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AFRICAN WATER DEVELOPMENT REPORT 2006

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This process was undertaken under the general direction of all the heads of the participating agencies, including the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the United Nations Human Settlements Programne (UN-HABITAT), the Food and Agricultural Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Economic Commission for Africa (ECA).

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Stephen Maxwell Donkor
Coordinator, UN Water/Africa

PREFACE

The general level of water resources development for meeting the needs of the African populace (for potable drinking, food security and other necessities of human life) is still very low. This situation could be a blessing in disguise if proper policy frameworks for planning, development, and management of water resources in African countries can be devised, taking advantage of the advancement in water science and technology and also the positive and negative experiences of the technologically-advanced countries through appropriate knowledge and technology transfer mechanisms. It is well known that the levels of scientific and technological tools for harnessing the resources of water bodies in its many forms of occurrence (rivers, lakes, seas and others), have exerted decisive influence on the development of human society and determined the level of general socio-economic development. It is therefore obvious that any accelerated development in Africa would, to a very large extent, depend on how effectively African countries are able to harness their water resources for a sustainable socio-economic development and, above all, for the eradication of endemic poverty without impairing the environment.

As we observed in the interim report of the ***African Water Development Report*** (AWDR), never in the history of the tortuous efforts in Africa aimed at reversing decades of endemic poverty and pervasive underdevelopment in Africa has the realization of the cardinal role of water in socioeconomic development been so high as at present. This positive trend has been achieved through decades of International and African concerted efforts at evolving policies and strategies for effective water resources development and management, culminating in the adoption of the Dublin Principles of Integrated Water Resources Management. These processes can generally be referred to as the ***"Water Journey from Rio to Johannesburg***". It is within this process that the African Water Vision 2025 was launched at the 2nd World Water Forum at The Hague in 2000, with the following message:

"An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment".

In recognition of the growing water crisis the world over, the United Nations family organizations launched a system-wide project called the ***World Water Assessment Programme*** (WWAP) to develop tools and skills that would foster a better understanding of the basic processes, management practices and policies that ensure that clean and sufficient water is available to all in a sustainable manner. The World Water Development Report (WWDR) was also instituted to publish, at regular intervals, the main trends and results of this process. It is intended to provide decision-makers at continental, sub-regional, regional, national and river basin levels with information that can be used at various levels to govern water wisely. The first WWDR was published in March 2003.

Due to the particular problems of water resources development and management in Africa, the ***Inter-Agency Group on Water*** in Africa (now referred to as **UN-Water/Africa**), took a challenging decision in April 2001 in Niamey to develop an African Water Development Report (AWDR). The AWDR would afford African countries and other stakeholders the necessary tools and skills to monitor the goals and targets of the African Water Vision, concisely formulated as follows:

> *Water can make an immense difference to Africa's development if it is managed well and used wisely. Given clear policies and strategies and real commitments to implementation, we can use water to help eradicate poverty, reduce water-related diseases and achieve sustainable development.*

The African Water Development Report (AWDR) is, therefore, intended to be more in-depth and African-owned but linked methodologically to WWAP and form an integral edition of WWDR.

The objectives of the AWDR are to:

- Provide a lasting and durable mechanism to monitor progress made in implementing the African Water Vision;
- Provide African decision makers with an authoritative basis for managing Africa's water resources; and
- Serve as an integrative programme for the strengthening of UN-Water/Africa.

The AWDR is structured to comprise:

An introductory section covering: water for socio-economic development, international and African milestones, freshwater resources of Africa and the main body, articulated along eleven key challenges.

1. ***Meeting basic needs****:* To recognize that access to safe and sufficient water and sanitation are basic human needs and are essential to health and well-being, and to empower people, especially women, through a participatory process of water management***;***
2. ***Securing the food supply****:* To enhance food security, particularly of the poor and vulnerable, through the more efficient mobilisation and use, and the more equitable allocation of water for food production;
3. ***Protecting ecosystems****:* To ensure the integrity of ecosystems through sustainable water resources management;
4. ***Sharing water resources****:* To promote peaceful co-operation and develop synergies between different uses of water at all levels, whenever possible, within and, in the case of boundary and trans-boundary water resources, between states concerned, through sustainable river basin management or other appropriate approaches;
5. ***Managing risks****:* To provide security from floods, droughts**,** pollution and other water-related hazards;
6. ***Valuing water****:* to manage water in a way that reflects its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision, taking into consideration the basic needs of the poor and the vulnerable;
7. ***Governing water wisely****:* To ensure good governance so that the involvement of the public and the interests of all stakeholders are included in the management of water resources;
8. ***Water and Cities***: Covering issues of urban areas and human settlements and their specific challenges to water management;
9. ***Water and industry***: To focus on industry needs in water and the responsibility to respect water quality and to take account of the needs of competing sectors;
10. ***Water and energy***: To recognize that water is vital for all forms of energy production and the need to ensure that energy requirements are met in a sustainable manner; and
11. ***Ensuring the knowledge base***: To recognize that good water policies and management depend upon the quality of knowledge available to decision makers.

A strategy was set up for the preparation of the first AWDR to be launched at the December 2003 Pan-African Water Conference (PANAFCON), led by UN-Water/Africa and other partners. However, due to unforeseen problems, which have held up production schedule and editorial mechanisms for the analysis and writing of country, sub regional and basin reports, we decided to come up with an interim edition, which based on some few national reports mainly from the western and central sub regions. The interim report was distributed during the PANAFCON conference with the intent of attracting feedbacks for its improvement and was also published in March 2004 in time for the meeting of the United Nations Committee on Sustainable Development in New York.

The process was continued with renewed vigour to cover the northern and southern sub

regions. It is with satisfaction that we can state that all the countries in these sub regions presented their national reports and sub regional synthesis reports for Both Northern and Southern Africa have also been prepared.. Due to lack of coherent and homogeneous data sets and indicators amongst various African countries, it was difficult to formulate the AWDR as an African regional synthesis report. The present document was therefore formulated by blending official data and indicators from various United Nation system wide organisations with those of the National reports within a framework of state of the art of hydro-climatic processes and water resources management in a sustainable environment. In this way, AWDR attempts to bring to policy and decision makers the status and perspectives of water resources development in the African region, bearing in mind the modern advances in science and technology. It must be emphasised that Africa needs strong environmentally scientific and technological approach to water resources assessment and development and not environmental politics which normally does not take into consideration the basic needs and aspirations of the majority of the African population living under endemic poverty. It is therefore hoped that by by linking the AWDR in the future with the WWDR, Africa can take full advantage of the rich store of scientific and technological knowledge and information bases largely available in the developed world in order to fully infuse the present day advances in science and technology into water resources development and management in Africa. In order to achieve some success in water security and environmental sustainability, it is vital that all African countries augment efforts at systematically monitoring key water and environmental parameters such as water quantity and quality, water use, biodiversity and land degradation towards developing homogenous indicators for decision makers and all interested stakeholders. Due to multiplicity of transboundary basins in Africa, regional and sub-regional cooperation is needed in establishing measurement stations and systems to collect and analyse such data with active participation of scientific advisory bodies.

In conclusion, the institutionalisation of the African Water Development Report (AWDR) as a monitoring and management tool for Policy makers, planners and practitioners is a task whose sustainability must be at the forefront of considerations by all interested parties in the development of Africa's water resources for socio-economic development. This is the challenge which all component members of the UN Water/Africa, national water-related institutions, scientific bodies and other stakeholders must collectively accept in order to initiate actions towards evolving a dynamic system of monitoring the progress in the implementation of the African Water Vision and other international challenges such as the Millennium Development Goals. There is no more time for sideliners or referees, all must become players so that the next edition of AWDR in two years' time shall decisively be better than the present one.

.Josue Dione
Director, Sustainable Development Division
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INTRODUCTION - WATER FOR SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT

WATER FOR SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT

"The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights" *United Nation's Committee on Economic, Social and Cultural Rights*

The above statement seems very obvious and a matter of course to many people of the world, especially those born and bred in a developed country, but not to a large portion of the African populace who struggle daily to have a minimum amount of water for their daily basic needs. Even though Africa is generally considered as a continent endowed with abundant water, both urban and rural people in the continent lack adequate and safe drinking water and face food security risks, coupled with exposure to preventable water-related diseases. This situation is attributable not only to lack of water but also to the very low level of access to safe drinking water and adequate sanitation facilities. The inadequate access to water and water scarcity affect women and girls disproportionately, especially in rural areas, due to great disparities in rights, decision-making power, tasks and responsibilities over water for productive and domestic activities. The International Water Supply and Sanitation Decade (IWSSD), 1981-1990, ushered in some progress in providing more of the African people with safe drinking water and suitable sanitation facilities. By the end of 1988, 40 million more people had been supplied with safe drinking water in urban areas in Africa and 52 million more with suitable sanitation facilities. This raised urban water supply and sanitation coverage from 66 per cent and 54 per cent in 1981 to 77 per cent and 79 per cent, respectively, in 1988 (Yilma E. 1996). In the rural areas, an additional 87 million and 1 million people were supplied with drinking water and suitable sanitation facilities, respectively, bringing coverage for rural water supply and sanitation from 22 per cent and 21 per cent to 26 per cent and 17 per cent, respectively, from 1981 to 1988.

Table 1.1: Access to Potable Drinking Water and Sanitation in Africa in 1990 and 2000

	1990 Population (millions)				2000 Population (millions)			
	Total population	Population served	Population not served	% served2	Total population	Population served	Population not served	% served
Urban water supply	197	166	31	84	297	253	44	85
Rural water supply	418	183	235	44	487	231	256	47
Total water supply	615	349	266	57	784	484	300	62
Urban sanitation	197	167	30	85	297	251	46	84
Rural sanitation	418	206	212	49	487	220	267	45
Total sanitation	615	373	242	61	784	471	313	60

Source: WPI, 2003

During the period 1990-1995, with population growth rate estimated at 4.38 per cent, an additional 19 million people were provided with safe drinking water, but as the population growth rate outpaced that of water supply the percentage of people with access to clean water in relative terms decreased. The total number of urban dwellers alone increased by about 19 million.

The *Global Water Supply and Sanitation Assessment 2000 Report* (WHO/UNICEF, 2001) identified Africa as having the lowest total water supply coverage of any region, with only 62 per cent of the population having access to improved water supply. The situation is much worse in rural areas, where coverage is only 47 per cent, compared with 85 per cent coverage in urban areas. Sanitation coverage in Africa is also poor, with only Asia having lower coverage levels. Currently, only 60 per cent of all the people in Africa have sanitation coverage, with coverage varying from 84 per cent in urban areas to 45 per cent in rural areas. It is predicted that Africa will face increased population growth over the coming decades, with the greatest increase occurring in the urban areas. As a result, approximately 210 million people in urban areas will need to be provided with access to water supply services, and 211 million people with sanitation services, if the international coverage targets for 2015 are to be met (WHO/UNICEF, 2001). A similar number of people in rural areas will also need to gain access. From the assessments concerning change in coverage over the 1990s, it appears that future needs for rural services may continue to be the most difficult to meet. Moreover, amidst the increasing and competing water demands, unequal power relations between genders, classes and races result, leading to major discrepancies in access to and control over water.

The most recent water supply and sanitation coverage assessment shows a timid progress for sub-Saharan African countries (WHO/UNICEF, 2004). The estimates carried out for 2002 show that access to improved water sources in sub-Saharan Africa gained a meagre 1 per cent increase over the 2000 figure to 58 per cent, even though with 1990 as baseline the increase is about 8 per cent (table 1.2). The situation in northern Africa is far better with an increase of 2 per cent, over 1990, to 90 per cent coverage (table 1.3).

Table 1.2: Water Supply Coverage in 1990 and 2002 - Sub-Saharan Africa

	1990 - Population (thousands)					2002 - Population (thousands)				
	Total	served	not served	per cent served	% house connect.	Total	served	unserved	% served	% house connect.
	Sample size (percentage in parenthesis)					sample size (percentage in parenthesis)				
Urban	141'445	115'985	25'460	(93) 82	(94) 47	241'439	197'980	43'459	(99) 82	(99) 39
Rural	362'929	130'654	232'275	(93) 36	(99) 4	443'334	199'500	243'834	(99) 45	(99) 4
Total	504'374	246'639	257'735	(93) 49	(98) 16	684'773	397'480	287'293	(99) 58	(99) 16

Source: WHO/UNICEF JMP, 2005 - http://www.wssinfo.org/en/332_san_africa

Table 1.3: Water Supply Coverage in 1990 and 2002 in Northern Africa

	1990 - Population (thousands)					2002 - Population (thousands)				
	Total	served	unserved	% served	% house connect.	Total	served	unserved	% served	% house connect.
	sample size (percentage in parenthesis)					sample size (percentage in parenthesis)				
Urban	57'349	54'482	2'867	(99) 95	(99) 83	76'101	73'057	3'044	(99) 96	(99) 91
Rural	60'719	49'790	10'929	(99) 82	(100) 33	71'217	59'822	11'395	(99) 84	(99) 54
Total	118'068	104'272	13'796	(99) 88	(99) 57	147'318	132'879	14'439	(99) 90	(99) 73

Source: WHO/UNICEF JMP, 2005 - http://www.wssinfo.org/en/332_san_africa

The situation for adequate sanitation is bleaker. Only about 36 per cent of the people in sub-Saharan Africa have access to improved sanitation facility, even though the increase over 1990 is about 4 per cent (table 1.4) In Northern Africa, the sanitation figure for 2002 is 73 per cent, showing an increase of 8 per cent over 1990 (table 1.5). In both cases of water supply and sanitation coverages, the disparity between urban and rural areas is quite high.

tal protection, but making them more vulnerable to faecal-oral diseases at the slightest exposure. There is ample epidemiological evidence that sanitation is as effective in preventing disease as improved water supply, but sanitation involves major behavioural changes and significant household cost. Access to sanitation facilities and improvement of environmental hygiene would no doubt reduce transmission of faecal–oral diseases by preventing human faecal contamination of water and soil right at the source. Given the gen-

Table 1.4: Sanitation Coverage in 1990 and 2002 in Sub-Saharan Africa:

	1990 - Population (thousands)					2002 - Population (thousands)				
	Total	served	unserved	% served	% house connect.	Total	served	unserved	% served	% house connect.
	sample size (percentage in parenthesis)					sample size (percentage in parenthesis)				
Urban	141'445	76'380	65'065	(93) 54	(86) 22	241'439	132'791	108'648	(99) 55	(91) 21
Rural	362'929	87'103	275'826	(96) 24	(92) 1	443'334	115'267	328'067	(99) 26	(92) 1
Total	504'374	163'483	340'891	(95) 32	(90) 7	684'773	248'058	436'715	(99) 36	(92) 8

Source: WHO/UNICEF JMP, 2005 - http://www.wssinfo.org/en/332_san_africa

Table 1.5: Sanitation Coverage in 1990 and 2002 in Northern Africa:

	1990 - Population (thousands)					2002 - Population (thousands)				
	Total	served	unserved	% served	% house connect.	Total	served	unserved	% served	% house connect.
	sample size (percentage in parenthesis)					sample size (percentage in parenthesis)				
Urban	57'349	48'173	9'176	(99) 84	(99) 63	76'101	67'730	8'371	(99) 89	(99) 71
Rural	60'719	28'538	32'181	(99) 47	(100) 15	71'217	40'594	30'623	(99) 57	(99) 20
Total	118'068	76'711	41'357	(99) 65	(99) 38	147'318	108'324	38'994	(99) 73	(99) 46

Source: WHO/UNICEF JMP, 2005 - http://www.wssinfo.org/en/332_san_africa

Sanitation and Health – Have African Germs Become Harmful to Africans?

There is a saying often repeated when one does not want to abide by hygienic practices that " African germs are not harmful to Africans". It made sense to some extent if considered from the point of view of immunity, since most children grew up playing on soils contaminated by human and animal faeces. It now seems things have definitively changed due to changing life-styles. The immunity of present day children to environmentally induced diseases has reduced due to improved housing conditions and paren-der-based division of work with regard to water fetching, women and girls are the most exposed to many water-related preventable diseases as they are more likely to be in direct contact with contaminated water. Children are the main victims of diarrhoea and other faecal–oral diseases, and also the most likely source of infection. Child-friendly toilets, and the development of effective school sanitation programmes, are important and popular strategies for promoting the demand for sanitation facilities and enhancing their impact. Adequate quantities of safe water and good sanitation facilities are therefore necessary conditions for healthy living, but their impact will depend

on how they are used. This is especially necessary for schoolgirls who need sanitation facilities that ensure their privacy as well as their necessities during the menstrual period.

Three key hygiene behaviors are of greatest likely benefit (Khan A. H., 1997):

(a) Hand washing with soap (or ash or other aid);

(b) Safe disposal of children's faeces; and

(c) Safe water handling and storage.

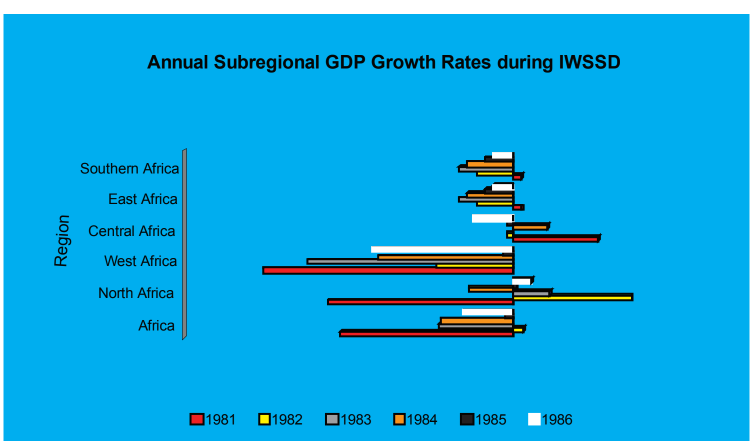
According to a pilot survey of some countries in Africa (Schleicher, 1995), primary schools in some of the poorest countries have inadequate sanitation facilities with about 90 young children in a school sharing one toilet or about 54 per cent of the toilets not functioning (Tab.1.6). By comparison, rural schools in Burkina Faso, Madagascar and Togo have fewer than 50 students per toilet. In urban areas, though, these three countries are among those with the worst record, with more than 50 pupils per toilet on average. Six countries have fewer than 50 students per toilet in city schools. Inadequate sanitation and water in schools jeopardize not only students' health but also their attendance. Girls, in particular, are likely to be kept out of school if there are no sanitation facilities (Khan A. H., 1997)

Table 1.6: Student Access to Toilets in some African Countries

	Pupils per toilet		% toilets non-usable
	rural	urban	
Madagascar	45	55	36
Benin	-	67	34
Burkina Faso	36	64	31
Tanzania	68	32	29
Cape Verde	-	90	24
Uganda	80	20	24
Togo	46	54	14
Ethiopia	77	23	12
Zambia	85	-	6
Equatorial Guinea	-	80	-

Source: A. Schleicher, M. Siniscalco and N. Postlethwaite, The Conditions of Primary Schools: A Pilot Study in the Least Developed Countries; A Report to UNESCO and UNICEF, September 1995.

Figure 1.1: Annual GDP Growth Rates During IWSSD by Subregion



Measuring Socio-economic Pressures in Africa

From the socio-economic point of view, Africa faces a crisis of endemic poverty and pervasive underdevelopment. For many African countries, economic performance in the immediate post-colonial era was good. However, for most of Africa, particularly, sub-Saharan Africa, since the oil crisis of the mid-1970s, economic performance has been poor and worsening (Mkandawire, T. and C.C. Soludo, 1999). Over the past 20 years, Africa's economic growth rates have been low, a situation that coincided with the IWSSD. Performance was particularly dismal in the 1980s. From 1980 to 1994, average GDP growth rates were lower than population growth rates (table 1.7). From figure 1.1 below, it can be observed that GDP during the decade declined in most subregions.

Consideration of the development of drinking water and sanitation as well as other water sector programmes in Africa during the mid-1970s would be incomplete if the economic, political and climatic conditions prevailing at that time were not taken into account. This is because those conditions negatively affected the progress in the water sector as it did all socio-economic development activities in the region.

The problems are simply listed for reference sake, for their consequences are only too obvious. These consequences, as outlined by Yilma E., (1996) follow:

(a) Economic Problems

(i) High rate of inflation;
(ii) Unfavourable terms of trade;
(iii) Falling prices for export commodities and rising prices of imports;
(iv) Mounting debt burden;
(v) Stagnant or decreasing inflow of Official Development Assistance (ODA).

(b) Political and Management Problems

(i) Political instability arising from frequent military intervention in government;
(ii) Civil wars;
(iii) Economic mismanagement at the national level.

(c) Socio-Cultural Problems

(i) Cultural and social norms which have perpetuated gender inequality in social roles, economic opportunities and political power;

Table 1.7: Socio-Economic Performance Indicators of Africa

INDICATOR	PERFORMANCE (%)					
	1965-73	1974-79	1980-85	1986-93	1990-94	1995-98*
Population growth rate	2.7	2.9	3.0	3.0	3.0	2.7
Growth rate of GDP (avg.)	5.7	3.5	1.8	2.5	1.9	3.75
Growth rate of per capita GDP (avg.)	3.0	0.7	-1.1	-0.5	-1.1	1.05
Growth rate of agricultural output (avg.)	2.7	3.0	1.5	2.7	2.1	3.4
Growth rate of manufacturing output (avg.)	7.3	6.7	5.2	2.5	1.3	2.9
Growth rate of investment (avg.)	9.6	6.9	-4.8	1.2	0.8	-
Savings-GDP (avg.)	16.2	20.9	16.3	15.6	15.3	-
Growth rate of exports (avg.)	8.2	2.6	0.4	3.0	0.6	5.25
Growth rate of imports (avg.)	7.4	6.2	-2.4	0.7	0.4	5.8

Source: AfDB, 1994. * Source: Africa Summary Briefings, Live database, *World Bank*

Table 1.8: Demographic and Social Data of some sub-Saharan African Countries (1987-1997)

Country	Surface Area (000 Km2)	Population (000)	Population growth rate, (%)	Percentage Urbanization	Urban population growth rate, (%)	Life expectancy Total (Years)	Illiterate population +15 years (%)
Angola	1247	11723	3,3	33,7	5,7	48	57,9
Burkina Faso	274	10971	2,5	30,9	5,9	47,1	80,8
Ivory Coast	322	14565	3,5	44,9	5,2	51	59,9
Eritrea	124	3639	2,7	17,9	4,4	51,6	...
Ethiopia	1101	59256	2,9	14	4,8	48,7	64,5
Ghana	239	18398	3	37,4	4,4	57,2	35,5
Kenya	580	29031	3,3	29,3	6,9	54,9	21,9
Mozambique	802	16537	2,2	34,2	7	46,6	59,9
Niger	1267	9781	3,3	17,8	5,7	47,4	86,4
Nigeria	924	118239	2,9	40,9	5,2	51,4	42,9
Senegal	197	8765	2,7	43,4	4	50,2	66,9
Somalia	638	10103	2,1	26,5	3,3	48	--
Sudan	2506	29326	2,9	25,6	4,6	53,3	53,9
Tanzania	945	31220	3	25,9	6,4	51,8	32,2
Uganda	236	21749	3,2	13,2	5,9	44,1	38,3
Zambia	753	9319	3	43,7	4,2	47,5	21,8
Zimbabwe	391	11708	2,7	33,6	5,3	52,3	14,9

Source: Africa in Figures, Economic Commission for Africa, Addis Ababa, 1998

(ii) Women's low level of education, which has a detrimental impact on maternal and child mortality and morbidity, fertility rates, nutritional status, HIV/AIDS infections and population growth.

More recent data show, however, that the period 1996-1998 recorded some economic recovery and average GDP growth rates exceeding population growth rates for the first time in two decades. The recovery was nevertheless considered fragile as more still needed to be done to achieve full and sustainable recovery.

Africa Water Vision 2025 - The Way Forward

AFRICA WATER VISION FOR THE YEAR 2025

AN AFRICA WHERE THERE IS AN EQUITABLE AND SUSTAINABLE USE AND MANAGEMENT OF WATER RESOURCES FOR POVERTY ALLEVIATION, SOCIO-ECONOMIC DEVELOPMENT, REGIONAL COOPERATION, AND THE ENVIRONMENT

The Africa Water Vision 2025, the result of a joint effort by the Economic Commission for Africa (ECA), the African Development Bank (ADB), the African Union (AU) and other stakeholders such as the Global Water Partnership, is designed to prevent the disastrous consequences that may be brought by failure in the field of water, and to build a future in which the full potential of Africa's water resources can be unleashed to stimulate and sustain the region's economic development and social well-being. At the national level, the Vision calls for a new way of thinking about water and a new form of regional cooperation based on partnership and solidarity among countries that share common water basins. At the national level, it advocates fundamental changes in policies, strategies and legal frameworks, changes in institutional arrangements and management practices, the adoption of participatory approaches, management at the lowest appropriate level, and mainstreaming of gender issues and the concerns of the youth. At the global level, achieving the Vision calls for assistance from Africa's development partners in mobilizing seed funding for priming urgent development needed to strengthen sustainable water resources management in the region with a view to the attainment of adequate water supply as a human right. This is in line with the General Comment 15 on the right to water, adopted in November 2002 by the Committee on Economic, Social and Cultural Rights, which states: '***the Human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses***'. This rights-based approach to water resources management recognizes equitable access to water as an inalienable human right whose achievement is the responsibility of all development actors within the international community and within States at all levels. The Water-for-all goal thus empowers women and men 'rights-holders' to demand from 'duty bearers' such as the State and development partners the fulfilment of these rights. The approach therefore provides a 'moral' basis to claim international assistance for meeting the water needs of African peoples.

The Resources in Crisis

Africa is generously endowed with abundant water resources in the form of large rivers, lakes, wetlands and limited but widespread groundwater. Much of this is located in Central Africa with a huge hydropower potential, the equatorial region and the sub-humid East African Highlands along the Rift Valley. The total water withdrawn for various uses is still very low compared to the renewable resources (UNECA, 2001).

The main threats to sustainable use of African water and land resources are identifiable natural and human factors, including factors in the many transboundary water basins, climate and rainfall variability, water scarcity from shrinking water bodies, drought and desertification and depletion of water resources.

High spatial and temporal variability of rainfall. Extreme spatial and temporal variability of climate and rainfall in the continent has far-reaching consequences for water resources management, especially with the imbalance in geographical distribution of rainfall thought the continent. For example while northern and southern Africa receive 9 per cent and 12 per cent, respectively, of the continent's rainfall, the Congo River watershed in the central humid zone, with 10 per cent of Africa's population, alone has over 35 per cent of the continent's annual runoff and combine with the humid equatorial zone in the Gulf of Guinea to record Africa's highest annual rainfall. Extremes in rainfall variability are features of the northern and southern edges of the continent.

Growing water scarcity. While the above-mentioned variations have led to a growing abundance in water-rich areas of the continent, they have also led to endemic and spreading drought, desertification and growing water scarcity in other areas, especially where low annual rainfalls are accompanied by low levels of internal renewable water resources as was the case with Libya, Tunisia, Algeria, Rwanda, Burundi, and Egypt

in 1995. Kenya, Morocco, South Africa, and Somalia have faced water stress conditions. These conditions (the apparent disappearance of Lake Chad is symptomatic), according to forecasts, will worsen by 2025, further increasing women and girls' burden of collecting and transporting water over long distances.

Depletion of water resources through human action: This reduces natural water quantity and quantity through widespread contamination from pollution, poor sanitation, wastes and decay of aquatic weeds and salinization, a problem compounded by poor land use and agricultural practices (UNECA, 2001). The result is the spreading of water-borne and water-based diseases, especially among women and children.

Multiplicity of transboundary water basins. A key water resource issue in Africa is the multiplicity of international water basins, about 80, in a situation of a weak cooperation and institutional regulatory instruments, and virtually all sub-Saharan African countries, plus Egypt, share at least one international water basin (African Development Bank, 1999). Prominent among these are the Nile, Congo, Niger, Volta and Lake Chad. Some countries have several international rivers passing through them, e.g. Guinea which has 12 such rivers. Water interdependency is accentuated by the fact that high percentages of total flows in downstream countries originate from outside their borders, e.g. Egypt, Mauritania, Botswana, the Gambia and the Sudan. Despite this, very few shared waters are currently jointly managed and even where efforts are made at this, national interests prevail over shared interests.

Poverty amidst plenty. In the midst of a plentiful water supply at the continental level, some African subregions and countries are experiencing growing water scarcity that is responsible for a number of water resources development and management issues facing the continent. Within countries, water scarcity affects people disproportionately depending on their gender, class, race, ethnicity and geographical location.

Access to safe water supply and sanitation services. Access to these facilities is highly inadequate in Africa and varies geographically and socially, for example between the urban areas and within both areas by social and economic status. Thus in rural Africa, about 65 per cent of the population lacks access to adequate water supply, and 73 per cent are without access to adequate sanitation (UNECA, 2001). In urban areas the distribution is 25 per cent and 43 per cent, respectively. As a result of these limitations, almost half of all Africans suffer from one of six main water-related diseases. The worst statistics are for cholera and infant diarrhoea. Africa also leads in schistosomiasis and Guinea worm cases. The poor access figures are likely to be compounded by the fact that population growth, at 3 per cent per annum, is the world's highest. This, accompanied by the rapid rate of urbanization, at 5 per cent per annum (UNECA, 2001), is increasing the umber of people vulnerable to diseases, especially women and children who also spend part of their precious economic and school time fetching water.

Water for food and energy security. During the past three decades, agricultural production increase was outpaced by population increase by a ratio of 2 to 3 per annum. According to UNECA (2001), cereal imports in Africa are expected to rise from 10 million metric tons per annum to 30 million metric tons in 25 years, as a third of the region's people live in drought-prone areas. In much of West Africa, average food supply (2430 kcal/day/person) is below the recommended minimum nutritional level of 2700 kcal/day/person. In Eastern and Southern Africa, the number of food insecure people doubled, raising the total number of people affected from 22 million in the early 1980s to 39 million in the early 1990s. For the whole continent a 3.3 per cent increase in agricultural output per annum is required to achieve food security. The impact of all this on water supply is the fear that even if the area under irrigation were to grow by a factor of 3 to over 16 million hectares, this would contribute to only 5 per cent of the required food produc-

tion increase needed by 2025. The irony is that high levels of food insecurity occur while most African countries have substantial underutilized potential for irrigation expansion, especially for rain-fed agriculture (UNECA, 2001).

The threat to environmental sustainability is due in part to failure to recognize the life-supporting functions of ecosystems (terrestrial and aquatic). In effect, the water quantity and quality requirements of ecosystems are not normally taken into account in the overall allocation of available water resources in much of Africa. Hence the important role played by wetlands in many rural economies (in the provision of highly productive agricultural land, dry season grazing for migrant herd, fish, fuel wood, timber needs and medicines) until recently, has not been adequately recognized and reflected in national water policies. As a result, such wetlands are increasingly being endangered by poor cultivation, deforestation and overgrazing.

Threats to environmental sustainability. These threats emanate from negligence of environmental sustainability and the life-supporting functions of terrestrial and aquatic ecosystems which are not normally taken into account when making water policy and allocating water resources in Africa. This results in non-protection of fragile ecosystems such as wetlands whose overexploitation and poor cultivation leads to overgrazing as well as de-humidification, contrary to the Dublin Principles of 1992. The conversion of land for various uses, including agriculture with the focus on export crops dominated by men using extensive agricultural methods to the detriment of subsistence farming dominated by women sometimes do not take account of the water and other ecological needs of such land. Other threats resulting from a combination of factors include: soil erosion which is acute in areas with dense human settlements; inadequate or inappropriate cultivation methods; loss of soil fertility due to soil mining and declining soil organic matter; harvesting of fuelwood which heightens deforestation and thus reduces groundwater levels in arid areas; poor management of drylands, particularly in areas of high population growth, causing increased desertification; and direct human action on water such as pollution and over-abstraction of surface water which affect quality and flow, reduce the consumptive uses and self-purification capacity of water and exacerbate saltwater intrusion which affects land productivity

From Vision to Action

Achieving the Africa Water Vision requires water governance, wisdom, meeting water needs and financing for a sound water future. The 2025 target itself calls for the following: transparency, accountability and participation in decision making for water; information and knowledge sharing; inter-country cooperation and team work; planning and programmimg; financing and equitable and consumer-friendly cost recovery; and political commitment and grassroots support.

The general socio-economic development of African countries depends, to a very large extent, on these countries' ability to effectively harness their water resources to solve their people's water and sanitation needs. The guidelines for achieving these are spelt out in the Africa Water Vision and the Millennium Development Goals (MDGs) adopted by the international community. These documents acknowledge the central and crosscutting role of water in achieving these targets for a society with reduced poverty, hunger and preventable diseases, while maintaining environmental sustainability.

Managing Water for Sustainable Development

The essential role of water in socio-economic development has just been mentioned. Such a development requires appropriately managing water resources to ensure water use for all purposes in order to achieve harmonious economic, social and environmental goals for the sustainable de-

velopment of a country and its component regions. Andah (2002a) outlines the measures and procedures for the targets as follows:

(a) Identification of existing water resources and their level of development for all purposes;
(b) Evaluation of the quality of available and potential surface and groundwater resources;
© Estimating future demands by women and men for all purposes within given time-frames;
(d) Assessing the resources available for future demand;
(e) Preparation of alternative gender-sensitive plans to develop the resources at the national or regional scale to match the forecast demands;
(f) Adoption and implementation of the optimum development plan; and
(g) Continuous monitoring and periodic review of the adopted plan.

In preparing a comprehensive and dynamic water policy, the immense store of information based on the experiences of developed and developing countries alike could serve as a useful guide. This information includes the broad consensus reached on the principles to be observed in establishing water management systems. They include the views:

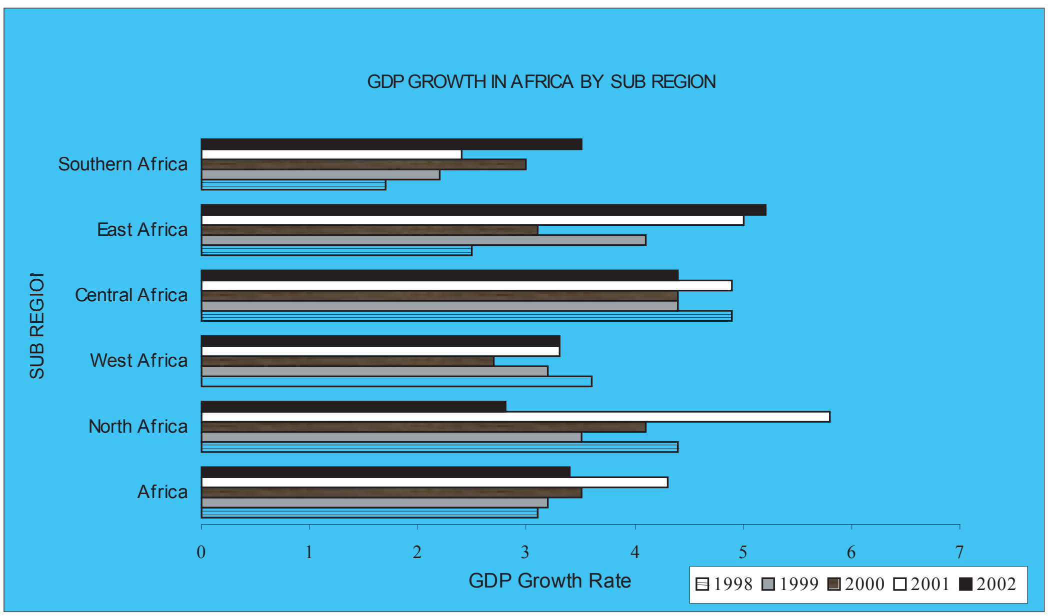
(a) That water is a resource vital to the general welfare of a nation and the people have a right to use it within the responsibility imposed by the need to preserve the environment;
(b) That the legitimate responsibility for water management lies with the government while the task of providing the water, the legal code for effective and efficient management of water resources and the distribution of jurisdiction lie with appropriate levels of management;
(c) That for water management to be effective and efficient it must be envisaged in an integrated form, including the quality and quantity of both surface water and groundwater;
(d) Water management must fit within the framework of national aims and policies with due regard to economic, social, environmental and regional conditions and this principle must govern the decision-making process in every aspect of water and its best use;
(e) Water management must be responsive to the criterion of economy of scarce resources and the nexus of quality of life and the environment;
(f) Government bodies and individuals involved in water management programmes must provide the funds needed for water management activities; and finally
(g) Government bodies should ensure 'Gender sensitive water and sanitation infrastructure and services, and equal access, voice and participation of women and men in decision making at all levels of water resources management'.

Effective water management requires dynamism and continuous planning for the maintenance of water quality and environmental protection. A long-term water resources plan should provide a comprehensive analysis of sectoral inter-relationships, their effect on the national economy and, where appropriate, on international provisions for water use. Such a plan must recognize regional needs and objectives and provide a mechanism or framework for meeting them thrugh decentralized action with feedbacks for integrated water resources management. The challenge for Africa is to reverse the ongoing rapid natural resources degradation by adopting an integrated approach to land and water resources management, based on the four main IWRM principles which recommend: a holistic approach; a participatory and gender sensitive approach; a recognition of the central role of women and a recognition of the economic value of water (ibid).

The New Thrust

After the so called "lost decade" of the 1980s, Africa is now at a turning point, and although the prospects are mixed, the positive indicators show that far-reaching economic reforms are under way across the continent and have begun to yield good results in some countries. Yilma E. (1996), in acknowledging this turnaround, refers to the structural adjustment programmes (SAPs) being implemented to correct structural economic imbalances and stimulate faster private sector growth; to the high growth rates ranging from 3 per cent to more than 8 per cent in some countries; and to the favourable climate for increased domestic and foreign investment being created, and to capital markets and African entrepreneurship.

Figure 1.2: Dynamics of GDP Growth in Africa



Greater awareness of the link between gender inequality and the perpetuation of poverty in Africa has led to renewed commitment to gender equality by African Heads of State who made a Solemn Declaration on gender equality in July 2004. These positive trends, especially the concerted efforts being made, point to better days for the provision of food security and safe drinking water for the majority of Africans.

The political and socio-economic atmosphere has changed for the better in many African countries (figure 1.2). Furthermore, Africa is at the forefront of international water concerns as the actions of the UN-Water Africa demonstrates. Significant is the stakeholders Conference on Water and Sustainable Development organized by this body in conjunction with the ADB in Accra in April 2002, to identify and establish a consensus on the main priorities for water development in the continent and to help mobilize the necessary financial resources for them. The Conference recommended the establishment of an African Water Facility to help organize the fifor meeting.

