Pages 217-235, in: (A.R. Turton & R. Henwood, Eds), *Hydropolitics in the Developing World: A Southern African Perspective*. Pretoria: African Water Issues Research Unit (AWIRU).

Water and HIV/AIDS: Some strategic considerations in Southern Africa

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INTRODUCTION

At first sight, the issues of HIV/AIDS and water would appear to bear very little relation to each other. HIV/AIDS is a global-scale pandemic that is transmitted between people primarily through sexual contact, while water is a renewable natural resource of which the availability depends on a variety of geographic and climatic factors. However, a closer inspection of the features that characterise the spread of HIV/AIDS and its implications for individuals, communities and societies reveals several significant linkages with water, as well as important consequences for water resource management. The links between HIV/AIDS and water reflect some of the often unanticipated effects of the pandemic on society, with long-term implications for effective water resource management and the provision of wholesome water supplies to communities. This chapter first provides a strategic overview of the HIV/AIDS pandemic in Southern Africa and then examines the extent to which it influences and is influenced by water resource management on the sub-continent.

The current state of the HIV/AIDS pandemic in Southern Africa

When the spread of the human immunodeficiency virus (HIV), which causes Acquired Immunodeficiency Syndrome (AIDS), was first formally recognised in the early 1980s (Hooper 2000; Janse van Rensburg 2000), no one predicted the extent to which the pandemic would proliferate or the extraordinary effects it would wreak on global and national economies (World Bank 1999; Whiteside 1999a; UNAIDS 2000a; Whiteside & Sunter 2000). Based on the numbers of people living with HIV/AIDS in 1991, the first estimates predicted that a probable maximum of 9 million people would be infected and 5 million would die by the end of the decade (UNAIDS 2000a). While detractors considered these predictions to be alarmist and pessimistic, the most recent monitoring results show clearly that the estimates were at least a three-fold under-prediction (Crewe 2000; UNAIDS 2000a). By the end of 2000, it was estimated that some 18.8 million people had already died of AIDS, while nearly 36.1 million people are now living with HIV (UNAIDS 2000b). In the absence of a miracle, perhaps in the form of freely available antiretroviral drugs, most of these infected people are likely to die within the next decade.

While these global figures are truly alarming, the spread of HIV/AIDS in the countries of sub-Saharan Africa has been fearsomely fast, far outstripping the rates recorded in other parts of the world. At the end of 2000, sub-Saharan African countries were estimated to be home to 25.3 million (more than 70%) of all adults and children living with HIV/AIDS in the world (Crewe 2000; UNAIDS 2000a; 2000b). Surveillance data

from sub-Saharan Africa for 2000 indicated that over 3.8 million adults and children were newly infected, while an additional 2.4 million adults and children had died, as a direct result of HIV/AIDS or AIDS-related diseases during this year (Karim 2000; UNAIDS 2000b). There is also compelling evidence that the current trends in HIV infection will have a profound impact on future rates of infant, child and maternal mortality, life expectancy and economic growth throughout the region (World Bank 2001). These macrolevel impacts are matched by the devastating burden of suffering among individuals and households. From being considered initially as a serious health crisis, HIV/AIDS is now recognised globally as an absolute crisis for human development (Whiteside 1999a; World Bank 1999; 2001; UNAIDS 2000a).

Within sub-Saharan Africa, some of the countries comprising the Southern African Development Community (SADC) have demonstrated a frightening acceleration in their rates of HIV/AIDS infection and now have the highest levels of HIV/AIDS infections in the world (Karim 2000; UNAIDS 2000a; 2000b; 2000c). In eight out of 12 of the mainland African countries comprising the SADC region, at least 15% of all adults are infected. In some of these countries, the infection rate among adults has risen to between one in four and one in three. HIV/AIDS prevalence rates in these countries have more than tripled in the past decade and the evidence indicates clearly that urban and rural centres have similar prevalence rates (UNAIDS 2000a; 2000b). Several authorities have indicated that the system of migrant labour, as well as expanded transport systems are very likely to be partly responsible for the spread of HIV/AIDS between Southern African countries, and between urban and rural centres (see Lurie 2000; Janse van Rensburg 2000; Williams et al 2000a).

In common with most other African countries, HIV/AIDS prevalence rates are slightly higher among women than men. Both genders show peak levels of infection within the age group 18 to 40, with lower, but still alarming levels of prevalence in the age groups 15-18 and 40-60 (Whiteside 1999a; World Bank 1999; Karim 2000; UNAIDS 2000a; 2000b). The age group 18 to 40 represents the most economically active proportion of society, most of whom are breadwinners and heads of families at this stage of their lives (Whiteside & Sunter 2000; Malan 2001). Apart from its more obvious direct effects on the health and well-being of individuals, HIV/AIDS also exerts an enormous variety of indirect influences on every sector of society. All economic sectors within a country are susceptible to the escalating human tragedy and, in turn, exert additional, subtle and overt pressure on the resources of the SADC region as a whole (Whiteside & Sunter 2000). Every country in the region faces a daunting challenge in halting the spread of HIV/AIDS, while dealing with the long-term social and economic consequences of the pandemic (UNAIDS 2000a; Williams et al 2000a).

The extent of HIV/AIDS infection among adults in the SADC region at the end of 2000 is shown in table 1. Based on census data that adults (aged 15 years and older) typically comprise some 50% of rapidly growing African populations (World Bank 1998), the data in table 1 indicates that some 13.3 million adults, 6.6% of the entire population of 201 million living in these 12 countries, are infected with HIV/AIDS. Importantly, the data does not show the additional numbers of children who are infected with HIV/AIDS as a result of mother-to-child transmission, nor does it reflect the large number of children who have been orphaned as a result of HIV/AIDS. Examination of the data in **Table 1** shows clearly that the adult

populations of countries such as Botswana (35.8%), Swaziland (25.3%), Zimbabwe (25.1%), Lesotho (23.6%), South Africa (22.6%), Namibia (20%) and Zambia (20%) are those most heavily infected. The available statistics for Angola and the Democratic Republic of Congo are considered to be inaccurate because of the difficulties of conducting effective HIV/AIDS surveillance campaigns due to the prevailing civil wars in these countries (UNAIDS 2000c).

