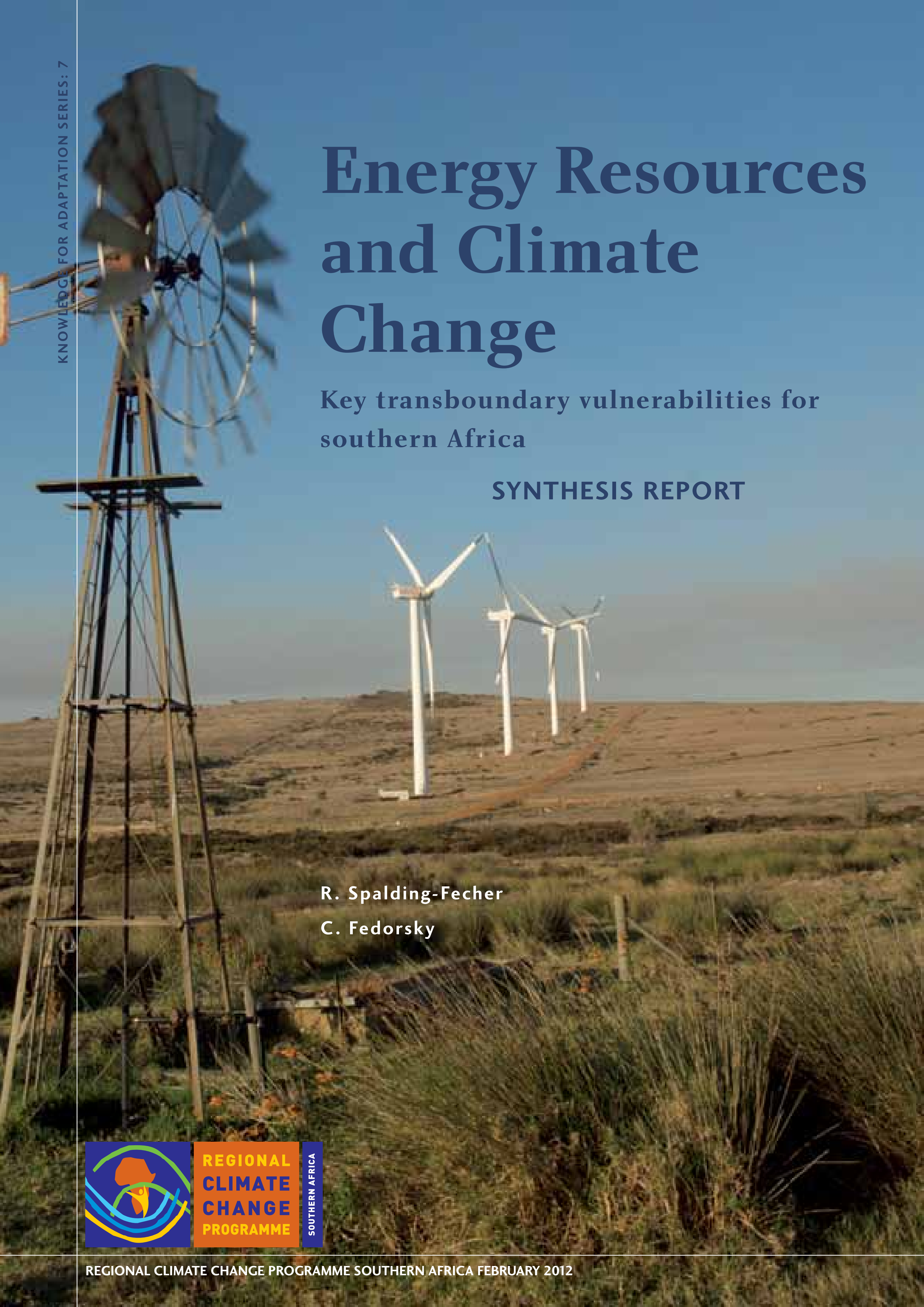

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Energy Resources and Climate Change

Key transboundary vulnerabilities for southern Africa

SYNTHESIS REPORT

R. Spalding-Fecher
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REGIONAL CLIMATE CHANGE PROGRAMME SOUTHERN AFRICA

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The Regional Climate Change Programme Southern Africa (RCCP)

The RCCP aims to contribute to the achievement of southern Africa's climate change adaptation needs, socioeconomic development and poverty alleviation objectives, including the Millennium Development Goals.

By synthesising the relevant climate change science, developing strategic research and strengthening science-policy-governance-finance dialogue, the RCCP will build an evidence base for appropriate transboundary responses, strengthen the region's voice on international platforms and negotiations, and enhance its ability to equitably access the necessary finance for effective climate change adaptation.

The five-year Regional Climate Change Programme of work (2009–2014) with Southern African Development Community (SADC) partners on the impact of climate change, aims to increase regional participation in globally funded adaptation projects and improving resilience. The RCCP has four outputs, the first of which focuses on the scientific basis for understanding climate change impacts in southern Africa.

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Many regional and international experts contributed their time and advice to the source documents in the RCCP, upon which this technical synthesis is based. These acknowledgements appear in the individual reports, but the synthesis authors again express appreciation for the support.

For this technical synthesis, the ideas and review comments from Stephanie Midgley, Arthur Chapman, Belynda Petrie and John Notoane of OneWorld have been invaluable.

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Contents

Southern Africa needs to diversify its energy sources portfolio, boost region-wide electricity supplies, reduce waste and improve efficiency whilst simultaneously embarking on a low carbon pathway. A coal-fired power station in Mpumalanga, South Africa.

Preface

The purpose of this report is to present a synthesis of the analysis, under the DFID-funded Regional Climate Change Programme for Southern Africa (RCCP), on climate change impacts and adaptation in the energy sector. The synthesis is based on four papers prepared under the RCCP, and as a synthesis document is limited to the scope of the underlying papers. Because the focus of the RCCP is on climate change issues that are inherently transboundary, the synthesis also focuses on those issues, even though there may be equally important climate change vulnerability issues that could be addressed at a solely national level. The final chapter of this synthesis is limited to the principles that should be followed in adapting to transboundary climate change impacts, as the four papers below did not include a detailed analysis of adaptation options.

Pöyry (Spalding-Fecher, R.). 2007. *Energy security and climate change.* Contribution to RCCP Biophysical and Socioeconomic Overview – Climate Impact Analysis for SADC – Adaptation Baseline Report. Submitted to OneWorld Sustainable Investments. Cape Town: Pöyry Management Consulting.

Pöyry (Spalding-Fecher, R.). 2010a. *Climate change implications for SAPP long-term planning*. R-2010-24. Submitted to OneWorld Sustainable Investments. Stockholm: Pöyry Management Consulting.

Pöyry (Spalding-Fecher, R., Nordström, M., Nielsen, H. & Aurell, E). 2010b. *Energy, climate change and the Millennium Development Goals*. R-2010-05. Submitted to OneWorld Sustainable Investments. Stockholm: Pöyry Management Consulting.

Fedorsky, C. 2011. *RCCP Energy situational analysis for transboundary adaptation strategies*. Submitted to OneWorld Sustainable Investments. Cape Town: University of Cape Town.

The citation in this report to Pöyry (2010a) refers to the second paper, Pöyry (2010b) to the third, and Fedorsky (2011) refers to the fourth.

This report is one of a series of Knowledge for Adaptation titles published by the RCCP. This series is targeted at SADC decision and policy makers and aims to support their leadership in securing government commitments in the climate change, health and development contexts, including influential institutions and other key stakeholders.

Key messages

The southern African energy sector faces major development challenges.

Energy is a critical driver of economic and social development. Domestic energy production and consumption has increased almost 100% over the last 20 years in most southern African countries. Yet, at the same time, energy consumption per capita has generally not kept up with population increases. Most of the rural and peri-urban population use traditional biomass stoves for their main energy needs of cooking. Electrification levels in many countries remain very low, and even with dramatic increases in electrification the absolute numbers without access are still predicted to climb. Power shortages frequently cripple national and regional economies, and, while investment in supply is catching up, the gap between supply and demand will persist for at least several more years. Dependency on oil imports leaves the region vulnerable to international energy price shocks. The development of new domestic fossil fuel and renewable energy resources has not kept pace with energy demand, with many large hydropower projects under discussion for decades without having reached financial and implementation closure. Renewable resources other than large hydropower and traditional use of biomass, are not yet a major part of the energy economy. Existing infrastructure is aging, and the requirements to modernise these energy systems is estimated at tens of billions of dollars.

Understanding the impacts of climate change on the energy sector is critical for making progress toward the Millennium Development Goals (MDGs) in southern Africa.

Most of the attention to climate change in the energy sector has been on how to reduce greenhouse gas emissions from energy production and consumption, and how to attract carbon financing to these mitigation efforts, even though the current low levels of emissions limit this potential. The impacts of climate change on the energy sector itself, however, are only beginning to be understood. On the supply side, changes in mean climate variables and climate variability could have serious consequences for both hydropower and biomass production. This could in turn jeopardise southern African's progress toward achieving the relevant MDGs, because many of these goals depend upon additional energy supply and access to energy.

Hydropower is the most vulnerable component of the southern African energy sector to climate change at a transboundary level.

Increases in temperature and projected decreases in rainfall in some areas not only impact run off for hydropower, but also intensify the competition between irrigation and hydropower for water supply. An increase in extreme events such as droughts and flooding could both severely limit hydropower supply and damage energy infrastructure. Biomass will also be affected, although the increase in atmospheric CO_2 concentration and temperature could be beneficial in some cases because a higher CO_2 concentration generally increases biomass primary productivity. More importantly, impacts on biomass will be primarily felt in local areas, because they are highly specific to local ecosystems. However, the impacts associated with hydropower production are inherently transboundary because almost all of the major river basins with significant hydropower potential cross national boundaries. The experience in the Zambezi, Congo and Ruaha River basins is proof of this vulnerability. Many southern African countries are highly dependent on hydropower, and the Southern African Power Pool (SAPP) plans for generation expansion include more than 6 GW of new hydropower capacity by 2015. The risks to these investments from both increased upstream water demands and climate change have not been adequately assessed, which limits the possibility of attracting private investment and increases the risk of both new and existing plants becoming 'stranded assets'.

Adaptation options are constrained by southern African transboundary policy frameworks, institutions, and lack of data and analytical tools.

While the overarching *policy frameworks* developed since the founding of SADC provide strong support for regional cooperation and integration, current energy policies and strategies (e.g. SADC Energy Protocol, Regional Energy Access Strategy and Action Plan) do not always address upstream and cross sectoral issues for hydropower or the impacts of climate change on the sector. These are new challenges that future policy development processes must face. In terms of *institutions*, the SADC Secretariat is an important structure for regional policy development and planning. Water and energy are both within the SADC Infrastructure and Services Directorate, but in practice there is limited engagement due to limited capacity and lack of formal coordination mechanisms. This makes it difficult to coordinate planning between energy, water, agriculture, and other relevant sectors. Similarly the SAPP management structures and coordination centre are not linked to regional water or agriculture planning structures or dialogues (e.g. SADC Multi-stakeholder Water Dialogue), which means that energy sector voices may not be heard in those regional dialogues. Several river basin commissions (e.g. OKACOM, ZAMCOM) have been set up to promote integrated water resources management and development, but these are not generally linked to the energy sector investment decisions, nor are they able to adequately address future changes in climate. Even where there is willingness to collaborate across sectors, the severe lack of publically available regional *energy data*, particularly on the demand side, and lack of integrated *analytical tools*, makes it almost impossible to adapt to regional development needs and changes in climate. The cost of developing these tools and regional/basin-wide databases is beyond the capacity of most project developers and utilities, who cannot invest in this type of 'public good'.

