



PMRC WATER RESOURCES SERIES
EFFICIENT WATER RESOURCE MANAGEMENT FOR SUSTAINABLE
SOCIAL AND ECONOMIC DEVELOPMENT

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ABBREVIATIONS

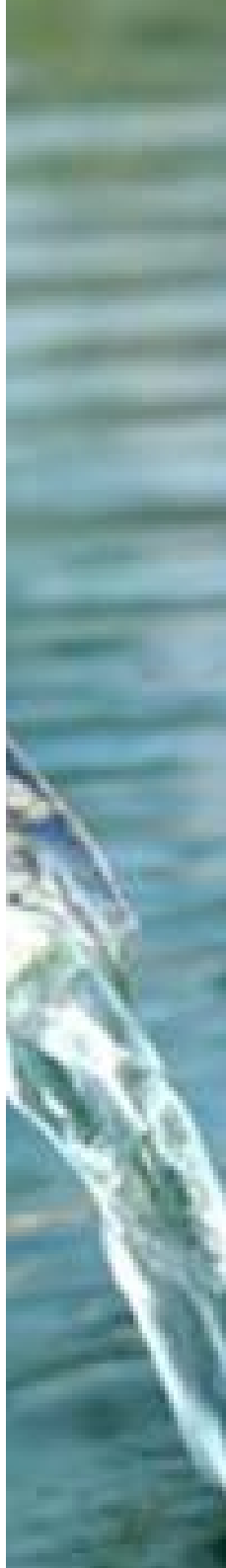
AFDB	African Development Bank	PMRC	Policy Monitoring and Research Centre
CSO	Central Statistics Office	R-SNDP	Revised Sixth National Development Plan
FAO	Food and Agricultural Organisation	SADC	Southern Africa Development Community
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit	UN	United Nations
ILUA	Integrated Land-Use Assessment	USGS	United States Geographical Survey
IPCC	Intergovernmental Panel on Climate Change	WB	World Bank
JICA	Japan International Cooperation Agency	WRMA	Water Resource Management Authority
MEWD	Ministry of Mines, Energy and Water Development	WWF	World Wide Fund For Nature
NWASCO	National Water Supply and Sanitation Council	ZEMA	Zambia Environmental Management Agency
PF	Patriotic Front		

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Water Resources Series

**EFFICIENT WATER RESOURCE MANAGEMENT FOR SUSTAINABLE
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INTRODUCTION

Water is an integral part of human development and sustainability. In comparison to other countries in Southern Africa, Zambia is one of the countries well known for its abundant water resources. The main source of water is rain, which replenishes the rivers, lakes and other water reserves. Zambia's average annual rainfall in 2011 was measured to be between 1400mm in the north and declining to about 200mm in the south.¹ The Integrated Land-Use Assessment (ILUA) (2008) reports that 3.0 million hectares (4%) of the country's total land area² is made up of water bodies.³ Although fresh water is said to be a renewable resource (can be replenished by rain), there is need for sustainable water resource management practices. Water is a critical resource to human livelihoods. It cuts across all sectors and sub sectors of social and economic development. It is a key resource to nutrition, agriculture, health, sanitation, construction, energy, tourism and manufacturing sectors.

This Background Note seeks to increase public awareness of the huge water resource base that Zambia possesses. It emphasizes the need for enhanced water resource management approaches, by highlighting the effects of various developmental activities on the country's water resources. The Background Note further underscores the possible effects of population increase and urbanisation on Zambia's water resources and how these determinants can be utilised for efficient water resource management practices.

UNDERSTANDING WATER RESOURCES STRATEGIES

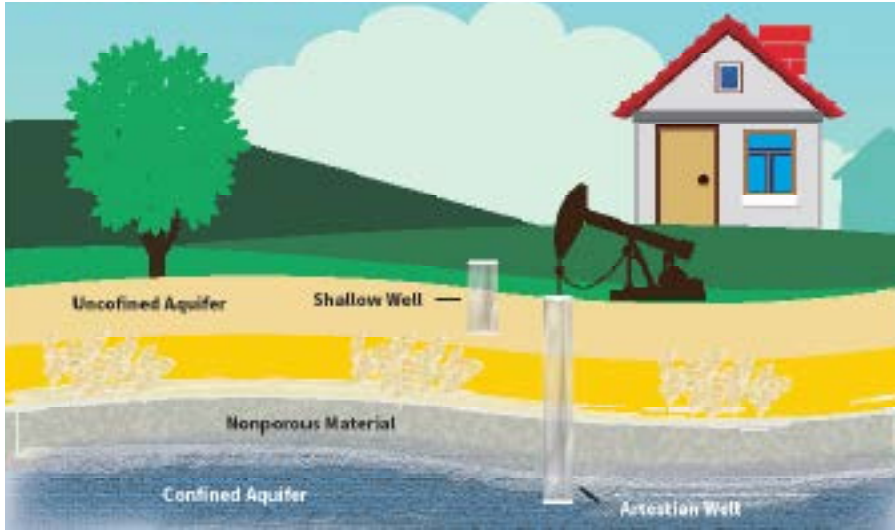
There are two main types of water resources commonly referred to and these are, Ground water and Surface water.

