especially the case in Lusaka, where, due to monitoring and governance gaps, the city is facing critical water shortages due to pollution of groundwater. Previously, borehole registration fell within the mandate of the construction industry. However, recent institutional restructuring, such as the transfer this responsibility to WARMA, who are better placed to manage complexities such as the surface-groundwater interface, is good for the country.

4. Long-term opportunities for water in the Zambian economy

A long-term focus on water in Zambia is necessary. However, this requires a high level of urgency, as communicated through the narratives. For instance, Zambia is projected to develop extensively. This is supported by the following quote from the President of Zambia in a recent address: "in the next five years, the broad macroeconomic objectives of my administration will include achieving double-digit gross domestic product growth, attaining single-digit inflation rate and increasing and broadening domestic revenue collection."[95] Therefore, a major focus on water is required so the resource is are able to sustainably support this development projection.

Although an abundance of water is currently perceived in Zambia, there are areas that are already showing water-related stresses. The economic powerhouse of Zambia, the Kafue, is one. Going into the future, it is likely that more catchments will become stressed. Development and climate-related challenges, together with transboundary obligations and poor institutional alignment, will fundamentally challenge the resilience of Zambia and will create the "perfect storm" for very difficult times in Zambia. Therefore, the above narratives are only likely to become worse. This is the call to urgently respond sustainably.

> ***"Our voices are not together around the challenges. We all need to work together"***
>
> ***Barley Farmer***

Continued development in Zambia is likely to continue impacting natural resources

The country's economic growth has stood at an annual average of 6% for the last decade. However, this development also places significant pressure on water resources; agriculture, energy, mining and industries are all

[94] AgWater, 2009. Zambia Situation Analysis. Agricultural Water Management National Situation Analysis Brief.
[95] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.

dependent on water resources, and have impacts on the use and governance of water resources, as well as on the livelihoods of the population of the Zambia.

Growth in Zambia has been driven primarily by the mining and metals industry (Figure 16). The impact of the significant growth in the sector will have long-lasting impacts, both good and bad, upon the economy and environment. Although GDP may rise, there may be associated environmental and/or social challenges. The impacts of a growing economy are likely to be further compounded by the stressors of climate change, making management of resources a further challenge. There is recognition in the recent national development plan that this (mining-focused) development trajectory needs to change, and the economy needs to become more diverse.

"To drive development in Zambia, we need to support other sectors, not just mining. Tourism, for example, has too many taxes."

