IMPACT OF THE FAILURE OF
THE KARIBA DAM

THE INSTITUTE OF RISK MANAGEMENT SOUTH AFRICA
RISK RESEARCH REPORT

RMISA
The Institute of Risk Management
SOUTH AFRICA

AON

Kariba Dam opened
1959

Safety and reliability
of the structure

Political & Economic
stability

Hydro Electric capacity
stabilised

Extend life of the dam for a further
100 years
still needs maintenance

Badly in need of repair lack of maintenance
56 years later

Impact
on other investments & projects in the region

Project delay from

- Flooding
- Skills
- Governance
- Funding

Next 3 years are critical

Problem identified
10 years ago

Zambezi River Authority (ZRA)
Manage the dam - Zambia & Zimbabwe

Reputation Region
- ZRA
- Advisers
- Funders
- Nation

Electricity generation
Hydro power

40% of the region's capacity

Funders
- World Bank
- African Development Bank
- European Union

Climate change,
Rainfall patterns,
Flooding, Drought

Challenging project
$294,2m
Skills availability, other projects in the region

Electricity
Revenue

Terrorism

Population of the region under review (2011)
116 million

Botswana - **1,8m**
Malawi - **14,4m**
Mozambique - **23,0m**
South Africa - **50,6m**
Zambia - **13,4m**
Zimbabwe - **12,8m**

RMOSA
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Risk - from which perspective?
- National, Regional, Investors, Existing industries
- Individuals, Communities, Environmental, Flora and Fauna
- The World, travel, tourism

Build-up to event
- Rainfall in Zambezi catchment area - past 2 years significant in January
- Management of water in Kariba Dam
- Release of water through floodgates (if they work)
- Dam can't cope
- Warning of potential collapse, evacuation downstream
- Media, Cellphone companies, TV, Twitter, Facebook ...
- Animals

The Event and the Impact ...

Tsunami like wall of water released downstream

4 x bigger than the largest on record
181 billion cubic metres of water from the full Kariba Dam
3.5 million lives at risk
8 hours to reach Cahorra Bassa
Tete wiped out after **10 hours**, population **1.8 million**
Electricity supply lost - **1,500 megawatts in South Africa**
Impact to **30 million** people for their basic needs
Animals - Crocodile, Hippo, Fish
Lack of water, waterborne diseases
Food shortages
Agriculture restricted
Access to region impacted
Travel curtailed, border management
Disaster relief, funding
Economic impact unknown
Debt repayment curtailed
Upstream and downstream impact - **Kariba Dam water unavailable**

Post Event and the Future ...

2065 - 50 years later

5 - 8 years to rebuild Kariba and Cahorra Bassa Dams
Poverty, Food security, **on-going support**
Water build up in the dams necessary for hydro power - climate change?
Other technology options for **power**
Funding of replacement dams
On-going **maintenance**
Eventual **de-commissioning**
Other dams in the region - **what is their status?**

AON

The Institute of Risk Management South Africa
Risk Research Report
Impact of the failure of the Kariba Dam

Completed June 2015
Sponsored by Aon South Africa
Researched and written by Kay Darbourn

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About IRMSA

The Institute of Risk Management South Africa (IRMSA) is the Professional Body for Risk Management in South Africa. IRMSA represents individuals and companies committed to the enhancement of the risk management discipline. IRMSA serves aspiring risk practitioners, risk professionals and decision makers in Southern Africa, dedicated to the advancement of the risk management profession through accreditation, research, promotion, education, upliftment, training, guidance and strong relationships with other institutes and associations.

IRMSA is the leading source of information and networking opportunities within the risk management industry, with members from a wide range of corporations both from the private and public sector and is the professional body for risk management in South Africa as recognised by the South African Qualifications Authority (SAQA).

Offering both individual and corporate memberships, IRMSA assists organisations in ensuring their employees become professionals and are supported in their growth and development through every stage of their career. By becoming a corporate member, entities can be aligned to a professional and recognised risk body and can assist, shape and be at the forefront of risk management.

Visit our website - www.irmsa.org.za - or give us a call on +27 11 555 1800.

We look forward to a very exciting future as the Institute continues on the path as the professional body for risk management in South Africa. The IRMSA team strives to offer service excellence for members and provide value for the membership fees paid.

Knowledge, Service, Prosper

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SOUTH AFRICA

1. Preface

Kay Darbourn is a member of the Institute of Risk Management South Africa (IRMSA) Risk Intelligence Committee, she is also a Fellow, Honorary Life member, past President and founding member of the Institute.

Considerable world-wide media attention was given to the possible collapse of the Kariba Dam during the last part of 2014. Most of the funding has been secured and one high level executive in an entity that may be significantly impacted has said "well, now the funding is in place, we can relax" but can we?

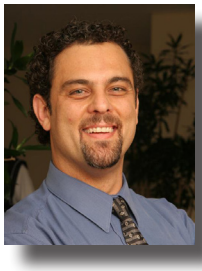
The Institute of Risk Management South Africa (IRMSA), through its Risk Intelligence Committee, completed the first South Africa Risks Report at the end of 2014 and this was published in January 2015. The IRMSA Risk Report highlighted a number of risks for the region to consider and reflected on the differences between IRMSA member's feedback on key risks and those featured in the 2014 World Economic Forum (WEF) Global Risks Report.

As the IRMSA Risk Report was being finalised, the committee suggested that we might take some of the risks identified within the report and complete "case studies" which go into more detail on specific areas of the risks and provide this work to our members as examples of how the risk report may be used as the base for further investigative risk reviews as relevant to specific entities and industries.

Two of the key risks for the region that were considered within the risk report were concerns related to electricity supply in South Africa and the need for improvements to infrastructure, both for new projects and the need to maintain existing structures. Research around the Kariba Dam was chosen as our first review and is presented as a story – we ask the question "what if the Kariba Dam should fail, what would the impact be?"

Research was focused on the region that might be impacted by the failure of the Kariba and Cahora Bassa Dams. The report considers some aspects of history, current challenges and some future concerns but is not intended to be a risk assessment – we hope that you will take what you can from this report, as it might impact you and your company, and continue with managing your specific risks and opportunities.

2. Foreword



Aon is committed to offering innovative risk solutions to the challenges that companies face around the world. Each new piece of crucial risk information presented places business leaders and risk managers in a better position to mitigate risks in an informed way.

The failure or shortage of critical infrastructure is amongst the top 10 South African risks identified by likelihood and consequence by both Aon in its Risk Management Survey 2015 and the Institute of Risk Management South Africa (IRMSA) in the first edition of their South Africa Risk Report 2015. The potential failure of the Kariba Dam is a Southern Africa regional risk that falls into the infrastructure risk category, but in addition it would lead to power supply constraints – another key challenge currently impacting the region.

Aon is a corporate member of IRMSA and proud to be part of this case study into the regional risks and consequences posed by the potential failure of the Kariba dam. This report shows that all of us in Southern Africa will suffer the impact if this risk materialises and calls for each of us to take an interest and be as involved as possible in preventing this potential disaster from happening. The impact will span across the entire risk consequence spectrum, from significant loss of life, damage to property and the environment, to economic fall-out.

This risk and its potential consequences need to be viewed as part of the existing power supply and demand challenges in the region and will require a strong commitment from governments, private companies and financiers to prevent the failure from happening.

By providing this information to our clients and other risk managers in the IRMSA network, we hope to empower you to make the right decisions with regards to the risks you and your company may face.

Nico Bianco
Executive: Aon Risk Solutions

3. Executive Summary

On 3 October 2014 the BBC reported that:

"The Kariba Dam is in a dangerous state. Opened in 1959, it was built on a seemingly solid bed of basalt. But, in the past 50 years, the torrents from the spillway have eroded that bedrock, carving a vast crater that has undercut the dam's foundations.

Engineers are now warning that without urgent repairs, the whole dam will collapse. If that happened, a tsunami-like wall of water would rip through the Zambezi valley, reaching the Mozambique border within eight hours. The torrent would overwhelm Mozambique's Cahora Bassa Dam and knock out 40% of southern Africa's hydroelectric capacity. Along with the devastation of wildlife in the valley, the Zambezi River Authority (ZRA) estimates that the lives of 3.5 million people are at risk."

"Can you answer the following questions please", said the chairman of your board after hearing the news report…

a. What will happen if the Kariba Dam fails?

b. Will our business and our people be impacted and when?

c. What are the key challenges we are likely to face should it happen?

d. What's the timeframe around the replacement of the dams, if Kariba fails?

e. Will I be impacted, personally?

f. Should we be doing something, and if so – what?

Well, can you answer these questions from your company's perspective?

There are many events and causes that might lead to the delay of the rehabilitation project and these are reviewed in more detail in this report.

Consider the key risks that might influence the likelihood of such a catastrophic event occurring in the next 5 years?

a. Project Delay

In December 2014, the critical period was defined as "the next three years" but the full project is due for completion in 2025. Project delay from any cause will seriously affect the likelihood of failure.

b. Climate change, unseasonal rainfall, drought or flooding

Rainfall in the region is key to hydroelectric power generation and the economies of the various countries. Revenue from power generation partially funds debt repayment in Zambia and Zimbabwe.

Flooding in the Zambezi basin may put additional pressure on the Kariba Dam necessitating the release of water through the floodgates and may cause a delay in the rehabilitation project.

c. Funding for the Rehabilitation Project

Whilst funding has been secured for the rehabilitation project, increasing costs as a result of global economic factors or delays may result in additional costs – will additional funding be available and will debt re-payment become an issue?

Chairman, in response to your questions and having read through the **IRMSA Risk Research Report**, my immediate thoughts would be:

1. What will happen if the Kariba Dam fails?

a. The water flow from Kariba will continue down the Zambezi River, impacting people, property, animals and plant life until it reaches the Cahora Bassa Dam at which stage the flow will cause this dam to be breeched and the cycle of damage will continue downstream. This will occur over a period of 8 to 10 hours until the flow dissipates.

b. The reduction in the supply of electricity to various countries in the region will be significant and immediate. Some countries rely totally on hydropower and their economies will be seriously impacted, both for industries that rely on electricity to operate and in terms of revenue generated from the sale of electricity. South Africa will lose 1,500 MW of imported power as the Cahora Bassa Dam fails.

c. Access to water for people in the Kariba and Cahora Bassa Dam areas for drinking, food and agriculture will be severely restricted.

d. Transportation and access to the areas affected will be curtailed, alternative routes across the Zambezi will need to be sourced, leading to increased cost and time for deliveries.

