# THE SEARCH FOR AN EQUITABLE BASIS FOR WATER SHARING IN THE OKAVANGO RIVER BASIN

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## Introduction

Escalating water scarcity in southern Africa is widely accepted as posing the greatest challenge to sustainable development in the region (Falkenmark, 1989; Conley, 1995; SARDC, 1996; Shela, 1996). The situation is particularly acute in the more arid portions of the sub-continent where water scarcity and associated increases in water pollution are often also linked closely to poverty, hunger and disease (Pallett, 1997; Gleick, 1999; FAO, 2000). Where water supplies are insufficient to meet human needs or are unreliable, the circumstances become difficult to resolve in situations where sufficient water is also needed to maintain the functioning of sensitive aquatic ecosystems and to protect the integrity of water resources (Falkenmark, 1994, 1999; Ashton, 2000a). These apparently conflicting needs (human needs versus ecosystem needs) have led to increasing competition for progressively scarcer water resources (Khroda, 1996). A further complication is that most of the larger river basins within southern Africa are shared by more than one country (e.g. the Zambezi, Okavango, Orange and Limpopo rivers). The question of who should be allowed to use how much water and for what purpose becomes extremely sensitive under these circumstances (Biswas, 1993; Ashton, 2000a; FAO, 2000).

The diversity of water users in the countries making up the Okavango River basin, together with their current and future needs, provides an ideal example of the complex and conflicting demands between human development interests and ecological interests (Ashton, 2000a). In particular, considerable local and international attention has been focussed on the unique ecosystems making up the Okavango Delta, as well as the possible consequences that may adversely affect these ecosystem components if the water resources are not managed sensitively and cautiously (Greenpeace, 1991; IUCN, 1993; Ramberg, 1997). Clearly, both human and ecosystem perspectives must be taken into account if an equitable and sustainable solution is to be found (Ellery & McCarthy, 1994; Ashton, 2000b).

It is vitally important that the water resources of the Okavango River basin are managed in a sustainable way so that the current and projected future needs of the three basin states (Angola, Botswana and Namibia) can be met in an equitable and sustainable manner, whilst still retaining the diverse array of ecosystem services and goods that are derived from the system. In order to achieve this, the individual basin states need to reach consensus on three critical issues, namely:

- The specific water requirements needed to sustain the sensitive aquatic ecosystems;
- The quantities of water that each country can justifiably claim for their own (consumptive) use; and
- The manner in which the water resources will be managed in future.

This paper examines the geographical and political context of water resource management in the Okavango River basin and highlights a series of possible options for consideration by water resource managers in the governments of the three basin states concerned. The anticipated consumptive water needs in each basin state are quantified, though the specific water requirements of the aquatic ecosystems in the Okavango River and Okavango Delta have not been defined here.

## The geographical and hydrological context

The catchment of the Okavango River basin straddles a transitional rainfall region located between the Inter-Tropical Convergence Zone (ITCZ) in the north and the Sub-Tropical High Pressure Zone (STHPZ) in the south. Year-to-year shifts in the boundaries of these two zones, plus the influence of the El Nino Southern Oscillation (ENSO) system, account for a large proportion of rainfall variability. Rainfalls across the Okavango catchment are highly seasonal and occur during the austral summer months, most often as high-intensity convective thunderstorms (McCarthy *et al*., 2000). Average rainfalls over the catchment are low in the south, increasing almost four-fold to higher rainfalls in the north (**Figure 1**). The variation in rainfall over the catchment gives rise to correspondingly wide differences in the relative contributions to runoff that each basin state provides to the Okavango River (CSIR, 1997; Ashton, 2000a, 2000b). The contributions made by each basin state to the surface runoff and flows entering the Okavango Delta are summarized in **Table 1**.