Hotel owner

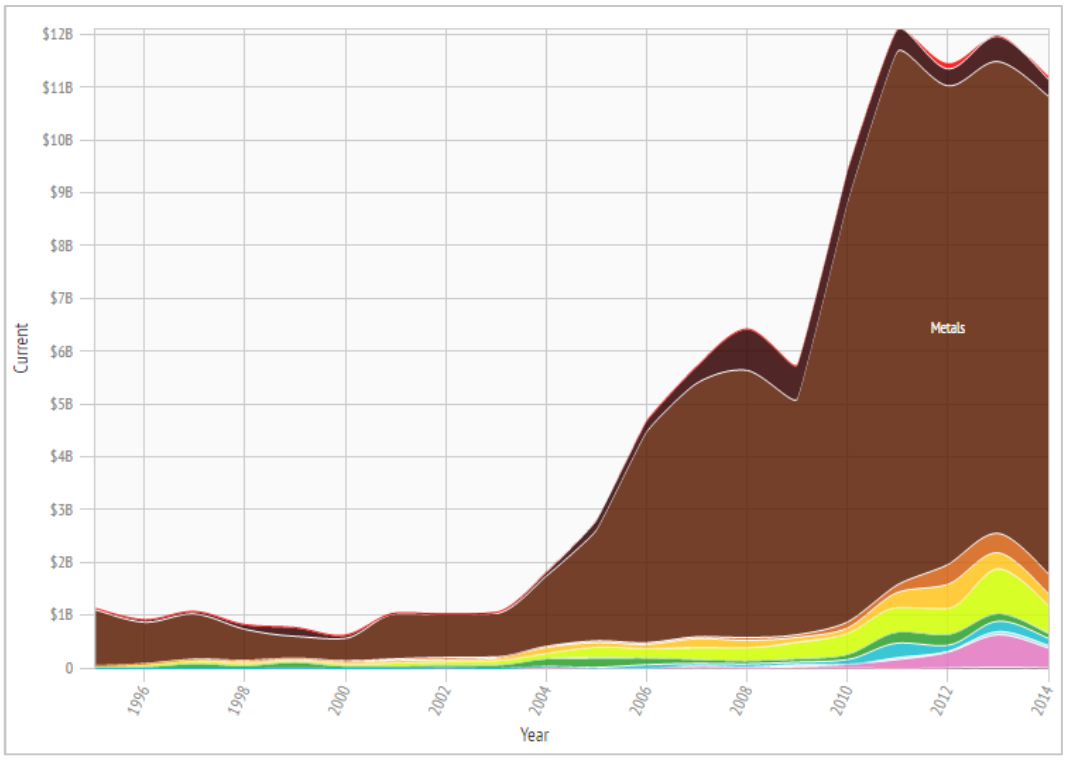


Figure 16: Zambian exports per sector[96]

The Revised Sixth National Development Plan (R-SNDP) of Zambia provides an ambitious goal towards development in Zambia. The R-SNDP, which is aimed at achieving the objectives set out in Zambia's Vision 2030 of becoming "prosperous middle-income country by 2030", recognises that development has "an impact on the quality and quantity of available water resources, [and] thus sectoral activities need to be effectively coordinated and regulated so as to protect the environment."[97] However, this challenge is compounded by absent or inadequate integrated water resources management (IWRM) at catchment levels. The catchment councils currently being developed in each of the catchments are hoped to mitigate some of these water resource challenges.

The inability to proactively manage water supply to meet development needs in Zambia will lead to shortages in water supply. Water demand for domestic and industrial use has been on the increase while supply has remained

[96] Center of International Development, University of Havard: http://atlas.cid.harvard.edu/explore/stacked/export/zmb/all/show/1995.2014.2/
[97] Zambia Sixth National Development Plan, 2011 - 2015.

stagnant."[98] The R-SNDP recognizes the need to "improve sustainable and equitable access to safe water supply in both urban and rural areas by enhancing the status of infrastructure and water distribution."[99] The practical outcome to a shortage in water supply and sanitation infrastructure is a stifling of possible industrial growth and development, which is dependent on stable water (and energy) supply.

> ***While a lack of water has severely affected food production, it has also had a devastating effect on industry. The shortfall in energy supply has impacted on manufacturing, mining and industry, increasing the costs of production, and is negatively impacting on the quality of life of Zambians with access to grid electricity. The power crisis adds to the list of negative shocks that have impacted on the Zambian economy in 2015.[100]***

Therefore, while continued development will result in an increase in demand for natural resource (such as water and energy), this development is required in order to improve the economy and livelihoods of the people of Zambia. However, with inadequate natural resource supply, increasing development creates an increase in the competition for natural resource. Inadequate natural resource management results in unequal access to water resources, thus limiting the amount of resources that are available for other members of society. This results in a natural resources' cycle, which hinders on effective resource management.

Climate in Zambia is a compounding risk factor for an already stretched system

The impacts of climate change on Zambia's water resources are uncertain and unpredictable, adding further complexity to the challenges being faced. The climate of Zambia, including its precipitation and temperature patterns, is expected to continue to change in the next 5 to 40 years. In the coming decades, the temperature across Zambia, along with the entire southern Africa region, is widely expected to increase, and probably at a faster rate than the global average for all seasons. The mean annual temperature in Zambia is projected to increase by 1.2 to 3.4°C by the 2060s, and 1.6 to 5.5°C by the 2090s. The projected rate of warming is a little more rapid in the southern and western regions of Zambia than the northern and eastern regions. All projections indicate substantial increases in the frequency of days and nights that are considered 'hot' in the current climate.

Projections of mean rainfall do not indicate large changes in the amount of annual rainfall, although total annual precipitation is expected to decrease slightly. Seasonally, the range of projections from different models is large, but the multi-model averages indicate decreases in September to November rainfall and increases in December to February rainfall particularly in the northeast part of the country.

The frequency of extreme precipitation events (causing flash floods) will probably become greater. The intensity of rainfall events and the time between them may also increase. In other words, this reduction in the frequency of rainy days could lead to longer dry spells interspersed by more intense heavy precipitation events, all without greatly altering total annual precipitation. The proportion of total rainfall that falls in heavy events (such as floods) is projected to increase between December to February.

