AVOIDING CONFLICTS OVER AFRICA'S WATER RESOURCES

Peter J. Ashton

Division of Water, Environment & Forestry Technology,
CSIR, P.O. Box 395, Pretoria 0001, South Africa.

Abstract

Some 85% of Africa's water resources are comprised of large river basins that are shared between several countries. High rates of population growth accompanied by continued increases in the demand for water have resulted in several countries passing the point where the scarcity of water supplies effectively limits further development. Present population trends and patterns of water use suggest that more African countries will exceed the limits of their economically usable, land-based water resources before 2025.

Normally, water allocation and distribution priorities within a country are aligned with national development objectives. Whilst this may achieve national "water security" objectives, greater emphasis needs to be placed on regional efforts to ensure that the available water resources are used to derive sustainable long-term benefits for the peoples of Africa as a whole. Ideally, each country's water resource management strategy needs to be aligned with that of its neighbours if peace and prosperity are to be maintained and conflict is to be avoided in the region.

Introduction and background

Throughout the world, water is recognized as the most fundamental and indispensable of all natural resources and it is clear that neither social and economic development, nor environmental diversity, can be sustained without water. Today, virtually every country faces severe and growing challenges in their efforts to meet the rapidly escalating demand for water that is driven by burgeoning populations (1 - 3). Water supplies continue to dwindle because of resource depletion and pollution, whilst demand is rising fast because population growth is coupled with rapid industrialization, mechanization and urbanization (2, 4 - 6). This situation is particularly acute in the more arid regions of the world where water scarcity, and associated increases in water pollution, limit social and economic development and are linked closely to the prevalence of poverty, hunger and disease (2, 3, 7).

In comparison to the rest of the world, the distribution of water resources in Africa is extremely variable and water supplies are unequally distributed in both geographical extent and time. Large areas of the African continent have been subjected to series of prolonged and extreme droughts; very often these droughts have been "broken" or "relieved" by equally extreme flood events. There is also compelling, though as yet unproven, evidence that projected trends in global climate change will worsen this situation. In addition to climatic variability, a significant proportion of the continent's water resources are comprised of large river basins or underground aquifers that are shared between several countries. The countries sharing these water resources often have markedly different levels of social, economic and political development, accompanied by very different levels of need for water. The wide disparities between socio-economic development and needs for water further complicate the search for equitable and sustainable solutions to water supply problems (8).

In virtually every African country, population numbers have grown dramatically during the past century; these trends are expected to continue, albeit at a reduced rate, despite the ravages caused by the HIV/AIDS pandemic that is sweeping across most parts of Africa (9, 10). Regardless of obvious inequalities within a variety of social, economic and political dispensations, this population growth has been accompanied by an equally dramatic increase in the demand for water. Several African countries have already reached or passed the point considered by Falkenmark (7) to indicate severe water stress or water deficit, where the scarcity of water supplies effectively limits further development. Based on present population trends and patterns of change in water use, many more African countries will reach, and exceed, the limits of their economically usable, land-based water resources before the year 2025 (8, 10). These sobering statistics emphasize the urgent need to find sustainable solutions to the problem of ensuring secure and adequate water supplies for all African countries.

Equitable access to sufficient water to sustain basic human needs (variously estimated at between 25 and 40 litres per person per day) is recognized as a fundamental right of all peoples (11, 12). However, whilst this principle has been endorsed implicitly in international conventions, it seems that differences of opinion over the quantity of water required to support basic human needs have prevented *explicit* endorsement and approval (12).

In parallel with the right of equitable access to sufficient water to satisfy basic human needs, it is vitally important that we develop a shared appreciation of the true value of water, and understand the critically important need to change or redirect our approaches to water management and utilization on regional and continental scales (3). Whilst water allocation and distribution priorities in each country need to be closely aligned with national and regional development objectives, greater emphasis now needs to be placed on concerted efforts to ensure that the continent's scarce water resources are used to derive the maximum long-term benefits for the peoples of Africa as a whole. However, this goal can only be achieved if water resource management is both judicious and cautious. As water supplies become scarcer, a key consideration will be the pressing need to evaluate the necessity to reallocate water from less productive sectors to those that are able to derive greater long-term economic returns per unit of water used (3, 12). In this process, it will be critically important to ensure that every community still has equitable access to the available water resources to meet their basic human needs. This aspect is particularly important in the case of Africa's shared river basins. Ideally, each country's water resource management strategies need to be closely aligned with that of its neighbours if peace and prosperity are to be maintained and conflict is to be avoided (3, 8, 13, 14).

Against this general background, it is instructive to examine the availability and distribution of water resources across the African continent and to evaluate the likely trajectories of change in the demand for water that will occur as Africa's populations continue to increase. Special attention is paid to those areas where water resource depletion has reached a point where the prospect of chronic water shortages could provide a strong incentive for disputes or even conflict between neighbouring countries. Particular emphasis is placed on the need to support the collaborative development and implementation of new water management policies and strategies that are specifically shaped to cope with the pressures of economic growth in situations where water supplies and water demand are unevenly distributed. The likely success or failure of different management strategies to change the existing patterns of water demand and use will determine whether or not we are able to avoid the looming potential for conflict over water resources in Africa.