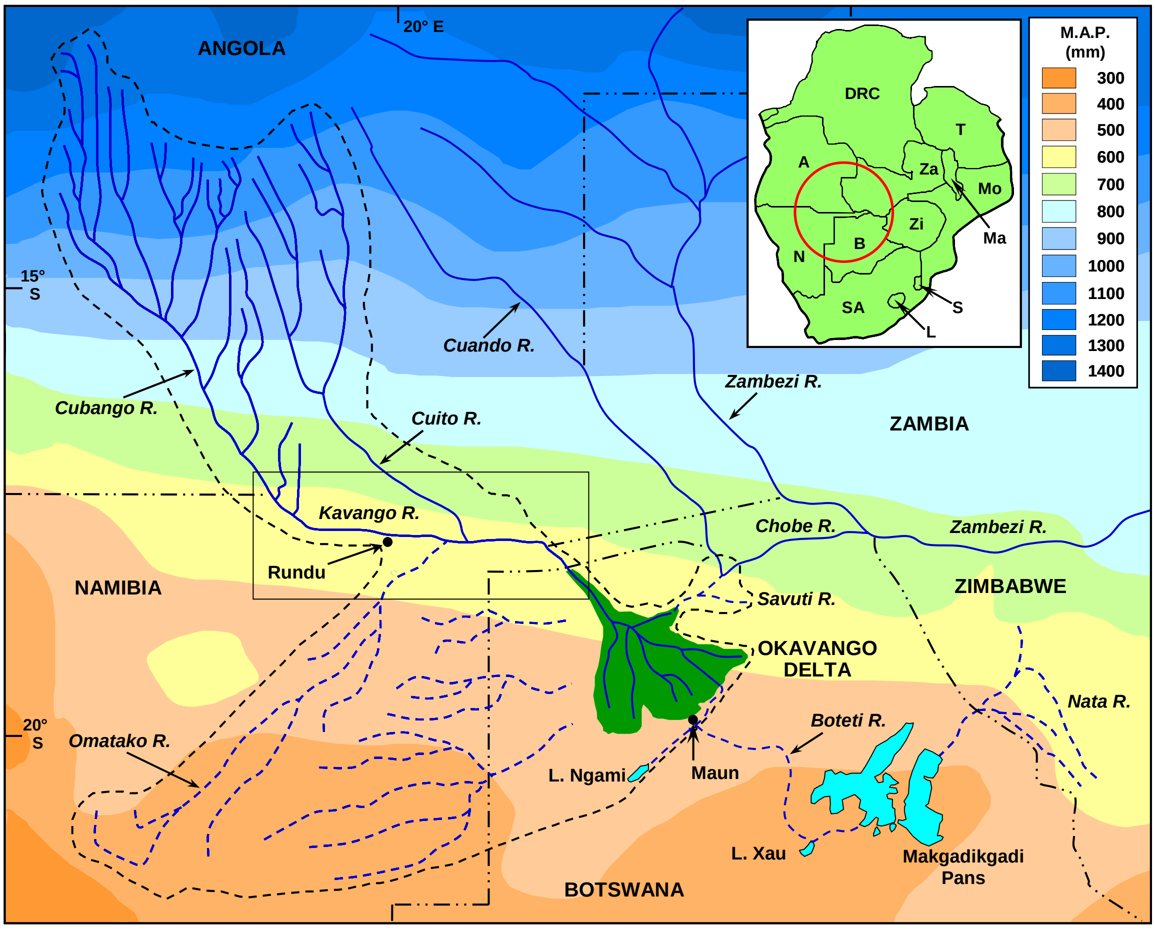


**Figure 1**: Sketch map of the Okavango River catchment, showing the distribution of mean annual rainfall isohyets (mm) and the different tributary rivers of the Okavango system. Rivers indicated by dashed lines do not provide surface runoff to the Okavango Delta. Inset shows the position of the Okavango River catchment in southern Africa. Inset box indicates the area enlarged in **Figure 2**.

The Okavango River rises in the central highlands of Angola as two main tributary systems, the Cubango and Cuito rivers. These flow in a south-easterly direction through progressively drier terrain towards north-eastern Namibia where they meet to form the Okavango River (**Figure 1**).

From the small towns of Katwitwi in the west to Mukwe in the east (**Figure 2**), the international border between Angola and Namibia is located in the centre of the main Okavango River channel. At Mukwe, the Okavango River turns southwards, flowing across the narrow Caprivi Strip of Namibia, before entering Botswana and emptying into the Okavango Delta (**Figure 2**).

**Table 1**: Summary table showing the areas of the three countries comprising the Okavango Delta catchment and their individual contributions to inflows and the overall Okavango Delta water balance. (Figures for average rainfalls and Delta inflows have been rounded off).

| Basin Country | Component Catchment Area ($km^2$) | Average Rainfall (mm) | Annual contribution to Delta Inflows | | Inputs to Total Delta Water Balance (%) |
|---|---|---|---|---|---|
| | | | ($Mm^3$) | (%) | |
| *Angola* | 151,200 | 873 | 9,572 | 94.45 | 71.76 |
| *Botswana*:<br>-River only<br>-Direct rainfall onto Delta only | <br>58,350<br>15,844 | <br>480<br>486 | <br>265<br>3,205 | <br>2.62<br>- | <br>1.99<br>24.03 |
| *Namibia* | 123,560 | 427 | 297 | 2.93 | 2.22 |
| *Totals*:<br>• Basin only | <br>333,110 | <br>639 | <br>10,134 | <br>100.00 | <br>- |
| • Basin + Delta | 348,954 | 632 | 13,340 | - | 100.00 |

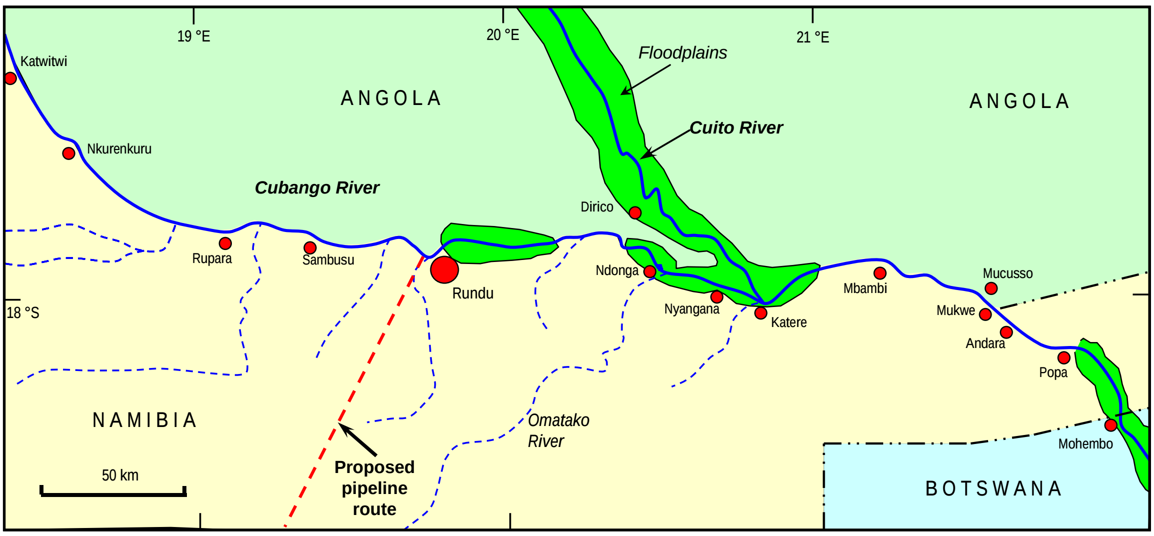


**Figure 2**: Sketch map of the north-eastern portion of Namibia, showing the location of the Cubango, Cuito and Okavango rivers in relation to local towns and international boundaries. The extensive floodplain areas along the rivers are shaded for emphasis, whilst seasonal or ephemeral rivers are indicated by dashed lines.

Along its course from the foothills of the Angolan highlands to the Okavango Delta, the Okavango River and its major tributaries function as a "linear oasis" in an otherwise relatively arid area (Ashton, 2000a). During years of exceptionally high flows in the Okavango River, outflows from the Okavango Delta feed the Boteti River and, ultimately, the Makgadikgadi Pans in Botswana (Wilson & Dincer, 1976). The Makgadikgadi Pans are also fed by seasonal and episodic flows from the Nata River in western Zimbabwe (**Figure 1**). Other, smaller tributary rivers rise in north-eastern Namibia but have not carried surface flows into the Okavango River or Okavango Delta in living memory (CSIR, 1997; Ashton & Manley, 1999). They are shown in **Figure 1** for completeness, since they indicate that the catchment segments they drain do not contribute inflows to the Okavango Delta (Ashton, 2000a; Ashton & Manley, 1999).