The impacts of future climate change can already be seen. Climate change has increased the frequency of floods and droughts over the past three decades and will continue to have an impact on climate-sensitive sectors such as rain-fed agriculture, fishing, and forestry.[101] For example, the above average rains in January 2008 that caused severe flooding in Zambia are believed to have been a combination of the presence of the Inter-Tropical

[98] Zambia Sixth National Development Plan, 2015
[99] Zambia Revised - Sixth National Development Plan, 2015
[100] World Bank, 2015. Zambia Economic Brief.
[101] World Bank, 2015. Zambia Economic Brief.

Convergence Zone (ITCZ) and La Niña. Floods from heavy rainfall events are also threatening food production, particularly in northern Zambia. Recorded effects of past floods on agriculture include inundation of farmland, destruction of crops, increased malnutrition and hunger, soil erosion, reduced cultivatable land, and loss of livestock.[102] Irrigation infrastructure is also vulnerable to climate impacts.

> ***"Zambians have been complacent, as the ITCZ passes over twice, making rain-fed agriculture possible. This is not changing, as seen by the failure of maize in the south."***
>
> ***Hotel owner***

The rising frequency of droughts and shorter rainy seasons has led to increasing crop loss and food insecurity. The recent drought has largely affected the south of the country with less than 40mm of rainfall recorded between mid-November (2015) and early January (2016), the lowest numbers since record-keeping began.[103] Low rainfall has reduced agricultural production, harming rural households' incomes. The 2014 - 15 agricultural season (October-March) was characterized by extensive rainfall deficits resulting in markedly below average end of season vegetation. This reduced agricultural production for 2015 and increased the prices of food items. Recent drier weather patterns have been strongly influenced by the El Niño, causing a drought event active from March 2015 into late 2016.

It is likely that current extremes and challenges from climate variability (manifested mainly as extreme and/or unpredictable floods and droughts) will be experienced for decades to come. For instance, in the Zambezi catchment, a 1.5°C increase in ambient temperature will result in a 16% reduction in yield for the basin and a 13% percentage irrigation deficit by the year 2030.[104] Therefore, Zambia is in a paradigm that is balancing between abundance and vulnerability. When there are times of plenty, it is very good, although floods often have negative consequences. However, when resources are stressed, large portions of the population are highly vulnerable. This will be felt by the economy and society of Zambia. Erratic rainfall has significant impacts on Zambia, especially on farming and human settlements. Extreme or unpredictable floods and their impacts on crop production, health, and economic infrastructure are the main concern. As agricultural and livestock production are largely dependent on rainfall, the country's high rainfall variability and limited irrigation capacity make them vulnerable to climate change.

> ***"Before 2003 we were not constrained in terms of water. With development and climate change, we do not have enough"***
>
> ***Commercial Utility***

Climate variability undermines attempts to reduce poverty and food insecurity, since most of Zambia's poor population consists of rural small-scale farmers who rely on rain-fed agricultural incomes. Thus, there is mounting pressure on the government to identify sections of the population that are most vulnerable to climate variability (and the associated impacts), and to devise more climate-resilient strategies that promote socio-economic development.

[102] USAID, 2012. Climate Change Adaptation in Zambia. Fact Sheet.
[103] Acces Africa: http://access-africa.com/southern-africa-and-the-economics-of-drought/
[104] The World Bank, 2010. The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis. Volume 3: State of the Basin.

Climate change poses a challenge to both hydropower and access to biomass for energy in Zambia. Considering that 99% of Zambia's electricity generation is based on hydropower and biomass energy accounts for 80% of the total energy use, the energy sector is vulnerable to climate change. Climate-related hazards and risks have the potential to negatively affect current and future outputs of Zambia's traditional energy sources. These hazards include droughts, excess rainfall, changes in wind regimes and cloud cover, which will result in impacts such as decreased flow, increasing siltation, infrastructure damage, and increasing evaporation. These impacts will increase the energy generation potential of hydropower plants.

Currently, the majority of hydropower in Zambia is produced in the southern regions of Zambia. These areas are at highest risk to climate change impacts. For example, the Lower Zambezi is home to Kariba Dam, which produces 50% of all electricity in Zambia, is projected to experience a 32% reduction of energy generation of hydropower (due to the impacts of climate change indicates such as reduced runoff yield and increased irrigation deficits, as well as a temperature increase of 1.5°C for evapotranspiration calculations).[105] Therefore, hydropower generation in this catchment is projected to be at high risk due to climate impacts. Hydro-climatic impacts will result in changes in the hydrological regime, as discussed above, which will impact energy supply. Therefore, diversification into other renewable energy sources is of critical importance.