2. Will our business and our people be impacted and when?

a. In terms of our people, we need to consider those that might be working in the area and indeed those that may have relatives in the area that will be impacted. Travel to the region needs to be re-considered as we go forward, specifically in terms of health risks.

b. We can expect our South African entities to suffer from a lack of electricity supply, leading to **load shedding** if our energy supply constraints remain as they are currently.

c. Our investments in the region may be at risk although property damage is unlikely outside the flood area. The lack of electricity supply will lead to a significant loss in production. Lack of water may also impact some of our operations.

d. We will need to re-think our new projects in the region as the ongoing lack of electricity and water will make these uneconomical, potentially for five to eight years. Investors will also be difficult to tap as they will be more focused on repairing the dams or funding alternative sources of electricity supply and potentially funding disaster relief.

3. What are the key challenges we are likely to face should it happen?

a. Communicating clearly with our people, board and shareholders will be key.

b. Our reputation and how we manage this catastrophe will support and maintain our share price.

c. Alternative sources of electricity and water might be costly and scarce, we may need to secure these in advance.

d. Our ability to change our future business strategies quickly will be important.

e. Decisions around our current investments in the region will need to be taken as soon as possible to avoid unnecessary on-going costs.

f. Our corporate social responsibility planning may need to refocus around how we can support people in the region.

4. What's the timeframe around the replacement of the dams, if Kariba fails?

a. Assuming both dams are to be replaced, funding will be required and overall it might take five to eight years to re-build the dams, including removal of debris caused by the collapse. It is even possible that the location of the dams might need to change and environmental factors will come into play.

b. Rebuilding and re-filling of the dams would depend on rainfall within the Zambezi River Basin, this could also take some time.

5. Will I be impacted, personally?

a. Chairman, your own personal reputation may be at risk if we have not addressed this potential exposure adequately.

b. Are you involved with other companies that might also be impacted? Are you on other Boards, do you have any personal investments in the region? Do you have any property in the region or relatives that might be impacted – you really need to look at your own Personal Risk Assessment separately from the company.

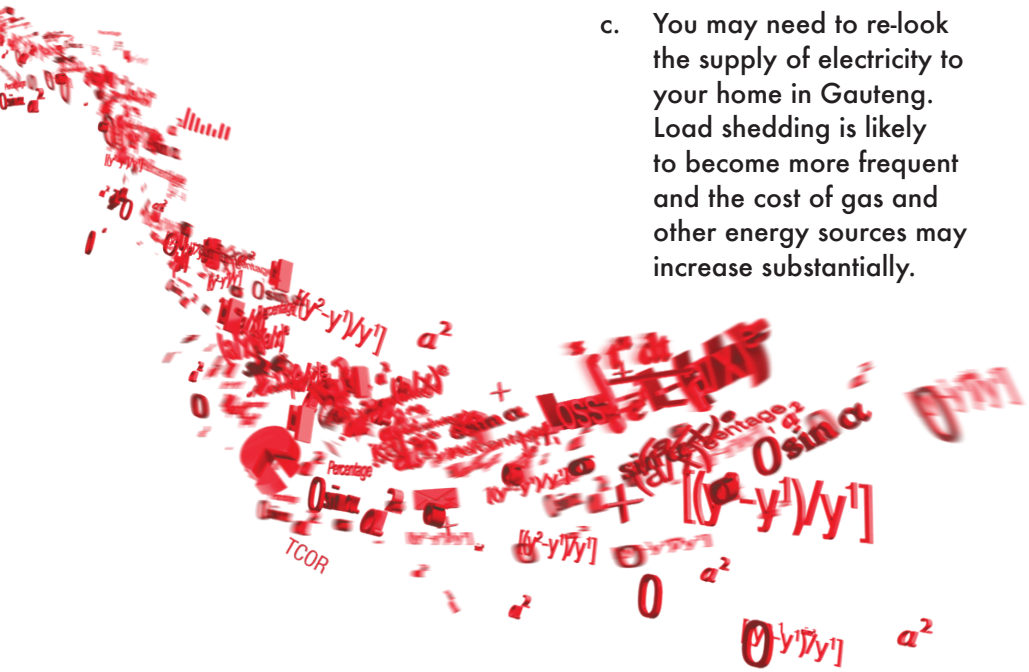
c. You may need to re-look the supply of electricity to your home in Gauteng. Load shedding is likely to become more frequent and the cost of gas and other energy sources may increase substantially.

6. Should we be doing something and if so - what?

a. Certainly, we need to consider the potential of the failure of the Kariba dam as one of the risks that may impact our company and complete the necessary risk assessments, evaluations and treatment plans as soon as possible. Even if the potential for such a catastrophe is unlikely, we need to ensure that our planning is flexible enough to deal with any emerging risk.

b. We need to keep up to date with how the refurbishment of the dam is going and the current and ongoing rainfall patterns in the region as this may impact the time taken for the refurbishment and the potential for the likelihood of the risk materialising. This should form part of our on-going environmental scanning for our business.

c. We might need to tap into our networks and relationships and ensure that this potential catastrophe receives the necessary focus across South Africa, the region and indeed the world. Let it not be said that we didn't try to make a difference.



Whether you are a Shareholder, Stakeholder, Board Member, Business Executive, Risk Manager or even a private individual – if you live, work, own property or have investments in South Africa, Zambia, Zimbabwe, Botswana, Mozambique or Malawi the chances are that if the Kariba Dam fails – you will be impacted!

4. The Kariba and Cahora Bassa Dams and the Zambezi River

The Zambezi River

The Zambezi River winds its way through six countries in Africa, starting in north-western Zambia and finishing in the Indian Ocean. The source lies at about 1,500 metres above sea level in the Mwinilunga District, very close to the border where Zambia, Angola and the Congo meet.

For years the people living along the banks of the Zambezi have depended on it for their survival and have harnessed its great power for electricity.

From its source it then flows through Zambia, Angola, Namibia and Botswana then back along the borders of Zambia and Zimbabwe finally discharging into the Indian Ocean at its delta in Mozambique. The area of its catchment basin is 1,390,000 square kilometres which is half that of the Nile.

The Upper Zambezi is only sparsely populated flowing towards the Victoria Falls which are considered the boundary between the upper and middle Zambezi. Below the falls, the river continues to flow, dropping some 250 metres over the next 200 kilometres, before entering Lake Kariba.

The Zambezi River Basin (ZRB) is shared by eight countries, Tanzania and Namibia joining those quoted above. In addition to meeting the basic needs of more than 30 million people and playing a central role in the riparian economies, the river sustains a rich and diverse natural environment. The Cooperation in International Waters in Africa (CIWA) Zambezi River Basin program of the World Bank (WB) has been envisaged as a long-term engagement at country level, among sub-regional clusters and across the basin. The challenge in the ZRB is to promote cooperative development and management of international waters in a way that drives sustainable economic growth and improves the livelihoods of the populations that critically depend on the sustainable use and management of shared waters.

Kariba Dam

The dam as seen from Zimbabwe

a. Some 420 kilometres downstream from Victoria Falls, the Kariba Dam is the largest man-made reservoir in the world. At a height of 128m and with a crest length of 617m, the dam has the capacity of holding 181 billion cubic metres of water. Designed as a double curvature concrete arc dam, the Kariba Dam was constructed across the Zambezi River between 1956 and 1959. Commissioned in 1960 and opened by Queen Elizabeth the Queen Mother, the dam has been central to regional energy security and economic development ever since.

   From 1958 to 1961, "Operation Noah" captured and removed around 6,000 large animals and numerous small ones threatened by the lake's rising waters.

b. The Kariba dam creates Lake Kariba – which is some 280km long at full level, 32km across at its widest, 5,400 square kilometres surface area and has a catchment area of 663,000 square kilometres.

c. The Kariba Dam is central to energy security in the form of hydropower electricity generated for Zimbabwe and Zambia and as the Zambezi continues to flow towards Mozambique it flows into the Cahora Bassa Lake and then continues to provide electricity for Mozambique and South Africa. The Kariba Reservoir supplies water to two underground hydro power stations with a total capacity of 1,839 MW. The North Bank station is operated by the Zambia Electricity Supply Company (ZESCO) in Zambia and has an installed capacity of 1,080 MW. The South Bank station is operated by the Zimbabwe Power Corporation (ZPC) in Zimbabwe and currently has an installed capacity of 750 MW, with projects underway to increase this to 1,050 MW.

d. Kariba Town is a serene home to 46,000 residents and also a variety of wildlife. According to a report from AllAfrica.com, sadly the town is not benefiting from proceeds associated with activities on Lake Kariba. Residents feel more could be done to boost tourism and funds generated towards further development of the area. Most of the residents are employed in the fishing industry, mainly Kapenta.

e. The dam was designed by Andre Coyne, a French civil engineer who designed 70 dams in 14 countries. See later in this report about the failure of the Malpasset dam in 1959, also designed by Andre Coyne.

f. Since 2010, Tractebel Engineering has been advising the (ZRA) on matters pertaining to safety, maintenance and satisfactory operation of the dam. The agreement includes engineering studies and works supervision of the spillway rehabilitation, construction of an emergency gate and sustainability of the plunge pool.

g. There is a new publication available - "Whispers from the Depths" a book by Liz and Mike Wickens and published by Tracey McDonald Publishers - this may be worthy of a read to gain more insight on the building of the Kariba Dam in the mid-1950s.

Cahora Bassa Dam

a. The Cahora Bassa Dam is in Mozambique and is one of three major dams on the Zambezi river system, the others being the Kariba and the Itezhi-Tezhi, the latter on the Kafue River, a tributary of the Zambezi.

b. Dam construction began in 1969 and the dam was opened in 1974. The dam is 171 metres high, by 303 metres wide and creates the Cahora Bassa Lake reservoir.

c. The Cahora Bassa system is the largest hydroelectric scheme in Southern Africa with the powerhouse containing five 415 MW turbines. Most of the power generated is exported to South Africa, which is done by the Cahora Bassa HVDC system, a set of high voltage direct current lines. The system includes two converter stations, one at Songo in Mozambique and the other at Apollo in South Africa. There are two parallel power lines between these two stations, covering 1,400 kilometres, of which 900 km is in Mozambican territory. Long stretches of the power transmission lines were sabotaged during 16 years of the Mozambican Civil War which ended in 1992.

d. When understanding the impact on the local population during and after construction, readers may like to refer to a book "Dams Displacement and the Delusion of Development – Cahora Bassa and its' legacies in Mozambique 1965-2007" by Allen & Barbara Isaacman. It is always important to understand the history behind such massive construction projects and appreciate all sides of any issue.

