



Options for Water Resource Management Areas for water accounting and water resource management in Botswana

**Report prepared for Department of Water Affairs
Ministry of Mineral, Energy and Water Resources**

By

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Abbreviations

CAR	Centre for Applied Research
DWA	Department of Water Affairs
IRBM	Integrated River Basin Management
IWRM	Integrated Water Resource Management
LIMCOM	Limpopo Watercourse Commission
MC	Management Centre
OKACOM	Permanent Okavango River Basin Water Commission
ORASECOM	Orange-Senqu River Commission
SADC	Southern African Development Community
SEEA	System of Environmental-Economic Accounting
UN	United Nations
WA	Water Accounting
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WE	Water Efficiency
WEAP	Water Evaluation and Planning system
WRM	Water Resource Management
WUC	Water Utilities Corporation
ZAMCOM	Zambezi Watercourse Commission

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1 Introduction

In Botswana, nation-wide 'System of Environmental-Economic Accounting' (SEEA) type water accounts have been prepared by the Department of Water Affairs (DWA) and the Centre for Applied Research (CAR) for the period 2010-2015 as a tool for integrated water resource management (IWRM) and improved water efficiency (WE).

Botswana has adopted IWRM-principles as shown in its 2013 IWRM-WE Plan (DWA, 2013) and the draft Water Policy, and recognises the principle of decentralised water resource management. This requires appropriate decentralised or regional Water Resource Management Areas (WRMA) where water resource management operates compatibly with the agreed national IWRM principles and IWRM-WE Plan (DWA, 2013). Following this, Botswana's Water Accounts should in time develop sub-national Water Accounts (WA). It is essential that the WA adopt the same WRMA for its sub-national accounts.

In SADC context, Botswana participates in shared transboundary river basin management. Decentralised management of water resources at the national level needs to take into account the boundaries of shared river basin resources.

One of the activities of the IWRM-WE Plan is to engage with stakeholder on the identification of the most appropriate WRMAs, based on surface and groundwater resources. It has been agreed in the context of the 'Wealth Accounting and Valuation of Ecosystem Services (WAVES)' project activities to produce a paper on possible WRMAs for WA and other purposes. This paper will be used for the planned IWRM-WE Plan activity on the identification of and agreement about the appropriate WRMAs for Botswana.

The **objective** of this paper is to systematically identify suitable options for WRMAs that can be used for WA, and for implementation of the Water Policy and IWRM-WE plan.

2 Criteria for demarcation of WRMAs

Systematic identification of WRMAs requires the application of appropriate criteria. While recognising the existing sub-national water resource management entities of the Water Utilities Corporation (WUC) and the Department of Water Affairs (DWA), it is useful to examine the major criteria that may guide re-arrangement or optimisation of such regions or zones. In accordance with IWRM principles, Water Resource Management Areas (WRMAs) need to be appropriately identified. In fact, Botswana is one of the few countries in southern African that has not yet identified WRMAs. Most countries have adopted less than ten catchment areas. South Africa has recently reduced its number to nine. Below, we discuss each criterion used.

Firstly, it is important to recognise the physical dimensions of (ground and surface) water resource management. This should take into account the physical characteristics of the land where the (water) resources are 'produced'. This means taking into account the existence of physical river basins and/or sub-basins and their boundaries or watersheds and catchments, also in terms of groundwater. In many countries, water resources are already managed on the basis of physical river basins e.g. in Namibia, South Africa and Zimbabwe.

Where river basins extend across international boundaries (for Botswana: Okavango, Zambezi, Limpopo and Orange), international river basin organisations have been established to jointly

manage water resources for the riparian states in line with the 2001 Revised SADC Protocol on Shared Water Courses and relevant UN Conventions (SADC, 2000; UN, 1997).

In Botswana, groundwater resources are very important and account for around half of total water abstraction, particularly at rural settlements and mines. Therefore aquifers and well fields need to be recognised, documented and integrated into the river basins. This requires knowledge of the location of the aquifers, which can then be attributed to a river basin. The available maps suggest that for Botswana it is possible in most cases to relate well fields and aquifers to relevant river basins.

WRMAs need to be practically sustainable and therefore ideally should represent equitable workloads in terms of area-size and water demand/use to the management units where possible. Moreover, the WRMAs need to be practically implementable and consider existing arrangements of relevant institutions, ministries and departments.

Based on the above, the following criteria may be considered relevant for the appropriate/optimal demarcation of sub-national zones for water resource management:

- a. Possibility of physical delineation. It should be possible to logically delineate sub-national water resource management unit areas on the basis of physical criteria such as basin or sub-basin boundaries, catchments or watersheds. These physical features relate to the amount of water draining into a common outlet destination such as a dam or through a river mouth into a lake or ocean.
- b. Relevance for IWRM implementation. WRMAs should be relevant for national IWRM implementation;
- c. Suitable for Water Accounting. WRMAs should be suitable for the production of water and other environmental-economic accounts with reference to both data inputs (data collection) and data outputs.
- d. Ease of governance. WRMAs should be based on 'practicalities', i.e. the regions should be not too large nor too small both in terms of area size and total water supply/demand/use and should take into account existing ministerial or departmental arrangements (e.g. DWA and WUC) where possible in order that they can be managed by (relatively small) regional offices.

The ideal WRMAs are hierarchically linked to the national IWRM effort, have measurement points to support water accounting, are manageable in terms of area size and water demand/use and can be demarcated physically in terms of (sub) basin physiography. Where practically possible, existing sub-divisions should be used.