As a landlocked country, Zambia has a number of transboundary river basins. This presents major pressure and responsibility for Zambia regarding the impacts of its development and water use

The majority of catchments in Zambia are shared with neighbouring countries. Therefore, there are a number of international agreements to which the country is a signatory. The principles such as equitable use and communication among riparian countries mean that many developments within Zambia do not impact Zambia alone.

"As the namesake of the Zambezi, and the major country of the basin, Zambia has a responsibility to its neighbours in developing sustainably."

WWF

The most significant river management transboundary organisation that Zambia is part of is ZAMCOM. Zambia represents 42% of the Zambezi's total basin area, while Angola, Namibia, Botswana, Zimbabwe, Tanzania, Malawi, and Mozambique make up the remainder in smaller proportions.[106] Within ZAMCOM countries, there have been interesting developments that impact upon Zambia. These include, for instance, the development of a possible pipeline from the Zambezi River to South Africa, to augment South Africa's water supply. Further mention has been made for a possible pipeline from the Chobe River to Botswana. These developments will have significant impacts on Zambia, as well all the other countries of the Zambezi. To ensure that developments do not take place without adequate engagement (from Zambia), it is critical that Zambia is proactive in its approach and engagement with transboundary organisations. This is critical as the country is both an upstream and downstream riparian state (as the Lower Zambezi is downstream of the Chobe River in Botswana, depending on the river's seasonal cycle), and therefore has both the need and responsibility for communicating with their neighbours.

Figure 17: Transboundary basins in SADC

[105] WorldBank: http://siteresources.worldbank.org/INTAFRICA/Resources/Zambezi_MSIOA_-_Vol_1_-_Summary_Report.pdf
[106] FAO: http://www.fao.org/docrep/W4347E/w4347e0o.htm

A journey towards the alignment of governance within the water sector and other sectors is needed

Water resource management and governance in Zambia falls under two sub-sectors: Water Resources Management and Development (WRMD) and Water Supply and Sanitation (WSS). A Water Sector Advisory Group (WSAG) plays a coordination role in bringing together other sectors such as environment, agriculture, mining, industry, housing and energy. Following a UN review on water management in Zambia, major identified challenges in the management and regulation of water resources include: inadequate human and institutional capacity, inadequate financing, and low infrastructure development and access to water.[107] There are limited water management regulations and the lack of capacity to enforce existing water rights regulations and fees.[108] These challenges are portrayed in the figure below.