Ground water

According to The United States Geographical Survey (USGS) (2014), Ground water is defined as the water located below the earth's surface. Precipitation⁴ seeps down through the soil until it reaches rock material that is saturated

1. WHO/UNICEF. 2010. Joint Monitoring Program for Water and Sanitation
2. Surface land area for Zambia is estimated at 752,614km
3. A body of water forming a geographical feature, for example a sea or a reservoir.
4. Rain, snow, sleet, or hail that falls to the ground

with water, forming aquifers⁵. The depth at which the spaces or fractures in rock becomes fully saturated is called the water table. Groundwater eventually flows to the surface naturally, through springs or wetlands, but can also be withdrawn through extraction wells. The illustration displays the makeup of ground water systems. Ground water is critical to sustainable economic and social development.



Source: adapted by PMRC from the World Bank Water Resource Management Africa Region. 2009

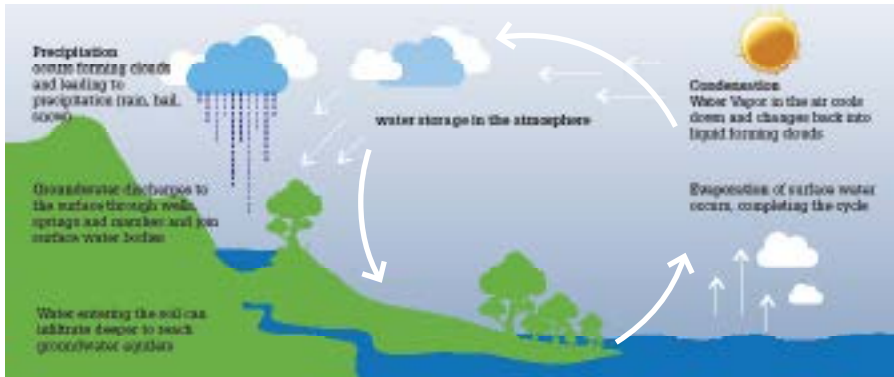
Surface water

Surface water is found above the earth’s surface and examples include rivers, lakes and streams. Surface runoff is the flow of water from rain, melt water or other sources over land, and is a major component of the water cycle. Various studies have revealed that Zambia holds about 40% of the total run off⁶, in the Southern Africa Development Community (SADC)⁷.

INTERACTION BETWEEN GROUND WATER AND SURFACE WATER

Ground and surface water are connected and feed into each other. To further understand how the two are inter connected, it is important to understand the general hydro-logic (water) cycle. The illustration next page displays this cycle.

5. A body of permeable rock, which can contain or transmit groundwater.
6. Is the flow of water that occurs when excess water from rain, meltwater, or other sources flows over the earth’s surface
7. Water & Sanitation Reforms in Zambia- Achievements & Challenges, Sikazwe. O. 2005



Source: Conservation Technology Information centre (2014).

The water cycle is a continuous process that needs protection to ensure water resources are renewed and replenished.

INSTITUTIONAL ARRANGEMENTS

The Ministry mandated to manage Zambia’s water resources is the Ministry of Mines, Energy and Water Development (MEWD) through The Water Resource Management Authority (WRMA). WRMA is a state corporation under the Ministry of Water and Irrigation founded under the Water Act 2002. This Institution is the lead agency in water resource management and its functions include developing principles, guidelines and procedures for the allocation of water resources, receiving and determining applications for permits for water use, and regulating and protecting water quality from adverse effects. Other supporting organisations include;



ZAMBIA ENVIRONMENTAL MANAGEMENT AGENCY - ZEMA
This institution is an independent environmental regulator mandated to provide for integrated environmental management and protection of natural resources.



MINISTRY OF LOCAL GOVERNMENT AND HOUSING
Whose mission is to promote decentralised and democratic local government systems and facilitate the provision of quality housing, infrastructure and other social services.



MINISTRY OF LANDS NATURAL RESOURCES
Whose mission is to efficiently, effectively and equitably deliver land, resource up to date land records and provide land information.



NATIONAL WATER SUPPLY AND SANITATION COUNCIL - NINASC
Which regulates the provision of water supply and sanitation services in the country.

Over the years, Government has also received support from various organisations such as;

- **The African Development Bank (AFDB)**
- **World Bank (WB)**
- **German Government through Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)**
- **United Nations (UN) Systems**
- **WWF and others.**

These institutions have supported Government's efforts in managing institutional arrangements, carrying out research, capacity building and infrastructure development.

POLICIES AND PLANS

The water sector in Zambia is guided by various policy documents. These primary policy guiding documents and plans include but are not limited to;

- 1. THE NATIONAL WATER POLICY OF 2010.** Framework for water developments in the future. This policy comprises modern principles of water resources management for increased poverty reduction.
- 2. THE WATER RESOURCES MANAGEMENT ACT, 2011.** Establishes the Water Resources Management Authority, defines its functions and powers; provides for the management, development, conservation, protection and preservation of the water resource and its ecosystems; provides for the equitable, reasonable and sustainable utilisation of the water resource among others. Most importantly, the Water Resource Management Authority is mandated to issue water permits and register and regulate all borehole-drilling activities.
- 3. THE ZAMBEZI RIVER AUTHORITY ACT.** This Act is an interstate agreement between Zimbabwe and Zambia, on the utilization of the Zambezi River. It is a repeal to part III of the Federation of Rhodesia and Nyasaland (Dissolution) Order in Council, 1963; to repeal the Central AFRICAN POWER ACT.
- 4. SADC WATER PROTOCOL.** This is a protocol that governs all shared water bodies and water systems in the SADC region⁸.