Innovative dialogue and analysis is a critical part of the solution.

A multi-stakeholder, multi-sectoral dialogue on energy, water and climate change, supported by relevant analyses informing regional policy frameworks, would be a first step toward effective climate change adaptation. A dialogue that brings together energy, water and agricultural decision makers, and includes climate scientists, could dramatically improve regional decision making, provided there is high level commitment to and participation in the process. This would then inform specific adaptation projects that could be developed for financing. Establishing principles for cross-sectoral resource management in advance, with high level commitment, would make it easier to address competition for increasingly scarce water sources. The SADC Multi-stakeholder Water Dialogue, with much greater participation from the energy sector, could form the nucleus of this dialogue process, but it could be supported by other similar regional platforms such as the global water partnership (GWP) and Southern African Power Pool. For this dialogue to be productive, however, it must be informed by ongoing integrated energy and water scenario analyses and tools, which are validated through consultation with regional experts and decision makers and provide public domain research that is regularly updated. These tools should consider both demand and supply side options for managing water resources and development of the energy sector, particularly hydropower, but also distributed resources and other energy sources. A consortium of southern African institutions has recently developed a proposal to develop integrated energy and water scenario modelling tools in close collaboration with stakeholders, which could be one important step towards addressing transboundary climate change vulnerability. Building this analytical capacity, and the foundation of energy, water and climate data beneath it, will also allow decision makers to continually develop more coherent and robust policy frameworks and strategies for a more sustainable energy sector that supports the region's development aspirations.

The vast majority of the population of southern Africa uses traditional biomass fuels for their cooking needs, which is linked to widespread respiratory health challenges.

1. Introduction: energy related development challenges

Energy is a key driver of development. There is a wide literature on the relationship between energy and development, and particularly how modern energy services for the poor are a prerequisite for economic and social development (Goldemberg, 1996; Spalding-Fecher *et al.*, 2005). Figure 1 shows the strong correlation between energy consumption and gross domestic product (GDP). A similar graph could be drawn for energy consumption versus Human Development Index (HDI) and other key development indicators.

The SADC faces significant energy and development challenges. Despite increases in domestic energy production and consumption of almost 100% over the last 20 years in most Southern African Development Community (SADC) countries, energy consumption per capita has generally not kept up with population increases (see Figure 2 and Figure 3). This has created a massive suppressed demand for energy services, driven by both the unavailability of resources (including access to modern fuels and power) and high upfront costs.

In terms of energy sources and demand, the vast majority of the population of southern Africa uses polluting and dangerous traditional biomass stoves for their main energy need of cooking, and electrification rates in some countries are still very low (see Table 1). In fact, a recent study showed that, even with dramatic increases in electrification rates in sub-Saharan Africa, the absolute numbers without access are still predicted to climb due to population growth (IEA *et al.*, 2010). Many SADC countries are also highly dependent on energy imports, particularly for liquid fuels (see Table 1), which leave them vulnerable to price shocks from international energy markets.

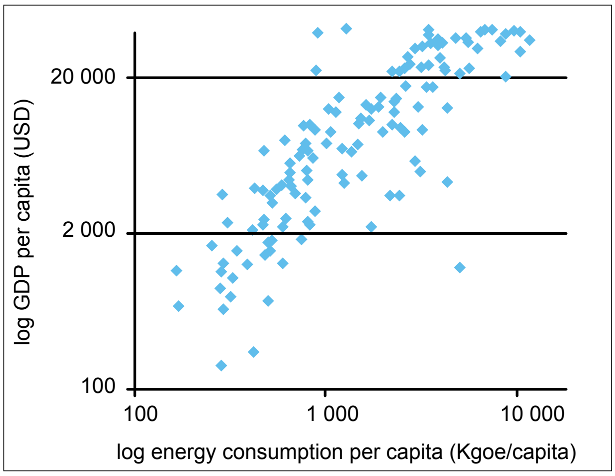

Figure 1: Energy consumption and GDP per capita, 2005

Source: GDP (UNDP, 2009); Energy consumption (Earthtrends, 2010); Correlation coefficient = 0.83

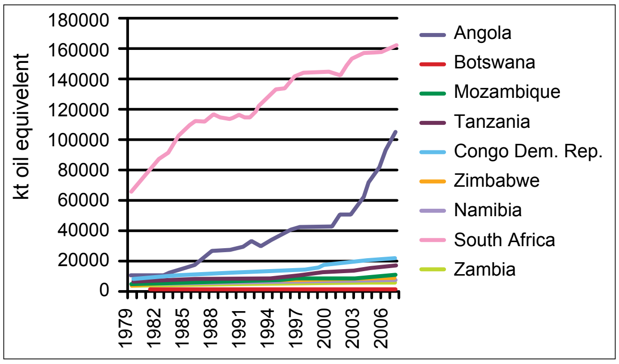

Figure 2: Domestic energy production

Source: World Bank database (data.worldbank.org)

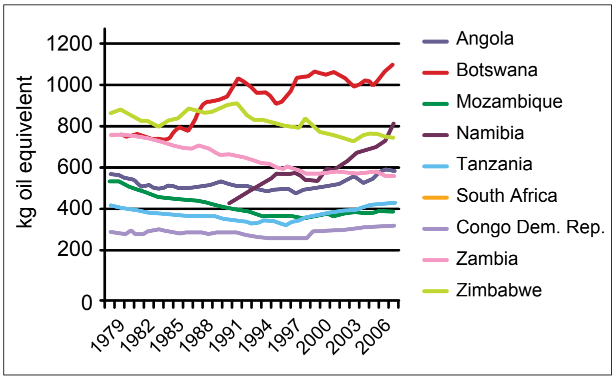

Figure 3: Per capita energy consumption

Note: South Africa was 2 829 kgoe in 1984, and 2 756 kgoe in 2008

Source: World Bank database (data.worldbank.org)

Table 1: Key data on energy access and vulnerability for selected SADC countries

Country	% pop. using biomass for cooking (2006)	% Net imports petroleum products consumption (2007)	Electrification rates (%) (2008)		
			Total	Urban	Rural
Angola	48	11	26.2	38.0	10.7
Botswana	43	100	45.4	68.0	12.0
DRC	95	100	11.1	25.0	4.0
Lesotho	62	100	16.0	44.0	6.0
Malawi	99	99	19.0	53.0	5.0
Mozambique	85	101	11.7	21.0	6.3
Namibia	63	99	34.0	70.0	13.0
South Africa	15	7	75.0	88.0	55.0
Swaziland	72	95	29.7	65.2	20.2
Tanzania	97	99	11.5	39.0	2.0
Zambia	84	15	18.8	47.0	3.3
Zimbabwe	67	99	41.5	79.0	19.0

Source: Biomass share (Legros *et al.*, 2009); Import ratio (EIA, 2011); Electrification (IEA, 2009); DRC from UNDP HDR 2007/8 and EIA

The power sector is in crisis in many countries, with severe outage problems currently in Tanzania, Democratic Republic of Congo (DRC) and Malawi, and power constraints in most countries in the last five years. The Southern African Power Pool (SAPP), which includes all of the national utilities of continental southern Africa[1], has forecast that the shortfall in supply will continue until at least 2013. This could extend further as many projects in the SAPP Plan are not reaching financial closure or starting construction as planned.

The development of new domestic energy resources in SADC has also not kept pace with growing demand. The new discoveries of natural gas reserves in Namibia, South Africa and Mozambique are largely untapped, although more exploration is underway and many companies have been working to create distribution systems for these resources. The Mozambique coal fields in Tete have also taken years to open up, and continue to be constrained by poor rail transport links (Figure 4).

Of more concern is that many of the major hydropower projects in the SAPP plan, or under discussion in the media today, have been under discussion for more than a decade – some for several decades – without closure regarding finance and implementation (e.g. Mphanda Nkuwa, Batoka Gorge). Renewable resources, other than large hydropower and traditional use of biomass, are still quite limited in SADC. Large hydropower is discussed in more detail later, but other renewable resources such as wind energy, solar thermal and solar PV are limited to the successful off-grid electrification programmes in a few countries and a handful of grid-connected projects (SADC, 2010). While these are important steps forward, their share of primary energy is very small, particularly when compared to the vast renewable resource base.

Existing energy infrastructure is aging, and the requirements to modernise these energy systems is estimated at tens of billions of dollars. A 2009 study by Pöyry for the World Bank showed that over the next ten years, the costs of refurbishing power stations in SAPP was more than $7 billion, while the projected costs of new transmission and distribution investments was between $16 and $23 billion (Rosnes and Vennemo, 2009).

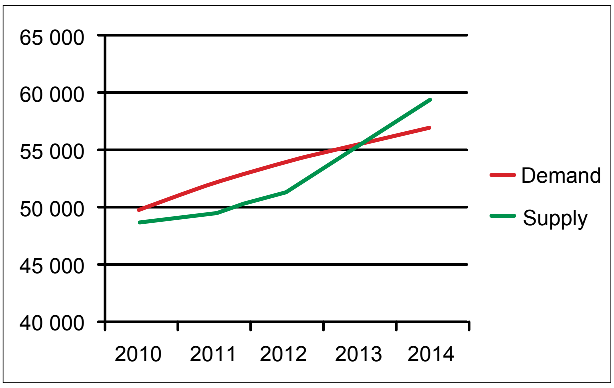

Figure 4: Actual and projected supply and demand for SAPP region until 2014 (MW)

Source: SAPP, 2010

[1] The national utilities from Angola, Malawi and Tanzania are non-operating members. SAPP does not include the utilities of the island states of Madagascar, Mauritius and Seychelles.

2. Climate change impacts on energy affect development

The overall dynamics among energy, development and climate change are complex. More importantly, certain aspects of these dynamics are much less well understood than others, which makes it difficult to identify the most important leverage points for mitigation and adaptation. Figure 5 shows the linkages among these three related spheres, and the fact that these linkages flow in both directions.

Most of the energy and climate change work in the literature has focused on the energy sector as a cause of anthropogenic climate change, and how reducing greenhouse gas emissions from the energy sector can mitigate climate change (Figure 5, arrow A) This is the focus of much of the scientific literature of IPCC Working Group I, in terms of how energy sector emissions contribute to climate change, and IPCC Working Group III, in terms of how reduction of energy sector emissions will mitigate climate change (Solomon *et al.*, 2007; Metz *et al.*, 2007). The study of the impacts of economic development on climate change is similar (Figure 5, arrow F), in terms of how other sectors such as industrial production, waste management and agriculture contribute to greenhouse gas emissions and how technological and behavioural change in these sectors would increase or decrease them.