Geographical considerations and the availability of water in Africa

Geographically, the African continent straddles the Equator, with an approximately equal range of latitudes to the north and south, though a larger proportion of the continent's land mass (approximately 57%) is located north of the Equator. During an annual cycle, the amplitude of the cyclical changes in the radiant energy that reaches the earth's surface increases with increasing distance from the Equator and gives rise to corresponding daily and seasonal cycles of day-length and temperature. In turn, these changes in temperature and day-length regulate the occurrence and intensity of winds causing seasonal differences in rainfall, giving rise to distinct "wet" and "dry" seasons.

The extent of seasonal temperature and rainfall variations at any given latitude is modified by the proximity of the oceans and the presence of warm and cold ocean currents. The continental interior of Africa tends to be drier and experience greater annual temperature extremes than equivalent coastal latitudes that have more moderate ranges. In addition to these features, the El Niño – Southern Oscillation (ENSO) phenomena have been closely linked to the occurrence of severe droughts interspersed with exceptional flooding events across large areas of Africa (15).

Both the southern and northern portions of Africa receive considerably less rainfall during any given annual cycle than their equatorial neighbours. These drier areas also experience greater variability in year-to-year rainfalls and generally have more extreme air temperatures and higher rates of evaporation. In combination, these features reduce surface water flows in rivers and streams, and provide little recharge to ground waters. Typically, river flows in the countries of southern Africa and North Africa range from some 20% of mean annual rainfall in the wettest areas to zero in the deserts. On average, flows in the rivers draining the northern and southern areas of Africa comprise less than 10% of the mean annual rainfall. This is in marked contrast to many equatorial African countries where surface runoff often comprises over 30-40% of the mean annual rainfall (**Figure 1**). Across the African continent, the geometric (spatial) average annual rainfall amounts to some 650 mm; this is approximately 24% less than the world average annual rainfall of 860 mm (15).

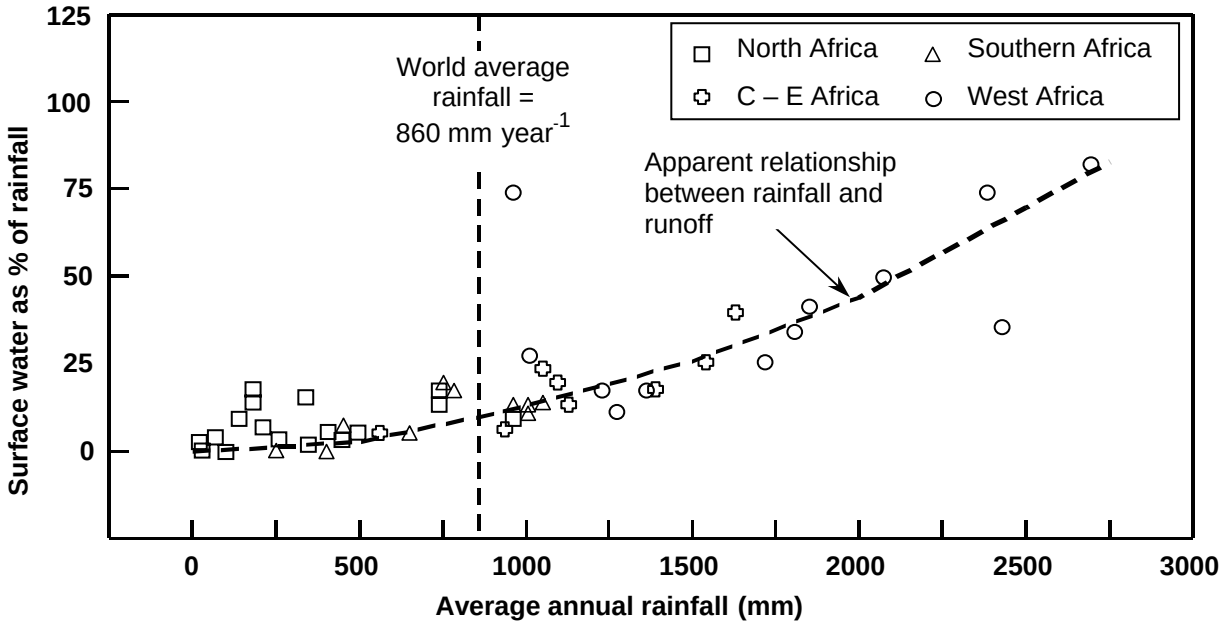

Figure 1. Comparison of surface runoff (expressed as a percentage of annual rainfall) versus average annual rainfall for mainland African countries. Data taken from FAO (17).

The variable and erratic rainfall patterns, extremes of temperature and high evaporation rates across the continent result in a striking absence of perennial rivers and lakes in both North Africa and the western parts of southern Africa (**Figure 2**; (8)). The distribution pattern of perennial rivers and lakes, and the locations of areas where some form of dispute or conflict have occurred or have been threatened, either over the availability of water or over some aspect of water supply, shows a remarkable correspondence (**Figure 2**).