The Zambezi River Authority (ZRA)

The ZRA was established as a body corporate on the first day of October, 1987 by parallel legislation in the Parliaments of Zambia and Zimbabwe following the reconstitution of Central African Power Corporation.

The ZRA operates under the Zambezi River Authority Act, and is mandated to harness and manage the Zambezi River waters for socio-economic development and to maintain the Kariba Dam complex including any future dams or infrastructure on the river forming a common border between Zambia and Zimbabwe.

The ZRA will manage the Kariba Dam Rehabilitation Project together with, Tractebel and other Consultants, Engineers and Construction entities as necessary and appointed for the project.

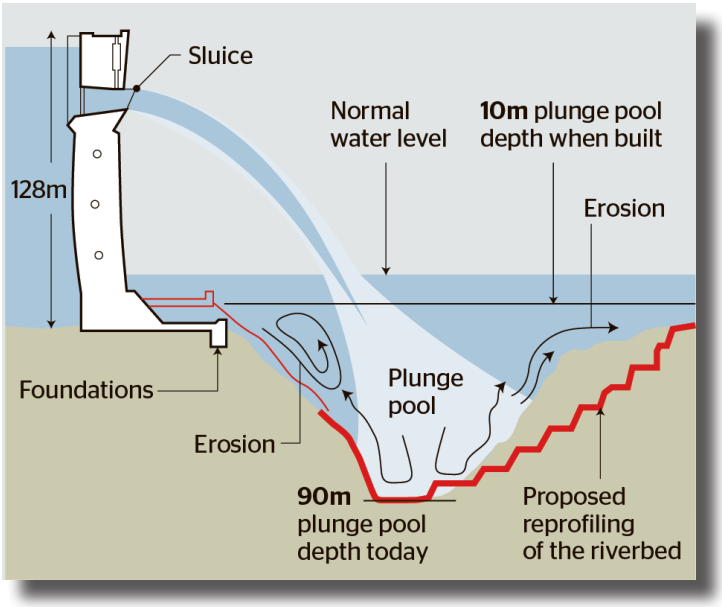
Go to www.zaraho.org.zm for more detail on the ZRA.

5. The Problem and the Kariba Dam Rehabilitation Project

After more than 50 years of providing power for the Southern African Region, the Kariba Dam now requires a series of rehabilitation works for its continued safe operation. The program is to be implemented over the next ten years, taking into account the need to continue operating the dam safely with minimal interruptions to power generation.

The rehabilitation project includes:

The plunge pool – media comment is that this problem was noticed a decade ago but no action was taken. Spillway torrents have excavated a massive cavern in the Zambezi river bed, now 10 times bigger and deeper than the original design dimensions, that threatens the stability of the wall foundations. It is necessary to reduce the turbulence from water, discharged at 8,000 tonnes a second at times, into the plunge pool below the dam by enlarging the cavern, and allowing the turbulence resulting from the spillway discharge to be dissipated in a less damaging way.



The reshaping of the plunge pool calls for the construction of a temporary cofferdam or barrage. This will enable the blasting and excavation of 300,000 cubic metres of rock from the downstream face and north and south bank sides of the pool in the dry season.

It was suggested that the work is only likely to start in May 2015, after the rainy season, beginning with the construction of the cofferdam, however according to the Zambia Daily mail in March 2015, the works are set to commence in September 2015.

Kariba's floodgates are designed to release the magnitude of floodwater that occurs once in 10,000 years, so if one gate is out of action for repair and the spillway capacity is reduced it is most unlikely to result in any problem, even with one gate out of action the spillway capacity would probably still be enough to pass the flood event that occurs once in 1,000 years. Floods on the Zambezi take some time to build up so there would be advance warning from rainfall monitoring in the upper catchment, allowing for time to respond.

This part of the project will take eight to 10 years to complete, partly because only one gate can be worked on at a time but also because the plunge pool excavation work cannot be done if the lake level is high and the dam is spilling, completion is projected for 2023.

Have a look at this video to see one of the Kariba Dam gates in action https://www.youtube.com/watch?v=qDnkfO3g63s

And this further video gives some information on the 2009 Sayano-Shushenskaya hydroelectric power station accident – this did not involve the total collapse of the dam but damage to the power station was considerable. Nine out of 10 turbines were damaged or destroyed and 75 people killed.

https://www.youtube.com/watch?v=bfW5MqT7CSA

Alkali Silicate Reaction (ASR) – an internet response related to a Business Day article in February 2015 "To the rescue of Kariba Dam" by 'JVG', was interesting:

http://www.bdlive.co.za/business/innovation/2015/02/17/to-the-rescue-of-kariba-dam

> *"The real danger-obscured by this article – is one of Alkali Silicate Reaction (ASR), in simple terms this is a chemical reaction that leads to the breakdown of the physical integrity of concrete, hence the term "swelling", although descriptive, is incorrect and softens the reality. Once ASR sets in, the reinforcement's integrity is endangered – as oxygen and moisture penetrate the weakened concrete and the reinforcement corrodes to a point where it actually fails. Ultimately – and in the Kariba case – most probably – it reached a stage where the steel reinforcement is severely weakened, point is – this dam WILL FAIL".*

Whilst obviously this is a personal opinion, it seems clear that the issue of ASR has been known for some time and has contributed to the current safety concerns.

The permanent secretary of the Zambian Ministry of Finance, Felix Nkulukusa, indicated in January 2015 that the danger arose from an alkali-aggregate reaction in the dam wall, which could induce swelling within the concrete mass. In addition, the spillway sluice gates were no longer opening and closing automatically to maintain the required water levels, owing to distortion and swelling of rusting steel components.

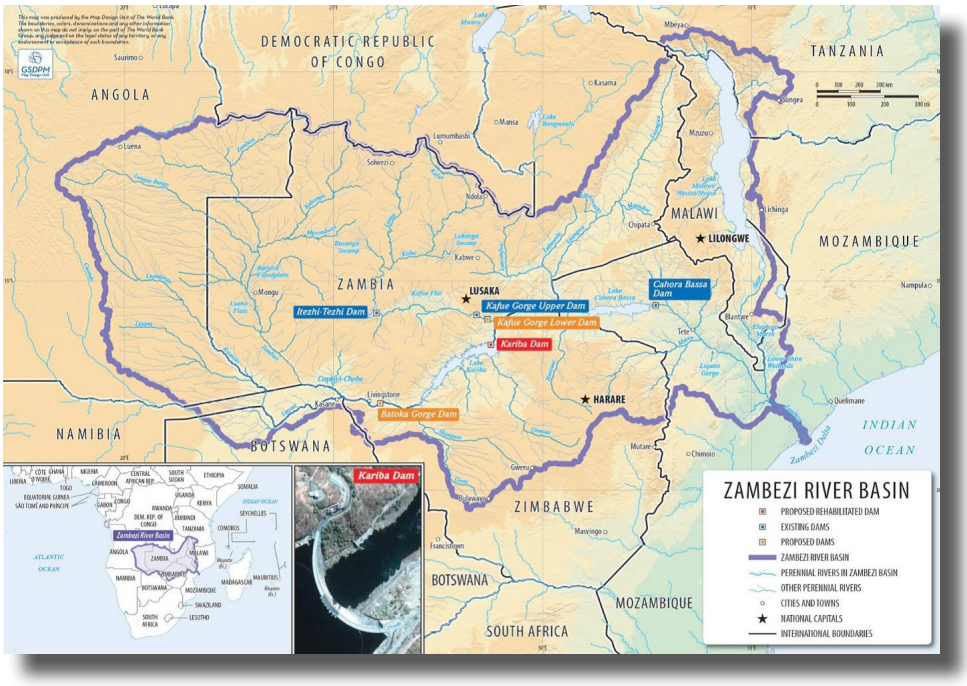
The project, according to the ZRA will:

- Assist in securing the long-term safety and reliability of the Kariba Dam Hydro-Electric scheme.
- Improve the socio-economic security associated with continued operation of the dam.
- Benefit the downstream riparian states of Mozambique and Malawi by avoiding a disaster that would affect the Cahora Bassa Dam and Lake Malawi.
- Through the rehabilitation works, contribute to the South African Power Pool (SAPP) both in terms of generation capacity and stability of the system and continued safe operation of the dam.
- Benefit the South African Development Community (SADC) through economic gains supported through the continued operation of the Kariba Dam Hydro-Electric Scheme.
- Extend the life of the dam for a further 100 years

The WB are leading the project from the funding perspective and their web site provides considerable information. It seems that the rehabilitation will extend over 10 years as the project closing date is noted as the 28 February 2025.

The project development objective from the WB perspective is to assist in improving the safety and reliability of the Kariba Dam. There are three components to the project totalling U$294.2m:

- Institutional and Project Management US$70.3m
- Plunge Pool Reshaping US$99.3m
- Spillway refurbishment US$124.6m



Map of the project area and the Zambezi River Basin

6. Risks and Opportunities

Risk issues and related comments are collated under five headings, following the categorisation utilised in the IRMSA Risk Report – South Africa Risks 2015, and the World Economic Forum (WEF) Global Perceptions Survey. An additional heading "other risks, challenges and opportunities" was included to cater for issues that did not appear to fit into the five WEF categories as these seem to reflect mainly negative impacts or causes.

6.1 Economic Risks

Risks in the economic category include fiscal and liquidity crises, failure of a major financial mechanism or institution, oil-price shocks, chronic unemployment and failure of physical infrastructure on which economic activity depends.