The large and rapidly expanding climate change vulnerability and adaptation literature focuses on how climate change, through a wide variety of impact pathways, will impact different aspects of sustainable development (Figure 5, arrow E). The impact pathways establish how changes in temperature, rainfall and frequency of extreme events lead to other biophysical system changes, which in turn impact sectors such as water supply, agriculture and human health. **Much of the RCCP scientific analysis and synthesis is to understand these impact pathways more clearly in key sectors in southern Africa.**
Economic and social development, in turn, increase the demand for energy services in terms of mobility, industrial development, household energy services, as well as in other sectors (Figure 5, arrow C). The breakthrough of integrated energy planning in the 1970s and 1980s internationally was the recognition that managing energy demand – in other words, how economic and social development was translated into final demand through technology and behaviour – was as important as managing the development of energy supply, although this thinking has not been applied as widely in southern Africa (see, for example, Ficket *et al.*, 1990; Moezzi, 2000; Spalding-Fecher *et al.*, 2005).

Of all of the linkages, perhaps the least well understood is the impact of climate change on the energy sector itself (Figure 5, arrow B). The challenge is that many of these impacts are 'third order' or 'fourth order' and have a variety of potential climate interactions that may actually have conflicting impacts. For example, hydropower production is clearly affected by the amount of runoff available at the plant site, but what determines the availability of water? Beyond the obvious drivers of upstream rainfall and evaporation (due to higher mean temperatures), this will also be influenced by competition for water with upstream irrigation development and by damage to reservoirs and infrastructure from flooding. The few studies that analyse this problem only consider rainfall and evaporation, while the other drivers (e.g. competition with increased irrigation demand for water) could potentially be even more important (Beck and Bernauer, 2011; World Bank, 2010; Tilmant *et al.*, 2010).

2.1 Vulnerability to climate change

In generic terms, climate change impacts on energy can be categorised as follows (Williamson *et al.*, 2009; AGECC, 2010; Pöyry, 2010b):

- Biomass supply: how climate change impacts the availability of fuel wood through indirect changes in biomass productivity and competition for land and water.
- Hydropower supply: how climate change impacts total and seasonal hydropower production through changes in rainfall, temperature, competition with other uses of water and quality of infrastructure.

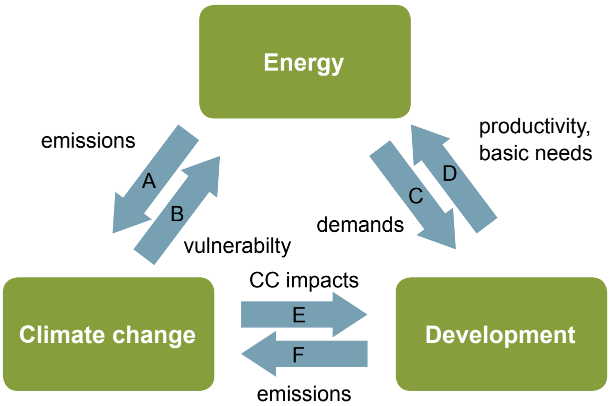

Figure 5: Energy, climate change and development linkages
Source: Author's analysis

Canges in runoff may also affect biomass and wood fuel production. Charcaol remains an important energy source, and an income opportunity in impoverished rural areas.

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- Fossil fuel power supply: how climate change, through changes in water availability, could impact the construction and operation of fossil fuel fired power plants.
- Energy demand: how climate change, through changes in temperature and rainfall, could increase energy service needs such as irrigation and commercial and residential cooling and heating.
- Energy infrastructure: how increased extreme events induced by climate change could impact electricity transmission lines, oil and gas pipelines and other energy infrastructure.
- Transportation infrastructure: how increased extreme events induced by climate change could impact bridges, roads, and other key transport infrastructure.

2.2 Energy sector influence on MDGs

The literature on the Millennium Development Goals (MDGs) clearly shows how energy services are necessary for their achievement in health, food security, water, poverty reduction, education, and environmental sustainability (OneWorld, 2007; DFID, 2002; Modi *et al*., 2006). Although energy is not specifically mentioned in any of the MDGs, energy services provide direct support to many of their key development objectives. There are strong relationships between access to energy and improved food security, human health and improved access to good quality water, and overall poverty reduction (see Box 1). The key question, therefore, is whether future changes in climate could reduce the availability of energy resources necessary to achieve the MDGs. This is explored in the following section.

Box 1: Energy and the Millennium Development Goals (MDGs)

Energy services can play a variety of direct and indirect roles in helping to achieve the MDGs:

To halve extreme poverty: access to energy services facilitates economic development – micro-enterprise, livelihood activities beyond daylight hours, locally owned businesses, which will create employment – and assists in bridging the ‘digital divide’.

To reduce hunger and improve access to safe drinking water: energy services can improve access to pumped drinking water and 95% of staple foods need cooking before they can be eaten.

To reduce child and maternal mortality; and to reduce diseases – energy is a key component of a functioning health system, for example, lighting operating theatres, refrigeration of vaccines and other medicines, sterilisation of equipment and transport to health clinics.

To achieve universal primary education; and to promote gender equality and empowerment of women – energy services reduce the time spent by women and children (especially girls) on basic survival activities (gathering firewood, fetching water, cooking, etc.); lighting permits home study, increases security and enables the use of educational media and communications in schools, including information and communication technologies (ICTs).

Environmental sustainability: improved energy efficiency and use of cleaner alternatives can help to achieve sustainable use of natural resources, as well as reducing emissions, which protects the local and global environment.

Source: DFID, 2002

3. Hydropower and climate change vulnerability

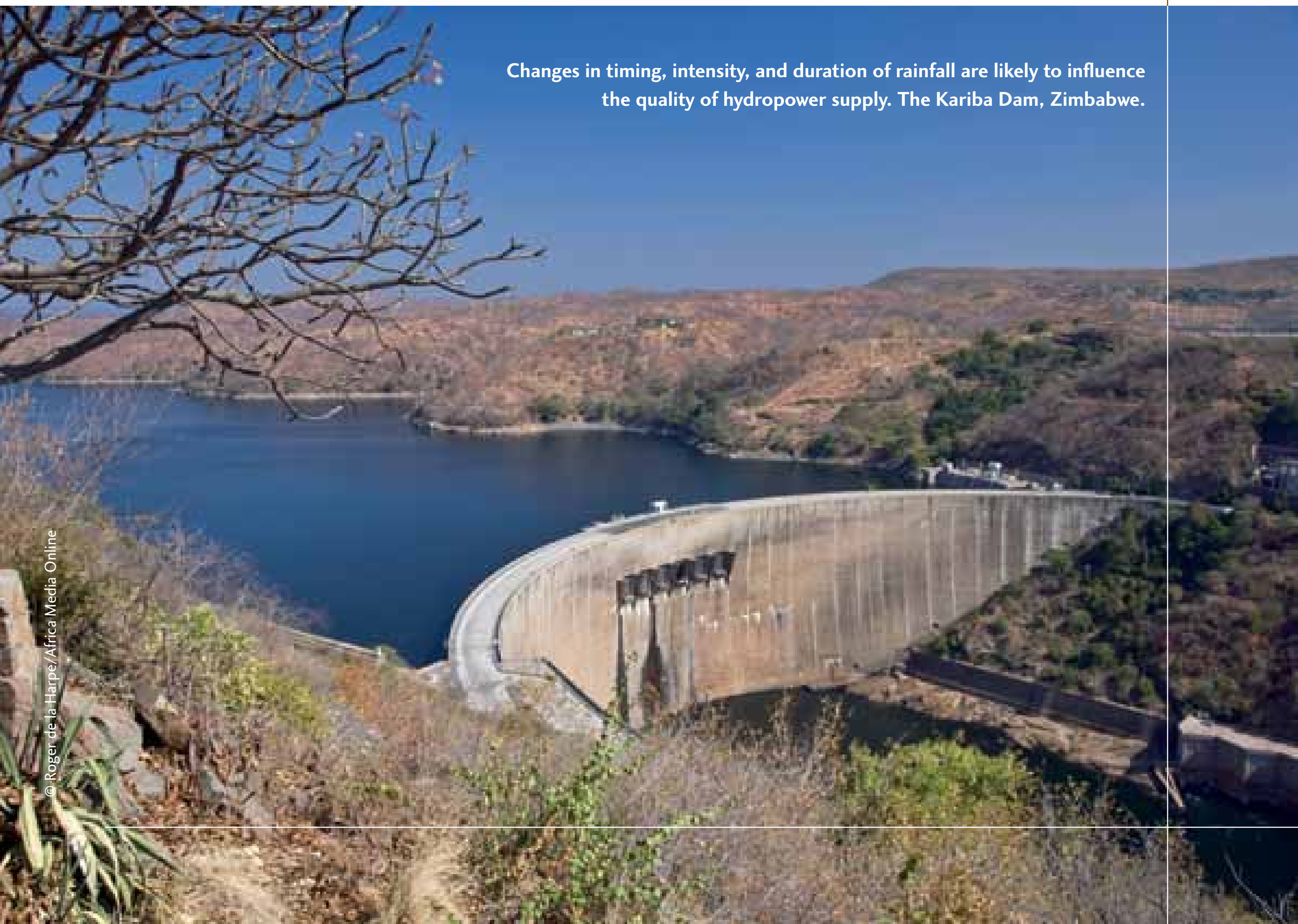
3.1 Climate change impacts on drivers of energy supply

Increases in temperature and projected decreases in rainfall in some areas not only impact run off for hydropower, but also intensify the competition between irrigation and hydropower for water supply. In addition, an increase in extreme events such as droughts and flooding could both severely limit hydropower supply and damage energy infrastructure.

Figure 6 shows a generic flow diagram of the drivers of hydropower supply, with the climate change impacts highlighted according to the order of impact[2]. Assessing the net impact of climate change on hydropower generation in southern Africa is complex, because not all of the effects are in the same direction. More importantly, it is not only changes in mean annual precipitation that will influence the quality of hydropower supply, but also to the changes in timing, intensity, and duration of rainfall. Runoff is only one factor that could impact hydropower output. The others include increased surface water evaporation, increased runoff and damage caused by flooding, and increased siltation deposits in reservoirs.

In addition to impacts on major hydropower facilities, changes in runoff could affect many of the smaller hydropower stations. Although these stations might be small relative to national or regional demand, they are often the only local source of electricity, and in some cases are not even connected to a national or regional grid. In these cases, relatively small changes in runoff (or flooding in cases of increased rainfall) could jeopardise energy supply to communities with no other local alternatives.

2 1st order impacts are changes in temperature, CO_2 concentrations and rainfall. 2nd order impacts are changes in nutrient cycles, hydrological cycle, soil health and ecosystem services. 3rd order impacts are sectoral impacts on productivity (e.g. agricultural yield, biomass productivity, urban infrastructure). 4th order impacts are macroeconomic, demographic and broader social impacts. (Source: OneWorld)



Changes in timing, intensity, and duration of rainfall are likely to influence the quality of hydropower supply. The Kariba Dam, Zimbabwe.