The climatic, and especially rainfall, characteristics of Africa, outlined briefly above, indicate very clearly that the average quantity of water available at a given time and place (within a country) will be a finite amount. Years of above-average rainfall will provide short-term relief in the form of additional water, whilst lower rainfalls during drought conditions will cause, or accentuate, water shortages. Several authors (e.g. 2, 7, 8, 15, 16) have repeatedly stressed the fact that freshwater resources in Africa and elsewhere represent a finite and vulnerable resource.

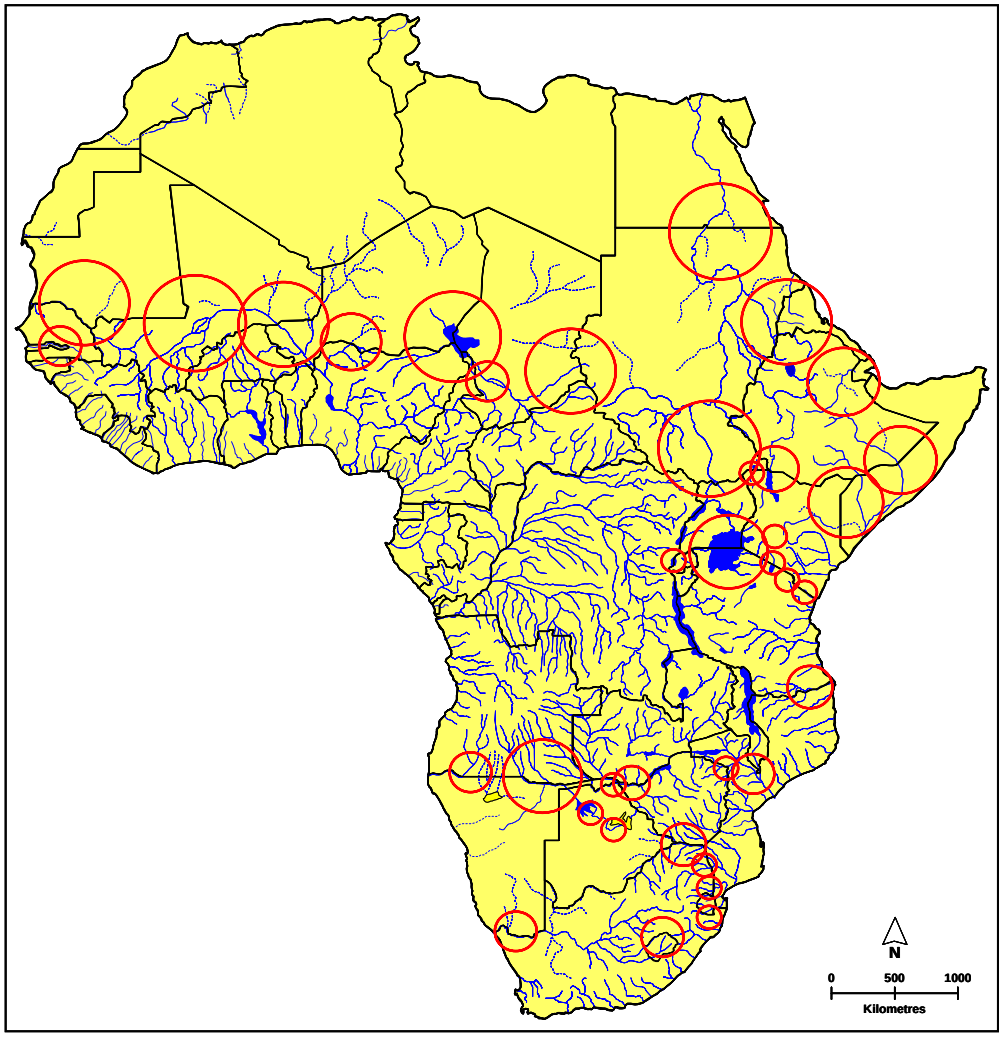

Figure 2. Diagrammatic map showing the locations of actual or potential water-related conflicts in Africa. Figure redrawn from Ashton (8).

A direct result of this realization is a growing awareness that increased population numbers and improved quality of life (i.e. "development" in its widest sense) contribute to a continual and inevitable reduction in the quantity of water that is available per person. This reduced *per capita* availability of water, coupled to an escalating trend in the degradation of its quality, represents the most serious and tangible single threat to the flows of various goods and

services required by society (17). However, on a very positive note, the threats posed by the impending water crisis have enhanced public recognition of the values generated by or linked to water, and have also expanded our understanding of the significant social and economic values that are embodied in the many ecosystem services that depend on water (4, 5, 17).

The extent of the water crisis facing Africa

The potential threat to society posed by increasing pressures for finite quantities of water is one that is not unique to Africa. Nevertheless, the broad scale and imminence of the threats posed to many African countries demand our urgent attention if we are to avoid large-scale hardship and possible future conflicts. Many authors have stressed the apparent inevitability of serious inter-state conflict over competition for diminishing water resources in different parts of the world (6, 18 - 21). Some authorities have extended these arguments even further and postulated the strong likelihood that reduced availability of water could ultimately lead to "water wars" between countries that may compete for the same scarce resource (18). Many of these arguments appear to be based on two groups of similar assumptions, namely: that communities, societies and even governments of countries have little or no choice in the matter, and that their only logical (or possible) reaction to the crisis of water shortage is one that is based on strong (even violent) competition for the resource.