Table 1: Demographic details and HDI ranking for 12 SADC countries, 2000

SADC country	Population in 2000 (millions)	Per capita GDP in 1999 (US$/p/year)	HIV/AIDS incidence (%)	1995		1999-2000*	
				Life expectancy (years)	HDI ranking	Life expectancy (years)	HDI ranking
Angola	12.903	336	2.8**	50	157	47	160
Botswana	1.639	2 904	35.8	60	71	39	122
Democratic Republic of Congo	52.046	110	5.1**	53	142	48	149
Lesotho	2.156	502	23.6	58	137	46	142
Malawi	10.778	132	16.0	46	157	39	159
Mozambique	19.980	92	13.2	52	166	43	169
Namibia	1.739	1 969	20.0	56	116	50	115
South Africa	43.265	3 281	22.6	60	100	48	101
Swaziland	0.928	1 255	25.3	58	110	46	114
Tanzania	33.744	124	8.1	50	149	45	156
Zambia	9.191	431	20.0	49	136	39	151
Zimbabwe	13.109	579	25.1	50	124	40	151

* Latest data available was for different years, either 1999 or 2000.
** Unreliable data due to civil war in these countries.
Sources: World Bank (1998), CIA (2000); SADC (2000); UNAIDS (2000c); and Whiteside & Sunter (2000).

An important feature of the data presented in **Table 1** is the apparent absence of a strong relationship between poverty (as reflected by per capita GDP values) and HIV/AIDS prevalence. Both relatively 'rich' countries (South Africa and Botswana with high GDP values) and relatively 'poor' countries (Lesotho and Zimbabwe with low GDP values) have comparably high prevalence rates. This suggests that there may only be a weak correlation between a country's economic status and the extent of HIV/AIDS in its population, despite the realisation that poor people are more vulnerable to HIV/AIDS. However, it is important to realise that many other features, including cultural norms and behavioural patterns (UNAIDS 2000a), as well as the migrant labour system (Lurie 2000) also contribute to the prevalence of HIV/AIDS within a specific country. Another crucial factor is the fact that while GDP is good indicator of the overall economic status of a country, it is not an ideal indicator for poverty. This is because GDP values mask disparities between different sectors within the population. An alternative index such as the GINI index provides a far better overview of these intra-population differences and could give useful additional insights into possible linkages between HIV/AIDS and poverty.

There is clear evidence that HIV/AIDS has contributed to a dramatic decline in life expectancy levels at birth, as well as a reduction in the United Nations Human

Development Index (HDI) ranking, an index of quality of life (World Bank 1999; UNAIDS 2000a; 2000b; 2000c). Indeed, when compared with the data available for 1990, life expectancy levels in most SADC countries have declined by between 15 and 20 years during the past decade (Crewe 2000; Karim 2000; UNAIDS 2000a; Whiteside & Sunter 2000). Similarly, population growth rates in most Southern African countries have also declined dramatically in the last five years (World Bank 1999; CIA 2000; UNAIDS 2000c; Williams et al 2000b).

Against the background provided by the data on HIV/AIDS prevalence in Southern Africa, it is instructive to examine the availability of water resources and the provision of water supplies and sanitation services in these countries. Adequate supplies of fresh water represent one of the scarcest natural resources within Southern Africa and have a clear potential to retard social and economic development (Conley 1995; Basson et al 1997; Ashton & Haasbroek 2002). Evidence for some of the more subtle, yet far-reaching effects of HIV/AIDS can also be demonstrated in an analysis of the implications of the pandemic for water resource management in the SADC region. The observations and deductions presented here assume that no new treatment or cure for HIV/AIDS materialises within the next three to five years. Therefore, this analysis provides a relatively bleak view of the scale of impacts that HIV/AIDS could have on water resource management, as well as the implications of such management practices for people infected with HIV/AIDS.

Water resource management in Southern Africa

In recent years, there has been a dramatic increase in public awareness that the world's fresh water supplies are a scarce and limited resource that is extraordinarily vulnerable to human activities (Falkenmark 1989; Biswas 1993; Gleick 1999). This consciousness is coupled with the growing realisation that it is becoming increasingly difficult and expensive to provide sufficient supplies of wholesome water to meet the growing needs of communities and countries. These tensions are accentuated by widespread population growth, as well as increased rates of urbanisation and industrialisation (Falkenmark 1991). While it appears clear that the basic reasons for increasing water shortages are well understood by all participants, the potential remains high for tensions to increase when countries experience extreme climatic events such as prolonged droughts (Pallett 1997; Gleick 1999).

The rapidly growing public recognition that water interdependence is already, or will soon become, a fact of life in many countries supports an increasing drive towards co-operative development of water resources in certain areas (Falkenmark 1989; Biswas 1993; Gleick 2000). This is also reflected in Southern Africa where recent political developments have been accompanied by a wider acceptance of the need for countries to work together to develop and implement joint strategies for the protection and management of regional water resources (SADC 1995; SARDC 1996; Pallett 1997). Large areas of the sub-continent are arid to semi-arid and the basins of most of the larger perennial rivers are shared by between three and eight countries (SARDC 1996; Pallett 1997). Supplies of fresh water are finite and the growing demands for water in some parts of the region are fast approaching the limits of exploitation that conventional technologies can provide (Conley 1995; Heyns 1995). In many cases, demands for additional supplies of fresh water will need to be met through the use of

unconventional technologies, the exploitation of new or novel sources of fresh water, or through the long-distance transfer of ever-larger quantities of water from regions that have ample supplies (Conley 1995; Heyns 1995; SARDC 1996). In the future, concerted attention will also have to be paid to reducing the demand for water and to increasing the efficiency with which water is used (Ashton & Haasbroek 2002).

The current reality of Southern Africa is one of expanding populations, albeit tempered by the HIV/AIDS pandemic (Williams et al 2000b), accompanied by escalating urbanisation and industrialisation, as well as rapidly increasing demands for water to redress past social, economic and political inequalities. National water resource management strategies in Southern Africa recognise water as a 'common good' and not as 'private property'. The principles of sustainable resource utilisation underpin national water resource management policies and ensure that all aspects of the water cycle are considered within the geographical bounds of a river basin or catchment area (Heyns 1995; SARDC 1996; Basson et al 1997).

Patterns of water use in Southern Africa

Broad patterns of water use in the SADC region are shown in **Table 2**. 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 (World Bank 1998; SADC 2000). The high proportion of water used for agriculture suggests that each SADC country relies heavily on food grown within its borders to meet national goals of food security (Pallett 1997).

