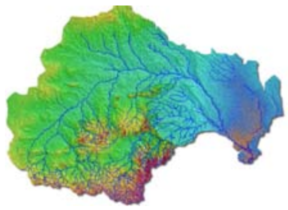

Limpopo River Basin Focal Project

Literature on Work Package 2 – Water Availability and Access

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1. WATER AVAILABILITY IN THE LIMPOPO BASIN

1.1 Introduction

This draft note aims to provide a survey of literature on water availability and use in the Limpopo basin as part of the Limpopo Basin Focal Project (LBFP) of the Challenge Program for Water and Food (CPWF).

The objective of this work package (WP2) is to assess the water availability and access in the context of the LBFP. The LBFP is divided into six thematic areas, namely:

WP 1: Poverty analysis
WP 2: Analysis of water availability and access
WP 3: Analysis of agricultural water productivity
WP 4: Institutional analysis
WP 5: Intervention analysis
WP 6: Development and application of knowledge base

Water availability assessment at basin level requires a holistic approach to understanding water resources (surface and groundwater) at basin, sub-basin and plot or field levels, as well as the temporal distribution and variability of water resources, which would define levels of opportunity and risk in harnessing agricultural use of water. Although agricultural water use is an important component of total water use in a basin, water use assessment at basin level also requires a prudent understanding and review of existing tools for assessing and forecasting water demands and use by all of the following sectors:

- Environment;
- Agriculture;
- Rural domestic;
- Urban;
- Industry (including mining).

Agricultural water requirements include irrigation, forests, grassland, irrigation, livestock, fish and other demands. Water is obtained from surface water (rivers, lakes, wetlands), groundwater (aquifers, springs) and return flows from irrigation, urban and mining abstractions.

Different riparian states within the basin have separately developed tools for water situation assessments and provide planning guidelines for the quantification of water use and demand at country level. These separate approaches are normally compatible and tend to portray a harmonised methodology for basin-wide assessment. Some significant differences do, however occur, which require some analysis and explanation … which we will try to provide in this draft report.

1.2 Scientific approach and tools for agricultural water assessment

Decision support systems need to be developed that fill the gap between knowledge and scientific understanding and provide tools to improve agricultural water management (as presented in Figure 1). The scientific assessment of agricultural water and productivity requires developing decision support tools that address:

1. **Agricultural water accounting** – a procedure that enables an accounting of water that falls as rainfall and how this translates into soil moisture contents in the root zone of plants, deep ground-water flow, surface runoff and supply of various water demands, presented as a balanced series of input and output variables.
2. **Agricultural water assessment scaling** – up-scaling and down-scaling the results of water accounting systems to indicate temporal and spatial variability of water supply and demonstrating the relevance of water accounting processes and procedures
3. **Water productivity assessment** – providing a link between crop yields, water consumption ratios and other indices, taking into account various risk and sustainability criteria for both rain fed and irrigated systems
4. **Water productivity intervention assessment** - assessing the impact of various water productivity improvement interventions and analysing cost/benefit relationships, which encompass trade-offs between productivity improvement and cost and include socio—economic impacts and the likely adoption intervention measures.