In simple terms, it seems that all of the proponents of these arguments rely on a relatively simplistic interpretation of what Falkenmark and her co-workers call "the numbers game" (17). Clearly, the "numbers" tell everyone that there is a continual and dramatic decline in the quantity of water available per person. This is incontrovertible. However, it is important to understand the emphasis that different authorities place on the numbers. For example, most arguments state the problem in terms of the continual decline in the quantity of water available per person (e.g. 15, 22). Again, this is accepted fact: the quantity of water available for each person in the world is declining steadily; nowhere is the rate of decline as dramatic as we continue to see in Africa. Even a cursory examination of the geographic and demographic statistics listed for each African country confirms this rapid decline and highlights the severity of the water crisis facing our continent.

However, importantly, the available statistics also reveal that the decline in water available per person is not uniform across Africa. Several countries will remain in a state of so-called "water abundance" (23) for many years to come, whilst others will experience increasing levels of "water scarcity" and "water deficit". This can be demonstrated by comparing, for 2000 and 2025, the anticipated changes in the proportions of population numbers, water available, and the total area of African countries within three classes of water availability (**Table 1**).

Table 1: Comparison of the proportional changes in area, total population and proportion of water available within each of three classes of water availability, for 2000 and 2025. The data are presented as percentages, and refer only to the African continent and exclude the islands of the Indian Ocean (Comores, Madagascar, Mauritius, Reunion and Seychelles).

Countries with water:	**2000**			**2025**		
	Area	**Population**	**Water**	**Area**	**Population**	**Water**
Abundance	52.5	60.8	95.2	34.7	23.9	78.3
Scarcity	26.0	24.3	4.4	39.1	57.3	20.6
Deficit	21.5	14.9	0.4	26.2	18.8	1.1
Total African Population:	786 million			1428 million		

A brief explanation of some of the data in **Table 1** helps to highlight the scale of the problem. In 2000, some 53% of the area of the African continent was comprised of countries considered to have "water abundance". These countries were home to 60% of the total African population of 786 million people and contained 95% of the continent's total renewable water resources. In contrast, the remaining 40% of the African population occupied 47% of the continental area, but this only contained 5% of the total renewable water resources available on the continent.

By the year 2025, it is anticipated that the total area of African countries considered to have "water abundance" will have shrunk to 35%. These countries will now house 24% of the continent's (now much larger) population but will still contain 78% of the continent's renewable water resources. In sharp contrast, the combined area of Africa considered to have a situation of either "water scarcity" or "water deficit" will increase from 47% to 65%. These countries will house some 76% of the continent's population but will have to rely on a mere 21% of the continent's renewable water resources in 2025.

It is important to remember that these purely numerical forecasts assume a steady (and unchanged) rate of population growth with no change in the total quantity of water available; according to these forecasts, the population of Africa will almost double (increasing from 786 million to 1428 million) between 2000 and 2025. However, the estimates of population growth should be treated with caution. Given the widespread incidence of water-borne diseases such as malaria and cholera (13, 15), together with the enormous implications of the African HIV+/Aids pandemic (9, 10), and declining levels of social and economic stability (1, 17), these forecasts may well be an over-estimate for the African population in 2025.

Despite the inherent inaccuracies in most attempts to predict population growth rates and associated demands for water, there is a clear trend of a continual decline in the quantity of water available per person (2, 17). Typically, this trend is almost always presented as an "increasing scarcity of water" and is supported by irrefutable numerical evidence that focuses on the quantity of water (e.g. 2). Communities, countries and even whole regions are carefully classified in discrete categories on the basis of the quantity of water available per person, and the apparent "severity" of the situation in specific areas forms the basis for justifying social, economic and technological attempts to alleviate the problem. This emphasis on the water (rather than the people) has driven many of the attempts to develop new water resources, develop new technologies to recycle and reuse water, design innovative ways to limit or reduce the demand for water, and even to investigate new and novel sources of fresh water (22). Intriguingly, very few people have attempted to review and interpret the evidence in the light of the original meaning that Falkenmark intended when her indices of water limits were developed (7, 17, 23). For clarity, both the original (numbers of people per flow unit) and modified (quantity of water available per person) interpretations of the water scarcity or water limits indices are shown in **Table 2**.

The original intention behind the elegant water limits index developed by Falkenmark was to highlight and emphasize the fact that the demographic dimension was the most important (23). This is clearly reflected in her original indices where different levels of water availability were expressed in terms of "crowding", as numbers of people per flow unit (one million cubic metres of water per year; **Table 2**). The reason why the original index has been inverted by so many authors is not clear (17). One possible reason is that the inverted index focuses attention on a more easily manageable issue – that of supplying sufficient water – rather than on the far more contentious issue of having to deal with or curb the primary problem, population growth, and its associated need for greater quantities of water. Nevertheless, whatever the reason, the original definition of the water limits index (water crowding index) explicitly illustrates that population growth is the determining factor behind the growing water scarcity (17, 24).

