ZAMCOM

WATER-ENERGY-FOOD NEXUS in the ZAMBEZI RIVER BASIN

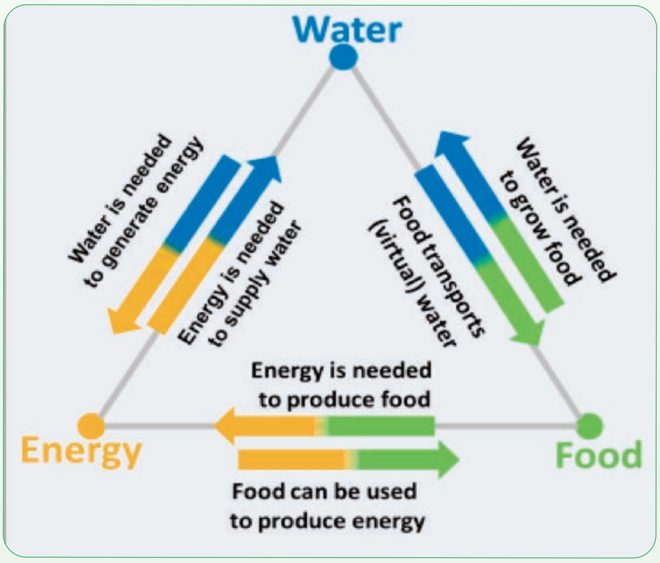
What is Water-Energy-Food Nexus?

Water, energy and food are essential for human wellbeing. Management of water, generation of energy and production of food are closely linked. In the Zambezi River Basin, these sectors often fall under separate ministries and departments, yet the use or management of one of these resources can impact on the other.

The nexus approach calls for greater collaboration among water, energy and food sectors. Such cooperation is essential, as demand for water, energy and food is increasing as a result of population growth, urbanisation and economic development.

The water, energy and food linkages are demonstrated in Figure 1.

Water-Energy-Food Nexus Figure 1



UNU, 2013

Energy is needed to supply water
Water extraction, treatment, and redistribution demand energy.

Water is needed to generate energy
Water is required for producing hydropower, cooling thermal power plants, as well as irrigating biofuels.

Water is needed to produce food
Irrigation is a major water user in the basin. Water is also used in food processing.

Energy is needed to produce food
Energy is required to produce agricultural inputs such as seed, fertilisers and agrochemicals, and to pump irrigation water.

Food can be used to produce energy
Crops such as sugar cane can be used for fuel generation.

Based on the connections shown in Figure 1, synergies can be identified in designing response options and interventions that are sustainable. Applying a nexus framework can change for the better the ways in which decisions are made, resources are managed and communities are supported.

State and Trends of Demand for Water, Energy and Food

The demand for water, energy and food is expected to increase due to demographic changes, economic growth, as well as changes in climate.

The Zambezi River Basin population was 31.7 million in 1998. Ten years later, in 2008, the population had reached 40 million, and it is estimated to reach 51 million by 2025.

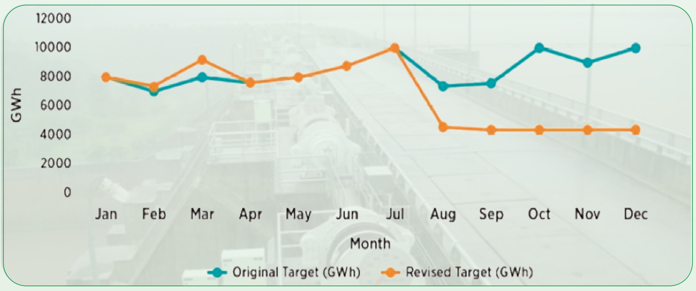
Water availability is affected by periodic droughts, such as the drought that affected the Zambezi Basin in the 2015/16 season. The drought resulted in 27 million people in southern Africa becoming food insecure, according to the Vulnerability Assessment Results released in June 2016.

In case of a drought, large parts of the basin record very low reservoir water levels affecting energy generation.

For example, the Zambezi River Authority reported that water levels in Kariba reduced to only 12 percent of capacity in February 2016 compared to the 53 percent recorded at the same time in 2015. As a result, potential annual power generation was reduced by more than 50 percent (Figure 2).