The catchment of the Okavango Delta comprises some 331,110 km$^2$, with an additional 15,844 km$^2$ contributed by the wetland area of the Okavango Delta plus its islands. Some 42.5% of the catchment area is considered to be "non-functional", since it receives very low rainfalls and, because of high potential evaporation rates, contributes no surface runoff or ground water inflows to the Okavango Delta (CSIR, 1997; **Table 1**). Recent estimates indicate that direct rainfall onto the Okavango Delta contributes an additional 3,205 Mm$^3$ (24%) of water to the Okavango Delta with the remaining 10,134 Mm$^3$ (76%) provided by surface and ground water inflows via the inflowing Okavango River (Ashton, 2000a; McCarthy *et al*., 1998, 2000). Overall, the Angolan portion of the Okavango catchment provides some 94.5% of the total runoff in the Okavango River, whilst some 2.9% originates in Namibia and the remaining 2.6% is contributed by Botswana (CSIR, 1997; **Table 1**).

Prolonged periods of severe drought during the 1980s and 1990s reduced average annual flows in the Okavango River by between 15% and 45% (McCarthy *et al*., 2000). Flows in almost every southern African river system have shown similar patterns of declining flows during the last twenty years. This pattern seems likely to be part of an eighty-year cycle of high and low flows that has been experienced in every southern African river system (McCarthy *et al*., 2000).

## The socio-economic and political context

In the Okavango River basin, the prolonged droughts have resulted in rural communities becoming progressively more impoverished. Consequently, many people have migrated towards urban centres along the Okavango River and the fringes of the Okavango Delta in search of drought relief. There is a clear and pressing need to relieve the problems faced by these people and to provide adequate water supplies for their growing needs. In addition to the need to provide water for domestic purposes, there is also an urgent need to expand the agricultural sector so that additional food can be grown the meet the needs of the growing population. This situation is particularly acute in Angola (FAO, 1995b, 1997) where the prevailing civil war has prevented any form of organized agricultural development in the Angolan segment of the Okavango catchment.

The northern border regions of Namibia are relatively remote from the main centres of development and population, and Namibia currently uses very little water from the Okavango River (Ashton, 2000a). At present, the few small-scale irrigation schemes located along the Okavango River in Namibia are insufficient to meet local food needs and will need to be expanded in future. Namibia has also communicated its intention to withdraw water from the Okavango River along the Namibian border with Angola, to meet the growing water deficits in the Central Areas of Namibia (Heyns, 1995a, 1995b; Republic of Namibia, 2000). Clearly, any such water abstractions will need to be arranged in collaboration with the other two basin states (Ashton & Manley, 1999). Recent Angolan military activities along Namibia's northern border with Angola have forced many Namibian communities to leave the Okavango River and move southwards to areas where hand-dug wells provide the main or only sources of water.

Small-scale irrigation developments (approximately 25 hectares in total area) located alongside the "Panhandle" section of the Okavango Delta in Botswana currently use relatively little water. However, there are plans to expand the irrigated area to over 150 hectares, and possible options are being examined to initiate additional irrigation schemes in areas where suitable soils occur (Ashton, field observations and unpublished data). In addition, more attention is being focused on the use of surface and ground water for domestic purposes in the small towns and communities located around the fringe of the Okavango Delta (MGDP, 1997). Recently, small pipelines have been installed along the western fringes of the Okavango Delta and Panhandle to provide potable water to communities in this region (Ashton, personal observations, August 2001). Clearly, this type of development is essential if the growing domestic needs for water are to be met in Botswana. Nevertheless, despite the very small quantities of water that are currently used from the Okavango River, the Botswana Government and a variety of non-governmental organizations (NGOs) remain concerned that proposals for new water developments in the upper and middle reaches of the Okavango River, as well as those within Botswana, may pose a serious threat to the ecological integrity and functioning of the Okavango Delta (Greenpeace, 1991; IUCN, 1993; Ramberg, 1997).

Once peace has been restored in Angola, growing populations and potential future agricultural developments and water abstraction schemes in the three basin states will be accompanied by escalating demands for water. This will place progressively greater pressure on the Governments concerned to reach some form of new consensus around acceptable levels of water exploitation from the Okavango River system. In turn, this will require each of the three states to reach agreement on the issue of exactly what constitutes a "fair and equitable" share of the available water that each state may claim a right to.

## Water rights versus water needs

International law (ILA, 1966; ILC, 1994; UN, 1997) technically entitles Angola, Botswana and Namibia to develop water systems that flow within the boundaries of their territories or to which they are riparian, provided that such developments do "…not cause appreciable harm" to other states that share portions of the same river basin. This right is confirmed in terms of the SADC Protocol on Shared Water Course Systems (Heyns, 1995a; SADC, 1995). As the lowermost basin state, Botswana is in a "vulnerable" position and would clearly like to ensure that its interests are not unduly prejudiced by any developments that may take place upstream in Namibia and Angola (IUCN, 1993; CSIR, 1997). At present, the quantity of water needed by the Okavango Delta in Botswana (in terms of ecological flow requirements) cannot be defined precisely, yet must represent a very large proportion of the total flows in the Okavango catchment. In effect, therefore, whilst Botswana provides a small quantity of water from within its own territory, the ecosystem "needs" of the Okavango Delta will undoubtedly represent the single largest water use in the catchment.

The Governments of Angola, Namibia and Botswana see the judicious (small-scale) use of water from the Okavango River (Angola and Namibia) or Okavango Delta (Botswana) as entirely legitimate from a territorial sovereignty viewpoint (Republic of Botswana, 1990; Heyns, 1995b; SADC, 1995). To date, none of the proposed water abstraction schemes (UNDP, 1976; SMEC, 1987; Heyns, 1995b) have yet been implemented and each country continues to rely on existing (small-scale) run-of-river abstractions and on the exploitation of nearby ground water supplies (MGDP, 1997).