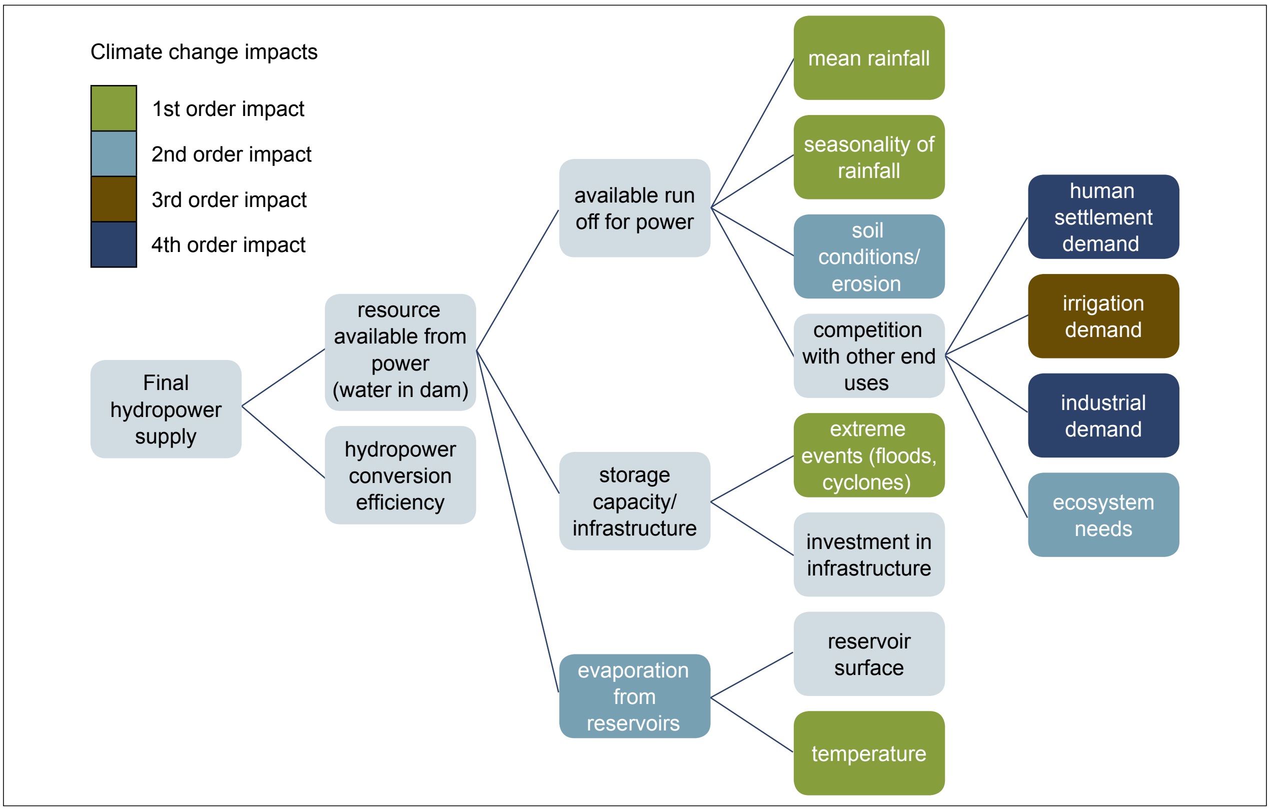


Figure 6: Climate change impacts on hydropower energy supply
Source: Pöyry, 2010a

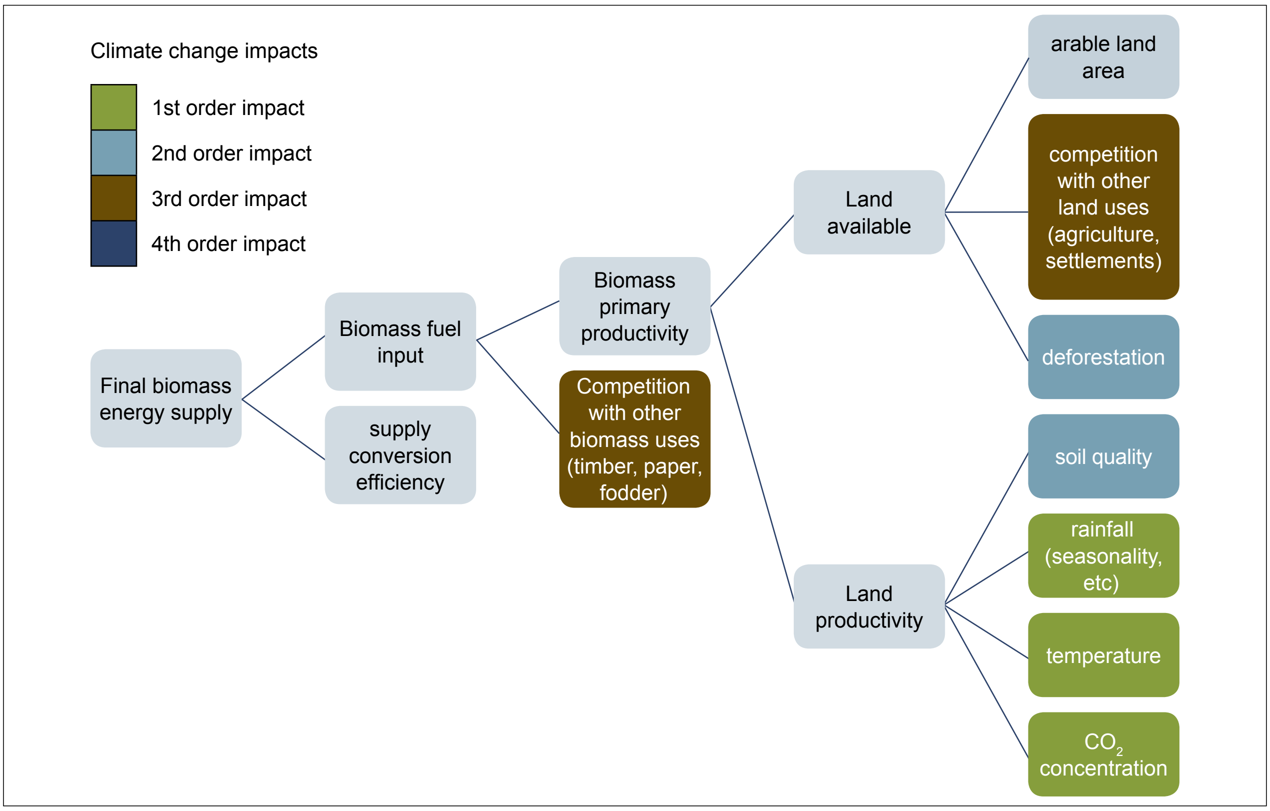


Figure 7: Climate change impacts on biomass energy supply (primarily fuel wood)
Source: Pöyry, 2010a

Biomass may also be affected, although the increase in atmospheric CO_2 concentration and temperature could be beneficial (see Figure 7 for drivers of biomass supply). This is because, while the impacts vary across species, generally biomass productivity increases as CO_2 concentration in the atmosphere rises (Parry *et al.*, 2007). More importantly, impacts on biomass will be primarily felt in local areas, because they are highly specific to local ecosystems. The liquid fuel sector could also be affected, as biofuels are developed more aggressively as alternatives to liquid fossil fuels. Biofuel production has similar climate change vulnerabilities to fuel wood, and could also create more competition for limited water supplies. This issue was not explored in the background reports to this synthesis due to limited resources, but should be considered in future research. Hydropower impacts, however, are inherently transboundary because almost all of the major river basins with significant hydropower potential cross international boundaries.

3.2 Example of impacts on hydropower

Figure 8 illustrates how the climate impacts on drivers of hydropower supply could look for Zambia, and the portion of the Zambezi River basin within that country. The colour of each box shows how historical trends have affected hydropower, while the arrows show the likely direction of future climatic changes. The challenge with this analysis, beyond the problem of not including upstream countries, however, is that it does not show what the net effect is likely to be if the drivers push in opposite directions. Because climate changes and variability also influence soil moisture, evapo-transpiration by plants, erosion of catchment areas, and evaporation from reservoirs, assessing future impacts on hydropower production requires sophisticated modelling of the hydrology of the basin, as well as critical assumptions about water demand from other sectors (particularly irrigation demand). Several studies have started the process of modelling this, but they do not all cover the necessary inputs and interactions (Harrison *et al.*, 2006; Beck and Bernauer, 2011; World Bank, 2010).

In terms of energy demand, increased temperatures can drive up cooling loads in urban areas which can be significant in more developed economies. In most SADC countries, however, commercial energy use is a small portion of total electricity demand, and residential and commercial cooling would be a small share of that load on a national level.

3.3 Recent experience with hydropower vulnerability

In June 2011, Tanzania announced 12-hour power cuts across most of the country, due largely to low water levels at the Mtera Falls Dam. As recently as February 2006, Tanzania faced a similar crisis, with hydropower levels falling to 50 MW available power out of 561 MW installed capacity. While the share of hydropower has declined significantly in recently years, this has also come at a high cost in many cases, due to the high prices for standby thermal power. DRC also currently faces crippling power cuts due to both low water and technical problems at the Inga I and II Dams[3]. In August 2011, the 800 MW installed capacity Inga plants were only able to deliver 350 MW.

[3] www.esi-africa.com/node/13212

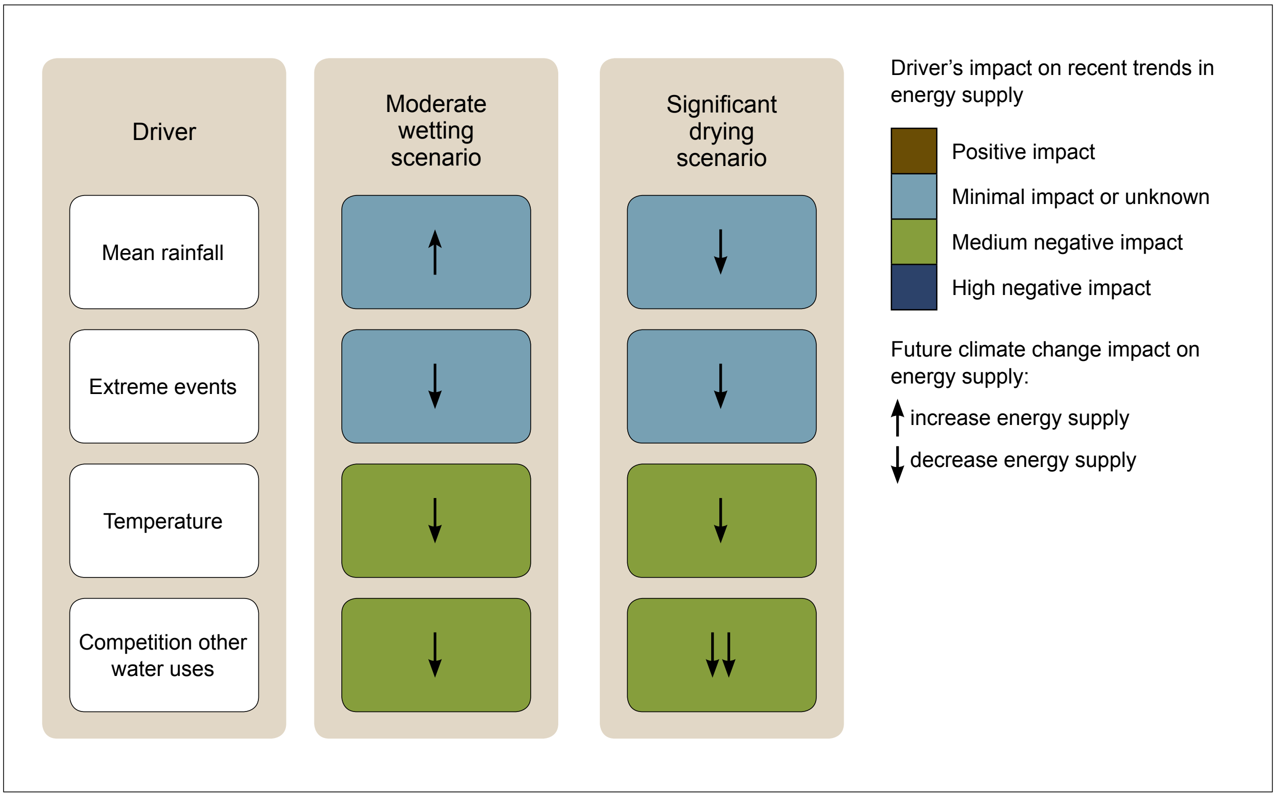


Figure 8: Potential climate change impacts on hydropower in Zambia
Source: Author's analysis