Countries, Industries and natural resources

Botswana is a completely landlocked country in the centre of Southern Africa. Covering an area of 582,000 square kilometres, Botswana shares borders with South Africa, Namibia, Zambia and Zimbabwe. The Kalahari Desert occupies more than 70% of the country and its capital City, Gaborone is located in the south east of the country. With a population of just over two million, the mining sector is the major contributor to the export base and the government is endeavouring to reduce the vulnerability arising from the heavy dependence on diamond mining. The livestock industry, specifically beef and beef processing is another significant export. Tourism is mainly focused on the Okavango Delta, the Kalahari Game Reserve and the Chobe National Park.

Zimbabwe occupies 390,757 square kilometres of land in south central Africa, between the Limpopo and Zambezi rivers and is richly endowed with mineral resources such as gold, chrome, asbestos, coal, iron ore, nickel, copper, diamonds and platinum. The land-locked country is bounded by Mozambique to the east, Zambia to the north and south west, South Africa to the south and to the south west by Botswana. With a population of over 14 million, Zimbabwe's economy is dependent on agricultural products, mining, industry and cattle farming. Tourism contributes approximately 5% of GDP however very little development in this area has occurred since 1996. At present Zimbabwe is facing severe socio-economic difficulties and the country is at high risk of debt distress, with an unsustainable external debt estimated at US$ 8.4 billion at the end of 2014. The government plans to hold a high-level international debt resolution forum in 2015 with the assistance of the African Development Bank (AfDB).

Zambia is an entirely land-locked country covering an area of 752,612 square kilometres, with a population of approximately 13 million. To the north it is bordered by the Democratic Republic of Congo and the United Republic of Tanzania, to the west by Angola, to the south west by Namibia, to the east by Malawi and Mozambique and to the south by Zimbabwe and Botswana. Lusaka is the capital city and is believed to be the fastest growing city in Central Africa. Mining and quarrying account for a large proportion of Zambia's merchandise exports. Zambia is presently the world's fourth largest producer of copper and has around 6% of the world's known reserves. Other contributors to the economy are industry, fishing and agriculture. The tourism sector has consistently demonstrated growth due to a rich natural heritage.

Mozambique lies on the east coast of Southern Africa, measuring a total of 799,380 square kilometres in area. The country borders the Untiled Republic of Tanzania, Zambia, Malawi, Zimbabwe, South Africa and Swaziland. With a total population in excess of 20 million, agriculture is the backbone of the economy providing employment for over 75% of the work force.

According to the International Monetary Fund (IMF), strong economic growth in Mozambique is supported by major investments in coal mining and natural gas sectors but stricter controls over state-run firms is necessary. Mozambique is in the process of offering over a dozen exploration blocks in its northern region, where US oil major Anadarko Petroleum and Italy's Eni are already developing multibillion dollar natural gas projects.

Malawi is a landlocked country located in southern central Africa along the western part of the Great Rift Alley of Africa. Covering a total area of 118,484 square kilometres, Malawi is bordered by the United Republic of Tanzania to the north and north east, Mozambique to the east, south and south west and Zambia to the west. Lake Malawi is the third largest lake on Africa and is the area's principal tourist attraction. Malawi has an estimated population of 14 million and agriculture is the largest sector of the economy.

The economy of **South Africa** is the second largest in Africa, behind Nigeria. It accounts for 24% of its gross domestic product in terms of purchasing power parity, and is ranked as an upper-middle income economy by the WB, one of only four countries in Africa in this category.

The country's economy is reasonably diversified with key economic sectors including mining, agriculture and fisheries, vehicle manufacturing and assembly, food processing, clothing and textiles, telecommunication, energy, financial and business services, real estate tourism, transportation and wholesale and retail trade. The majority of these industries require an adequate and reliable electricity supply to maintain performance.

The high levels of unemployment and inequality, together with crime related events, are considered by the government and most South Africans to be the most salient economic problems facing the country.

Dam construction and management

a. The cost of a new dam to replace the Kariba dam is estimated at US$5bn by a number of Zambian sources, what is not clearly understood is whether this includes removal of the damaged infrastructure following the dam collapse. The timeframe around this "new build" is unknown but is likely to be a minimum of five years with potentially another three years to remove the existing structure. The location of any new dam is likely to be far downstream of Kariba at some sites previously identified however environmental issues may be a cause for concern.

b. The cost of replacing the Cahora Bassa Dam, following a devastating failure of the Kariba Dam and the flooding that would reach Cahora Bassa in an estimated eight hours after this catastrophic event, is unknown but is likely to be similar in terms of the cost and timeframe noted for Kariba. The dams might be repaired or replaced concurrently rather than one after the other and funding will be a key challenge.

c. Whilst reviewing the impact of the failure of the Kariba Dam it has been assumed that the dam would be re-built, however with climate change and rainfall patterns impacting future dam levels and new technologies coming to the fore, will this necessarily be the solution?

d. Reports from many sources indicate that "if nothing is done, the dam will collapse in three years" however there are many differing thoughts around this, primarily around the possible underlying causes that may trigger such a catastrophic event. Business Day live notes that in the event of a "catastrophic Kariba Dam failure", economic damage to the region will exceed R88 billion and will include the washing away of the Cahora Bassa Dam and the loss of 40% of Southern Africa's Electricity capacity". It is not clear how this number was arrived at and based on the potential lead time for any replacement of electricity generating capacity and the funding requirements, together with the impact on the region's people and economies it seems a rather low number.

e. Design life of dams – according to engineering comments, large dams have an indefinite life. Their structure could last as long as the pyramids (5,000 years). For as long as they hold water someone will have to look after them and maintain the spillways and powerhouse. This implies that designers, builders and owners must look further ahead than they have done in the past and ensure that their dams can be maintained indefinitely or, if necessary dismantled.

   Large dams usually have an "economic life" of 50 or more years, reaching the end of that "life" when they have paid themselves off – if they silt up later it is seen as no great loss in present value terms. The Kariba rehabilitation project is said to increase the life of the dam by a further 100 years.

   Silting may also be a concern for the Kariba dam which is said to be less than efficient. When silting occurs the bottom outlets are first to be blocked followed by the power intakes. Finally silt fills the reservoir to spillway level and as it is heavy, the load on the dam is much increased.

f. De-commissioning of Dams – referring again to engineering comments the question arises – how do you de-commission a dam? Looking at Kariba specifically, and 100 to 500 years hence, there are a number of possible scenarios but it is not possible to drain the dam – there is no provision for de-watering; the power station could be shut down, and the spillway gates opened but this would mean the gates would soon need repair and the plunge pool would need evacuation downstream; the dam could be blown up, but the water flow would then destroy Cahora Bassa and flood the Zambezi valley. The cost of de-commissioning is unknown but should include bringing the area back to as near pristine condition as possible. Again this would need funding.

g. Looking to the future, it would seem that the Kariba dam, and indeed most dams within the region, will need adequate maintenance for a significant period of time, was this considered in the original project planning or was the objective shorter term focused?

Electricity & infrastructure

a. Deloitte's report on Sub-Saharan Africa (SSA) Power Trends makes interesting reading. The report indicates that low levels of infrastructure and power supply are a deterrent for many wanting to invest across various sectors in Africa. The development of large capital projects relies on robust planning, reliable funding, and resilient operating structures together with skills development. The team note that unreliable, insufficient and costly power generation and distribution across the African continent has arguably been the Achilles heel to higher and more inclusive growth and socio-economic development of the region. Infrastructure stock levels have impeded rather than facilitated growth and development although this is changing rapidly. The report suggests that

> *"A disruption displaces an existing market, industry or technology and produces something new and more efficient and worthwhile. It is at once destructive and creative"*

Six disruptors were highlighted:-

i. African economic growth, transformation and rising demand

ii. A shifting energy mix giving rise to new capital and players

iii. Changing role and type of customers

iv. Renewable technologies

v. Changing market structures and dynamics

vi. Smarter grids and systems, smarter utilities

b. In December 2014, the SAPP suggested that the region could experience savings of over US$48 billion if all the current electricity generation projects in the pipeline are implemented in a coordinated fashion. This would mean synchronizing the implementation of various planned energy projects with expected capacity of 27,881 MW and the current completion date in 2018. There appears to be little chance of this occurring as national plans seem to take precedence over regional plans.

c. **Zambia** relies on hydro power for more than 90% of its electricity, according to Bloomberg Business. Water levels have declined at Lake Kariba and Kafue Gorge plants which are the source of three-quarters of that supply. Load shedding will increase during 2015 to approximately 600 MW, almost 30% of available capacity, directly due to reducing water levels. Two new plants are expected to provide up to 420 MW by the end of this year.

Lusaka's energy demand has grown at 6% a year over the past 10 years, with demand outstripping installed capacity. Engineering news reports that Aurecon will provide engineering, design and construction supervision services for ZESCO for a US$200m WB funded Lusaka transmission and distribution rehabilitation project, due for completion in 2019.

Zambia's Copperbelt Energy Corporation (CEC) is the largest supplier of power to mines in the southern African nation. Reliability of supply for mining customers seems to be a major issue with a number of blackouts occurring each year. CEC is in talks with Old Mutual over a possible US$205m hydro power station on which work has already started with completion anticipated in 2018.

Impacting both Zambia and Zimbabwe, the Batoka Hydro Electric scheme is expected to go ahead through the ZRA. US$6m has been released by the WB for the feasibility study. The project is expected to start in 2016 with completion in 2021. Go to http://victoriafalls24.com/blog/2015/01/26/latest-update-batoka-dam-project/ for more information and to see some of the risks highlighted.

A recent news report from the Zambia Daily Mail talks about the knock-on impacts of load shedding "Apparently the only people who are enjoying load shedding are call-girls who are taking advantage of the situation to provide outdoor flings to their clients in dark corners of the streets" and "Some electricity consumers are considering temporarily stopping paying for their DStv bouquets until load shedding is over".

d. **Mozambique** – The entity that operates the Cahora Bassa dam on the Zambezi River – Hydroelectric de Cahora Bassa (HCB), advises that a further hydro power station with the capacity to produce 1,045 MW is to be built once funding is agreed. Construction will take six years and will add to the current 2,075 MW capacity. The country currently supplies power to neighbouring South Africa, Namibia, Zimbabwe and Swaziland and is likely to extend this to include the DRC and Tanzania.

The existing HCB dam was built by Portugal, South Africa and Germany during colonial times. A few years ago, the dam was transferred to the Mozambican state for US$700m, following lengthy negotiations between Maputo and Lisbon.