Another extremely important consideration is the degree to which the populations of different Southern African countries have access to sanitation services and safe, wholesome supplies of water (**Table 3**). To a large degree, the level of urbanisation determines service provision in Southern African countries. As is evident from the data presented in **Table 3**, there are wide disparities between Southern African countries in terms of the degree to which their populations are urbanised, ranging from Malawi at 14% to Botswana at 64%. Overall, some 69.3 million people (34.4%), out of a total SADC population of 201.5 million live in formal urban areas while 132.1 million people (65.6%) live in rural areas.

An examination of the urban populations of Southern African countries reveals enormous differences in the provision of water supply services, ranging from 17% in Mozambique to 100% in Botswana (**Table 3**). Overall, some 43.1 million people (62% of all urban residents) have access to safe water supplies, while the remaining 26.2 million urban residents do not have such access. A slightly smaller number (42.3 million, 61%) of all urban residents also receive some form of formal sanitation service.

Table 2: Patterns of water use by different sectors in 12 SADC states in 1998.

SADC country	Proportion of water used by different sectors (%)		
	Agriculture	Industry	Domestic
Angola	76	10	14
Botswana	48	20	32
Democratic Republic of Congo	23	16	61
Lesotho	56	22	22
Malawi	86	3	10
Mozambique	89	2	9
Namibia	68	3	29
South Africa	62	21	17
Swaziland	71	8	21
Tanzania	89	2	9
Zambia	77	7	16
Zimbabwe	79	7	14

Sources: Gleick (1999) and WRI (2000)

Table 3: Comparison of population size, proportion urbanised, and levels of access to safe water and sanitation facilities by the urban and rural populations of each mainland SADC country in 2000.

SADC country	Population in 2000 (millions)	Proportion urbanised (%)	Access to safe water (%)		Access to sanitation (%)	
			Urban	Rural	Urban	Rural
Angola	12.903	31	69	15	34	8
Botswana	1.639	64	100	91	91	41
Democratic Republic of Congo	52.046	29	37	23	23	4
Lesotho	2.156	25	65	54	53	36
Malawi	10.778	14	80	32	52	24
Mozambique	19.980	35	17	40	53	15
Namibia	1.739	37	87	42	77	32
South Africa	43.265	49	80	40	79	50
Swaziland	0.928	32	61	44	66	37
Tanzania	33.744	25	67	45	74	62
Zambia	9.191	43	64	27	75	32
Zimbabwe	13.109	43	90	69	90	42

Sources: CIA (2000), FAO (2000a) and UNAIDS (2000c)

In comparison to their urban counterparts, the larger rural population of Southern Africa have far lower levels of access to appropriate sanitation services or safe water supplies (**Table 3**). Out of a total rural population of 132.1 million, some 46.9 million

(36%) are able to access safe water supplies while 39.3 million people (30%) have appropriate sanitation facilities. Again wide disparities are noticeable between the levels of services available within the different Southern African countries. For example, access to safe rural water supplies ranges from 15% in Angola to 91% in Botswana, while access to appropriate sanitation services ranges from 4% in the Democratic Republic of Congo to 62% in Tanzania.

In summary, 90 million (44.7%) of the total Southern African population have access to safe supplies of water while 81.6 million people (40.5%) have access to appropriate sanitation facilities. Importantly, these figures also confirm that some 111.5 million people (55.3%) have inadequate access to safe water supplies while some 120 million people (59.6%) have inadequate access to appropriate sanitation facilities.

Implications of the HIV/AIDS pandemic for water resource management

In its broadest sense, water resource management involves achieving a delicate balance between the protection of a country's water resources, while simultaneously ensuring that the reasonable demands for water by each water use sector in such a country are met in a timely manner. Large numbers of skilled and semi-skilled individuals from a wide variety of economic, social and technical disciplines are needed to accomplish the broad array of complex and complicated tasks involved in achieving this equilibrium. Key issues for the success of these processes rely on the collection and interpretation of information relating to the geographical and temporal distribution of demands for water, as well as the design, construction and operation of appropriate water supply and treatment works to meet these demands. Depending on their size and complexity, water supply schemes may take between 5 and 15 years to commission from the time they were first conceptualised. It is therefore imperative that water resource managers have rapid access to accurate and current information on the demographic distribution of populations and their likely future water demands (Conley 1995; SADC 2000; Ashton & Haasbroek 2002).

Some important consequences of the HIV/AIDS pandemic in Southern Africa have been most easily visible as the dramatic increase in mortality rates and an equally spectacular reduction in population growth rates. For example, population growth rates in several Southern African countries have decreased by over 50% in the last five years (CIA 2000; UNAIDS 2000a). Clearly, demographic changes of this magnitude can have enormous social, economic and environmental implications for the timely provision of water supplies and sanitation services to both urban and rural communities (SARDC 1996; Pallett 1997). Insufficient supplies of water cause unnecessary hardship and stress, while over-provision leads to wastage, environmental damage and economic loss (Ashton 2001). Specific categories of water stress or scarcity and their equivalents in volumes of water required per person per year are shown in **Table 4** (Falkenmark 1989).

A summarised overview of the populations in twelve Southern African countries, together with the volumes of water available for use within each country, is shown in **Table 5**. This table also includes projections for possible future (2025) population numbers in these countries and their subsequent likely demands for water, based on

population growth rates for 2000. These future projections will clearly be incorrect if population growth rates continue to decline further as a result of HIV/AIDS. Nevertheless, the volumes of water available per person in 2000 and 2025 can be used to demonstrate which countries may be likely to experience different levels of water scarcity and stress (Ashton 2001).

Table 4: 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.

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.	500-1 000
Water stressed: *frequent* seasonal water supply and quality problems, accentuated by occasional droughts.	1 000-1 666
Moderate problems: *occasional* water supply and quality problems, with some adverse effects during severe droughts.	1 666-10 000
Well-watered: *very infrequent* water supply and quality problems, except during extreme drought conditions.	>10 000

Source: Modified from Falkenmark (1986; 1989; 1991).