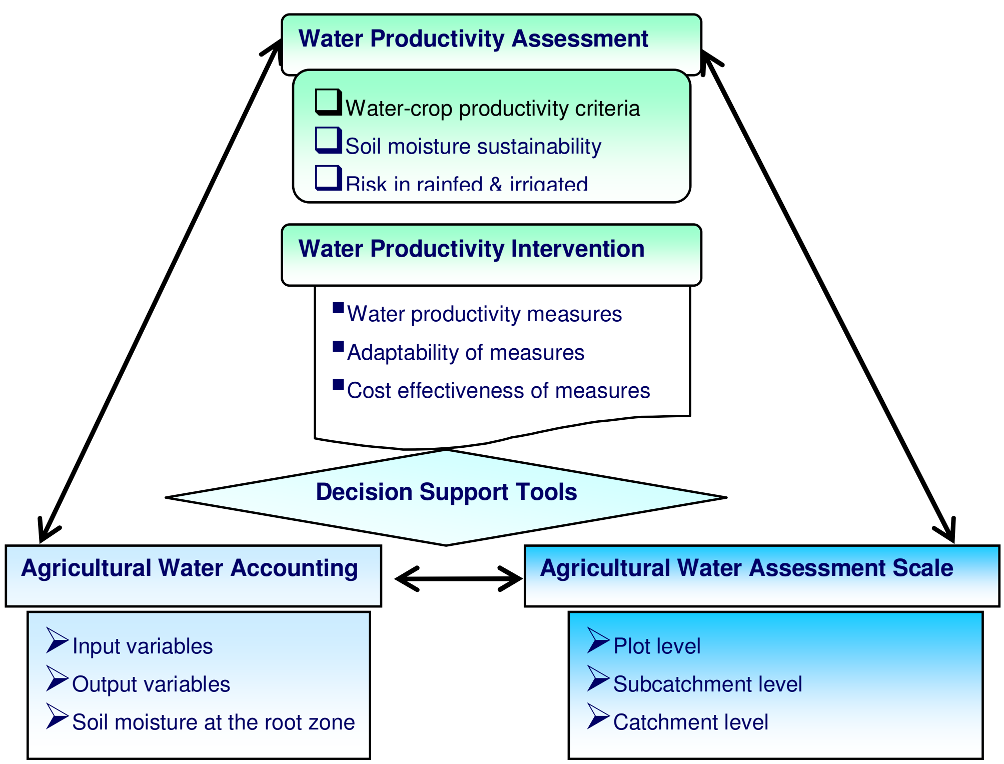

Figure 1. Conceptual framework for scientific assessment of agricultural water (Source: Alemaw, 2006a (modified))

Several detailed methodological approaches for assessing agricultural water productivity and establishing water accounting systems have been generated through the CPWF and could provide useful tools (e.g., Cook et al., no date a, b).

Interventions to improve agricultural productivity are multi-dimensional and multi-faceted. Detailed information is available from the Comprehensive Assessment of Water Management in Agriculture Report, chapter 7 on Pathways for increasing agricultural water productivity (Molden and Oweis, 2007).

Agricultural water availability, access and assurance levels are complicated by the El Nino Southern Oscillation (ENSO phenomenon). The Southern Africa region, including the Limpopo basin, is particularly affected by this phenomenon (Jury and Pathack 1993; Ropelewski and Halpert, 1987; Alemaw and Chaoka, 2006b). The availability and assurance of water resources can also be influenced by, and manifested in terms of, the natural variability of rainfall that results in exaggerated variations in river runoff (e.g., Alemaw and Chaoka, 2002).

2. ASSESSMENT OF WATER DEMAND IN CATCHMENTS

2.1 Definitions of water demand and use

The terms water use and water demand are often used interchangeably. However, these terms have different meanings. Definitions of these terms as used in this study are as follows:

2.1.1 Water use

The following three types of water use are described:

- **Withdrawals or abstractions,** where water is taken from a surface or groundwater source, and after use returned to a natural water body, e.g., water used for cooling in industrial processes that is returned to a river. Such return flows are particularly important for downstream users;
- **Consumptive water use** or water consumption that starts with a withdrawal or an abstraction but in this case without any return flow. Water consumption is the water abstracted that is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock or otherwise removed from freshwater resources. Water losses during the transport of water between the points of abstractions and the point of use, (e.g., resulting from leakage from distribution pipes), are excluded from the consumptive water use figure. Examples of consumptive water use include steam escaping into the atmosphere and water contained in final products, i.e., it is water that is no longer available directly for subsequent uses;
- **Non-consumptive water use**, i.e., the *in situ* use of a water body for navigation, in-stream flow requirements (to meet environmental demands), recreation, effluent disposal and hydroelectric power generation.

2.1.2 Water demand

Water demand is defined as the volume of water requested by users to satisfy their needs. In a simplified way it is often considered equal to water consumption, although conceptually the two terms do not have the same meaning as, particularly in rural parts of southern Africa, the theoretical water demand often considerably exceeds actual consumptive water use.

A conceptual framework for determining agricultural water use in the set of conflicting water uses is presented in Figure 2.