The Government of Botswana has long recognized that the Okavango Delta is a unique and valuable resource, particularly in terms of its conservation and tourism value (IUCN, 1993;

Ramberg, 1997), and through its provision of a wide variety of ecosystem services and goods to local residents (FAO, 2000). Local and international non-governmental organizations strongly support this view and their concern is reflected in the designation of the Okavango Delta as a Ramsar site (Ramberg, 1997). Concern by Botswanan and international organizations to conserve the unique ecosystems that make up the Okavango Delta underpinned opposition to earlier Namibian plans to abstract water from the Okavango River and Botswanan plans to increase outflows from the Okavango Delta (Greenpeace, 1991; IUCN, 1993; Ramberg, 1997). Whilst it can be argued that this support has strengthened Botswana's otherwise "unfavourable" position as the lowest riparian state in an international river basin, this strategy has also effectively limited the range of development options that are open to Botswana (Ashton, 2000a).

The question of "equity" lies at the centre of almost all disagreements over water sharing. Essentially, this issue should be the basis upon which waters in a river basin will be shared (UN, 1997). However, because the term "equity" is vague and often undefined in international law, it has been applied in a variety of ways, with different degrees of success (Wolf, 1999; FAO, 2000; van der Zaag *et al*., 2000). For example, some countries sharing a river basin have argued that water resources should be apportioned on the basis of "the rights of prior (established) use"; other countries take the view that water "shares" should be based on the proportion of runoff contributed by each of the states forming the river basin (Mwiinga, 2000). The variety of possible positions makes it difficult for individual states to reach agreement. Legal mechanisms, similarly, are seldom available to enforce whatever principles of equity may have been agreed upon by the different parties (Wolf, 1999; van der Zaag *et al*., 2000).

More recently, there is increasing acceptance that the application of the principles inherent in "equity" requires parties to move away from claims for water based on various real or perceived "rights", to one where the parties motivate their "needs" for specific quantities of water. There seem to be several reasons why this move has occurred, but it is important to note that it is far easier for a country to quantify and justify its *needs* for water, than to provide the same level of support for its real or perceived *right*s to water (Wolf, 1999; Ashton, 2000a; van der Zaag *et al*., 2000).

In the Okavango River basin, a needs-based approach to water sharing offers a far greater prospect of the basin states reaching agreement on each state's fair and equitable share of the basin's water resources, than does a "rights-based" approach. To achieve this, it will be important for each of the basin states to agree on the mechanisms that will be acceptable for:

- Deriving quantitative estimates of each country's *needs* for water;
- The basis for estimating or (preferably) calculating the "fair and equitable" share of the catchment's water that each country can reasonably expect to receive; and
- The procedural and institutional mechanisms whereby the water resources of the catchment will be managed in the future.

**Estimates of water needs in the basin states**

In any attempt to estimate and evaluate the water needs within a river basin, it is important to distinguish between the supply of water (usually as direct rainfall onto the catchment surface), which is required to maintain essential terrestrial ecosystem services and their associated ecosystem goods, and the water that is subsequently available in river (and ground water) systems for direct utilization by people and for the maintenance of aquatic ecosystems (Falkenmark, 1999). In the past, most attention has been paid to the second of these two categories, the so-called "blue water"; this water is relatively easy to manipulate, manage and allocate by means of conventional engineering solutions. In contrast, the so-called "green water", consists predominantly of the water in soils and vegetation that can only be manipulated or influenced through changes in land use (Falkenmark, 1999; Rockström *et al*., 1999; FAO, 2000; Ashton, 2000a; van der Zaag & Savenije, 2000).

Increasing attention is now being paid to understanding the dynamic inter-relationships between “green” and “blue” water that underpin essential terrestrial and aquatic ecosystem services (Falkenmark, 1999; FAO, 2000). The available evidence indicates clearly that all “green” water and a proportion of “blue” water are needed to sustain terrestrial and aquatic ecosystem structures and functions, and maintain sustainable water supplies (Ellery & McCarthy, 1994; FAO, 2000). The two key implications here are that:

- Virtually none of the “green” water should be considered as available for re-allocation and alternative use within a basin state, except where the “green water” can be made available through changes in land use; and
- Whilst most of the “blue” water should be considered as available for allocation and direct use by society, a proportion must always be reserved for the maintenance of essential ecosystem functions and services (Falkenmark, 1999; FAO, 2000).

Against this background, estimates of the consumptive water needs of the three basin states comprising the Okavango River basin (Angola, Botswana and Namibia) have been based on projections of population numbers and growth rates, as well as data on current land use patterns (FAO, 1995a, 1995b; CSIR, 1997; Ashton, 2000a; UNAIDS, 2000a, b, c). The population data and projections presented in **Table 2** reflect the most recent estimates for the population growth rates of the three countries (FAO, 1995a; UNAIDS, 2000b; Ashton & Ramasar, 2001) and take into account the dramatic implications of the HIV/AIDS pandemic that is sweeping Africa (Karim, 2000; Lurie, 2000; UNAIDS, 2000a, b, c; Whiteside & Sunter, 2000; Ashton & Ramasar, 2001; World Bank, 2001), though they do not account for possible immigration or emigration due to the Angolan civil war (Ashton, 2000a). The available data indicate that population growth rates in the three basin states (**Table 2**) have declined by between 32% (Angola) and 71% (Botswana) during the last two years as a direct result of the extraordinary increase in HIV/AIDS prevalence recorded in each country (UNAIDS, 2000a, b, c; Ashton & Ramasar, 2001).

**Table 2**: Anticipated population growth trajectories in the Angolan, Botswanan and Namibian segments of the Okavango catchment until the year 2020.

| **Basin Country** | **Annual Population Growth (%)** | **Total Basin Population (Millions)** | | |
|---|---|---|---|---|
| | | **2000** | **2010** | **2020** |
| Angola | 2.15 | 849,882 | 1,051,338 | 1,300,547 |
| Botswana | 0.76 | 119,616 | 129,024 | 139,172 |
| Namibia | 1.57 | 143,675 | 167,895 | 196,197 |
| **Basin Total:** | - | 1,113,174 | 1,348,257 | 1,635,916 |

The population estimates for Namibia and Botswana appear to be reasonably reliable since they are based on confirmed census data (UNAIDS, 2000b, c). In contrast, the population estimates for Angola are uncertain because of the civil war raging in that country. Nevertheless, the Angolan estimates presented here have been derived from information presented by the FAO (1995a, 1995b, 1997) and are the best available.