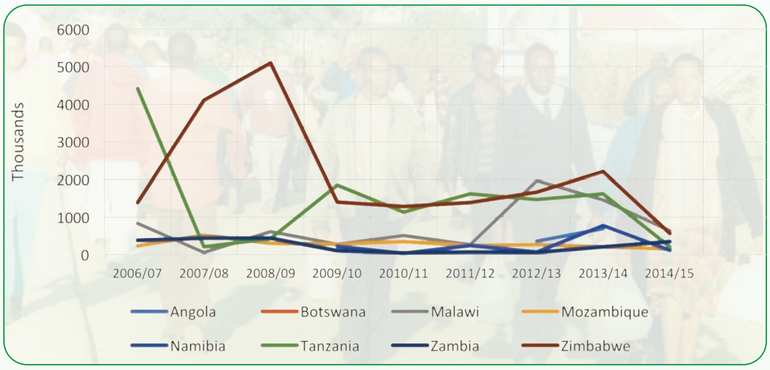
At SADC level current available operating capacity stands at 46,910MW against demand of 55,093MW. According to the SADC Regional Infrastructure Development Master Plan (RIDMP) of 2012, assuming an average economic growth rate of eight percent per annum, energy demand is expected to increase to more than 77,000MW by 2020 and to over 115,000MW in 2030.

Reduction of Hydropower Generation due to Low Rainfall in 2015 at Kariba Dam Figure 2



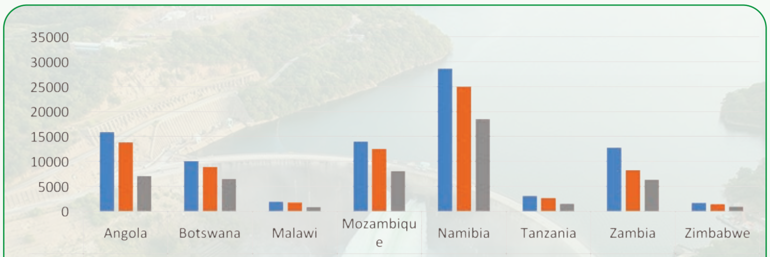
SADC Energy and Water Ministerial Workshop: "Energy and Water Crisis in the Region." Issues Paper

Trends in Food Insecure Population in Zambezi Basin Countries **Figure 3**



SADC Regional Vulnerability Assessment and Analysis Synthesis Report 2014

Per Capita Water Availability **Figure 4**



	Angola	Botswana	Malawi	Mozambique	Namibia	Tanzania	Zambia	Zimbabwe
1995	15920	10075	1995	14026	28616	3134	12747	1735
2000	13832	8904	1840	12525	25041	2745	8275	1483
2025	7093	6476	920	8080	18496	1587	6345	1030

1995 2000 2025

Zambezi Environment Outlook 2015

Note: Namibia values are high due to the Orange and Okavango river allocations but faces distribution challenges
Water Stress - Availability less than 1 700cu m/capita/year
Water Scarcity - Less than 1000cu m/capita/year
National average annual figures mask large seasonal, inter-annual and long-term variations. Geographical variations are also a factor, for example, in Namibia and Malawi.

Sixty percent more food will be needed to feed the region in 2050, and this is expected to increase demand for energy and water. Figure 3 shows that a significant percentage of population in basin countries faces a food security challenge.

Energy consumption is projected to grow up to 50 percent by 2035 while water withdrawals for irrigation are projected to increase by 10 percent by 2050. Climate experts project that by 2025 Tanzania and Zimbabwe will be water stressed while Malawi will experience water scarcity as illustrated in Figure 4.

The Added Value of a Nexus Approach

The Zambezi Basin countries can achieve long-term benefits through integrated and coordinated operation of existing and planned hydropower facilities, cooperative flood management, and irrigation development. The 2011 *Dam Synchronization and Flood Releases in the Zambezi River Basin Project* investigated the extent to which the timing of releases for electricity production, agricultural demands, environmental flow, dam safety, and flood protection can result in more advantages. With full cooperation of the riparian countries, a reasonable balance between hydropower and irrigation investment could result in energy generation of 30,000 GWh/year and 774,000 hectares of irrigated land.

Most large dams in the basin were previously built to meet one specific purpose. There are planned efforts to retrofit such dams for multipurpose use. An example is Itezhi-Tezhi in Zambia designed for both hydropower production and irrigation.

Although Kariba Dam was primarily commissioned for hydropower generation, its other major uses include aquaculture, urban water supply tourism, support to national parks and wildlife, lake transportation and mining activities.

The Zambezi Basin and its rich resources provide opportunities for sustainable, cooperative investment in water, energy and food security. To meet demand for food in the next 20 years, farmers will need to increase production by 70-100 percent and reduce post-harvest losses.