There is need to redefine institutional arrangements in an effort to set clear, complementary mandates among the key institutions in the sector. One of the preconditions for effective policy implementation is coordination amongst key institutions. This supports the attainment of goals and also assists in monitoring

8. SADC countries are, Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe

performance of the sector. Government must promote efficient and effective monitoring of both ground and surface water resources to ensure adequate planning. This would further promote increased access to water, infrastructure development, capacity building and institutional coordination for efficient and effective sustainable water development. In cooperating with neighbouring countries, Zambia has since made progress. The government has signed the “Zambezi Water Resource Commission” (Mozambique and Zimbabwe) and Zambia is also one of 14 signatories of the Southern African Development Community (SADC) protocol on shared watercourse systems. This provides for shared management of the Zambezi River and Lake Tanganyika as well as the Congo River basin that are covered within the Southern African Development Community (SADC) protocol.

Zambia's Water Resources

Zambia has a number of rivers, lakes, streams and swamps. It has five main river basins⁹, namely Zambezi, Kafue, Chambeshi, Luangwa and Luapula. Besides these are natural lakes that include Bangweulu, Mweru wa Ntipa, Mweru and Tanganyika of which two are shared with neighbouring countries.

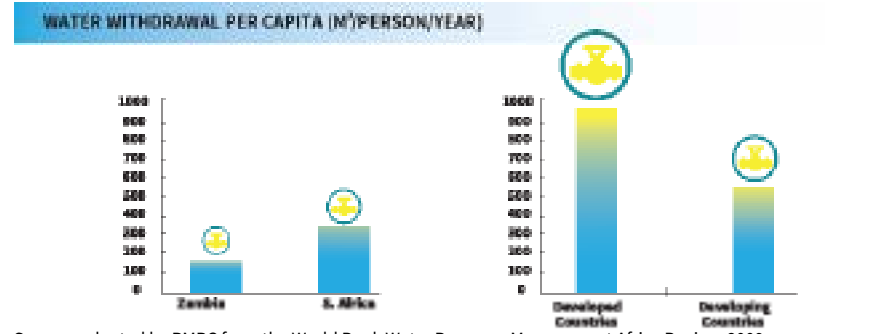
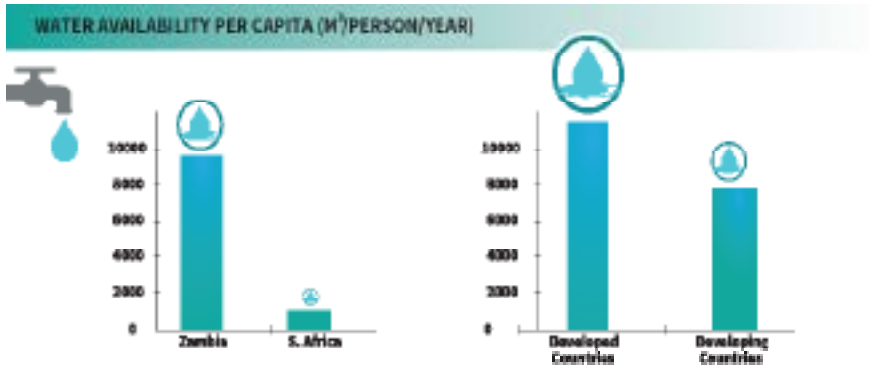


Note: Refer to Map on page 10 and 11

In addition to all the above-mentioned water sources, Zambia has vast ground water resources. However, underground water resources are unevenly distributed across the country¹⁰; the northern part of the country generally has higher levels of rainfall and general water resources, while the southern part of the country has lower rainfall levels and is more prone to drought. This calls for efficient planning in order to prevent drought and foster a conservative approach to water resource management.

In 2009, the World Bank undertook research to assess and quantify the availability of water in Zambia. The availability of water resources is measured by ‘per capita freshwater available’ i.e. the number of people living in a country determines how much water is available for each individual per year¹¹. The illustration below highlights that Zambia’s water availability per capita is higher than South Africa by almost 8000 km³/person/year.