Recently HCB has announced it will spend about US$14m on protecting transmission lines against the effects of flooding. This will involve strengthening the pylons on or near river banks to be able to withstand the forces of waters during peak moments of a flood. On the 12th January 2015 a massive flood on the Licungo River, in the central province of Zambezia swept away 10 pylons on the transmission lines carrying Cahora Bassa power to the north of the country, leaving parts of the region without power for four weeks. HCB power is carried to South Africa along two high voltage direct current lines each running for about 1,400 kilometres and with a total of 2,000 pylons.

Other projects under review include:

- The Lupata Hydro Electric facility – 416 MW
- The Boroma Hydroelectric dam – 210 MW
- The Mphanda Nkuwa dam – 1,500 MW
- Lurio Hydroelectric plant – 180 MW
- Alto Malema Hydroelectric dam – 60 MW

e. **Zimbabwe** – the power utility ZESA has a number of challenges to contend with, the most recent related to the declining water levels in the Kariba Dam, which have led to a 400 MW reduction in generation power and then a fault at the Hwange Power Station which occurred in June 2015, apparently related to the aging plant and the need for refurbishment. With only 1,000 MW available and a demand of 2,000 MW, Zimbabwe has been experiencing crippling power shortages for a long time, allAfrica.com comments that "the country will endure its' darkest winter season in history this year".

Unfortunately the power crisis is likely to lead to increasing unemployment in the country together with increasing poverty levels, with job seekers potentially seeking relief across adjacent borders.

RioZim, which mines gold, diamonds and coal in Zimbabwe wants to work with state-owned power utilities in South Africa and Namibia to build a 1,400 MW electricity plant near its Sengwa coal fields and export power to Eskom and Nampower. Coal for the plant will come from the company's coalfields in northern Zimbabwe, while it will draw water from Lake Kariba, 85km to the north. So, whilst we look at options to deal with the power supply problem, utilising coal as the fuel source, we need to appreciate the amount of water to run a coal power station. If the water supply for this proposed station is not available, the plant will be unable to produce.

Engineering news in April 2015 reported that Zimbabwe plans to build new power stations to generate 3,500 MW at a cost of US$5 billion according to the national power company ZPC. Where funding for this construction will come from is not clear as lenders like the IMF and WB have said they will only resume lending to the country once it clears its debts with the global lenders. However The Southern Times newspaper commenting on the project to increase capacity at the South Kariba hydro power station by 300 MW notes that this upgrade has been facilitated by a US$319m loan from China. It further states that this deal is a clear example of Zimbabwe's "Look East" policy which was adopted after falling out with Western powers.

A decline in commodity prices with a strengthening of the US dollar makes debt unsustainable in many economies. Zimbabwe's massive external debt, amounting to 40% of GDP, remains a sign of vulnerability and other countries in the region, such as Mozambique and Tanzania, are racking up debt to fuel growth. Debt servicing will squeeze public expenditure for many years within such economies, what can we learn from the crisis in Greece?

f. **South Africa** – Eskom Holdings (Eskom) is a State owned company that generates, transports and distributes approximately 95% of South Africa's electricity, making up 60% of the total electricity consumed on the African continent. Eskom is the world's eleventh largest power utility in terms of generating capacity, ranks ninth in terms of sales, and boasts the world's largest dry-cooling power stations.

Eskom sells power directly to some 6,000 industrial, 18,000 commercial, 70,000 agricultural and 3 million residential customers. It owns and operates a number of coal-fired, gas-fired, hydro and pumped storage power stations, as well as one nuclear power station.

Eskom's 26,000 kilometres of transmission lines span the entire country and extend into most SADC countries.

The situation within South Africa in terms of available electricity supply has been of concern for a number of years with the Utility's reserve margin at far less than optimum levels. Two major new coal-fired power stations are in the process of being built but delays have resulted in significant cost increases and the need to utilise Open Cycle Gas Turbines on a regular basis or to load-shed customers. Increasing costs of supply need to be met by consumers, however the National Energy Regulator (NERSA) has not allowed the Eskom recommended tariff increases in the past few years. This has led to a downgrading of Eskom by credit rating agencies and an increase in the cost of debt.

A lack of maintenance on existing stations within the Eskom fleet has led to a less than efficient fleet with unplanned breakdowns, further reducing the available capacity.

A long term agreement for the importing of power from HCB accounts for 1,500 MW of the Utility's total available capacity and the failure of the Kariba Dam would have a serious effect on Eskom's ability to continue to provide sufficient power to their customers. If we look at two of the units of one of the new stations being more or less equivalent to the loss of the imported power from Cahora Bassa, it is clear that such an event would be severe for all South Africans, let alone the rest of the region.

g. Deloitte Corporate Finance experts comment that inadequate infrastructure remains a major obstacle towards Africa achieving its full economic growth. Meeting the demand for key infrastructure has been identified as a priority creating an exciting opportunities for global investors who need to look past the traditional Western view of Africa as a homogeneous block and undertake the detailed research required to understand the nuances and unique opportunities of each region and each individual country.

Is there an opportunity perhaps for the risk fraternity to consider a new type of risk assessment – Regional Risk Management – looking specifically at the systemic risks impacting the entire region?

h. Creamer Media's Engineering News reports on the WEF Global Strategic Infrastructure Initiative (ASII) which hopes to draw billions of dollars to boost infrastructure projects in Africa.

> *"Africa has a US$100 billion a year infrastructure gap. It needs to spend U$1.5 trillion in the next 15 years to provide water, electricity, sanitation, roads, rail and economic growth necessary for 80 million young people in Africa to get jobs every year".*

i. According to a report in Business Day Live, among the significant external activities likely to cause concern on the integrity of the dam are the drill and blast operations at the Kariba south bank during the project. Such activity causes vibrations and shock waves which must be capped at certain thresholds. It has been recommended that all drill and blast operations taking place at and near the dam are monitored, logged, analysed and controlled according to recommendations for the Kariba Dam.

j. With all of the construction related projects in progress or anticipated in the region, competition for skills, specifically engineering and consulting expertise, is likely to be a significant challenge.

k. The total cost of works is estimated at US$294m. The Governments of Zambia and Zimbabwe have mobilised funding from the AfDB, the European Union (EU), the Government of Sweden and the WB to support the ZRA in the project.

   View Marcus Wishart from the WB as he talks about the project: https://www.youtube.com/watch?v=hXclsm2wll4&feature=player_embedded

A WB "Chair Summary" related to a meeting held 9 December 2014 and considering the Kariba Dam Rehabilitation Project, although not an approved record, states:

> *"Directors acknowledged that a potential catastrophic failure of the dam would result in devastating regional flooding, significant loss of human life, and unprecedented economic damage downstream in the Zambezi River. They also acknowledged the complexity and risks of the proposed undertaking and underscored the importance of building strong capacity and sound institutional arrangements for success. The importance of close monitoring and taking appropriate precautions to mitigate environmental and social risks was strongly urged".*

More details are available for those interested in further research on the WB web site – www.worldbank.org.

It seems evident that failure to obtain funding to rehabilitate the Kariba Dam, and of course to actually ensure the project is completed, would have such an impact on other projects in and around the Zambezi that this specific project surely had priority in terms of funding.

Revenue generated for Zambia, Zimbabwe and Mozambique specifically around electricity generation and the reduction in revenue if hydroelectric power from the Zambezi is reduced or eliminated for a significant period would severely impact the economies of these countries – could it also lead to failure to repay existing loans and impact further investment?

6.2 Environmental Risks

Risks in the environmental category include both natural disasters, such as earthquakes and geomagnetic storms, and man-made risks such as collapsing ecosystems, freshwater shortages, nuclear accidents and failure to mitigate or adapt to climate change.

a. If the tidal wave of water from the collapse of the Kariba Dam reaches Mozambique and the Cahora Bassa dam, it is likely to overwhelm this dam releasing another 51 billion tons of water, making the spillage four times bigger than the largest on record.

b. Flood Disaster Management. Until the Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) documents are available it would be unfair to comment on whether sufficient attention has been given to the downstream flood potential and impact. There is no doubt that a catastrophic failure of the Kariba Dam would have a long term impact on the people of the area, the flora and fauna and agriculture which is a key to the economies of most of the riparian states.

c. New Civil Engineer International Magazine reports that a Kariba collapse would be a repeat on a massive scale of the 1959 collapse of the Malpasset dam in the South of France, which was also the work of Andre Coyne who designed Kariba. The Malpasset dam was completed in 1954, but on 2 December 1959 it collapsed releasing a 40m high wall of water that killed 423 people. The villages of Malpasset and Bozon were completely destroyed. Heavy rain was suggested to be one of the causes and the water levels behind the dam were unusually high, delays in opening the flood-gates were also noted as an issue but the main cause was held to be a tectonic fault in the underlying gneiss. Coyne never recovered from the shock of the disaster and died soon afterwards at the age of 69.

d. Climate change in SADC – The Intergovernmental Panel on Climate Change (IPCC) provides good information on this topic. Climate modellers indicate further increases of mean temperatures between 2 and 4.5 degrees centigrade in the next 50 to 100 years, these variances are expected to be greater in the summer than in the winter season.

According to the AfDB Project Appraisal Report, the IPCC has categorised the Zambezi as the river basin exhibiting the "worst" potential effects of climate change among 11 major African basins, due to the resonating effect of increase in temperature and decrease in rainfall. The Zambezi runoff is highly sensitive to variations in climate, as small changes in rainfall produce large changes in runoff. Over the next century, climate change is expected to increase this variability, and the vulnerability of the basin and its hydropower dams to these changes.