From **Table 2**, it is estimated some 76% of the Okavango River basin’s total population is located within the Angolan segment of the Okavango basin, whilst the Namibian and Botswanan segments of the basin contain 13% and 11% of the basin population, respectively (FAO, 1995a; CSIR, 1997). Within the Angolan segment of the basin, virtually all of the population is concentrated in the uppermost reaches of the Cubango and Cuito sub-catchments, in the eastern and southern portions of the Huila, Huambo, and Bié Provinces (**Figure 3**). The population here is particularly concentrated around the many towns and villages in this region where population densities exceed 700 persons/km$^2$ (FAO, 1995a). Very few people occupy the drier south-eastern segment of the Angolan catchment, in the Cunene, Moxico and Cuando-Cubango Provinces, where population densities are less than 2 persons/km$^2$ and are mostly concentrated along the Cubango and Cuito rivers (FAO, 1995a). In Botswana and Namibia, most of the people who live within the Okavango River basin boundaries are located along the Okavango River in Kavango Province (Namibia) or around the fringes of the Okavango Delta in Ngamiland (Botswana) (CSIR, 1997).

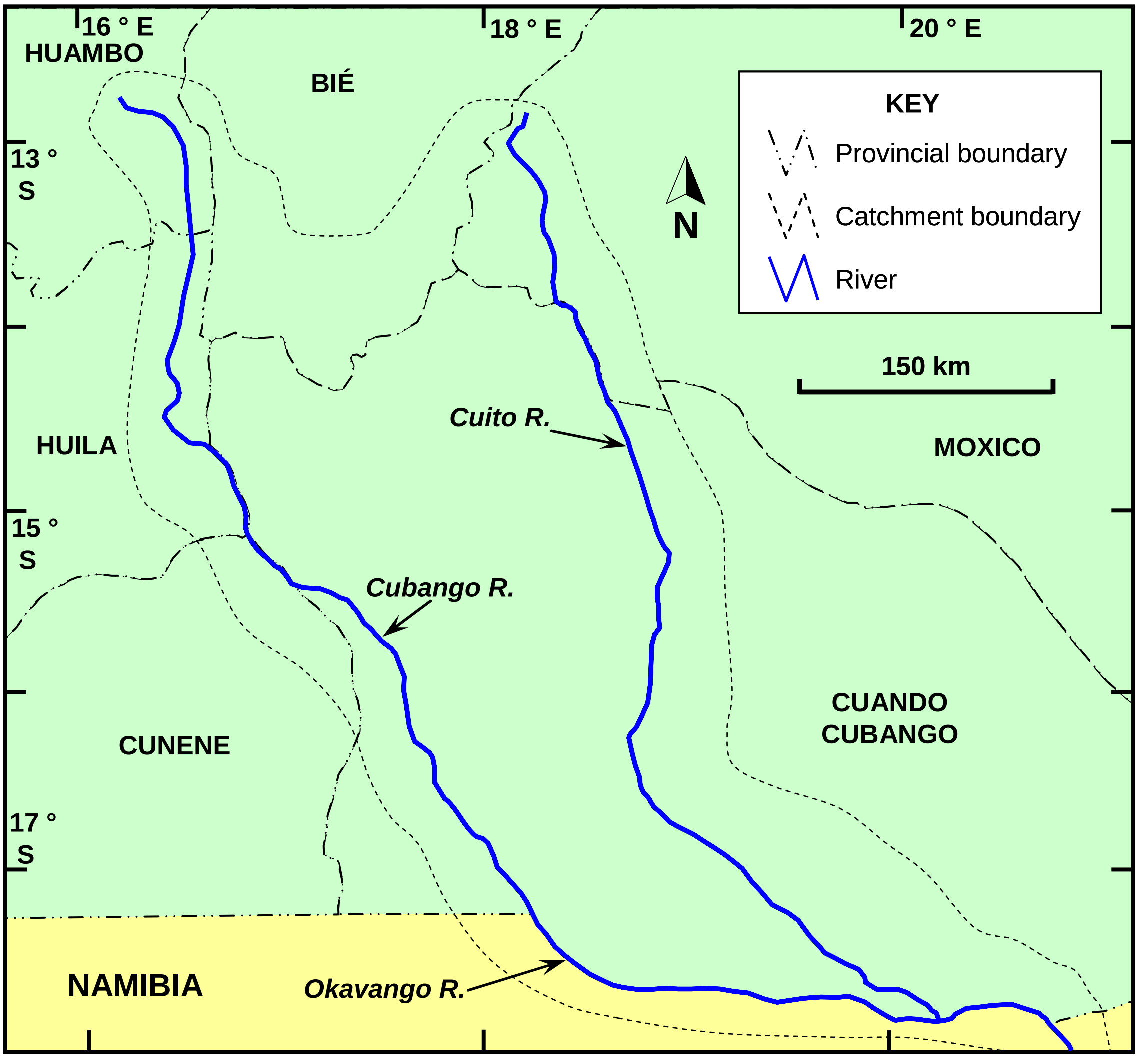


**Figure 3**: Sketch map of the Angolan segment of the Okavango catchment, showing the positions of the Cubango and Cuito rivers and provincial boundaries in southern Angola. (Note: most of the tributary rivers in Angola have been omitted for clarity).