The Conference further recommended that the Facility be housed within the ADB, that detailed studies be undertaken to determine the financial resources required, the possible sources of funding and the operational modalities. The objective of the Facility is to provide investment support for water resources management and water ser-

Box 1.1: The African Water Facility is Operational

In the past three years, there has been a concerted effort to develop policies and programmes and to speed up investment in all aspects of water resource management and development in Africa. The Second World Water Forum held in The Hague in 2000 was instrumental to the establishment of and provision of support to the African Water Vision for 2025. The Vision set out targets and goals for improving access to water and water resource management. In April 2002, the African Water Task Force (AWTF) with the support of the African Development Bank organized a pre-WSSD Stakeholders Conference on Water and Sustainable Development in Accra, Ghana. One of the results of the Accra Stakeholders Conference was the recommendation of the establishment of an African Water Facility to be housed within the African Development Bank.

The Inaugural Meeting of the Governing Council of the AWF was held on 8 July 2005, at the African Development Bank Headquarters in Tunis, Tunisia. This Council comprises five Subregional representatives from the African Ministers' Council on Water (AMCOW), five representatives of Development Partners/Donor Agencies, one representative of AU/NEPAD, one representative of UN Water/Africa and one representative of the host institution, the African Development Bank (AfDB). The Chairman of the Council is an independent African with a broad international experience in the water sector. His Excellency M. Abu Zeid, the Minister of Water of Egypt was elected as the first Chairman of the Council in his personal capacity, and an Executive Director, Mr. Kordje Bedoumra, has been appointed by the AfDB and will serve as an ex-officio member of the Governing Council. The African Water Facility is unique among the many initiatives for Africa that have been launched not only because it was conceived by Africans in response to the challenges faced by Africa; but also because it is in fact the practical outcome of several years of development of policy frameworks to address these challenges. Given its alignment with NEPAD and AMCOW, the AWF is strategically placed to shape the development process through its experience and to "raise the profile of water" politically within Africa and among donors through AMCOW. Because the AWF seeks to address capacity building at the subregional, regional, and national levels, and given its links with Africa-wide and international initiatives and goals, it can provide a harmonization of policy goals with practical outputs.

Priority objectives fall into three major areas:

(a) Providing investment support for water management programmes and projects;
(b) Speeding up the development, approval and implementation of integrated water management plans in those countries which lack them; and
(c) Facilitating commitment of additional funds to the water sector in Africa.

The African Water Facility aims to improve project preparation directly and indirectly through grants for building capacity in areas such as public and financial management, skills and knowledge transfer, research and data collection and training. The proposed operational structure also suggests that the AWF lead by example, by adopting programme evaluation principles at the outset (including preparation, execution, and evaluation of projects and programmes). Thus, the AWF has the potential to demonstrate efficient use of funding and to actively share these skills and experiences with its partners in Africa and its grant recipients.

Item	Description	Target 2025Annual Investment (US$ Billion)	Annual Investment (US$ Billion)
1	Water supply for basic needs	5.00	6.00
2	Sanitation and hygiene	7.00	
3	Irrigation and water productivity improvement	4.00	2.00
4	Water for industry, energy and transport	2.10	2.00
5	Flood and drought management	0.40	
6	Policy and institutional reform	0.35	
7	Knowledge and information	0.45	
8	Awareness and education	0.45	
9	Research and development	0.25	
Total		20.00	10.00

The investment required for the long-term African Water Vision 2025 targets is US$ 20 billion per annum. An initial investment target of US$ 10 billion per year is suggested for meeting urgent needs. The breakdowns for both investments is shown in the following table:

vice provision programmes in Africa that are designed to remove bottlenecks and help leverage additional financial resources from multilateral and bilateral sources as well as from public, private and community resources. This will be done by promoting innovative actions by both countries and donors; assisting in the creation of an enabling environment; and helping to build governance and management capacity within implementing institutions.

The Facility would be defined under the broad framework of NEPAD, the Africa Water Vision and the priority areas identified at the Accra Water Conference. An evolving Facility will require gradually increasing resources available for investments. The Facility will be expected to raise $US 300-500 million in the short to medium term to leverage funds to contribute toward the $US 20 billion needed annually to meet the continent's water targets for 2025. Initially, the Facility will focus on assisting countries to gain access to existing sources as well as to additional funds that would be made available to it.

The areas of focus of the Facility include supporting appropriate priority programmes at the regional, subregional and national levels. At the national level, the focus will be on:

(a) Integrated water resources management planning, projects and programmes;
(b) Capacity building, especially in the context of programme development, affordability and procurement;
(c) Data collection, analysis, and dissemination; and
(d) Designing and implementation of policy and institutional reform.

Moreover, there is a synergy between political and technical institutions in Africa, coupled with a strong cooperation and collaborative efforts with United Nations bodies through the UN-Water/Africa. All these components, if well blended, would definitely become a driving force for the implementation of the Africa Water Vision challenges, around which the African Water Development Report is being developed.

The African Water Development Report

With the current awareness of the impending water crisis the world over, the United Nations system and various international fora have called for an innovative way to manage our water resources not in a "business as usual" manner. That is:

> *To stop the unsustainable exploitation of water resources by developing water management strategies at the regional, national and local levels which promote both equitable access and adequate supplies.*

In pursuance of this objective, and in recognition of the growing water crisis, the United Nations family organizations launched a system-wide effort called the World Water Assessment Programme (WWAP):

(a) To identify and describe the nature of the water crisis;
(b) To report progress on the achievements of the agreed targets; and
(c) To strengthen the efforts of member States to monitor and report progress towards achieving targets (UNESCO, 2003).

The aim is to develop tools and skills that would foster a better understanding of the basic processes, management practices and policies that ensure that clean and sufficient water is available to all. WWAP is an ongoing exercise to map the world's progress towards sustainable use of its freshwater resources. The World Water Development Report (WWDR) was also instituted to publish the main trends and results of this process at regular intervals. It is intended to provide decision makers at the continental, subregional, regional, national and river basin levels with information that can be used at various levels to govern water wisely. The first WWDR was published in March 2003.

Box 1.2: Africa Water Vision Messages:

- Provide safe and adequate water and sanitation for all, urgently.
- Make equitable and sustainable use of Africa's water resources.
- Ensure sustainable development and management of water resources for all.
- Develop water resources for food security and agricultural development.
- Develop water resources to stimulate socio-economic development.
- Treat water as a natural asset for all in Africa.
- Share management of international water basins to stimulate efficient mutual regional economic development.
- Ensure adequate water for life-supporting ecosystems.
- Manage watersheds and flood plains to safeguard lives, land and water resources.
- Price water to promote equity, efficiency and sustainability.

In response to the particular problems of water resources development and management in Africa, UN- Water/Africa took a decision in April 2001 in Niamey to develop an African Water Development Report (AWDR) as an integral part of the WWDR. The AWDR would provide African countries and other stakeholders the necessary information for obtaining tools and skills to monitor the goals and targets of the Africa Water Vision, which can be summed up as follows:

> *Water can make an immense difference to Africa's development if it is managed well and used wisely. Given clear policies and strategies and real commitments to implementation, we can use water to help eradicate poverty, reduce water-related diseases and achieve sustainable development.*

The objectives of the AWDR are therefore

(a) To provide a lasting and durable mechanism for monitoring progress made in implementing the Africa Water Vision;

(b) To provide African decision makers with an authoritative basis for managing Africa's water resources; and

(c) To serve as an integrative programme for the strengthening of UN-Water/Africa.

The development of the AWDR will rely on reports from various countries and transboundary basins prepared by consultants who are familiar with the specific problems of the countries or areas concerned, adopting and adapting the methodologies used in the WWDR. The present report is at an interim phase in the process of developing the AWDR. It is based on worldwide information sources, mostly from the UN system-wide databases, various special national reports solicited by UN Water/Africa and blended together to give a state-of-the-art and informed picture of the role of water in the sustainable socio-economic development of Africa.

Turning the Messages into Challenges for Water Security

The African Water Development Report is therefore articulated along eleven key challenges. The following seven are contained in the Hague Ministerial Declaration (2000):

1. ***Meeting basic needs**:* To recognize that access to safe and sufficient water and sanitation are basic human needs and are essential to people's health and well-being, and to empower people, especially women, through a participatory process of water management;
2. ***Securing food supply**:* To enhance food security, particularly of the poor and vulnerable, through more efficient mobilization and use, and more equitable allocation of water for food production;
3. ***Protecting ecosystems:*** To ensure the integrity of ecosystems through sustainable water resources management;

4. ***Sharing water resources:*** To promote peaceful cooperation and develop synergies between different uses of water at all levels, whenever possible, within and, in the case of boundary and transboundary water resources, between states concerned, through sustainable river basin management or other appropriate approaches;
5 ***Managing risks:*** To provide security from floods, droughts, pollution and other water-related hazards;
6. ***Valuing water:*** To manage water in a way that reflects its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable;
7. ***Governing water wisely:*** To ensure good governance so that the involvement of the public and the interests of all stakeholders are included in the management of water resources.

   The other four challenges emerged through further interactions among policy makers and other stakeholders and were included in the World Water development Report. They are:
8. ***Water and cities***: Covering issues of urban areas and human settlements and their specific challenges to water management.
9. ***Water and industry***: To focus on industry needs in water and the responsibility to respect water quality and to take account of the needs of competing sectors.
10. ***Water and energy***: To recognize that water is vital for all forms of energy production and ensure that energy requirements are met in a sustainable manner.
11. ***Ensuring the knowledge base***: To recognize that good water policies and management depend upon the quality of knowledge available to decision makers.

> "People don't want to live in reality." But reality has a way of forcing its way into human consciousness, and sooner or later we must acknowledge that our relationship to water is intimate, complex, and primal: if we abuse it, we inevitably suffer the consequences. Remove trees from the watershed, and the river below floods; deplete aquifers, and the land above subsides; pollute or obstruct the river, and the effects flow all the way to the sea. We must accommodate ourselves to water, not the other way around. *Jacques Leslie*

Concerted African Efforts to Implement Regional and International Commitments.

It is evident from both political and institutional points of view that regional and subregional concerted efforts can go a long way to help African countries face the challenging task of harnessing their water resources for sustainable development. The African Union initiatives, the African Ministers' Council on Water (AMCOW), the African Water Facility and the increasing role of the African Development Bank in the water sector, with special reference to the Rural Water and Sanitation Initiative, are all vivid indicators to the ongoing growing commitments to water sector development. One of the most important events which needs emphasising is the meeting of Heads of State and Government of the African Union, at the second Extraordinary Session of the Assembly of the Union, in Sirte, Libya, from 27 to 28 February 2004, in response to the proposal to convene an Extraordinary Session of the Assembly on Africa's economic development, which was initially made by the Libyan Leader, Muammar Ghaddafi, during the second Ordinary Session of the Assembly of the Union, held in Maputo, in July 2003. The meeting was specifically dedicated to Agriculture and Water and culminated in the Sirte Declaration (Box 1.3 and Box 1.4)

At the international level, the implementation of the targets of the Millennium Development Goals will surely give impetus to the achievement of the Africa Water Vision 2025. It is being emphasized in most MDG assessment reports that water is directly or indirectly crucial in all the targets and, as such, improvement of access to water supply and sanitation and harnessing Africa's water resources for food security are prerequisites for poverty reduction and sustainable development. But in spite of all the efforts mentioned above, many African countries still face problems of famine, as the present food situation in the Niger amply demonstrates. Meeting the targets in 2015 is still a formidable challenge to almost all sub-Saharan African countries.

An analysis in the Millennium Development Task Force report (2005), based on the 2004 WHO/UNICEF Joint Monitoring Programme report (WHO/UNICEF JMP 2004), assessed coverage for both improved drinking water and improved sanitation in the baseline year of 1990 and in 2002, which is the half-way point for the 2015 targets. The JMP report, which is the most reliable source of global water supply and sanitation information, indicates that sub-Saharan Africa, Oceania, Eastern Asia, and Southeast Asia, are the regions where coverage is lowest for both water supply and sanitation (MDG Millennium Project Task Force on Water and Sanitation, 2005).

Box 1.3: Sirte Declaration of African Heads of State on the Challenges of Implementing Integrated and Sustainable Development on Agriculture and Water in Africa

Portions relevant to agriculture

WE, the Heads of State and Government of the African Union, meeting at the 2nd Extraordinary Session of our Assembly in Sirte, Great Socialist People's Libyan Arab Jamahiriya, from 27 to 28 February 2004, in response to the proposal to convene an Extraordinary Session of the Assembly on Africa's economic development, which was initially made by the Leader of the Great Al Fatah Revolution, Brother Muammar Ghaddafi during the 2nd Ordinary Session of the Assembly of the Union, held in Maputo, Mozambique in July 2003;

We are aware that Africa's underdevelopment is not irreversible and that the ingenuity and potentials of our countries and peoples can overcome all obstacles to development in the Continent, eradicate poverty, ignorance and disease and establish a new Africa;

We are conscious of the importance of mobilizing the huge human and natural resources on our Continent for development;

We are further aware that in order to provide effective support from scientific research, guidelines and agricultural planning and tackle problems of desertification, land conservation and environment protection for sustainable agricultural and animal resources development;

We further reaffirm that sustained, just and balanced development is based on partnership, utilizing resources and sharing of their benefits in accordance with the principles of international law;

We recognize that to attain self-sufficiency in food production and eradicate hunger, it is necessary to promote strategic food crops, in particular, wheat, rice, corn, cash crops and others in regions appropriate for their production;

We further recognize the importance of animal and fishery resources in ensuring food security, their contribution of more than 25% of the total agricultural production and in consideration of the continent's huge animal and fishery resources adequate to meet the needs of the continent and more as well as the need to preserve and develop these resources;

With regard to water supply, meeting the target requires that services be extended to 359 million more persons in sub-Saharan Africa, another 363 million persons must obtain access to sanitation by 2015 in order to meet the target (figures 1.9 and 1.10).

Box 1.4: Sirte Declaration of African Heads of State on the Challenges of Implementing Integrated and Sustainable Development of Agriculture and Water in Africa

Portions relevant to water

We, the Heads of State and Government of the African Union, meeting at the 2nd Extraordinary Session of our Assembly in Sirte, Great Socialist People's Libyan Arab Jamahiriya, from 27 to 28 February 2004, in response to the proposal to convene an Extraordinary Session of the Assembly on Africa's economic development, which was initially made by the Leader of the Great Al Fatah Revolution, Brother Muammar Ghaddafi during the 2nd Ordinary Session of the Assembly of the Union, held in Maputo, Mozambique in July 2003;

We are aware that Africa's underdevelopment is not irreversible and that the ingenuity and potentials of our countries and peoples can overcome all obstacles to development in the Continent, eradicate poverty, ignorance and disease and establish a new Africa;

We are conscious of the importance of mobilizing the huge human and natural resources on our Continent for development;

We are further aware that in order to provide effective support from scientific research, guidelines and agricultural planning and tackle problems of desertification, land conservation and environment protection for sustainable agricultural and animal resources development;

We are further convinced of the fact that water is the main factor for all important economic sectors and in order to assure the preservation of water resources and its proper distribution in different regions of the Continent to meet irrigation needs, human and industrial consumption in the face of the threat of drought and desertification, while large quantities of water escape into the oceans and seas;

We are further conscious of the fact that it is not possible to realize sustained development in both agricultural and water fields independently of the complimentary programmes of these sectors;

To support the African Ministerial Council on Water in its role in developing the plans and policies related to the management of water resources on the continent.

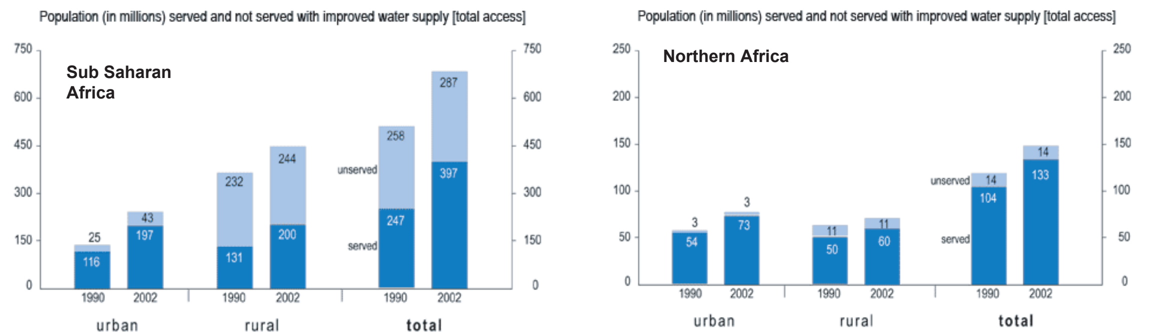
To reactivate the existing mechanisms at the level of the water basin and establish new ones wherever appropriate in order to:

(a) Develop and promote water resources through support to infrastructure projects, including the establishment of dams, laying down of canals, sinking of wells and provision of irrigation equipment;

(b) Exploit water falls to provide electric power and link it to the Continent's general network.

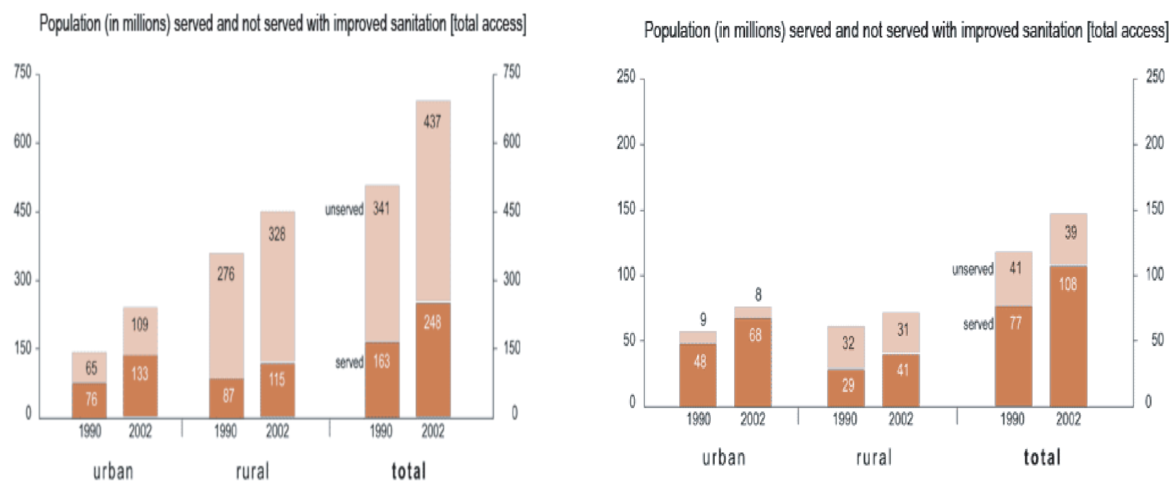
Carry out studies on untapped water in areas where it is available in large quantities to benefit the continent in accordance with the principles of international law, including the protocols concluded between the riparian States.

Figure 1.9: Population served and unserved with improved water supply



Source: *WHO/UNICEF JMP, 2005*

Figure 1.10: Population served and unserved with improved sanitation



Source: *WHO/UNICEF JMP, 2005*

The results of the *Human Development Report* analyses also indicate that in sub-Saharan Africa only Mauritius has already achieved the Millennium Development target for water. Nine other countries in Africa are considered to be "on track "toward achieving the goal while 13 are either lagging somewhat behind, considerably behind, or are even slipping in their progress toward the targets (table 1.9). The countries where access to water is poor and progress toward the goal is stalled or reversing include, Ethiopia, Mauritania, Madagascar, Guinea, Togo and Libyan Arab Jamahiriya. Countries with better prospects for meeting the goal but where challenges are still formidable are, Uganda, Malawi, Cameroon, the Niger, Nigeria, Namibia, Côte d'Ivoire and South Africa. Several of the poorest countries, such as Sierra Leone and Burkina Faso were not assessed due to insufficient data. These countries would likely be included in the last mentioned group (UN Millennium Project Task Force on Water and Sanitation, 2005).

In terms of access to sanitation, there are eleven African countries where access to services is poor and progress toward the goal is stalled or revers-

ing. These include Ethiopia, the Niger, Benin, Central African Republic, Mauritania, Madagascar, Guinea, Togo, Nigeria, Mali and the Sudan. African countries with better prospects for meeting the goal but where challenges are still substantial are nine, namely, Chad, Namibia, Côte d'Ivoire, Zimbabwe, Botswana, Malawi, Cameroon, South Africa, and Burundi.

Consideration of the link between inadequate access to water supply services and the incidence of water-borne diseases such as diarrhea led to the identification of eight countries in which water supply coverage is less than 50 per cent and diarrhea prevalence 20 per cent - 40 per cent of households. These countries include Angola, Burkina Faso, Chad, the Congo, Ethiopia, Eritrea, Guinea, and Mauritania. A similar analysis for sanitation services produced 13 African countries with coverage rates below 50 per cent and diarrhea prevalence 20 per cent - 40 per cent. These countries which therefore have a greater need for urgent action are shown in table 1.9 as Angola, Benin, Burkina Faso, Central African Republic, Chad, the Congo, Ethiopia, Eritrea, Mauritania, Mozambique, Namibia, the Niger and Togo.

The Millennium Project report also quoted a recent WHO cost-benefit analysis which showed that achieving the MDG target in water and sanitation would bring substantial economic gains from both health and other benefits. Each US$1 invested would yield an economic return of $3-$34 depending on the region. Improvement in sanitation, hygiene and water contributes to improved health, generates savings for households and national health budgets and contributes to the savings of poor households through reduced costs and loss of time. Saving time would allow for productive activity and school attendance, especially for girls (www.thelancet.com, 2005).

Table 1.9: High-need African Countries identified by different assessment projects

Water supply			Sanitation		
Low access, slow progress (UNDP 2003)	Moderate access and progress (UNDP 2003)	Low access, High diarrhea incidence (WHO/UNICEF JMP 2004)	Low access, slow progress (UNDP 2003)	Moderate access and progress (UNDP 2003)	Low access, High diarrhea incidence (WHO/UNICEF JMP 2004)
Africa					
Ethiopia	Cameroon	Angola	Benin	Botswana	Angola
Guinea	Côte d'Ivoire	Burkina Faso	Ethiopia	Burundi	Benin
Madagascar	Malawi	Chad	Central African Republic	Cameroon	Burkina Faso
Mauritania	Namibia	Congo	Guinea	Chad	Congo
Togo	Niger	Eritrea	Madagascar	Côte d'Ivoire	Eritrea
	Nigeria	Ethiopia	Mali	Malawi	Ethiopia
	South Africa	Guinea	Mauritania	Namibia	Central African Republic
	Uganda	Mauritania	Niger	South Africa	Chad
			Nigeria	Zimbabwe	Mauritania
			Togo		Mozambique
					Namibia
					Niger
					Togo

Source: *MDG Millennium Project Task Force on Water and Sanitation, 2005.*

Box 1.5: Water on top of development agenda - African Development Bank

Water and sanitation are critical elements in the poverty reduction strategy of the African Development Bank Group. The water sector is at the forefront of its Strategic Plan 2003-2007. The Bank has now developed an Integrated Water Resources Management strategy which considers the provision of accelerated access to safe drinking water supply and sanitation to the rural population in Africa as one of its contributions to achieving the Millennium Development Goals and the African Water Vision. Rural Africa, where an estimated 60 per cent of the people live, lacks adequate access to safe drinking water and sanitation. It has been estimated that some 400 million people in Africa lack access to safe water supply and an even higher number lack adequate sanitation. Nearly 330 million of these people live in rural areas. Consequently, rural populations are burdened to a greater extent by preventable water and sanitation-related diseases, suffer greater deprivation from women and children not attending school or engaging in economic activities due to time and effort needed to fetch water.

The target of the initiative is to provide 66% of the African rural population with access to drinking water supply and sanitation by 2010 and 80% by 2015. The average annual investments in the first seven years (up to 2010) are estimated at US$1.4 billion. Thereafter, it will be about US$940 million per annum. In order to provide access to safe drinking water supply and sanitation to those not served over the next two decades, the rate of increase in coverage during the period has to exceed 19 million rural inhabitants a year, and requires:

(a) The development of fast-track mechanisms (flexible, transparent, and fast-paced procedures) for preparation and implementation of actions so as to significantly quicken the implementation of national rural water supply and sanitation programmes;
(b) Implementation of projects, with the participation of beneficiaries, to extend and sustain rapid coverage of water supply and sanitation services to rural areas;
(c) Promotion of technologies that are appropriate, based on consensus as to acceptable levels of services, ease of implementation, local skills and knowledge for their operation and maintenance; and
(d) Mobilization of higher levels of funding from official development assistance (ODA) and the promotion and support of local initiatives for funding rural water supply and sanitation.

The Initiative will in practice initially begin in five to seven countries with a relatively well-developed water sector policy and existing capacity to implement the Initiative. It will thereafter proceed to other countries on the continent. Eight countries, Algeria, Burkina Faso, Benin, Ethiopia, Ghana, Mali, Mozambique, Rwanda and Uganda, have been tentatively selected to commence the implementation of the Initiative. However, the final selection will be linked to progress made in water sector reforms and criteria in accordance with the Monterrey Consensus and will be made after further elaboration of the Initiative and acceptance by the countries concerned.

The Rural Water Supply and Sanitation Initiative, which will build on or complement ongoing activities in the sector, will work jointly with the African Water Facility to source some funds as well as with other cooperating partners involved, e.g., USAID, CIDA, JICA and the Netherlands Government. The Initiative will also work with NEPAD in implementing policy reforms under the IWRM policy of the Bank Group. In addition, the Initiative will use the framework of NEPAD and the African Ministers' Conference on Water to generate sustained political commitment from RMCs. In 2003, the Bank Group approved a total of 16 loans and grants to the Water Supply and Sanitation sector amounting to 290.15 million Units of Account (UA) or 16.4% of all loans and grants approved during the year. This placed the sector in the fourth position among the 14 sectors that benefited, after the Social sector (18.9 per cent), Finance (17.1) and the transport sector which received 16.6 per cent; which is set to gain further prominence in the Bank Group's operations when RWSSI is formally launched this year.

Cumulative Bank Group Loan and Grant Approvals by Sector, 1963-2003

Sector	Percentage Loan and Grant
Industry	5.8%
Water Supply	7.6%
Power Supply	9.4%
Socia	11.7%
Finance	13.6%
Multisector	14.6%
Transport	16.0%
Agriculture	18.5%
Other Sectors	2.8%

Targets for Extending Access to Rural Water Supply and Sanitation in Africa

Year	2000	2010	2015	2020	2025
Rural Population (million)	497	551	572	588	600
Rural Pop. Served (million)	169	366	459	547	600
Target % Served	34	66	80	93	100
Investment Cost (US$ billion)	9.9	4.7	4.4	4.2	

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INTERNATIONAL AND AFRICAN MILESTONES

Never in the history of the tortuous efforts in Africa aimed at reversing decades of endemic poverty and pervasive underdevelopment has the realization and awareness of the cardinal role of water been as high as it is now. It has also become obvious that the general socio-economic development of African countries would, to a very large extent, depend on how effectively these countries are able to harness their water resources for socio-economic development and, above all, for reduction of the endemic poverty. In fact, Africa is at the heart of various UN and international declarations issued and implemented during the past three decades regarding general efforts at socio-economic development and, in particular, improvement of water supply and sanitation access.

The process of sensitizing Governments, especially in developing countries, towards improved access to and provision of water supply and sanitation services has progressed from broad recommendations of Habitat: United Nations Conference on Human Settlements, held in Vancouver, Canada in 1976 to the Mar del Plata Action Plan which called upon countries to set targets, establish suitable standards and prepare specific projects. This led to the launching of the International Drinking Water Supply and Sanitation Decade (IDWSSD, 1981-1990) by the United Nations General Assembly. More recently, the Earth Summit in Rio de Janeiro in 1992 drew up a comprehensive programme of action contained in chapter 18 of Agenda 21, and identified the areas where environment and economic development intersect, adopting the Dublin Principles, based on Integrated Water Resources Management (IWRM).

The culminations of these international efforts are enshrined within the eight Millennium Development Goals (MDGs) adopted by the international community. It is evident from the targets embodied in the MDGs that water is cross-cutting and essential in achieving these goals in order to build a society free from extreme poverty, hunger and preventable diseases while ensuring environmental sustainability. However, opinions differ as to the progress or otherwise of Africa's participation in such programmes given the snail pace or lack of substantial progress in addressing these pressing problems in previous target-oriented programmes such as the IDWSSD.

Relevant International Milestones

Recommendation C.12 of Habitat: United Nations Conference on Human Settlements:
Held in Vancouver, Canada in 1976, called upon Governments to adopt programmes with realistic standards for quality and quantity, to provide water for urban and rural areas by 1990, if possible, and to adopt and speed up programmes for the sanitary disposal of excreta and wastewater in urban areas.

The Mar del Plata Action Plan (1977):
Called upon countries to set targets, establish suitable standards and prepare specific projects. Countries requiring assistance were expected to request such assistance from international organizations.

International Drinking Water Supply and Sanitation Decade (IDWSSD, 1981-1990):
Launched by the United Nations General Assembly in November, 1980, with the purpose of ensuring that Governments adopt and implement programmes so that by the end of 1990 all peoples in the world would have access to safe and adequate drinking water supply and sanitary excreta and household waste disposal facilities.

The Lagos Plan of Action
Aimed at the economic development of Africa over the period 1980-2000, the Lagos Plan of Action endorsed the objectives of the IDWSSD

and specifically recommended to African Governments that in the formulation of national water plans those pertaining to water supply should represent national aspirations during the IDWSSD.

As the end of the IDWSSD and the 1990s dawned, two important events took place to build up the momentum. One of these was the Global Consultation held in New Delhi, India, from 10 to 14 September 1990. From the statement issued at the end of the consultations, four guiding principles emerged urging United Nations agencies, the international community and non-governmental organizations (NGOs) to intensify their efforts with a view to:

(a) Protecting the environment and safeguarding health through integrated management of water resources and liquid and solid water;
(b) Bringing about institutional reforms for promoting an integrated approach, including changes in procedures, attitudes and behaviour;
(c) Enhancing community management of services; and
(d) Introducing sound financial practices achieved through better management of existing assets.

The Consultation agreed that the sectoral challenge in the 1990s for most developing countries would be "some for all, rather than more for some".

The second event was the African Water Supply and Sanitation Sector Conference held in Abidjan, Côte d'Ivoire, from 10 to 11 May, 1990. From this Conference emerged a statement known as the "Abidjan Accord" that endorsed the agreement entitled "Guidelines for the Development of Country Strategies for the 1990s". This guideline comprehensively elaborated on the principles for strategy formulation and the actions required to implement water supply and sanitation programmes in Africa.

The Earth Summit in Rio de Janeiro in 1992 drew up a comprehensive programme of action contained in Chapter 18 of Agenda 21, and identified the areas where environment and economic development intersect. It outlined the basis for action, objectives, activities and means of implementation, including the required capital outlay and scientific and technological means that are needed. The concerns of Agenda 21 in the context of Africa are also reflected in the Report on the African Common Position on Environment and Development.

Rio and After

The United Nations Water Conference (Argentina, 1977) and its follow-ups, the International Conference on Water and the Environment (Dublin, 1992) and the United Nations Conference on Environment and Development (Rio, 1992) gradually began to put emphasis on water as a fundamental resource for all socio-economic development and on maintaining healthy ecosystems. Water is therefore to be considered not only as an economic good but also a social good. The Dublin Conference focused on the development, management and utilization of water resources in harmony with environmental conservation within the concept of sustainability, and called for the adoption of Integrated Water Resources Development and Management, under four main principles, namely:

(a) A holistic approach in the development of human societies and economies, and the protection of natural ecosystems;
(b) A participatory approach in institutions and arrangements for water development and management;
(c) Recognition of the central role of women in the provision, management and safeguarding of water; and
(d) Recognition that water has an economic value and should therefore be considered as an economic good.

These recommendations were further emphasized at the Ministerial Conference on Drinking Water and Environmental Sanitation (Noordwijk, 1994). In the face of the predicted increase in freshwater stress across the globe, estimated to affect about two thirds of the world population by the year 2025, the First Water Forum (Marrakech, 1997) established the World Water Council and entrusted it with developing a World Water Vision for 2025. Consequently, the World Commission on Water for the 21st Century encouraged the formation of continental, regional and national commissions to formulate their respective visions.

Global, continental, regional and national water vision documents with their respective framework for action were presented at the 2nd World Water Forum (The Hague, 2000) and the Ministerial Conference also at The Hague at the same time. Many outputs from the Second World Water Forum were capped by two documents, the Vision and the Framework for Action. The first of these, *"A water secure world - Vision for Water, Life, and the Environment in the 21st Century"* was prepared by the World Commission on Water, and was accompanied by a detailed Vision report from the Vision Management Unit entitled *"Making Water Everybody's Business"*.

The second output was the Global Water Partnership's report "*Towards Water Security: A Framework for Action*", which is based on the vision material and focuses on the steps involved in moving from vision to action. The Ministerial Conference, aimed at mobilizing official governmental support to counter global water predicaments with political action, welcomed the *Vision* and *Framework for Action* documents. The Ministers came out with a Ministerial Declaration on Water Security in the 21st Century, including seven key challenges to achieving water security.

Vision messages for a water secure world

- A holistic, systemic approach relying on integrated water resources management must replace the current fragmentation in managing water.
- Participatory institutional mechanisms must be put in place to involve all sectors of society in decision-making.
- Fresh water must be recognized as a scarce commodity and managed accordingly.
- Full-cost pricing of water services with targeted subsidies for the poor.
- Fresh water must be recognized as a basic need, with adequate access ensured for the poor.
- Incentives for resource mobilization and technology change are needed.
- Institutional, technological and financial innovation is needed.
- Private investment and community action.
- Political will is needed – going beyond Dublin and Rio.
- Governments are key actors – as enablers and regulators.
- Behavioural change is needed by all - no more business as usual.

Ministerial Declaration – The main challenges

- *Meeting basic needs:* Recognizing that access to safe and sufficient water and sanitation are basic human needs and are essential to health and well being, and to empowering people, especially women, through a participatory process of water management;
- *Securing food supply:* Enhancing food security, particularly of the poor and vulnerable, through more efficient mobilization and use and more equitable allocation of water for food production;
- *Protecting ecosystems:* Ensuring the integrity of ecosystems through sustainable water resources management;
- *Sharing water resources:* Promoting peaceful cooperation and developing synergies between different uses of water at all levels, whenever possible, within and, in the case of boundary and trans-boundary water resources, between States concerned, through sustainable river basin management or other appropriate approaches;
- *Managing risks:* Providing security from floods, droughts, pollution and other water-related hazards;
- *Valuing water:* Managing water in a way that reflects its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable; and
- *Governing water wisely:* Ensuring good governance, so that the involvement of the public and the interests of all stakeholders are included in the management of water resources.

The *Africa Water Vision for 2025* was formulated under the theme: Equitable and Sustainable Use of Water for Socio-economic Development. In short, the African Shared Vision has been stated as follows: *"An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment."*

Milestones and targets of the Africa Water Vision for 2025

Actions	Targets		
	2005	2015	2025
Improving governance of water resources 1. Development of national IWRM policies and comprehensive institutional reform • In process of development • Full implementation	100 % of countries	100 % of countries	
2. Enabling environment for regional cooperation on shared water • Initiated in existing river basin organizations • Implemented in existing river basin organizations • Initiated in new river basin organization • Implemented in new river basin organization	100 % of organizations 50 % of organizations	100 % of organizations 100 % of organizations 50 % of organizations	100 % of organizations
Improving water wisdom 1. Systems for information generation, assessment and dissemination • Established at national level • Established for international river basins • Established at Africa wide level	50 % of countries 30 % of basins	100 % of countries 100 % of basins	100 % complete
2. Sustainable financing for information generation and management • Review of global experience • Implementation at national level • Implementation at river basin level • Established at Africa wide level	100 % complete 50 % complete 30 % complete	100 % complete 100 % complete 30 % complete	100 % complete
3. IWRM capacity building • Create public awareness and consensus • Knowledge gaps identified • Partnership for strategic assistance • National research institutes established • Regional research institutes established • Gender/youth concerns mainstreamed	100 % of countries 100 % of countries 100 % of countries 20 % of countries One established 30 % of countries	60 % of countries Two established 100 % countries/ basins	90 % of countries Three established
Meeting urgent water needs 1. Proportion of people without access: • To safe and adequate water supply • To safe and adequate sanitation	Reduce by 25 % Reduce by 25 %	Reduce by 75 % Reduce by 70 %	Reduce by 95 % Reduce by 95 %
2. Water for achieving food security • Water productivity of rain-fed agriculture and irrigation • Size of irrigated area	Increase by 10 % Increase by 25 %	Increase by 30 % Increase by 55 %	Increase by 60 % Increase by 100 %

3. Development of water for agriculture, hydro-power, industry, tourism and transportation at national level	5 % of potential	10 % of potential	25 % of potential
4. Conservation and restoration of environment, biodiversity, and life-supporting ecosystems • Allocation of sufficient water for environmental sustainability • Conserving and restoring watershed ecosystems	Implemented in 30 % of countries Under development	Implemented in 100 % of countries Implemented in 50 % of countries	Implemented in 100 % of river basins
5. Effective management of droughts, floods and desertification	Under development	Operational in 50 % of countries	Operational in 100 % of countries
Strengthening financial base for desired water future 1. Sustainable financing for policy and institutional reform and capacity-building 2. Sustainable financing for information generation and management 3. Financing urgent water needs • Implementation of pricing and full cost recovery • Increasing private sector participation • Mobilizing finance from national and international sources	Operational in 60 % of countries Secured in 100 % of countries Operational in 60 % of countries Operational in 30 % of countries Secured in 50 % of countries	Operational in 100 % of countries Operational in 100 % of countries Operational in 100 % of countries Secured in 100 % of countries	

Source: UNECA et al., (2000).

The International Development Targets agreed at the Second World Water Forum include reducing by halve the population not served with water and sanitation by 2015. According to the data from a recent survey, urban Africa will require a 80 per cent increase in the numbers served over the next 15 years to meet this target. Just to maintain current levels of coverage in the face of natural growth and rural migration, the served urban population must increase by more than 10 million each year over the same period. "Business as usual" in African urban water and sanitation is therefore not an acceptable scenario, given the public health consequences of failing to improve both coverage and effective use of urban WSS facilities.

The real challenge is to learn new ways of working to increase our capacity to address these needs; the answers must lie fundamentally in the institutional, financial, and social arrangements that determine how much is spent on water and sanitation and by whom. Technical options that reduce cost, simplify maintenance, and improve the quality of service are also a key to success. The fundamental requirements for these changes in the sector will be the human capacity (technical, managerial, and motivational), the political will to achieve it, and sound strategies to ensure that each of the partners in the effort can contribute effectively.