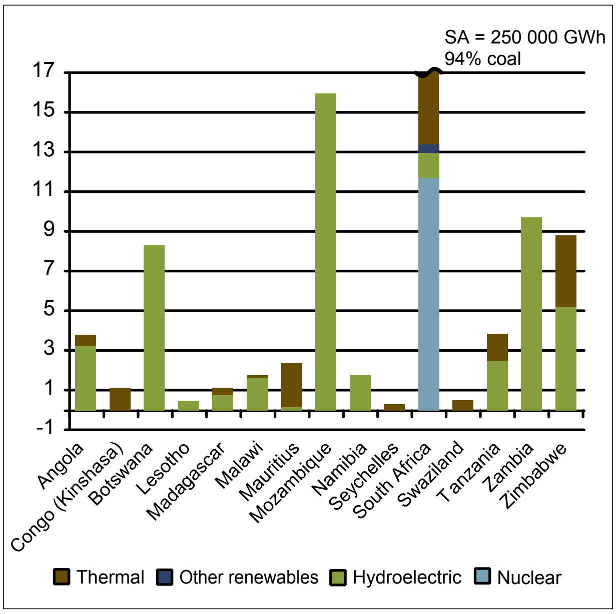


Figure 9: Generation from SADC countries by fuel type, 2007 (000 GWh)
Source: Energy Information Agency Statistics (www.eia.gov/countries/data.cfm), accessed 19 October 2010

This has triggered blackouts throughout Kinshasa and caused havoc for many businesses. Malawi has faced rolling power cuts this year as well, while the debate continues over whether to interconnect the Malawi and Mozambique electricity grid to allow for trading.

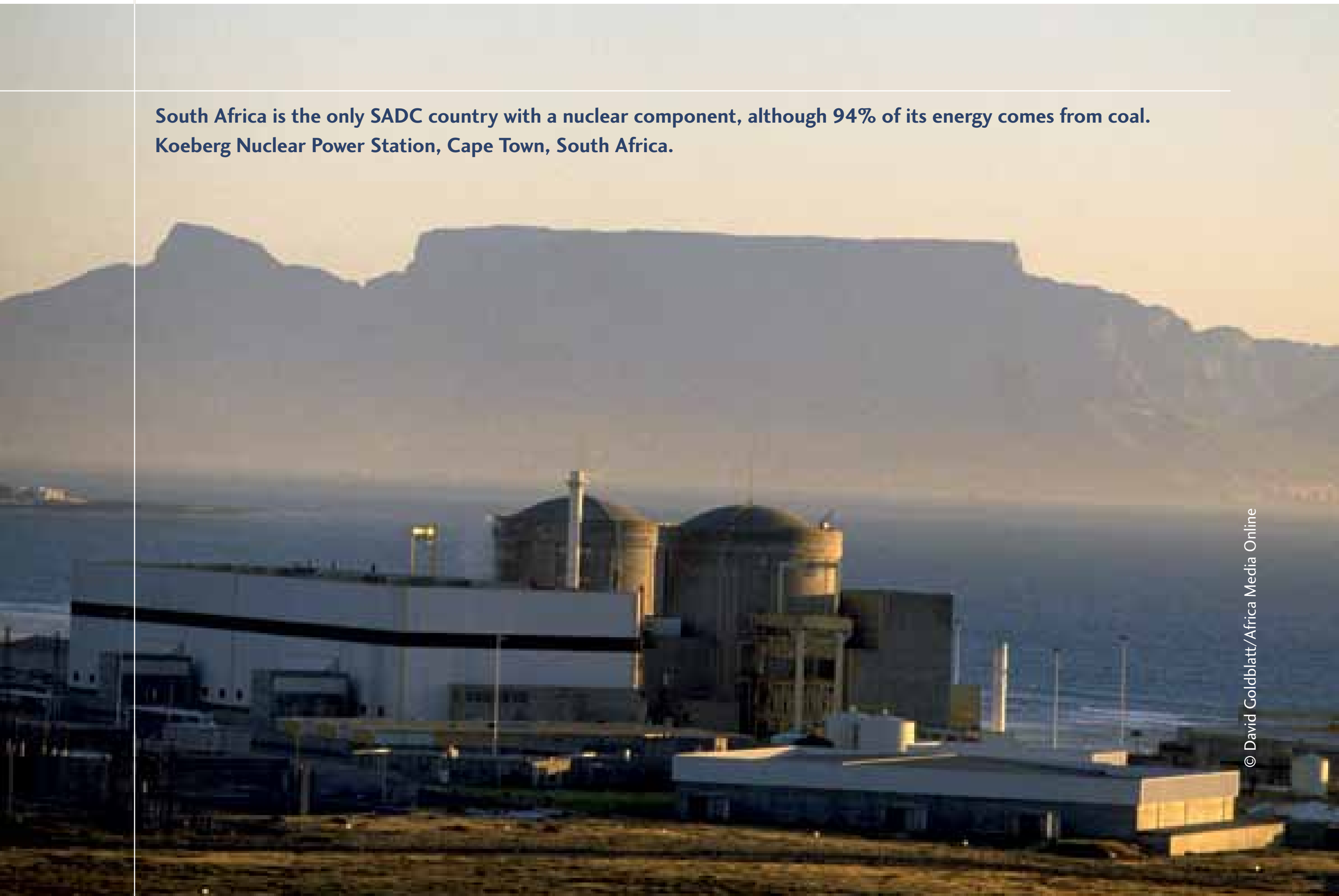
Zambia and Zimbabwe were hit by a similar calamity in the early 1990s, with five recorded drought seasons in one decade in the catchment area for Lake Kariba. In 1991–1992, hydropower production at Kariba fell by 30%, inflicting losses of more than $102 million in GDP and $36 million in foreign exchange on Zimbabwe alone (Soils Inc., 2000; Benson and Clay, 1998). In terms of future risks, the World Commission on Dams' analysis of Kariba also noted that declines in runoff of 20–30% due to future climate variability and climate change could reduce the reliability of hydropower to 56–71% and the reservoir would rarely be full for hydropower production under those scenarios (Soils Inc., 2000).

3.4 SAPP expansion and operational plans depend critically on hydropower

While South Africa is by far the largest power generator in the region, and is almost entirely coal-based (Figure 9), many of the SAPP utilities are entirely dependent on hydropower for their electricity supply (Figure 10).

To address this shortfall and future demand growth, SAPP has an ambitious programme to install 28 162 MW of new capacity from 2010 to 2015. Hydropower investments make up 22% of this planned capacity expansion (Figure 11), which is a 60% increase in hydropower capacity in southern Africa in just five years (SAPP, 2010). Many of the largest potential hydropower investments in southern Africa, however, are not yet in the formal SAPP expansion plan – either because of the long lead time or, more often, because funding has not been secured. These investments include another 6 500 MW of hydropower in the Zambezi River Basin. There may be other potential developments underway in other shared basins, but these represent most of the largest projects.

South Africa is the only SADC country with a nuclear component, although 94% of its energy comes from coal. Koeberg Nuclear Power Station, Cape Town, South Africa.



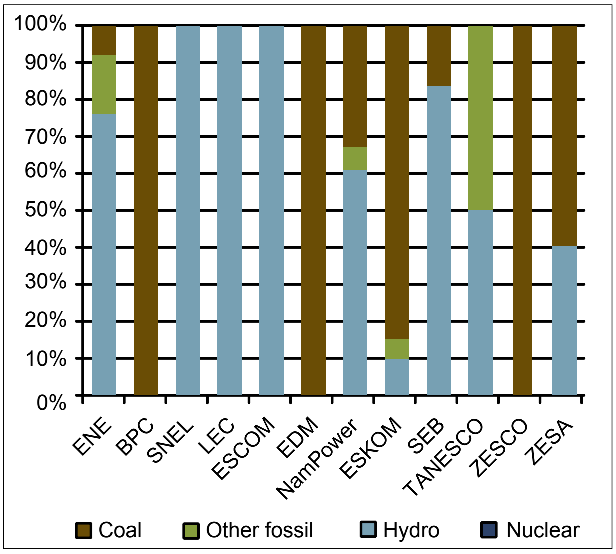


Figure 10: Hydropower share of installed capacity for SAPP utilities, 2010

Note: See abbreviations at front of report for utility names.

Source: SAPP, 2010.

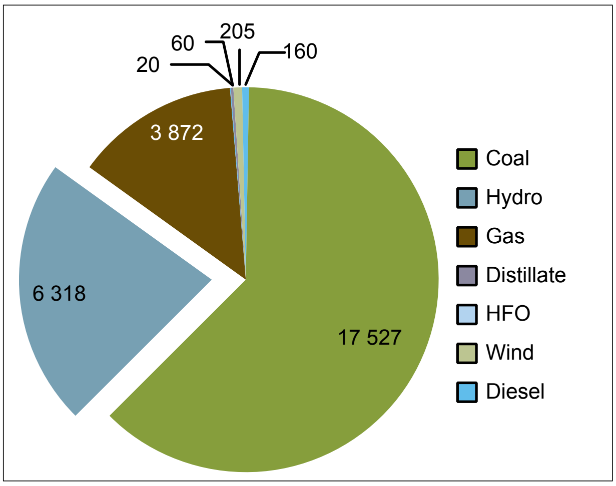


Figure 11: SAPP planned capacity, 2010–2015 (MW)

Source: SAPP, 2010

For many of the SAPP countries the only option is to build hydropower because they do not have fossil fuel reserves or access to the capital required for large scale development of other renewable resources. In addition, the operating and maintenance costs for hydropower plants are generally much lower than for fossil fuel plants. This means that these countries' ability to develop domestic industries, particularly mining and heavy industry, is dependent upon the success of this hydropower expansion. In Zambia, for example, the further development of hydropower is critical for the development of the mining sector, of which copper alone accounts for 75% of Zambia's exports. In addition, hydropower itself could be a significant potential foreign exchange earner for some countries. This is already the case with Mozambique, and is part of the development plans in Zambia and DRC.