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9. A river basin (or ‘catchment’) is the entire area drained by a river, including its tributaries. WWF Panda- http://www.panda.org/about_our_earth/about_freshwater/rivers/irbm/river_basin_approach/
 10. Sievers, P, 2006, Zambia Water Sector-Challenges for Integrated Water Resources Management in Zambia Water Sector Coordination Unit, Royal Danish Embassy, Zambia, p. 3



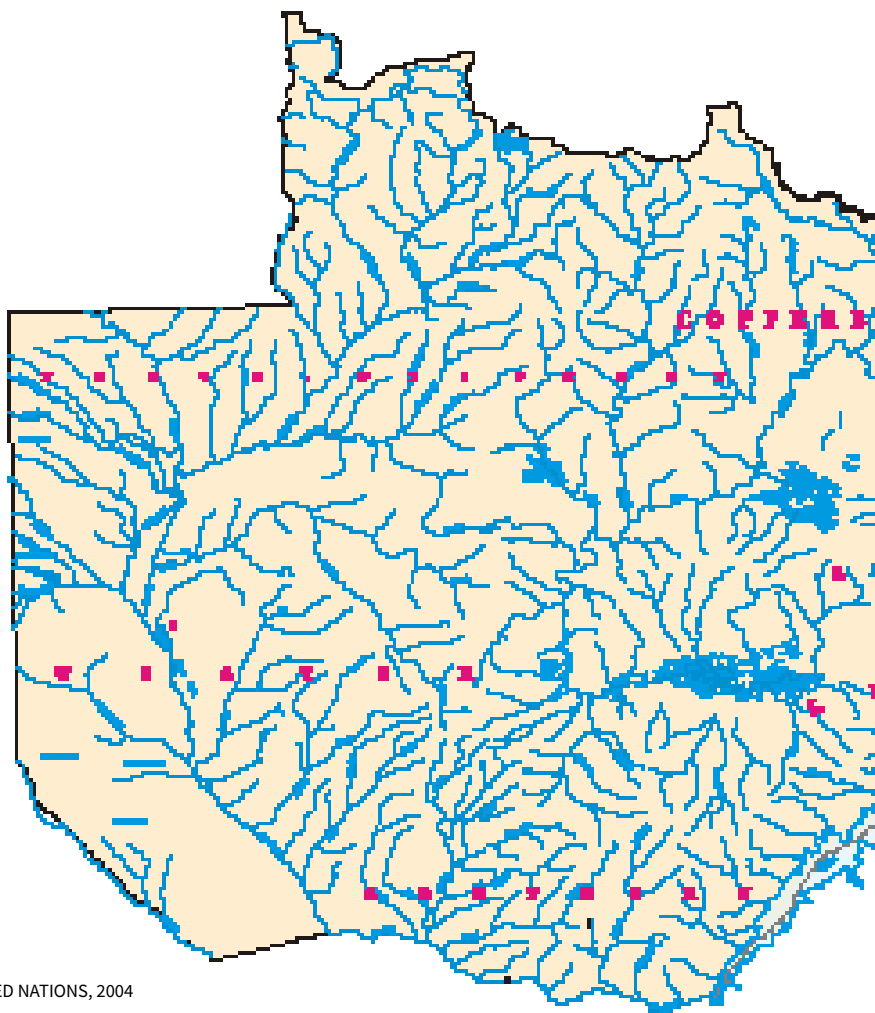
Source: adapted by PMRC from the World Bank Water Resource Management Africa Region. 2009

In 1995, Zambia’s annual total renewable potential for surface water was estimated at just over 100 Km³, and its ground water potential was estimated at an average of 49.6 Km³.¹² According to the Environmental Research Letters (2011), Zambia’s ground water potential¹³ generally ranges from very high (more than 20.0 litres per second) to moderately low (0.5-1.0 litres per second). The research further revealed that Zambia has two areas that have low aquifer productivity, part of the Southern Province and an area in the Northern Province. The table below displays the amount of water that every major water body contributes to the nations total water resources. Each river system contributes to the total run- off of the country’s surface water resource base. Below is a summary of the water catchment areas and the main river basins in Zambia as highlighted by the Ministry of Energy and Water Development.

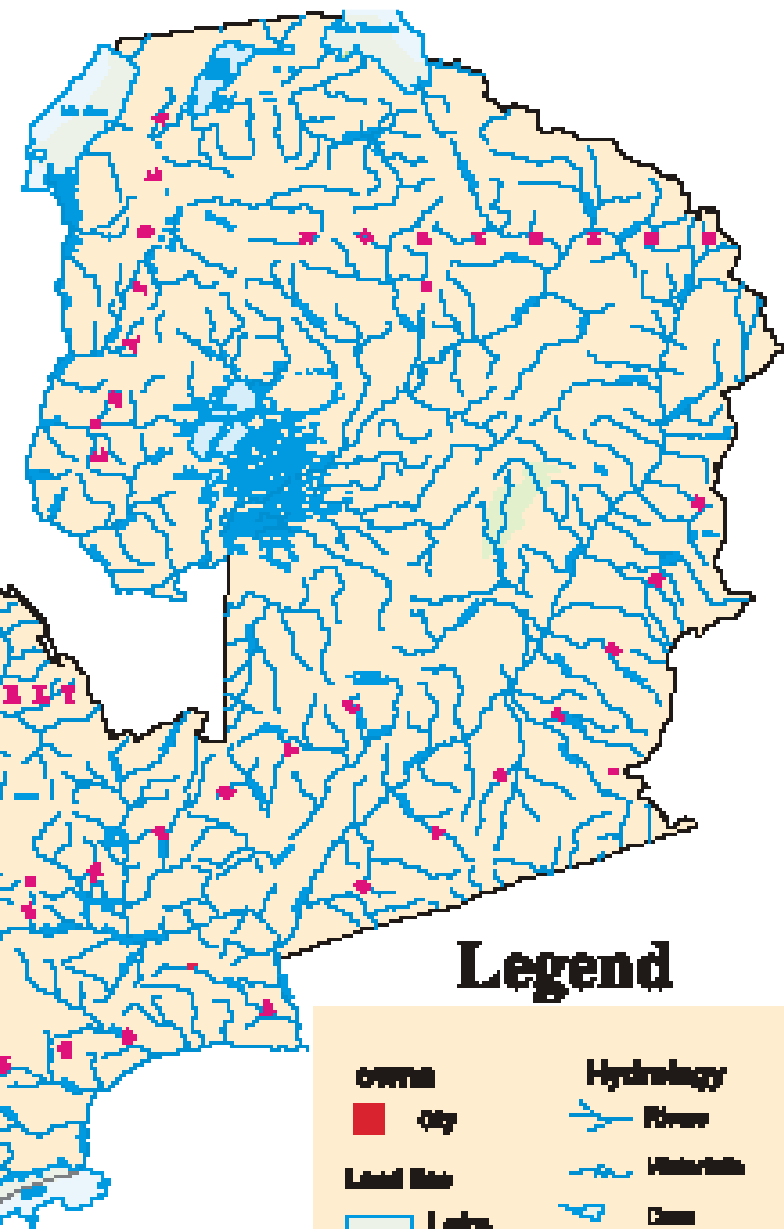
11. Kathleen Mogelgaard . 2011. Why Population Matters to Water Resources, Population Action International
 12. Imasiku A.N& Feilberg M, 2007. Zambia – National Water Resources Report for WWDR3 (Theme - Water in a Changing World). Ministry of Energy and Water Development
 13. WHO/UNICEF. 2010. Joint Monitoring Program for Water and Sanitation