3 Discussion of WRMA criteria

3.1 Criterion 1: Alignment with river basins

The first step is to identify and document river basins. A river basin is defined as "*an area of land drained by a river and its tributaries*", i.e. smaller *river*s flowing into a larger *river*. The watershed is the area of highland *surrounding the* river basin. Using river (sub)-basins as water resource management units allows for the use of models such as WEAP (Water Evaluation and Planning system) and permits Integrated River Basin Management (IRBM) which rests on the principle that naturally functioning river basin ecosystems, including accompanying wetland

and groundwater systems, are the source of our fresh water. IRBM is closely linked with Integrated Water Resource Management (IWRM) at basin level.

Management of river basins must include the management of the natural functions of the basin and thus the maintenance of ecosystem functioning. River basins are dynamic over space and time, and any single management intervention has implications for the system as a whole.

Key elements to a successful IRBM (Integrated River Basin Management) initiative are:

- a. A long-term vision for the river basin, agreed to by all the major stakeholders;
- b. Integration of policies, decisions and costs across sectoral interests such as industry, agriculture, urban development, navigation, fisheries and conservation;
- c. Strategic decision-making at river basin scale, guiding actions at sub-basin or local levels;
- d. Active participation by stakeholders in transparent planning and decision-making;
- e. Adequate investment by governments, the private sector, and civil society in capacity building for river basin planning and participation processes;
- f. A solid foundation of knowledge of the river basin and the natural and socio-economic forces that influence it.

In summary: "Integrated river basin management (IRBM) is the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximise the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems." (Adapted from Integrated Water Resources Management, Global Water Partnership Technical Advisory Committee Background Papers, No. 4, 2000.)

At a very general scale, Botswana is part of four river or drainage basins: Okavango, Zambezi, Limpopo and Orange. These are shown in their regional context in Figure 1.

Figure 1: Botswana: regional river basins

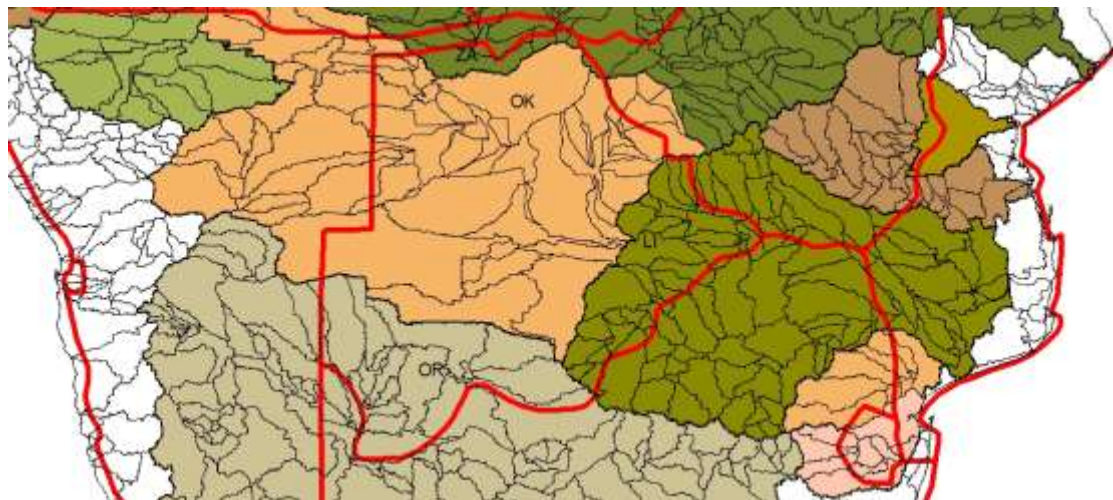
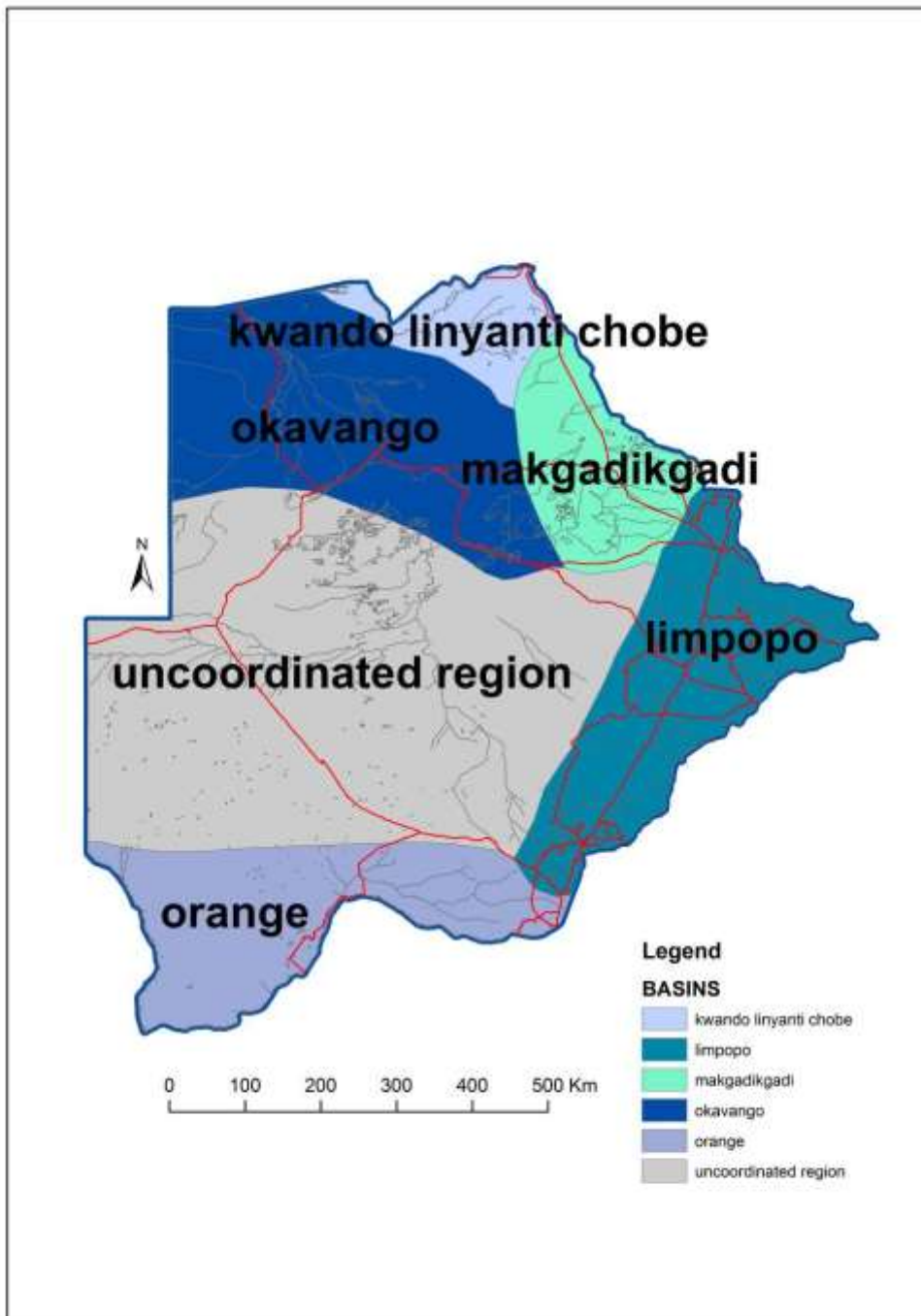