Table 2: 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 Africa, and the linkage to Falkenmark's original "water crowding" concept of the numbers of people per flow unit. Modified from Falkenmark (7, 23).

Water Scarcity Category and Associated Problems	Original index: Numbers of people per flow unit (million m^3)	Modified index: Volume of water available per person (m^3 $person^{-1}$ $year^{-1}$)
Beyond the "water barrier": continual, wide-scale water supply problems, becoming catastrophic during droughts.	> 2000	< 500
Chronic water scarcity: continual water supply problems, worse during annual dry seasons; frequent severe droughts.	1000 – 2000	500 – 1000
Water stressed: frequent seasonal water supply and quality problems, accentuated by occasional droughts.	600 - 1000	1000 – 1666
Moderate problems: occasional water supply and quality problems, with some adverse effects during severe droughts.	100 – 600	1666 – 10 000
Well-watered: very infrequent water supply and quality problems, except during extreme drought conditions.	< 100	> 10 000

It is vital to note that Falkenmark's water limits index provides no information on the fraction of a country's water resource that can realistically be withdrawn from the natural systems and provided to society (25). Here, it is also important to be able to distinguish between the natural supply of water (usually as rainfall), almost all of which is required to maintain essential terrestrial and aquatic ecosystem services and their associated ecosystem goods, and the water that is normally available in river systems for direct utilization by people. 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 first category, the so-called "green water", consists predominantly of the water in soil and vegetation, can only be manipulated or influenced through changes in land use (5, 17).

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 (5, 17). The available evidence indicates clearly that almost all "green" water and a large proportion of "blue" water are needed to sustain ecosystem structures and functions, and maintain sustainable water supplies (17). The key implication here is that not all "blue" water should be considered as available for direct use by society; a proportion must always be reserved for ecosystem functions (5, 17).

Most of the statistics on water availability in African countries refer only to the more manageable "blue water" component. An important consideration here is the availability of the necessary social, economic and technical resources that are needed to take advantage of the available water. These features have been referred to as "the coping capability" or "social adaptive capacity" of a society that enable it to take advantage of the available natural resources (3, 16, 20, 26, 27). In particular, this capability of a society depends on a high degree of human ingenuity and the ability to adapt and adopt plans, strategies and tactics that will help to promote more effective and efficient use of water (3, 28). Indeed, there is convincing evidence that countries (such as Israel) which display a highly developed social

adaptive capacity, have been able to overcome severe water shortages, whilst other countries (such as Burundi) where there is less evidence of social adaptive capacity, have not been able to do so (26).

Societies with low or high levels of social adaptive capacity will have different abilities to deal with changing levels of water availability (26, 27). The typical set of consequences is demonstrated in **Figure 3**. A society with low social adaptive capacity will be unable to deal effectively with water scarcity, thereby entering a situation that Turton (26) has called "water poverty".

		Relative ability to develop and adopt coping strategies	
		Low	**High**
Relative availability of water per person	**Scarce**	**Water poverty**	**Structurally-induced water abundance**
	Abundant	**Structurally-induced water scarcity**	**Water security**

Figure 3. A comparison of the likely outcomes of societies with two levels of "second order resources" (i.e. social adaptive capacity) having to deal with two levels of "first order resource" (i.e. water abundance of water scarcity). Figure redrawn and modified from Turton (26).

In a similar fashion, low levels of coping skills will prevent a society from making full use of abundant water resources, thereby forcing it to enter a condition of "structurally-induced social scarcity". In contrast, a high level of social adaptive capacity will allow a society to develop and implement a series of coping strategies that will permit a situation of so-called "structurally-induced water abundance" (26, 27). Equally, a country that possesses and deploys a high level of social adaptive capacity and has access to abundant water resources can be considered to be in a state of "water security" (**Figure 3**).

This straightforward comparison (**Figure 3**) demonstrates very clearly how important it is for societies to develop and implement sets of coping strategies and skills to enable them to deal effectively with conditions of impending water scarcity. Inevitably, every country in Africa will have to face the same prospect: dwindling quantities of water that can be supplied to meet demands. Some countries are already "beyond the water barrier" (5, 17) and are dealing with this urgent matter now; other countries with more water available now will have to deal with the issue in future. In any event, an enormous effort will be needed from every country if the challenge is to be met successfully.

Factors contributing to conflict potential

Against this background, it is important to examine the series of factors or conditions that could contribute to a heightened potential for conflict over scarce water resources. In this process it is useful to distinguish between those sets of circumstances where the issue of water is likely to be incidental to any conflict, from those where water is or will become a central issue. This aspect is particularly significant in the case of river basins that are shared by more than one country, especially where the countries involved have different levels of social and economic development (8, 29).

One of the remaining legacies of past colonial administrations is the apparently arbitrary fashion in which the national boundaries of most African countries were set (30). As a result, these boundaries seldom conform to river catchments and virtually all of the larger river systems in Africa are shared by several countries (13). Consequently, several African countries have had to compete directly or indirectly to derive the maximum possible benefits from the available water resources. This situation has been accentuated in those situations where the downstream countries may be economically "poorer" or politically and militarily "weaker" than their upstream neighbours (8). This competition between "upstream" and "downstream" countries for the same water resource is considered to pose the greatest potential threat of conflict over water in Africa (8).