RIVERS, LAKES, DAMS AND SWAMPS IN ZAMBIA



Source: UNITED NATIONS, 2004



Legend


owna	Hydrology
 City	 River
 Local Lake	 Waterfalls
 Lakes	 Dam
	 Swamp or Marsh


River Length and Basin Area of Six Main River Main River Basins (After JICA-MEWD, 1995)

River System	Length in Zambia (Km)	Basin Area (Km ²)		
		Total	In Zambia	Out of Zambia
Zambezi River Main River Basin	1,700	687049	268235	418,814
Kafue River Basin	1,300	156,995	156,995	0
Luangwa River Basin	850	147,622	144,358	3,264
Chambeshi River Basin	560	44,427	44,427	0
Luapula River Basin	615	173,396	113,323	60,073
Lake Tanganyika Basin	250	29,000	15,856	233,144
Other Basin	-	-	8,658	-
Total	5,275	1,458,487	751,852	715,295

Source: Adapted by PMRC from JICA- MEWD (1995)

The importance of water as an economic input has not been quantified or effectively communicated to the masses. It is important to consider the wide range of social and economic sectors that are affected by the availability of water, as the tourism, construction, agriculture and energy sectors are all influenced by the availability of water.

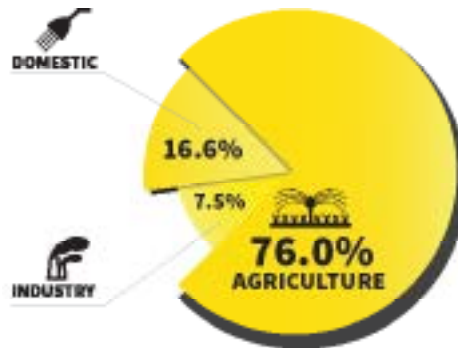
 **T**ravel advisors such as African Safari Experts (2014) specify that though Victoria Falls is spectacular throughout the year, the best time to visit be from February to May after the rainy season. This is when individuals see the greatest fall of water. Government recognized the economic potential in the sector and reclassified it as an economic sector. The sectors GDP contributions are gradually increasing and this is mainly as a result of increased tourist arrivals. The World Travel and Tourism Council Data (2013) states that Zambia’s tourism contribution to GDP is about 5.6%. There are various efforts in place to ensure the sector performs better but one of the key determinants is conservation of natural resources. The nation has about 16 major waterfalls and 8 fresh water lakes that are major tourist sites. These need to be protected for sustainable tourism development.

 **T**he construction sector has been a major contributor of the countries economic growth. The Ministry of Finance highlighted that in 2013, the sectors GDP contribution was at an average of 24%. In construction, water is key to many building activities and the lack of it may cause adverse results. It affects the time of delivery, and may compromise the standards of a building.



Agriculture is a sector that thrives on abundant water resources. According to Food and Agricultural Organisation (FAO) 2000, Zambia's agriculture sector was the highest consuming sector of water. Zambia's total water withdrawal was 1.737 km³ and the agriculture sector accounted for about 1.320km³ (76%) of the total domestic water use, illustrated below.

Water Withdrawal Total: 1737 Km³ In 2000



Source: Adapted by PMRC from Food and Agricultural Organization (FAO) 2000.

According to the CIA World Fact book (2014), Zambia's agriculture sector has been contributing an average of **19.8%** to the overall GDP.

CIA World Fact book (2014)

Reduced water resources would affect the overall performance of the sector by reduced production and productivity.