Figure 2 River (sub) basins of Botswana



At national scale level, the territory of Botswana, including areas without active surface drainage, is usually subdivided into the following river (sub)-basins (Figure 2):

- i. Limpopo Basin in eastern Botswana;
- ii. Okavango Basin in north west Botswana;
- iii. Linyanti Chobe-Zambezi Basin in northern Botswana;
- iv. Makgadikgadi/Nata Basin in central-eastern Botswana;
- v. Molopo-Nossop (sub)Basin (part of Orange-Senqu basin) in south-western Botswana; and
- vi. Central Botswana is not part of specific active river basins, but it is sometimes partly considered part of the Okavango and/or Molopo-Nossob basin.

In Botswana, river basin boundary issues emerge with respect to the Makgadikgadi-Nata River basin, which is sometimes considered part of the Okavango River Basin and with the Okavango and Linyanti- Chobe-Zambezi River Basins, where the Linyanti-Chobe is linked to the Okavango Basin via the ephemeral Makgwegwane River and the Selinda spillway.

The Central Botswana area does not have actively flowing rivers or tributaries and is as such not part of any river basin. In terms of topography, however, i.e. on the basis of watersheds, Central Botswana can be (partly) assigned to the Okavango and/or Molopo/Nossob basins.

The area extent of the individual (sub) basins differs enormously as shown in Table 1, partly depending upon the actual demarcation of the basin.

Table 1: Drainage (sub) basins Botswana

	Drainage Basin	Area (km ²)	Districts, incl. portions of
1	Limpopo	80 000	North –East, Central, Kgatleng, Kweneng, Southern, South-East
2	Makgadikgadi	30 000	Central
3	Okavango	97 000	Ngamiland
4	Kwando/Linyanti/Chobe	26 000	Chobe, Ngamiland
5	Molopo/Nossop	71 000	Southern, Kgalagadi
6	Uncoordinated/Central	259 000	Ghanzi, Kgalagadi, Central

Sources: DSM, 2001 & DWA, 2013

The basins also differ in their physical characteristics. The Molopo/Nossop, for example, experiences negligible flow, while the Limpopo is semi-perennial. Groundwater resource management is therefore of extra importance in the Molopo-Nossop sub-basin.

A second step is to overlay and integrate groundwater into the river basins. Figure 3 shows aquifer yield and major well-fields across the country. Groundwater resource management can be zoned to suit the extent of the river basins in a flexible manner. The management of boreholes (Figure 4) can also be aligned with the river sub-basins.

Apart from physical differences, the basins are very different in terms of their socio-economic development and resident populations. The bulk of the national population and economic activities occurs in the Limpopo basin as do the major water-storage dams. Consideration

must therefore be given to subdividing the Limpopo basin for management purposes (e.g. into northern, middle and southern sections).