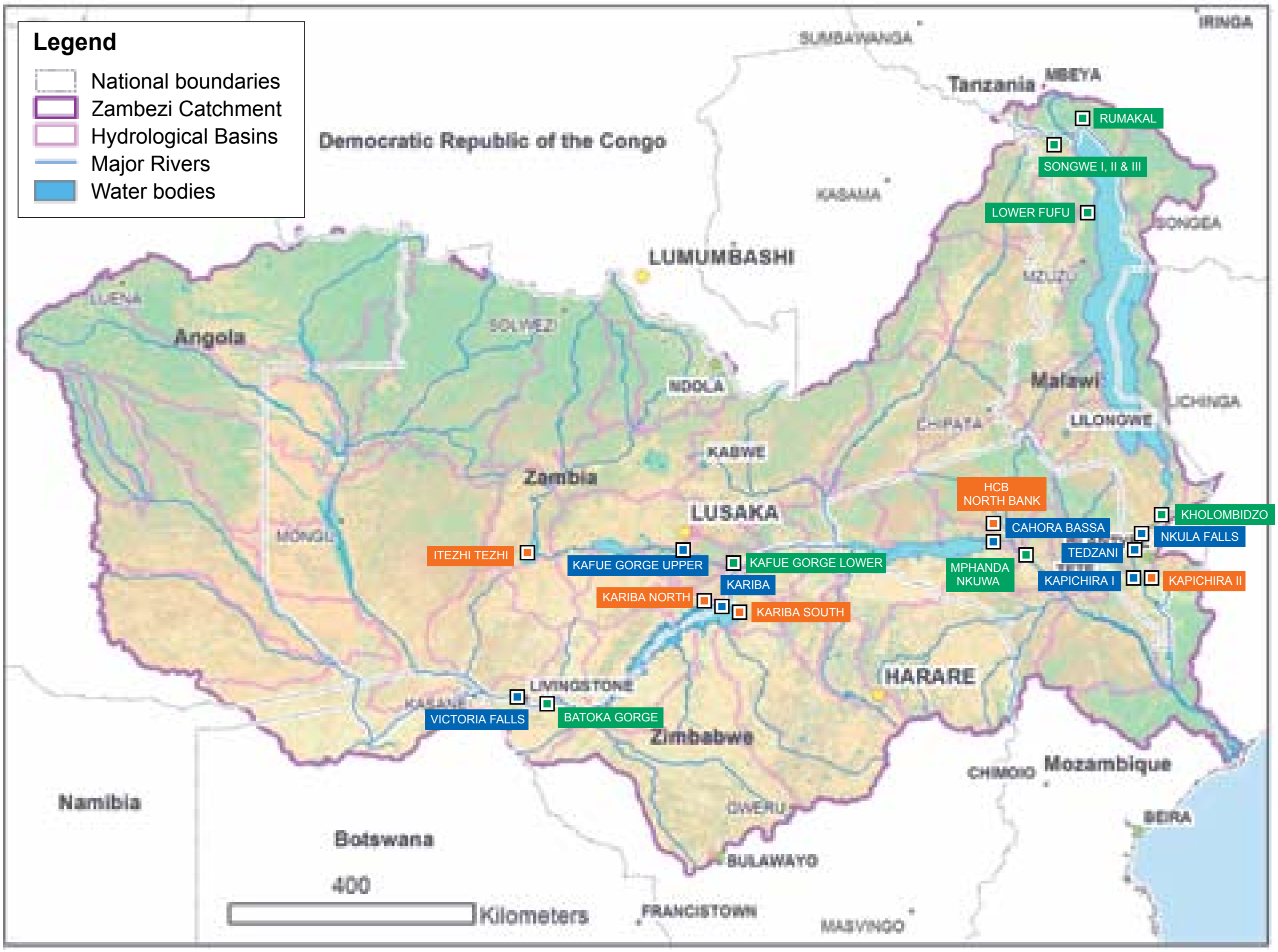
3.5 Emerging research: Zambezi River Basin

Several recent studies have started to make the links between climate change, upstream development and hydropower in the Zambezi River basin, albeit not always with a complete picture of these future impacts. For example, the preliminary report for the World Bank Multi-Sector Investment Opportunity Study (MSIOS) for the Zambezi River basin (Niras and BRL Ingénierie, 2009) looked at how increasing temperatures would increase evapo-transpiration by crops. The resulting increase in irrigation demand would then reduce water available in hydropower reservoirs, where this irrigation is upstream of the power generation plants. This effect on its own only reduces total hydropower production by 1–2% although firm power from planned hydropower plants Itezhi-Tezhi and Kafue Gorge Lower could be reduced by 39% and 27% respectively. This obviously has implications for the investments in those two new facilities. The preliminary study did not consider how significant changes in mean and seasonal rainfall would impact hydropower production. In the development scenarios that included significant additional irrigation, flood control and water transfers (but no climate change), hydropower production decreased by 8% on average and 22% for firm power. This shows that the development impacts on hydropower production may be as important as the climate change impacts.

The final report for this study did not provide the same level of detailed results, but stressed the same overall view: "The impact of climate change in this analysis was evaluated in terms of change in air temperature, basin yield (for natural flows), and irrigation water deficit. The preliminary indications are that some parts of the basin would be affected more than others with potential reduction of up to 30% in hydropower generation. As noted, this will need further detailed analysis." (World Bank, 2010)

Another study that has modelled climate change impacts on Zambezi hydropower production is the recent work of Lucas Beck and Thomas Bernauer (Beck and Bernauer, 2011). This analysis included a hydrological supply model and a demand model covering consumptive and non-consumptive uses of runoff. This study analysed the combined changes caused by temperature, rainfall (mean and seasonal), soil moisture, evapo-transpiration with the increased use for development (e.g. irrigation). While the climate change scenarios in the Beck and Bernauer study are both drying scenarios[4], the results highlight some significant risks for hydropower. The current Kafue Gorge plant could continue production even with a decrease in runoff, possibly because much of the current flow is discharged over the spillway in any case, and the plant has a 1-year reservoir upstream at Itezhi-Tezhi. Maintaining power production would, however, cause damage to fishing and agricultural activities in the flood-plains below the dam, so could be unacceptable politically. In other words, the Kafue basin would face acute water shortages, and a

4 The moderate drying scenario is moderate decrease in precipitation in southern and western parts of the ZRB, moderate increase of potential evapo-transpiration, while the significant drying scenario is strong decrease of precipitation in southern and western parts of the ZRB, strong increase in evapo-transpiration.



Existing Hydropower Plants		Projected Hydropower Plants		Hydropower Plant Extensions	
Cahora Bassa	2,075 Mw	Mphanda Nkuwa*	2,000 Mw	HCB North Bank	850 Mw
Kariba	1,470 Mw	Batoka Gorge	1,600 Mw	Kariba North	360 Mw
Kafue Gorge Upper	990 Mw	Kafue Gorge Lower**	600 Mw	Kariba South	300 Mw
Nkula Falls	124 Mw	Kholombizo	240 Mw	Itezhi Tezhi	120 Mw
Victoria Falls	108 Mw	Songwe I, Ii & Iii	340 Mw	Kapichira Ii	64 Mw
Tedzani	90 Mw	Rumakali	256 Mw		
Kapichira I	64 Mw	Lower Fufu	100 Mw		

Hydropower capacity estimates are based on the Southern Africa Power Pool, Nexant (2007) Study and updated as of 2010.
* The estimate for Mphanda Nkuwa has been increased to 2,000 MW
** The estimates for Kafue Gorge Lower are 600 MW with the potential for an additional bay of 150 MW

Figure 12: Hydropower plants in the Zambezi River Basin.
Source: Pegram *et al*., 2011; World Bank, 2010.

trade-off between hydropower and other key uses.[5] For Kariba, the analysis shows that moderate drying could reduce power output by 35% and the significant drying could eliminate almost all hydropower production during parts of the year. Of course, Kariba has a substantial reservoir, but this study was projecting long term trends, so the reservoir would only delay the eventual decline in production, even though it assists with managing variability in water supply.

Another example of this type of analysis is a study on the proposed 1600 MW Batoka Gorge hydropower plant to assess how climate change might influence the technical and financial viability of that investment (see Harrison *et al.*, 2006, and preceding papers). This paper analyses the sensitivity of power station revenue streams and financial performance to changes in precipitation and temperature in a manner that is akin to standard sensitivity studies as used in capital investment analysis. The plant was modelled using software developed by the authors, which includes a series of serially-connected components (hydrological, reservoir, market and financial models) that allow the projection of river flow, energy production and financial performance based on scenarios of climate. The results showed that even for a scenario with 10% decrease in annual runoff (9.5% wet season and 12.1% dry season), the net present value (NPV) for the project fell by more than 60%. For scenarios with greater decreases in runoff, the NPV became negative (Harrison *et al.*, 2006). Clearly these potential impacts must be considered in the planning and analysis of future hydropower investments.

The most recent analysis published on this issue is from Professor Francis Yamba and colleagues on the implications of climate change for hydropower in the Zambezi River basin (Yamba *et al.*, 2011). This analysis examined changes in rainfall and runoff due to climate change, and how these would influence water availability for hydropower, assuming constrained water demand growth with GDP growth. While the study did not look specifically at irrigation development plans, and used relatively coarse climate change projections, the results are startling. Gross hydropower potential at Kariba, Itezhi-Tezhi, Cahora Bassa and Mphanda Uncua could fall by more than a third on average between 2010 and 2035, with dry years falling even further. The modelling predicts some recovery of hydropower potential in the period between 2035 and 2050, but this is followed by continued declines after 2050.

One key message from the literature reviewed in this study is that competition with irrigation could be even more important for hydropower than future changes in climate[6]. Currently in southern Africa only 9.2% of total actual renewable water resources are withdrawn for consumptive uses, of which 6.2% is for agriculture. This is higher than African levels on average (3.8% total withdrawals of which 3.3% is for agriculture). While some shared SADC river basins may see overall and seasonal increases of flows due to climate change, the Zambezi River basin faces some additional challenges. In the Zambezi River basin, currently 20% of runoff goes to consumptive uses – of which 15% is evaporation from the major hydropower reservoirs (SADC, 2008). The development plans of the riparian states could increase this to 40% by 2025, with further development of hydropower, irrigation and industrial and domestic use (SADC, 2008). Without agreement of development priorities by the riparian states of the major basins, increased irrigation and other consumptive demands could potentially threaten new hydropower investments, and the industry and exports they support, even more than climate change, or could add a major stress on top of changes in climate. One recent study goes so far as to say that, "The analysis of simulation results reveal that most of the planned irrigation schemes in Zambia, Zimbabwe, Namibia, Angola and Botswana are not economically sound if the power stations that are in an advanced planning phase are implemented" (Tilmant *et al.*, 2010). While this may not be true for all of the shared river basins, it points to an urgent need to increase dialogue between these sectors and to provide the analytical support for evaluating a combination of energy and agricultural investments.