Table 5: Water availability, population numbers and growth rates for SADC countries, and projections for 2025, taking HIV/AIDS into account

SADC country	**Total water available (km^3)***	**Country population in 2000 (millions)**	**Water per person in 2000 (m^3/p/yr)**	**Population growth rate** (%)**	**Country population in 2025 (millions)**	**Water per person in 2025 (m^3/p/yr)**
Angola	205.0	12.903	15 888	2.15	21.961	9 335
Botswana	1.6	1.639	976	0.76	1.981	808
Democratic Republic of Congo	1 019.0	52.046	19 579	3.19	114.111	8 930
Lesotho	5.2	2.156	2 412	1.65	3.246	1 602
Malawi	17.5	10.778	1 624	1.61	16.068	1 089
Mozambique	117.0	19.980	5 856	1.47	28.776	4 066
Namibia	2.7	1.739	1 553	1.57	2.567	1 052
South Africa	52.8	43.265	1 220	0.50	49.010	1 077
Swaziland	2.8	0.928	3 017	1.22	1.257	2 228
Tanzania	80.0	33.744	2 371	2.57	63.636	1 257
Zambia	127.0	9.191	13 818	1.95	14.895	8 526
Zimbabwe	15.5	13.109	1 182	0.26	13.988	1 108

* This is the total of surface plus ground water that is generated within the geopolitical boundaries of the country *each year* and excludes water that flows in from neighbouring states (FAO 2000a). Minor volumes of recycled water are included in the values for water available in South Africa.

** Population growth rates in each country have been adjusted to account for the current prevalence of HIV/AIDS in the country (CIA 2000).

Sources: CIA (2000) and FAO (2000a)

Based on a comparison of the categories of water scarcity listed in table 4 and the volumes of water available in Southern African countries in 2000 (table 5), four countries (Malawi, Namibia, South Africa and Zimbabwe) are considered to be 'water stressed', while Botswana experiences 'chronic water scarcity'. If the anticipated population growth projected in **Table 5** actually occurs, another two Southern African countries (Lesotho and Tanzania) will join their four water-stressed neighbours, while Botswana will continue to face chronic water scarcity. At least for the next 23 years, the other Southern African countries (Angola, Democratic Republic of Congo, Mozambique, Swaziland and Zambia) will have sufficient water supplies to avoid shortages.

Against the background provided by the prevalence of HIV/AIDS and the availability of water resources in the countries of Southern Africa, six groups of problems or 'problem areas' can be identified where HIV/AIDS impinges on water resources management. These problem areas are first listed, below, and then each is discussed separately.

- Inaccurate estimates of population growth rates and mortality rates lead to incorrect estimates of water demand in specific geographic areas. In turn, inadequate or incorrect demographic information hinders proper planning and prevents construction schedules from matching water demand profiles.

- Changes in the socio-economic profiles of communities receiving services such as water supplies and sanitation are such that there is widespread difficulty to pay for these services. New and innovative funding and cross-subsidisation mechanisms are required to recover the operation and maintenance costs of water supply schemes.

- Loss of key skilled and semi-skilled staff leads to increased staff turnover in all sectors, with concomitant requirements for increased training of new staff, as well as increased cost implications and possible production delays.

- Staff members infected with HIV/AIDS show a dramatic decline in productivity as the disease progresses. Additional productivity losses will be attributable to workers having to care for sick family members and relatives, as well as attending funerals.

- Any decline in drinking water quality caused by inadequate water treatment will lead to increased public health risks, particularly for individuals with compromised immune systems. Health risks will be higher in areas where inadequate sanitation

facilities are available, leading to an increase in the incidence of water-borne diseases and related mortalities.

- There is a small risk that local ground water resources may become contaminated if individuals bury their relatives in areas that are unsuitable for the location of graveyards. This practice will also prevent these areas from being used for alternative purposes.

Inaccurate estimates of population growth rates and mortality rates

One of the most important considerations that have arisen from the available information on the spread of HIV/AIDS in Southern Africa is the difficulty in accurately projecting possible population numbers over a long timeframe (Whiteside & Sunter 2000). Population projections that extend beyond a five to seven year timeframe contain increasingly larger inaccuracies and should be treated with caution (UNAIDS 2000a). This is largely due to uncertainties around probable behavioural changes in response to the anticipated massive mortalities that can be expected as the pandemic proceeds (Williams et al 2000a; 2000b). Population projections are also affected by uncertainties around the numbers of new immigrants who arrive in urban areas each year, either from rural areas or from neighbouring countries (Lurie 2000). Therefore, due caution must be exercised when population projections are made for periods beyond 2005 (Karim 2000; Lurie 2000; UNAIDS 2000a). In addition, it is essential to remember that the limited availability of accurate, widespread surveillance in Southern Africa suggests that any estimates made are likely to underestimate the true prevalence of HIV/AIDS.

Predictions of mortality rates due to HIV/AIDS are based almost exclusively on the realisation that no effective cure for HIV has yet been discovered. At this time, every person recorded as HIV-positive appears certain to die within a period of between seven to ten years from the date of first infection, unless antiretroviral therapy is administered to halt the progression of the disease. In children, the situation is far worse and life expectancy can drop to as low as two years for babies. Informed medical opinion considers that the prevalence of HIV/AIDS appears to reach a plateau at between 32 and 35%, when approximately one in every three individuals is infected (Whiteside 1999a). Prevalence survey data demonstrates that somewhat fewer men than women are infected with HIV/AIDS (Whiteside 1999a; Karim 2000; UNAIDS 2000a).

Given the range of uncertainty around predictions of the possible numbers of people infected with HIV/AIDS and the resultant mortalities, it is clear that estimates of population numbers will also likely be inaccurate (Whiteside & Sunter 2000). Together, these uncertainties will reduce the accuracy and reliability of future water demand estimates for specific geographic areas and countries (Ashton 2000).

If water demand estimates do not take HIV/AIDS-related mortality into account, demands for water could be overestimated by between 10 and 30%. This would pose several possible unanticipated consequences for the construction and operation of large-scale water supply schemes. In particular, if anticipated HIV/AIDS mortalities do indeed reach the very high levels suggested above, this would delay the demand for

water by between 10 and 20 years. In addition, if this scenario were to hold true, the construction of large water supply schemes within current planning timeframes would result in unnecessary expenditure of capital (Ashton 2000). The converse situation is also important: if mortality rates are overestimated, the growth in water demand profiles of an area or country will not be anticipated correctly. Given the relatively long lead-in times for water supply projects (Basson et al 1997), a population would face undue hardship if adequate water supplies cannot be provided in time (Ashton 2000).