Zambia's energy sector is largely dependent on water. The country is reported to have an estimated large-hydro power potential of 6,000 Mega Watts (MW). About 99.44 % of the current total power output is hydroelectricity (electricity powered by water). If not managed efficiently, the reduction of water supply may affect power generation, which in turn affects all other economic activities. An aspect of water resource management that is most often neglected is the recognition of wetland areas. Wetlands play a cardinal role in ground and surface water purification and they need to be protected. Although the key threat of these areas emanates from domestic practices such as cattle rearing, Government must partner with citizens and traditional authorities to agree on the most appropriate solution to the challenge.

CHALLENGES TO ZAMBIA'S WATER RESOURCES

Climate Change

Climate change is increasingly factoring into national and international discussions and policies. Climate change refers to a change in average weather conditions or to the incidence of more or fewer extreme weather events¹⁴.

Although scenarios from the Intergovernmental Panel on Climate Change (IPCC) project that sub-Saharan Africa will experience a declining trend in rainfall during the 21st century, there has been little change in annual rainfall in Zambia during 1970 to 2010; however, variability in annual rainfall remains high and this is likely to continue during most of this century while the pattern in the frequency of floods and droughts is also expected to continue. According to the Country Water Resources Strategy prepared by the World Bank, Zambia faces significant water resources management challenges related to climatic variability, recurring droughts and floods, and chronic underinvestment in water infrastructure. Frequent water shocks such as droughts and floods have a significant impact on the country's economic performance. Rainfall is also the most crucial climatic element whose abundance or deficiency strongly impacts the national agricultural output. One World Bank estimate indicated a loss of around US\$4.3 Billion between 2006 and 2016 due to rainfall variability.¹⁵

POPULATION GROWTH AND WATER RESOURCES

Population growth has been identified as one of the major challenges contributing to water scarcity. In most cases, areas with the highest threat of water scarcity are those with high population growth rates and high population densities.¹⁶ It is estimated that one third of the world's population live in countries that have medium to high water stress and this ratio is expected to increase by 2025¹⁷. Despite the current vast water resources, Zambia must plan and project the demand of water based on the growing population. Population growth also increases the fixed demand for water by increasing per capita water, which later results in a developmental challenge affecting health and other social and economic concerns. The Integrated Water Resource Management- Background Paper (2002) states that developing countries are more prone to experience

14. Drought, high temperatures, changing landscape rising seas and other events

15. Environmental and Social Management Framework, Water Resources Development Project, Final Draft Report, Ministry of Mines, Energy and Water Development, December 2001

16. United Nations (UN)-Water and Food and Agriculture Organization of the United Nations (FAO). 2007. Coping with Water Scarcity: Challenge of the Twenty-First Century. New York, NY: UN-Water and FAO.

17. Global Water Partnership. 2000. Integrated Water Resource management- Background Paper, Denmark

high demand for water due to the ever-increasing needs of growing social and economic sectors. The National Water Resources Report WWDR3 (2007) highlighted that though there has not been any concrete indication of depleting water resources, ground water reserves are being threatened by possible over pumping due to increased farming settlements in Lusaka, Ndola and other areas. Furthermore there are some aquifers¹⁸ that are at risk of pollution from increasing population growth. Areas such as Lusaka are exposed to pit latrines, septic tanks and unplanned quarrying.

Between 2000-2010, Zambia's population increased from 9,885,591 to 13,092,666, which represents population growth rate of about 32.4%. This increase in population resulted in an increase demand for energy, increased construction activities and others that directly correlate to the increase in the demand for water. The population growth was higher in urban areas, than it was in rural areas, indicating the increasing rural to urban migration and pressure on resources in urban areas. The illustration below displays this increase with a specific focus on the regions (rural and urban).



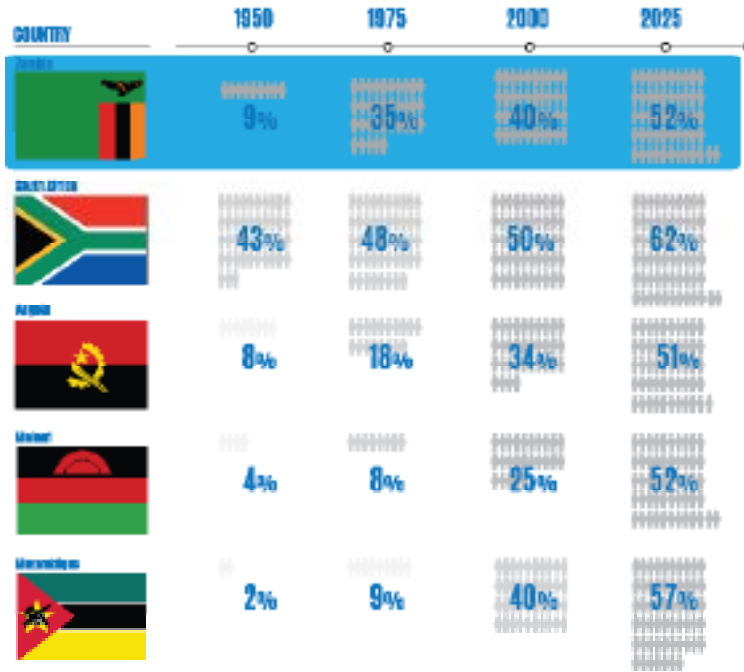
Source: Adapted by PMRC from Central Statistical Office (2001)

The effects of population growth on a countries water resource are similar to those of urbanisation. Most of the world's population growth in the next 40 years is expected to be concentrated in urban areas¹⁹. This development is expected to be associated in less developed regions with high urbanisation rates. Research by the United Nations (2000) revealed that Zambia is relatively highly urbanised in comparison to countries like Tanzania, Uganda and Zimbabwe. The illustration shows past urbanisation percentages and projects future percentages in Norway's developing aid recipients in Africa 1950 -2025 (Percent).