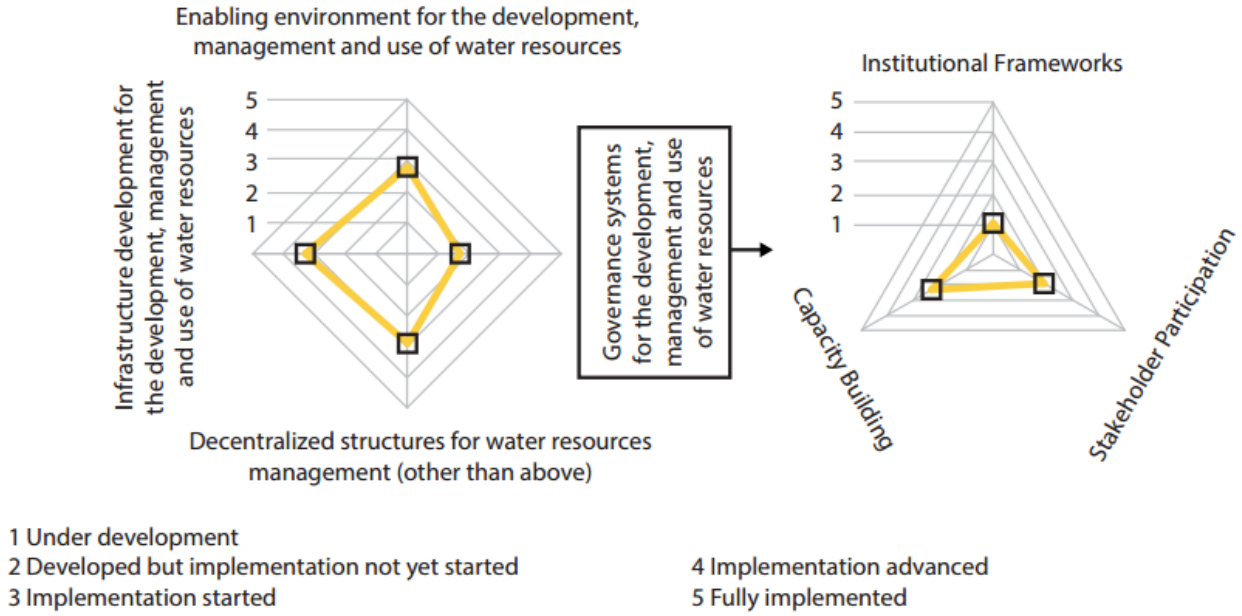


Figure 18: UN-Water survey on integrated approaches in the development, management and use of water resources governance, 2012 (UN-Water)

The often overlapping institutional mandates or gaps in mandates among the water sector public institutions poses major challenges. Following conversations with a number of commercial water utilities (CUs) in Zambia, together with WARMA, it is clear that there are some gaps in the governance of the water value chain. In addition, there are areas where mandates are overlapping between more than one institution. For instance, one CU stated that "the mandate of the utilities is limited. We cannot report industry pollution instances as that is the job of ZEMA. We cannot control borehole licenses, that is the job of WARMA." This creates not only confusion among the water sector, but also means that we are not strategically managing the scarce resource in the most practical or efficient way possible. Further analysis is required to better understand where these gaps and duplication exist.

> ***"There are gaps in the local council leadership. We are unable to fix this properly, as we are always looking to the next election."***
>
> ***Tourism developer***

There are some examples in Zambia where public sector institutions, such as the CUs, are being negatively impacted by decisions made by other public sector institutions. Examples include City Councils, who also own the CUs, in

[107] UNWAter: http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/ZMB_pagebypage.pdf
[108] UNWAter: http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/ZMB_pagebypage.pdf

> ***"Our aquifer is getting polluted due to encroachment of settlements. This is the job of the Land Use Planning Department"***
>
> ***Commercial Utility***

cities such as Ndola, Kitwe and Lusaka: CUs are negatively impacted by the uncontrolled or unregulated development of housing and/or infrastructure within the CUs water supply area (i.e. river banks). These developments negatively impact the CUs ability to function.

The journey towards improved governance alignment is a long and arduous one. The very fact that these gaps can be identified indicates that Zambia is in a position to make changes that will improve the sustainable management of water resources, for the benefit of all.

It is promising to see that the Zambian Government has recognised the systemic, national need to integrate and align. This is reflected by the following quote from the President of Zambia: "it is against this background that government directed the ministry responsible for national planning to ensure that the Seventh National Development Plan is premised on the integrated multi–sectoral approach. Similarly, I expect the national budget to be responding and be aligned to The Seventh National Development Plan, in line with the integrated multi-sectoral approach."[109]

> ***"Our major challenges include access to finance and poor coordination among our institutional structures"***
>
> ***WARMA***

5. Concluding Remarks

As indicated in this brief, water plays a fundamental role within Zambia. Not only for society, but also for the economy, the environment, and also cultural activities. "Zambia has good water resources. It is important that we translate these good water resources into our society and economy for dignity and wealth" (WARMA).

As a natural resource-based economy, Zambia is wholly dependent upon water resources for its economic growth. Each of the sectors that drive the economy of Zambia, are wholly reliant upon stable water supply; agriculture is reliant upon water for irrigation, while mining, industry, and other economic sectors located in cities, are reliant upon hydropower to drive electricity needs. The demand for energy represents a demand for embedded water within the cities too; in each city, the demand for water is threefold due to the nexus of water, energy and food needs. Added to this, the rural and agrarian nature of the Zambia population means that water is critical for livelihoods - not only for smallholder agriculture, but also for the ecosystem goods and services that they provide.

It is evident that water plays a critical role underpinning the sustainable development (i.e. economic, social and environmental) of Zambia. Water resources, and the essential services they provide, are critical to achieving poverty reduction, inclusive growth, public health, food security and livelihoods, as well as promoting environmental sustainability.[110] As Zambia is developing, the development goals, whether in mining, agriculture, manufacturing or tourism, all require sufficient water at adequate quality. It is important that these water-related needs are taken into consideration when planning for future development in the country. This is especially true for businesses and industry planning to invest in Zambia, who require stable access to water and also to energy. It is important that the Zambian Government internalize what this means for their policies and planning. This is echoed by the following call to action from the President of Zambia, "that all institutions, public, private, civil society must become radically responsive to our people and fully engaged in finding and implementing solutions."