From Vision to Johannesburg – The African New Thrust

- **1999:** Stakeholders Meeting (mainly NGOs) in Gaborone, Botswana, condemned regional bodies such as the OAU, ECA, ADB for not mobilizing Africa for the Vision Development Process.
- ADB reacted by holding Stakeholders consultations in Abidjan in late 1999. Decision made to organize Africa Caucus Day at 2nd WWF in The Hague.
- **March 2000:** Caucus held successfully and Vision present in The Hague.
- **April 2000:** Follow-up Meeting in Addis Ababa between OAU, ADB, ECA and tasks shared:

- OAU political mobilization.
- ECA technical analyses.
- ADB financial mobilization.
- Failure to get Vision approved by Head of States Meeting in Lomé, Togo in July.
- Suggestion to create AMCOW by UNEP(Halifa Drammeh).
- September: Core Ministers meet in Nairobi on sidelines of the launch of AWF, supported by the World Bank.
- **April 2001:** IGWA meets in Niamey and decide to programme Inter-Sessional activities
- **September 2001:** 1st IGWA/IWRM Sub regional Meeting in Accra:
  - WWAP invited to discuss Focus on Africa at WSSD
  - IGWA decides on African Water Development Report (AWDR) to be linked methodologically to WWAP but more in-depth and Africa-owned.
- **September 2001:** African Water Task Force is created.
- Dutch Support for Partnerships with ADB and ECA:
  - ECA Support for AWDR, AWICH, IWRM Workshops and Accra Conference.
- **April 2002:** Accra Conference of AWTF (Setting Priorities and Accra Declaration). Launch of AMCOW and Abuja Statement.
- AWTF decides to organize Water Dome at WSSD.
- **August 2002:** Water Dome a great success and WSSD makes water the number one priority out of five: water, energy, hygiene, agriculture and biodiversity (WEHAB). AMCOW Constitution approved by Ministers and Africa Water Facility announced by AWTF.
- Consultative Meeting on writing AWDR for North and West Africa.
- **October:** AWTF Meeting in Abidjan.
- **November 9th:** IGWA Session in UNEP.
- **December:** IWRM Workshop for Southern Africa.
- **February 2003:** IWRM for Central Africa.
- **December, 2003:** Pan-African Implementation and Partnership Conference on Water, Addis Ababa

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INDICATORS - MEASURING THE PROGRESS OF THE AFRICAN WATER VISION

The Africa Water Vision 2025 was formulated to guide the development and management of water resources for sustainable development. By instituting rational and integrated development of these resources, it would help prevent improper orientation of the planning and implementation of relevant projects and programmes within and across nations and, by so doing, contribute positively to the general development of the continent while maintaining the integrity of the ecosystems. A number of indicators were selected along the lines of the methodologies developed for the World Water Development Report (WWDR) in order to quantitatively measure progress in the implementation of water-related projects. These indicators reflect the socio-economic drivers for the implementation of Integrated Water Resources Management (IWRM) principles and the goals of the Africa Water Vision. The IWRM principles and the Africa Water Vision goals together inform the first edition of the African Water Development Report (AWDR)

Identification and Development of Indicators

As indicators can be used in scientific, economic and social contexts to infer, show and gauge conditions and information, they are indispensable tools for policy making, implementation, monitoring and evaluation. Since water systems and the way they interact with other natural and human conditions to which they are intricately linked are much more complex than they appear, the development and management of these systems no doubt require indicators:

(a) To present projects and programmes in a meaningful, understandable and comparable objective numbers to guide decision makers and the public; but the identification and choice of indicators themselves is a task on its own;
(b) To establish objective benchmarks to analyse changes over time and space, thus serving as a useful tool for feedback.

Approaches

Water policy, like most other socio-economic policies, uses the following approaches to obtain and process information that eventually leads to the identification and choice of an indicator or indicators:

The bottom-up approach

This approach is based on logic, but has its weaknesses:

The Logic framework: goes from data to variable to parameter to indicator**.**
It is based on the information pyramid, whereby available primary data are aggregated into hierarchical levels, using intuitive and mathematical tools. It is mostly used in data rich situations.
Weaknesses: This could be through a simplification of analogy in an attempt to explain a complex process or phenomenon, thus boiling down to a reductionist approach leading to reduction of internal variability and loss of relational relevance to other resources and processes.

The top-down approach

A top-down approach also uses the logic framework but in the reverse or inverted-pyramid form. Here:

The logic framework: goes from vision to themes to indicators in terms of the cause-effect approach and the system approach.

It is based on the log frame, which is a Programme Management Tool serving purposes in both design and monitoring within the Programme Cycle Management.

A generalized log frame approach consists of:
(a) A Goal – a real world attainable outcome;
(b) Purpose – designed actions around interventions; and
(c) Output – backed by a number of activities.

Methodological Approaches

The methodological approaches include the Systems and the Cause and Effect approaches:

(a) **Systems Approach:** This approach is based on the hypothesis that all systems depend to some degree on the resource providing capacities and waste absorbing capacities of their environment. The systems approach has various applications, as follows:

(i) **Applications to sustainability indicators**
a. Human systems – social and individual development and governance;
b. Support systems – economic and infrastructure;
c. Natural systems – resources and environment.

(b) Cause and Effect Approach: This is the most widely used approach, and its first conceptual framework is called:

PRESSURE – STATE – RESPONSE (P-S-R) (OECD, 1994), which is based on**:**

(a) Enabled trade-offs; and
(b) Link between environmental, economic and social indicators.

Weakness: This form of the systems approach often fails to take entire systems into consideration and lacks explicit linkage to policy.

Other cause-effect classifications based on P-S-R- Framework:

(a) Driving force-Pressure-State-Response (D-P-S-I-R) framework (EEA, UNEP, WRI;
(b) Driving force-State-Response (D-S-R) framework, used by the United Nations Commission on Sustainable Development for Agenda 21 Indicators;
(c) Pressure-State-Impact-Response (P-S-I-R) framework;
(d) Driving force-Pressure-State-Exposure-Effects-Action (D-P-S-E-E-A) framework used in the Burden of Disease (BOD) studies of WHO/UNICEF/WSSCC.

Indicator-selection criteria

Scientific requirements

(a) Robust, well-founded basis in scientific knowledge;
(b) Representativeness, describing the state or quality of an issue or subject, giving significant and precise information;
(c) Clearly and consistently defined so as not to be ambiguous, lend themselves to various interpretations, or to give inconsistent results in different situations;
(d) Be developed within an agreed upon conceptual and operational framework;
(e) Quantitative expression;
(f) Be sensitive such that any small change to be measured should result in a measured change in the indicator;
(g) Anticipatory, early warning, signalising: capable of indicating a degradation before serious harm occurs;
(h) Stability: low natural variability in order to separate stress caused effects from random fluctuations;

(i) Specific for a certain stress or effect;
(j) Broadly applicable to many stressors and sites, usable in different regions;
(k) Capable of specifying uncertainties;
(l) Transformable (intelligent).

Policy requirements

(a) Tailored to the needs of the primary users;
(b) Have ownership by users;
© Problem has to be manageable, thus cause-effect chain of indicator has to be known to enable tackling of the problem;
(d) Having a target or threshold against which to compare or an explicit scale ranging from undesirable states to desirable states (along with specific weightings) in order to assess the significance of the information;
(e) Recording either changes in the means recommended by policy or changes in the development impact attributable to policy;
(f) Lend itself to be linked to models, forecasting and information systems;
(g) Simple, easily interpretable and appealing to society in order to ease communication between policy makers and society;
(h) Matching with national and international policy plans and indicating the progress of policy;
(i) Availability of historical data in order to show trends over time;
(j) Data should be readily collectable and, thereby, lowering the technical and collection costs; and
(k) Normalized to make things comparable and providing a basis for regional, national and international comparison.

Collected from: Report WWDR indicator workshop, Hoon et al., 1997, Van Harten 1995, De Zwart 1995, Hendriks 1995, Swart & Bakkes 1995, OECD 1994, Kuik & Verbruggen 1991, Liverman et al. 1988.

Overview of a number of indicators, their aims and the correct spatial scale of their use

Indicator	Information provided	Aim	Spatial scale
Gross National Product (GNP)	Economic activity per country	Comparison of economic activity between countries	Global
Water Stress Index (WSI)	Percentage of water demand that cannot be satisfied without taking measures	Indication of areas suffering from water stress	Low spatial scale: grid cell or watershed
Water Poverty Index (WPI)	Index based on the components resource availability, access to water, capacity of people to manage water, use of water, environment	Providing information on water and poverty related issues	Different scales possible depending on the aim: - Communities and regions for comparison within a country - Countries for comparison on a global scale
Indicator species	Presence or abundance of the species	Indication of the ecosystem quality	The scale of one ecosystem or comparable ecosystems located in same climate range

Source: WWDR, UNESCO, 2003

List of minimum significant indicators selected for the first edition of AWDR

Challenge Areas	Indicators
Drivers	(a) Human poverty index: 5 indicators (b) Incidence of water-related diseases (c) Population figures/growth rates (d) Internal renewable water resources with a country (e) Withdrawals: % of total annual renewable freshwater (f) Water scarcity: proportion of people affected (g) Water shortages: proportion of people affected today (h) Proportion of people without minimum drinking water (i) Trans-boundary rivers: % of population dependent on (j) Polluted water: % of population exposed to pollution indicators like coliforms, industrial substances, acid, heavy metals, nitrates, sediments, salinization, pesticides (k) Natural disasters: deaths from water-related causes (l) Climate change: effect on water scarcity
Meeting basic needs	(a) Actual and total water supply coverage (urban, rural disparities) (b) Actual and total sanitation coverage (urban, rural disparities) (c) Percentage or number of people not served with basic sanitation (d) Percent or number of people not served with improved drinking water and extension of piped water supply (e) Incidence of water-related diseases (f) Investment in drinking water supply and sanitation (g) % of Health Impact Assessment (HIA) of water resources development and compliance with HIA recommendations
Water for cities	(a) Growth of mega-cities (b) Proportion of urban population with access to improved water supply and sanitation (c) Access to “improved” water supply: % for different types (house connection, yard tap, public tap, not served) (d) Water supply cost per litre (e) Water supply: unaccounted for water- % of distribution input (f) Water consumption levels: Domestic: litres per capita per day, water meter tariff punitive structure aimed at reducing undue consumption) (g) Types of water sources (ground water, river, mix.) (h) Industry & commercial consumption: m^3 per day (i) Under-five child mortality rates: death per 1000 live births (j) Children < 5yrs: diarrhoeal diseases linked to inadequate water and sanitation (k) Water source (river) distance from demand center: > 8 km, inter-basin transfer: %
Securing food supply	(a) Average food price (b) Average per capita food consumption (country and regions): show breakdown into cereals, oil crops, livestock and fish (c) Irrigated area versus total arable land in the country (d) Agricultural water use by country (e) Average grain yield (f) Consumption of livestock products (regions and countries) (g) Fish consumption (marine, inland and aquaculture for whole country) (h) Water use for irrigation (net and gross) (i) Internal and external investment sources for irrigation and drainage (j) Food imports/exports

Water and ecosystem	(a) Land converted to agriculture (b) Area of wetland drained (c) Hydrological indicators (flow etc.) (d) Emissions of water pollutants by sector (e) Compliance with water quality standards for key pollutants (f) Number or presence/absence of non-native (alien) species (g) Rapid Biodiversity Inventory- Conservation International/Field museum AquaRAP (h) Numbers and proportion of threatened species (i) Commercial and other fisheries catch (j) Food production trends
Water and industry	(a) Industrial use per capita by total developed water (b) Efficiency/productivity (output per m^3) (c) Pollution (limited available data)
Water and Energy	(a) Distribution of households with access to electricity (rural, urban) (b) Total electricity production and sources (c) Cost per unit of electricity (d) Hydroelectricity (potential and developed capacity) (e) Efficiency/productivity of hydro power plant (output per m^3) (f) Pollution (limited available data)
Sharing water	(a) Dependence of countries water resources on inflows from neighbouring countries (b) Inflow as ratio of total water availability) (c) Number of international basins (d) Number of treaties/cooperative events for international rivers (e) Shared aquifers- number/resource volume/conflicts relating to changes that might suggest international basins where there is a requirement for greater co-operation. (f) Indicators of these types of changes are: (i) Newly internationalized basins; (ii) Basins with unilateral projects and lack of institutional capacity; (iii) Treaties/bodies/positive relations; (iv) International basins where non-water-related hostilities exist between states (g) Proportion of water use by industry, agriculture and domestic sector
Managing risks	(a) List of severe natural disasters since 1994 (b) Losses in human life (number per year) (c) Losses in real and relative social and economic values (total losses, % of GNP, growth, investments and development benefits) (d) Population exposed to water-related risk (number of people per year, income groups) (e) Number of people living within 100-year flood zone. Vulnerability map based on the proportion of land within 1 km of river with slope of less than 1 degree (f) Legal and institutional provisions for risk-based management (established /not established) (g) Budget allocation for water risk mitigation (total and % of total budget/yr) (h) Risk reduction and preparedness action plans formulated (% of total number of countries)
Valuing water	(a) Annual investment in water for agriculture, water supply and sanitation and environment & industry (b) Sources of investment funds (c) Level of cost recovery for water supplies for agriculture and rural water supplies (d) Level of cost recovery for water supplies for urban water supplies (e) Costs per litre of urban and rural water supplies (f) Price of water charged to farmers for irrigation (g) Comparison of the price of water from the public utilities and informal water vendors.

Governing water	(a) Existence of institutions (water resources authorities) responsible for management (including issuing abstraction and discharge licences), which are independent of water users. Percentage of land area covered by such institutions. Number of water authorities and average area covered by each (b) Existence of water quality standards, for effluent discharges, minimum river water quality targets (c) Numbers of instances when water service providers experience a raw water shortage (d) Existence of legislation advocating Dublin principles (e) Institutional strengthening and reform since 1992
Ensuring the knowledge base	(a) Gross primary school enrolment (b) Illiteracy rate (c) Density of hydrological monitoring stations by river basin and national (d) Research and development expenditure (e) Number of television sets and radio receivers per 1000 people (f) Number of telephone lines per head (g) Inventory of water-related data bases

Logical framework (draft) of the GWP used to prepare the Framework for Action of the WORLD WATER VISION 21

Intervention logic

(a) ***Goal:*** Economic well-being and social development under environmental sustainability and regeneration improved;

(b) ***Purpose:*** Global water security provided through efficient, equitable and sustainable management and use of water;

(c) Outputs:

(i) Political will to mobilize people and resources secured;
(ii) Effective water Governance for IWRM achieved;
(iii) Effective water wisdom generated;
(iv) Solutions to urgent water priorities prepared: protecting the resource, enhancing crop productivity per drop, improving sanitation, urban upgrading, improved flood management;
(v) Investment needs for water security identified and agreed upon.

TARGETS
International development targets met, in particular: (a) The proportion of people living in extreme poverty in developing countries should be reduced by at least one-half by 2015 (Copenhagen).. (b) death rate for infants and children under the age of five years should be reduced in each country by two thirds the 1990 level by 2015 (Cairo). (c) There should be a current national strategy for sustainable development, in the process of implementation, in every country by 2005, so as to ensure that current trends in the loss of environmental resources are effectively reversed at both global and national levels by 2015 (Rio). (d) The number of undernourished people on earth should be reduced by half by 2015 (Rome).

Purpose: Global water security provided through efficient, equitable and sustainable management and use of water

Global water security targets achieved:
(a) Comprehensive policies and strategies for IWRM in the process of being implemented in 75% of countries by 2005 and in all countries by 2015
(b) Pro portion of people not having access to hygienic sanitation facilities reduced by half by 2015
(c) Proportion of people not having sustainable access to adequate quantities of affordable and safe water reduced by half by 2015
(d) Increase water productivity for food production from rain-fed and irrigated farming by 30% by 2015
(e) Reduce the risk from floods for 50% of the people living in floodplains by 2015
(f) National standards to ensure the health of freshwater ecosystems, established in all countries by 2005, and programmes to improve the health of freshwater ecosystems implemented by 2015

Outputs: Political will to mobilize people and resources secured

(a) Complete targets and logical frame for water security by August 2000.
(b) Regional and National Programmes for Action completed by August 2001.
(c) Programmes for Action discussed at the Bonn Conference (Dublin+10) in January.
(d) Programmes for Action and national targets prepared by Governments before Rio+10 meeting in mid 2002.
(e) 3rd World Water Forum (on major water issue arising from 2nd World Water Forum) held in March 2003.
(f) First edition of World Water Development Report published March 2002.

Effective water Governance for IWRM achieved.

(a) IWRM mainstreamed in policy and strategy implementation processes in all countries by 2005.
(b) Cooperation mechanisms between riparian States in all major river basins developed and strengthened by 2005, and shared waters agreements formulated by 2015.
(c) The economic value of water recognized and reflected in national policies and strategies by 2005, and mechanisms established by 2015 to facilitate full cost pricing for water services.
(d) GWP Toolbox of options for water management developed by 2001.

Effective water wisdom generated.

(a) Water awareness initiatives instigated in all countries by August 2001.
(b) Capacity for informed decision making at all levels and among all stakeholders increased by 2005.
(c) Investment in research on water issues increased by August 2001.
(d) Hygiene education in 80% of all schools by 2010.

Solutions to urgent water priorities prepared: protecting the resource, enhancing crop productivity per drop, improving sanitation, urban upgrading, and improved flood management.

(a) Programmes to tackle urgent priorities formulated, resourced and under implementation in all countries by 2005.
(b) Action programmes to protect surface and groundwater resources prepared and in the process of being implemented by 2003, and defined standards achieved by 2010.
(c) Task force on food-water security reports by end 2001 and action programmes for enhancing crop per drop prepared and in the process of being implemented by 2003.
(d) Action programmes for sanitation formulated and in process of implementation, and knowledge/information about good hygiene practices made universal by 2003.
(e) Action programmes to integrate water needs (supply and waste) with spatial planning and social and economic needs prepared and in the process of being implemented by 2003.
(f) Action programmes for flood preparedness and protection formulated and in the process of being implemented by 2003.

Investment needs for water security identified and agreed upon.

(a) Investment needs for closing the resource gaps identified and (indicative) investment plans developed in all countries by 2002.
(b) Mechanisms for mobilizing new financial resources identified and in the process of being implemented by 2003.
(c) Investments committed to the water domain doubled by 2005.
(d) Private sector-led International Research Foundation established by 2002.

An example of indicator values per state on water supply and sanitation as a percentage of people with access to improved drinking water resources and those with access to improved sanitation facilities.

	% of population with access to improved drinking water in the year 2000			% of population with access to improved sanitation facilities in the year 2000		
	Total	Urban	Rural	Total	Urban	Rural
Congo Rep.	44	63.7	17.1	68.5	85.6	44.9
Nigeria	57	81	39	63	85	45
Gabon	70	73	55	21	25	4
Benin	63	74	55	23	46	6
Dem R. Congo	77	89	26	20	53	6
Burundi	65	94	63	89	67	90

(Source: AWDR National Authors: 2003).

Table 5.1: Adopted targets and indicators for use in the first Cameroon Water Development Report

Targets	Indicators
1. To reduce by 25% the proportion of people without access to safe and adequate water supply by the year 2005, by 75% by the year 2015 and by 95% by the year 2025. 2. To reduce by 25% the proportion of people without access to safe and adequate sanitation by the year 2005, by 70% by the year 2015 and by 95% by the year 2025.	• Actual and total water supply coverage (urban, rural disparities) • Actual and total sanitation coverage (urban, rural disparities) • % or number of people not served with basic sanitation • % or number of people not served with improved drinking water and extension of piped water supply • Investment in drinking water supply and sanitation • % of Health Impact Assessment (HIA) of water resources development and compliance with HIA recommendations • Incidence of water-related diseases like diarrhoea, cholera, and malaria.

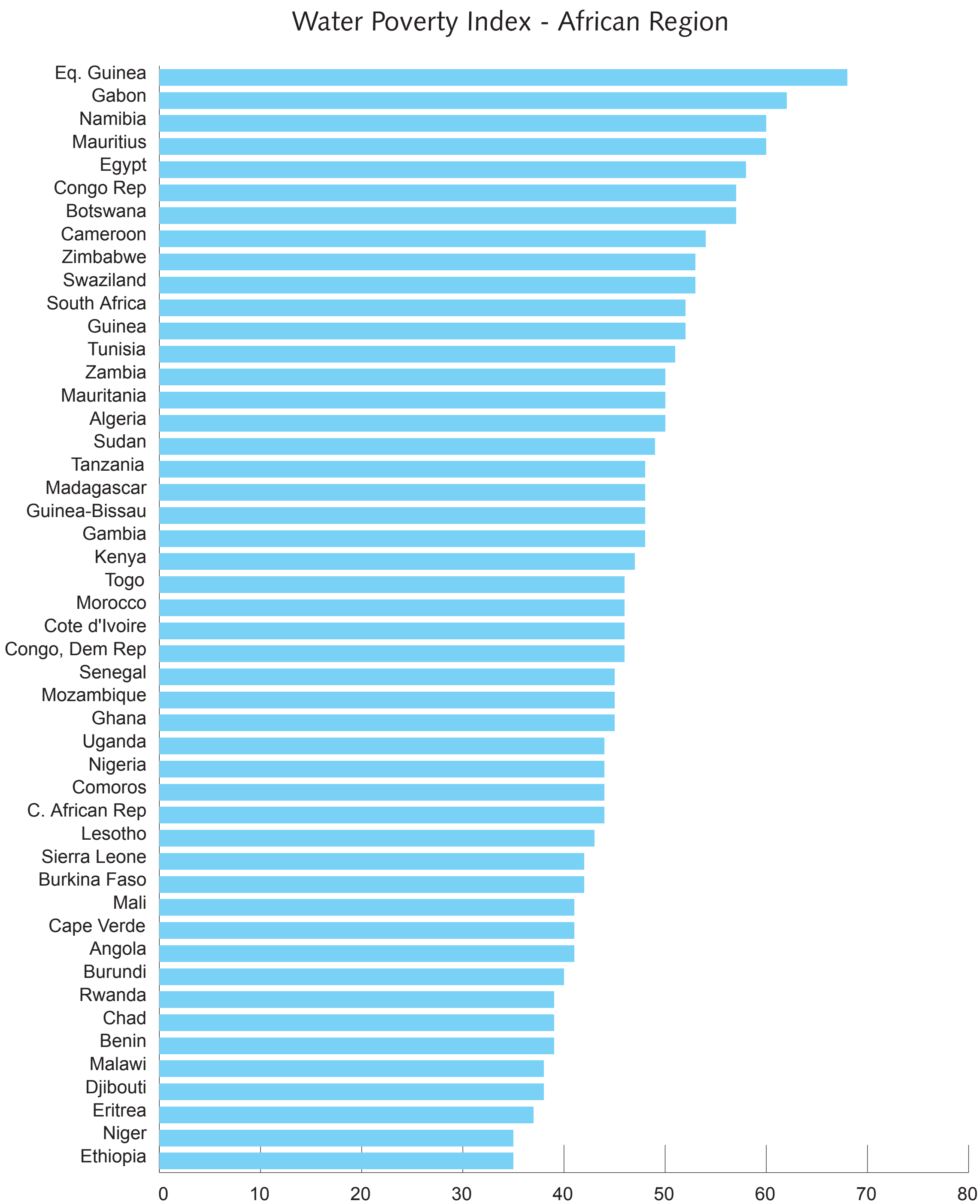
Holistic indicators for sustainable development

The Water Poverty Index (WPI): This is an easy-to-use indicator designed to provide a standardized framework for monitoring how best water can be managed to meet the basic needs of development. Monitoring progress in the water sector requires an interdisciplinary approach that may involve both qualitative and quantitative assessment techniques. These should be integrated in such a way as to allow a range of issues to be addressed, while at the same time allowing the views and values of a range of stakeholders to be represented. The Water Poverty Index (WPI) measures, for a given country, the impact of water scarcity and water provision on human populations. WPI is a number between 0 and 100, where a low score indicates water poverty and a high score indicates good water provision. WPI is the culmination of an interdisciplinary approach that combines the physical quantities relating to water availability and the socio-economic factors relating to poverty to produce an indicator that addresses the diverse factors that affect water resources management.

The Water Poverty Index is therefore based on the formulation of a holistic framework for water resources evaluation, which incorporates a wide range of variables in keeping with the Sustainable Livelihoods Approach used by many donor organisations to evaluate development progress. The scores of the index range on a scale of 1 - 100, with the total being generated as a weighted additive value of five major components, where a low score indicates water poverty and a high score indicates good water provision. Each of the 5 components is also scored on a scale of 1 - 100, and they are:

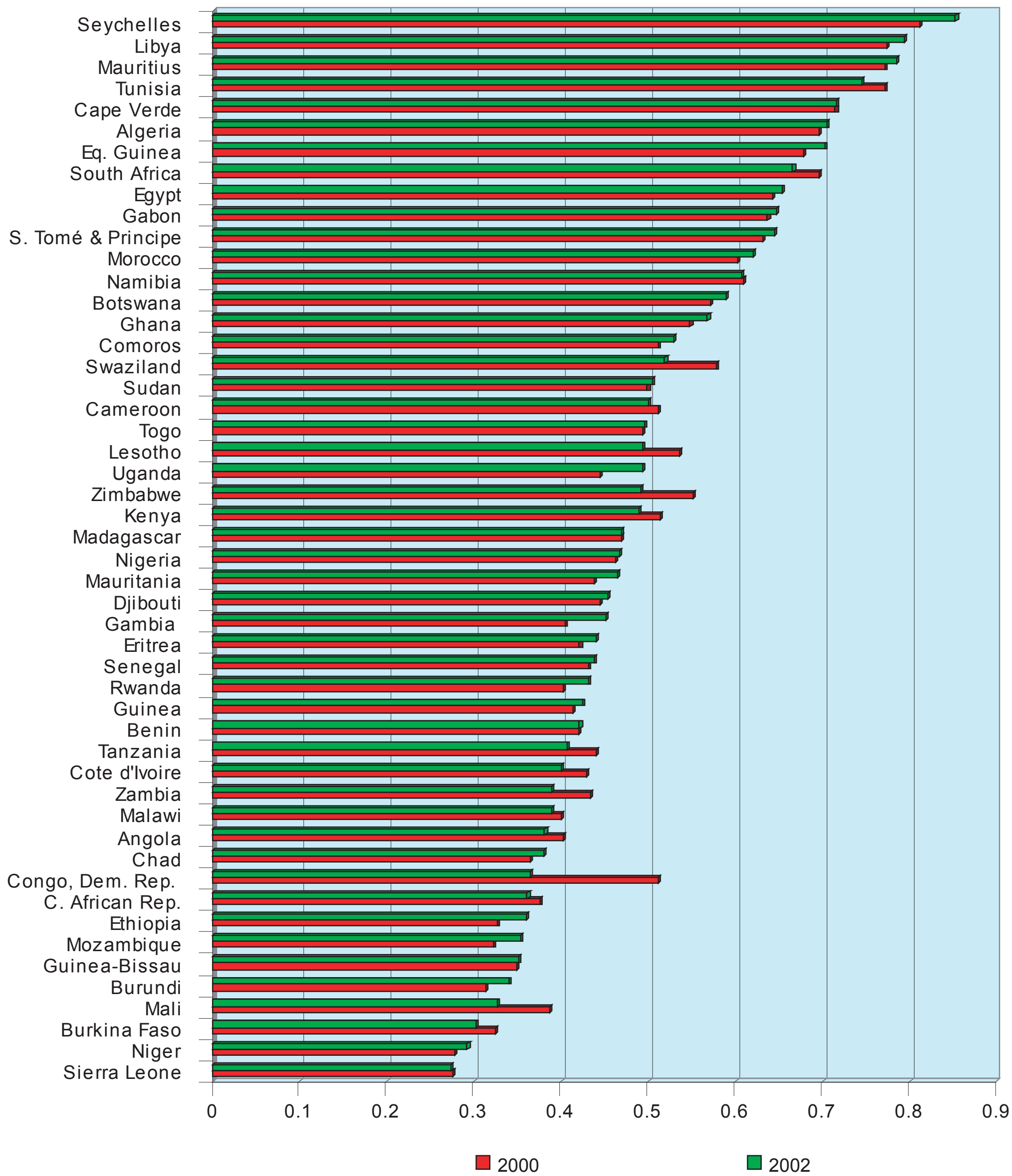
- **(a)** **Resource**: The measure of ground and surface water availability, adjusted for quality and reliability;
- **(b)** **Access**: Indicates the effective access people have to water for their survival;
- **(c)** **Use**: Captures some measure of how water is used, including sectoral shares;
- **(d)** **Capacity**: Represents human and financial capacity to manage the system; and
- **(e)** **Environment**: Tries to capture an evaluation of ecological integrity related to water

The raking of African countries according to their water poverty index is shown in the figure below.



Source: World Resources Institute, Natural Environment Research Council, Centre for Ecology and Hydrology. 2002. Note: For a detailed account of alternative methods and their shortcomings, please refer to the 2002 print publication Calculating a Water Poverty Index: http://www.nerc-wallingford.ac.uk/research/WPI/images/WaterPovertyIndexPaper.pdf.

Human Development Index (HDI): This is a brief measurement of human development, established by the United Nations Development Programme (UNDP). It measures the average achievement in three basic dimensions of human development: A long and healthy life, as measured by life expectancy at birth; knowledge, as measured by a combination of adult literacy (two-thirds weight) and the combined primary-, secondary- and tertiary- gross enrolment ratios (one-third weight) and; a decent standard of living, as measured by GDP per capita (PPP $US). HDI is calculated as a simple average of the dimension indices that refer to the relative level of actual attainment between the maximum and minimum values.



Source: UNDP (2001, 2004)

From the UNDP Human Development Reports (2002, 2004) it can be noted that only Seychelles was ranked among the high-income group in 2002 (UNDP, 2004) while about 18 countries fell into the medium group. Even though the report indicates that the methodology has been updated in such a way that care must be taking when comparing the figures for 2000 and 2002, it is worth noting that in the report of 2002, about 21 countries were ranked in the medium income group. The human development index (HDI) values and corresponding ranks of African countries are shown in the figure above and the table below.

Ranking of African countries according to the Human Development Index 2002

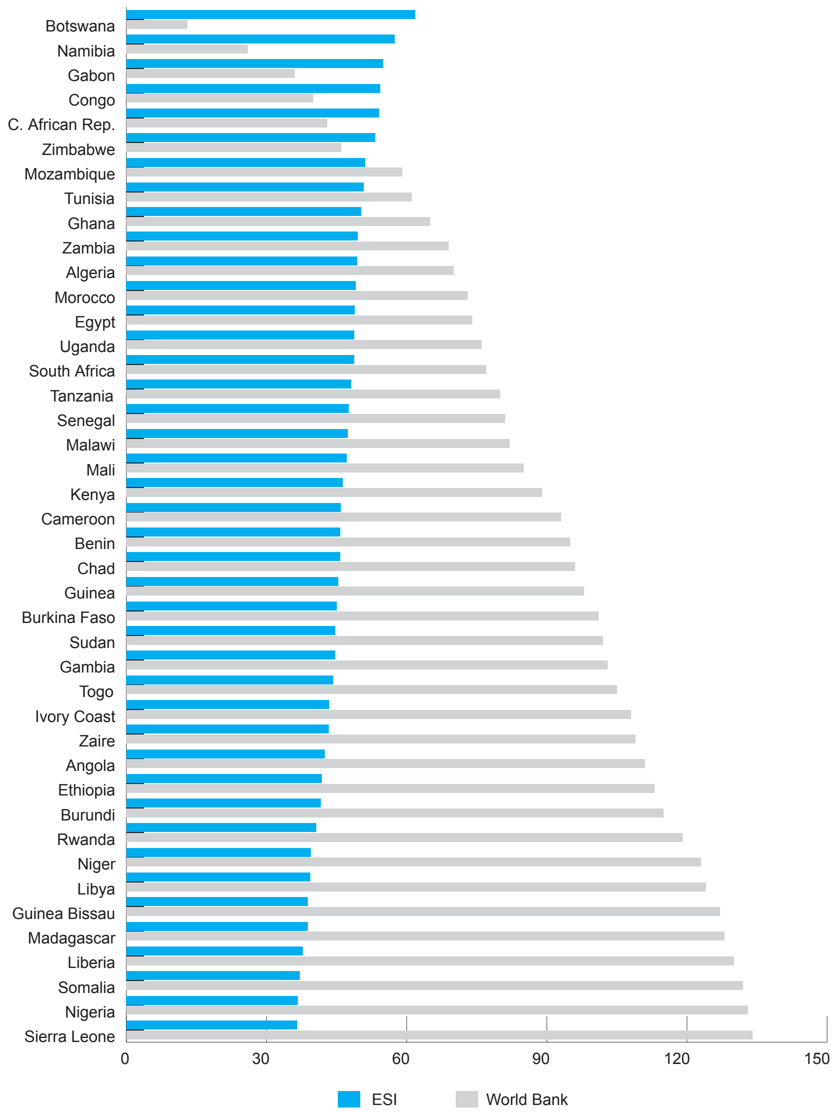
1 Human development index MONITORING HUMAN DEVELOPMENT: ENLARGING PEOPLE'S CHOICES . . .

HDI rank[a]	AFRICA	Life expectancy at birth (years) 2002		Adult literacy rate (% ages 15 and above) 2002[b]		Combined gross enrolment ratio for primary, secondary and tertiary schools (%) 2001/02[c]		GDP per capita (PPP US$) 2002		Life expectancy index	Education index	GDP index	Human development index (HDI) value 2002	GDP per capita (PPP US$) rank minus HDI rank[d]
High human development														
35	Seychelles	72.7	m	91.9	l	85		18,232	p,q	0.8	0.9	0.87	**0.853**	-2
Medium human development														
58	Libyan Arab Jamahiriya	72.6		81.7		97	h	7,570	v	0.79	0.87	0.72	**0.794**	6
64	Mauritius	71.9		84.3	l	69		10,810		0.78	0.79	0.78	**0.785**	-15
92	Tunisia	72.7		73.2		75	h	6,760		0.79	0.74	0.7	**0.745**	-23
105	Cape Verde	70		75.7		73	h	5,000	q	0.75	0.75	0.65	**0.717**	-12
108	Algeria	69.5		68.9		70	h	5,760	q	0.74	0.69	0.68	**0.704**	-25
109	Equatorial Guinea	49.1		84.2	f,k	58		30,130	f,q	0.4	0.76	0.95	**0.703**	-103
119	South Africa	48.8		86		77		10,070	q	0.4	0.83	0.77	**0.666**	-66
120	Egypt	68.6		55.6	f,l	76	f,t	3,810		0.73	0.62	0.61	**0.653**	-12
122	Gabon	56.6		71	w,x	74	h	6,590		0.53	0.72	0.7	**0.648**	-50
123	São Tomé and Principe	69.7		83.1	m	62		1,317	f,s	0.75	0.76	0.43	**0.645**	29
125	Morocco	68.5		50.7		57		3,810		0.72	0.53	0.61	**0.62**	-17
126	Namibia	45.3		83.3		71		6,210	q	0.34	0.79	0.69	**0.607**	-48
128	Botswana	41.4		78.9		70		8,170		0.27	0.76	0.73	**0.589**	-67
131	Ghana	57.8		73.8		46		2,130	q	0.55	0.65	0.51	**0.568**	-3
136	Comoros	60.6		56.2		45		1,690	q	0.59	0.53	0.47	**0.53**	4
137	Swaziland	35.7		80.9		61		4,550		0.18	0.74	0.64	**0.519**	-37
139	Sudan	55.5		59.9		36		1,820	q	0.51	0.52	0.48	**0.505**	-3
141	Cameroon	46.8		67.9	z	56	h	2,000		0.36	0.64	0.5	**0.501**	-9
Low human development														
143	Togo	49.9		59.6		67		1,480	q	0.41	0.62	0.45	**0.495**	5
144	Congo	48.3		82.8		48	h	980		0.39	0.71	0.38	**0.494**	17
145	Lesotho	36.3		81.4	z	65		2,420	q	0.19	0.76	0.53	**0.493**	-24
146	Uganda	45.7		68.9		71		1,390	q	0.34	0.7	0.44	**0.493**	4
147	Zimbabwe	33.9		90		58	h	2,400	f	0.15	0.79	0.53	**0.491**	-25
148	Kenya	45.2		84.3		53		1,020		0.34	0.74	0.39	**0.488**	11
150	Madagascar	53.4		67.3	f,k	45		740		0.47	0.6	0.33	**0.469**	20
151	Nigeria	51.6		66.8		45	f,t	860		0.44	0.59	0.36	**0.466**	15
152	Mauritania	52.3		41.2		44		2,220	q	0.45	0.42	0.52	**0.465**	-25
154	Djibouti	45.8		65.5	f,k	24		1,990	q	0.35	0.52	0.5	**0.454**	-21
155	Gambia	53.9		37.8	f,k	45	h	1,690	q	0.48	0.4	0.47	**0.452**	-15
156	Eritrea	52.7		56.7	f,k	33		890	q	0.46	0.49	0.36	**0.439**	8
157	Senegal	52.7		39.3		38	h	1,580		0.46	0.39	0.46	**0.437**	-11
159	Rwanda	38.9		69.2		53		1,270	q	0.23	0.64	0.42	**0.431**	-6
160	Guinea	48.9		41	w,x	29	f	2,100		0.4	0.37	0.51	**0.425**	-30
161	Benin	50.7		39.8		52	h	1,070		0.43	0.44	0.4	**0.421**	-5
162	Tanzania, U. Rep. of	43.5		77.1		31	f	580		0.31	0.62	0.29	**0.407**	12
163	Côte d'Ivoire	41.2		49.7	f,k	42		1,520		0.27	0.47	0.45	**0.399**	-16
164	Zambia	32.7		79.9		45		840		0.13	0.68	0.36	**0.389**	3
165	Malawi	37.8		61.8		74	h	580		0.21	0.66	0.29	**0.388**	9
166	Angola	40.1		42	w,}	30	f	2,130	q	0.25	0.38	0.51	**0.381**	-38
167	Chad	44.7		45.8		35	f	1,020	q	0.33	0.42	0.39	**0.379**	-8
168	Congo, Dem. Rep. of the	41.4		62.7	f,k	27	f,{	650	q	0.27	0.51	0.31	**0.365**	4
169	Central African Republic	39.8		48.6	z	31		1,170	q	0.25	0.43	0.41	**0.361**	-15
170	Ethiopia	45.5		41.5		34		780	q	0.34	0.39	0.34	**0.359**	-1
171	Mozambique	38.5		46.5		41		1,050	q	0.22	0.45	0.39	**0.354**	-14
172	Guinea-Bissau	45.2		39.6	f,k	37	f	710	q	0.34	0.39	0.33	**0.35**	-1
173	Burundi	40.8		50.4		33		630	q	0.26	0.45	0.31	**0.339**	0
174	Mali	48.5		19	f,l	26	f	930		0.39	0.21	0.37	**0.326**	-11
175	Burkina Faso	45.8		12.8	f,l	22	h	1,100	q	0.35	0.16	0.4	**0.302**	-20
176	Niger	46		17.1		19		800	q	0.35	0.18	0.35	**0.292**	-8
177	Sierra Leone	34.3		36	w,x	45	f	520		0.16	0.39	0.28	**0.273**	-1

Source: UNDP (2004)

The Environmental Sustainability Index (ESI) is a measurement of overall progress towards environmental sustainability. It was developed for 122 countries. ESI scores are based upon a set of 22 core "indicators", and each of them combines two to six variables for a total of 67 underlying variables. The indicators and variables are chosen through careful review of the environmental literature and available data combined with extensive consultation and analysis, identification of best practices and investigation into interactions between environmental and economic performance. Although in broad terms high-income countries scored higher, among countries of similar levels of per capita income no strong correlation exists between income and overall environmental sustainability. ESI has been developed through a transparent and interactive system of parameters.