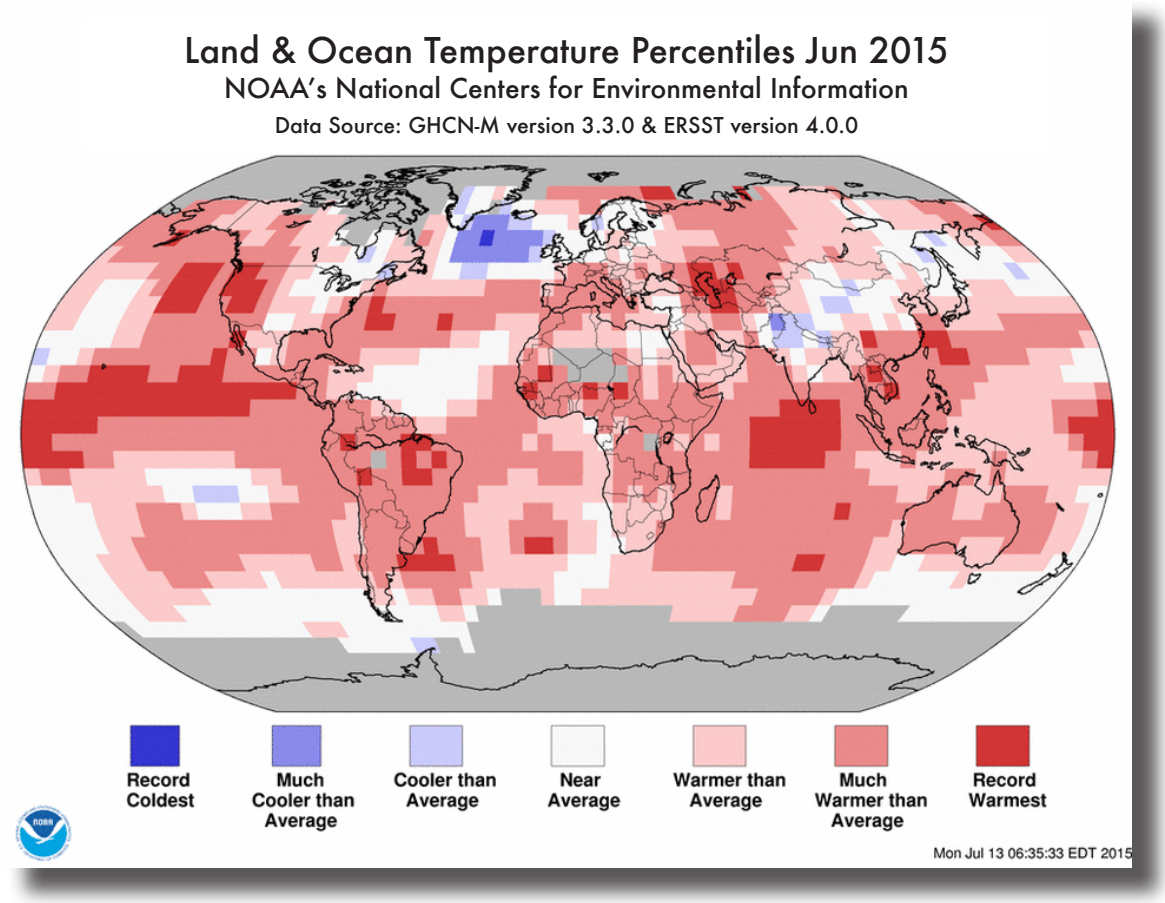
The future picture for Southern Africa's climate is increasingly clear, based on observed trends over the past century and increasing confidence in the range of climate change scenarios developed. Overall the Zambezi will experience drier and more prolonged rough periods, and more extreme floods.

In considering the aspect of climate change related to this report, it is clear that the loss of water in both the Kariba and Cahora Bassa dams, should Kariba fail, will take some time to build up again to current volumes. If we consider the time to repair or replace these two dams, the impact both up and downstream may be significant for five - 10 years.

Refer to the SADC report "Climate change and adaptation in SADC – A Strategy of the Water Sector." The IPCC has identified Southern Africa as being very susceptible to climate change.

- Temperatures have risen by over 0.5% over the last 100 years and a further 2 to 4.5 degrees are indicated in the next 50 to 100 years.
- The region's climate will become hotter and dryer.
- A downward trend in rainfall patterns has been experienced with frequent droughts.
- Beside volumes, precipitation patterns are also expected to change in intensity and frequency. More extreme events and longer periods between rainfalls.
- Southern Africa is one of the five regions in the world exposed to serious risk of flooding in coastal and deltaic areas.
- Drought-prone areas of Namibia, Botswana and Zimbabwe are likely to be more vulnerable.
- Socio-Economic impacts relate to an adverse effect on agriculture production and diminishing fishing resources in large lakes due to rising temperatures, limiting food supplies.
- Previously successful eradication programmes may need to be re-instated as a resurgence of water-related vector borne diseases may increase.
- The impact on the GDP of counties within the region, impacting economic growth, attributed specifically to drought in the past has been significant.

A recent report from the National Oceanic and Atmospheric Administration (NOAA) notes that "off the charts heat" is getting to be a monthly thing. They calculated that the world's average temperature in June 2015 hit 61.48 degrees Fahrenheit breaking last year's record by 0.22 degrees. Usually temperature records are broken by one or two one-hundredths of a degree, not nearly a quarter of a degree. Consider the following picture when the half-year is considered:



Flooding and Flash Flooding

In January 2013 and again in 2015, significant flooding occurred in the region.

In 2013, flash flooding across Zimbabwe's Masvingo and Matabeleland provinces, which are normally dry areas caused substantial damage to infrastructure and affected an estimated 8,490 people. Further across the region, floods occurred in Botswana and Malawi with 30,785 people impacted and in Mozambique about 250,000 people were affected.

The 2015 floods impacted mostly in Mozambique and Malawi with more than 100 people killed and 15,000 displaced. Reuters has commented that a lack of funds has hampered the region's to tackle the effects of the disaster.

Seasonal rainfall patterns are evident in the region and it is understood the repairs to the Kariba dam could only commence in May 2015, outside of this rainfall window. What impact could unseasonable rain have on the rehabilitation project we might ask – potentially delay could be a major factor but the inability to use the floodgates effectively may be serious.

Some reports suggest that the capital of Zambia, Lusaka, would be totally flooded if the Kariba Dam were to fail catastrophically, others suggest that this comment was "media hype" and this might only occur if the Dam was at its maximum capacity.

At the time of writing this report, Zambia is facing a reduction of 300 to 560 MW of hydro power generating capacity because of the lack of rainfall, leading to restrictions in water flow through the hydro station. They are also seeking to import power to alleviate these shortages.

Business Report comments that the region is headed for a major crisis because of the worst drought in key crop producing centres since 1992 according to the UN Food and Nutrition Security Working Group. The report claims that the region's maize production belt had been hampered by a drought since February 2015 and the expected maize crop is estimated to be 31% less than last year and 20 percent below the average for the last five years. The cost of importing the required grain will translate to a price increase from July to December 2015 but will have a knock on impact for other food stuffs such as red meat and eggs that are reliant on grain for fodder. If we consider this current situation, what could the impact be without the Kariba and Cahora Bassa dams over potentially a five to eight year period?

Earthquake

With thanks to the University of Pretoria Hazard Centre, it seems that in terms of seismicity, the country of Zimbabwe can be viewed under three broad seismic zones – the eastern area, the Zambezi basin and the central area. Seismic activity is mostly centred along the Zimbabwean borders with Mozambique to the east in the Deka fault zone in the Hwange area. Further activity may be seen to the northwest and over the mid-Zambezi basin the Lake Kariba area.

Seismic events of magnitude higher than 5.0 have occurred in the mid-Zambezi basin. Some of the events in the region that are worthy of review:

- 25 June 2004 and 15 March 2008 Nyamandlovu earthquakes at 4.3 magnitude, these were felt in Bulawayo some 120km away.
- 22 February 2006 Mozambique earthquake at 7.0 magnitude, which killed four people near the Zimbabwe border with Mozambique and caused a lot of destruction in the Chipinge area and is regarded as one of the biggest events in Africa.
- 31 August 2010 saw a 5 magnitude movement of the ground which is observed as an earthquake in the Lake Kariba Cluster (mid-Zambezi basin). Seismic activity in the area is related to the extra water pressures created in micro cracks and fissures in the ground under and near the reservoir.

Details of other historical seismic events are available and the potential for future significant events is worthy of consideration.

6.3 Geopolitical Risks

The geopolitical category covers the areas of politics, diplomacy, conflict, crime and global governance. These risks range from terrorism, disputes over resources and war to governance being undermined by corruption, organised crime and illicit trade.

a. Aon's 2015 Terrorism and Political Violence Risk Map indicates that the countries under review of this report are not significantly at risk however border management may need further consideration. Tanzania has been rated at an increased risk, whereas Mozambique has reduced in risk.

b. In the event of a catastrophic failure of the Kariba Dam, support from world-wide aid agencies will be key to the ability to minimise the impact of this event. Little detail is currently available around any proposed disaster management or emergency preparedness and response plans around the rehabilitation project. It is suggested that the response to such a disaster must be immediate, comprehensive, and demonstrate very clear lines of command. A mechanism needs to be in place to quickly draw upon external resources available at higher levels of government, or even internationally, when the local level of response will not be sufficient.

c. **Geo-economics.** The WEF is clear that business, like government, must master geo-economics. Today we are faced with a host of ever more tightly interconnected factors: from international security, jurisdiction, global governance and diplomacy, combined with a global economic landscape in which leaders struggle to interpret the interconnected complexities of monetary and fiscal regimes, currency shocks, shifting international trade frameworks, global investment, talent migration and a host of other globalised macroeconomic forces. For business, this uncertainty offers huge risks. Companies that fail to understand the impact that geopolitical events have on their respective industries will lose, however for those who are informed and engaged, opportunities will dominate.

   As this report involves several countries in Africa with differing economic and political profiles, it is important to take a multi-country and interconnected approach to risks and opportunities arising from the Kariba Dam project.

   The failure of the Kariba Dam and the consequent failure of the Cahora Bassa Dam would seriously impact the economies of the region for many years.