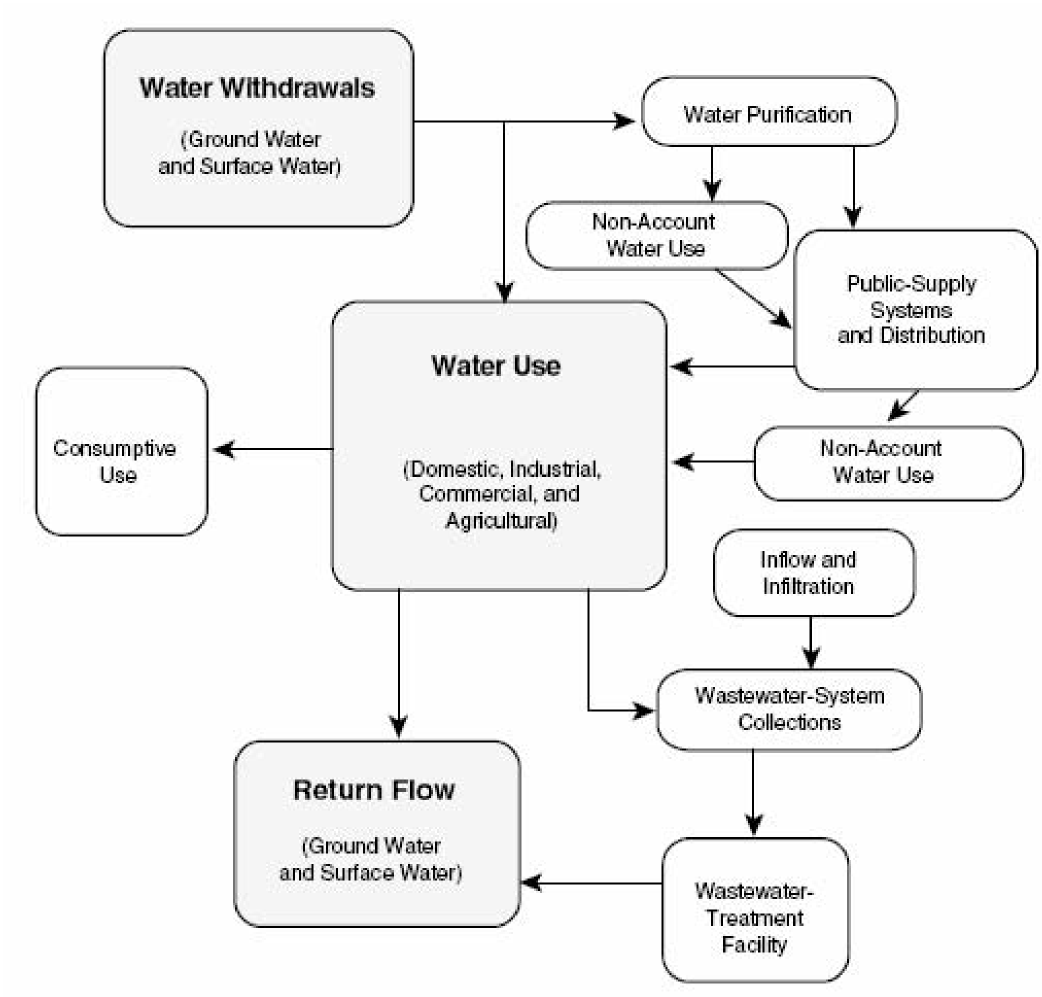

Figure 2. The components of water use

2.2 Overview of water use in the Limpopo Basin

The four riparian nations of the Limpopo basin, Botswana, Mozambique, South Africa and Zimbabwe, have over the years developed their water resources to meet their socio-economic requirements. Basin-wide estimates, with some variation by various studies, according to FAO (2004), put the renewable freshwater resources at an annual average of 4,800 million m^3 distributed in the region's rivers, lakes and aquifers. The sections below give an overview of water use in the Limpopo basin.

2.2.1 Water use by sector in the Limpopo Basin

Table 1 gives broad patterns of water use in the Limpopo basin riparian countries. While the absence of data on the total volumes of water used in each country prevents detailed comparisons from being made, agricultural water use in each country clearly dominates when compared to the domestic and industrial water use sectors. The high proportion of water used for agriculture suggests that each Limpopo riparian country relies heavily on food grown within its borders to meet national goals of food security.

Table 1. Water use by sector for Limpopo riparian states

Country	Agriculture (%)	Industry (%)	Domestic (%)
Botswana	48	20	32
Mozambique	89	2	9
South Africa	62	21	17
Zimbabwe	79	7	14

Source: Reference: SADC, 1999

2.2.2 Level of water scarcity in the Limpopo Basin

Table 2 presents categories of water scarcity associated with varying levels of water supply per person per year, the typical scales of problems encountered in each category in southern Africa.

Table 3 provides estimates of the total water available for each of the continental SADC states on a per capita basis for the years 2000 and 2025. The estimated populations for the year 2025 take into account the likely effects of HIV/AIDS on population growth.

Table 2. *Levels of water scarcity index*

Water scarcity category and associated problems	Volume of water available (m^3/person/year)
Beyond the "water barrier": continual, wide-scale water supply problems, becoming catastrophic during droughts.	< 500

Chronic water scarcity: continual water supply problems, worse during annual dry seasons; frequent severe droughts.	500 to 1,000
Water stressed: frequent seasonal water supply and quality problems, accentuated by occasional droughts.	1,000 to 1,666
Moderate problems: occasional water supply and quality problems, with some adverse effects during severe droughts.	1666 to 10,000
Well-watered: very infrequent water supply and quality problems, except during extreme drought conditions.	> 10,000

Source: Reference: SADC, 1999

Table 3. *Water availability for Limpopo basin riparian states*

Country	Total water available (km^3) *	Population in 2000 (millions)	Water per person in 2000 (m^3/person/year)	Estimated population in 2025 (millions)**	Water per person in 2025 (m^3/person/year)
Botswana	1.6	1.6	976	2.0	808
Mozambique	17.0	20. 0	5,856	28.8	4,066
South Africa	52.8	43.3	1,220	49.0	1,077
Zimbabwe	15.5	13.1	1,182	14.0	1,108

Notes:

*This is the surface plus ground water that is generated within the geo-political boundaries of the country each year and excludes water that flows in from neighbouring states. Minor volumes of recycled water are included in the values for water available in South Africa.