The figure below shows the 2002 ESI values for African countries and their respecting placements in the world ranking.



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Minimum Significant Indicators from some National AWDR Reports

Economic and social indicators of Morocco

Amounts (billions of DH)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
National accounts											
Gross domestic product at constant prices	110.3	109.1	121.2	112.7	126.2	124	133	134	135	143	148
Agricultural GDP	15.5	14.5	23.3	13.1	23.4	17.1	21.4	18.3	15.4	19.6	20.7
Non-agricultural GDP	94.8	94.6	97.8	99.6	102.8	107	111	115	120	124	127
Gross domestic product at current prices	241.2	247.7	279.3	281.2	320.9	318	343	346	354	383	398
Agricultural GDP						49.1	58.1	52.9	49	59.7	64.1
Non-agricultural						269	285	293	305	324	334
National income available	253.2	256.7	289.4	289.3	330.3	330	357	359	372	415	426
National Consumption	199.8	208.6	236.5	241.7	270.1	264	281	281	294	309	320
Gross fixed capital formation	54.9	55.4	57.9	62.9	64.7	65.8	76.7	81.9	85.4	85.4	91.1
National savings	53.3	48.1	53	47.5	60.3	65.1	75.8	78.3	78.9	106	107
Indices of the costs for life (base 100 into 1989)	122.2	128.5	135.1	143.4	147.7	149	153	154	157	158	163
Foodstuffs	125.3	133.2	142.5	153.9	155	153	158	157	159	158	164
Non-foodstuffs and services						146	149	152	156	159	161
External accounts											
Total exports	34	34.3	36.5	40.2	41.3	67.1	68.6	73.6	78.8	80.7	86.6
Total imports	62.8	61.8	66	72.9	71.9	90.7	98.7	106	123	125	130
Global commercial balance	-28.8	-27.5	-29.4	-32.6	-30.6	-24	-30	-32	-44	-44	-44
Trips balance	+9.6	+9.2	+8.6	+7.3	+9.0	10.8	12.7	14.7	17.1	24.8	24.3
Balance current transfers						21	22.5	21.1	26.4	40.2	36.7
Currant account balance	-3.7	-4.9	-6.7	-13	-5.7	-0.8	-1.4	-1.6	-5	18.2	16.4
Currant account balance as % of GDP	(1.6)	(2.0)	(-2.4)	(-4.6)	(1.8)	-0.3	-0.4	-0.5	-1.4	4.8	4.1
Total service of the external national debt	22.3	29.4	27.7	30.1	28.3	29.8	28.2	28.7	26.6	27.8	28.3
Outstanding national external debt						186	179	177	171	163	142
National external debt as % of the GDP						58.4	52.4	51	48.3	42.6	35.7
Public finance											
Ordinary balance	+12.6	+13.8	+9.8	+4.9	+'7	12	8.1	24.9	7.3	26.4	8.4
Investment expenses	17.2	19.5	19	19.7	16.6	18.4	14.9	18.9	19.2	21.3	20.3
Budget deficit	-5.4	-5.7	-8.9	-14.8	-9.7	-6.3	-10	3	-21	-10	-17
Budget deficit as % of GDP	(2.2)	(2.3)	(-3.2)	(-5.3)	(-3)	-2	-3.1	0.9	-5.9	-2.6	-4.3
Top of form Currency Bottom of form											
M1 aggregate							150	168	181	210	229
Monetary mass (M1)	146.5	159.3	174.2	186.5	198.8	231	245	270	293	334	355
Top fo form External assets Bottom of form	33.7	38.2	41.5	34.1	36.3	40.6	43	59.1	54.7	102	111
State debt	55.5	60.5	65.2	74.2	76.4	86.4	84.5	76	85.9	78.3	80.7
Contribution to the economy	66	71.8	79.3	91.4	100.9	159	176	193	208	217	227
1DH # 1,1$											

Significant Indicators - Libya

1. Life expectancy: 72.5 yrs (2003), 70 yrs (2002) , 46 yrs (1970)
2. Infant mortality: 118 per 1000 (1973), 24 per 1000 (1995)
3. Social and health services: 11% of the budget (1973-1985); 19% of the budget (1976-2000)
4. 95% of population with access to medical services (1995)
5. 45% of population with access to medical services (1973)
6. Illiteracy rates: 14% (2000), 61% (1973)
7. School enrollment for ages between 6 and 24 yrs. 77% (2001), 64% (1973)
8. Female enrollment in basic education: 78.5% (1995), 11% (1973)
9. Male enrollment in basic education: 80.4 (1995), 23%(1973)
10. 76% of housing units are connected to potable water networks (2002), 61% (1973)
11. 48% of housing units are connected to sewage collection networks (2002), 17% (1973)
12. 99% of housing units are connected to electrical power supply (2002)
13. Administrative and managerial staff (% of females) 10% (1995)
14. Unemployment rate (2003): Male 16.87, Female 18.47, Total 17.28
15. Unemployment rate (1995) Total 10.86
16. % of workers in agriculture, fisheries (2003) 4.8%
17. Rural population (as % of total) 15.0 (1995)
18. Annual growth rate of rural population: (-2.20) 1995
19. Education budget (as % of national budget): 38.2 (1998)
20. Number of centers and institutions for scientific research: 18 (1998)
21. Number of staff at R&D centers (as per 100000 people): 1100 (1998)
22. Percentage of female (as % of staff at R&D centers): 13.0 (1998)
23. University degree holders (as % of the staff at R&D centers): 80 (1998)
24. Urban population (as % of total) 60.2% (1973), 85.7% (1995)
25. Annual population growth rate (973-1995): 3.5%
26. Electricity consumption (kw per capita): 2688 (1998)
27. Real GDP (million dinars) based on 1997 prices:
    1998: 13159.2
    2000: 14141.6
    2001: 14206.2
    2002: 14557.6
    2003: 15234.9
28. Average of inflation rate in 1998 (as % of 1992): 48
29. GDP growth rate in 1997 (as % of 1992=100): 136.3

SOUTH AFRICA

INDICATORS FOR DRIVERS				
Serial	Indicator	Quantified Indicators		Qualified Description or Comment
		VALUE	YEAR	
1	Human Poverty Index: 5 indicators	16.4 22.3	1995 2003	
2	Incidence of water-related diseases	2778 11243	2004 2004	Cholera cases Malaria cases
3	Population	46.6m	2004	
4	Population growth rate	2%	1996-01	Growth between official census figures
5	Renewable water resources within a country	49 040 Mm^3		
6	Withdrawals: % of total annual renewable fresh-water	26.2 %	2000	
7	Water scarcity: number of countries			South Africa is on the threshold of water scarcity
8	Water shortages: no. of people without formal infrastructure in South Africa	3.7m	2005	Unable to interpret this indicator to South Africa
9	No. of countries unable to supply minimum drinking water			South Africa is able to supply minimum drinking water
10	Transboundary rivers: (% population dependent on them)	72.3%	2000	
11	Polluted water: (% of population exposed to it)			Unable to interpret this indicator to South Africa
12	Natural disasters: deaths from water-related causes	1406	1950-96	Flood related
13	Climate change: effects on water scarcity	-10%	2015	Reduction in runoff in the western ar-eas of the country

	SOURCES ACCORDING TO SERIAL NUMBER:
1	UNDP. The Challenge of Sustainable Development in South Africa. Third Human Development
2	Report. 2003. p45
3	SA Department of Health. on 11 April 2005
4	Statistics South Africa. Mid-year population estimates, 2004. Statistical release P0302
5	Statistics South Africa. Census 2001: Census in Brief. 2003
6	National Water Strategy, Table 2.1. Sept 2004
10	National Water Strategy, Table 2.1. Sept 2004
12	National Water Strategy, Fig 2.3 (underlying data). Sept 2004
13	DWAF. Historical flood documentation in South Africa – 1652 to 1996. Report TR152. 1997
	South Africa. Initial National Communication under the United Nations Framework Convention on
	Climate Change 2000 p35

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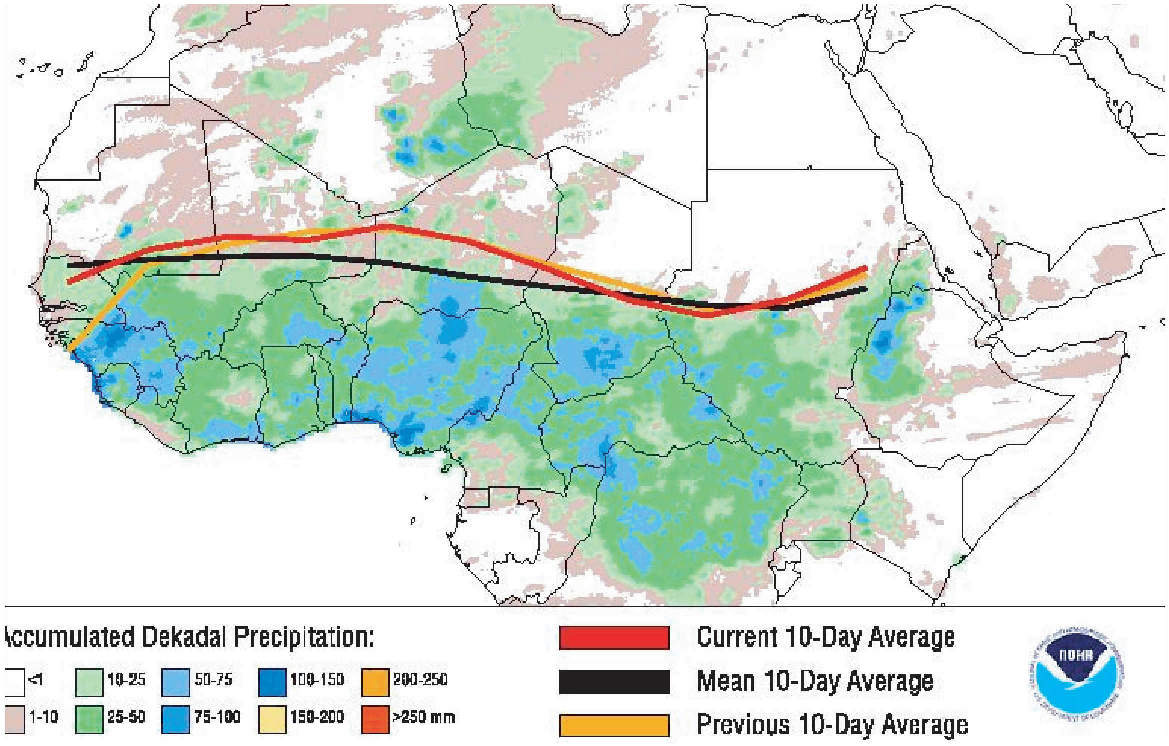
FRESHWATER RESOURCES IN AFRICA

The main climatic mechanism that influences moisture input into Africa is the movement of the Inter-Tropical Convergence Zone (ITCZ) over the continent. Seasonal rainfall over Africa is basically attributed to the position of the Inter-Tropical Front which together with the strengths of the southwesterly monsoons and the upper easterly air currents, accentuated by local physiographic and orographic conditions, determine the direction and amounts of the rains. For example, rainfall is expected in the southern parts below 10°N around March-April, while the regions up to 20°N receive rain from June-September. Generally, Africa is characterized by extreme climatic zones; from humid equatorial and tropical zones through the semi-arid to the arid North, creating about seven distict hydro-climatic zones (table 4.1). The distribution of rainfall over Africa therefore exhibits extreme unevenness, both spatially and temporally.

Figure 4.1: Current vs Mean Position of the Africa ITCZ, as analyzed by the NDAA Climate Prediction Centre (June 2005 Dekad 2)



Source: NWS, 2005

Table 4.1:Hydro-Climatic Subregions in Africa

SUBREGION	COUNTRIES
Northern	Algeria, Egypt, Libya, Morocco, and Tunisia
Sudano-Sahelian	Burkina Faso, Cape Verde, Chad, Djibouti, Eritrea, Mali, Mauritania, Niger, Senegal, Somalia, Sudan
Gulf of Guinea	Benin, Cote d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Nigeria, Sierra-Leone, Togo
Central	Angola, Cameroon, Central African Republic, Congo, Equitorial Guinea, Gabon, Sao Tome, Democratic Republic of Congo
Eastern	Burundi, Ethiopia, Kenya, Rwanda, Tanzania, Uganda
Islands	Comoros, Madagascar, Mauritius, Seychelles
Southern Africa	Botswana, Lesotho, Malawi, Namibia, South Africa, Swaziland, Zambia, Zimbabwe

Source: Africa Water Vision - 2025

Rainfall in Africa

Table 4.2 below shows that, Africa has a plentiful supply of rainwater, a total of 20,211 cubic kilometers per year or 673.1 mm per year. However, at the subregional level, the distribution is varied. The highest rainfall occurs in the island countries (1700mm per year), the central African countries (1430mm), and the Gulf of Guinea (1407mm). In contrast, the lowest rainfall occurs in the northern countries, where the average annual rainfall is only 71.4mm.

At the continental level, Africa has abundant rainfall and relatively low levels of withdrawals of water for its three major uses, namely, agriculture, community water supply and industry. This water abundance is depicted in Table 4.2. The first column shows Africa divided into seven subregions, from north to south. The three columns after that represent the rainfall in each of the subregions, measured in cubic kilometers per year and in millimeters per year. The next three columns illustrate, for each subregion, the internal renewable water resources or the average

Table 4.2:Regional Distribution of Water Availability and Withdrawals in Africa

Sub-Region	Area	Rainfall		Internal Renewable Resources (IRR)			Withdrawals for Agriculture, Community Water Supply and Industry			
	1000x km^2	km^3/yr	mm/yr	km^3/yr	mm/yr	% of rainfall	km^3/yr	mm/yr	% of rainfall	% of IRR
Northern	5753	411	71.4	50	8.7	12.2	76.3	13.3	18.6	152.6
Sudano-Sahelian	8591	2878	335.0	170	19.8	5.9	24.1	2.8	0.8	14.1
Gulf of Guinea	2106	2965	1407.9	952	452.0	32.1	6.1	2.9	0.2	0.6
Central	5329	7621	1430.1	1946	365.2	25.5	1.4	0.3	0.02	0.1
Eastern	2916	2364	810.7	259	88.8	11.0	6.5	2.2	0.3	2.5
Islands	591	1005	1700.5	340	575.8	33.8	16.6	28.1	1.7	4.9
Southern	4739	2967	626.1	274	57.8	9.7	18.9	4.0	0.6	6.9
Total	30027	20211	673.1	3991	132.9	19.7	149.9	4.0	0.7	3.8

Source: ECA and FAO, 1995

annual flows of rivers and groundwater that are generated from the rainfall that occurs within the subregion (UNECA, 2001). The final four columns provide information on the total amount of water withdrawn in each of the subregions for agriculture (85 per cent), community water supply (9 per cent), and industry (6 per cent).

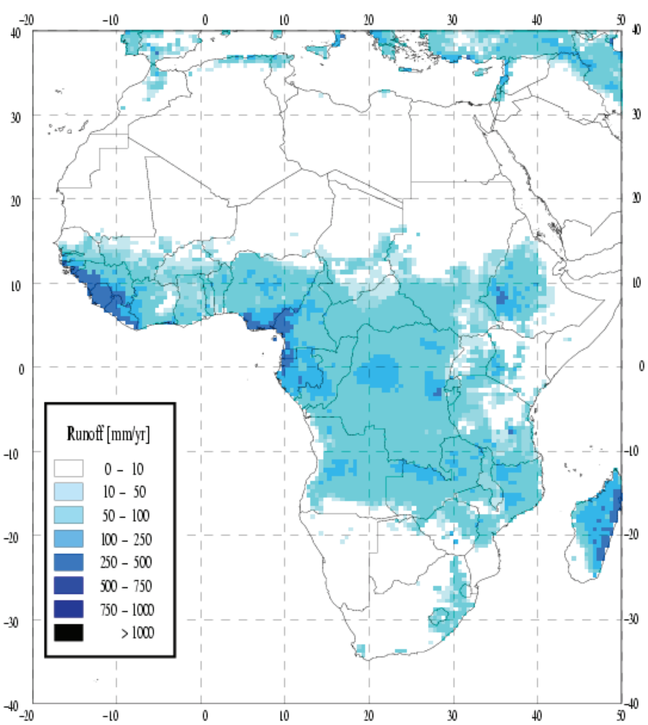
It must be noted that rainfall anomalies, both positive and negative, are very frequent over the continent. Most freshwater comes from seasonal rains, which vary with the climatic zone. The heaviest rainfall occurs along the equator, especially the area from the Niger Delta to the Congo River Basin. The Sahara Desert has virtually no rain. Northern and Southern Africa receive 9 and 12 per cent, respectively, of the region's rainfall (FAO 1995). In West and Central Africa, rainfall is exceptionally variable and unpredictable (UNECA, 2001).

Internal renewable resources

A second significant feature of water resources in Africa is the extremely low runoff in relation to precipitation (fig. 4.2). Major runoff characteristics of principal river basin systems in Africa are shown in table 4.3 with the Congo river being the largest and having the highest runoff volume of 1300 km^3/year Generally the amounts of surface and groundwater flows that are generated from rainfall within the subregions are all low (table 4.4). At the continental level, the renewable water resources constitute only about 20 per cent of the total rainfall. In the Sudano-Sahelian and Southern African regions, the figures are 5.9 and 9.25 per cent, respectively. This may reflect high losses from the rainfall. These losses may occur, in part, through evaporation from surface waters or from plants. The low values of the internal renewable resources also show that there is room for improvement in conservation of rainwater, the lack of which accounts, in part, for the endemic drought in parts of the continent (UNECA, 2001). The actual renewable water resources are shown at the continental level in figure 4.3 and relative country values are also demonstrated by subregion in figure 4.4 and table 4.5.

An example of abundant renewable water is found in the Democratic Republic of the Congo,

Figure 4.2: Mean Annual Runoff - Africa



Source: UNEP-Vital Climate Graphics Africa, 2002

which has 90 per cent of its territory drained by the Congo River whose mean annual flow at its mouth is 1,269,000 Mm^3. The renewable water resources represent 70 per cent of the total flow, with the renewable groundwater resources estimated at 421,000 Mm^3 per year. Spatial distribution of annual runoff across the continent is shown in figure 4.2.

The distribution and dynamics of runoff production and renewable water resources by subregion and also by examples from some countries are shown in the subsequent tables and figures. An example of the complex water situation in the northern subregion is shown with the experience of Egypt in Box 4.1.

Table 4.3: Major Characteristics of Principal Rivers in Africa

River	Drainage area, $10^3 km^2$	Length, km	Average discharge at mouth, m^3/s	Runoff volume, km^3/year	Runoff layer, mm
Congo	3680	4370	41250	1300	353
Nile	2870	6670	1696	53,5	18.6
Niger	2090	4160	4217	133	63.4
Zambezi	1330	2660	3519	111	83.4
Orange	1020	1860	486	15.3	15.0
Chari	880	1400	1252	39.5	44.9
Juba	750	1600	546	17.2	22.9
Senegal	441	1430	545	17.2	39.0
Limpopo	440	1600	824	26.0	59.1
Volta	394	1600	1288	40.6	103
Ogowe	203	850	4729	149	734
Rufiji	178	1400	119	35.3	198
Cuanza	149	630	946	29.8	200

Source:.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

Table 4.4: Subregional Mean Relative Monthly Distribution of Renewable Water Resources and in Selected Countries in Africa

Subregions, Countries	Internal water resources, km3/year	Monthly runoff distribution, as % of mean annual value											
		1	2	3	4	5	6	7	8	9	10	11	12
Northern	41	4.5	3.7	3.4	3.6	3.9	4.2	8.7	22.6	20.9	12.4	6.8	5.3
Western	1088	2.7	2.2	2.0	1.9	2.0	2.2	6.2	18.3	24.4	21.3	11.4	5.4
Central	1770	8.5	7.6	7.0	7.2	7.5	6.7	6.0	5.9	7.8	10.6	12.7	12.5
Eastern	749	4.1	6.2	10.3	18.2	17.2	11.4	6.3	6.3	5.8	5.5	3.9	4.8
Southern	399	13.4	15.0	16.5	9.1	6.5	7.1	7.9	3.6	3.6	4.1	5.8	7.5
Nigeria	274	9.6	10.2	9.8	6.7	2.8	1.4	2.8	9.4	20.5	11.2	7.5	8.2
Congo Dem.Rep.	987	8.3	7.2	6.5	7.5	8.4	8.6	7.8	6.9	8.4	9.4	10.2	10.7

Source:.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

Fig. 4.3: Actual Renewable Water in Africa

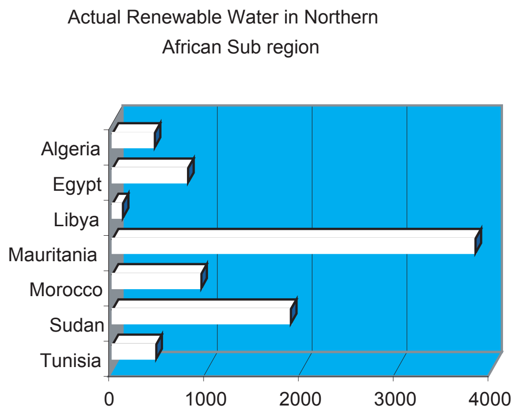
Sources: World Resources Institute – Earth Trends; FAO (2003)

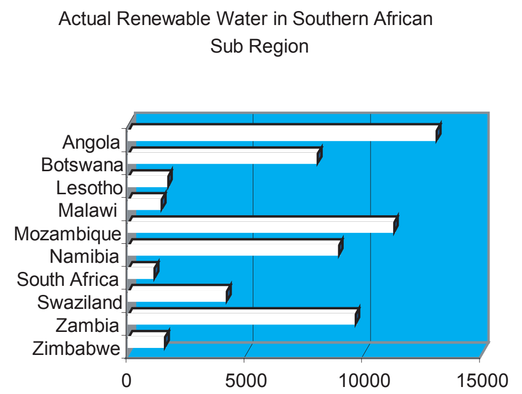
Table 4.5: Renewable Water Resources in Selected Countries in Africa

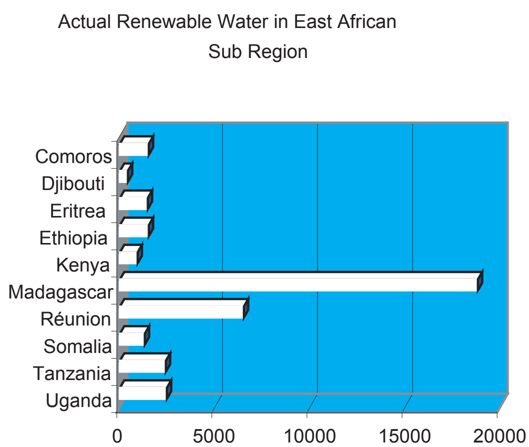
Countries	Area, 103 km2	Water resources, km3/year					Annual runoff layer, mm
		local			imported	total	
		max	min	average			
Gabon	268	272	133	205	15.6	221	765
Gambia	11	5.69	1.24	3.97	6.70	10.7	361
Niger	1267	5.40	0.28	2.33	32.1	34.4	18
Nigeria	924	437	148	275	43.7	319	293
Senegal	196	31.1	6.31	21.4	14.9	36.3	109
Sudan	2505	65.3	9.74	34.6	132	167	53
Congo. Dem. Rep.	2345	1328	786	989	313	1300	133

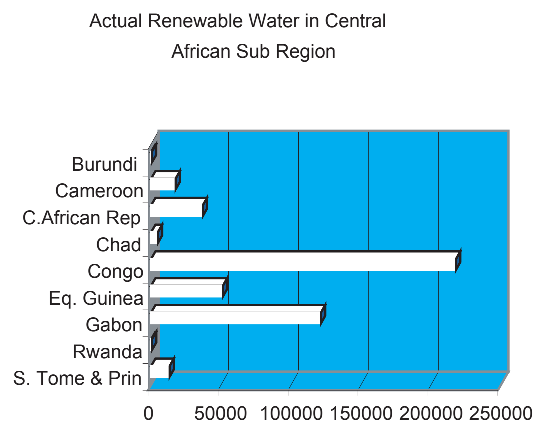
Source:.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

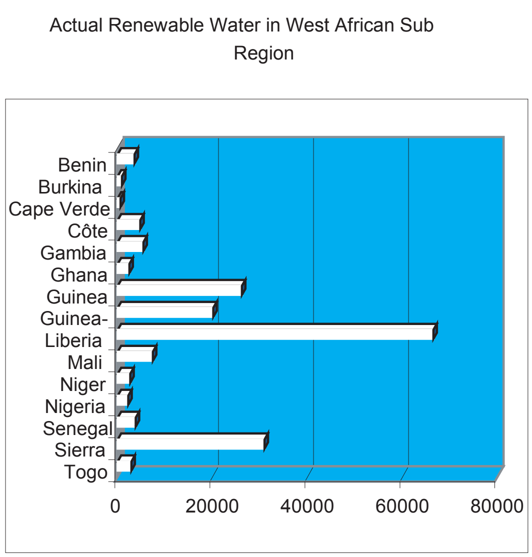
Fig. 4.4: Actual Renewable Water Resources by Subregions











Sources: World Resources Institute – Earth Trends; FAO (2003)

Box 4.1: Water Availability and Services in Egypt

With a population of 70 million and a cultivable/habitable area of only 40,000 km2 (4% of its territory), Egypt is one the most densely populated countries in the world. Increasing the inhabited area to 25% of the territory puts a heavy strain on the available water resources. For its water resources, Egypt is extremely dependent on the River Nile. Fossil groundwater is available only in parts of the desert. As a rough global indicator of water sufficiency if the annual amount of water available per capita is less than 1000 m3 /cap/yr, water scarcity occurs. In Egypt this critical value was reached by 1997. Water availability now stands at 950 m3/capita and with an expected population growth to 83 million in 2017, this will decrease to 720 m3/capita, which indicates a relatively high level of scarcity.

Agriculture is the main activity of a large portion of the Egyptian population. The agricultural sector consumes about 85% of the total available water resources. Irrigated agriculture accounts for 95% of net water use. Agriculture represents 17% of GDP and 40% of the labour force. Present cropping intensity of 1.93 harvest/year may drop to 1.5 in 2017. Efficiency of water use at the field level can be improved, but only up to a limit, as water is needed for leaching of salts. Irrigation is highly efficient on basin scale through intensive reuse of drainage water, which leads to a deteriorating water quality downstream.

Potable water reaches about 97% of the population, although for 25% the supply may be only for a few hours or even per week. Only 70% of the urban and 10% of the rural population is served by sewerage and sanitation. The population growth and small habitable area leads not only to a concentration of population in large cities, but also to a strong urbanization of the rural areas. The declining role of agriculture is compensated for by an increasing role of industry. Urbanization and industrialization pose a real threat to the quality of surface and groundwater.

The deterioration of water quality is becoming a main water management issue: it is a health hazard and it reduces the availability of freshwater downstream. The environmental and ecological water demand is severely threatened by the decrease in available water and the deterioration of water quality. The expansion of urban areas and agricultural land encroach on fragile habitats. Also, the development of new, but marginal lands in a vulnerable environment requires careful integrated planning. It may lead to environmental land degradation as is witnessed in the closed basins.

Table 4.6: Renewable Water Resources in Cameroon

Nature of resources	Value
Total internal renewable water resources (km^3/year)	271.0
Total external renewable water resources (km^3/year)	12.5
Total renewable water resources (km^3/year)	283.5
Dependency ratio (%)	4.4

Source: AWDR National Report

Table 4.7: Synthesis of Water Resources Assessment in the Northern Subregion

Country	P	AP	ERI	ESRst	ESRs	TER	POP	POT	DEP	MOB
	mm	km3/ year	km3/year	km3/ year	km3/ year	km3/year	Mill.	m3/hab/year	%	km3/ year
Algeria	89	211,50	15,15	2,70	12,35	15,15	32	473	3	8
Egypt	51	51,37	9.00	7.5	1,50	63.00	68	926	97	49,7
Libya	56	98,53	0,60	0,40	0,20	0,60	5.6	107	0	0,635
Mauritania	92	94,66	0,40	0,30	0,10	7,40	2.7	2741	96	-
Morocco	346	154,68	29,00	10,00	22,00	29,00	30	967	0	20
Sudan	417	1043,67	30,00	4,00	26,00	30,00	33.5	896	77	-
Tunisia	313	51,26	4,85	2,15	2,70	4,56	10	456	9	3,6
Total		1705	89	27.05	64.85	149.71	181.8	825		

P:Average rainfall AP: Rainfall volume ERI : Internal renewable water ESRst: Internal renewable ground warter ESRs: Internal renewable surface water TER: Total renewable water MOB : Total mobilizable water

Table 4.8 : Renewable Water Resources the Northern Subregion

	Maurita-nia	Mo-rocco	Algéria	Tunisia	Libya	Egypt	Sudan	Total
Renewable water resources (Mm3)	7400	29000	15150	4560	600	63000	30000	149710
Part in subregion (%)	5%	20%	10%	3%	0,4%	42%	20%	100%

Source :AWDR National Report, 2005

Table 4.9: Surface Water by Watershed in Morocco

Watershed	Area		Average Surface Flow	
	km2	% of country surface	Mm3	% of total flow
Loukkos, Tangérois and Mediterranean Coasts	20 600	2,9	4119	21,7
Moulouya	57 500	8,1	1656	8,7
Sebou	40 000	5,6	5600	29,4
Bou Regreg	20 000	2,8	830	4,4
Oum Er Rbia	35 000	4,9	3680	19,4
Tensift	37 500	5,3	1110	5,8
Souss- Massa	35 400	5	701	3,7
South Atlas Region	164 190	23,1	1300	6,8
Sahara	300 660	42,3	30	0,15
TOTAL	710 850	100	19026	100

Source :AWDR National Report, 2005 (DRPE)

Table 4.10: Surface Water by Watershed in Algeria

Watershed	Oranie Chott Chergui	Chéliff Zahrez	Algérois Soumam Hodna	Constantinois Seybouse Mellègue	South	Total
Potential Resources (Mm^3/year)	1025	1840	4380	4500	600	12 345
%	8,7	15,7	37,3	38,3	0,48	100.0

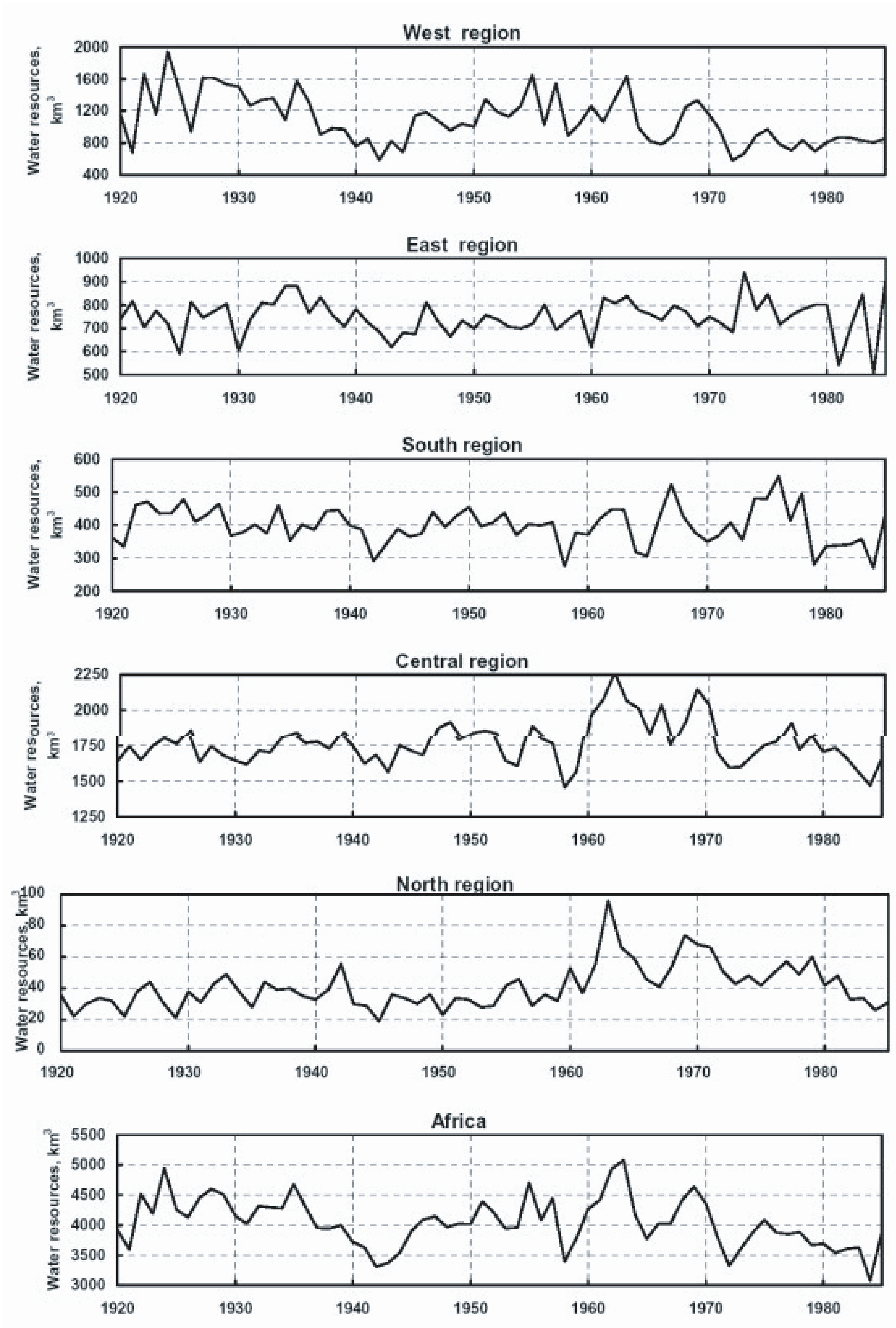
Source: AWDR National Report, 2005 (Ministry of Water Resources)

Table 4.11: Overall Assessment of Surface Water in Tunisia

Region	Area %	Low flow Mm^3	Medium flow Mm^3	Total flow Mm^3	Flow by region %
North	28	365	1825	2190	81
Centre	28	41	279	320	11
South	44	9	181	190	8
Tunisia	100	415	2285	2700	100

Source : AWDR National Report, 2005 (Hydrology Yearbook (DGRE))

Figure 4.5: Mean Annual Renewable Water Resources for Africa and Sub Regions



Source:.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

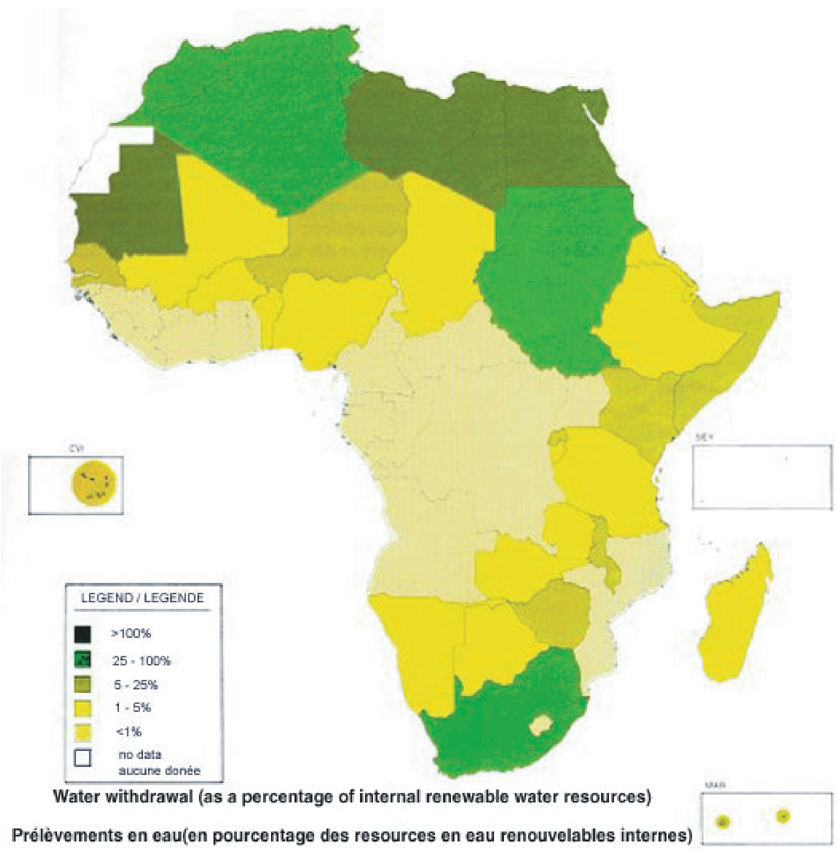
Table 4.12: Dynamics of Water Use, Renewable Water Resources and Water Availability by Subregion

Subregions	Available Water Resources km3/year			Water Use km3/year			Water Use in Relation to Water Resources (%)		Per capita Water availability 103 m3/year	
	local	inflow	total	1950	1995	2025	1995	2025	1995	2025
Northern	41	140	181	43.0 34.6	110 78.0	144 94	61 43	80 52	0.62	0.32
Western	1088	30	1120	2.3 1.7	26.0 20.1	52 32	2.3 1.8	4.6 2.8	4.9	2.1
Central	1770	80	1850	0.5 0.18	2.5 1.4	14 9.0	0.14 0.08	0.76 0.49	27.2	12.0
Eastern	749	29	778	3.7 2.8	50.4 41.0	83 59	6.5 5.3	10.7 7.6	3.6	1.5
Southern	399	86	485	6.5 5.0	26.4 19.1	43 28	5.4 3.9	8.9 5.8	5.3	2.8
Continent	4050	-	-	56.0 45.0	215 160	331 216	5.3 4.0	8.2 5.3	5.2	2.4

Source:.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

Note: the first line indicates water withdrawal; the second line – water consumption

Figure 4.6: Water Withdrawals as a Percentage of Internal Renewable Water Resources



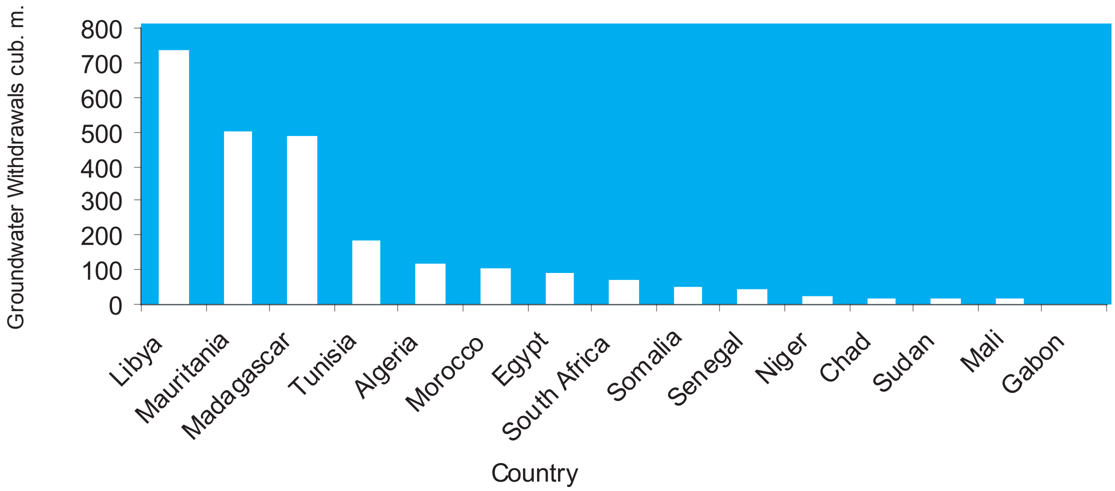
Source: FAO, 1995

Groundwater in Africa

Groundwater is extremely important in Africa. It is estimated that more than 75 per cent of the African population uses groundwater as the main source of drinking water supply. This is particularly so in North African countries, such as Libya, Tunisia, and parts of Algeria and Morocco, as well as in Southern African countries, including Botswana, Namibia and Zimbabwe. However, groundwater accounts for only about 15 per cent of the continent's total renewable water resources. In South Africa, for example, groundwater accounts for only 9 per cent. As a rule, groundwater tends to occur in small sedimentary aquifers along the major rivers and in the coastal deltas and plains. Groundwater resources are crucial for many countries and people in Africa, particularly during the dry season and in large arid zones. Groundwater is a main source of water in many rural areas, including for nearly 80 per cent of the human and animal populations in Botswana and at least 40 per cent in Namibia (GEO 2000, 1999). In Libya, groundwater accounts for 95 per cent of the country's freshwater withdrawals, while in areas such as the Pangani Basin of Tanzania groundwater is a significant source for irrigated agriculture. In many parts of the continent, groundwater resources have not yet been fully explored and tapped.