The risks to new hydropower investments of both increased upstream water demands and climate change have not been adequately assessed, which limits the possibility of attracting private investment and increases the risk of these plants becoming 'stranded assets'.

5 Note that there is another study underway that allocates water to various users and sectors, to consider this issue further (Tumbare, M., University of Zimbabwe, personal communication, 18 December 2011)

6 A two-year study is currently being undertaken by OneWorld in collaboration with other partners to further assess climate change impacts on irrigation and hydropower.

4. Adaptation options: limitations in southern Africa

4.1 Current energy policies

While the overarching policy frameworks developed since the founding of SADC provide strong support for regional cooperation and integration, current energy policies and strategies (e.g. SADC Energy Protocol, Regional Energy Access Strategy and Action Plan) do not sufficiently address upstream and cross sectoral issues for hydropower or the impacts of climate change on the sector. Table 3 highlights some of key policies in the energy sector that are relevant for transboundary adaptation to climate change.

Much of the energy policy and strategy development within the region has been and continues to be done in isolation. Sectors tend to work in isolation and focus on what their sector alone needs to accomplish. Energy policy needs to engage and influence policy and planning in other key sectors such as water, agriculture, and economic development.

4.2 Regional and transboundary institutions

In the SADC Secretariat in Gaborone, climate change is currently primarily under the Food, Agriculture and Natural Resources (FANR) directorate. While FANR is tasked with developing a climate change strategy, this process has moved slowly. The Directorate for Infrastructure and Services, on the other hand, covers the energy, water, transport, meteorology and regional tourism programmes. While this would ideally mean close cooperation between energy and water planning, albeit with insufficient connection to climate change, in practice this is challenging. The Secretariat has a wide range of responsibilities and very limited staff, particularly the energy programme. In addition, there are no formal mechanisms for coordination between energy and water, not to mention climate change, planning processes or ministerial conferences.

Similarly the SAPP management structures and Coordination Centre do not interact with regional water or agriculture planning structures or dialogues (e.g. SADC Multi-stakeholder Water Dialogue). The SAPP Environment Subcommittee (ESC) does address some climate change issues, but this is mainly related to mitigation through renewable power investments. Moreover, the Planning Subcommittee does not have the inputs from the water sector or climate experts that would be required to judge whether the hydropower investments included in the pool plan will have sufficient water resources in the future (see Box 2).

River Basin Commissions are important transboundary institutions as well, and have the potential to promote a more integrated approach to planning. Not all of the major river basins have functioning commissions, however, nor are they directly involved with energy sector investment decisions (see Table 4). In addition, few commissions would have access to information on future climate changes and the implications for an entire basin. The commission for the Zambezi River basin is discussed in Box 3.

4.3 Analytical tools for integrated analysis and public domain data

One of the greatest challenges in adapting to climate change and upstream development impacts on hydropower is the lack of analytical tools in the region to integrate climate projections with water and energy supply and demand. This requires not only much greater cross-sectoral integration than normally happens in traditional energy planning, but also a strong policy focus and the ability to communicate with stakeholders about the process, inputs and results of the modelling. Too often, both water and energy modelling exercises become 'black box' exercises, which are difficult for policymakers to understand, and are highly sensitive to small changes in assumptions. On top of this, the models and their inputs are not in the public domain, so other experts in the energy, water and climate sectors cannot interrogate the assumptions and create alternative scenarios. Finally, this analysis must be ongoing and regularly updated for it to be useful for regional planning procedures. Once-off exercises may yield useful insights, but they will not address the long term need for cross-sectoral integration of planning or provide the data to manage the energy-water nexus.

Even where there is willingness to collaborate across sectors in the region, the severe lack of publicly available regional energy and water data, particularly on the demand side, is a major barrier to analysis. Energy consumption data within the region is particularly poor. For example, of the 15 countries covered by a previous RCCP review (Fedorsky, 2011), only 7 had reliable energy balance data. Lack of robust data complicates planning and decision making.

Developing integrated tools and regional datasets will be beyond the scope of what most individual utilities or project owners can undertake. These systems are 'public goods' in the sense that they can benefit all of the actors in a sub-region or basin. This makes a compelling case for developing these analytical tools on a basin-wide, cross-sectoral basis, where the public domain principle and commitment to stakeholder engagement is built into the process from the beginning.

Table 3: Relevant SADC policies and strategies

Name and status	Relevance to transboundary water and energy issues
Revised SADC Protocol on Shared Watercourses[1] *Entry into force in 2003*[2]	The Protocol calls for the establishment of shared watercourse agreements and institutions (SWI) to facilitate and coordinate the joint management of shared watercourses. Parties may form river basin commissions, joint water commissions or technical committees, or joint water authorities.
SADC Regional Indicative Strategic Development Plan (RISDP)[3] *Adopted in 2003 by SADC member states*	The RISDP recognises that climate change has an impact upon the poor as does desertification, soil erosion and land degradation, water pollution and scarcity of the resource, and the depletion of forests and other natural resources due to poor agricultural practices, urban development and population growth. The energy sector is described under the cluster entitled 'Infrastructure and services.' It highlights the need for energy to be available, sufficient, reliable, and at 'least-cost' to assist in economic development and poverty alleviation while ensuring the sustainable use of energy resources. The RISDP lists the following sub-sectors for cooperation in the energy sector, i.e. wood fuel, petroleum and natural gas, electricity, coal, new and renewable sources, and energy efficiency and conservation. An energy technical committee should provide technical guidance, assistance, direction and quality control to the Secretariat.
SADC Regional Water Policy *Adopted in 2005*	The policy provides a framework for the sustainable, integrated and coordinated development of national and transboundary water resources in SADC.
SADC Regional Water Strategy *Adopted in 2006*	A long-term planning instrument implemented nationally through National Water Strategies and regionally through the Regional Strategic Action Plan (RSAP), which addresses transboundary issues extending over periods of five years.
SADC Energy Protocol *Entry into force in 2008*	Two guiding principle of the Protocol are that the member states "use energy to support economic growth and development, alleviation of poverty and the improvement of the standard and quality of life throughout the region" and "ensure that sectoral and sub-sectoral regional energy policies and programmes shall be in harmony with the overall policies and programmes of SADC and with the strategies and programmes of other SADC sectors." These principles are relevant in the integration of water, climate change and broader environmental aspects of energy that may impact upon the social and economic development of the region.
SADC Regional Energy Access Strategy and Action Plan *Adopted in 2009*	Member states have as a "strategic goal the harnessing of regional energy resources to ensure, through national and regional action, that all the people of the SADC region have access to adequate, reliable, least cost, environmentally sustainable energy services". Member states have as the "operational goal to endeavour to halve the proportion of people without such access within 10 years for each end use and halve again in successive 5 year periods until there is universal access for all end uses". Key elements of the action plan are to: • hire an energy technical advisor for an initial period of 3 years; • engage consultants to produce a guideline on national energy access strategies and a guideline on energy access reporting; • produce a baseline energy access yearbook; and • establish and support a SADC energy website. These elements are relevant to the transboundary energy needs of the region to improve coordination and communication within the region, but also the provision of much needed additional energy data and information.
Renewable Energy Strategy and Action Plan (RESAP) *Underway since early 2011*	This will improve the support for the local development of and the possible deployment of greater renewable energy to meet the regional energy demands, especially those based in remote areas unlikely to be reached in the short term by the formal grid-connected electricity system.
SADC Regional Strategic Action Plan on Integrated Water Resource Management and Development (RSAP-IWRM)[4] *Adopted 2011 for 2011–2015*	The RSAP is designed to provide an effective and dependable framework contributing to poverty reduction, regional integration, peace and security and socioeconomic development. It promotes interventions in three strategic areas: i) water governance, ii) infrastructure development and iii) water management. Within each of these strategic areas the RSAP provides a coherent set of activities to contribute to the achievement of three strategic objectives: i) capacity development, ii) climate change adaptation and iii) social development.

[1] SADC Regional Strategic Action Plan – Integrated Water Resources Management and Development, 2011.

[2] First ratified in 1998; revised in 2003 to reflect the principles adopted in the United Nations Convention on the Law of Non-Navigable Uses of International Watercourses. Signed by all SADC member states in 2000 and entering into force in September 2003 after obtaining nine ratifications.

[3] SADC Regional Indicative Strategic Development Plan (RISDP), 2003.

[4] SADC Regional Strategic Action Plan – Integrated Water Resources Management and Development, 2011.

Box 2: The Southern African Power Pool (SAPP)

The SAPP was created in August 1995 at the SADC summit held in Kempton Park, South Africa, when governments of SADC (excluding Mauritius) signed an Intergovernmental Memorandum of Understanding for the formation of an electricity power pool in the region under the name of the Southern African Power Pool. The ministers responsible for energy in the SADC region signed the Revised Intergovernmental Memorandum of Understanding on 23 February 2006.

The SAPP is governed by four agreements: the Intergovernmental Memorandum of Understanding; the Inter-Utility Memorandum of Understanding (which established SAPP's basic management and operating principles); the Agreement between Operating Members, (which established the specific rules of operation and pricing); and the Operating Guidelines, which provide standards and operating guidelines. The SAPP Agreement between operating members and the Operating Guidelines are under review.

The SAPP has twelve member countries represented by their respective electric power utilities organised through SADC. In addition, SAPP has observers from other major power producers in the region, such as Hidroeléctrica de Cahora Bassa and MOTRACO.

The SAPP has four working committees: the Environmental Subcommittee, the Markets Subcommittee, the Operating Subcommittee and the Planning Subcommittee, all under a management committee which in turn reports to the executive committee. The Markets Subcommittee is a new subcommittee that was created in April 2007 following the signing of the Revised Inter-Utility Memorandum of Understanding by the SAPP executive committee on 25 April 2007. Also created in April 2007 was the Coordination Centre Board to govern the activities of the SAPP Coordination Centre.

The SAPP coordinates the planning and operation of the electric power system among member utilities, and SAPP provides a forum for regional solutions to electric energy problems. The SAPP established the Short-Term Energy Market in April 2001. From January 2004, the SAPP started the development of a competitive electricity market for the SADC region. The Day-Ahead Market (DAM) was launched in 2009 and will facilitate increased regional trading.

Source: SAPP website (www.sapp.co.zw), accessed 15 March 2011

Box 3: The Zambezi Watercourse Commission (ZAMCOM)

In 1987, the Southern African Development Community (SADC) developed the Action Plan for the Environmentally Sound Management of the Common Zambezi River System and launched the Zambezi River Action Plan (ZACPLAN). The purpose of the plan was to promote joint management of the water resources of the river and address both technical and political issues, including the formation of a Zambezi Watercourse Commission (ZAMCOM). A draft ZAMCOM agreement was developed by the riparian countries in 1998, but this process was then superceded by a process involving all SADC members, which resulted in the Revised SADC Protocol on Shared Watercourses, ratified in 2003.

In October 2001, the ZACPLAN process was again initiated through the launch ZACPRO 6 Phase II Project, with assistance from the governments of Sweden, Norway and Denmark.

The objectives of ZACPRO 6 Phase II project were to: establish the national and regional enabling environment for strategic water resource management through ZAMCOM; establish water resources management systems including models, tools and guidelines; and develop an integrated water resources management strategy. By April 2008, the Zambezi Water Information System (ZAMWIS) had been established and the Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin was finalised.