Figure 3: Aquifers and river basins

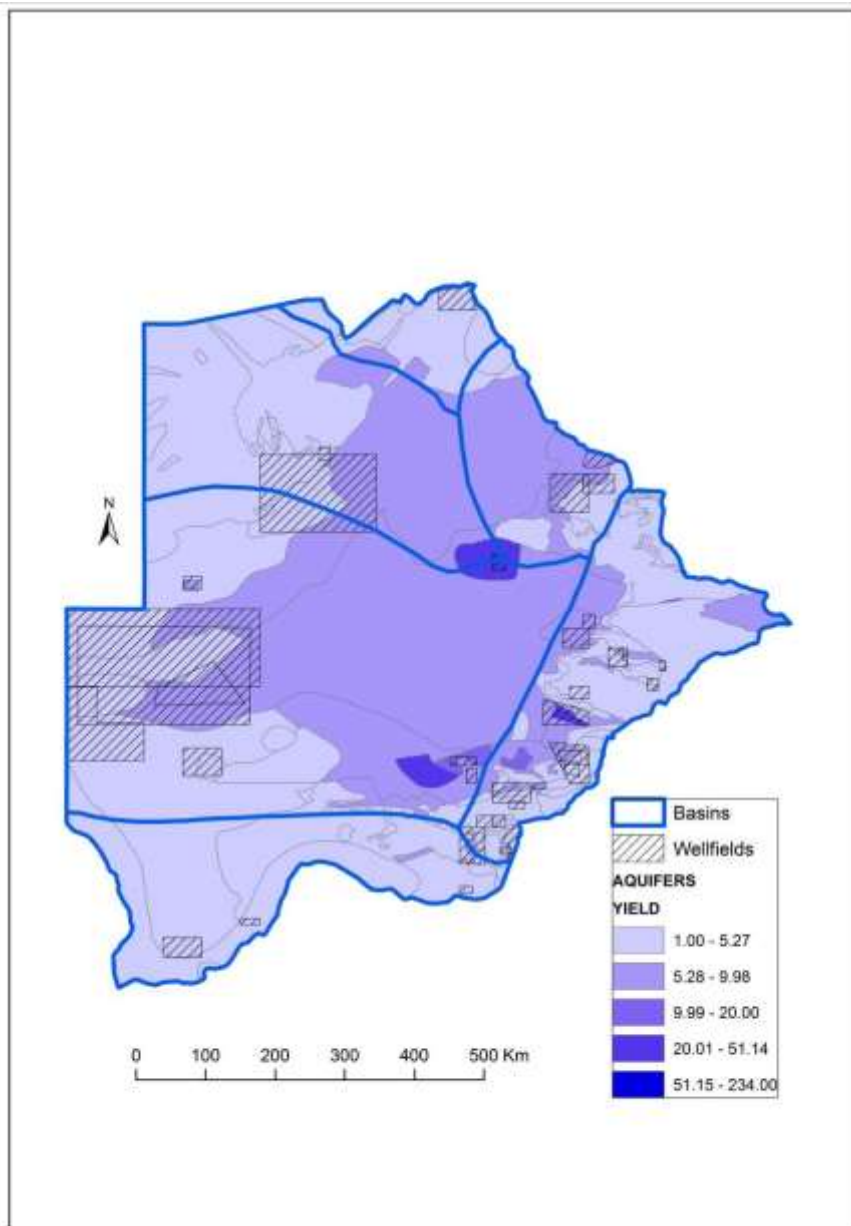
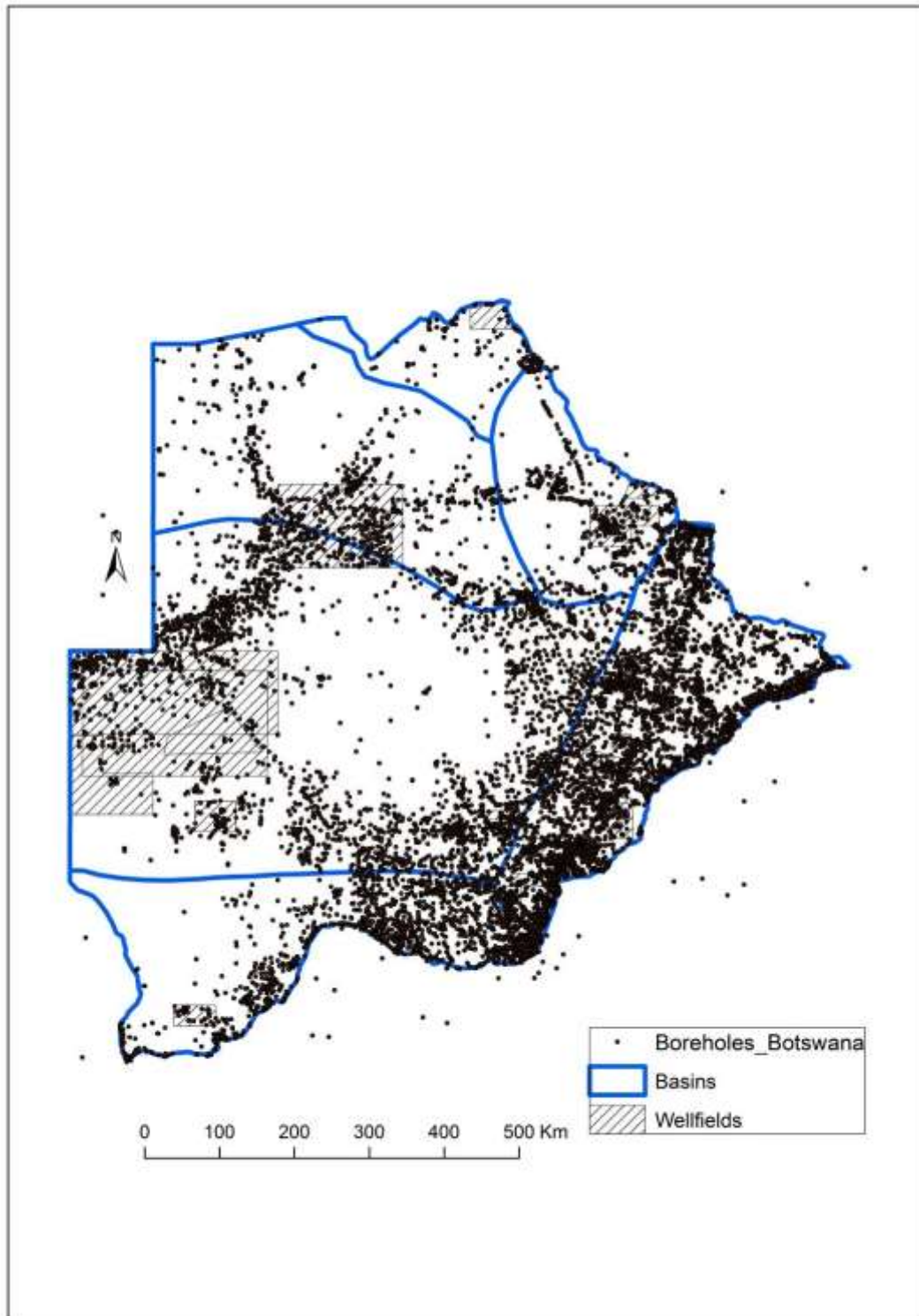