18. An aquifer is an underground layer of water-bearing rock. Water-bearing rocks are permeable, meaning that they have openings that liquids and gases can pass through- http://education.nationalgeographic.com/education/encyclopedia/aquifer/?ar_a=1

19. United Nations Population Division. 2010. World Urbanization Prospect: The 2009 Revision. New York: UN Population Division.

Proportion of population residing in urban area



Source: Adapted from United Nation (2000)

High urbanisation is a threat to water resource development. It leads to increased demand for water, as individuals are more concentrated to one area, which may have limited water supply. The high number of people embarking on various social and economic developmental projects in these urban areas increases demands for a high provision of water. The supply and demand dynamics of Zambia's water sector hinge on two main factors, (1) popular awareness and understanding of the availability of resources and (2) risk management. These factors are the basis on which Zambia can balance the use of water resources for human livelihoods while ensuring the increased population and high urbanisation does not negatively affect conservation of water resources for sustained social and economic development.

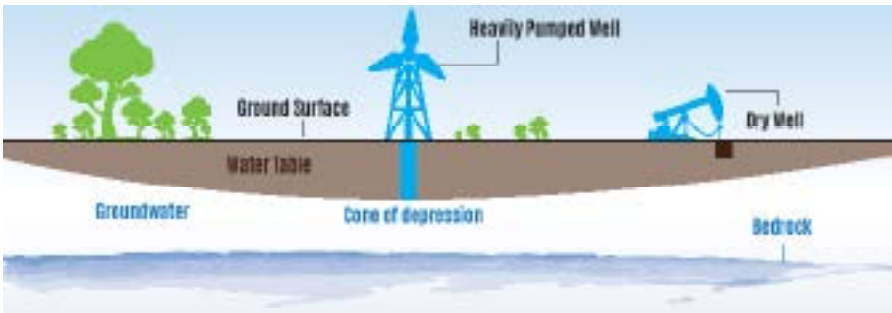
In light of these changes, Government has recognised the need for appropriate technologies and approaches for effective water resource management. According to the water and sanitation sector objective of the Revised- Sixth

National Development Plan (R- SNDP), Government has committed to conduct research and demand driven surveys and further strengthen the institutional capacity for hydro- meteorological and groundwater monitoring. In addition to this, the Integrated Water Resources Management and Water Efficiency Implementation Plan (2005-2030) have also been affected for efficient water resource management and the Patriotic Front (PF manifesto) supports all these efforts by further focusing on technological advancement for enhanced irrigation and the creation of dams and canals. However, there is need for a comprehensive detailed water audit of Zambia’s surface and ground water bodies in order to adequately plan for developmental projects in each locality. This process must be consistent to allow for effective planning and management.

POSSIBLE EFFECTS OF URBANISATION AND POPULATION GROWTH

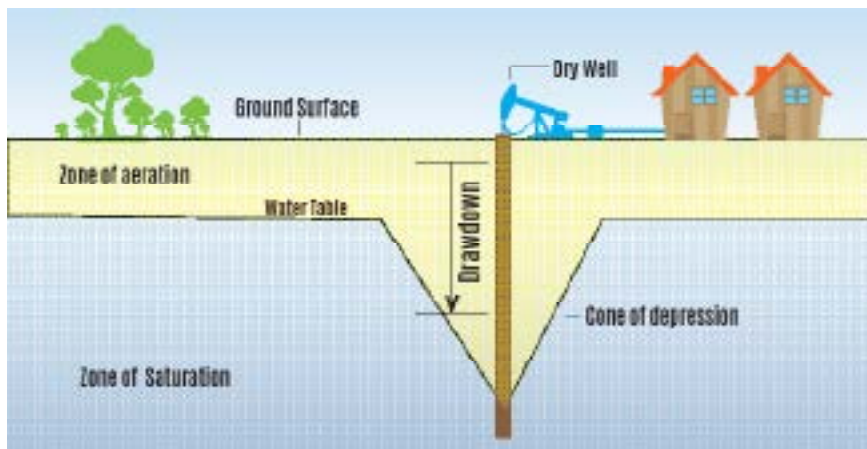
Increased population and urbanization lead to increased economic activities that are accompanied by **overdraft**, **drawdown** and **subsidence of water resources**.

- **Overdraft** happens when ground water is extracted faster than it is replaced²⁰. It results in depleted water resources, contamination and salt water infusion in some cases.



- **Draw-down** occurs when the water table lowers due to pumping²¹. In this case, the water table is simply replenished when water supply is recovered through the cycle.