Renewable groundwater resources in North Africa are in the form of shallow alluvial aquifers, recharged from the main rivers (such as the alluvial aquifer beneath the Nile Delta in Egypt) or from precipitation (along the north African Mediterranean coast). In the Sahara Desert, the major water resources are the combined Nubian Sandstone Aquifer (NSA) and the Continental Intercalaire non-renewable aquifer, which extend from Egypt to Mauritania. Current annual rates of groundwater withdrawal in the subregion are 407 per cent of the recharge rate in Egypt, and 560 per cent in Libya. Exploitation of groundwater resources over the past ten years has led to a reduction in water pressure levels at the oasis of the western desert. Over extraction from the delta shallow aquifer has led to increased water salinization and a rapid inland advance of the saltwater interface. NSA is a huge fossil water resource located in the eastern Sahara. It is shared among four countries (Chad, Egypt, Libya and the Sudan) and contains an estimated 150 000 km^3 of groundwater. The total current extraction from the NSA is estimated at 1 500 million m^3/yr (UNEP Africa Environment Outlook, 2002). Owing to the highly variable levels of rainfall in Africa, large numbers of people are dependent on groundwater as their primary source of freshwater (UNEP, 2002). In Algeria, for example, more than 60 per cent of all withdrawals are from groundwater and, in Libya, 95 per cent of all withdrawals are from groundwater (fig. 4.7). Other countries, such as Algeria, Egypt, Libya, Mauritius, Morocco, South Africa and Tunisia, make use of desalinated water to assist in meeting their withdrawal requirements (UNEP 2002).

Figure 4.7: Major Groundwater Withdrawals in Africa



Source: Facts Africa, www.nationmaster.com

Table 4.13: Potential of ground water in Morocco

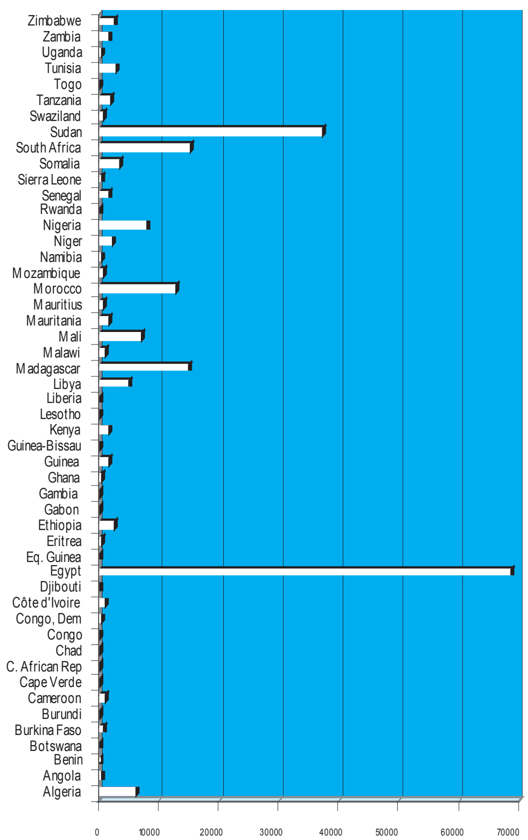
Watersheds	Potential exploitable water (Mm3/an)	Actual extraction (Mm3)	Remaining possibility of extraction (Mm3)
Loukkos, Tangérois and			
Mediterranean Coasts	226	140	86
Moulouya	779	270	509
Sebou	453	380	73
Oum Er Rbia	326	500*	
Bou Regreg	126		
Tensift	458	510*	-
Souss- Massa	240	640*	-
South Atlas Region	762	230	532
Sahara	16		
Diffus flow	614	-	-
TOTAL	4.000	2.670	1.200

Withdrawals

The total amount of water withdrawn in each of the subregions for use in agriculture, community water supply and industry show that both at the continental and at subregional levels, the withdrawals are rather low in relation to both the rainfall and the internal renewable resources. The only exception is in the northern countries where the withdrawals are, respectively, 18.6% and 152.6 per cent of the rainfall and internal renewal resources. It is noteworthy that for Africa, as a whole, the amount of water withdrawn for the three major uses of water amounts to only 3.8 per cent of the internal renewable resources. This may reflect a low level of development and

use of water resources in the continent. However, variability in rainfall results in frequent bouts of water scarcity and, during these times, demand exceeds supply. Human settlement patterns also influence freshwater availability which, in turn, influence them. Even though the countries of the northern subregion have the minimum internal renewable water, they have higher water withdrawals. From figure 4.8, it can be observed that Egypt and the Sudan have the highest total water withdrawal while they are joined by other countries like Libya, Swaziland, and Madagascar as the countries with the highest per capita withdrawal of water (fig. 4.9).

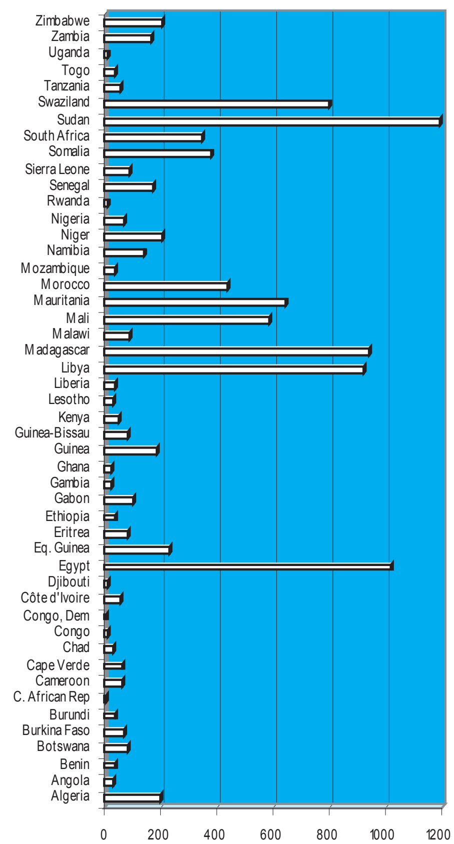
Fig. 4.8: Annual Total Water Withdrawal in African Countries



Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/

Note: Annual Total Water Withdrawals is the gross amount of water extracted from any source, either permanently or temporarily, for a given use. It can be either diverted towards distribution networks or directly used. It includes consumptive use, conveyance losses, and return flow.

Fig. 4.9: Africa Per Capita Water Withdrawal



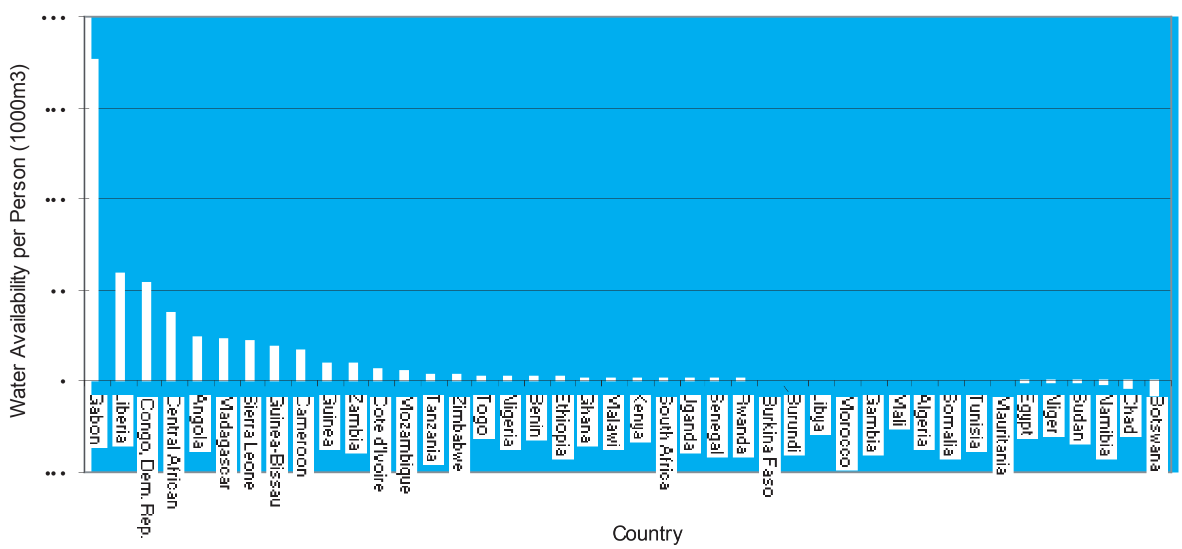
Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/

Note: Per Capita Annual Total Water Withdrawals is the gross amount of water extracted, on a per person basis, from any source, either permanently or temporarily, for a given use. It can be either diverted towards distribution networks or directly used. It includes consumptive use, conveyance losses, and return flow

Annual freshwater withdrawals in East Africa are a small percentage of the total available, ranging from less than 3 per cent of the total resources available in Burundi to 12 per cent in Rwanda (UNEP 2002). For example, in Kenya only 33 per cent of the land area has adequate and dependable water, but this area is home to 70 per cent of the population. The countries of Central Africa have the highest per capita availability of water (fig. 4.10) together with some countries like Liberia, Sierra Leone, Angola, Madagascar and Guinea from other subregions.

In 1998, the annual withdrawal of freshwater for Central Africa was estimated to have been less than 1 per cent of the total available (fig. 4.11). However, the uneven distribution of water resources, with respect to time and population distribution, has created challenges for water supply. The traditional response to this challenge has been to dam rivers and to distribute water to the people, rather than resettling people closer to water resources. Given the relatively high reliability of rainfall in this subregion, irrigation is not always required, and the agricultural sector only consumes 33 per cent of all withdrawals, whereas the domestic sector accounts for more than 50 per cent of all withdrawals (UNEP 2002, Shiklomanov 1999).

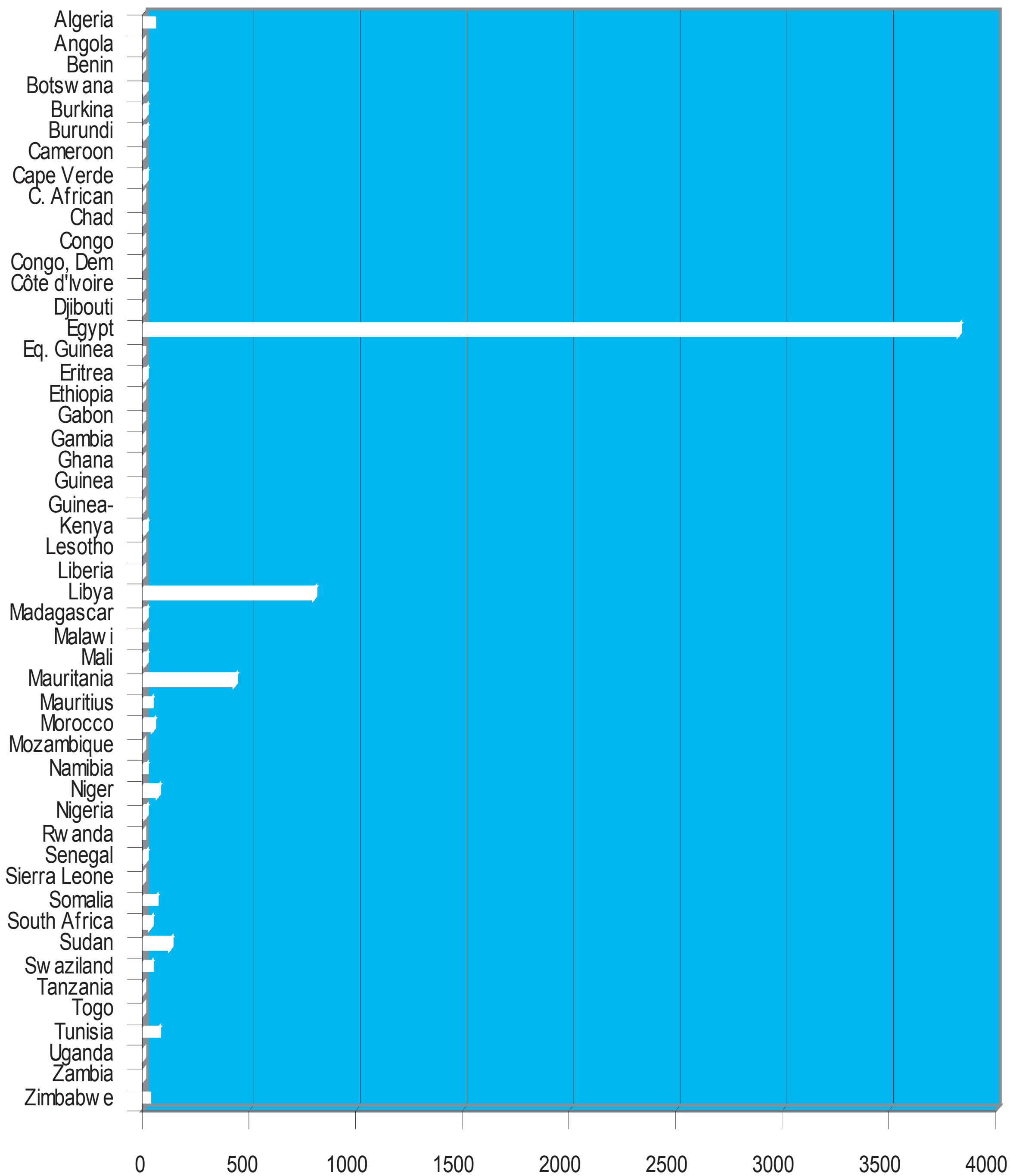
Figure 4. 10: Water Availability Per Capita (1961-1990)



Source: Center for Environmental Systems Research, University of Kassel, WaterGAP 2.1B, 2001 via ciesin.org

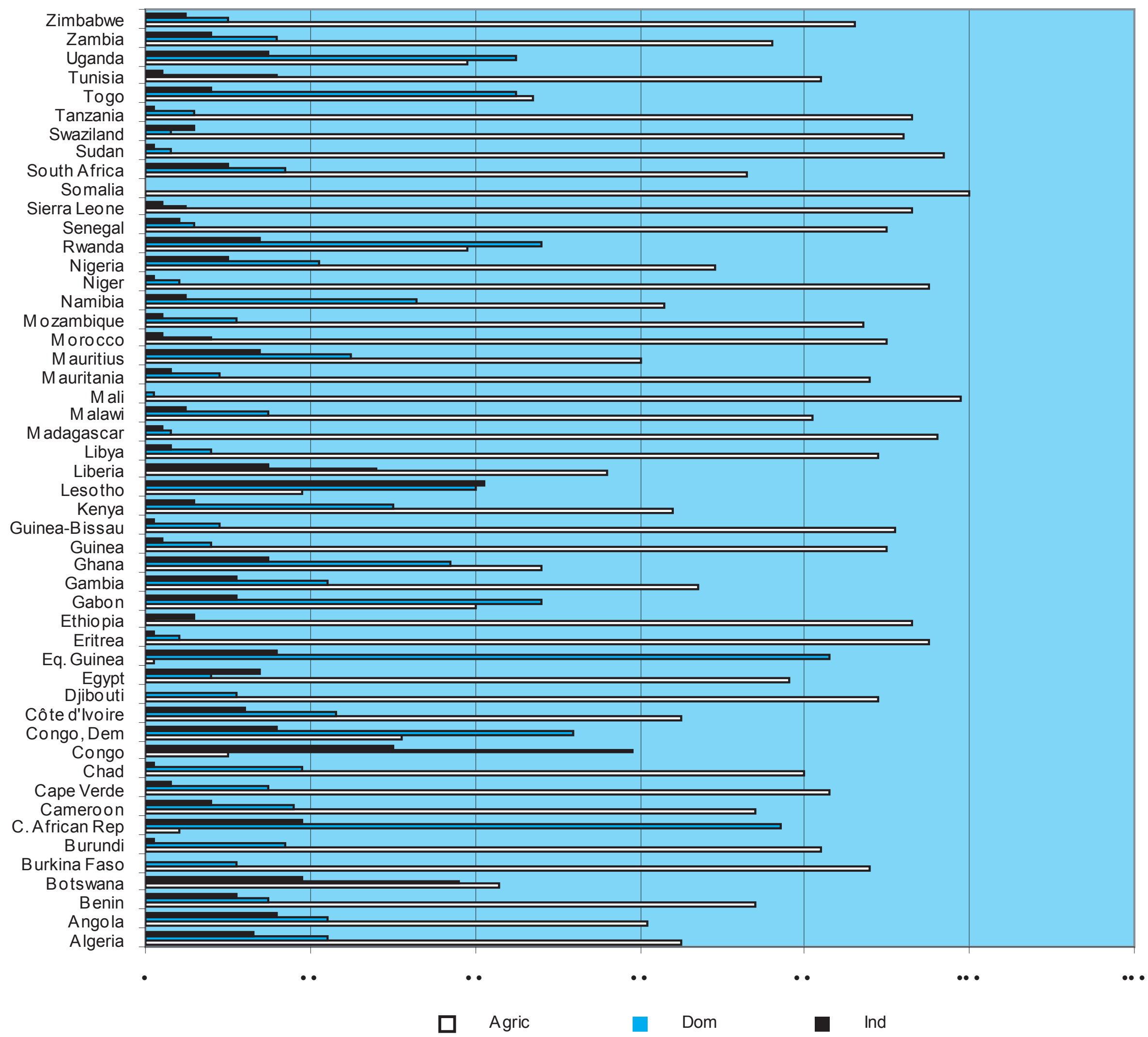
Despite efforts to provide water to municipalities in central Africa, there are significant shortfalls, for example, in Chad, where only 27 per cent of the population has access to improved water sources. Demand for water in West Africa has been steadily increasing in all sectors as a result of population growth, commercial agricultural expansion, and industrial development. Current total withdrawal of water for domestic, industrial and agricultural consumption is 11 km^3/yr, and demand for water from all sectors is expected to increase to some 36 km^3/yr by 2025 (fig.4.12).

Fig. 4.11: Water Withdrawal as Percentage of Internal Water Resources



Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/

Fig. 4.12: Percentage of Domestic, Agricultural and Industrial Water Use in Africa



Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/

Non-Conventional Water Resources

Owing to the limited renewable water resources in the northern subregion, giving rise to what is generally referred to as water resources man0agement in drought prone areas, there is a wide recourse to harnessing non-renewable and non-conventional sources of water.

Non-renewable water resources in the Northern Subregion

Nearly all surface water, e.g. those which flow in rivers, are renewed. On the other hand, a relatively great part of water which infiltrates into the ground reaches depths which make it inaccessible; it is thus protected from evaporation and can be preserved even through geological times. Generally non-renewable water, known also as "fossil water", is made up of very old seepage waters under climatic and morphological conditions, different from current conditions, and thus out of the contemporary water cycle. Groundwater aquifers, which can be qualified as fossils, are not entirely fossils, because there is always a refill; but the speed of flow between the zones of refill (not very wide) and the places of use are very slow (thousands of years). Only advanced methods of analysis, particularly those by marking with tritium, allow distinctions to be made between renewable waters in a scale of

time in one year. The potential and exploitable non-renewable water resources in the northern subregion are given in table 4.14 with respect to the countries of the region. Generally the constraints of management of non-renewable water are as follows:

(a) The extractable quantities of water are quite lower than the calculated reserves.
(b) The depth of pumping is limited technically and economically to 250 m. The fast fall of the piezometric level limits the possibility of their exploitation;
(c) The exhaustion of this resource is likely to pose environmental problems,
(d) The sustainability of the projects, which use this water, is compromised in the long run;
(e) This resource has a strategic role which it is necessary to safeguard for the future generations.

The exploitation of fossil water should thus be made only in the event of great need and after having been surrounded by all the precautions to avoid their negative impacts. Generally located in arid climate areas, where an alternative water resource is missing, fossil water shall be used, for example, only for drinking water, which is not the case for all the countries of the subregion.

Table 4.14: Potential and Exploitable Non-renewable water in the Northern Sub Region

Country	Non-renewable Water Reserves (Mm3)	Exploitable and/or Exploited
Mauritania	50	-
Morocco	8,000 (annual renewable of 240)	640
Algeria	5000 (annual renewable of 800)	1600
Tunisia	1400 (53.7% renewable)	-
Libya	. Shared with Algeria and Tunisia, on one hand, and Egypt,Sudan and Tchad	2000 (projected)
Egypt	20 million	7500
Sudan	562000	-

Extracted from Draft Sub Regional Synthesis of AWDR National Reports, 2005

Non-Conventional Water Resources

Non-conventional water resources include agricultural drainage water, desalination of brackish groundwater and/or seawater, and treated municipal wastewater. In this case also the northern subregion is far ahead of the others. The northern subregion has, between brackish and sea water desalination, a capacity production of about 1,400,000 m3/day (table 4.15). The desalination of water is introduced gradually into the subregion when it is the only possible alternative for the production of fresh water, and when it is justified economically. Its cost, still high, mainly makes it still difficult to reach for the countries of the subregion, mainly the poorest ones, and/or those having low potential in energy resources.

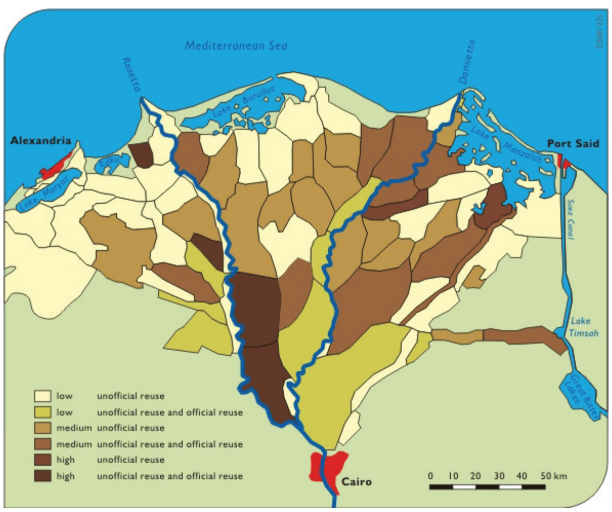
Table 4.15: Desalination capacities by countries in the Northern Subregion

	Mauritania	Morocco	Algeria	Tunisie	Libya	Egypt	Sudan	Total
Production Capacity (m3/j)	0	100	340	70	700	200	15000	1425000
%	0	7	24	5	49	14	1	100

Source: Draft Sub Regional Synthesis of AWDR National Reports, 2005

Box 4.2" Reuse of Agricultural Drainage Water in Egypt

The agricultural drainage of the southern part of Egypt returns directly to the Nile River where it is mixed with the Nile fresh water and reused for different purposes downstream. The total amount of such indirect reuse is estimated to be about 4.07 BCM/year in 1997/98. This drainage flow comes from three sources; tail end discharges and seepage losses from canals; surface runoff from irrigated fields; and deep percolation from irrigated fields (partially required for salt leaching). The first two sources of drainage water are of relatively good quality water. The deep percolation component is more salty and even highly saline, especially in the northern part of the Delta, due to seawater intrusion and upward seepage of groundwater to drains.



The other source of freshwater is the treatment of wastewater, both from domestic and industrial effluents. The reuse of the wastewater after treatment is not yet diffused in the countries of the subregion, in spite of the scarcity of water, and the environmental imperatives, which compel them to have recourse to it. In comparison with the other subregions the northern subregion is again quite ahead (table 4.16).

Table 4.16: Waste Water Re-Use Capacities in Northern Sub region

	Maurita-nia	Mo-rocco	Algeria	Tunisia	Libya	Egypt	Sudan	Total
Treatment Capacity of produc-tion (Mm3)	0	70	(70)	30	100	700	1	971
%	0	7	7	3	10	72	0.1	100

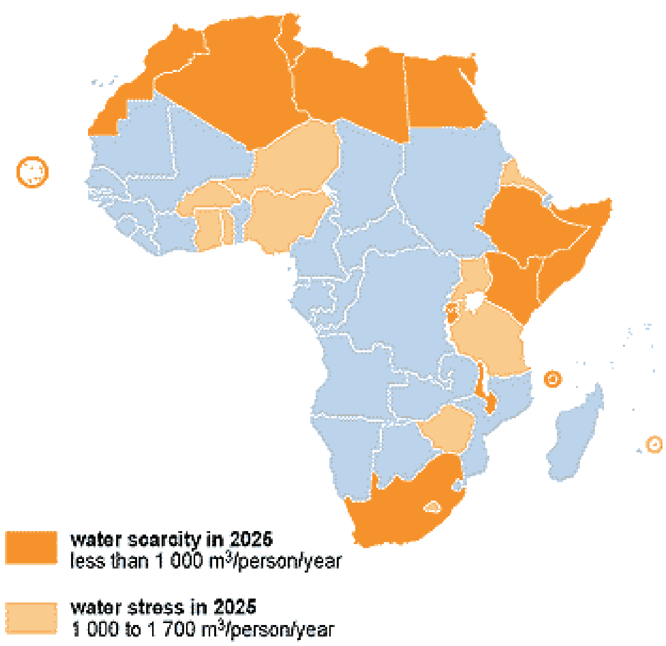
Source: Draft Sub Regional Synthesis of AWDR National Reports, 2005

Freshwater Crisis

While Africa uses only about 4 per cent of its renewable freshwater resources (WRI, UNEP, UNDP and WB, 1998), water is becoming one of the most critical natural resource issues. The continent is one of the two regions in the world facing serious water shortages (Johns Hopkins 1998). Although it has abundant freshwater resources, there are great disparities in water availability and use within and between African countries because the water resources are so unevenly distributed.

For example, the Congo River watershed contains 10 per cent of Africa's population but accounts for about 30 per cent of the continent's annual run-off (GEO-2000). Other contributing factors are the inadequate assessment and underdevelopment of water resources, the lack of technical and institutional infrastructure as well as the lack of investment in water resource development. While the Sahelian countries have limited supplies of freshwater, most countries in the humid tropical zone have abundant water. The availability of water varies considerably, even within countries, and the situation is further complicated by frequent droughts as well as inappropriate water management programmes. The demand for water is increasing rapidly in most countries due to population growth and economic development.

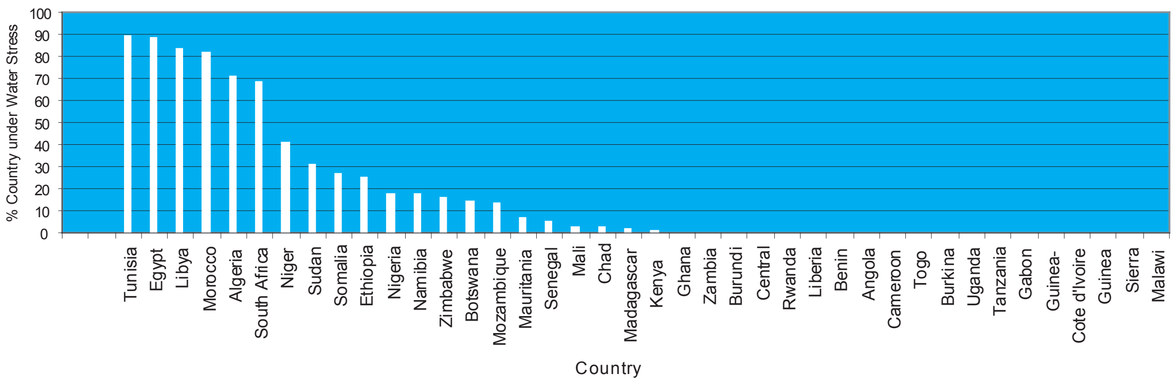
Figure 4.13: Water Stress and Water Scarcity in the year 2025



Source: Johns Hopkins 1998

Although some African countries have high annual averages of available water per capita, many others already or will soon face water stress (1700 m3 or less per person annually) or scarcity conditions (1 000 m3 or less per person annually). Currently, 14 countries in Africa are subject to water stress or water scarcity, with those in northern Africa facing the worst prospects (Figure 4.13, Johns Hopkins 1998). A further 11 countries (see map) will join them in the next 25 years (Johns Hopkins 1998) while Figure 4.14 gives about 20 countries (CESR, 2000).

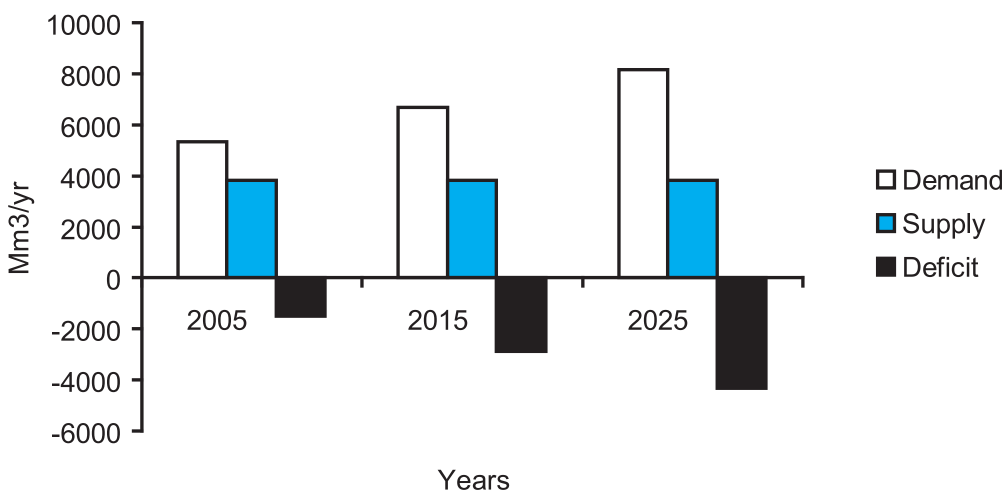
Figure 4.14: Estimated Extreme Water Stress in African Countries (1961-1990 avg.)



Source: Center for Environmental Systems Research, University of Kassel, WaterGap 2.1, 2000 via ciesin.org

Note: These data are derived from the WaterGap 2.1 gridded hydrological model developed by the Center for Environmental Systems Research, University of Kassel, Germany, using grid cell estimates for every country of whether the water consumption exceeds 40 percent of the water available within a grid cell. These were then converted to land area equivalents, and the percentage of the territory under severe water stress was calculated.

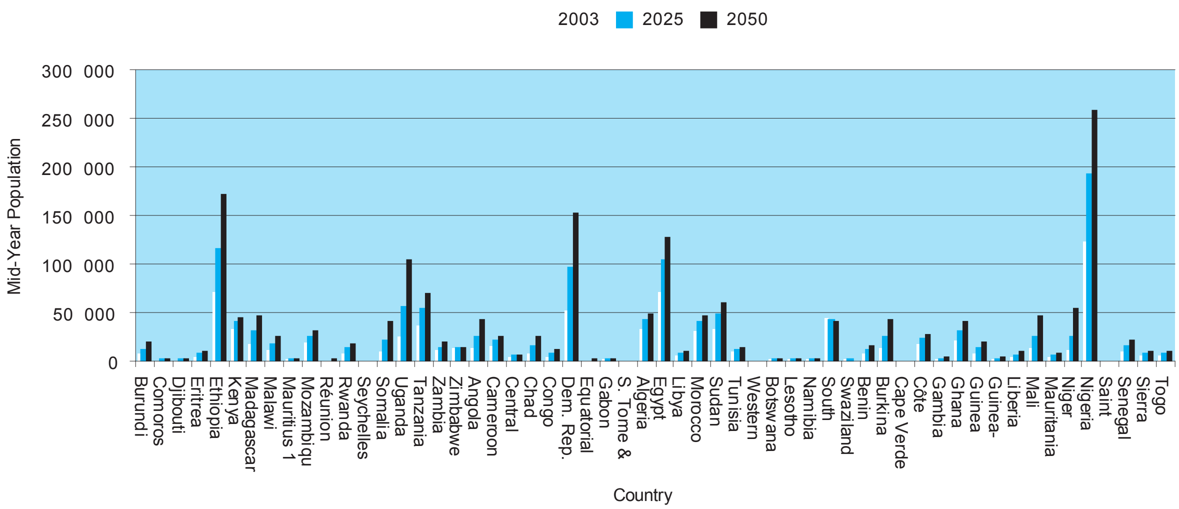
Fig. 15: Expected Projected Water Deficits in Libya



Source: AWDR National Report, 2005

A projected future water deficit scenario in Libya is shown in figure 4.15. According to Sharma *et al.* (1996), eight countries were suffering from water stress or scarcity in 1990; this situation is getting worse as a consequence of rapid population growth, expanding urbanization, and increased economic development. Moreover, by 2025, the number of countries experiencing water stress will rise to 18, affecting 600 million people. Many countries will shift from water surplus to 2020, a rate about equal to the region's population growth rate. It has been estimated that by 2025 up to 16 per cent of Africa's population (230 million people) will be living in countries facing water scarcity, and 32 per cent (another 460 million) in water-stressed countries (Johns Hopkins, 1998). Africa's share of water on a per capita basis is estimated to have declined by as much as 50 per cent since 1950.

Figure 4.16: Projected Mid-Year Population of African Countries



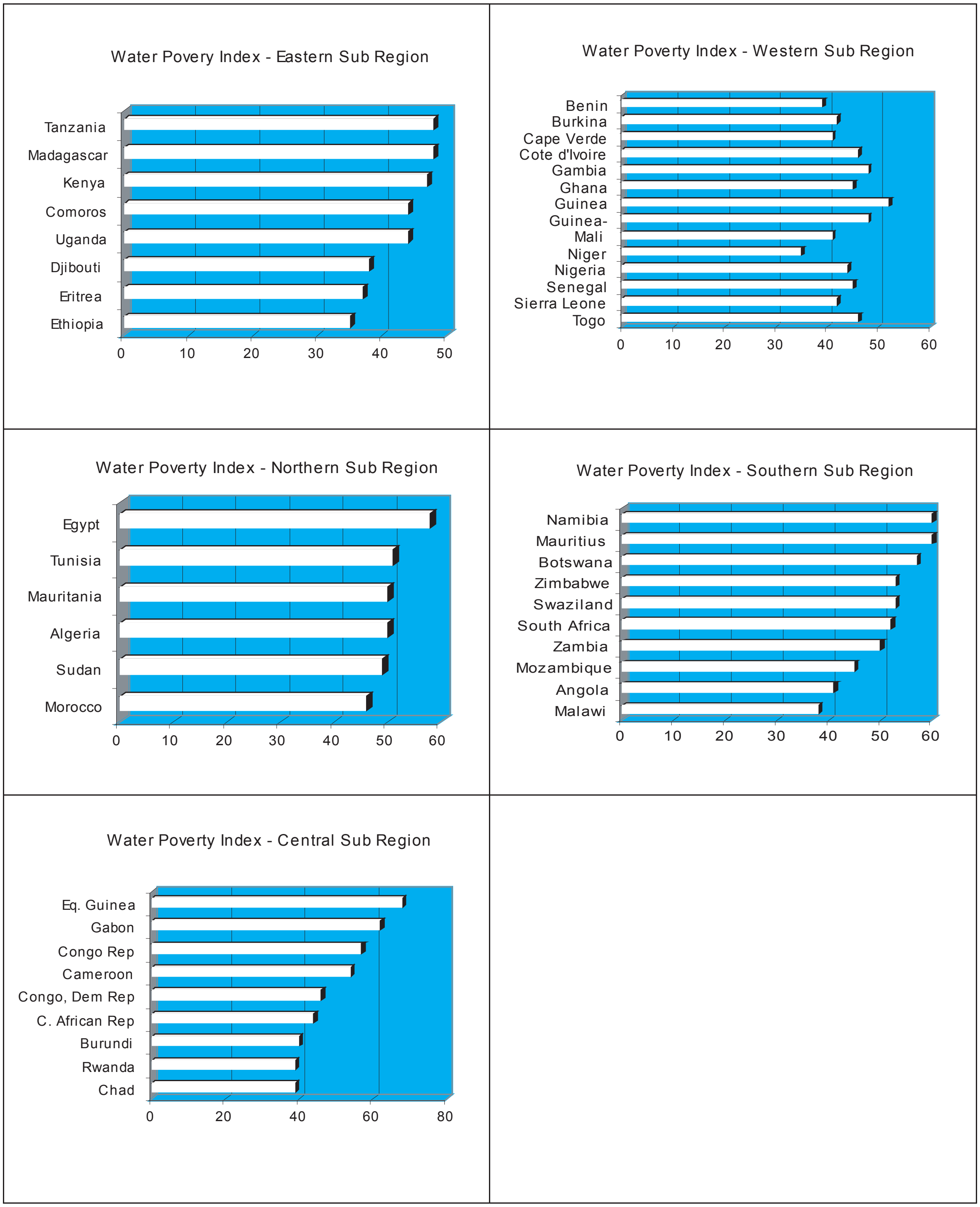
Source: World Population Prospects: The 2002 Revision. New York: United Nations Secretariat, 2003.

water scarcity as a result of population changes alone, between 1990 and 2025 (fig. 4.16), using a per capita water-scarcity limit of 1,000 m3 yr-1. Long-term precipitation records from the Sahara give a clear indication of declining precipitation in that region (GEO 2000, 1999).