The latest population estimates for 2000 shown in **Table 2**, have been combined with data on land use activities drawn from earlier surveys (CSIR, 1997) and published sources (FAO, 1995a, 1995b), to provide the basis for estimating current patterns of water use for each land use type, within each of the three basin states. In each country, subsistence water needs were estimated at 50 litres per person per day in accordance with World Health Organization recommendations (FAO, 1997; Gleick, 1999). The calculated water demand data for each country are shown in **Table 3**. These data suggest that the total water needed within the catchment during 2000 was likely to amount to some 23.2 $Mm^3$/year; this is approximately equivalent to 0.23% of the mean annual runoff recorded at Mohembo, the primary inflow point to the Okavango Delta. Of this total, Angola would require 13.8 $Mm^3$ (approximately 60%), whilst Botswana and Namibia would need approximately 4.1 $Mm^3$ (18%) and 5.2 $Mm^3$ (22%), respectively. It is important to note that these estimates are purely for consumptive water needs and exclude any allowance for the quantity of water likely to be needed to maintain essential ecosystem services within the Okavango River or the Okavango Delta.

**Table 3**: Breakdown of existing consumptive water demands in the Angolan, Botswanan and Namibian segments of the Okavango catchment, by water use sector, for 2000, based on landuse patterns. (All values in $Mm^3$/year).

| Water Use Sector | Angola | Botswana | Namibia |
|---|---|---|---|
| Subsistence use (Rural) | 5.646 | 1.484 | 1.266 |
| Domestic use (Urban) | 7.445 | 0.699 | 0.813 |
| Stock watering | 0.250 | 0.267 | 0.145 |
| Industrial activities | 0.000 | 0.025 | 0.060 |
| Agricultural activities | 0.500 | 1.220 | 2.830 |
| Tourism facilities (e.g. lodges) | 0.000 | 0.418 | 0.100 |
| **Catchment total**: | 13.841 | 4.113 | 5.214 |

Within each of the three basin states there are small, yet subtle differences in the water use patterns. In Angola, rural and urban populations account for some 95% of all the water used, primarily for subsistence and domestic use. This reflects the almost complete absence of irrigated agriculture in the Angolan segment of the Okavango basin (FAO, 1995b, 1997) as a result of the ongoing civil war. In contrast, the rural and domestic water use sectors use considerably less water in Namibia and Botswana, whilst agricultural activities (principally small-scale irrigation and subsistence agriculture) consume between 30% (Botswana) and 54% (Namibia) of all the water used.

Against this background, it is important to estimate the likely future needs for water that each of the basin states may have in the medium-term (20 years). To achieve this, two scenarios were selected:

A. No change in the current patterns of water use within each water use sector; water needs increasing only as a result of population growth, taking into account the reduced population growth rates attributed to the HIV/AIDS pandemic, and not enhanced by new developments; and

B. The same rates of population growth in each basin state as listed in Scenario A, but with additional (new) developments (specifically new irrigation water needs in each basin state and additional water for transfer out of the Okavango basin in Namibia only).

The additional quantities of water referred to in Scenario B consist of the following specific quantities of water:

- An additional 100 $Mm^3$/year required for new irrigation developments in Angola, based on the available area of arable land suitable for irrigation (FAO, 1997). This development has been assumed to increase gradually and evenly from zero, over the twenty-year period, reaching full scale in 2020.
- An additional 50 $Mm^3$/year, comprised of some 45 $Mm^3$/year required for additional irrigation developments along the Panhandle zone of the Okavango Delta in Botswana. This estimate is based on discussions with officials from the Botswana Department of Agriculture in June 2000, plus an estimated need for 5 $Mm^3$/year for additional water supplies for domestic and light industrial use around the town of Maun and for smaller communities around the western fringe of the Okavango Delta). Again, this development has been assumed to increase gradually and evenly from zero, over the twenty-year period, reaching full scale in 2020.
- An additional 120 $Mm^3$/year required for transfer from the Okavango River to the Central Areas of Namibia around Windhoek, to meet projected water shortfalls in that region. This estimate is based on published information (Heyns, 1995a; Republic of Namibia, 2000) and represents the only volume of water that Namibia proposes to transfer out of the Okavango basin. Once again, this development has been assumed to increase gradually from zero over the twenty-year period, reaching full scale in 2020. Importantly, this proposed water transfer from the Okavango River only represents a proportion of the estimated volume of water required to meet Namibia’s future needs for water. The Namibian Government intend to meet the remaining water demand in Namibia by improved water demand management, additional recycling and reuse of effluents, desalination of sea water and transfers from Namibia’s other border rivers (Orange, Cunene, Cuvelai and Zambezi).

The estimated water needs for each of these two scenarios are presented in **Table 4** and were based on field observations (P.J. Ashton, CSIR, unpublished data) and published information (FAO, 1995b, 1997; Heyns, 1995a; CSIR, 1997; Republic of Namibia, 2000). These provide preliminary estimates of possible lower (Scenario A) and upper (Scenario B) limits for the quantities of water likely to be needed by each basin state over the next twenty years. Clearly, the projections of future (domestic) water needs depend heavily on the rates of population growth. These rates may alter dramatically if the HIV/AIDS pandemic worsens even further in the three basin states.

In the lower estimate (Scenario A), water needs would be anticipated to increase by approximately 44% between 2000 and 2020 if there is no change to the current patterns of water use. The amount likely to be needed in 2020 (33.3 $Mm^3$) is equivalent to 0.33% of the mean annual flow at Mohembo, where the Okavango River enters Botswana (**Figure 2**). The implications of this estimate are that the growing populations living within the three basin states would not change their current level of development and would therefore not require larger daily volumes of water per person.

In contrast, Scenario B suggests that the potential increased quantities of water needed to meet possible irrigation developments in the three countries, plus possible water transfers out of the Okavango River basin within Namibia, could lead to a thirteen-fold increase in the total quantity of water needed each year. For comparison, the total quantity of water listed in Scenario B (303.3 $Mm^3$; **Table 4**) is equivalent to 3.0% of the mean annual flow at Mohembo. Of this amount, the consumptive needs in Angola would amount to 40.2%, whilst the consumptive needs in Botswana and Namibia would amount to 17.9% and 41.9%, respectively. Whilst there is clearly a highly significant difference in the quantities of water needed in Scenarios A and B, Scenario B is likely to represent the *maximum* quantity of water (i.e. the worst case scenario) needed from the Okavango basin by the three basin states within the 20 year time-frame evaluated.