The other side of this coin for large-scale water supply schemes is that these projects may inadvertently lead to increased transmission of HIV in an area, thereby changing HIV/AIDS projections for that area. Increased transmission is a recognised consequence of introducing a large, predominantly male workforce into an area surrounding the water scheme development.

Inability to pay for (water supply) service delivery

Arising from the projected HIV/AIDS mortality rates for different age groups of the population, it is highly likely that the working-age population (20-50 years of age) will experience the greatest reduction in numbers (Karim 2000; UNAIDS 2000a; Whiteside & Sunter 2000; Williams et al 2000a; 2000b). The net result of these high mortality rates will be a somewhat smaller population with proportionately higher numbers of juveniles (<20 years old), who would normally still depend on their parents, and elderly people (>50 years old) who would not normally make up a large proportion of the national work force of economically active people. Given that juveniles (<20 years of age) also demonstrate some of the highest rates of HIV/AIDS prevalence (Whiteside 1999a; Crewe 2000; Williams et al 2000a), it can be anticipated that a significant proportion of surviving juveniles would also be infected with HIV/AIDS and therefore unlikely to survive into old age (Williams et al 2000a). This will cause a dramatic change in the age structure of the population and similar trends are anticipated for each Southern African country (Whiteside 1999a; Karim 2000; Lurie 2000).

If this scenario holds true, the size of the economically active population will decline or remain static and the surviving juveniles and elderly people will be required to shoulder the burden of providing for their families. In extreme cases, households will be headed by surviving teenagers who have to look after younger siblings, together with elderly relatives who may be unable to work or who have to rely on state support. Such a situation will pose extraordinary social problems for most communities. Teenage-headed households will have great difficulty in securing sufficient funds to pay for normal municipal services such as electricity, water supply and sanitation, while still having to provide for food, education and housing for themselves and their siblings (Whiteside & Sunter 2000; UNAIDS 2000a). This example demonstrates a strong link between the economic status (poverty level) of a household or community and its ability to cope with the ravages of HIV/AIDS (UNAIDS 2000a). Even in households with economically active adults, the increased need for healthcare for sick family members will divert funds away from other expenditure such as water and sanitation services.

In such situations, water supply agencies would find it extremely difficult to recover the expenses associated with providing water supplies and sanitation services. It would then become necessary to institute some form of cross-subsidisation from more

affluent members of the community to ensure that poorer communities could still receive basic services. If the number of such cases is high, or continues for an indefinite period, national government support would be required to resolve the issue. The resulting additional taxation burden would cause increased public resistance to prolonged support of poorer communities.

Loss of skilled employees

Given the implications of the projected mortality rates described above, it can be anticipated that skilled and semi-skilled employees in most sectors of society would also display similar HIV/AIDS infection rates to those predicted for their respective national populations. Typical age profiles of skilled and semi-skilled employees span the range between 20 and 45 years of age; this is also the section of the population most likely to be impacted heavily by HIV/AIDS (Whiteside 1999a; UNAIDS 2000a; 2000b; Williams et al 2000a). The construction of a typical large water supply scheme can be used to illustrate some of the implications of the features described above. If the construction work for large-scale water supply projects takes between three and ten years to complete, and up to one in every three persons employed on such a project could be HIV-positive with an expected post-infection lifespan of between seven and ten years, normal employee turnover rates can be expected to increase dramatically. It is therefore possible that 30 to 50% of the total construction staff complement could die during the construction period, or no longer be able to work as a result of HIV/AIDS (Ashton 2000).

The primary implication of increased employee turnover is that there needs to be a corresponding increase in the recruitment of new staff (Whiteside 1999a). This has important ramifications in terms of additional training needs, as outlined below. Similarly, there are also important implications for a likely decline in productivity, as described later.

Based on the anticipated decline in numbers of skilled and semi-skilled employees due to HIV/AIDS, there will be a corresponding need to recruit increased numbers of replacements (Morris & Cheevers 2000). This is likely to place a heavy demand on the available (unemployed and presumably untrained or partially trained) population in a country (Williams et al 2000a). If new staff members are recruited from neighbouring countries, this is unlikely to reduce the prevalence of HIV/AIDS, since most Southern African countries display comparable HIV/AIDS prevalence statistics (Whiteside 1999a; Lurie 2000; Malan 2001; UNAIDS 2000a; 2000b; 2000c). In an attempt to avoid this situation, a few organisations in Botswana have recently started to hire skilled and semi-skilled employees from overseas countries where HIV/AIDS prevalence rates are lower, to replace Botswana citizens who have already died as a result of AIDS (Elias 2001 – personal communication). However, this can also be problematic as increased mobility of people can promote the transmission of HIV/AIDS to overseas countries.

In order to deal with the anticipated high rates of employee turnover, companies and organisations will have to focus considerable attention on employment of suitable new staff (Morris & Cheevers 2000). Importantly, the HIV/AIDS prevalence of these new recruits is also likely to match regional and national averages. The typical employment equity legislation in most Southern African countries contains specific references to the

need to eliminate discrimination based on race, gender, religion and HIV status (Whiteside 1999a). It would be illegal for employers to screen potential recruits for their HIV status prior to employment, in an attempt to employ new staff members that are not HIV-positive (Ashton 2000).

The projected increase in employee turnover at all levels that can be attributed to HIV/AIDS mortalities of between 30 and 50% will be accompanied by an increased demand for training to ensure that vacant posts are filled in a timely manner with appropriately trained individuals. Failure to provide adequate training will result in decreased productivity and, in extreme cases, could lead to unsafe work practices or costly delays. Clearly, this need for increased training should be anticipated in good time so that sufficient numbers of trainers and adequate training materials are available when needed (Ashton 2000). With a poor understanding of the HIV/AIDS prevalence in the workforce, employers are hindered in anticipating changes and managing the situation by not knowing the extent of the problem.

The projected AIDS deaths in a South African workforce (1997-2015) are expected to increase so that, by 2015, almost four times as many deaths will occur than normal (**Figure 1**; LoveLife, 2001). While some companies may be able to operate with a lower staff complement, most companies will need to replace HIV-infected staff, leading to a high annual turnover rate. The exact numbers of staff that will be affected annually will be dependent on the HIV prevalence in the workforce and the disease progression in the individuals concerned. Recent estimates suggest that staff will leave the workforce six to seven years after infection (Rosen et al 2000). In addition, risk modification attempts by the company and the degree to which work processes have been planned to take HIV infection into account will alter the turnover rates and associated costs of the epidemic.