Examples of Integrated Solutions for the WEF Nexus

Combined Heat and Power Production at Sewage Treatment Plants

Anaerobic digesters produce methane biogas and fertilizer (which is used for growing food) from sewerage sludge. Further investment in a Combined Heat and Power (CHP) plant converts the biogas to heat and electricity which is used by the water treatment plant. CHP plants are now being deployed in Tanzania and Mozambique as well as in other countries outside the basin.

Demand Side Management in Water and Energy

The Southern African Power Pool (SAPP) has taken significant steps in establishing Demand Side Management (DSM) programmes. These include energy efficiency technologies such as the replacement of incandescent bulbs with Compact Fluorescent Lamps (CFLs) and introduction of the Solar Water Heater (SWH) programme, Hot Water Load Control (HWLC) and the Commercial Lighting (CL) programme. The HWLC has water-saving showerheads to reduce water consumption at the same time reducing associated energy consumption.

Switching from traditional light bulbs to CFLs has been an effective programme by SAPP to reduce energy use at home and prevent greenhouse gas emissions that contribute to climate change.

Compared to incandescent bulbs, CFLs have been shown to save up to 80 percent of electricity consumption.

Similarly, the HWLC programme has enabled consumers to install load control switches that automatically turn off power during peak periods or when appliances such as geysers have reached maximum demand. The energy efficiency measures have resulted in significant savings of about 4,500MW as of September 2015 since the launch of the initiative in 2011.

To date, the majority of SAPP member countries in the basin have introduced the CFLs and the SWH and HWLC on a large scale. All countries in the basin except Malawi and Angola are members of SAPP. The power savings are expected to gradually increase to 6,000MW by 2018, by which time the use of incandescent bulbs would have been banned in all Member States and a SAPP Energy Efficiency

Framework Document would be in place. A task force has been formed to finalize framework, which is expected to spell out how the power pool would roll out its energy efficiency programme.

DSM in energy and water-efficiency initiatives should be pursued vigorously in order to reduce demand and allow savings realised to be channelled to productive sectors and stimulate economic growth.

Renewable Energy in the WEF Nexus

The basin has the capacity to address its energy challenges if its vast renewable energy sources such as hydro, wind and solar are fully harnessed. Water needs for solar photovoltaics and wind are negligible compared to thermal power generation where substantial quantities of water are needed for cooling. Solar pumps can support the expansion of irrigation, reduce dependence on grid electricity or fossil fuel supply.

According to the *SADC Energy Monitor 2016: Baseline Study of the SADC Energy Sector,* the total hydropower potential in SADC countries is estimated at about 1,080 terawatt hours per year (TWh/year) but capacity being utilized at present is just under 31 TWh/year. A terawatt is equal to one million megawatts (MW). Renewable energy provides an opportunity for the region to address climate change concerns by increasing its uptake and therefore, reducing greenhouse gas emissions.

Using renewable energy in post-harvest processing can reduce losses and enhance the sustainability and competitiveness of the industry. Food drying, in particular, stands out among other food preservation techniques because it can be performed using low-temperature thermal sources. It is applicable to many different food types including fruits and vegetables, and the dried food that is produced is light weight, easily stored and transported, and has an extended shelf life.

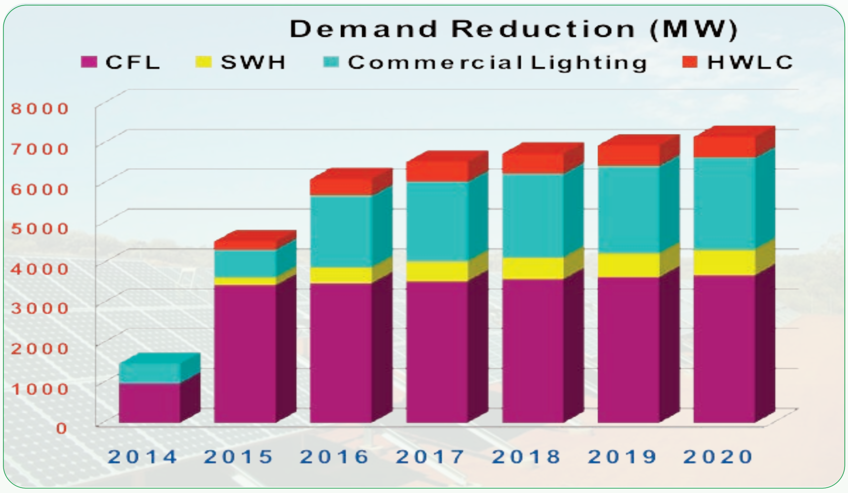
Other Strategies

Improving water and energy efficiency in agriculture, reusing agriculture wastewater to significantly extend the productivity of limited water resources;