Figure 4: Boreholes and river basins



There is currently scope (and need) for improvement of the basic data about Botswana's river basins, including their delimitation, drainage networks, measuring stations and their data as well as groundwater data.

3.2 Criterion 2: Relevance for national IWRM

IWRM principles guide water resource management within the SADC region and within Botswana. Almost all surface water in Botswana consists of shared water (as is the case in most southern African countries). Botswana participates in transboundary river basin management committees to manage shared water resources. This applies to the Okavango (OKACOM: Angola, Botswana, Namibia), the Limpopo (LIMCOM: Botswana, Zimbabwe, South Africa, Mozambique), the Zambezi (ZAMCOM: Botswana, Namibia, Zambia, Zimbabwe, Mozambique) and the Orange (ORASECOM: Botswana, Namibia, South Africa, Lesotho). The Makgadikgadi-Nata is also a shared water resource (with Zimbabwe), but it is sometimes incorporated into the Okavango basin. National level input is required for these transboundary organisations, but relevant WRMAs should also be represented and contribute to management.

Currently, the DWA regions are not yet firmly defined and established. This offers the opportunity to align them with the WRMAs to facilitate the implementation of the IWRM-WE Plan and the Water Policy. In other words, the current DWA regions can be taken into account but there is flexibility for adjustments of the number and the current boundaries of the DWA region.

3.3 Criterion 3: Suitability for water Accounting

WRMAs should be suitable for the production of water and (if possible) other environmental-economic accounts with reference to both data inputs (data collection) and data outputs. Water accounts (supply and use) require data from WUC and self-providers, including mines, irrigation farms, livestock farmers etc. Moreover, for stock accounts, data are required regarding the water stocks in dams, aquifers etc. (DWA and WUC). Monetary accounts require data on the expenditures and revenues associated with water supply and use (DWA, WUC, mines, farmers).

Data outputs for the relevant Water Resource Management Areas can, if necessary, be compiled or aggregated from data collected for areas with different alignment.

The large water self-providers (e.g. mines and irrigation) are site specific and can easily be overlaid on amended river basin maps. Water use by livestock can be integrated into the basin based WRMAs through overlaying the agricultural districts with their associated livestock figures. Livestock numbers can be pro-rated for the relevant (sub) basins. Figure 5 shows the agricultural districts in relation to national river basins.

3.3 Criterion 4: Ease of governance

WRMAs should also be based on 'practicalities', i.e. the regions should be not too large nor too small both in terms of area size and total water supply/demand/use and should take into account existing ministerial or departmental arrangements where possible in order that they can be managed by (relatively small) regional offices.

Currently, there are sixteen WUC water management centres (MC) in the country (Table 2) serving 16 regions. Of these, twelve are in the Limpopo basin which has the largest population and economic base (see Figure 7). There are also eleven regional offices for DWA, which are more evenly spread over the river basins than the WUC MCs. The MCs are partly based on administrative district boundaries and partly on river basin boundaries. See Figures 6 and 7.

Figure 5: Agricultural districts and river basins.