Although data on infection levels in the workforce is scarce, and workforce profiles may change in time, the number of employees lost to AIDS over the next decade could be equivalent to 40 to 50% of the current workforce in some companies. By 2010, it is estimated that approximately 15% of all highly skilled employees will have contracted HIV.

The projected need for increased training can be extended further, for example, to those who are employed at water treatment works and sewage treatment works (Ashton 2000). These individuals also occupy vulnerable socio-economic strata in society and would presumably also reflect similar statistics for HIV/AIDS prevalence and mortality rates. In other words, if similar patterns of HIV/AIDS prevalence and mortality also apply to the operators of water treatment works, it can be expected that some 30 to 50% of these individuals will also to be affected by HIV/AIDS.

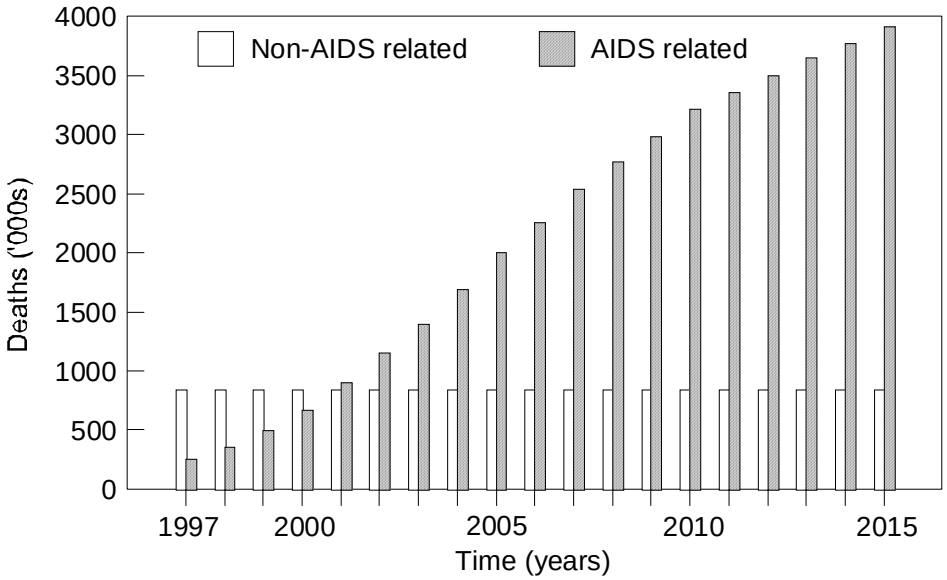

Figure 1: Estimates of AIDS-related and non-AIDS deaths in the South African workforce between 1997 and 2015. Source: Figure re-drawn from figure 5 in LoveLife (2001).

Clearly, operators of water treatment works and sewage treatment works are not the only sector of a national workforce who would be affected. Nevertheless, this group has been singled out as it fulfils a critical role in the management of water resources and the provision of wholesome water supplies for domestic and industrial use. An increased turnover of operators at water treatment works and sewage treatment works of between 30 and 50% will also need to be matched by a corresponding increase in the training of replacement operators (Ashton 2000). If this specific need for increased training is not met in time, the performance of these treatment plants will suffer. In turn, this will lead to periodic, or perhaps more frequent declines in potable water quality and a concomitant increase in health-related problems for water users (Ashton 2000).

Decline in productivity

Workers who are infected with HIV/AIDS provide the most obvious cause for a decline in productivity. HIV-positive workers with impaired immune systems are more susceptible to common illnesses such as tuberculosis, influenza, common colds and gastro-enteritis (Whiteside 1999a; World Bank 1999; Crewe 2000; UNAIDS 2000a; 2000b), as well as other more serious diseases such as malaria and bilharzia (Ashton 2000). Increased levels of illness will naturally result in increased requests for sick leave or, if these workers remain in the workplace, they will not be able to perform their duties to their full ability (UNAIDS 2000a). The net result is a decline in worker productivity.

It is almost impossible to provide any accurate predictions of the degree of lowered productivity in this type of situation (Whiteside 1999a). However, a crude estimate can be based on the prevalence of HIV/AIDS among workers: if some 30% of a workforce are HIV-positive, their productivity will decline progressively during their illness, from

being fully productive at the onset of HIV/AIDS until they are simply unable to continue working. Given the provisions of typical employment equity statutes, employers will not be allowed to discriminate against such workers (Heywood 1999; Smart & Strode 1999). Instead, additional replacement workers will need to be employed to fulfil the functions of the sick workers during the tenure of their illness or during treatment sessions (Heywood 1999; Ashton 2000; Whiteside & Sunter 2000).

A second possible cause for a decline in productivity relates to workers who need to care for relatives and family members who may be infected with HIV/AIDS, or to attend the funerals of those who have died as a result of HIV/AIDS (Ashton 2000; UNAIDS 2000a; 2000b; Whiteside & Sunter 2000). Virtually every African society firmly embraces the concept of the 'extended family', where family-type relationships exist, for example, between men of the same circumcision group or men and women of the same tribal clan. In each of these examples, all the members of a group consider themselves to be related to one another and are able to call on the other for support and help in time of need. This is also clearly applicable to blood relatives and relatives by marriage.

Given the anticipated high levels of HIV/AIDS mortality within a typical construction workforce, frequent attendance of burial services would lead to a marked decline in the number of workdays per year that an employee would be present on any particular job. This would result in a corresponding decline in productivity and, in turn, could lead to serious delays in construction programmes (Heywood 1999; Ashton 2000; Morris & Cheevers 2000). Importantly, the general uncertainty caused by inaccurate estimates of HIV/AIDS prevalence has resulted in widely different estimates of possible productivity losses in the business sector. In turn, these inaccurate or 'unbelievable' estimates have often prompted inappropriate or inadequate responses (Michael 2000).

In addition to lost productivity and increased recruitment costs, employers may also have to carry the additional costs of treatment for opportunistic diseases, funeral expenses and benefit payments. Indeed, the move by companies such as Anglo American to provide antiretroviral treatment may set a precedent that forces other employers to provide similar services for their employees. The greater costs to employers may be passed on to the consumer via increased costs of services, or to the employee via lower wage income and shorter-term contracts.