In the Southern African Development Community (SADC), water demand is projected to rise by at least 3 per cent annually until the year

Even though the use of the Water Poverty Index for assessing the level of water resources development and management, has not met universal consensus, the country values within subregions are hereby indicatively shown in figure 4.17.

Fig. 4.17: Water Poverty Index by Subregion in Africa



Source: World Resources Institute Website Natural Environment Research Council, Centre for Ecology and Hydrology. 2002, Wallingford.

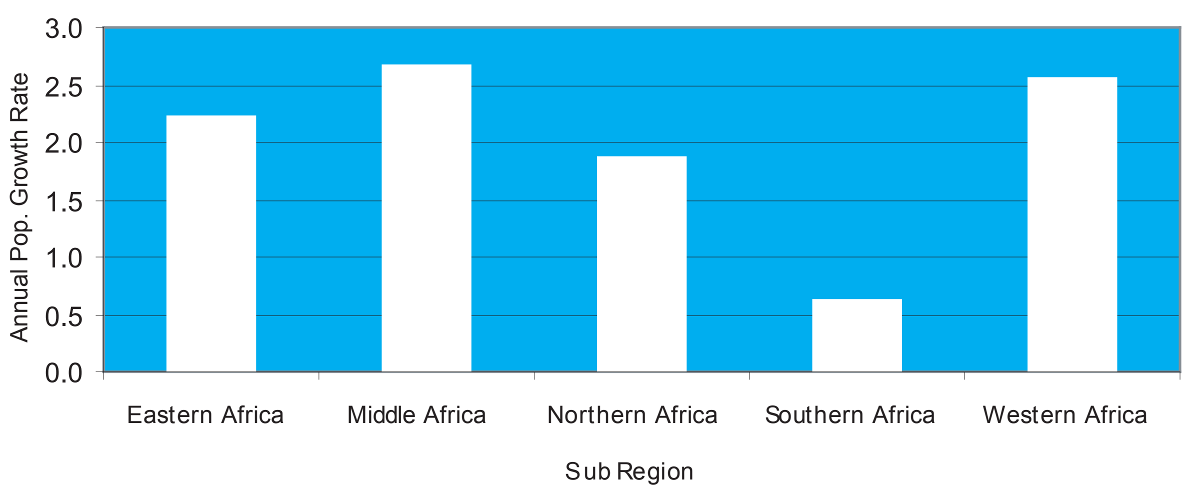
What impact are we having on our freshwater resources?

In addition to overuse, pollution of available water resources can add to the burden and costs of supplying water to urban areas. Human impacts on freshwater resources in Africa are mainly derived from the following:

(a) Population growth incompatible with economic growth;
(b) Fast growing urban cities;
(c) Human and animal faecal disposal onto the environment;
(d) Waste water and storm water run-off disposal; and
(e) Urban waste refuse disposal.
(f) Fertiliser use in agriculture (R. Meissner, 2002)

Even though the African continent is the least populated in the world, there has been a great deal of dicussion on the so-called "African population explosion", in the past three decades. It all depends on how this pernicious argument is tackled, either from the neo-Malthusian point of view or from the newly emerging social view. The neo-Malthusian argument concerning demography was challenged for the first time in an official setting at the 1974 Bucharest World Conference on Population under the auspices of the United Nations Population Fund (UNFPA), according to which the population explosion has led to an unhealthy environment across the entire globe. On the other hand, the central argument of the social view is that rapid population growth is a symptom of social and economic predicaments and not the cause thereof. In other words, people are not necessarily poor because they have many children and a large family to support, but they have many children because they are poor (R. Meissner, 2002). Traditionally, children are a source of social security, therefore leading to high fertility rates and to also compensate for high child mortality rates. Moreover, African children are seen as a useful source of domestic labour, helping with household responsibilities, such as fetching water and gathering wood for fuel. It is the greater access to social security services, such as water supply, health care and education that allow people, especially women, to have fewer children and not the material poverty per se. It is therefore hoped that the observed reducing trend of population growth in Africa will be sustained in the long-term (Figs. 4.18 and 4.19).

Figure 4.18: Projected Annual Population Growth Rate by Subregion in Africa (2003-2050)



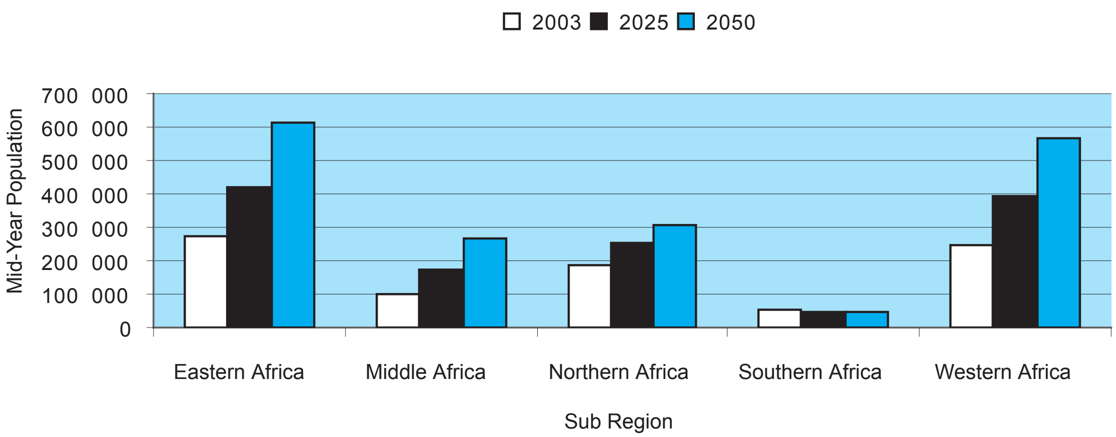
Source: World Population Prospects: The 2002 Revision. New York: UN Secretariat, 2003

The problem of wastewater disposal is as important as that of water supply in many urban areas. The discarding of wastewater and other refuse from large urban centres in both developed and developing states has a negative impact on a wider range of ecosystems. Aquatic ecosystems, from where urban areas obtain their water, either directly or indirectly, have severe impacts on the supply of water to urban populations.

the increasing use of fertilisers in African countries in the period 1999-2001.

These areas sometimes also have the lowest gross national product (GNP), which is a limiting factor on capital needed for wastewater treatment. Wastewater can be handled in a number of ways: Treatment measures from developed States can be applied by developing countries. It can also be recycled for reuse in urban areas, as is the

Figure 4.19: Dynamics of African Population Growth by Subregion

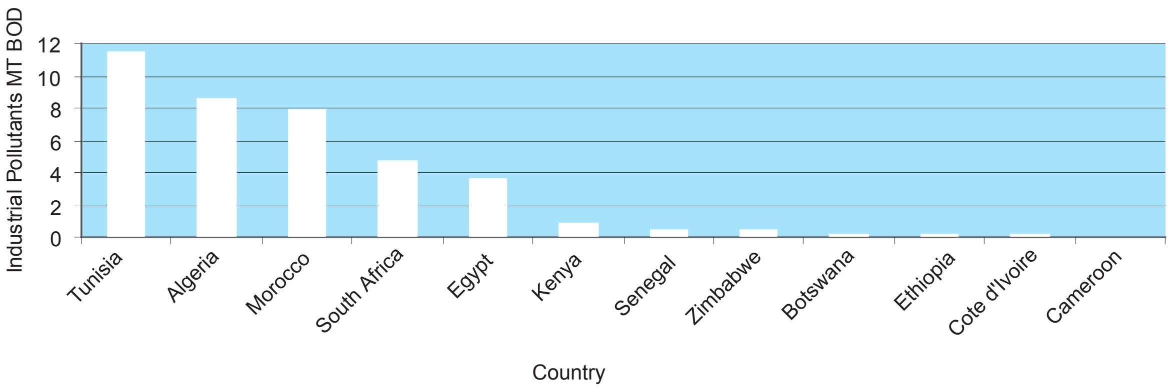


Source: World Population Prospects: The 2002 Revision. New York: UN Secretariat, 2003

Not only do they raise the cost of purification, but waterborne diseases may also threaten the health of those who live near water sources in urban areas. These people usually live in shantytowns in large cities in developing States, and quite close to rivers and streams from which they draw their daily water. It is not uncommon to hear about a cholera outbreak on the periphery of cities in developing states, where most of these townships are located. This occurred in 2001, in Alexandra, a township near the Johannesburg City Center (R. Meissner, 2002). Wastewater creates the greatest problem where the population of an urban area grows most rapidly, particularly in the developing world. One of the sources of pollution is the washing of fertiliser residues from agricultural production into water bodies. Figure 4.20 shows

case in Windhoek, the capital city of Namibia, which has been recycling wastewater for urban use since the mid-1960s. Wastewater can also be partially treated and used in the agricultural (Israel) and industrial sectors (ibid). The interrelationship between population growth and global and regional water resources is of such a nature that demography does not only affect the quantity of water but also on its quality. The more people there are the less the water available per person. There might even be less freshwater in future if policies and initiatives are not proposed and implemented to address the matter of pollution within the context of global and regional water resources even though the present levels of chemical pollution are still low (fig.4.20).

Figure 4.20: Industrial Organic Pollutants Per Available Freshwater



Source: World Bank, World Development Indicators 2001, Washington, DC: World Bank, 2001 (for BOD *emissions)and Center for Environmental Systems Research, University of Kassel, Water Gap 2.1, 2000 (for data on water quantity)*

Figure 4.23: Renewable Water Resources by Country in Africa (all figures in km^3/yr.)

		Internal Renewable Water Resources				Incoming Water from Other Countries			Total Renewable Water Resources.			Water Other Resources	
	COUNTRY	Surface Water	Ground Water	Overlap	Total	Surface water		Ground Water	Surface Water	Ground Water	Total	Desalination	Ground Water Depletion
			C.		(1+2-3)	T	B		(1+5+6)	(2+7)	(8+9-3)		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	ALGERIA	13.2	1.7 a	1	13.9	0.4	0	0.03	13.6	1.73	14.33	0.03	5
2	ANGOLA	182	72 b	70	184	0	0	0	182	72	184	x	0
3	BENIN	10	1.8 a	1.5	10.3	0.5	15	0	25.5	1.8	25.8	0	0
4	BOTSWANA	1.7	1.7 a	0.5	2.9	11.5	0.3	0	13.5	1.7	14.7	0	0
5	BURKINA FASO	13	9.5 a	5	17.5	...	x	0	x+13	9.5	x+17.5	0	0
6	BURUNDI	3.5	2.1 b	2	3.6	x	0	0	x+3.5	2.1	x+3.6	0	0
7	CAMEROON	268	100 b	100	268	...	0	0	268	100	268	0	0
8	CAPE VERDE	0.18	0.12 a	0	0.3	0	0	0	0.18	0.12	0.3	x	0
9	CENT. AFRICAN REP.	141	56 b	56	141	0	x	0	x+141	56	x+141	0	0
10	CHAD	13.5	11.5 b	10	15	28	0	0	41.5	11.5	43	0	0
11	COMOROS	x	x	x	1.05	0	0	0	x	x	1.02	0	0
12	CONGO	222	198 b	198	222	...	610	0	832	198	832	...	0
13	COTE D'IVOIRE	74	37.7 a	35	76.7	1	x	0	x+75	37.7	x+77.7	0	0
14	DJIBOUTI	x	x	x	0.3	0	2	x	x+2	x	x+2.3	0	0
15	EGYPT	0.5	1.3 a	0	1.8	65.5	0	1.2	66	2.5	68.5	0.01	...
16	EQUATORIAL GUINEA	25	10 b	5	30	...	0	0	25	10	30	0	0
17	ERITREA	x	x	x	2.8	0	6	0	x	x	8.8	0	0
18	ETHIOPIA	x	x	x	110	0	0	0	x	x	110	0	0
19	GABON	162	62 b	60	164	0	0	0	162	62	164	0	0
20	GAMBIA	3	0.5 b	0.5	3	5	0	0	8	0.5	8	0	0
21	GHANA	29	26.3 a	25	30.3	22.9	0	0	51.9	26.3	53.2	0	0
22	GUINEA	226	38 b	38	226	0	0	0	226	38	226	0	0
23	GUINEA-BISSAU	12	14 b	10	16	11	0	0	23	14	27	0	0
24	KENYA	17.2	3 a	0	20.2	...	10	0	27.2	3	30.2	0	0
25	LESOTHO	4.73	0.5 b	0	5.23	0	0	0	4.73	0.5	5.23	0	0
26	LIBERIA	200	60. b	60	200	32	0	0	223	60.	232	0	0
27	LIBYA	0.1	0.5 a	0	0.6	0	0	0	0.1	0.5	0.6	.003	2 to 4
28	MADAGASCAR	330	55. b	50	337	0	0	0	332	55	337	0	0
29	MALAWI	16.14	1.4 b	0	17.54	1.14	0	0	17.28	1.4	18.68	0	0
30	MALI	50	20 a	10	60	40	0	0	90	20	100	0	0
31	MAURITANIA	0.1	0.3 a	0	0.4	0	11	0	11.1	0.3	11.4	x	0
32	MAURITIUS	2.03	0.68 a	0.5	2.21	0	0	0	2.03	0.68	2.21	0	0
33	MOROCCO	22.5	7.5 a	0	30	0	0	0	22.5	7.5	30	.004	0
34	MOZAMBIQUE	97	17 b	17	97	106	5	0	208	17	208	0	0
35	NAMIBIA	4.1	2.1 b	0	6.2	11.3	28	0	43.4	2.1	45.5	.003	0
36	NIGER	1	2.5 a	0	3.5	29	0	0	30	2.5	32.5	0	0
37	NIGERIA	216	87. b	80	221	59	x	0	x+273	87	x+280	0	0
38	RWANDA	5.2	3.6 b	2.5	6.3	0	x	0	x+5.2	3.6	x+6.3	0	0

	COUNTRY	Internal Renewable Water Resources				Incoming Water from Other Countries			Total Renewable Water Resources.			Water Other Resources	
		Surface Water	Ground Water	Overlap	Total	Surface water		Ground Water	Surface Water	Ground Water	Total	Desalination	Ground Water Depletion
			C.		(1+2-3)	T	B		(1+5+6)	(2+7)	(8+9-3)		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
39	SAO TOME & PRINCIPE	x	X	x	2.18	0	0	0	x	x	2.18	0	0
40	SENEGAL	23.8	7.6 b	5	26.4	2	11	0	36.8	7.6	39.4	0	0
41	SEYCHELLES	x	X	x	x	0	0	0	x	x	x	0	0
42	SIERRA LEONE	150	50 b	40	160	0	0	0	150	50	160	0	0
43	SOMALIA	5.7	3. b	3	6	7.5	0	x	13.2	x+3.3	x+13.5	0	0
44	SOUTH AFRICA	40	4.8	0	44.8	5.2	0	0	45.2	4.4	50	x	0
45	SUDAN	28	7	0	35	119	0	0	147	7	154	0	0
46	SWAZILAND	x	x	x	2.64	1.87	0	0	x+1.87	x	x+4.51	0	0
47	TANZANIA	80	30 b	30	80	0	9	0	89	30	89	0	0
48	TOGO	10.8	5.7 a	5	11.5	0.5	0	0	11.3	5.7	12	0	0
49	TUNISIA	2.31	1.21 a	0	3.52	0.32	0	0.1	2.63	1.31	3.94	.009	1
50	UGANDA	35	29 b	25	39	27	0	0	62	29	16	0	0
51	ZAIRE	934	421 b	420	935	84	x	0	x+1018	421	x+1019	0	0
52	ZAMBIA	33.1	47.1	0	80.2	35.8	x	0	x+68.9	47.1	x+116	0	0
53	ZIMBABWE	13.1	5b	4	14.1	0	x+5.9	0	x+19	5	x+20	0	0
	TOTAL	3721	1517	1370	3988								

C: Method of computing ground water: a = recharge of the aquifers, b= baseflow of river system;

Source: ECA, 2000

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WATER FOR MEETING BASIC NEEDS

> Achieving the World Summit on Sustainable Development (WSSD) targets on water supply and sanitation is not simply a question of providing "taps and toilets", but also ensuring the sustainable management of the resources that provide the water and the appropriate treatment of used water before re-entering the water cycle. The water supply and sanitation "cycle" frequently undergoes many repetitions before water finally reaches the marine environment. The issue also has direct implications for public and ecosystem health – *United Nations Environment Programme (UNEP)*

Generally, it is estimated that to ensure the basic water needs of humans, 20 to 50 litres of water free from harmful contaminants are needed every day. A child in the developed world consumes 30 to 50 times as much water as one in the developing world. Africa is endowed with immense renewable natural resources, including a surface area of more than 21 million sq. km. of water and land resources, which are critical for the continent's economic and social development (World Bank, 1989). The crucial role of water in meeting Africa's socio-economic development goals is widely recognized, especially as the continent faces a crisis of endemic poverty and pervasive underdevelopment.

Even though water is intimately linked with African cultures, religions and societies in myriad ways, modern African societies have not sufficiently developed the adaptive capacities to fully provide the basic water needs for households and other vital services. These needs include sufficient water to maintain a basic standard of personal and domestic hygiene and health. Meeting basic needs does not only entail having access to water in adequate quantities but also the water being of adequate quality to maintain health by being free of harmful biological and chemical contamination. In most African countries, especially in the rural areas, providing for daily water needs is a burden on households with inadequate supply in a number of ways. In addition to the direct health threats arising from shortages, water sources and the methods of supply, water has to be carried from long distances, which takes time and effort, a burden borne mainly by women and children. In urban and peri-urban areas water is often only available from vendors at a price that is usually several times higher than that for water provided through formal services, and could be of poor quality. Generally, the very low level of water resources development in most African countries is attributed to poor economic performance and increasing population growth incommensurate with economic expansion and growth.

Socioeconomic Constraints

For many African countries, economic performance in the immediate post-colonial era was good. However, since the oil crisis of the mid-1970s, economic performance has been poor and worsening, particularly for sub-Saharan Africa (Mkandawire, T. and C.C. Soludo, 1999). Performance was particularly dismal in the 1980s. From 1980 to 1994, average GDP growth rates were lower than population growth rates. More recent data show, however, that the period 1996-1998 experienced a slight economic recovery with an average growth rate of about 3.3 per cent as compared to 2.9 per cent in 1997 and 4.0 per cent in 1996. For the first time in the past two decades, the average GDP growth rates exceeded population growth rates. In 2000, the African population was estimated at 794 million which, and if compared to that of 1995, represents an annual growth of 2.4 per cent during the five-year period. From the 1960s through to the 1980s, Africa's population grew at an average rate of more than 3 per cent but went into a downward trend from the 1990s. During the period 1975-1980, countries like Djibouti and Somalia had growth rate higher than 8 per cent (fig. 5.1). Erratic population fluctuations in countries like Rwanda are due to civil strife.

Figure 5.1: Africa's Population Growth

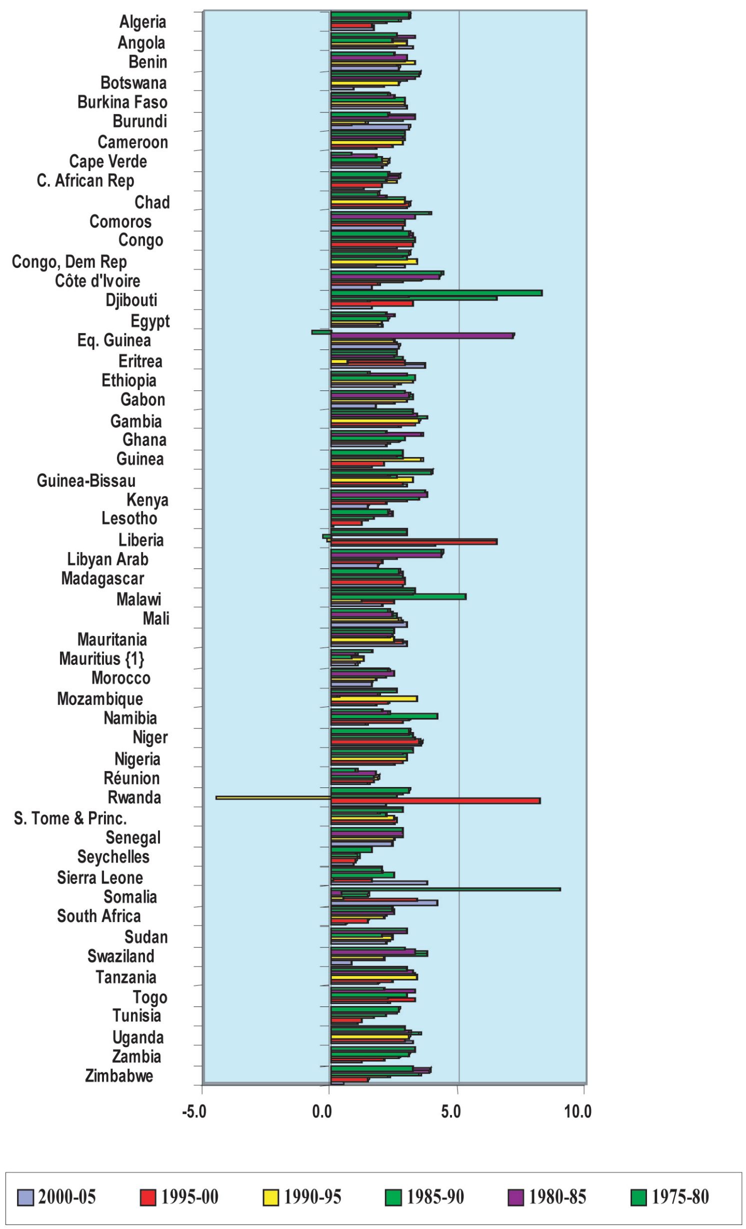
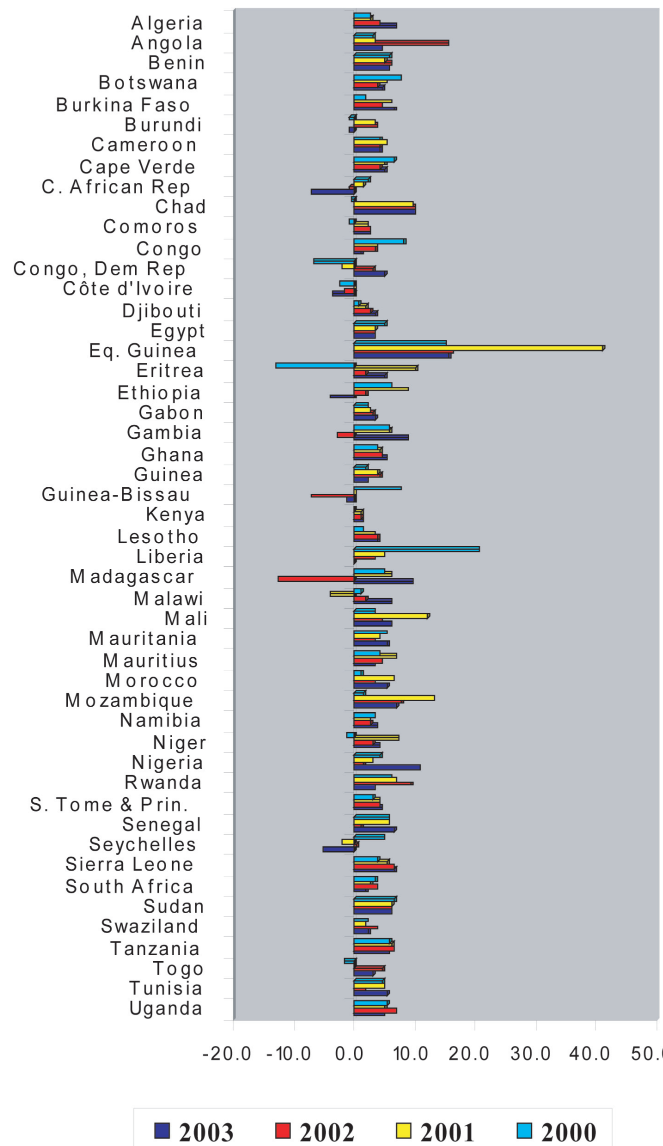


Figure 5.2: Annual GDP Growth Rate 2000-2003



The population of Zimbabwe, for example, grew from 10.4 million in 1992 to 11.6 million in 2002, with a density of 30 persons/km^2. This represents an average annual intercensal growth rate of 1.1 per cent from 1992 to 2002. The increase in population was accompanied by an increase in the number of households from 2.16 million in 1992 to 2.65 million in 2002. This rapid increase in the country's population and households also means that the demand for water increases. (National AWDR Report, 2005).

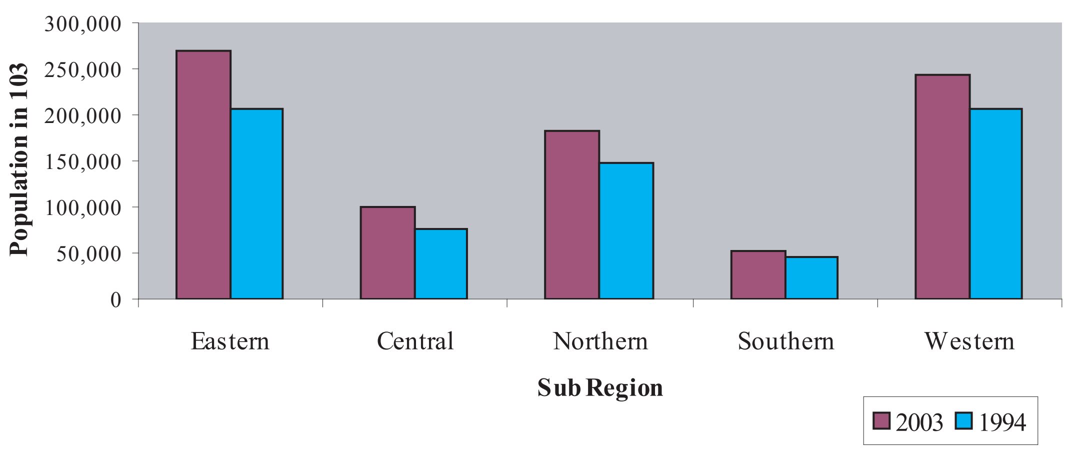
During the period 2000-2003, the economic performance of most African countries was steady and good leading to a positive GDP growth (Fig.5.2), except for some countries like Eritrea (2000), the Democratic Republic of the Congo (DRC) Guinea-Bissau (2002), Madagascar (2002) and Seychelles (2001-2003). With respect to subregions, the Eastern and Western subregions had the highest population growth rates during the period 1994-2003 (fig. 5.3).

Box 5.1
Population and economy of Cameroon

The NIS (2001) estimated the population of Cameroon in the year 2000 to be about 15,292,000 with an annual growth rate of 2.87%. The population is essentially youthful with about 64% of the population under the age of 25 years. One out of two people live in urban areas with the urban population increasing at an average rate of about 4.7% per year. About 35% of the urban population lives in the two biggest towns of Douala and Yaounde. The population density is estimated at 33 inhabitants/km^2 nationally with the highest value of 127 inhabitants/km^2 recorded in the West Province.

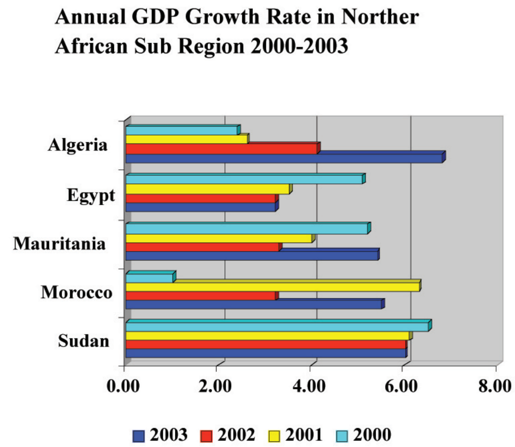
BEAC (2002) estimated the GDP of Cameroon to be 7,076 billion FCFA or 462 700 FCFA per capita with an annual growth rate of about 5% and an inflation rate of 2.8 % a year. The growth rate in the GDP has been at this level during the last six years (NIS, 2001). The primary sector contributes about 24% of the GDP, the secondary sector about 27% and the tertiary sector about 28%, while about 22% comes from non-merchant services and taxes.

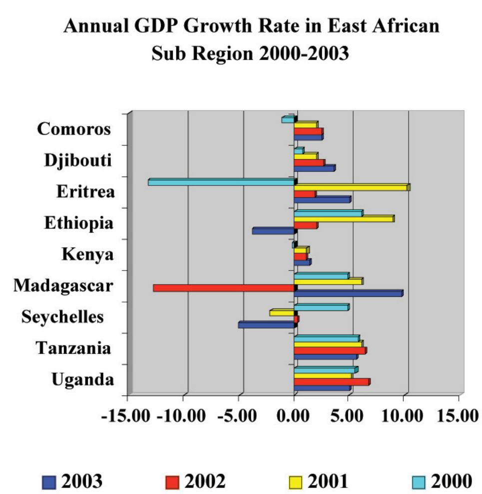
Figure 5.3: Africa's Population Growth 1994/2003 by Subregion



Source: UNDP, 2003b

Fig. 5.4: Annual GDP Growth Rate by Subregion





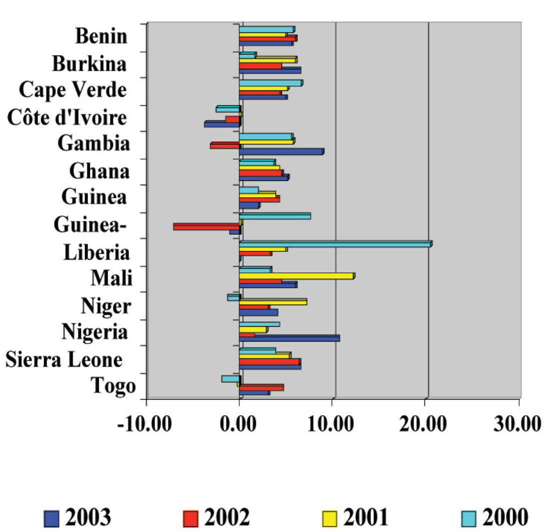
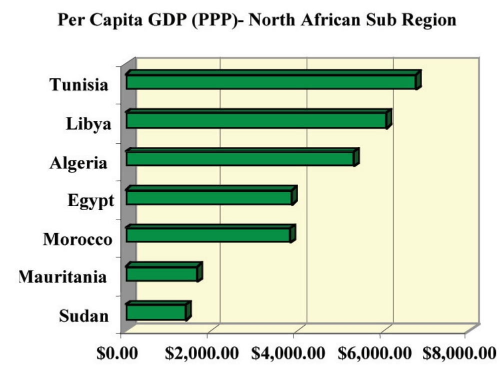
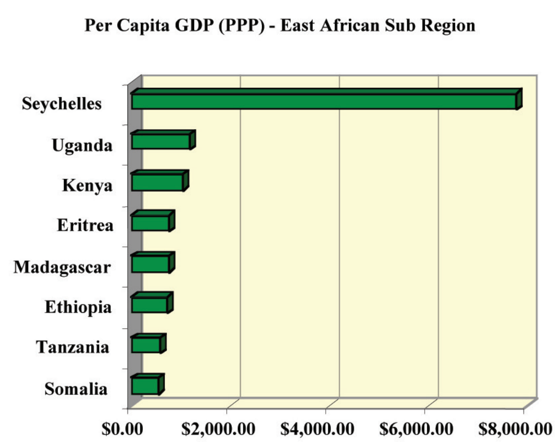
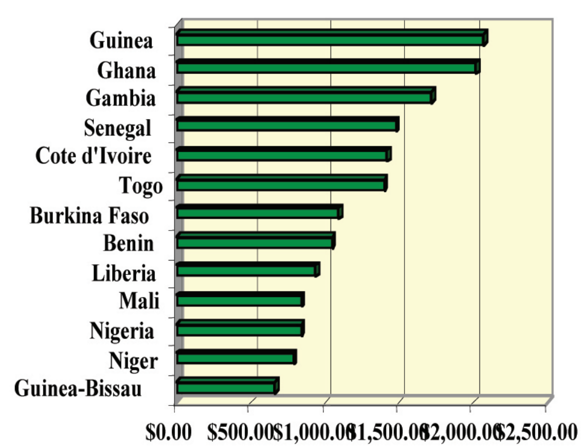
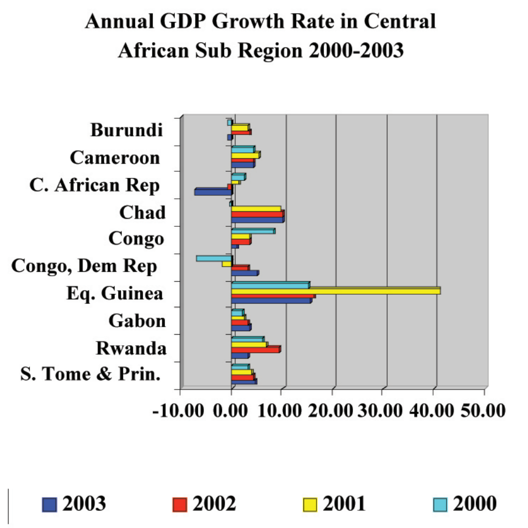


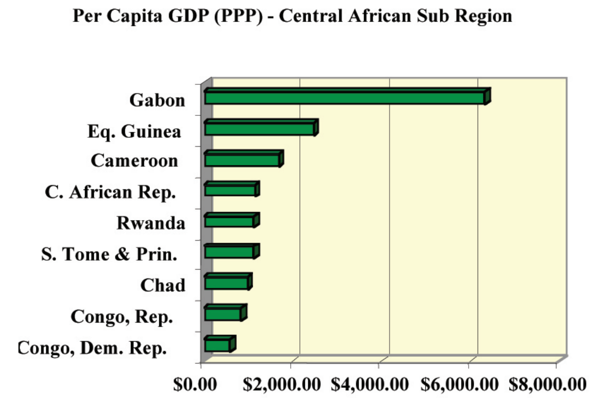
Fig. 5.5: Per Capita GDP (PPP) by Subregion

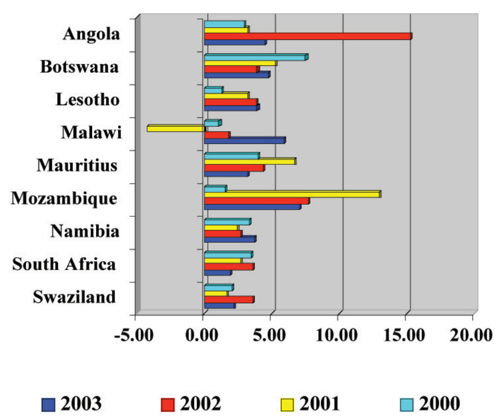


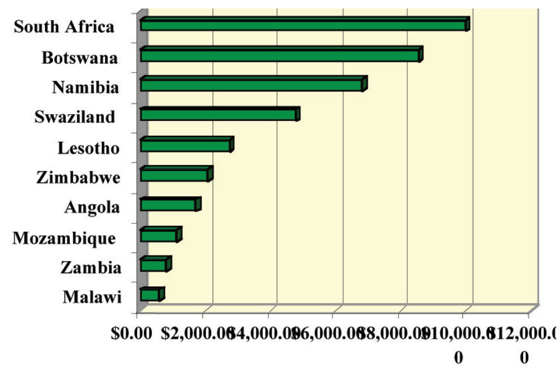




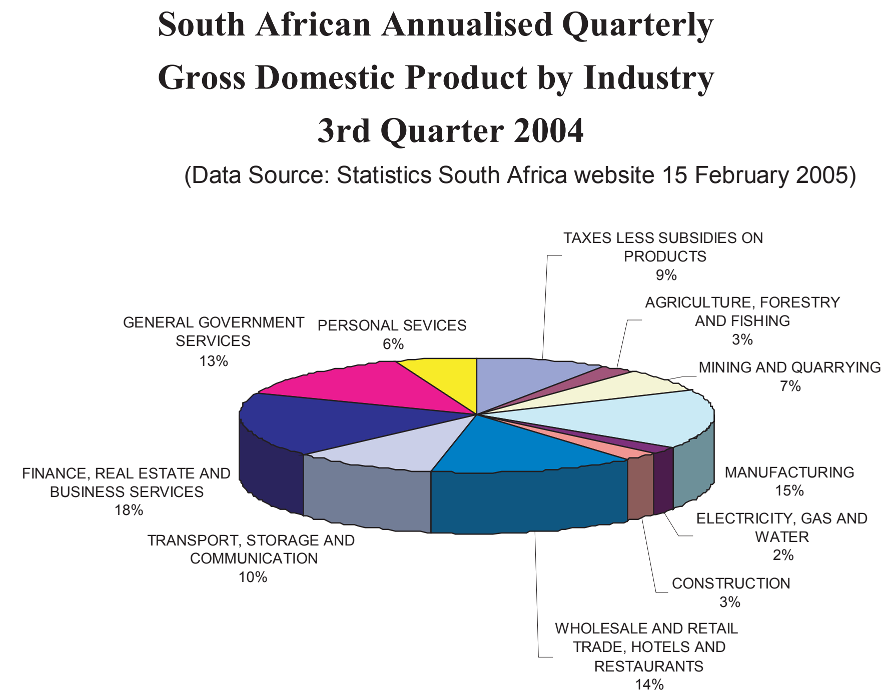








In recent decades, Africa has been the world's worst performing region in terms of poverty reduction (Ravallion and Chen, 2000). From 1987 to 1998 poverty incidence remained at 46 per cent, while the number of poor people increased from 217 million to 290 million. Per capita income in sub-Saharan Africa (SSA) fell by 20 per cent from the peak period of 1974 to the bottom period of 1994 (World Bank, 2002). The 1990s saw some recovery in the form of improved macroeconomic management, growth and poverty reduction in selected countries in sub-Saharan Africa (Christiaensen, Demery, and Paternostro, 2002), and there was a modest 4 per cent increase in per capita income from 1994 to 2000. The question that however remains is whether African economies can achieve the goals of poverty reduction and improvements in human development set out in the Poverty Reduction Strategy Papers (PRSPs) and the MDGs. Distribution of the annual Gross Domestic Product among various sectors of the national economy is illustrated in figure 5.6

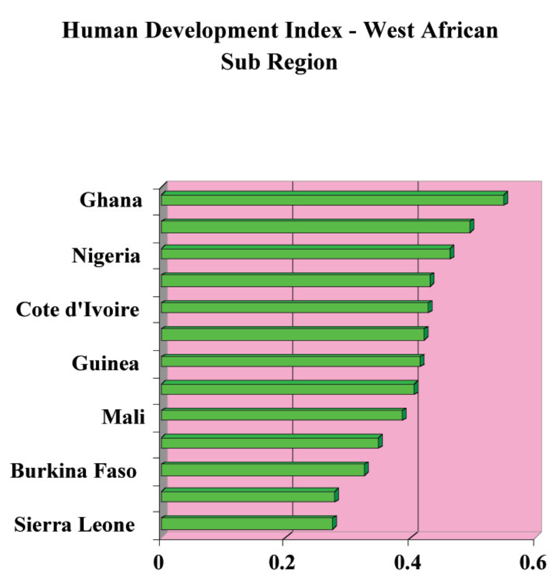


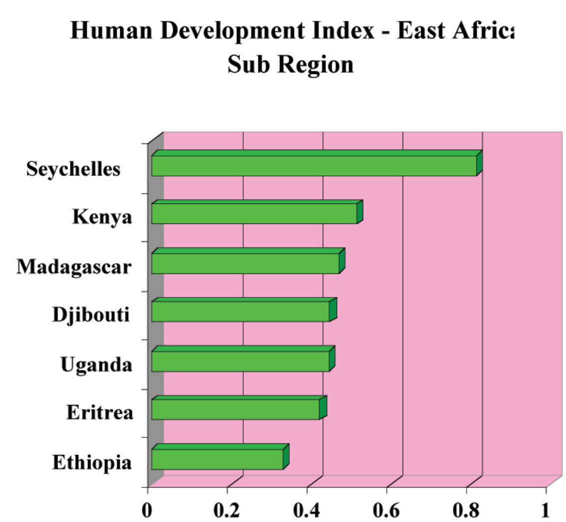
Source. AWDR National Report, 2005

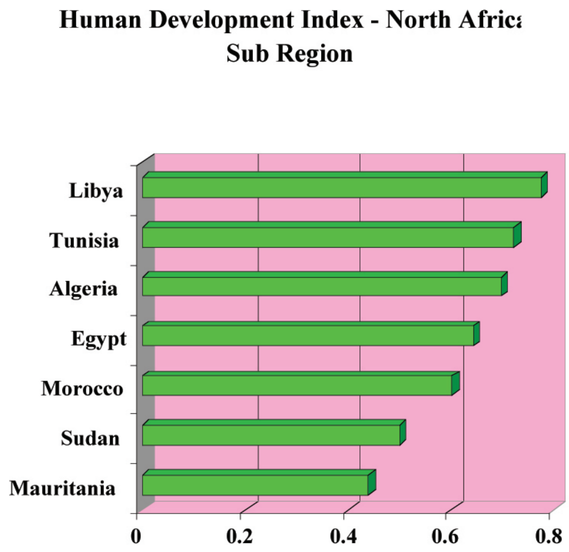
Human Development Index

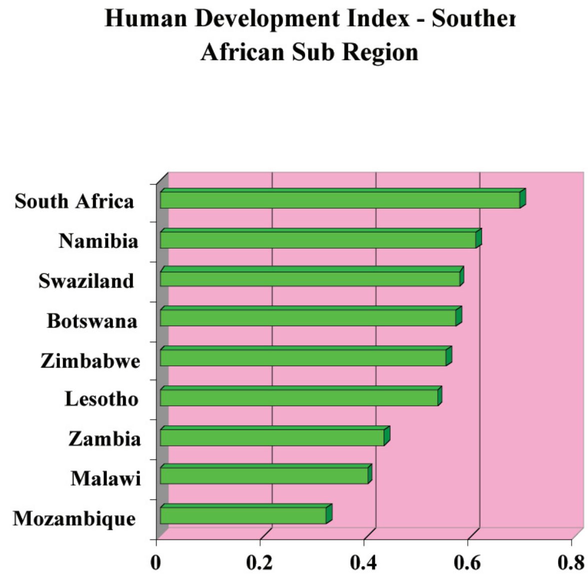
In spite of these encouraging figures, little progress was made in improving the people's average living standard. According to the 2002 Human Development Report of UNDP, about 80 per cent of the low-human-development countries - with high population growth rates, low income, low literacy levels and low life expectancy - are in Africa (fig. 5.7).