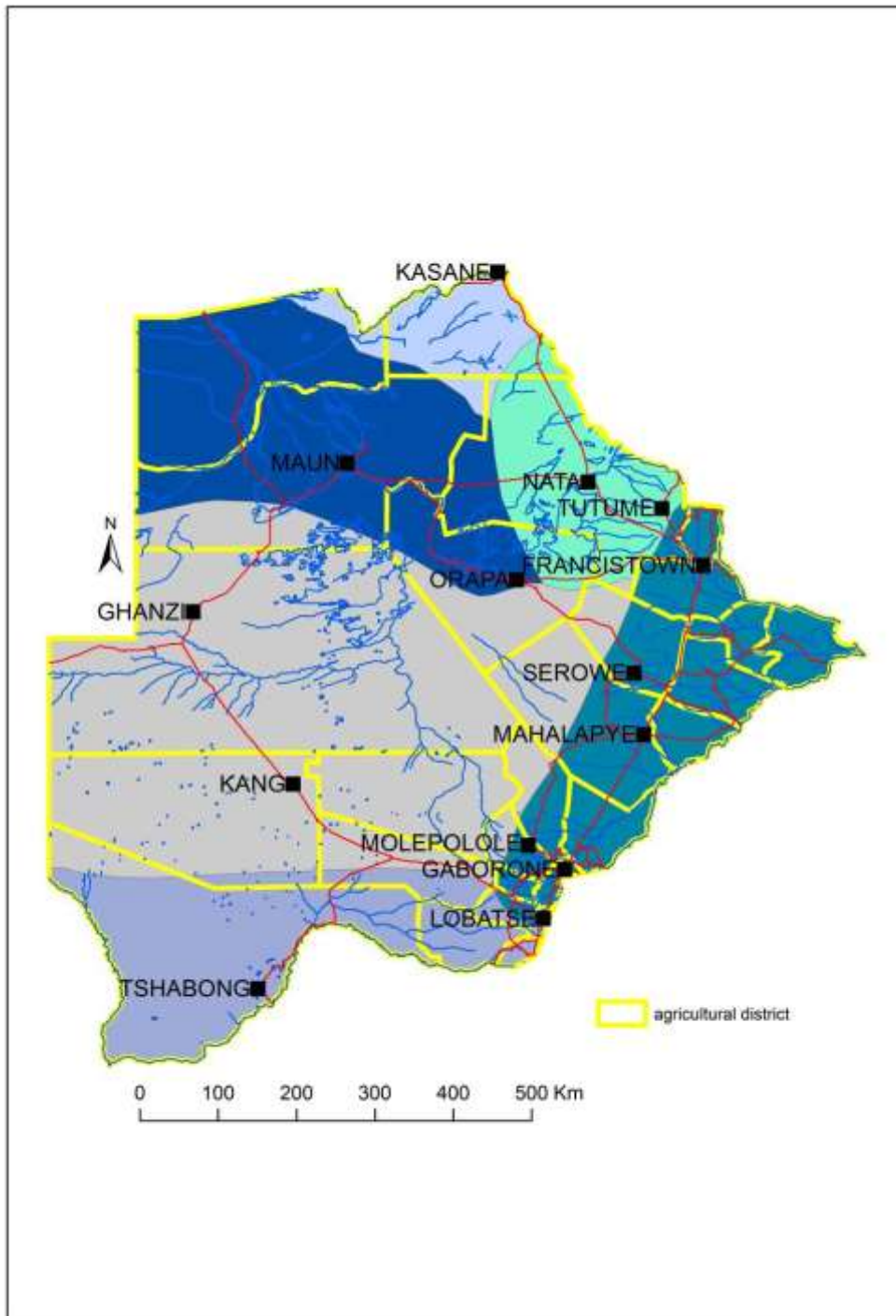


Table 2: WUC MCs and DWA station by river basin and district.

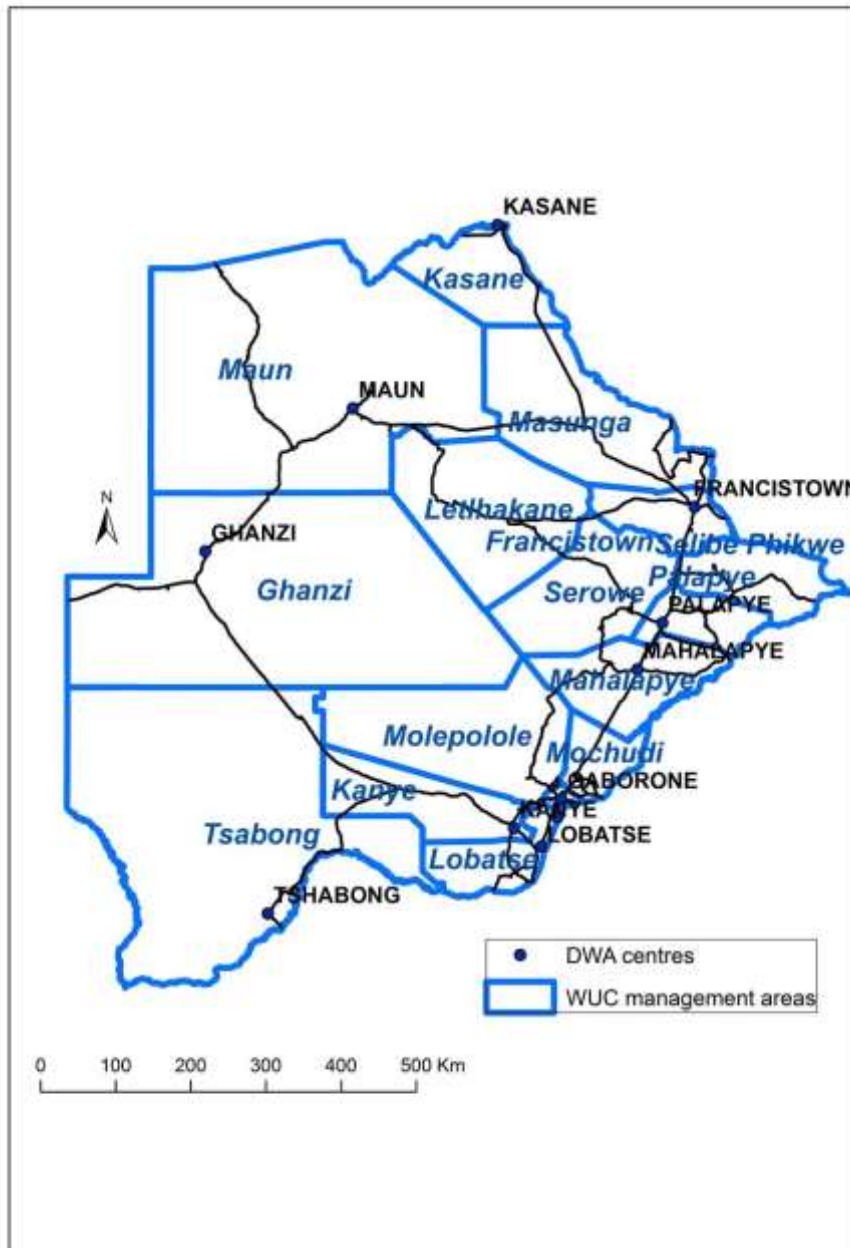
	WUC Man. Centres	DWA regions	Administrative District, including part of:
Limpopo	Masunga		North-East & Central
	Lobatse	Lobatse	Southern
	Mochudi		Kgatleng
	Gaborone	Gaborone/ Ramotswa	South-East
	Palapye	Palapye	Central (sub-district)
	Mahalapye	Mahalapye	Central (sub-district)
	Francistown	Francistown	North East
	Selebi Phikwe		Central (sub-district)
	Molepolole		Kweneng
	Kanye	Kanye	Southern
	Serowe		Central
	Letlhakane		Central (sub district)
Chobe	Kasane	Kasane	Chobe
Orange-Molopo	Tshabong	Tshabong	Kgalagadi
Okavango	Maun	Maun	Ngamiland
		Gumare	
Uncoordinated	Ghanzi	Ghanzi	Ghanzi