Increased vulnerability to water-borne diseases/susceptibility to water quality problems

A decline in the numbers of trained operators at water treatment works and sewage treatment works is likely to be accompanied by periodic deterioration in the quality of potable water supplies in urban and rural centres. The basis for this assertion lies in two interlinked issues:

- First, an increased incidence of HIV/AIDS among the operators of water treatment works will increase the likelihood that water treatment processes may periodically be incomplete or ineffective.
- Second, there is a probability that inefficient or ineffective water treatment will increase the risk of adverse health effects in water users.

Clearly, this scenario does not have be restricted to urban and peri-urban areas that are served by extensive water reticulation systems. The scenario could also apply in rural areas where communities or households receive treated water, or where residents draw water directly from rivers and streams that may be contaminated by incorrectly treated effluent that is discharged from upstream sources. The health risks to these communities would be compounded if any community members were HIV-positive and their immune systems already compromised. Indeed, the immune systems of HIV-positive people are susceptible to a wider range of common illnesses and diseases than individuals whose immune systems are not compromised by HIV/AIDS. HIV-positive individuals are therefore likely to have a greater requirement for 'clean' water than their uninfected (HIV-negative) neighbours (Ashton 2000). Families caring for sick members may have less time to collect 'clean' water or treat 'unclean' water, thereby exposing themselves to greater risks. As the population becomes more vulnerable because of HIV/AIDS, people will become aware of the value of clean water and suppliers of water and sanitation services may be pressured to increase rates of delivery.

This situation could worsen if the incidence of water-borne diseases increases. For example, discharges of incompletely treated sewage effluent could lead to increased outbreaks of disease attributable to the organisms *Giardia* and *Cryptosporidium*. Both organisms cause extremely debilitating diseases in humans and their adverse effects would be far worse in HIV-positive individuals. While both HIV-positive and HIV-negative individuals would experience increased health risks that would cause a general decline in productivity, the impact significance is likely to be the greatest in HIV-positive individuals (Ashton 2000). A similar increase in the incidence of other (bacterial) water-borne diseases such as cholera can also be expected in these circumstances (UNAIDS 2000a).

The ecological consequences of impaired water quality are closely allied to the human aspects of this scenario and discharges of incompletely treated effluent will have a range of adverse effects on aquatic ecosystems. The adverse effects will be worse in those aquatic ecosystems that receive proportionately larger quantities of incompletely treated effluent. In consequence, the aquatic ecosystems will provide fewer 'ecosystem goods and services' (such as food, building materials and medicinal plants) to the users of such services (Falkenmark 1999; FAO 2000b). Ultimately, these ecosystem services would become stressed by the demands made upon them and may then collapse (Ashton 2000).

Possible contamination of ground water resources

To date, there remains a pervasive and widespread sense of 'shame' associated with HIV/AIDS sufferers. In many cases, family members are very reluctant to admit to relatives, friends and colleagues that one or more members of the family are HIV-positive. In the past, this situation has been aggravated by the violent reactions of friends and neighbours to the news that one of their friends or colleagues has HIV/AIDS or has died as a direct or indirect result of HIV/AIDS. In some cases, reactions have escalated to the point where surviving family members may be driven out of the community or, in extreme cases, erstwhile friends and relatives have even killed HIV/AIDS sufferers who admitted their illness (Jackson 1999). To avoid

confrontation, family members often attribute the death of a relative to a cause other than HIV/AIDS. In many cases, this is supported by the fact that the individual concerned may well have been infected with other opportunistic illnesses such as tuberculosis or cholera. Unfortunately, this situation also contributes to reducing the accuracy of HIV/AIDS prevalence and mortality estimates (Ashton 2000).

One of the unintended consequences of the so-called 'legacy of shame' that attaches to HIV/AIDS victims is that family members also feel a deep sense of personal shame and sometimes do not announce the death of their relative publicly. Where this happens, the feeling of shame has sometimes driven families to bury their dead relatives in so-called 'unofficial' graveyards with few of the normal rituals and ceremonies. While this situation can disrupt the social fabric of communities and can also aggravate or prolong the feeling of shame in affected families, there may also be further unanticipated side-effects. An example of this is the possibility that inappropriately sited unofficial graveyards could lead to contamination of local ground water that is used as a community water supply. Clearly, the health risk in this situation is not one of possible transmission of HIV to ground water; that is impossible. Instead, it is linked to increased nutrient levels and bacterial contamination from graves entering nearby ground water systems (Engelbrecht 1998). If nearby communities rely on boreholes or wells to supply potable water from shallow aquifers, this could also lead to potential health risks for these communities (Ashton 2000).

While there are a few anecdotal records of instances where unofficial graveyards have been located on or near to shallow aquifers, it is not possible to provide a quantitative estimate of the extent to which this situation has occurred. Nevertheless, given the prevailing public abhorrence of HIV/AIDS and the high-profile media reports of instances where HIV/AIDS sufferers have been rejected by their families and communities, an increase can be anticipated in such instances in future (Ashton 2000).

A further, unanticipated effect of unofficial graveyards is that other development options (roads, houses, cultivation) for these sites are very often precluded by the presence of a grave. Whatever their legal status, graveyards take on a special, sanctified significance in society that very often prevents the land in question from being used for alternative purposes. Nevertheless, even if the stigma of HIV/AIDS is removed, cultural practices of burial will still lead to an increased demand for gravesites. With limited land resources, it is likely that unsuitable ground will be used in some instances.

Current responses to the implications of HIV/AIDS in the water resource management arena

Every Southern African country faces the truly daunting prospect of dealing with the devastating effects of HIV/AIDS on every sector of its society. However, individual countries have responded to the pandemic in widely different ways to date. These responses cover a range from relatively small-scale reactions by individuals and communities, but with little formal government support (in Zimbabwe; see Kerkhoven & Sendah 1999), to concerted, organised and integrated programmes involving international, national and local authorities and organisations, as well as communities and concerned individuals (Swaziland and Zambia; see Whiteside 1999b; Jackson

1999). Countries such as Angola and the Democratic Republic of Congo appear to be preoccupied with resolving their respective civil wars and seem unable to deal with the threats posed by HIV/AIDS at this time.