**Population growth rates in each country used to estimate the population in 2025 have been adjusted to account for the current prevalence of HIV/AIDS in that country.

Source: Reference: SADC, 1999

Table 3 indicates that most countries in the Limpopo basin are water stressed and that Botswana faces a chronic scarcity of water. Table 3 also indicates that the water availability per person will significantly decrease by 2025.

2.3 Balancing supply and demand

There are various ways in which water can be allocated. The challenge is to find an optimal allocation that, firstly, adheres to laid down regulations, and secondly, satisfies the water demand of all users as much as possible. The problem of water allocation can be said to be, how to obtain an equitable balance among a whole set of competing obligations, which include:

- International conventions;
- Basic human needs (for wellbeing of both upstream and downstream communities);
- Protection of land productivity;
- Environmental demands of both terrestrial and aquatic ecosystems; and
- Resilience of ecosystems to both natural and man-made disturbances (Falkenmark and Folke, 2002).

Water allocation is not generally an issue when water availability surpasses water demands. All demands can then be satisfied, and no need arises for a regulated allocation of water. This is, however, not the case for most rivers in southern Africa. In most river systems in southern Africa water shortages occur frequently. Water supply allocations must then be regulated to ensure and equitable distribution of scarce resources.

Water allocation is not limited to physical allocation of water. More broadly it involves balancing satisfying competing water demands which encapsulate demands for water quality, quantity and reliability of supply. Other supply issues could include:

- Water for navigation (e.g., navigability is often reliant on minimum water levels);
- Hydropower (e.g., a minimum head difference may be required);
- Environment (e.g., many aquatic species require a certain flow regime or seasonal fluctuations in water level to live and breed);
- Cultural and recreation (availability of water is often necessary for cultural and recreation needs).

Although many of these functions are consumptive only to a limited extent, they can cause conflict in both the timing and in the spatial distribution of demands. Flood protection and early flood warning systems, are also a function of water resource management. Flood protection achieved through the construction of storage dams can have a positive impact on water availability for other functions (e.g., hydropower), but can also have negative impacts on the environment or other demands. Appropriate rules for allocating water resources will naturally involve complex interactions between competing demand issues, both on the supply and the demand side.

2.3.1 The supply side

On the supply side the generation of water in a catchment area naturally fluctuates, both within years and between years. Water also occurs in different forms that often have different uses. Special reference is made to rainfall and its use as "green water" in agriculture. Green water cannot be allocated in the same way as "blue" water occurring in rivers and aquifers. Dryland agriculture and other land uses do, however, influence the partitioning of rainfall into groundwater recharge, surface runoff and soil moisture storages and can, therefore, significantly influence water availability.

2.3.2 The demand side

Various parameters affect demand at a catchment level.

(1) **Variability of water demands:** Fluctuations in demand are normally much less than those on the supply side. However, for many types of water use, demand increases as water availability decreases (during the dry season).

(2) **Degree of water consumption:** Much of the water abstracted will not return to the water system in the form of "blue water"; consumptive water use typically converts blue or green water into water vapour, which, in this form cannot be allocated to other users. Water uses that are non-consumptive allow others to use the water afterwards. Recreational water uses are a typical example. However, some non-consumptive uses alter when this water becomes available for other users. A typical example is water used for the generation of hydropower: electricity is needed also during the wet season, and thus water has to be released from dams for power generation when demands from other water use sectors may be low. This results in water that is used for electricity generation being unavailable to other potential users when they need it. Environmental demands (often regarded as non-consumptive use of water), are frequently out of sync with the needs of other users, which is precisely why environmental water requirements are increasingly being recognised as an important water management issue.

(3) **Return flows:** Many uses of water generate return flows that in principle are available for other uses. However, return flows are often of lower quality than the water originally abstracted. This may severely limit their re-use. The quality of return flows may pose risks to public health and the environment.

(4) **Supply assurance:** For arable (non-perennial) irrigated crops, levels of supply assurance of 75% (i.e., failure to produce the maximum yield owing to water shortages in one out of four years) may be acceptable. For urban water supply assurance levels of 98% or higher are the norm (failing once in 50 years or less).