6.4 Societal Risks

The societal category captures risks related to social stability – such as severe income disparities, food crises and dysfunctional cities – and public health, such as pandemics, antibiotic-resistant bacteria and the rising burden of chronic disease.

a. The ZRA is undertaking the necessary Environmental and Social Management Assessment, along with the associated instruments to ensure the sustainability of the project through appropriate preventative, mitigation and monitoring interventions. These are to be finalised in 2015, before the commencement of the works, which are themselves expected to be completed by 2019 and 2023 for the plunge pool and spillway components respectively.

b. In terms of the environmental and social impact, an ESIA was to be completed by February 2015, complying with the legal and regulatory requirements of both the Zambia and Zimbabwe Environmental Acts as well as WB and AfDB environmental and social safeguards policies. Provision within the funding has also been made for an ESMP. The AfDB Project Appraisal report indicates that the final ESIA and ESMP reports will be produced and disclosed before commencement of works and on relevant web sites for 120 days prior to first disbursement. As at the 30 June 2015, there were no updates on the WB, AfDB or ZRA sites related to the ESIA or ESMP – has this already delayed the start date?

c. From an environmental and social context, according to the WB, the two rehabilitation components of the plunge pool and the spillway, include in situ works on existing infrastructure to secure operations in accordance with international dam safety standards. The rehabilitation measures are not expected to have any significant adverse environmental or social impacts.

d. There appears to be consensus that the failure of the Kariba Dam would impact 3.5 million people living downstream, with significant loss of life and livelihoods. There is no detail around the anticipated loss of life that this event may lead to however sufficient warning of the flood would materially reduce any loss of life if people are able to move to higher ground in good time. Communication and adequate emergency planning will be critical in reducing loss of life.

e. In terms of flora and fauna, little information is currently available. It is suggested that the outcome of the ESIA might provide more information.

f. There is debate on whether Lusaka, the capital of Zambia, would be flooded – sources comment that only if the Kariba Dam was full at the time of the breech would Lusaka be materially impacted. Downstream impacts are not clear but severe flooding in and around the area of Tete is extremely likely as is further flooding in Mozambique.

g. The impact on agriculture and fishing in the region is likely to lead to food shortages that may impact the entire region and result in increasing food prices and further exacerbate levels of poverty.

h. The Tokwe-Mukosi Dam is located in Masvingo, Zimbabwe and is used for water storage, flood control, irrigation, fisheries and power generation. Construction began in 1998 and the dam was opened in 2015 – construction cost US$200m. The Guardian newspaper advised in April 2014 that the flooding involving the partially built dam which had occurred in February 2014 had shown that disaster preparedness in Zimbabwe is extremely weak. The flooding displaced thousands of people and forced the government to declare a national disaster.

i. The impact on tourism of the recent Ebola virus outbreak was considerable and would be further impacted with a major catastrophe such as the failure of the Kariba Dam. Flooding brings with it an increase in waterborne diseases which are caused by pathogenic microorganisms that most commonly are transmitted in contaminated fresh water. Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food thus infected. Various forms of waterborne diarrheal disease probably are the most prominent examples, and affect mainly children in developing countries; according to the World Health Organization.

6.5 Technological Risks

The technological category covers major risks related to the growing centrality of information and communication technologies to individuals, businesses and governments. These include cyber-attacks, infrastructure disruptions and data loss.

a. **Media reporting.** In June 2014, a report in the New Civil Engineer International magazine commented that "the ZRA regrets the misinterpretation on the facts about the Kariba Dam wall impending collapse which caused alarm among stakeholders and the public in general".

   There were a number of reports in the media dealing with the problem identified and they vary in credibility depending on the audience they desire to influence, some of the comments have been found to be rather exaggerated and other issues have been played down. It seems that funding for the rehabilitation of the Dam was the key motivator and if we make this assumption then reporting on the problem was extremely successful. The balance between creating a scenario designed to encourage funding yet balanced and factual enough not to cause panic has to be a real challenge and a potential reputation nightmare.

b. **Cell phone communication.** "A simple text message is the difference between success and failure" according to the WB and whilst this research was focused on reminding forgetful patients to take their medication, specific, focused text messages may make a considerable difference in the event of a catastrophe, perhaps warning of a severe flood. The key however will be who takes the decision in "real-time" to send a text and whether regulatory constraints will hamper the ability of cell phone companies to provide this kind of support to customers.

c. **Facebook** and other similar "on line" sites. Getting a warning message out in the event of a problem with the dam would be useful through any method, including social media.

   Have a look at the Facebook site 'StopTheBatokaDamOnTheZambeziRiver" for some interesting views on this new project.

d. **Twitter.** In addition to warning alerts in terms of flooding, as a social networking tool used by millions, Twitter can be a great help in disaster operations according to researchers who have created real-time flood maps using data from tweets. This information is also extremely useful to find people who are affected or to support evacuation planning.

e. **Print media** reporting on the Kariba problem and the rehabilitation project continues to be of interest with differing points of view depending on the angle and publication. Have a look at the Daily Maverick article below:

   http://www.dailymaverick.co.za/article/2014-05-13-analysis-a-damn-crazy-idea/#.VZEefXkw-vG

   > *"When the huge floods hit in 2000 and again in 2001, Kariba engineers opened all their sluices to protect the dam but failed to inform their counterparts at Cahora Bassa. To prevent overtopping, Cahora Bassa suddenly opened all eight sluices, causing the wall to vibrate so violently on one occasion that engineers are reported to have fled the wall"*

   So, it seems that communication downstream is something that needs attention.

f. **Radio and Television** will have a significant role to play in warning of a possible problem at Kariba and Cahora Bassa – it will be important for a clear unambiguous message to be communicated to support an "early warning" alert for people to get to higher ground.

g. **Cyber risks** continue to be mentioned in practically every risk report, survey and magazine. If we consider the countries and entities that are involved in the Kariba rehabilitation project, the potential for such an attack impacting the project timelines is worthy of more research. This risk may also be an opportunity for terrorist activity in the region.

6.6 Other Risks, Challenges and Opportunities

a. In terms of the rehabilitation project time lines - Business Day live comment that the short timeline for repairs is the real peril, and the scope of work to be done is daunting and will test the skills of some of the best engineering experts assembled for the task.

   May 2015 - "Kariba's real race is against that great enemy – time. The consensus of engineers from around the world is that Kariba has a life span of three years if extensive repairs are not undertaken immediately".

   The start date seems to be changing, originally noted as May 2015 it now seems to have moved to September 2015.

b. HKV Consultants based in the Netherlands, constructed an animation of the potential flood resulting from a dam breach in the Cahora Bassa dam. The short movie shows a more detailed inundation around the city of Tete, the largest city along the Zambezi River in Mozambique. The flood wave reaches Tete about 10 hours after the breach. The peak arrives after 24 hours. The maximum water levels show an increase of more than 10 m, going up to 20 m on some locations.

   https://www.youtube.com/watch?v=KLAWQmeItm4&feature=youtu.be

   Tete is a province of Mozambique and has an area of 98,417 square kilometres and a population of 1,783,967 (2007 census). The Tete Province is reported to host coal reserves of approximately 6.7 billion tons, of which 3 billion tons represent sub-economic or economic grades. Now, the province is regarded geologically as the largest undiscovered coal province in the world and it is estimated that the province could be producing 25% of the world's coking coal by 2025.

c. A recent report in Creamer's Mining Weekly related to the use of powerships as a cost effective business continuity plan was of interest. These floating power plants have generating capacities up to 500 MW and use both natural gas and heavy fuel oil as the power source and they can give significant savings over the current cost of operating Eskom's Open Cycle Gas Turbines. Whilst this might assist the situation in South Africa as the vessels are generally located on the coast this option may limit the response in the case of this particular study. What if they could be located on the Kariba Dam to alleviate the current supply constraints, or are they not cost-effective?

d. Whilst no real detail is provided, the WB Implementation Status and Results Report for the Kariba Dam implementation Project, provided as at the 31 March 2015 indicates that the current rating of risks is as follows:

Political and Governance	Moderate
Macroeconomic	Low
Sector Strategies and Policies	Low
Technical Design of Project or Program	High
Institutional Capacity available for implementation & Sustainability	Moderate
Fiduciary	Moderate
Environment and Social	Moderate
Stakeholders	Substantial
Overall	Substantial

Full details of the Risk Assessment and rating process were not available however a review of the WB Systematic Operations Risk-Rating Tool – SORT (June 25, 2014) Interim Guidance Note, may be of interest.

e. The AfDB Project Appraisal Report - December 2014 - advises that the Bank is contributing to the creation of work synergy between the South African Power Pool and the ZRA to enhance regional integration. In terms of knowledge management, the project will include a capacity-building component which includes training for technical staff of the ZRA and skills transfer through the supervision engineer and panel of experts. The programme will strengthen ZRA's Emergency Preparedness Plan and also includes a programme for improved emergency preparedness.

The project objectives are "to assist the ZRA to secure the long-term safety and reliability of the Kariba Dam complex and to forestall a potential dam failure that could disrupt commerce and livelihoods in nine Southern African countries, should the dam fail".

A review of the SADC Regional Infrastructure Development Master Plan (RIDMP) - go to http://www.ridmp-gis.org/ – is useful to appreciate the sheer number of projects and the cost involved. Key areas have to be unlocked to ensure that the RIDMP, as a guide to the development of seamless and cost-effective trans-boundary infrastructure, is successful. These areas include the development of adequate power supply, developing transport sectors, ensuring sufficient water supply and operating efficiently through information and communications technology.

Through the SADC corridor strategy, the RIDMP is planning to intensify investment in roads, rail and ports and resolve issues around cross-border trade. Demand for power in the region was expected to continue to grow and it is hoped that sufficient power would be available to meet demand by 2018, with a further 20% reserve by 2022.

In the short term, an investment of US$62 billion would be ploughed into key power generation projects such as the Cahora Bassa hydroelectric scheme in Mozambique and the Kudu gas project in Namibia. By 2027 the RIDMP aims to generate 56,000 to 96,000 MW through these and other projects.