However, the available evidence indicates very strongly that territorial sovereignty issues have been implicated in virtually every dispute or conflict that has taken place over, or near to, water. In most cases, these disputes have been linked to disagreements over the precise positions of territorial boundaries and have tended to involve relatively small areas (8). Indeed, there is ample supporting evidence that despite many predictions to the contrary (e.g. 21), "true" water wars have happened very rarely, if at all (31).

More recently, attention has switched to the increasing number of water-related problems that are being recorded from countries that share the water resources within a single river basin. In several reported cases, increased water use by "upstream" countries, combined with increased levels of water pollution, has had adverse effects on "downstream" countries. Whilst many of these incidents may only extend over a small geographic scale, occur for a short period of time, or implicate few water users, they invariably elicit a very strong reaction from the neighbouring state (13, 15). This situation can be particularly sensitive where the states sharing a river basin make use of the available water without due consideration for each other's needs (8, 32).

In its widest sense, water is a critical component of the national prosperity of a country because it is inextricably woven into irrigation and food production processes as well as into the provision of energy and, occasionally, into transportation systems. Access to adequate water supplies is usually seen as a "life or death" issue; any threat to disrupt or prevent access to essential water supplies becomes an emotionally charged and volatile topic of intense debate (8). Importantly, water is also a key determinant in the industrial and service sectors (e.g. tourism) of a country's economy. Since these sectors seldom consume large volumes of water in relation to the economic return that they generate, there are strong arguments for countries to ensure that these sectors are supplied with all their water needs at all times. In this vein, Allan and Karshenas (33) have promoted the importance of the *virtual water* concept and its increasing relevance in national economies and water budgets, especially in water-scarce countries.

At a strategic level, five key geographical and geo-political characteristics or features influence the ease with which water can become a source of strategic rivalry or confrontation between neighbouring states (8). The first four of these have previously been stated by Gleick (2); the fifth is added here as an important determinant in Africa:

- The degree of water scarcity that already exists in the region;
- The extent to which a water supply is shared by one or more states or regions;
- The relative power relationships that exist between water-sharing states;
- The availability of alternative water sources and their accessibility; and
- The degree or extent to which a particular country's international boundaries are aligned with, or located along, shared river systems.

The outcome of this situation is then framed within the context of the strategic goals and objectives that each country has set for itself. In particular, two closely inter-related aspects are important here (8):

- First, the degree of attention or effort that each country is willing to focus on actions designed to maintain its territorial integrity or national sovereignty, and the circumstances and costs that it is prepared to bear to achieve this aim; and
- Secondly, the political, social and economic lengths to which each country is prepared to go to achieve a state of *national* "resource security" in terms of achieving national self-sufficiency of water, food and energy supplies, rather than developing a more pragmatic, regional, and shared perspective with its neighbours.

Everyone is aware that a river knows no boundaries. Whatever happens to a river at one point will be transported, transformed and expressed along its entire length until it reaches the ocean. Where human activities divert or interrupt the flow of water, or cause degradation in water quality, the consequences are always attenuated, translated and transmitted downstream (8). Since very few of the larger rivers are contained within the borders of a single country or state, access to wholesome supplies of water increasingly becomes a source of potential conflict whenever a river crosses an international boundary. This issue becomes particularly acute where water resources are unevenly distributed and where a single river system may traverse or form several international borders (8, 13). The potential for conflict in such situations is brought sharply into focus in the case of countries that have to rely on water originating in neighbouring states for the major proportion of their fresh water supplies. For example, Egypt, Botswana and Niger obtain, respectively, 97%, 94% and 68% of their total fresh water from neighbouring states; this undoubtedly contributes to a sense of vulnerability (8, 15).

The tensions characteristic of most “upstream-downstream” situations can be compounded by large seasonal variations in flow and by periodic droughts and floods. In some cases, this has promoted international trade in water; Lesotho is a case in point, earning valuable foreign exchange from the water it sells to South Africa. However, in the context of "water trading", there appears to be very little shared understanding or agreement as to the value of water; it is usually treated as a “migrant” or “fugitive” resource with a variable value. This absence of an agreed system for valuing water also contributes to potential conflicts between neighbouring states. The value of water may also vary with its availability; for example, during floods, the unit value of abundant water supplies is considerably less than an equivalent unit of water that may be available during a drought (8).

In addition to the "international" dimension of potential causes of water conflict, we can add a wide variety of more local, inter- and intra-community conflicts over water that can occur within the boundaries of a single community or country. Perhaps the most important or frequently encountered of these smaller-scale conflicts relates to water quality problems caused by upstream activities, followed in importance by problems of access to water during critical periods (8). Further complexity is introduced by the need for members of the public to be involved in decisions around water-related issues that affect their lives and livelihoods. Failure to provide opportunities for public participation in the past has led to several instances where dissatisfied members of the general public have rejected proposals for water infrastructure projects (8).