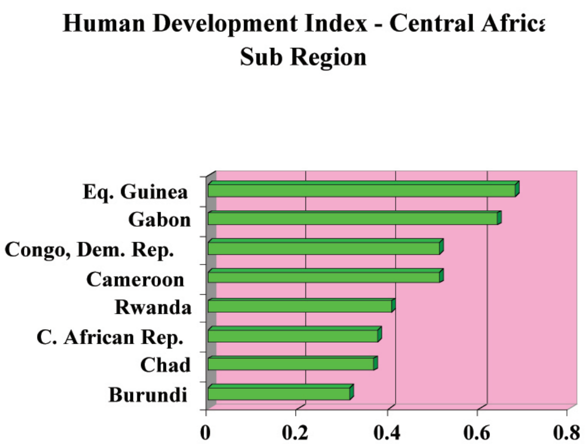
Fig. 5.7: Human Development Index - 2002 by Subregion









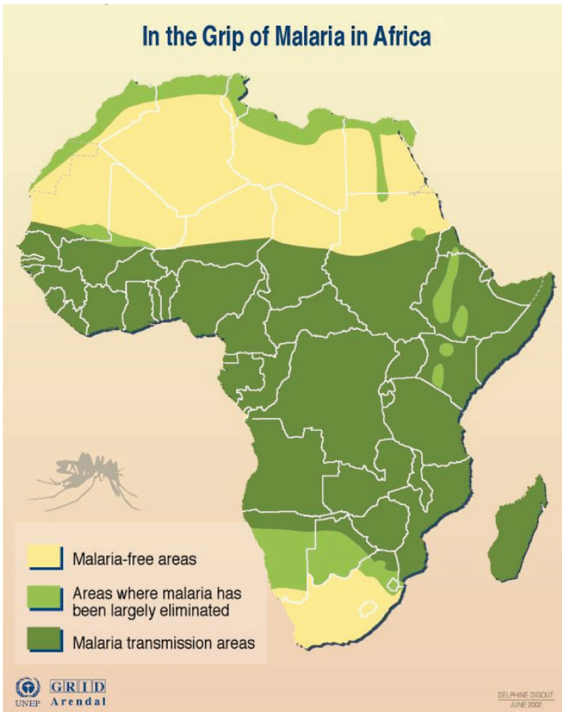


Forty per cent of the people still live at or below the line of absolute poverty and the gap between the rich and the poor keeps on widening. According to the UNDP Human Development Index (HDI), computed for the year 2002, 21 African countries surveyed were in the medium human development range, with the rest in the low range.

Water and Health Two Interlinked Precious Resources, *Water for Health, World Water Day, 2001, WHO*

Vector-borne diseases, affecting a total of more than 700 million people a year, are considered the most sensitive to climatic and environmental conditions. Malaria, the best-known vector-borne disease, has been declared 'public enemy number one' by the World Health Organization (WHO) and affects more than 500 million people in 90 countries, causing 1.5-2.7 million deaths a year (WHO 1997a). The spatial distribution of malaria across the continent of Africa is shown in figure 5.8. Water-related infections are caused by direct water contamination by dangerous pathogens or through vector-borne diseases.

Figure 5.8: Distribution of Malaria Infection in Africa



Sources: A. Platt McGinn, *Malaria, Mosquitoes, and DDT*, World Watch, Vol.15. No.3, May-June 2002.

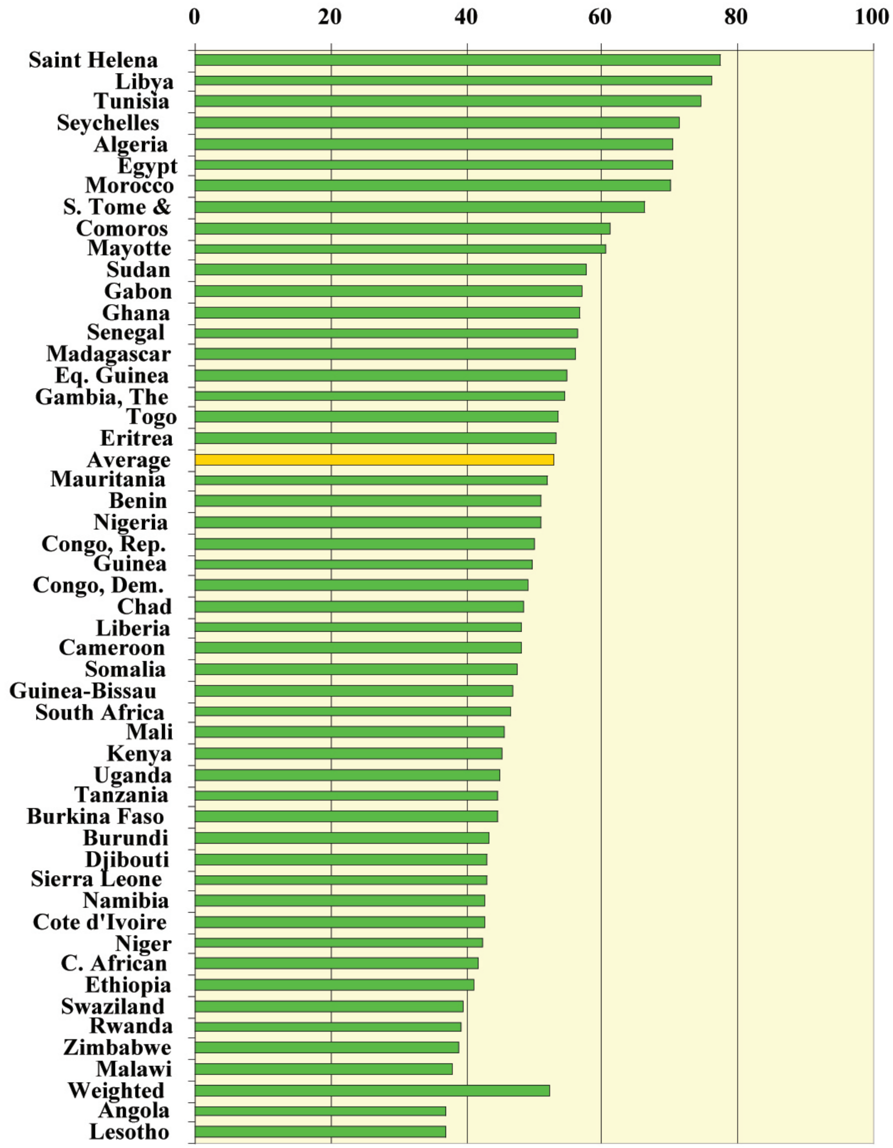
The Burden of Water-associated Ill-health

Waterborne diseases infect billions of people annually and the mortality reaches five to ten million cases. Inappropriate handling of excreta, insufficient water to maintain personal cleanliness and poor management of the water environment may cause enormous risks of ascariasis and other forms of helminthiasis, leprosy, schistosomiasis and malaria. The World Health Organization (WHO) states that 70 per cent of disease episodes in developing countries are closely linked to polluted water and/or inappropriate excreta treatment. It also notes that six million children die of gastro-intestinal diseases and 500 million people lack clean water to wash their faces annually (Endo T. and Magara Y., 2002). The increasing world population brings with it an increasing need for clean freshwater for drinking, hygiene and household purposes as well as for agricultural irrigation. Population growth also brings in its trail a high load of municipal sewage, livestock excreta and industrial wastewater on the source of drinking water, both surface and groundwater. Most faecal-oral pathogens are identified as the cause for gastrointestinal illnesses, with a few exceptions like the hepatitis viruses.

There may also be a myriad of pathogens excreted by humans or animals. The greatest impact of water pollution on human health comes from drinking water serving as a major vehicle for the transmission of a wide variety of infectious diseases. In many industrialized countries, the widespread occurrence of the protozoan parasites *Cryptosporidium* and *Giardia* in surface waters indicates that any drinking water treatment plant that draws its water from a surface source, is at risk (Yamamura S. T. el al., 2002).

Lack of access to good quality drinking water and lack of sanitation, leading to environmental health hazards contribute largely to the very low life expectancy in many African countries (fig. 5.9). Life expectancy in more than two thirds of African countries is below the regional average of about 52 years. Apart from the States in northern Africa, with the exception of Mauritania, only a few sub-Saharan African countries have life expectancy above the average. These include Ghana, Gabon, Senegal, Togo, Eritrea and the island countries of Saint Helena, Seychelles, Sao Tomé and Principe, the Comoros, Mayotte and Madagascar. The variation within various subregions in sub- Saharan Africa is shown in Figure 5.10. The absence of any country of the Southern Africa subregion can be attributed to the high prevalence of HIV/AIDS as demonstrated in Box 5.2 for Malawi.

Fig. 5.9: Life Expectancy at Birth in African Countries



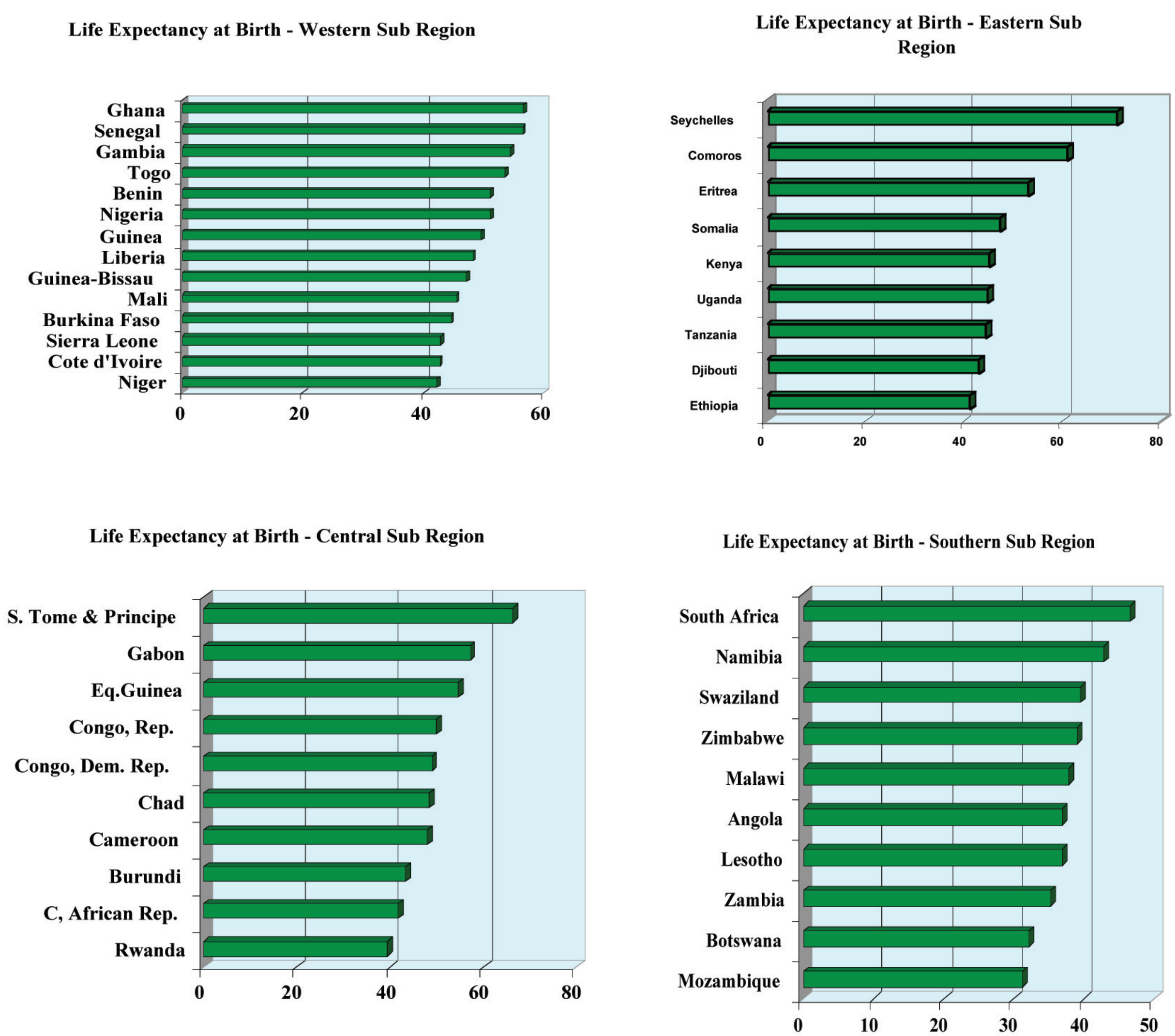
Source: Africa Facts: http://www.nationmaster.com

The development of water supply and sanitation can reduce waterborne diseases (Yamamura S. T. el al., 2002). The Global Water Supply and Sanitation Assessment Report, 2000, emphasizes that lack of improved domestic water supply leads to diseases through two principal transmission routes:

(a) **Waterborne diseases from drinking contaminated water.** This has led to many dramatic outbreaks of faecal–oral diseases such as cholera and typhoid. Outbreaks of waterborne diseases, including those transmitted by the faecal–oral route, (diarrhoea, typhoid, viral hepatitis A, cholera, dysentery) and dracunculiasis continue to occur across the developed and developing world;

(b) **Water-washed diseases which occur when there is insufficient water for washing and personal hygiene.** Without enough water, people cannot keep their hands, bodies and domestic environments clean and hygienic. Skin and eye infections (including trachoma) are as easily spread as are faecal–oral diseases.

Fig. 5.10: Life Expectancy at Birth by Sub Regions



Source: Africa Facts: http://www.nationmaster.com

Box 5.2
Incidence of HIV/AIDS and Life Expectancy – The Case of Malawi

Government estimates in 2004 put the median age in Malawi at 16.4 years, 16.1 years as male median age and 16.7years as female. The population growth rate is at 2.14 % compared to the 1987 population census which gave a growth rate of 3.2%. Despite a birth rate of 44.35 per 1,000 persons, the mortality rate is also high at 23.01 per 1,000, and there is a zero migration rate This and other life-reducing factors have put life expectancy at birth at 37.48 years, male life expectancy at 37.08 years and female at 37.88 years. The life expectancy was in the range of 60 years some 15 years ago before HIV/AIDS took its toll on the county's population. HIV/AIDS prevalence among adults is at a rate of 14.2 % as estimated in 2003. The number of people living with HIV/AIDS is estimated at 900,000. In 2003, HIV/AIDS-related deaths were put at 84,000.
(National AWDR Report, 2005)

Diarrhoea is the most serious public health problem associated with water and sanitation and can be both waterborne and water-washed (fig.5.11). Safe water supply and appropriate sanitation are the most essential requirements for a healthy and prosperous life. Therefore, simultaneously ensuring safe water and appropriately discharging wastewater must be considered an indispensable integrated cycle. In a case where water is not available close to one's premises, energy must be spent fetching water. This work trades off other productive activities, a fact corroborated by research which discloses that access to direct water supply systems provides the opportunity to spend more time in the field or on educational activities. Furthermore, if human excreta is not treated appropriately, it would degrade water resources and additional costs would have to be incurred to treat the contaminated water or to capture uncontaminated water (Yamamura S. T et al, 2002).

Fig. 5.11: Global Burden of Diseases Linked to Water, Sanitation and Hygiene

World Health Organization

Water, Sanitation and Hygiene Links to Health

"Safe water supply and adequate sanitation to protect health are among the basic human rights. Ensuring their availability would contribute immeasurably to health and productivity for development".
Dr Gro Harlem Brundtland, Director-General, WHO

***FACTS AND FIGURES**

Global burden of disease from water, sanitation and hygiene

- 3.4 million people, mostly children, die annually from water-related diseases.
- 2.4 billion people lack access to basic sanitation include the poorest in the world.
- 1.1 billion people lack access to even improved water sources.
- Access to safe water supply and sanitation is fundamental for better health, poverty alleviation and development.

Diarrhoea

- 2.1 million people die every year from diarrhoeal diseases (including cholera) associated with inadequate water supply, sanitation and hygiene. The majority are children in developing countries.
- Water, hygiene and sanitation interventions reduce diarrhoea incidence by 26% and mortality by 65%.

Malaria

- 1 million people - mainly children under 5 - die of malaria each year.
- 300 million people suffer from malaria every year, 90% of the disease burden is in Africa and South of the Sahara.
- Intensified irrigation, dams and other water related projects contribute importantly to this disease burden.
- Better management of water resources reduces transmission of malaria and other vector borne diseases.

Schistosomiasis

- 200 million people are infected with schistosomiasis.
- 20 million suffer severe consequences.
- The disease is still found in 74 countries of the world.
- Basic sanitation reduces the disease by up to 77%.

Arsenic

- 35 - 77 million from a total of 125 million in Bangladesh are at risk of drinking contaminated water.
- At least 100 000 cases of debilitating skin lesions caused by arsenic are believed to have occurred in Bangladesh.
- Arsenic contamination of ground water is a global problem. It has been found in many countries, including Argentina, Bangladesh, Chile, China, India, Mexico, Thailand and the United States.

Trachoma

- 6 million people are visually impaired by Trachoma.
- 146 million are threatened by blindness.
- 500 million people are at risk from Trachoma.
- Trachoma can be prevented by improving sanitary conditions and hygiene practices.

Japanese encephalitis

- 20% of persons with Japanese encephalitis with clinical symptoms die.
- 35% have permanent brain damage.
- Improved management for irrigation of water resources reduces transmission of disease, in South, South East, and East Asia.

Fluorosis

- It is estimated that nearly 28 million people suffer from chronic fluorosis primarily due to exposure to fluoride in drinking-water, in China alone.
- Removal of excessive fluoride from drinking-water reduces crippling fluorosis.

Hepatitis

- 1.5 million cases of clinical hepatitis A every year.

* these figures are as of 28 August 2002.

For more information, visit http://www.who.int/phe or email bravardf@who.int

Water Management for Health

More than 300 million people in Africa still lack access to sufficient safe water and a larger number to adequate sanitation (UNDP 1996). In sub-Saharan Africa, only about 51 percent of the people have access to safe water, and 45 percent to sanitation (UNDP 1997). However, the proportions vary widely throughout the continent. In Libya and Mauritius, almost the entire population has access to safe water and sanitation, as opposed to only about a quarter in Chad, Ethiopia and Madagascar (UNDP 1997). Urban residents generally have better access to safe water and sanitation than those living in rural areas. For example, in 1994, only 30 per cent of the rural people in Uganda had access to safe water, as against 60 per cent in urban centres (Ministry of Natural Resources, Uganda, 1995). With recurring droughts and chronic water shortages in many areas, most countries and people pay an increasingly high price for water and lack of it. The poor, especially women and children, usually pay the highest price, in cash terms, to buy small amounts of water. They also expend more in calories by carrying water from distant sources, suffer more in impaired health from contaminated or insufficient water, and lose more in diminished livelihoods and lives.

The 2000 Assessment Report gives a breakdown of some water-related diseases by means of provision, in addition to estimated overall coverage, as follows:

(a) **Approximately 4 billion cases of diarrhoea each year cause 2.2 million deaths,** mostly among children under the age of five. This is equivalent to one child dying every 15 seconds, or 20 jumbo jets crashing every day. These deaths represent approximately 15 per cent of all deaths of children under the age of five in developing countries. Taking steps to solve water, sanitation and hygiene problems reduce diarrhoeal diseases by about one quarter and one third on average;

(b) **Intestinal worms infect about 10 per cent of the people in the developing world.** These can be controlled through better sanitation, hygiene and water supply. Intestinal parasitic infections can lead to malnutrition, anaemia and retarded growth, depending on the severity of the infection;

(c) **It is estimated that 6 million people are blind from trachoma** and the number of people at risk from this disease is approximately 500 million. In analysing rigorous epidemiological studies linking water to trachoma. Esrey et al. (1991) found that providing adequate quantities of water reduced the median infection rate by 25 percent;

(d) **About 200 million people in the world are infected with schistosomiasis.** Of these 20 million suffer severe consequences. The disease is still found in 74 countries of the world. Esrey et al., in reviewing epidemiological studies, found that well-designed water and sanitation measures reduced the disease by about 77 per cent;

(e) Cholera is a worldwide problem that can be prevented by ensuring that everyone has access to safe drinking water, adequate excreta disposal systems and maintains good hygiene behaviours.

Major health risks arise where there are large concentrations of people and hygiene is poor. These conditions often occur in refugee camps, and special vigilance is needed to avoid outbreaks of disease. Most of the 58,057 cases of cholera reported in Zaire in 1994 occurred in refugee camps near the Rwandan border. A decrease to 553 cases in Zaire in 1995 reflected the stabilization of refugee movement. A cholera epidemic that began in Peru in 1990 spread to 16 other countries in Latin America. A total of 378 488 cases were reported in Latin America in 1991. Ten years later, cholera remains endemic, after it had disappeared from the continent for nearly a century (WHO/UNICEF, 2001)

No other type of action has a greater overall impact on national development and public health than does the provision of safe drinking water and proper disposal of human excreta. The direct effects of improved water and sanitation services on health are most evident in the case of water-related diseases, which arise from the ingestion of pathogens in contaminated water or food and from insects or other vectors associated with water. Improved water and sanitation can reduce morbidity and mortality rates of some of the most serious of these diseases by 20 per cent to 80 per cent (WHO Fact Sheet, 1996).

Benchmarks for Health Expenditures, Services and Outcomes in Africa

A WHO study in 2000 found that although most post-independence African countries achieved remarkable improvements in health conditions during the last four decades, Africans still suffer from some of the worst health problems in the world and have the highest mortality and fertility rates. In 1990, the median age of death was estimated at five years. African countries face enormous difficulties in mobilizing and managing resources to improve public health. Two thirds of all the countries in Africa are classified as low income and have limited potential to mobilize resources. Nearly all have weak health management systems. The challenge of a massive burden of disease (predominantly water-related diseases) from largely preventable or treatable conditions that precede the epidemiological transition, the emergence of new diseases and such health problems as AIDS and drug-resistant tuberculosis, together with political changes, increase the need for more information for management and accountability of the health sector in African countries. Good information is vital to making intelligent choices about strategies and investments in health. Yet in much of Africa, information that would be critical to policy makers, health systems managers and public consumers of health services is often not available, despite increasing emphasis on data collection in many countries. The findings are summarized below (WHO, 2000).

Box 5.3

Health-adjusted life expectancy (HALE) is defined as the number of years that a newborn can expect to live in full health based on current rates of ill-health and mortality. Healthy life expectancy combines information on mortality and disability, making it a valuable policy tool for assessing health burdens internationally. The data can assist in identifying the major causes of poor health for a particular group; it can also show variation in levels of health across a population and trends in levels of health over time. The data are for the year 2002. WHO published the first country-level dataset on health adjusted life expectancy (HALE) for 191 countries in 2001. Since that time, WHO has been working jointly with member States to refine HALE estimates. As a result, the estimates for 2002 are not directly comparable with the previously published estimates for 2000 or 2001. WHO publishes The *World Health Report* annually. This dataset represents the culmination of more than fifteen years of work by WHO to measure severity-weighted incidences of ill-health. Estimates are grouped by age, sex, and epidemiological subregions of a particular population. Calculation of HALE is a multi-step process. First, researchers must determine, on average, the number of healthy years "lost" in an individual life due to a specific illness or injury:

YLD = Prevalence x Duration x DW

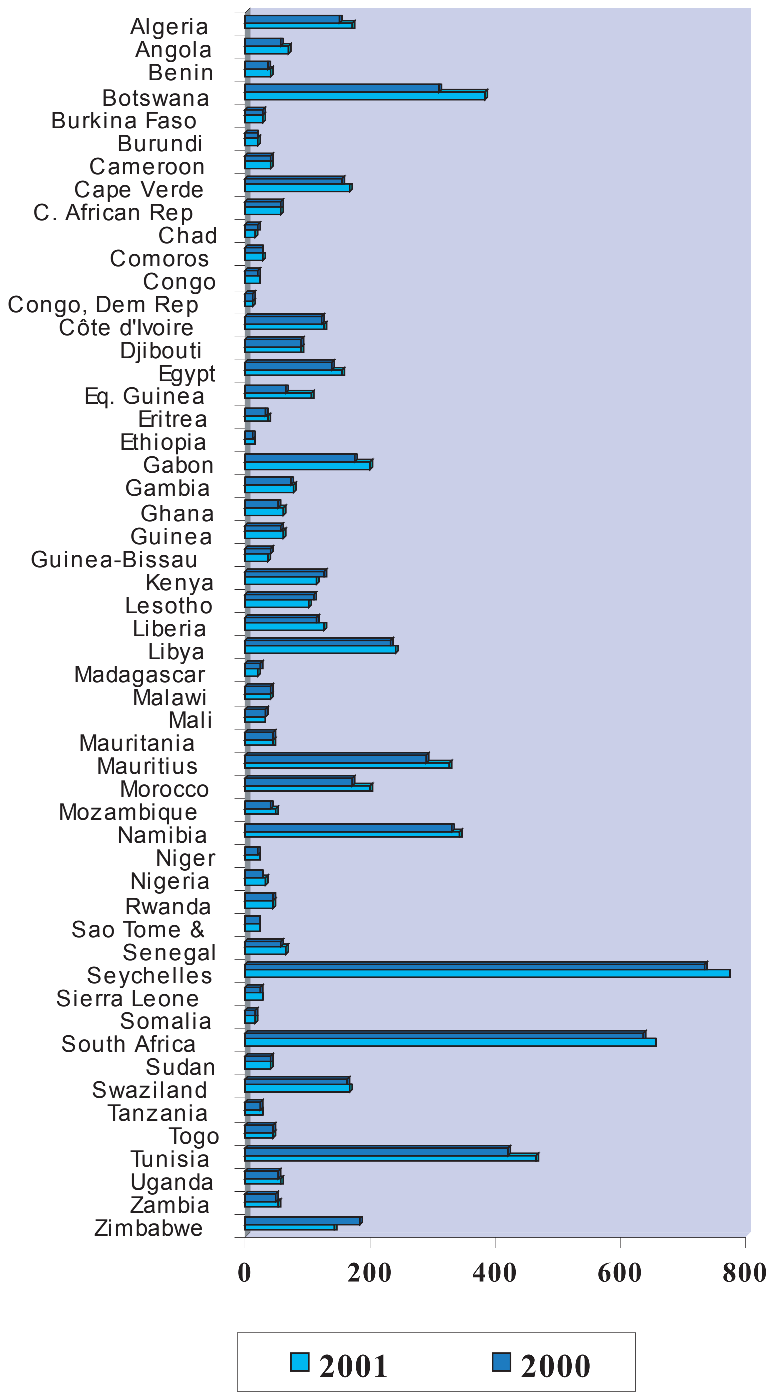
where YLD is years lost due to disability for a particular illness or injury,

Prevalence is the percentage of the population affected by the disability. Duration is the average time period that an individual is in ill health, and DW is the disability weight. The disability weight is an index number between 0 and 1 indicating the severity of the disability.

After the years lost due to disability (YLDs) are calculated for 175 groups of illnesses and accidents, the cumulative impact of all disabilities is subtracted from ordinary life expectancy to calculate healthy life expectancy:

HALE = Ordinary Life Expectancy - Sum of YLDs for all disabilities

Fig. 5.12: Per Capita Public Health Expenditure in Africa



Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/ Adapted from: World Health Organization (WHO). 2004. World Health Report: Statistical Annex

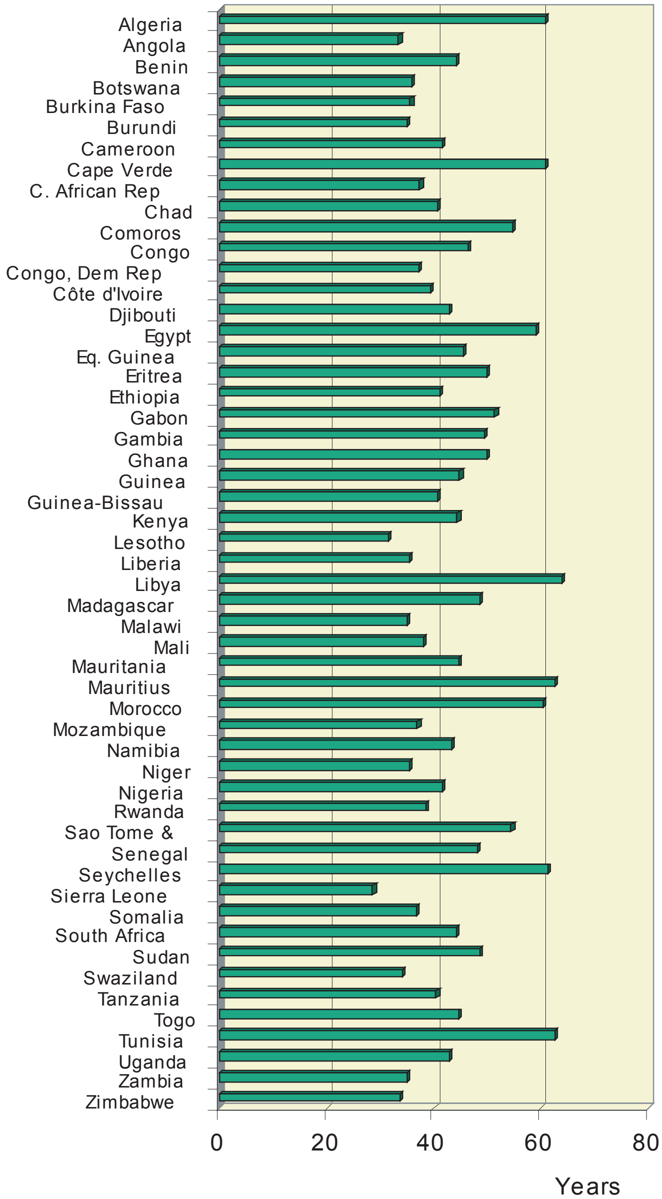
Per capita public health expenditure is still very low in most African countries irrespective of subregions. The countries with the highest public health expenditure include Seychelles, Tunisia, Botswana and South Africa; followed by Mauritius, Namibia, Libya, Swaziland, Zimbabwe, Gabon, Algeria and others (fig. 5.12). The effect of such a situation can be demonstrated through WHO's Health Adjusted Life Expectancy (Figs. 5.13 and 5.14)

Ethiopia

Ethiopia, a country with 58.1 million people in 1996, belongs to the lowest-income group with a per capita GNP of only $ US 110. Its social indicators are poor, even for lowest-income Africa: only 25% of adult female population is literate; 10% of the population has access to safe sanitation; and 27% access to safe water. However, ratings of its legal framework (2.3) and government bureaucracy (1) are better than those of most other lowest-income African countries, and are about average for Africa as a whole. As a proportion of GDP, Ethiopia's public sector spending on health during the period 1990-1996 (1.2%) was at the 25th percentile of African countries, and below average for lowest-income Africa, even though it was increasing its levels over this time. In real terms, this translates into less than $US 2 per capita, placing it near the bottom of the Africa table.

In terms of health services, Ethiopia's latest indicators show a mixed picture. It has some of the lowest levels of supervised deliveries in Africa (14%; only Somalia is known to be lower), its contraceptive prevalence (4%) places it below the 25th percentile, below average for lowest income Africa, whereas its DTP3 immunization coverage (39% during 1990–1996) varied considerably from year to year, but was near the African average by 1995. Among its health outcomes, Ethiopia stands out as having one of the highest levels of malnutrition (48% of children were underweight) and fertility (total fertility rate 7 children) in Africa. Its infant mortality rate (116) is better than that of a quarter of African countries, but still higher than the average for lowest-income Africa.

Fig. 5.13: Health Adjusted Life Expectancy in African Countries - 2002



Source: WRI, Portal: http://earthtrends.wri.org/; WHO, 2004

Note: See Box 5.3 for the definition and significance of Health Adjusted Life Expectancy HALE

Ghana

With a population of 17.5 million and a GNP per capita of $ US 390 in 1996, Ghana has many indicators typical of the other low-income countries in Africa.

Its levels of female literacy (53%), access to safe water (56%) and sanitation (32%) are near the average, though ratings of its legal framework (3.3) and government bureaucracy (2) are better than average. It provides lower public sector health expenditures (both in real per capita terms and as a percentage of GDP) and receives an average amount of donor assistance for health. For a low-income African country, Ghana is one of the few African countries with sufficient data on types and sources of health expenditures and stands out as having a relatively high proportion of capital expenditures, particularly with investment funded from Government rather than almost exclusively from donor sources. This may indicate less reliance on donors, or suggest that closer examination of capital expenditures is warranted. Nonetheless, Ghana's health service output, in terms of supervised deliveries (44%), DTP3 coverage (47%) and contraceptive prevalence rates (20%) was slightly below average for low-income Africa and for Africa as a whole. Despite this, its infant and child mortality rates (76 and 116, respectively) were lower than average for low-income Africa, whereas its fertility rates (5.4 children/woman) and levels of malnutrition (27% underweight) are about average. The data suggest that higher public expenditures and better levels of health services are feasible for a country such as Ghana.