The volumes estimated for current use in irrigation agriculture are based on estimates provided for small-scale irrigation developments in the Kavango Province of Namibia (CSIR, 1997), as well as irrigation water estimates for different rainfall regions provided by FAO (1995b, 1997). The volumes of water used in tourist facilities were obtained from field studies in the Kavango Province of Namibia and the Okavango Delta in Botswana (CSIR, 1997). The projected volumes of additional water shown in Scenario B (**Table 4**) are based on published estimates of proposed water transfer schemes in Namibia (Heyns, 1995b; Republic of Namibia, 2000) and estimates of irrigation potential for each basin state (FAO, 1997). In combination, these estimates are based on the best available information and are therefore considered to be "reasonable", rather than over-estimates or "excessive". Overall, therefore, the projections of water needs contained in **Table 4** are considered to be slightly conservative, though reasonable, estimates for the different water use sectors in the Okavango basin.

**Table 4**: Projected growth in consumptive water demand in the Okavango catchment under two scenarios: [A] where the existing patterns of water demand remain and demand grows only as a result of population growth (shown in **Table 2**); and [B] where existing patterns of water demand are supplemented by new developments such as transfers out of the basin, or new agricultural (irrigation) developments.

| **Basin Country** | **Total Consumptive Water Demand (Mm$^3$/year)** | | |
|---|---|---|---|
| | **2000** | **2010** | **2020** |
| **[A].** *Existing demand patterns with no new developments* | | | |
| Angola | 13.841 | 17.352 | 21.750 |
| Botswana | 4.113 | 3.984 | 4.328 |
| Namibia | 5.214 | 6.130 | 7.206 |
| **Basin Total:** | 23.168 | 27.466 | 33.284 |
| **[B].** *Existing demand patterns plus potential new (transfers + irrigation) developments* | | | |
| Angola | 13.841 | 67.352 | 121.750 |
| Botswana | 4.113 | 28.984 | 54.328 |
| Namibia | 5.214 | 66.130 | 127.206 |
| **Basin Total:** | 23.168 | 162.466 | 303.284 |

Given that natural flows in the Okavango River have varied by between 10% and 45% of the mean annual flow (McCarthy *et al*., 2000), a decrease in mean annual flow of 3% may not appear to be significant and, indeed, to be well within the "normal" range of variation in inflows (Ashton & Manley, 1999). However, the absence of sufficient information regarding the scale, significance and resilience of ecosystem responses within the Okavango Delta to decreased inflows of this magnitude makes it extremely difficult to predict with any accuracy or certainty the likely scale of responses to a *sustained* decrease in inflow. However, it is clear that a sustained decrease in inflows to the Okavango Delta will reduce the flooded area of this wetland (Ramberg, 1997; Ashton, 2000a). The likely extent and implications of such a decrease must be fully evaluated before any decisions are taken.

Despite the relatively small size of the potential decreases in inflows to the Okavango Delta (~ 3%), several individuals and NGOs (e.g. Greenpeace, 1991; Ramberg, 1997) have expressed concern that declining inflows could have catastrophic consequences for the structure and functioning of the Okavango Delta. However, this perception is unlikely, given the large scale of natural variation in inflows that the Okavango Delta has experienced in recent years (Ashton & Manley, 1999; McCarthy *et al*., 2000). Nevertheless, it is essential that the basin states collaborate to derive acceptable estimates of the volumes of water that each state may justifiably lay claim to. In addition, it will be essential for the three basin states to ensure that all water abstractions are carefully controlled and managed (Ashton, 2000a), whilst any resulting impacts on the Okavango Delta are monitored and evaluated as vigilantly as possible.

**Deriving a "fair and equitable" basis for water sharing**

The rational and efficient management of the water resources in a shared river basin depends heavily on the joint realization and acceptance by the basin states concerned that water resource management should be fully integrated across the different parties (van der Zaag & Savenije, 2000). This relatively simple statement masks a great deal of underlying political, social, economic, ecological and institutional complexity. Truly integrated water resource management of a shared river basin should be based on a whole basin approach (Heyns, 1995b; Savenije & van der Zaag, 1998, 2000). In addition, each basin state needs to collaborate closely with its neighbours and reach agreement as to what proportions of the water resource can be equitably and reasonably allocated for specific uses in each country, and how the resource will be managed.

Against this background, however, it is important to examine possible options that the basin states could consider as an appropriate basis for deciding what volumes of water would constitute "fair and equitable" shares of the Okavango basin's water resources (Wolf, 1999; van der Zaag & Savenije, 2000; van der Zaag *et al*., 2000). Here, it is essential to realize that each river basin has a range of unique political, social, hydrological and ecological characteristics and requirements. Thus it is difficult to simply "transplant" unchanged a set of solutions from one catchment to another and expect the solutions to work equally well in their new setting (Wolf, 1999). Despite this *caveat*, however, the general principles for deriving estimates of "blue" and "green" water, and for deriving estimates of water needs can be universally applied.

In moister regions where mean annual rainfall over a catchment is reasonably reliable, van der Zaag *et al* (2000) have suggested that a simple and elegant calculation can be made of the relative quantities of "green" and "blue" water that are needed within each basin state. Relevant principles embodied in international water law can also be built into the process by incorporating allowances for quantities of water that would ensure a downstream basin state received sufficient water to meet both its consumptive and non-consumptive needs. Each basin state can then be allocated an equitable "share" of the total water resource based on its contribution to the basin water balance and on its needs for "green" and "blue" water (van der Zaag *et al*., 2000). The technical simplicity of this approach is appealing since it allows estimates to be generated from data that are readily available. These estimates then provide the basis for open consultations and negotiations between the basin states and the estimates can be adapted and modified until agreement is reached between the basin states.

However, this approach is less easy to apply in the case of a catchment such as the Okavango River basin that is located in a transition zone between high and low rainfall regions. Because rainfalls are extremely variable across the catchment, large areas of the catchment in the different basin states provide little or no runoff to the river system. Consequently, there are enormous differences in the quantities of water contributed to the catchment water balance by each basin state (Ashton, 2000a; **Table 1**). In such a situation, it is vitally important that the basin states collaborate with each other to reach consensus on how the water resource can be shared equitably and fairly (Ashton, 2000a).