Sources: DWA and WUC.

Figure 6: Administrative districts



Figure 7: WUC Management centres



4 WRMA options

Having acknowledged the importance of river (sub)basins as units for integrated water resource management and given the existing situation, there are several options for the (improved) designation of WRM zones on the basis of the criteria mentioned above. These are summarised in the text and in the Table below.

4.1 Option 1: Use of current DWA regions and WUC management centres

Leaving the current situation unchanged (11 DWA regions and 16 WUC Management Centres) is an option and, given appropriate coordination between the DWA and WUC centres, may function satisfactorily. This would, however, not easily lead to improved integrated water resource management as two very different spatial zonations are used and the linkages with the river basins remain vague, particularly for the WUC MCs. Furthermore, it complicates data collection for Water Accounting.

4.2 Option 2: Use of administrative districts (Figure 6)

District administrations used to play an important role in water issues (as providers of water to rural settlements). An option could be to realign WUC and/or DWA centres with the (sub) district administrations. This may improve intersectoral cooperation and data collection but again does not necessarily result in improved integrated water resource management as the links with river basins remain unclear.

4.3 Option 3: Realignment of DWA regions with river basins (Figure 7)

The option that allows for potentially improved integrated water resource management is the re-alignment of DWA centres with the river (sub) basins in the country. The Limpopo basin can be subdivided on account of it having most of the storage dams and most of the national population.

4.4 Option 4: Alignment of WUC MCs and DWA zones to river basins (Figure 7)

This option has the advantage of having both water resource management (DWA) and water usage (WUC) aligned to river (sub) basins, facilitating data collection, compilation and analysis and thus water resource management. However, it is likely to pose challenges to WUC's operation as they have just restructured their organisation in line with their new expanded mandate of water provision to all settlements and wastewater treatment.

Table 3 summarises and evaluates the four options. Additionally, there is a possible intermediate option, which combines a mixture of the previously mentioned criteria. This is

next described as option 5. Options 1 and 2 are least preferred. While option 4 may be best, it is likely to pose difficulties for WUC. So option 3 then becomes the preferred one. This option can be further modified and detailed (see option 5 below).

Table 3: Options for WRMAs

	Options	Assessment	Advantages	Disadvantages
1	Leave WUC and/or DWA zones as they are	Not suitable for WA and decentralised management	no change needed	Existing zones are not designed for water resource management but more for water use allocations. There have been reassignments of tasks between WUC and DWA with DWA concentrating on WRM. DWA zones thus need to be suitable for WRM.
2	Merge DWA zones with WUC zones and align with district admin	Not suitable for WA and decentralised management	Limited admin reshuffling required & this creates more efficiency and might ensure that decisions by WUC, DWA and the District Admins are aligned.	no direct link with River Basin resources Need to fit in groundwater data
3	Leave WUC zones as they are; realign DWA zones by river basins.	Suitable but with WUC data conversion or alignment problems	DWA alignment to river basin resources (and groundwater)	Possibly adverse implications for regional DWA staff. Unclear how this fits into DWA restructuring plan. Possible WUC data conversion problems. Need to fit in groundwater data
4	As 3 and realign WUC MCs with DWA & river basins	Most suitable for WA and decentralised WRM but with difficulties for WUC	WUC & DWA river basin aligned Ease of data collection & WA compilation	Need to restructure WUC (sub-) zones. Difficult with WUC client base (not sufficiently detailed in eastern Botswana) & lots of extra WUC work. Need to fit in groundwater
5	Intermediate: Based on 3 and 4	See below		

4.5 Option 5: WRMA based on basins, adjusted DWA and administrative boundaries

This option is based on the river basins with alignment to administrative (sub) districts (where possible) and adjustment of DWA regions to the resulting WRMA (as shown below).

1.Okavango (Maun): Maun MC plus DWA-Maun-Gumare

This incorporates the Okavango basin aligned with the Ngamiland district.

Justification: WRM based on river basin, while administration coincides with district

NB1. To more fully include the Okavango basin would require for the Boteti region (the Central Boteti (sub) district) to be added. However, there may be need to keep this area separate or to join it to the Makgadikgadi region to create a more manageable area unit.

NB2. If necessary, the Gumare office could be maintained as a satellite station

2.Chobe (Kasane): Kasane MC plus DWA

incorporating the Kwando-Linyanti-Chobe-Zambezi system within the Chobe District

Justification: WRM based on river basin while administration coincides with district

NB. as this is a small region (with important water resources), there may be justification in adding the Makgadikgadi- Nata sub-basin to it. Alternatively, there may be need to keep that area separate or to join it to the Boteti region to create a more manageable area unit.

3.Ghanzi:

incorporating Ghanzi district (mostly groundwater resources)

Justification: WRM based on groundwater resources while administration coincides with district

4.Tshabong:

incorporating the Molopo-Nossob (sub)basin and the rest of Kgalagadi district.