[109] Government of Zambia, 2016. Official opening of the first session of the Twelfth National Assembly by the President of the Republic of Zambia, Mr Lungu.
[110] WWAP, 2015. The United Nations World Water Development Report 2015: Water for a Sustainable World. WWAP (United Nations World Water Assessment Programme). Paris, UNESCO.

Key messages for the Ministry of Water and the Government of the Republic of Zambia:

The Zambian Government already recognizes the fundamental role that water plays in the economy of Zambia through the national development plans. This is a powerful indication of the importance of water. However, this needs to be given effect through appropriate governance mechanisms within the country. In Zambia, water is both a catalyst and a constraint to future development. The Zambian Government needs to put in place adequate plans for the future, in an effort to leverage the opportunities and manage increasing demands on the resource, alongside increased variability in availability. The following are notable action steps:

- Integrated landscape planning is a useful lens through which to manage the competing needs of different sectors. By looking at the broader landscape of development within Zambia, the integrated relationships of water, land, energy and food should be taken into consideration more deeply. Although built infrastructure is critical to enable access to natural resources such as water for both the economy and society, it is critical that natural (green) infrastructure is part of the planning process. This is because healthy freshwater ecosystems play an integral part in ensuring healthy natural resources (such as rivers and wetlands). **Effective landscape planning, therefore, requires a balance between built and green infrastructure, as well as an integrated planning approach that considered the integrated and changing nature of natural systems.**

- **For integrated development planning to become possible and effective, it is of paramount importance that the currently unaligned/overlapping departments and ministries find a practical and workable method in which they can communicate and work together.** There is, therefore, a need to minimize the overlap between different governmental functions. There is also the need to fill some of the gaps in the government capacity and resources to support water resources management. The journey towards improved governance alignment is a long and arduous one. By recognising that these gaps exist, Zambia is in a better position to create institutional structures that are more efficient.

- **Water is embedded in the value chains of sectors that are driving the economy of Zambia.** Therefore, in order to ensure that these sectors continue to thrive, it is critical that government ensures water security. This, however, requires some hard decisions to be made, and for the government to ensure that one sector's actions and impacts on natural resources do not impact other sectors of the economy.

- Planning for the economy and population of Zambia should consider the variable nature of water resources, particularly when considering climate-related impacts. This includes not only seasonal climate-related impacts (i.e. droughts and floods), but also long-terms changes in climate patterns and water resource availability. Sectors such as energy (through hydropower and biomass), and agriculture are directly exposed to climate impacts. **Planning with climate considerations will ensure that sectors and the population are able to adapt to changing environments.**

- A high reliance on hydropower and on importing energy to meet local energy shortages exposes the country to external risks. **By diversifying the energy mix away from hydropower and continuing efforts to expand energy supply, the country minimizes its exposure to regional political risks as well as climate-related impacts on water resources.**

- Monitoring and compliance enforcement is a vehicle that is available to government to ensure water resources management. **Successful implementation not only protects natural resources, but is also a tool to provide financial resources to government and CUs**; these financial resources can be used to

strengthen the monitoring and compliance network (by building skills and capacity, providing information and data, and/or filling technology needs).

Key messages for the Private Sector in Zambia:

The private sector plays a fundamental role in the future socio-economic development of Zambia. In addition, as most companies are either impacted by water, or have an impact on water resources, it is important that business leaders understand their risks associated with water resources within Zambia. This includes physical, regulatory and reputational risks. However, there is also an opportunity for companies to collectively understand that they have a role in supporting government in responding to the risks associated with water in Zambia. The following are key action steps for companies in Zambia:

- **Water is an enabler or constraint for doing business.** Companies in Zambia need to realise that the absence of water or electricity will translate to increased running costs, disruptions to operations, and/or impacts on the company's business case. Therefore, supporting water resources management is investing in business sustainability.

- **It is important for companies to understand the shared risks in the catchments that the operate in.** This is because external catchment conditions create risk for different sectors in that catchment. For example, issues such as aging infrastructure, water scarcity, pollution and climate change will impact various sectors and companies in the catchment. Understanding these shared risks provides a vehicle for collective action. By effectively managing these shared risks, the companies will reduce the negative impacts on the business, which will not only minimise reputational risks, but will ensure operational sustainability.