3. WATER RESOURCES OF THE LIMPOPO BASIN

3.1 Hydrological studies of the Limpopo River Basin

Various hydrological models and studies have been used to describe the natural water resources of the Limpopo basin. The following country studies and resource development plans have been produced by different entities:

- Drought impact mitigation and prevention in the Limpopo River Basin: A situation analysis (FAO, 2004; this study provides further references for the list below)

- Sharing water in southern Africa (Pallett, J, 1997)
- Monografia hidrografica da bacia do rio Limpopo (1996, Mozambique);
- Hydrological Modelling of the Limpopo Main Stem (1999, South Africa).
- Limpopo Water Utilization Study (1989, Botswana);
- Botswana National Water Master Plan Study (1990, Botswana);
- Joint Upper Limpopo Basin Study (JULBS) (1991, Botswana and South Africa);
- Zimbabwe National Master Plan for Rural Water Supply and Sanitation (1986, Zimbabwe);
- Surface Water Resources of South Africa (1990, South Africa);
- Various studies on a number of tributaries (various years, all riparian states; e.g., McCartney et al., 2004, for the Olifants);

According to Görgens and Boroto (1999), hydrologically, the JULBS study was particularly significant, as it revealed the existence of significant transmission losses, attributable to alluvial channel and floodplain recharge and channel evaporation, as well as consumptive use by the well established riparian vegetation.

3.2 Catchments of the Limpopo River Basin

The Limpopo Basin covers 412,938 km^2, and is drained by the River Limpopo and its tributaries, of which the Olifants and the Changdne drain the largest areas (Figure 3 and Table 4). Rising as the Crocodile River in the Witwatersrand of South Africa, the Limpopo flows northeast along the border of South Africa with Botswana, eastward between South Africa and Zimbabwe, then southeast across Mozambique, before emptying into the Indian Ocean. Descriptions of the hydrology and water resources, with references to more general literature, may be found in the FAO (2004) report.

The mean annual rainfall of the basin varies considerably (200-1500 mm) with much of the northern and western parts of the basin receiving less than 500 mm annual rainfall. Rainfall is highly seasonal with 95 percent occurring between October and April. The rainy season is short with the annual number of rain days seldom exceeding 50. Consequently, the Limpopo and its tributaries have very pronounced seasonal variation in flow, with negligible low season flows. Rainfall varies considerably from year to year.

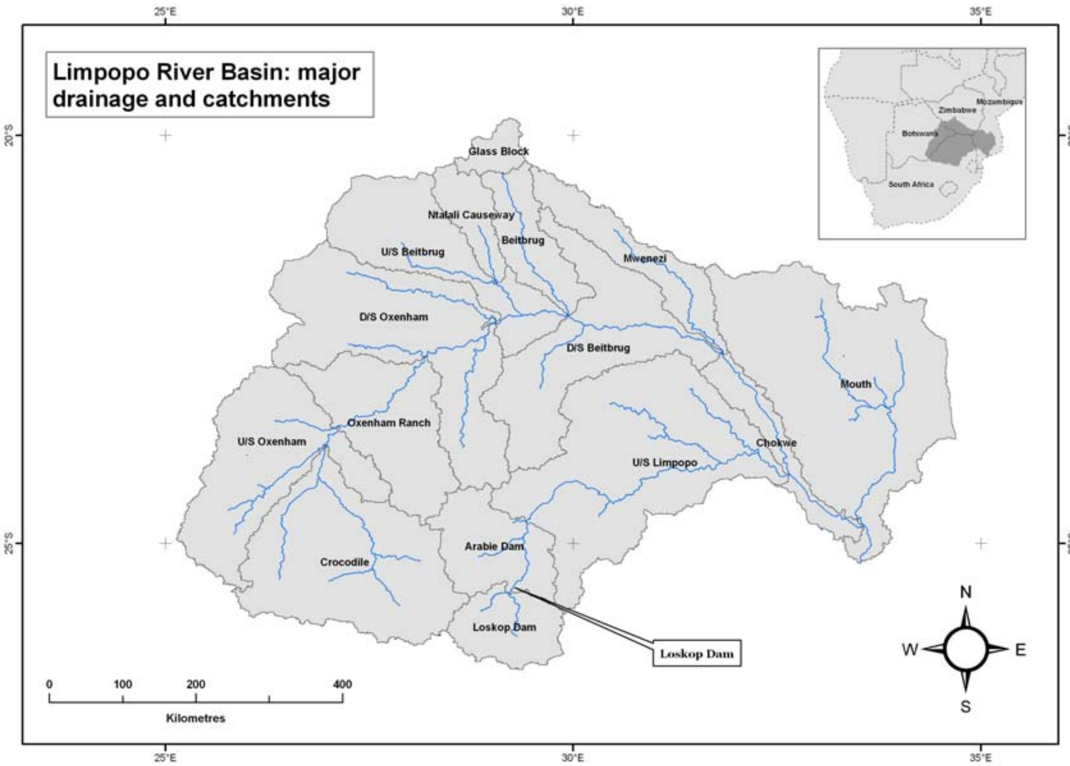

Figure 3. The Limpopo Basin, with the catchments used for a water use account produced for the CPWF by Mainuddin et al., 2007,