The draft ZAMCOM Agreement was revised and signed by seven of the eight riparian countries in July 2004, and finally came into force in June 2011 after six countries had ratified.

Under the ZAMCOM Agreement, a Council of Ministers is responsible for overall guidance, strategic planning, financial overview and decisions, liaising with institutions outside the Zambezi River Basin, and evaluation of relevant programmes. A technical committee implements policies and decisions of the Council, develops the strategies, compiles hydrometric data, and monitors water abstraction. Furthermore, the technical committee makes legal, political and technical recommendations to the Council and, in theory, is intended to supervise the ZAMCOM Secretariat (ZAMSEC). Both the Council of Ministers and ZAMSEC met in September 2011.

Sources: World Bank, 2010; local media articles

Table 4: Tansboundary River Basin Commissions (RBOs) in southern Africa

Basin name and institution[5]	Countries	Institutional status	Links to energy
Zambezi River Basin and Zambezi River Authority	Zimbabwe and Zambia	Established in 1987, as the successor to the Central African Power Corporation (CAPCO).	In charge of operation and maintenance of Kariba Dam Complex, investigation and development of new dam sites on the Zambezi River and analysing and disseminating hydrological and environmental information pertaining to the Zambezi River and Lake Kariba.
Zambezi River Basin and Zambezi Watercourse Commission (ZAMCOM)	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, and Zimbabwe.	(See Box 3)	SAPP and utilities working to synchronise dam operations and improve forecasting for hydropower and flood control.
Okavango River Basin and Okavango River Basin Commission (OKACOM)[6]	Angola, Botswana and Namibia	Signed 1994, and established permanent commission whose primary objective is to technically advise) on conservation, development and utilisation of the common resources. Secretariat established in 2007.	Working to balance competing demands from hydropower and water extractions, as well as plans for future shared hydropower such as Epupa Falls.
Limpopo River Basin and Limpopo Watercourse Commission (LIMCOM)	Botswana, Mozambique, South Africa, and Zimbabwe	Cooperation since 1986. Formal agreement on LIMCOM in 2003, which was ratified in 2010.	Commission addressing balance between hydropower demands and other water extraction demands.
Inco and Maputo River Basin and Inco-Maputo Tripartite Permanent Technical Committee	South Africa, Mozambique and Swaziland	Established 1983. Interim Inco-Maputo Agreement signed in 2003.	Manages the water flow of the Inkomati River and Maputo River specifically during times of drought and flood.
Congo Basin and International Commission for the Congo-Oubangui-Sagha Basin (CICOS)	Cameroon, Central African Republic, Democratic Republic of Congo and the Republic of Congo	Created in 1999 to improve cooperation amongst the member states, through improved communication, using the Congo River and its tributaries.	A future objective is to promote IWRM, in order to enhance development and alleviate poverty in the member states.
Kunene River Basin and Permanent Joint Technical Commission (PJTC)	Namibia	Established in 1964, including provision for Namibia to abstract water at Calueque for diversion to the Cuvelai Basin in northern Namibia.	Has included detailed studies of hydropower and water diversion potential.
Lake Tanganyika Authority (LTA)	Burundi, Democratic Republic of Congo, Tanzania and Zambia	Launched in December 2008 as an institution management structure that includes the Conference of Ministers, the Management Committee and the Secretariat	Promotes regional cooperation for socioeconomic development and sustainable management of natural resources.
Orange-Senqu River Basin and Orange-Senqu River Commission (ORASECOM)	Botswana, Lesotho, Namibia and South Africa	Agreement signed 2000, following agreement on SADC Protocol on Shared Water Course Systems.	
Ruvuma River Basin and Ruvuma Joint Water Commission (Ruvuma JWC)	Mozambique and Tanzania	Agreement signed 2006	Objective to ensure sustainable development and equitable utilisation of common water resources of Rovuma/Ruvuma River basin.

Source: Adapted from Fedorsky, 2011 and SADC ICP website (www.icp-confluence–sadc.org/rbosummary), accessed 2 September 2011

[5] http://www.icp-confluence-sadc.org/rbosummary Web accessed 16 September 2011

[6] OKACOM web site. www.okacom.org/okacom.htm

5. Dialogue and analysis

As mentioned in Section 1, the four RCCP papers upon which this synthesis is based did not include a detailed analysis of adaptation options, so the final chapter of this synthesis is limited to the principles that should be followed in adapting to transboundary climate change impacts. The RCCP analysis of climate change and energy resources has identified a number of potential interventions that could improve the adaptive capacity of the sector (Fedorsky, 2011). The need for greater regional integration in the energy sector, as called for in almost all of the SADC policies and strategies, is particularly great in the power sector. Greater interconnection of the SAPP system will increase the security of overall supply, particularly when climate change may impact river basins differently over time. Where one basin may face increasing water scarcity, others may have a surplus of water. Investment in new transmission lines is therefore a key priority.

The most important first step towards adaptation, however, is the need for a **multi-stakeholder, multi-sectoral dialogue on energy, water, agriculture and climate change, supported by relevant analysis and informing regional policy frameworks**. This responds directly to the challenges highlighted in the previous section, because the dialogue supports these institutions and policy development, while the analysis would fill the current gaps in integrated, cross-sectoral modelling that is policy relevant and in the public domain.

A focused multi-stakeholder dialogue that brings together energy, water and agricultural decision makers, and includes climate scientists, could dramatically improve regional decision making, provided there is a high level commitment to and participation in the process. Ministerial level commitment to engage across sectors, and take climate change and other water and agricultural development into account in power planning, would open up space for the national officials, technical experts, and educational institutions to create ongoing support for such a dialogue. The dialogue process would need a clear work plan and objectives as well, and accountability to regional governments. Establishing principles for cross-sectoral, transboundary resource management in advance through this dialogue, with high level commitment, would make it easier to address competition for increasingly scarce water sources.

The SADC Multi-stakeholder Water Dialogue (MSWD) is one example of how this new process could work, and could even form the basis for the cross-sector engagement (see Box 4). Energy sector participation in the MSWD has been limited thus far, so making this an effective platform would mean much greater engagement not only from SADC Secretariat but also from SAPP. This is not to say that other regional platforms could not also work, but only that building on an existing institutional framework could be valuable.

Box 4: SADC Multi-stakeholder Water Dialogue

Since 2007, SADC has conducted the Multi-stakeholder Water Dialogue as a platform for regional stakeholders to discuss and share experiences on different aspects of Integrated Water Resources Management (IWRM). The water dialogues are held under the overall theme of 'Watering development in SADC' and highlight how IWRM approaches can address key aspects of socioeconomic development and poverty reduction in southern Africa.

Under the theme, 'Watering development in SADC: Financing water for climate resilience to ensure regional security', the 2011 water dialogue focused on the importance of climate finance in ensuring that water continues to contribute to regional security. Considering the centrality of water in regional development, with regards to energy, food security, industrial development and health, financing the resource to ensure adaptation to climate change is critical.

The SADC Multi-stakeholder Water Dialogue is an annual activity that originated through the IWRM Awareness Creation Component of the SADC–DANIDA Regional Water Sector Programme in the SADC Water Division's Second Regional Strategic Action Plan.

Source: SADC website (www.sadc.int), accessed 16 September 2011

Box 5: Project on analytical tools and stakeholder dialogue in the Zambezi River Basin

A consortium of organisations is implementing a project to take forward and develop the ideas on integrated analytical tools and stakeholder dialogue raised in this synthesis paper. The consortium includes University of Cape Town's Energy Research Centre, Pöyry Management Consulting, OneWorld Sustainable Investments, Centre for Energy Environment and Engineering Zambia, University of Eduardo Mondlane and University of Zambia. The objective of this project is to make a 'first pass' assessment of how upstream changes in climate, and also changes in irrigation demand, will affect water availability for one or two major downstream Zambezi basin hydropower plants. Because of the scientific uncertainties around future climate and runoff projections, as well as the policy uncertainties around agricultural investments, this study takes a 'scenario approach'. These scenarios would represent different plausible futures for the water, energy and agricultural sectors in the Zambezi basin. In addition, the study will show how changes in water availability for hydropower will affect the Southern African Power Pool (SAPP) overall electricity system and the financial viability of the hydropower investments. The project includes not only the analysis of potential impacts but also engagement with stakeholders – to validate the information used as well as the conclusions of the analysis. The methodological approach to integration is a combined water scenario analysis using the Water Evaluation and Planning (WEAP) model and an energy scenario analysis using the Long-range Energy Alternatives Planning (LEAP) model, incorporating consistent development and climate scenarios for the SADC region as inputs to both of these systems.

For this dialogue to be productive, it must be informed by ongoing integrated energy and water scenario analyses, which are validated through consultation with regional experts and decision makers and provide public domain research that is regularly updated. As discussed in the previous section, these tools should consider both demand and supply side options for managing water resources and development of the energy sector, particularly large scale hydropower but also distributed resources and other energy sources. A project to develop integrated energy and water scenario modelling tools, in close collaboration with stakeholders, has recently been launched by a consortium of southern African institutions, and could be one important step towards addressing transboundary climate change vulnerability (see Box 5). Building this analytical capacity, and the foundation of energy, water and climate data beneath it, will allow decision makers to continually develop more coherent and robust policy frameworks and strategies for a sustainable energy sector that supports the region's development aspirations. This analytical capacity can also support 'climate proofing' of specific policies and projects, as long as it is set up to be ongoing, publicly accessible and multi-disciplinary.

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Acronyms and abbreviations

BPC	Botswana Power Corporation
CICOS	International Commission for the Congo-Oubangui-Sagha Basin
DFID	Department for International Development
DRC	Democratic Republic of Congo
EdM	Electricidade de Mozambique
ENE	Empresa National de Electricidade (Angola)
ESC	Environment Subcommittee (of SAPP)
ESCOM	Electricity Supply Commission of Malawi
GDP	Gross Domestic Product
GW	Gigawatt
GWP	Global water partnership
IPCC	Intergovernmental Panel on Climate Change
JWC	Joint Water Commission
LEC	Lesotho Electricity Corporation
LIMCOM	Limpopo Watercourse Commission
LTA	Lake Tanganyika Authority
MDG	Millennium Development Goals
MSIOS	Multi-Sector Investment Opportunity Study
MSWD	Multi-stakeholder Water Dialogue
MW	Megawatt
NPV	Net present value
OECD	Organisation for Economic Cooperation and Development
OKACOM	Permanent Okavango River Basin Commission
ORASECOM	Orange-Senqu River Commission
PJTC	Permanent Joint Technical Commission (of the Kunene River Basin)
RCCP	Regional Climate Change Programme (for Southern Africa)
RISDP	Regional Indicative Strategic Development Plan
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SEB	Swaziland Electricity Board
SNEL	Société Nationale d'Électricité (DRC)
TANESCO	Tanzania Electric Supply Company Limited
ZACPLAN	Zambezi River Action Plan
ZAMCOM	Zambezi Watercourse Commission
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia Electricity Supply Corporation Limited
ZRA	Zambezi River Authority
ZRB	Zambezi River Basin

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