Expanding water-harvesting and storage systems for extending temporal availability of water supply; and

In the Zambezi Basin only about eight percent of the wastewater is treated and reused. Wastewater treatment includes energy inputs for collection, treatment and discharge. Wastewater itself holds immense potential for energy production. The energy contained in wastewater and bio-solids exceeds the energy needed for treatment by 10-fold.

Projected Savings from DSM Initiative in Southern Africa — Figure 5



SAPP Annual Report 2015

Institutional Framework Supporting WEF Nexus

The Zambezi Basin Integrated Water Resources Management Strategy of 2008 has components of the Water-Energy-Food nexus approach. It calls for consideration of the nexus approach in future water, energy and food security initiatives.

ZAMCOM has strong representation at national level that could ensure buy-in of the nexus approach to enable the basin's perspective and cooperation to be considered when planning. The ZAMCOM Strategic Plan provides for nexus approach implementation, with data support from the Zambezi Watercourse Information System and Decision Support Systems. These are platforms for sharing data in the basin. The adoption of rules and procedures of data sharing by ZAMCOM Council of Ministers in February 2016 is a step ahead in availing data and information for the WEF nexus.

At regional level, the WEF nexus makes up programme eight of the 4th SADC Regional Strategic Action Plan on IWRM for 2016-2020, a blue print which guides the implementation of the SADC Water Policy and the SADC Revised Protocol on Shared Watercourses. The need for integrated planning across sectors of water, energy and food is recognized in the SADC Regional Infrastructure Development Master Plan and the Revised SADC Regional Indicative Strategic Development Plan.

Facts about WEF Nexus

- Reliable, pertinent and timely data is essential to assess and analyse nexus interactions;
- Strengthen institutional capacity to facilitate data sharing and data collection as well as analysis;
- Achieve water, energy and food security through recognition of the connections by policymakers and practitioners;
- Tailor the nexus approach to the context of Basin States to enable growth and development of the economies, as well as place more emphasis on infrastructure development and institutional capacity in all Basin States;
- Expand the mandate of river basin organizations for sustainable and effective solutions, and promote opportunities and capacities for integrated research as well as engage the private sector;
- Stimulate the uptake of renewable energy products and technologies;
- Develop appropriate river simulation models to identify the influence of dam operations on the downstream flow regime, including unregulated tributaries and optimize multipurpose management of existing reservoirs;
- Grow biofuel crops in areas that rely on rain rather than irrigation. This would not only reduce pressure on water resources, but there would be less need for energy to pump water for irrigation;
- Promote wastewater management for use in irrigation;
- Develop practical integrated energy, water and food planning tools to enable decision-makers to quantify power generation investment trade-offs at both the national and basin level, and take account the uncertainties imposed by climate change;
- Take into account the full economic costs of water that is withdrawn for hydropower generation, including downstream impacts, such as changes to river flow rates, and silting patterns, and consider synergy solutions, such as multipurpose reservoirs;
- Have a better understanding of the WEF nexus so as to unlock opportunities for collaboration among Member States, thereby boosting basin-wide and regional cooperation and development; and
- As envisaged in the Zambezi IWRM Strategy, the WEF nexus approach should consider the following:
  - Joint development of feasible package of major hydropower sites, taking into account multiple functions in coordination with SAPP;
  - Identify and promote options for smallscale hydropower development;
  - Support the development of agriculture through basic facilities such as reliable input supply and better road networks as well as expand irrigated agriculture;
  - Promote and support the restoration and sustainability of flood plain agriculture;
  - Enhance the productivity of rain-fed agriculture through improved water management options.

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This Factsheet is part of a series produced by the Southern African Research and Documentation Centre for the Zambezi Watercourse Commission to focus on key environmental issues in the Zambezi River Basin, and is targeted primarily for decision and policy makers, and for researchers, media, youth, and communities in the Basin. The Factsheets seek to achieve the ZAMCOM Communication Strategy objective of communicating development in the Zambezi River Basin and enhancing ZAMCOM's profile at national and regional levels through raising awareness about its activities.

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