While the scale and variety of the responses reflect the wide array of concerns expressed by governments, communities and individuals, the primary focus in each country appears to be one of dealing with the specific problem areas within such a country. Indeed, regardless of the level of response that the pandemic has elicited in individual countries, there is little evidence of concerted, region-wide programmes of action. The absence of cohesive, region-wide programmes of action also reflects the widespread differences of opinion that exist regarding the responsibilities and roles of individuals, communities, governments, aid organisations and the private sector. While individual businesses, companies, organisations and sections of government departments have started to implement programmes of action to remedy impacts that have already affected their spheres of business, others seem to be waiting for their respective governments to initiate formal (national) programmes of action.

In the water resource management arena in Southern Africa, there is very little in the way of a concerted response to the array of threats posed by HIV/AIDS. A few key government departments that deal with water-related issues have initiated calls for national and regional assessments of the implications of HIV/AIDS for their activities. Similarly, certain of the larger water utilities have realised that they face decreased worker productivity and therefore an array of associated cost increases, as well as increased staff turnover and hence an acute need for additional training programmes. At a more general level, industry, business and governments are increasing their educational efforts to enhance worker awareness of HIV/AIDS and its main modes of transmission, as well as providing counselling services for infected victims and their families. In addition, national government departments in most Southern African countries have embarked on intensive educational campaigns to promote public awareness of HIV/AIDS and its dangers for individuals, communities and society.

A variety of associated activities launched by government departments in some Southern African countries have a direct bearing on the linkages between HIV/AIDS and the water sector, and the vulnerability of poor people to HIV/AIDS. Examples are the efforts to provide poor rural and urban communities with safe supplies of drinking water and sanitation services in Mozambique, Namibia and South Africa. Originally, these programmes sought to alleviate historical disadvantages experienced by these communities as a result of previous political dispensations and to reduce the risks of water-borne diseases such as cholera. Fortunately, these programmes also help to reduce the risk that people infected with HIV/AIDS will be exposed to poor quality water. As a result, there are likely to be considerable indirect benefits in terms of reduced worker absenteeism due to illness, reduced infant, child and adult mortality due to disease, and a reduction in potential losses in national productivity. In summary, while most of the current Southern African responses to the HIV/AIDS pandemic appear, individually, to hold great promise, they seem to lose much of their impact because they are fragmented and seldom enjoy the benefits and advantages of integration within national or regional programmes.

The road ahead

It is now widely accepted that HIV/AIDS is a true development crisis that threatens the social and economic fabric, as well as the political stability, of entire nations (UNAIDS 2000a). Nowhere does this statement appear to be truer than in the countries of Southern Africa. However, there is good evidence that the pandemic is not out of control everywhere. Some African countries have managed to stabilise or reduce their HIV infection rates, while others have maintained low HIV/AIDS prevalence rates. In yet other countries, significant progress has been made in community and individual programmes for the care and support of victims and their families (UNAIDS 2000a; Whiteside & Sunter 2000). Changes in the behaviour of individuals and communities, together with the improved accessibility of commodities and services, as well as reduced discrimination based on gender and improved human rights, have all been critically important factors that contributed to these successes. Importantly, the social and economic roots to people's vulnerability to HIV/AIDS have been recognised and are being acted upon (UNAIDS 2000a; Williams et al 2000b).

Successes achieved elsewhere in Africa (Uganda; see UNAIDS 2000a) have provided extremely useful insights into possible approaches to combat HIV/AIDS in Southern Africa. Clearly, no single 'ideal response' or 'universal blueprint' is likely to emerge as the preferred option for controlling or reducing the prevalence of HIV/AIDS and its impacts on society. Instead, a number of basic common principles of effective responses can be identified (UNAIDS 2000a). These should form a basis for the design and implementation of locally relevant strategies in each country. Importantly, these strategies should be integrated into a single cohesive unit within each country and, ideally, within the Southern African region. Each sector of society will need to be closely involved in and committed to the execution of its own (national) programme, as well as its share of the overall (regional) programme.

The urgency and severity of the current situation in Southern Africa make it imperative that immediate, concerted actions are undertaken to provide reliable estimates of the prevalence of HIV/AIDS, as well as the numbers of people who succumb to the disease or die from illnesses associated with an impaired immune system. This should be coupled with concerted actions aimed at supporting and strengthening national initiatives designed to reduce the spread of HIV/AIDS, and inducing the widespread and sustained behavioural changes that will be required to achieve this.

Water resource managers will need to develop accurate forecasts of the demographic spread of water demand across the sub-continent and work closely with their counterparts in neighbouring states to improve regional water resource management approaches. Simultaneously, water supply utilities in each country will need to continue expanding and extending their water supply networks to meet national demands for water. Particular attention will need to be paid to ensure that poorer communities, who experience difficulty in paying for service delivery, receive assured water supplies.

Within the water sector, there is a clear need to develop, test and implement robust and reliable water treatment processes that do not require constant supervision or management interventions. These would help to reduce the potential health risks associated with ineffective water treatment that can be expected as a result of

increased mortality of operators of water treatment works. In addition, the water sector can help national efforts to expand public awareness of the dangers associated with untreated water and inadequate personal hygiene practices. Further, the sector can actively promote and adopt training schemes designed to increase the numbers of skilled and semi-skilled workers required to manage the region's water resources.

The regional situation will only start to improve when every society and national population comes to terms with the scale and severity of the HIV/AIDS problem in Southern Africa and this increased awareness results in appropriate social, cultural, behavioural and institutional changes. The tragic consequences of a failure to act, or of acting either inappropriately or too late, are already visible in many parts of Southern Africa and elsewhere on the African continent. Speedy and concerted implementation of appropriate responses is the only way in which the ravages of HIV/AIDS can be checked and contained, and its potential impacts reduced. Success in this endeavour depends on the full co-operation and collaboration of every individual, community, organisation and national government in Southern Africa.

Acknowledgements

Sincere thanks are due to Dr Barbara Heinzen and Professor Alan Whiteside for providing several constructive suggestions that improved an earlier draft of this chapter.

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Citation / reference for this paper:

Ashton, P.J. & Ramasar, V. (2002). Water and HIV/AIDS: Some strategic considerations for southern Africa. Pages 217-235, in: (A.R. Turton & R. Henwood, Eds), *Hydropolitics in the Developing World: A Southern African Perspective*. Pretoria, African Water Issues Research Unit (AWIRU).