Justification: WRM partly based on river basin while administration coincides with district

5. Boteti/Makgadikgadi-Nata

incorporating the Boteti (sub)basin and the Nata-Makgadikgadi basin coinciding with the Boteti and Tutume sub districts

Justification: WRM partly based on river basin while administration coincides with sub-districts

NB. Alternatives are in this case to add Boteti to the Okavango unit and either keep the Makgadikgadi-Nata as a (small) separate unit or add it to the Chobe unit.

6.Limpopo basin: this is most complex basin where the bulk of the population is concentrated and the storage dams are located. There is need for coordinated integrated water resource management for the entire basin portion in Botswana.

Currently there are 11 MCs wholly or partly concerned with a portion of the Limpopo basin.

It may be necessary to designate one of the MCs as the overall coordinating MC for the Limpopo. Others can be subsidiary, e.g. a northern zone and a southern zone, based on e.g. Francistown and Kanye.

For example:

The northern zone incorporates North-East, Bobonong, Serowe-Palapye and Mahalapye.

The southern zone incorporates Southern, South-East, Kgatleng and Kweneng districts.

Justification: WRM based on river-basin resources; admin hierarchical.

NB1. the western sections of Kweneng and Southern District are not technically part of the Limpopo basin but would need to be included.

NB2. An alternative would be to have 3 Limpopo zones: Northern (North-East, Bobonong), Middle (Serowe-Palapye, Mahalapye) and Southern (Southern, South-East, Kweneng, Kgatleng) Limpopo zones.

Option 5 would generate 6-8 WRMA. But possibilities exist to reduce the number (e.g. combining Ghanzi and Tshabong and only 2 Limpopo WRMA instead of 3)

Table 4 provides a summary of the intermediate option as described above. The maps in the Appendix show examples for possible zonation options (Makgadikgadi-Nata as a separate zone or combined with other zones and 2 or 3 Limpopo zones).

Table 4: Intermediate option for WRMA.

	(D)WA Zone	Link with current zones	Comments	Justification
1	Okavango	Maun MC plus DWA-Maun-Gumare	Incorporating the Okavango basin aligned with the Ngamiland district and (optionally) the Central Boteti (sub) district	WRM based on river basin, while administration coincides with district
2	Chobe	Kasane MC plus DWA	Incorporating the Kwando-Linyanti-Chobe-Zambezi system within the Chobe District (optionally the Nata Makgadikgadi basin could be added to it).	WRM based on river basin while administration coincides with district
3	Ghanzi		Incorporating Ghanzi district (mostly groundwater resources)	WRM based on groundwater resources while administration coincides with district
4	Tsabong		incorporating the Molopo-Nossob (sub)basin and the rest of Kgalagadi district.	WRM partly based on river basin while administration coincides with district
5	Boteti/Makgadikgadi-Nata	incorporating the Boteti (sub)basin and the Nata-Makgadikgadi basin coinciding with	Alternatives are in this case to add Boteti to the Okavango unit and either keep the Makgadikgadi-Nata as a (small) separate unit or add it to the Chobe unit.	WRM partly based on river basin while administration

		the Boteti and Tutume sub districts		coincides with sub-districts
5-7	Limpopo basin	currently there are 11 MCs concerned with a portion of the Limpopo basin. It may be necessary to designate one of the MCs as the overall coordinating MC for the Limpopo. Others can be subsidiary, e.g. a northern zone, a middle zone and a southern zone, based on e.g. Francistown, Palapye and Kanye	this is the most complex basin where the bulk of the population is concentrated and the storage dams are located: there is need for coordinated water resource management for the entire basin portion in Botswana; western sections of Kweneng and Southern District are not technically part of Limpopo basin but would need to be included. Sub division in 2 or 3 (sub)regions is recommended.	WRM based on river-basin resources; admin hierarchical

5 Conclusions and next steps

DWA wishes to reach agreement about scientifically sound, relevant, acceptable and workable WRMAs to decentralise water resource management. This paper has reviewed options and identified at least two options (3 and 5) that are relevant and sound and appear workable. This needs now to be tested in consultations where the acceptance also needs confirmation.

The next steps are:

- a. DWA needs to initiate country-wide and sectoral stakeholder discussions to review WRMA options; this (amended) paper could serve as the starting point of the consultations;
- b. Revision of the WRMAs based on the results of the stakeholder consultations;
- c. Amendment of the DWA regions to the new WRMAs;
- d. Establishment of WRMA management institutions; and
- e. Development of WRMAs water accounts.

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APPENDIX with additional MAPS (NB: separate file).

LIST OF MAPS

Figure A. Option: Existing situation maintained (16 WUC MCs, 11 DWA regional offices) .

Figure B. Option: Align Water Resource Management with District administration.

Figure C. Option: Use sub(Basins) as Water Resource management units.

Figure D a-e Intermediate (Combined) option with variations

a Basins aligned with Districts with 2 Limpopo zones and Boteti joined to Okavango, Makgadikgadi-Nata joined to Chobe.

b Basins aligned with Districts with 2 Limpopo zones and Boteti joined to Okavango; Makgadikgadi-Nata separate

c Basins aligned with Districts with 2 Limpopo zones and Boteti /Makgadikgadi-Nata as a separate unit.

d Basins aligned with Districts with 3 Limpopo zones, Boteti joined to Okavango, Makgadikgadi-Nata joined to Chobe

e Basins aligned with Districts with 3 Limpopo Limpopo with 3 zones, Boteti /Makgadikgadi-Nata as a separate unit