According to the RIDMP Executive Summary, the sectors require funding as follows:

i.	Energy	US$	12,270 billion
ii.	Tourism	US$	,324 billion
iii.	Transport	US$	16,650 billion
iv.	ICT	US$	21,400 billion
v.	Meteorology	US$	,192 billion
vi	Water	US$	13,480 billion

With climate change and rainfall being so significant for the future of the region it is hoped that sufficient research into these specific risk areas has been considered.

f. **Investment treaties** - although some risks in cross-border investments are unavoidable, some strategies protect and provide avenues of relief against these risks. One such measure of protection is the use of International Investment Agreements (IIAs). IIA's are agreements entered into between states for the express purpose of protecting and promoting foreign investments. They provide a state with a strong incentive to treat foreign investments fairly. One such treaty is the Energy Charter Treaty, which entered into force in 1998, with 54 signatories and covering economic activity in the energy sector. These IIA's exist independently and in addition to any contractual rights so a direct contract with a government is not necessary to gain protection. It would seem however, that the countries under review for this report are not members.

g. In terms of catastrophe/disaster management and recovery what happens right after a natural disaster matters almost as much as what takes place during the calamity itself according to the Economist, reporting after the 7.9 magnitude earthquake that struck west of Kathmandu on the 25th April 2015. Injured victims need to be given the necessary medical treatment, rescued as necessary from the affected areas and provided with water and food supplies. The risks for survivors grow if proper hygiene is not preserved or if those made homeless are exposed to poor weather.

h. **Crisis management and Communication** - there appears to be little clarity at this stage as to who would take the lead in managing a major catastrophe in the region. It is hoped that more clarity will be provided once the ESIA is completed.

i. **Drones** - there have been many press reports recently on the use and regulation of drones. Willis Resilience news reported in April 2015 that drones are able to detect property damage and can scan and photograph the disaster altered terrain. 3D printers are then used to create a detailed model of the topography which can then be used to deploy search and rescue operations more quickly, safely and effectively. This seems to be mainly used in the USA currently but perhaps could be used proactively within the area that could be impacted by the failure of the Kariba Dam.

j. Working with the thermal imaging experts from Aon South Africa, a test was conducted on a local dam to see if thermal imaging was of any value in identifying leaks that are not visible to the naked eye as a proactive method to identify areas for maintenance. Further research will be required but it would seem that this process may be of value going forward.

k. Procurement arrangements – AfDB have agreed that the rehabilitation project is being managed by the ZRA and that the nature of the works is such that it cannot be split into separate contracts and the estimated contract amount for these works can only be sourced under joint financing considering the resources available. The WB has comparable and acceptable fiduciary standards with those of the AfDB and the WB has been in the lead on the project. It seems that the WB and AfDB will be keeping a close watch on the ZRA who have not implemented a project of this size in the past.

   AfDB indicate that the risks of construction, hydrological issues and delayed commencement of the project are key concerns and that appropriate mitigation measures have been put in place.

l. The ZRA will be regulating truck loads at the Kariba Dam. One of the discussion items at the March 2015 meeting of the Council of Ministers of the ZRA was around the need to regulate to ensure that the axle loading of vehicles do not exceed the required weight limits, to ensure safety of the dam wall.

m. Water infrastructure will be key to success in the region - there is a real need to ensure adequate water supply, not only for domestic communal consumption, but also for industry. This is one of the key objectives of SADC's RIDMP and it has been stated that "future wars will be about water".

n. History should always be considered when looking at future risks. Construction on the massive Birecik Dam located on the Euphrates River was completed in 2000, causing flood waters to rush into Southern Turkey. For six months the waters continued to rise some 4 inches every day, threatening a world of archaeological remains that had only begun to be uncovered in Zeugma. The rising waters brought about an immediate emergency to salvage the artefacts, left behind by the Roman civilisation that once prospered in the region.

o. In terms of insurance or risk financing, some government entities cannot or do not purchase insurance protection for their assets and liabilities. Funders will however require project construction risks to be insured and many of the major insurance brokers and insurers world-wide are able to assist with the necessary insurance protection for projects although there are restrictions for dam construction.

   In the event of failure of the Kariba dam it will be interesting to consider, when the proximate cause of the failure has been determined, whether any construction risk insurance for property or liability risks might be applicable or whether the event is deemed to be uninsured. Whichever is the case the total economic impact is likely to be far greater than any insurance cover that may be applicable.

   Darlington Munhuwani, Regional Controller for Aon in Sub-Saharan Africa, speaking to Commercial Risk Africa Magazine on whether insurers are innovative enough in Africa comments that *"The next level of innovation must be to empower clients to understand their risk profile to make informed decisions about the type of risks to insure and the level of cover to buy."*

7. Risk Management

As previously noted, this report is not intended to be a risk assessment. Most entities now have a formalised risk management process within their companies, required in terms of good governance.

For further guidance on enterprise risk management (ERM), go to the IRMSA Risk Management Guideline, www.irmsa.org.za which is based on the ISO 31000 Guideline.

Whilst risk is currently defined as "uncertainty around objectives" in terms of ISO 31000, allowing for both the negative and positive aspect of risk, one of the challenges around this specific issue is the different number of objectives in the region, from the various nations and their economies, to individuals, investors and industries.

When we talk about "the organisation" in defining the context for a risk assessment we look at the organisation as being a single person or a group that achieves its objectives by using its own functions, responsibilities, authorities and relationships. It can be a company, corporation, enterprise, firm, partnership, charity, association, or institution and can either be incorporated or unincorporated and be either privately or publicly owned. It can also be an operating unit that is part of a larger entity. A recent discussion on linked-in around the definition of "the organisation" concluded that the way we think about organisations in risk management is not so simple after all, it certainly is a challenge when looking at a regional issue such as envisaged within this report.

The inter-connectedness of the risks to various entities and stakeholders is evident from the details provided in this report, further work on systems behaviour and perhaps a causal loop diagram may be of value.

This report focuses on the Kariba and Cahora Bassa Dams – there are a significant number of other dams that may also need some attention and may impact countries in the region – go to https://en.wikipedia.org/wiki/List_of_dams_in_South_Africa - just to see those in South Africa.

When considering the objective for this report, it was the intention to highlight the potential risks and other issues around the status of the Kariba Dam as reported from August 2014 to June 2015, and to suggest what the impact of the failure of the dam might be.

8. Conclusion

Whilst we can debate whether the Kariba Dam will fail, why it might occur and when, there is no doubt that the impact across the region would be devastating.

What do you, or your company need to do to understand and manage your risks around this potential catastrophe?

What can you or your company do to support the people responsible for the Kariba Dam rehabilitation project to reduce the likelihood of this event occurring?

9. A personal observation

It has been fascinating to do the research around this project and to improve my understanding around the various inter-connected issues in the region, specifically around power supply and infrastructure. The interest from friends and colleagues when discussing various aspects of the research was fabulous and I greatly appreciate their efforts to help me put this report together.

My learning through the process of research for this project, mostly through the internet, has been considerable and having the time to consider and reflect on the various aspects of this situation has certainly led to my personal growth around the aspects of "country" and "regional" risk management. Looking at risks and opportunities from different stakeholder perspectives and the involvement of the world-wide investment community in the region has been enlightening!

Water infrastructure will be key to success in the region - there is a real need to ensure adequate water supply, not only for domestic communal consumption, but also for industry. This is one of the key objectives of SADC's RIDMP and it has been stated that "future wars will be about water".

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10. Disclaimer

11. References, links and documents used in this report

1. African Development Bank – Project Appraisal Report
2. All Africa.com
3. www.africaneconomicoutlook.org
4. Aon 2015 Terrorism and Political Violence Risk Map
5. Bloomberg Africa, Bloomberg Business
6. Business Day, Live
7. Business Report
8. www.canadianunderwriter.ca
9. Commercial Risk Africa
10. Daily Mail
11. Daily Maverick
12. Department of Energy SA
13. Department of Public Enterprises SA
14. Deloitte – Sub Saharan Africa Power Trends, Infrastructure
15. The Economist
16. www.erm.com (ESIA)
17. Eskom Holdings
18. www.fin.24.com
19. www.floodlist.com
20. Creamers Engineering News
21. Google and Google alerts
22. 2The Guardian
23. Huffington post.com
24. Intergovernmental Panel on Climate Change
25. www.imf.org
26. www.internationalrivers.org
27. www.iol.co.za
28. Linked-in ISO 31000 members
29. Lusaka Times
30. Leyland, Bryan – Large Dams, The implications of immortality
31. Marco Hartman, HKV Consultants - Netherlands
32. Marsh South Africa – Geopolitical Risks
33. www.mediaupdate.co.za
34. Creamer Media's Mining Weekly
35. New Civil Engineer International – www.ncc.co.uk
36. www.news24.com
37. www.newsday.co.zw
38. www.poandpo.com
39. www.polity.org.za
40. www.peacefulwarriors.net
41. www.pwc.co.za
42. www.sadc.int – Regional Infrastructure Development Master Plan, Climate Change Adaptation in SADC
43. www.rivierareporter.com
44. www.southerntimesafrica.com
45. Sunday Times
46. Spyghana.co
47. Strategic Risk Global.com
48. www.the.times.co.uk
49. www.twitter.com
50. United nations Food and Nutrition Security Working Group
51. University of Pretoria, Natural Hazard Centre
52. www.ventures-africa.com
53. www.victoriafalls-guide.net
54. Wikipedia
55. Willis Resilience reports
56. World Economic Forum
57. World Bank
58. World Health Organisation
59. You Tube
60. Zambia Daily Mail
61. Zambezi River Authority – web site
62. www.zamlii.org.zm
63. www.zarho.org.zm
64. The Zimbabwe Mail
65. www.zurichna.com
66. www.zpc.co.zw

12. Acronyms and abbreviations

AfDB	African Development Bank Group
ASR	Alkali Silicate Reaction
BBC	British Broadcasting Corporation
CIWA	Cooperation in International Waters in Africa (WB)
CEC	Copperbelt Energy Corporation
Eskom	Eskom Holdings SOC
EU	European Union
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social management Plan
HCB	Hydroelectric de Cahora Bassa
IIA's	International Investment Agreements
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRMSA	Institute of Risk Management South Africa
MW	Mega Watts
NERSA	National Energy Regulator South Africa
NOAA	National Oceanic and Atmospheric Administration
RIDMP	Regional Infrastructure Development Master Plan
SADC	Southern African Development Community
SAPP	Southern African Power Pool
US$	United States Dollars
WEF	World Economic Forum
WB	World Bank
ZESCO	Zambia Electricity Supply Company
ZESA	Zimbabwe Electricity Supply Company
ZPC	Zimbabwe Power Company
ZRB	Zambezi River Basin
ZRA	Zambezi River Authority

13. Support from IRMSA members

- **Chairman Christopher Palm**, and members of the IRMSA Risk Intelligence Committee
- **Gillian le Cordeur**, IRMSA CEO and the IRMSA team
- **Aon South Africa**, Nico Bianco, Liza Kok and their teams
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- **Quentin Swart**, Hentus Trading, South Africa
- **University of Pretoria**, Natural Hazard Centre
- **Alan Chemaly**, Dam Specialist, Aurecon Group South Africa

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