Accordingly, it is recommended that the provisional projections of water needs within the three basin states presented here (**Table 4**) could provide the basis for discussions and negotiations between the three basin states. These discussions should focus initially on reaching consensus as to the acceptability of the estimates and, where required, providing refined estimates for specified water use sectors. In addition, careful attention will need to be given to the issue of defining the quantity, quality and timing of the water flows that are needed to maintain ecosystem functions within each of the basin states. This will provide a sound basis for the basin states to reach agreement on the criteria for defining “fair and equitable” shares of water for each basin state.

## Management implications and recommendations

The effective, efficient and integrated management of water resources that are shared by several basin states requires a high degree of trust between the basin states, as well as a firm commitment to inter-state collaboration and co-operation (Lundqvist, 1999). These responsibilities are not easy to incorporate into the existing institutional structures within each basin state. Many of the policies, priorities and strategies that would be needed are far broader and extend beyond the line-function boundaries of conventional government departments. Past experience elsewhere in the World has shown that the establishment of a river basin organization (RBO) that represents the interests of all basin states and can undertake integrated water resource management across political boundaries, has the greatest likelihood of success (Lundqvist, 1999; Mwiinga, 2000; van der Zaag & Savenije, 2000).

The creation of such an RBO requires each state within the river basin to acknowledge and accept the roles and responsibilities of its partners, whilst committing itself to the maintenance of a spirit of harmony and good will amongst its partners (Pallett, 1997; Lundqvist, 1999; Savenije & van der Zaag, 2000). An important part of any such international partnership is the full realization that the rights and obligations of each party are mutual and reciprocal, rather than unilateral (Granit, 2000).

In its normal, day-to-day operations, a typical RBO will be faced with a series of problem areas that must be overcome. Typical challenges that face such a river basin organization include:

- Collecting and processing appropriate and comparable information (hydrological, physical, landuse, social, economic) that will facilitate effective decision-making, and enable basin state residents to be correctly and timeously informed and consulted;
- The development of effective and efficient water use plans and water management plans for each basin state within the framework of an overall (basin-wide) water management plan, that ensure the water resources are protected, utilized, managed and controlled in a responsible manner;
- The development of appropriate disaster prevention / mitigation plans that will allow the organization to deal effectively and timeously with any unforeseen consequences of natural disasters (e.g. floods and droughts) in their area of jurisdiction;
- The development of appropriate institutional frameworks, structures and processes that promote public participation and transparency, as well as facilitating water resource management within each basin state;

- The development and expansion of appropriate technical and managerial capacity within the basin states to ensure the effectiveness and efficiency of integrated water resource management at all levels and in all basin states;
- The joint development of suitable protocols and processes that can form the basis for dispute prevention strategies, as well as the formalization of procedural issues for the resolution of any disputes that may arise between the basin states;
- The development of appropriate reporting protocols and procedures so that the relevant government departments within each of the basin states can be informed of the river basin organization's activities, achievements and concerns, as well as any failures that may have occurred; and
- The enforcement of the provisions of international water law and basin agreements that have been signed and ratified by the basin states, together with the provisions and requirements of appropriate agreements and treaties amongst the SADC states.

Ideally, an RBO should only comprise of executive members who have been drawn from the basin states concerned. Each basin state should have equal representation on the RBO and no basin states should be excluded for any reason. The executive members would be appointed to the organization by their respective governments because of their technical or management skills, or the level of integrative skills they are able to provide. Once it has been constituted formally, the RBO will be able to bring in or contract external parties and individuals to deliver specific services or functions. The financing of all RBO activities should be approved by the basin states concerned; the respective governments would also be responsible for ensuring that the RBO is provided with skilled personnel and physical facilities.

External parties, governments and non-government organizations should ideally not form part of the executive membership of an RBO. Instead, the involvement of these parties should be limited to offers of advice and training, as well as technical and financial assistance when required. This arrangement will firstly help to strengthen the management and decision-making capability within the RBO, whilst simultaneously reducing the possibility that external organizations can be charged with directing or manipulating the RBO or its officers and officials.

## Charting the way forward

In 1994, the Governments of Botswana, Namibia and Angola jointly launched the tripartite Permanent Water Commission on the Okavango River basin (OKACOM) to investigate ways in which the legitimate water needs of each of the three countries could be accommodated in a sustainable manner without prejudicing the needs of neighbouring riparian states (OKACOM, 1994). This Commission seeks to develop an integrated water management strategy for the entire Okavango River basin. Several investigations have already been launched to provide the basis for estimates of water availability and patterns of current use (OKACOM, 1995). The estimates of projected water needs in each of the basin states shown in **Table 4** provide a useful basis from which to initiate further discussions.

Once the basin states have reached agreement on the mechanisms that will be used to derive quantitative estimates of each country's "share" of the water resource, this will need to be formalized in the form of an international agreement. In addition, it will also be necessary for the basin states to agree on an appropriate institutional structure that will be responsible for day-to-day management of the basin's water resources. Once an agreed institutional structure has been formalized, the basin states can instruct this organization to make certain that agreed management strategies are followed with the prime aim of ensuring that each basin state benefits equitably.

The existing institutional arrangements, in the form of the OKACOM commission, provide the most logical framework for initiating discussions and negotiations between the basin states. Clearly, these discussions and negotiations will require extreme care and tact because of the enormous sensitivities that have developed over the issue of using water from the Okavango River (e.g. Greenpeace, 1991; Ramberg, 1997). The OKACOM institutional structure also provides the logical starting point for the development of a formal RBO to manage the water resources of the Okavango system.

An important cautionary note that should be borne in mind is that advice from other multi-state river basin organizations in other parts of the world should be carefully scrutinized and evaluated before it is accepted. This is because, to date, none of the multi-state river basin organizations elsewhere in the world have been able to prevent conflict over competing uses or abuses of the water in their areas of jurisdiction. This fact alone should alert the parties concerned to be extremely careful in all aspects of their deliberations. A final point that is worth noting is that once riparian states agree on the extent and justification of their needs for water, and then confirm these in a river basin agreement, these needs will then become formalized as the “rights” of each country in law (Ashton, 2000a). At this point, each signatory to such an agreement shares a mutual responsibility to uphold the spirit and intention of the agreement.

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