20. Ram Charita Sah. (2001). Ground Water Depletion and Its Impact on the Environment in Kathmandu Valley. Kathmandu
 21. Conservation Technology Information Centre. (2014). Ground and Surface Water: Understanding the Interaction



- **Subsidence** is a result of over pumping. The water table declines, pressure reduces and the general water capacity reduces. In addition to this, the land above can sink ²², causing damage to the property.

Granular sediments fall into secondary openings in the underlying carbonate rock



A column of overlying sediments settles into the vacated spaces (a process termed "piping")



Dissolution and infilling continue, forming a noticeable depression in the land surface.



The slow downward erosion eventually small surface depressions (inch to several feet in depth and diameter).



Adequate water supply is a prerequisite for development. In many cases access to water for health and sanitation is considered to be one of the key indicators of human development in developing countries²³. The demand and supply of water is based on the fact that water is a cross cutting resource that is required for both social and economic development.

22. Timothy H. Dixon(2006) Space geodesy: Subsidence and flooding in New Orleans.

23 Solanes.M and Fernando G. (1999). The Dublin Principles of Water as Reflected in an Assessment of Institutional and Legal Arrangements of Integrated Water Resource Management.

KEY DETERMINANTS OF EFFECTIVE WATER RESOURCE MANAGEMENT

Although water is a renewable resource, efficient and effective management is essential to sustainable development. Five determinants have been identified as key aspects of efficient and effective water resource management. These were derived from the *Dublin Principles of Water as reflected in a Comprehensive Assessment of Institutional and Legal Agreement for Integrated Water Resource Management*.²⁴

1. INCLUSION AND PARTICIPATION

Increased awareness and understanding of a country's resource base is cardinal. In order for a Government to effectively manage water resources, they must involve the users. There must be inclusion at all levels of governance (planners, policy makers and the communities).

2. HARMONISED HOLISTIC APPROACH TO MANAGEMENT

There is need to identify and establish the linkages between the water sector and all other social and economic sectors. This facilitates for effective management by highlighting and managing the demands and threats that are placed on the resource. In this vein Government must further ensure that all institutional arrangements are coordinated and harmonised. A number of different institutions and economic sectors have been identified as involved in and dependent on water resources. Ensuring collaboration and coordination across all sector ministries and institutions can support the attainment of this goal.

3. HARNESS INTERSTATE RELATIONS

User relations are key to water resource management, hence the implementation of policies such as the SADC Protocol on shared water bodies. It is imperative that upstream and downstream user relations are managed effectively. Various upstream human activities may result in deprivation of downstream recipients of water resources. These policies must be implemented effectively to resolve this and prevent possible conflicts.

Data Collection and Record Keeping Management. Adequate and reliable data and information is key to efficient planning and management. In order to achieve sustainable water development, there is need for an evidence-based approach to planning and managing water resources. It is imperative that continuous

24. Global Water Partnership/ Swedish International Development Cooperation Agency.1999

research is carried out and consistent monitoring of the quality and quantity of the water is consistently recorded.

4. BUDGETARY ALLOCATION AND FUNDING.

Efficient water resource management requires a proficient human resource base, combined with good infrastructure. There must be strong political will exhibited by adequate funding to the sector. Many Southern African countries have been recognised as having a lack of boldness when it comes to investing in groundwater infrastructure. This is reflected in Zambia's budgetary allocations to water resources, with the illustration below highlighting the need for consistency and increased funding to the sector. These allocations are taken from concurrent budget speeches presented by the Ministry of Finance in each year (2001-2015). The amounts all fall under the housing and community amenities, under a sub- category commonly know as water supply and sanitation. The 2015 allocations are more than 30% lower than in 2013.

Budgetary Allocation to water and sanitation 2012 - 2015



Source: 2012, 2013, 2014 & 2015 National Budget Addresses

Analysis of the listed determinants reveals that Zambia's water resource management can be further strengthened and improved. In order to improve water resource management for sustainable development, Government must increase participation and inclusion through the set structures of the

decentralisation implementation plan. This will ensure all citizens are involved in the conservation of water resources. They must also strengthen coordination among key institutions to improve information sharing for planning and management. In addition to this, Government must harness interstate relations for improved policy implementation and further strengthen the daily operations of WRMA. This must include capacity building for effective data collection for water level monitoring and other related tasks. Most importantly, there must be a detailed review of the budget performance for improved planning and effective budgeting.

CONCLUSION

Zambia's growing economy has been characterised by various manufacturing and production ventures. Population growth and urbanisation have resulted in increased farming and construction. Government must protect the well-being of the citizens by securing water for basic human needs, economic activities and other social activities while protecting the ecosystem and the environment. There must be improved data gathering, record keeping and general capacity building for enhanced water resource management. Efficient and effective water resource management will result in effective planning, budgeting and lead to water development and conservation. These must be combined with continuous capacity building and skills development for increased proficiency in policy implementation. Every citizen has the responsibility to utilise Zambia's water resources prudently. In order to achieve this, citizens must be provided with information and guidance by responsible institutions that have been mandated to plan and manage the nations water resources.

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Strategy for Zambia

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