Table 4. *Catchments in the Limpopo Basin with their areas*

Catchment	Location	Area, km2
Crocodile	Crocodile	44691
Limpopo	U/S Oxenham	33716
Limpopo	Oxenham Ranch	25335
Limpopo	D/S Oxenham	46180
Tuli	Ntalali Causeway	7445
Limpopo	U/S Beitbrug	26406
Umzingwane	Glass Block	3937
Limpopo	Beitbrug	12002
Mwenezi	Mwenezi	14732
Limpopo	D/S Beitbrug	34742
Olifant	Loskop Dam	11833
Olifant	Arabie Dam	16424
Olifant	U/S Limpopo	58036
Limpopo	Chokwe	9611
Limpopo	Mouth	67849
Total		412938

3.2.1 Surface water resources of the Limpopo River Basin

Different sources and available literature provide different estimates on the surface water resources of the Limpopo basin. Pallett (1997) has estimated the total natural runoff of the Limpopo River at more than 5,500 million m^3. Recent figures for South Africa (GOSA–DWAF, 2003a–d) indicate a figure of about 8,000 million m3. The vast majority of past hydrological studies, however, estimate the total mean annual surface runoff of the basin at between 4,800 and 5,200 million m^3 Entering Mozambique, the main river has an average natural MAR of 4,800 million m^3 (FAO, 2004). According to Görgens and Boroto (1999), the current MAR at its mouth is about 4,000 million m^3, although other studies suggest that this figure may be as low as 3,600 million m^3. All of the above represent total consumptive water use in the basin of between 800 and 1,600 million m^3 per annum (which represents a wide range of uncertainty).

The following observations can be summarised from different studies (FAO, 2004):

1. The Elephants (Oliphants) River, which joins the Limpopo in Mozambique, has the largest catchment area and is also the largest contributor of flow to the Limpopo River. The Massingir Dam in Mozambique is located on the Elephants River.
2. The Luvuvhu River is the tributary with by far the highest unit runoff and also has a high ratio of denaturalized to naturalised MAR (86 percent), indicating a relatively low level of development in the catchment. The water of the Luvuvhu River flows directly into Mozambique at Pafuri.
3. The Crocodile River, which is the tributary with the second-largest catchment area, has a low ratio of denaturalized to naturalised MAR (43 percent), indicating a high level of development in its catchment.

The naturalised MARs of the Shashe, Umzingwane, Bubi and Mwenezi Rivers are not known. However, the level of development in the Umzingwane is known to be high because of the large number of storage dams constructed in this river system. Some dams also exist in the Shashe catchment. Data on most of these dams are available in the FAO AQUASTAT database.

For Botswana, a comprehensive national water resources study is available in the form of National Water Master Plans. Alemaw (2006) also assessed and reviewed the water resources potential of three rivers which are found in the main headstream of the Limpopo basin, with the availability of records and catchment characteristics shown in Table 5. The monthly and annual runoff variability of these rivers is shown in Figures 4 and 5 respectively.

Table 5. *Availability and characteristics of three main rivers in Botswana*

Main River System	Catchment area (Km^2)	River/discharge gauge site (record period)
Shashe at Lower Shashe	7810	Shashe at Lower Shashe (1968-99)
Shashe at Mooke Weir	3650	Shashe at Mooke weir (1968-99)
Motlouste at Tobane	7930	At Tobane (1969-1995)
Source: Alemaw (2006)		

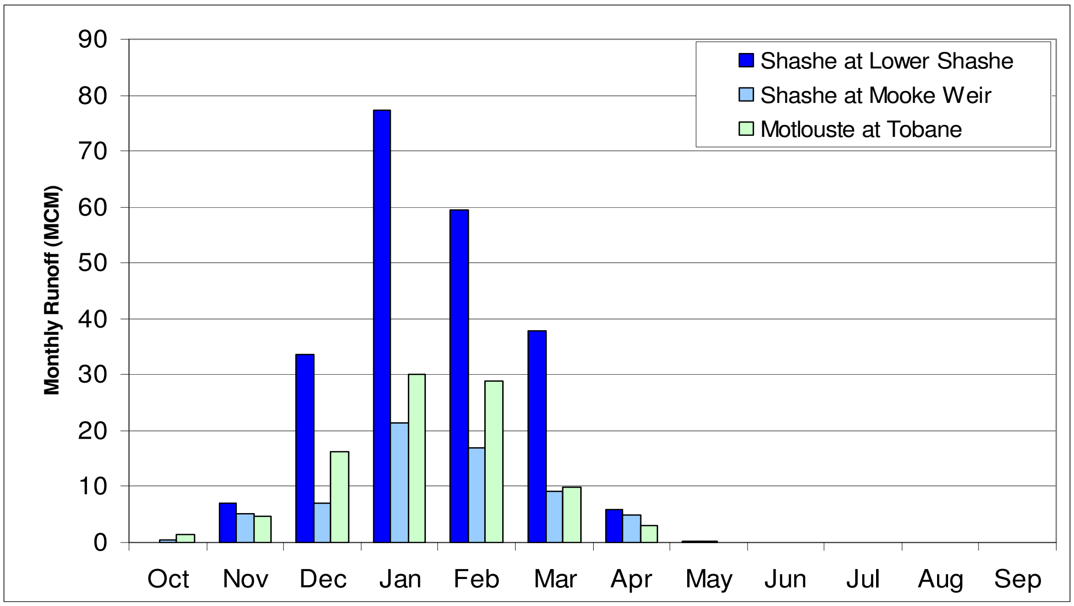

Figure 4. Long-term Monthly Runoff variation in the three rivers of in the Limpopo basin of Botswana