- **Companies need to acknowledge the entire region in which they operate in (including ecosystems, society and economy), and realise that they do not exist in silo.** It is essential that companies act as responsible citizens (and do not impacts on the external environment), and ensure that they return the environment to the state that they found it in. This is particularly true for the mining sector, as impacts from metals and minerals can impact citizens for generations to come.

- There is an important role for the private sector in creating a unified voice through which to communicate with government around challenges associated with water supply within Zambia. It is important that the broader economic and social cost of inadequate water supply and quality to these companies is highlighted. It is also critical that trust and understanding is developed amongst the different stakeholders in a proactive manner. **Private sector companies need to come together and discuss their shared interests regarding water security in Zambia.** Acting out of the principles of stewardship will support not only their legal license to operate, but also their social license to operate.

In summary, the challenges associated with water resources management in Zambia cannot be underestimated. This is because Zambia is home to both a dilemma and a paradox: there is either too much or too little water, in the wrong place or at the wrong time. Yet it is this variability that creates the rich and diverse ecosystems on which the country depends. Therefore, it is critical that strong relationships are created amongst a broad range of stakeholders before any crises associated with water resources are realized. It is less complicated trying to solve a crisis with those you trust than those that you don't. The private sector needs to be proactive in engaging others in recognizing this opportunity.

6. References

6.1. Works Cited

This document is based on the report developed for SAB and WWF, which is referenced is:

SAB Miller and WWF, 2016. The Social and Economic Value of Water in Zambia. Full Report

Additional references are provided as footnotes.

6.2. Image Gallery

The images used in this document include: Charcoal maker crossing the Kafue River (Front Page)[111]; Zambezi River, near Victoria Falls (Page 2)[112]; Kariba Dam (Page 6)[113]; Mopani Mine in Zambia (Page 8)[114]; Smallholder farmers in Zambia (Page 12)[115]; Kuomboka Ceremony, Zambia (Page 18)[116]; Victoria Falls (Page 23)[117]; Kenyama community, Lusaka (Page 25)[118]; Flooded Community in Zambia (Page 30)[119]

6.3. Stakeholders Consulted

The findings of this report have been validated through engagement sessions with stakeholders in Zambia. Below is a list of people and/or organisations that provided useful guidance to aid the completion of this study.

1. Barley Farmer in Lusaka (Private)
2. Chamber of Mines
3. Chilubuma Mine
4. Climate Change Secretariat - ZNCCS
5. GIZ Zambia
6. Hydrology Specialist (Private)
7. Kazangula Farming Block
8. KPMG
9. Kufubu Water and Sewerage Company
10. Lukanga Water and Sewerage Company
11. Lusaka Borehole Drilling Company (Private)
12. National Heritage Conservation Commission
13. Southern Water and Sewerage Company
14. Tourism Investor (Private)
15. University of Zambia
16. Water Resources Management Authority (WARMA)
17. Wildlife and Env. Conservation Society of Zambia (Livingstone Branch)
18. WWF Zambia
19. Zambeef Products Plc
20. Zambia Breweries (Lusaka Head Office)
21. Zambia Breweries (Malting Plant - Lusaka MFEZ)
22. Zambia Breweries (Ndola)
23. Zambia Chamber of Commerce and Industry (ZACCI)
24. Zambia National Farmers Union
25. Zambia Tourism Agency
26. Zambia Wildlife Authority (ZAWA)

[111] Accessed at https://www.flickr.com/photos/127791230@N02/15246466872/ in March 2017
[112] Accessed at https://www.flickr.com/photos/pius_mahimbi/8520169147/ in October 2016
[113] Accessed at https://www.flickr.com/photos/hagviken/16599337359/ in October 2016
[114] Accessed at https://www.flickr.com/photos/63744740@N07/5876615579/in/photostream/ in October 2016
[115] Accessed at http://rtoafrica.com/rent-to-own-boosting-agricultural-growth-with-smallholder-farmers-in-zambia/ in February 2017
[116] Accessed at http://www.barotseland.info/KUOMBOKA_CEREMONY.htm in October 2016
[117] Accessed at https://www.flickr.com/photos/mister-e/196445388/ in October 2016
[118] Accessed at https://www.flickr.com/photos/gtzecosan/5268483477/ in October 2016
[119] Accessed at https://africa2010a.wikispaces.com/Zambia+Economy in February 2017