The importance of scale

The issues of spatial and temporal scales have been touched on briefly in the earlier descriptions of some of the potential causes of different types of water-related conflicts in Africa. It is essential to remember that these (spatial and temporal) scales of water conflict often influence decision-makers when individuals, communities and governments are searching for appropriate solutions (8). Therefore, they should be reviewed so that their significance can be placed in the proper perspective.

Clearly, issues of scale must play an important role in the decisions taken by water resource managers and politicians. For example, a local-scale disagreement between two adjacent landowners over access to water requires far less strategic (government-level) intervention than another water access problem that may be confounded by a territorial dispute over the precise location of an international boundary. Nevertheless, it is vital to remember that smaller, "local-scale" conflict situations can escalate very rapidly and require appropriately rapid responses. In contrast, most larger-scale, or "international", conflicts tend to develop more slowly or gradually; responses to these situations should also be appropriate to the scale of the problem confronted (8). Importantly, the geographical scale of the issue also influences the number and variety of practical options that are available for resolving the matter. For example, very few resources and dispute-resolution options are available to individuals in the case of a localized dispute, compared with the wide variety of resources and options that can be called upon to resolve an international dispute.

In terms of geographical scale, five separate classes can be recognized (8), namely:

- *Intra-community*, where conflict of some aspect of water may occur over a very small area between members of the same community;
- *Inter-community*, representing a slightly larger scale, where all or most of the individuals within each community may present a united front in their dispute or conflict with a neighbouring community;
- *Inter-provincial*, where groups of communities or local authorities within a single province or regional authority in a country may dispute the rights of a neighbouring provincial authority in the same country to water that is not located within the geographical area of jurisdiction (e.g. typical of inter-basin water transfers, where "donor" catchments are seldom compensated adequately, and "recipient" catchments reap almost all of the benefits);
- *International*, where one country may contest some or all of the rights to use water from an aquatic system that it shares with of one or more of its neighbours. Typical examples of this type would include so-called riparian rights to rivers that are located on international boundaries, and the situations where a river crosses an international boundary and gives rise to disputes between "upstream" and "downstream" countries; and
- *Urban – Rural*, where escalating rates of urbanization have resulted in greater emphasis being placed on meeting the growing needs of urban communities, often at the expense of rural communities who often have to rely on water sources of uncertain reliability and dubious quality.

In addition to these strictly spatial scales, geo-political considerations can add additional dimensions of complexity to those provided by the spatial scales outlined above. Here, typical examples would include (8):

- Conflicts that could arise between "upstream" and "downstream" countries as a result of specific activities or demands of one or both of the countries concerned;
- Conflicts that could arise when neighbouring countries dispute the precise location of the international boundaries that separate them and which also coincide with, or are aligned with, rivers or other aquatic systems; and
- Conflicts that could be caused by the natural or artificial "alteration" of river courses that are aligned with or demarcate international boundaries between two countries.

The scale of activities carried out by the individual countries concerned can often accentuate the problems of "geographical" and "geo-political" scale. For example, if an "upstream" country constructs and operates a large impoundment, this will affect the timing, frequency, duration and quantity of water flows, as well as the corresponding silt loads and water quality that are received by the "downstream" country (8). Similarly, effluents discharged by an "upstream" country can have marked adverse consequences for water users in the "downstream" country (25).

An understanding of the complex inter-relationships between people and water resources provides extremely useful insights into the driving forces that shape national and regional water resource management policies, as well as the associated social, economic and political responses to such policies. In turn, suitable long-term strategies and programmes of action can then be formulated to avoid or prevent specific situations that could cause or lead to water conflict (8). All of these strategies must acknowledge the central role played by people and societies – it is simply not sufficient to focus attention on water.

Strategies to avoid conflict or diminish conflict potential

In the light of the evidence already presented, it is clear that: **water conflicts in Africa will be inevitable if we do nothing to prevent them from occurring**. This somewhat simplistic statement is guided by the knowledge that Africa's fresh water resources are finite and cannot continue indefinitely to support the escalating demands that we make of them. If no actions are taken, competition for the available water supplies will continue to increase to a point where radical interventions will be required to avert conflict (8).

Turton (28) has argued convincingly that water is most unlikely to be the direct cause of a "war" over water in Africa. Nevertheless, there is a distinct possibility that increasing demands for water could contribute to regional instability if the demands approach the limits of the available supplies and the "competing" societies are unable to adapt appropriately to this situation (8). Clearly, where more than one country or an entire region is involved in a dispute, a wide array of coping strategies and mechanism can be deployed to resolve the problem. The presence of effective communication mechanisms and efficient institutional structures forms an extremely important component of all such strategies.

The common-sense statement: "prevention is better than cure" provides a perfect outline of the goals and objectives that should direct our strategies and actions when we seek to deal with the complex issues of water-related conflicts. However, despite its apparent simplicity, this ideal often eludes us in practice (8). A large part of the reason for this lies in the diverse, and often contradictory, ways in which we attach value to water, and the ways in which we strive to derive both individual and collective benefit from our use of water. Too often our objectives have a short-term, local focus aimed at meeting objectives and solving problems today, rather than a far longer-term focus on the sustainable and equitable use of our water resources on a regional or continental scale (8, 17).