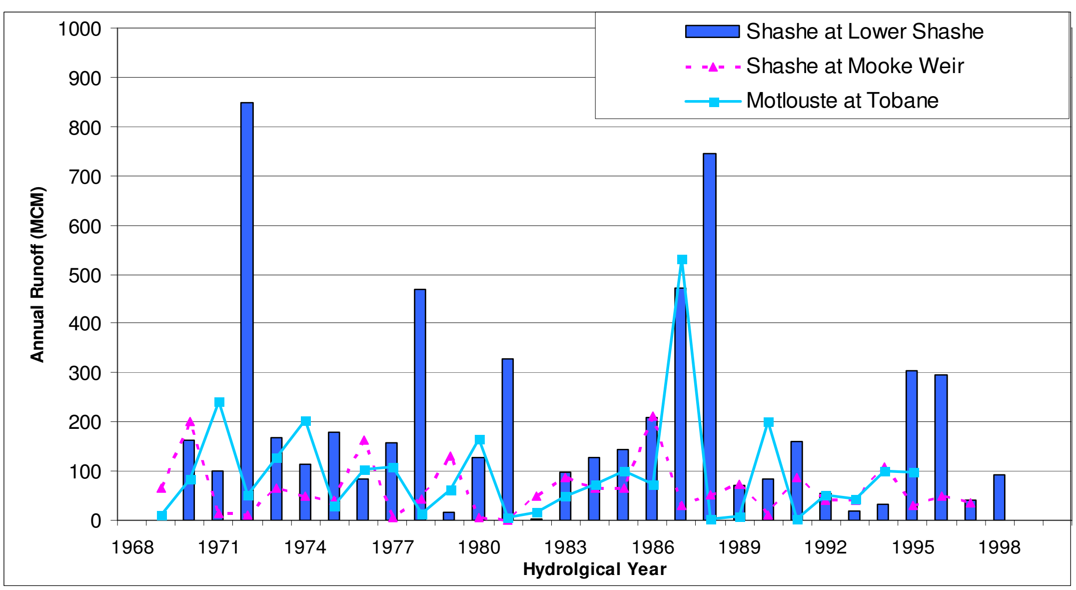

Figure 5. Annual Runoff Variation in the Three Rivers in the Limpopo basin of Botswana

3.2.2 Sand river beds

Apart from surface stream-flow and borehole yields, the sand river beds remain a vital source of fresh water resources of the Limpopo basin. Drinking water abstraction from sand beds is common among rural communities along the length of the main-stem Limpopo. Some argument exists as to whether water contained in sand beds below the natural watercourse of the river should be treated as surface flow which would emerge at the following dyke or rocky outcrop. This has significant implications on water allocation regulation during drought periods.

Table 6*. Sand River Resources potential in the Limpopo river of Botswana*

Sand river bed	**Sustainable Resource?**	**Comment**
Upper Shashe	24 m^3/d/km	Study length 67.8km
Lower Shashe	133 m^3/d/km	Study length 76.58km
Motloutse	100 m^3/d/km	Study length 210km
Tati	30 m^3/d/km	Study length 74km
Ramokwebana	150 m^3/d/km	Study length 16.2km (3 basins)
Mahalapswe	20 m^3/d/km	Study length 82km
Lotsane	0 m^3/d/km	Study length 80km
Nkange	19 m^3/d/km	Study length 4.2km (1 basin)
Metsimotlaba	17 m^3/d/km	Study length 43km
Ntshe	14 m^3/d/km	Study length 65km
Tutume	30 m^3/d/km	Study length 29.5km
Thune	21 m^3/d/km	Study length 33km
Rakabeswa	7 m^3/d/km	
TOTAL	565 m^3/d/km	
Source: Government of Botswana, National Water Master Plan Review, 2006		

Near the confluence of the Motloutse and Limpopo Rivers a series of shallow abstractions take place from the sand which is between 5 - 20 m deep. The largest deposit is found at the Talana Farms area, where the aquifer is approximately 2 - 4 km^2. Boreholes that have been pump tested show a transmissivity in the order of 2700 m^2/d.

Similar estimates for the other river sections of the Limpopo basin in South Africa, Zimbabwe and Mozambique are also available from different studies.