If our demands for water outstrip our ability to manage water as a focus for cooperation and the achievement of common goals, there is a very real risk that we will enter an ever-tightening spiral of poverty, whose social, economic and environmental consequences will threaten the fabric of society. In contrast, if we can attain an equitable balance between the demands we make for the services and goods that we derive from the use of water, and our ability to exercise our custodianship of water, we will be able to achieve a far more harmonious and sustainable situation. However, to achieve this, all our policies and strategies concerning water must be guided by the values of sustainability, equity, mutual cooperation, and the attainment of optimal benefit for society (34).

Neighbouring countries that have to share a single water resource need to answer four key questions, namely:

- How will the water resource be managed to ensure compliance with any agreement?
- What fraction or proportion of the water can be allocated for society's use without impairing the resource beyond unacceptable limits?
- How will the water requirements of rural and urban populations in each country be met equitably and timeously, within the constraints of national economies and international treaties?
- What constitutes a fair and equitable share of the water resource for each country?

Clearly, the countries concerned should not attempt to answer these questions in isolation from one another; a solution put forward by one country is likely to be rejected by the other states involved. Instead, the states should first agree to form an appropriate, formal institutional structure that will take responsibility for the judicious management of the shared water resource (12). Several such institutional structures or river basin organizations already exist in Africa and elsewhere in the world; these provide ideal examples to be emulated. The formation of a suitable institutional structure should then be followed by agreement as to the most appropriate technical or investigative methods to use to answer the key questions, and, finally, agreement to abide by the results or findings produced.

The formation of a suitable institutional structure probably represents one of the greatest obstacles that river basin states need to overcome since this will formalize and legitimize the technical deliberations that take place. The question as to what fraction of the water can be allocated for society's use without jeopardizing or impairing the water resource will depend on the importance that each country attributes to the necessity to maintain essential ecosystem functions. This can be achieved by consensus-seeking approaches based on a thorough analysis of the structure, functioning and characteristics of the water resource and associated terrestrial systems in the catchment (8, 12).

The final question, what constitutes a fair and equitable share of the water resource, is often viewed as the most difficult one to answer and one where participating states are most likely to disagree. Clearly, the basis of the answer will depend on the relative degree of importance that the participating states attach to the needs of their people for water, and the necessity to maintain essential ecosystem functions and services (17, 35). The principle of "reasonable and equitable use" embodied in Article 5 of the United Nations Convention is somewhat vaguely worded, provides little guidance in this regard and is prone to subjective interpretations (36).

Essentially, each of the participating states needs to agree on the fraction of water to be reserved for ecosystem functions, and the precise criteria that should be used to calculate the "fair and equitable share" that each country is then entitled to (35, 36). Preliminary evaluations of a set of six tentative criteria have demonstrated that, if agreement can be reached on the precise nature of the criteria, then it is a relatively simple procedure to derive the respective shares of the available water (36). Whilst this approach is not yet able to account for seasonal and year-to-year variations, it has an inherent simplicity that will make it attractive to decision-makers. However, because it is still incomplete, further development and testing are needed before it can be adopted.

Conclusions

Based on the available evidence, we can conclude that conflicts over water in Africa will be inevitable unless we can jointly take preventative actions. The inevitable increase in population numbers continues to place ever increasing stresses on our continent's finite

water resources. It is important to remember that the any solutions to the problems of water supply must involve people; purely technological solutions that are designed to provide more water will not solve the underlying demographic problems (12).

A set of preventative strategies has been briefly outlined as a suggested basis for preventing water-related conflicts. The success or failure of these strategies will depend on processes of joint decision-making, within suitable institutional and legislative frameworks. It is important to note that the possible options for conflict prevention are generic in nature and these will have to be customized to make them site-specific, to suit the individual needs of the communities and countries involved.

The issue of the scale of a potential conflict is important, as well as the specific circumstances that may have given rise to the problem. It is clear that "downstream" countries and communities will always be more vulnerable than "upstream" countries. In turn, the degree of vulnerability felt by a "downstream" individual, community or country would be determined by perceptions of the relative strengths and power relationships of the different parties (8). Despite dire predictions to the contrary, the available evidence suggests very strongly that it is highly unlikely that "true" water wars will ever occur in Africa. However, this is no reason for complacency on our part. We all share the responsibility of ensuring that water conflicts never occur in Africa, or elsewhere. We need now jointly to identify those so-called "hot spots" where water conflicts are imminent or could arise in future, and then to develop collaborative strategies to defuse these situations (8).

Each of us shares the responsibility to promote the principles of equity, sustainability and maximum efficiency of use in all our dealings with water users and water resource managers throughout Africa. Particular attention must be paid to water demand management in a concerted effort to reduce inefficient and wasteful patterns of water usage. Similarly, we should also seek new ways to influence the relevant water management institutions and authorities to focus their efforts on those longer-term policies, plans and actions that will prevent water disputes, rather than retaining only a short-term focus and then trying to resolve disputes after they have occurred. If we fail to achieve this, there is a very strong possibility that water-related conflicts will occur.

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