3.3 Internal Strategic Perspective Studies in South Africa

The Department of Water Affairs and Forestry (DWAF) of South Africa has conducted a comprehensive water resources planning study, known as the Internal Strategic Perspective (ISP) with the aim of assessing the water resources availability and utilisation in the various water management areas of South Africa. The Limpopo basin in South Africa is subdivided into four water management areas (WMAs), as described in the following table:

Table 7. *Water Management Areas of the Limpopo Basin in South Africa*

	Name of Water Management Area	Main rivers
WMA 1	Limpopo	Major rivers include the Limpopo, Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele
WMA 2	Luvuvhu and Letaba	Major rivers include the Mutale, Luvuvhu and Letaba
WMA 3	Crocodile (West) and Marico	Major rivers include the Crocodile (West) and Marico
WMA 4	Olifants	Major rivers include the Elands, Wilge, Steelpoort and Olifants

The available water resources of the Limpopo Basin in South Africa (in million m^3/ annum) for the year 2000, is summarised in Table 8.

A typical breakdown of water resources availability and use in the WMA 3 is given in Table 9. The DWAF study has generated very useful data that can be further used in the LBFP. However, WMAs need to be expanded to include the other WMAs in Botswana, Mozambique and Mozambique.

Table 8. *Available water resources of the Limpopo Basin in South Africa in Year 2000 (million m^3/annum)*

Sub-area	Natural resources		Usable return flow			Total local yield	Transfer	Grand Total
	Surface water	Groundwate r	Irrigatio n	Urba n	Mining			
WMA 1	160	98	8	15	0	281	18	299
WMA 2	244	43	19	4	0	310	0	310
WMA 3	203	146	44	283	42	718	519	1237
WMA 4	410	99	44	42	14	609	172	781
Total	1017	386	115	344	56	1918	709	2627
Reference: DWAF, 2003a-d								

***Table 9.** Water Requirements in WMA 3 for Year 2000 (million m^3/annum) as per the NWRS*

Sub-catchment	Irrigation	Urban	Rural	Mining	Power	Forestation	Total	Transfer out	Grand Total
Apies/Pienaars	41	211	7	6	15	0	280	87	367
Upper Crocodile	208	292	5	38	13	0	556	17	573
Elands	32	23	10	48	0	0	113	24	137
Lower Crocodile	137	3	3	28	0	0	171	0	171
Marico	24	5	9	2	0	0	40	7	47
Upper Molopo	3	13	3	5	0	0	24	0	24
Total for WMA 3	445	547	37	127	28	0	1184	10	1194
Reference: GOSA-DWAF, 2003c									

***Table 10.** Available Yield in WMA 3 in Year 2000 (million m^3/annum) as per the NWRS*

Sub-catchment	Natural resource		Useable return flow			Total yield
	Surface water	Groundwater	Irrigation	Urban	Mining	
Apies/Pienaars	38	36	4	106	2	**186**
Upper Crocodile	111	31	21	158	15	**336**
Elands	30	29	3	10	14	**86**
Lower Crocodile	7	29	14	1	8	**59**
Marico	14	12	2	3	1	**32**
Upper Molopo	3	9	0	5	2	**19**
Total for WMA 3	**203**	**146**	**44**	**283**	**42**	**718**
Reference: GOSA-DWAF, 2003c						

4. FUTURE WORK IN THE LBFP

Major challenges and future work in the remaining period of LBFP include:

- In depth assessment of water availability and accessibility including water quality in the Limpopo basin
- Assessment of risk levels and the actual impacts on agricultural development potential of the Limpopo basin
- Assessing impact of risks on rainfed agricultural systems and productivity (as input and synergy with WP3)

- Assessing the impact of water supply risks faced by irrigated systems (various case studies of reservoirs) on sustainability and productivity (as input to and in synergy with WP3)
- Detailed review of literature review on water availability and access
- Refinement of the Limpopo Water Use Account Model (Kirby 2008), currently being evaluated and verified, and demand data as documented in various sources and documents
- Generating water accounting graphs and diagrams
- Demonstration of an updated Water Use Account for LIMCOM.
- GIS-based maps of water access and availability [(1) River flow (incl. dry beds); (2) Groundwater (BHs); (3) MAP/ Mean annual precipitation and seasonal probabilities); (4) Dams; (5) Wetlands and pans; (6) Environmental flow requirements, IFRs (as % MARs); (7) Population; (8) International and national guidelines on level of access for buffer zoning of water source to population distribution]
- Tabulating agricultural risk and sustainability of rainfed and irrigated cropping, based on evaluation of reservoir systems – for specific crops - case studies and mini papers
- Tabulating agricultural water use and ET modelling, including water stress and drought indices (monthly and annual) - case studies and mini papers
- Report on water availability in the Limpopo basin and scientific papers (3-4 journal paper or refereed conference articles)

5. AVAILABLE LITERATURE[1]

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