Cote d'Ivoire

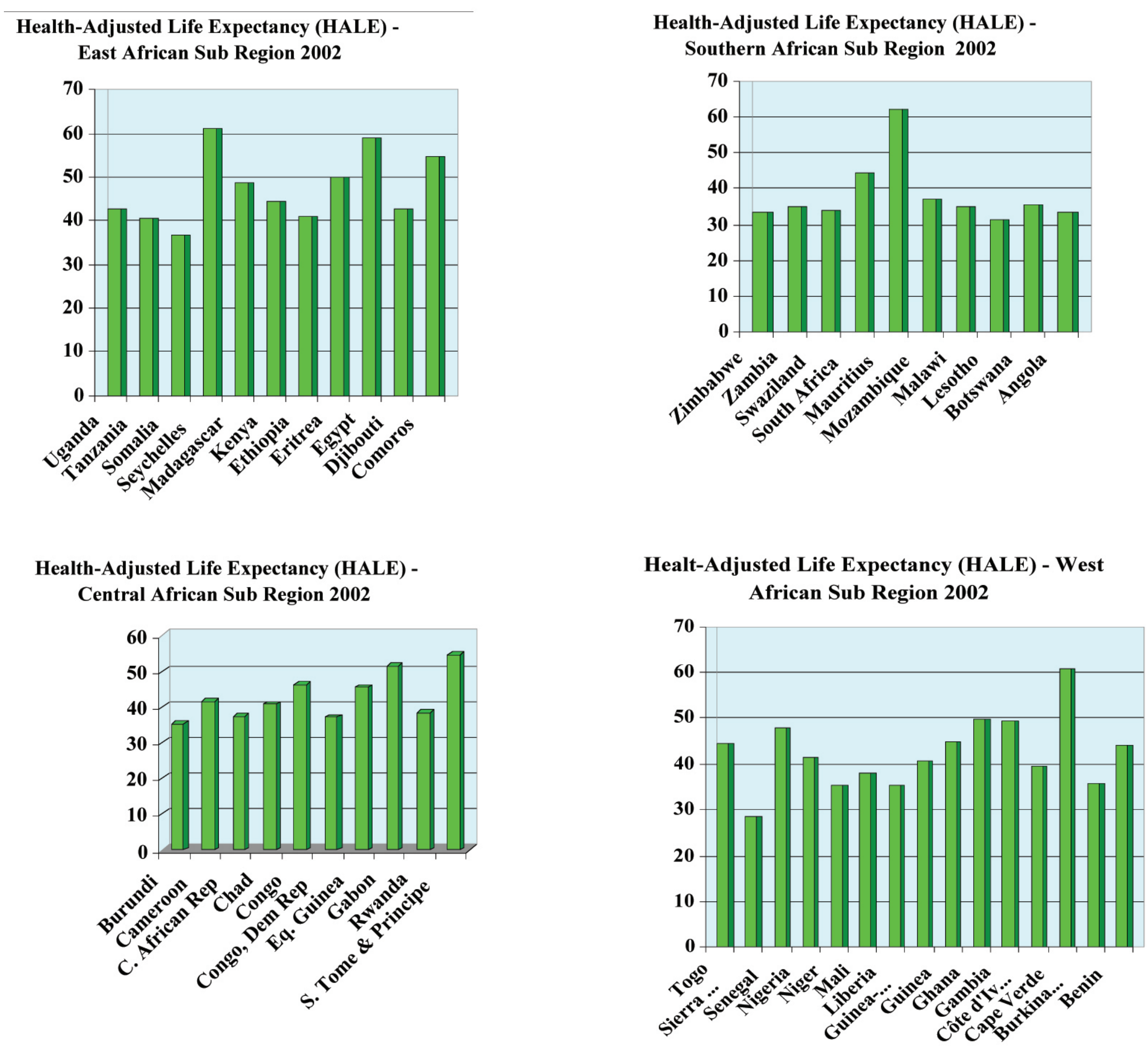
Cote d'Ivoire is another low-income country ($ US 701 per capita GNP), but differences are evident. Compared with other African countries, it has a relatively sound public service (bureaucracy rated 2) and legal and regulatory environment (3.3), spends fairly large sums of public money on health ($ US 12.7 per capita), and relatively little on defence (1.1% of GDP). Yet the performance of Côte d'Ivoire on some measures is about average for Africa (e.g. 0.09 physicians per capita; 45% supervised deliveries). Performance in public health programmes such as immunizations is weaker than in most African countries (DTP3 coverage was 47%), and its health outcomes (infant and child mortality rates of 88 and 138, respectively) are below the average for low-income African countries. The implication is that Côte d'Ivoire may wish to pay relatively greater attention to public health and preventive services and to the way public expenditures on health are allocated, rather than on mobilizing more public funds for the health sector.

Gabon

Gabon (population just over 1 million) is one of the few middle-income countries in Africa, with a GNP of $ US 4290 per capita in 1996. Nonetheless, its health statistics are poor, with an infant mortality rate (92) and total fertility rate (5) closer to levels of low-income countries, and fertility levels apparently increasing. Despite relatively good access to safe water (67%) and sanitation (76%), it has comparatively low levels of female literacy for a middle-income country (53%). As a proportion of GDP, Gabon spends very little of its public resources on health (0.6%) even though this translates into over $ US 28 per capita.

Although it has an average level of supervised deliveries for middle income Africa (80%), it performs poorly in immunization coverage. Overall, the data suggest that Gabon substantially under performs in terms of effort and results, compared with Africa as a whole and particularly with middle-income African countries.
Since Gabon's current health spending is relatively inefficient compared with other African countries, changing the pattern of spending and the quality of its use may be more important than simply increasing public sector health spending, even though Gabon could afford to spend more.

Fig. 5.14: Health Adjusted Life Expectancy by Sub Regions



Some of the shortcomings faced by the WHO study included:

(a) Limited information on national health expenditures, services, and outcomes in African countries during the 1990s;
(b) Serious gaps in data, particularly concerning private sector delivery and financing, health service utilization, equity and efficiency measures; and
(c) General lack of data disaggregated by regions within a country, or among different social groups of interest, such as the poor.

Examination of these types of data limitations is very relevant to monitoring effects and targeting the implementation of health policy, especially public spending, within a country. There are often urban, rural and regional differences in public spending, availability of services and health outcomes within a country. For example, in examining Ministry of Health spending in 22 African countries, Vogel found that 16 of these countries spent more than half of their budgets in urban areas, whereas their populations were predominantly rural (5). Similarly, the richest people in African countries tend to benefit much more from public spending on health than the poorest, though the poorest people usually have greater need than the richest (6). For example, in Côte d'Ivoire in 1994, the under-five mortality rate for the poorest 20 per cent of the population was 172, whereas for the richest 20 per cent it was 121, and the prevalence rate of malnourished children was 30 per cent among the poorest, and 20 per cent and 15 per cent among the richest 20 per cent of the population. The issue of poverty, equity and health deserves a higher place on the health policy agenda of African countries and their international partners, and should be backed up by more evidence on how well spending on health is targeted to meeting the needs of the poor.

Access to Safe Water Supply and Sanitation Services

Africa has the world's most rapid rate of urbanization, at 5 per cent per annum. Given its current economic situation, Africa cannot afford to spend its constrained resources on producing water that is allowed to go to waste; yet there is a lot of water wastage. For example, the average level of unaccounted-for water is about 50 per cent in urban water supplies; and as much as 70 per cent of the water used for irrigation is lost and not used by plants. Currently, most African countries consider water as supplied from any of the following sources as safe potable water:

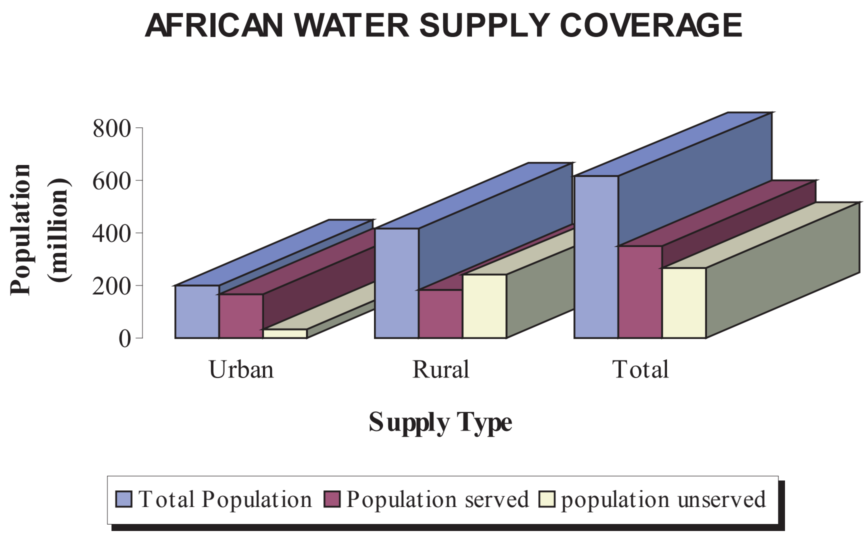
(a) Pipe-borne water (in homes or at public standpipes or from a neighbors tap);
(b) Bore holes;
(c) Protected wells and springs; and
(d) Rainwater.

Moreover, the WHO and UNICEF report includes under "improved drinking water sources" all of household connection, public standpipe, borehole, protected dug well, protected spring and rainwater collection.

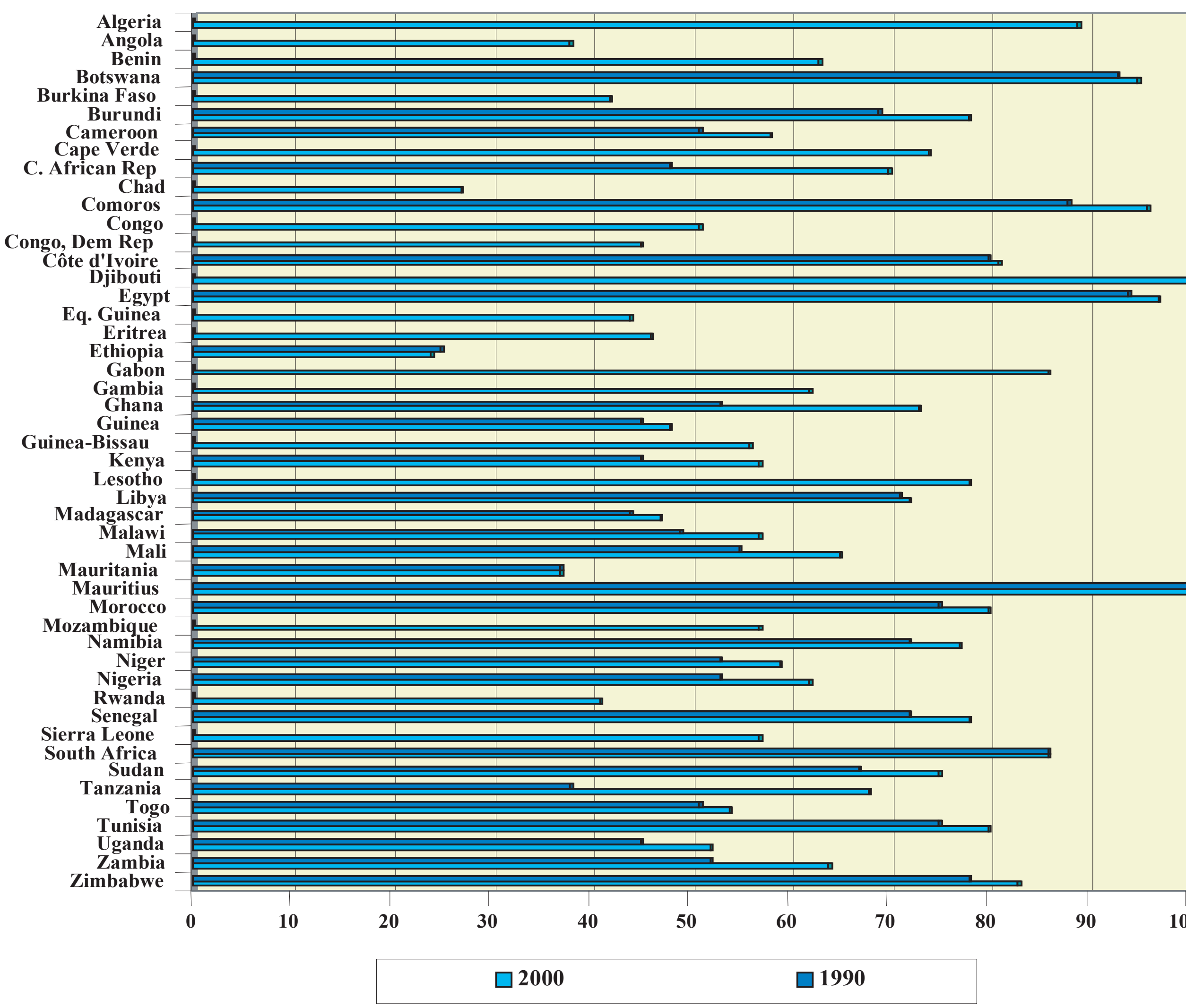
The water supply coverage for urban and rural environments for Africa as a whole is shown in Figure 5.15. The progress made by African countries in improving access to water supply in the period 1990-2000 is shown in Fig. 5.16 and the disparity between uurban and rural access to Improved Water Source is shown in fig. 5.17.

One example of progress in water improvement is Malawi, which increased from 48 per cent to 62 per cent (85 per cent in urban and 58 per cent in rural areas), access to potable water supply for its people since 1994. It is also estimated that 64 per cent of the population has access to some form of sanitation, although only 9 per cent is served through a sewage system or sewer connecting septic tanks.

Figure 5.15: Summarised Water Supply Coverage in Africa

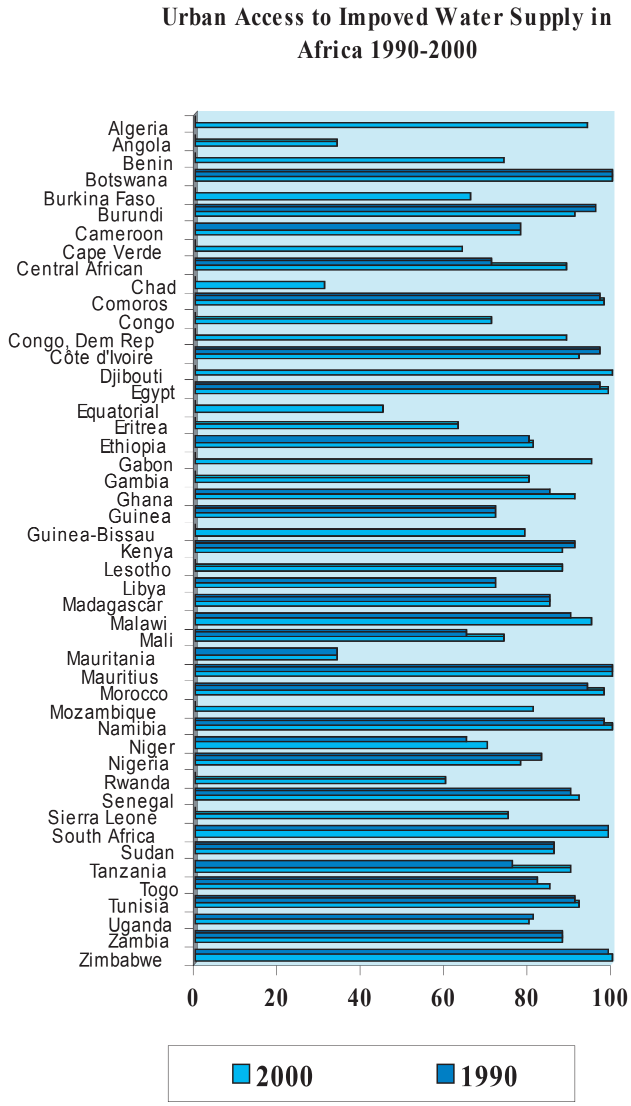


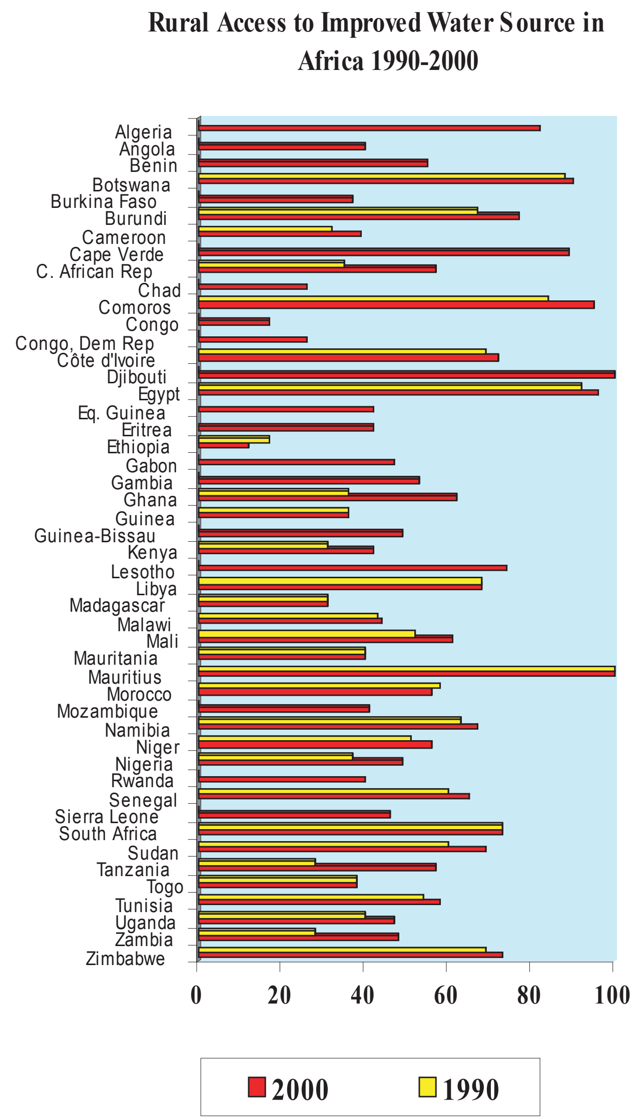
Source: WHO/UNICEF, 2001



Source: World Resources Institute – Earth Trends. The Environmental Information Portal: http://earthtrends.wri.org/

Fig. 5.17: Progress in Urban and Rural Access to Improved Water Source in African Countries





Source: World Resources Institute – Earth Trends. The Environmental Information: http://earthtrends.wri.org/

Access to drinking water supply services in the Congo Republic decreased by 0.5 per cent in the urban environment and increased by 8.8 per cent in the rural areas, an overall growth of 5 per cent (AWDR National Report, 2003). The people not served usually make do with water from a variety of sources to cover their drinking and domestic water needs. These sources include:

(a) Water direct from streams and rivers;
(b) Unprotected wells and springs; and
(c) Water vendors.

A typical African access to potable drinking water situation exemplified by the situation of Sudan is demonstrated in Box 5.4.

Access to sanitation services in Africa

Most governments and communities have placed a higher priority on safe water, but that in itself is not a panacea for all ills. Without a stronger commitment to sanitation, it will be difficult to reduce the incidence of diarrhoea, a major child killer, and other diseases that flourish in unsani-

Box 5.4
Suffering in getting drinking Water and Difficulties in accessing drinking water in Sudan

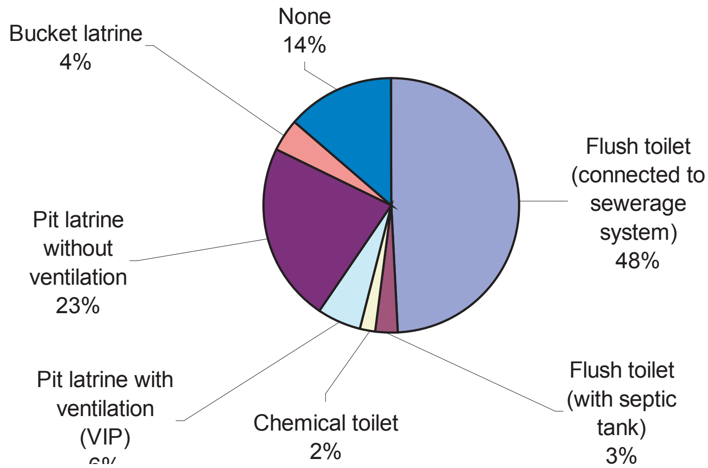
According to the National Water Corporation (NWC) annual report, about 70% of urban residents have access to a reasonable supply of safe water. However, due to inefficiency and problems associated with water delivery infrastructure and pumps, only 50% have adequate access to safe water. This is based on consumption per capita in urban areas taken as 50 l/day, which is far below the real need and WHO standard. Therefore, even the 50%

is not realistic. Rural areas have on average less access; about 47% of rural residents have access to safe water which drops by 25% during the dry months of the year (January to June). The rural daily consumption per capita is taken as 18 l/day. In 2001, the urban population was estimated to be about 30% while the rural was 68% and nomad 2%. In 2003, it was estimated at 48% in the urban areas, 50% in the rural areas and 2% for nomads. Therefore, according to the NWC the total drinking water requirement for urban areas is 0.8 billion m^3 and for the rural is 0.3 billion m^3 annually. The water required for livestock was estimated at 4.0 billion m^3. The total domestic water required by 2025 is estimated at 8 billion m^3 (2.5 billion m3 for drinking water and 5.5 billion m3 for livestock and others).

Source: Extracts from AWDR National Report, 2005

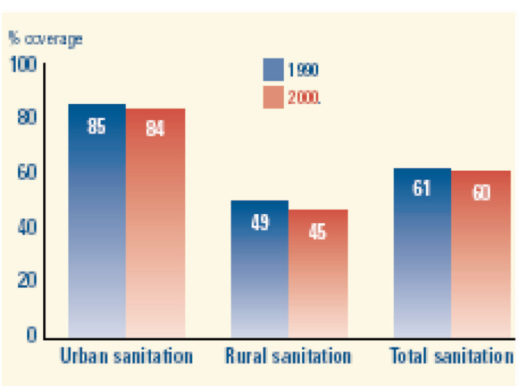
tary conditions. Among steps to combat disease and malnutrition, the Convention on the Rights of the Child calls on countries to provide clean drinking water and sanitation (Article 24). Assessing the adequacy of sanitation facilities bearing in mind environmental and public health concerns is more complex than assessing water supply. In terms of coverage, the basic question that arises is: Which level of sanitation? Is a traditional pit latrine a sufficient sanitation service, or a VIP latrine? In most African countries, the choice of the basic standard generally depends on the level of economic development and urbanization, and not the perceived public and environmental health safety standards. An example of different types of sanitation facilities in use in South Africa is shown in figure 5.18 and the recommended indications for improved drinking water sources and sanitation facilities are given in table 5.1 (WHO/UNICEF JMP, 2004).

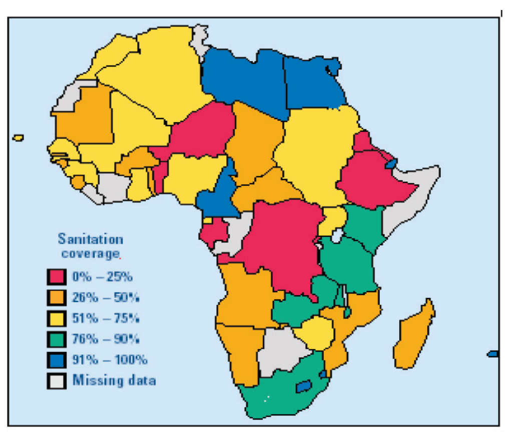
Figure 5.18: Type of Sanitation by Household in South Africa



Coverage for the whole of Africa and some countries is shown in Figures 5.19 and 5.20. There are disparities between the urban and the rural coverage of both water supply and sanitation as shown in figures 5.20 and 5.21. A country example, using Cameroon, is shown in figure 5.22. In Libya about 48 per cent of the households are connected to national sewage systems, even though the variation is very wide.

Figure 5.19: Sanitation Coverage in Africa





Source: *WHO/UNICEF, 2001*

Table 5.1: Indications for improved drinking water sources and sanitation facilities

Improved drinking water sources	Unimproved drinking water sources
Household connection	Unprotected well
Public standpipe	Unprotected spring
Borehole	Rivers or ponds
Protected dug well	Vendor-provided water
Protected spring	Bottled water
Rainwater collection	Tanker truck water
Connection to a public sewer	Public or shared latrine
Connection to a septic system	Open pit latrine
Pour-flush latrine	Bucket latrine
Simple pit latrine	
Ventilated improved pit latrine	

Source: WHO/UNICEF JMP, 2004

Fig. 5.20: Progress in Access to Improved Sanitation in Africa, 1990-2000

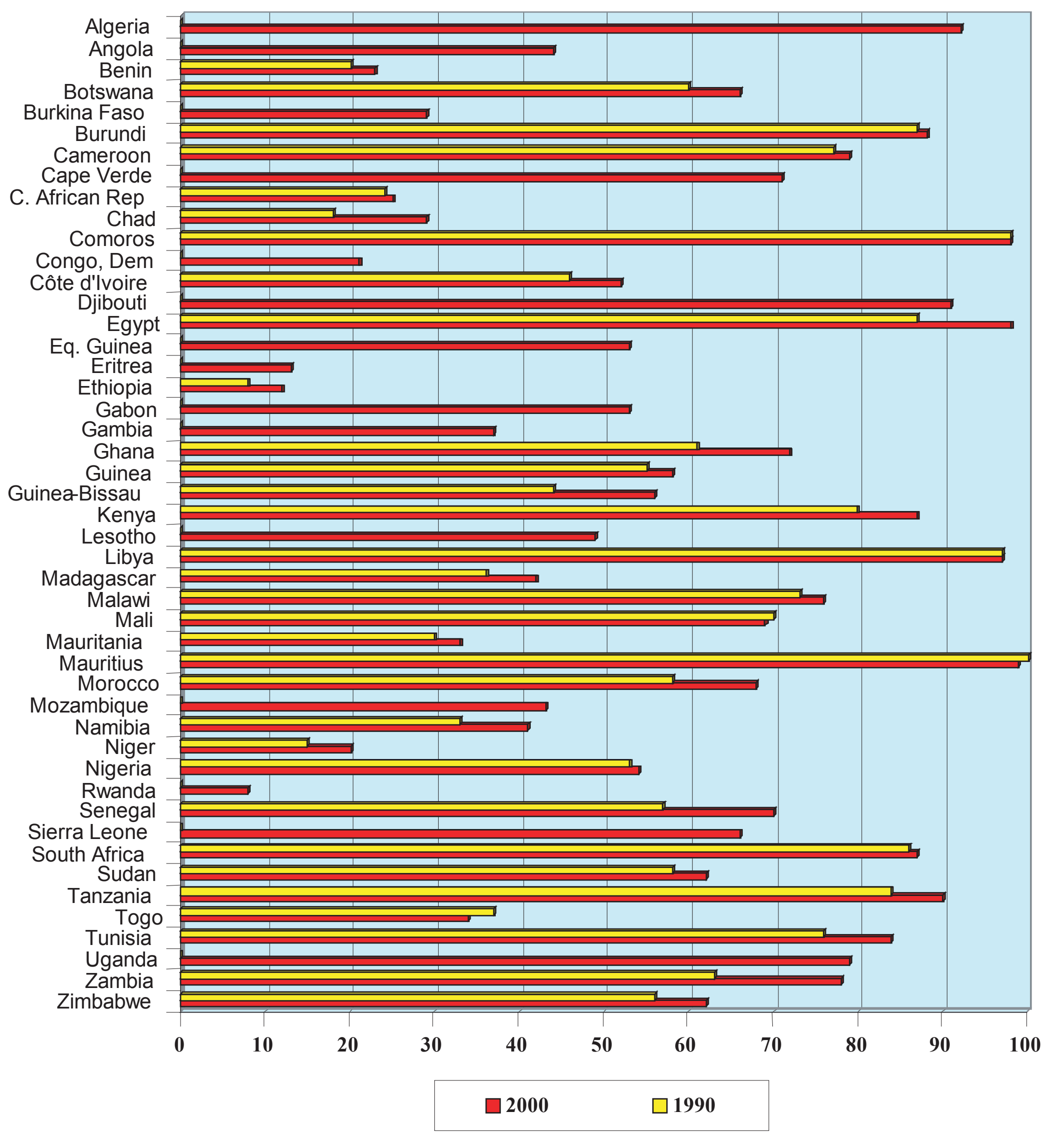
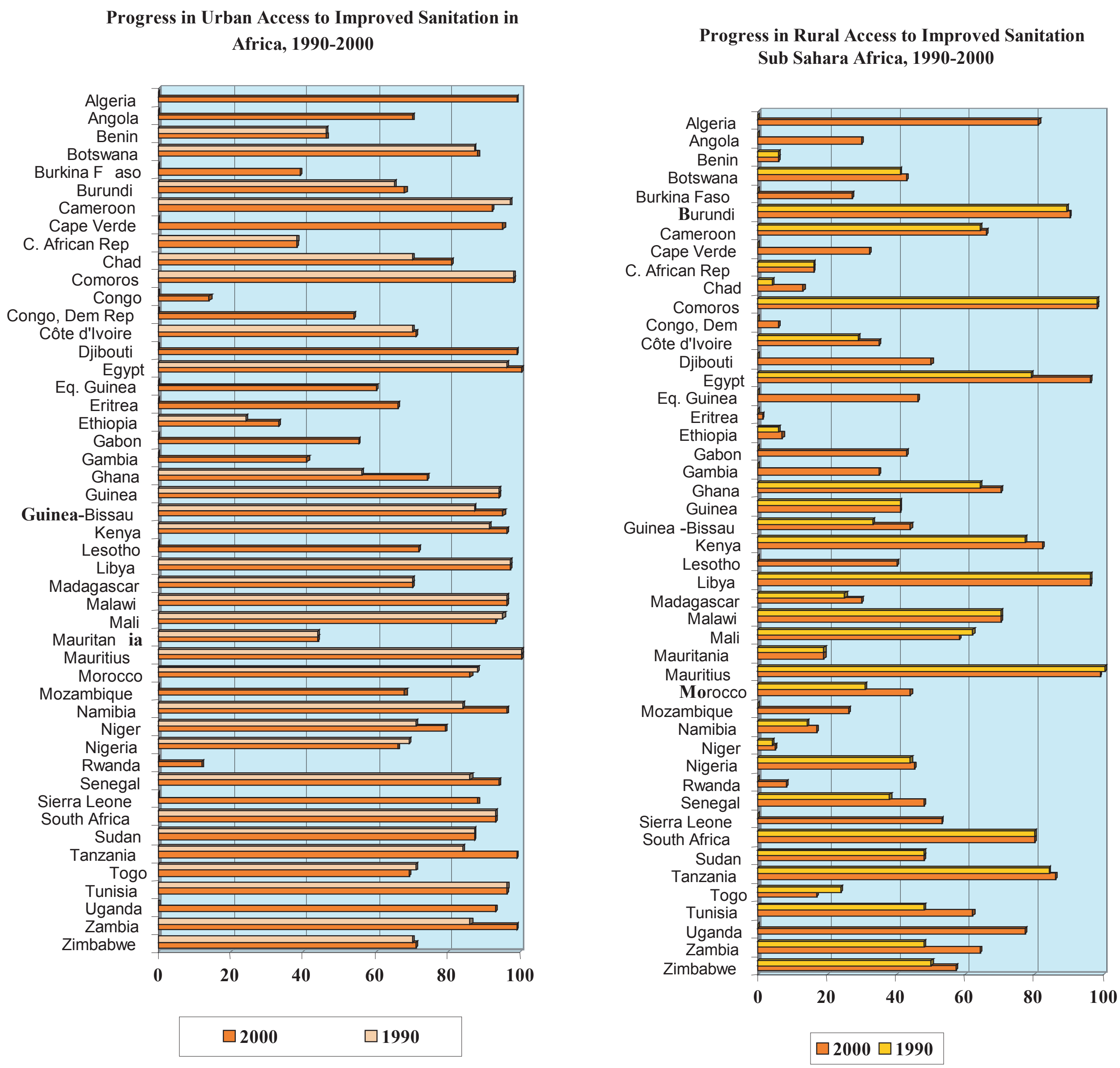


Fig. 5.21 Urban and Rural Access to Improved Sanitation



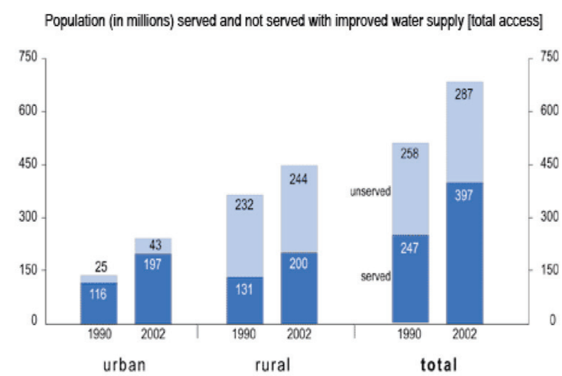
Progress in and Current Levels of Access to Improved Water Supply and Sanitation

Since 1990, there has been some progress in the number of people with access to improved water supply and sanitation in Africa but the percentage of coverage did not increase much due to the considerable increases in population. According to the WHO/UNICEF Joint Monitoring Programme in 2004, in sub-Saharan Africa some progress was made in the rural areas where 69 million more people gained access to water supply in rural settings during the period 1990-2002 (over 9 per cent).

Although the percentage of people served in the urban areas did not change during the same period, 82 million more people gained access to water supply in towns. The percentage of the supply increase was offset by that of the urban demographic growth and rural-urban migration which increased the population of towns/cities by 100 million more people. In northern Africa, some progress was also made in the rural areas where coverage increased by 2 per cent, rising from 82 per cent to 84 per cent.

During the same period, while about a million more people were served with improved water supply in urban areas, the urban population in-

Fig. 5.22: Population served and not served with improved water supply sources - 1990



Source: WHO/UNICEF JMP, 2004

Fig. 5.23: Population served and not served with improved water supply sources - 2002

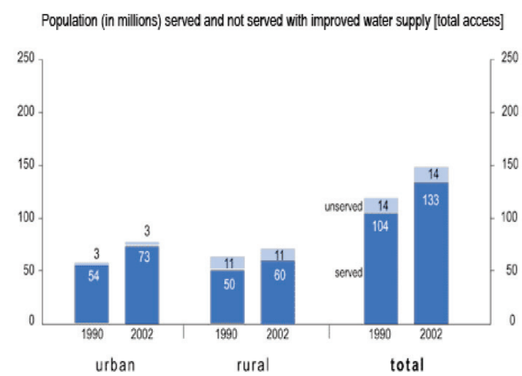
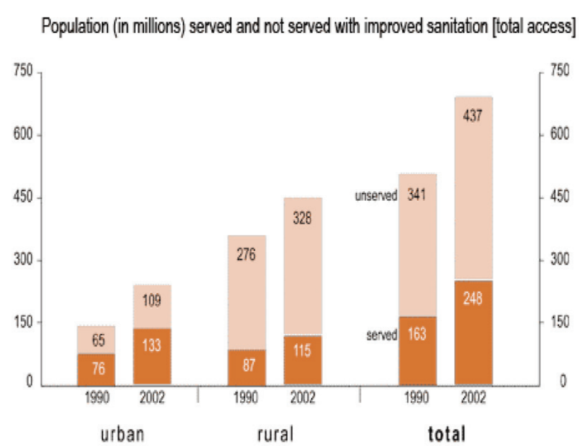
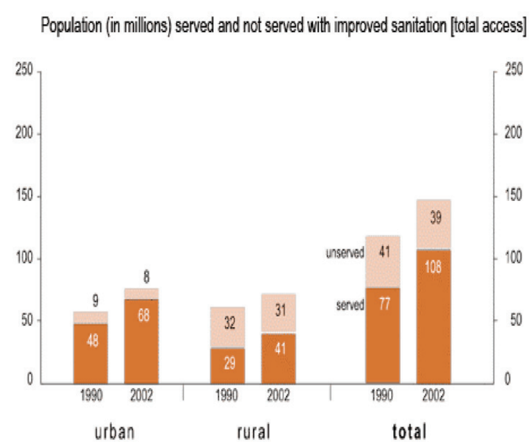


Fig. 5.24: Population served and not served with improved sanitation - 1990



Source: WHO/UNICEF JMP, 2004

Fig. 5.25: Population served and not served with improved sanitation - 2002



creased by roughly the same number of inhabitants. This reduced the increase in coverage to only a minimal 1 per cent (Figs. 5.22 and 5.23).

From 1990 to 2002, the percentage of people served with improved sanitation facilities in sub-Saharan Africa rose by 4 per cent as shown in figures 5.24 and 5.25. Some 85 million more people gained access to improved sanitation, most of them in urban areas. A high demographic increase of over 181 million people offset the percentage increase in the number of people served (WHO/UNICEF JMP 2004).

During the same period, northern Africa also saw an 8 per cent increase in the number of people provided with improved sanitation facilities. In this part of Africa, 31 million more people gained access to sanitation, one third of them in rural areas and the other two thirds in urban areas (WHO/UNICEF JMP 2004). The disparities in water supply and sanitation between the northern Africa subregion and sub-Saharan Africa are shown in tables 5.2 and 5.3, respectively. Those for some other African countries are shown in figure 5.26. Figure 5.27 gives the example of Cameroon

According to MDG Task Force on Water and Sanitation, 2005, in some African countries progress towards meeting the MDG access-to-water goal is poor, stalled or reversing. These countries include Ethiopia, Mauritania, Madagascar, Guinea, and Togo. Countries with better prospects for meeting the goal but where challenges are still formidable include Uganda, Malawi, Cameroon, the Niger, Nigeria, Namibia, Côte d'Ivoire, and South Africa Many of the very poor African countries such as Sierra Leone and Burkina Faso could also be included in this list for which there were insufficient data. In terms of access to sanitation, the African countries where progress in this area is poor, stalled or reversing include Ethiopia, the Niger, Benin, Central African Republic, Mauritania, Madagascar, Guinea, Togo, Nigeria, the Sudan and Mali. Countries with better chances of meeting the goal but where the challenges are still substantial include Chad, Namibia, Côte d'Ivoire, Zimbabwe, Botswana, Malawi, Cameroon, South Africa, and Burundi (ibid).

Table 5.2: Access to improved drinking water sources in Africa, 2002

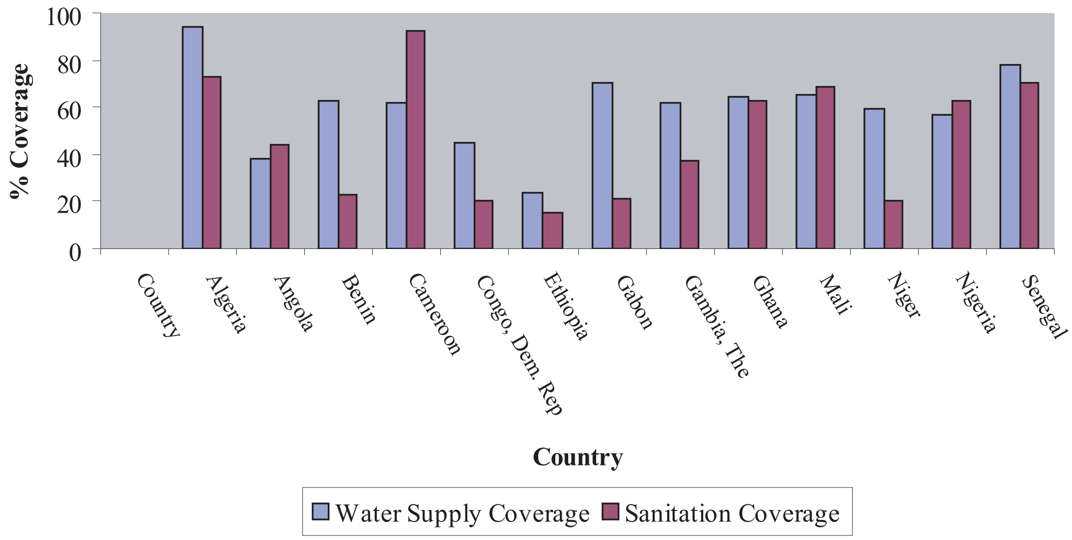
Region	Number of people in region lacking access (millions)	Share of regional population lacking access (percent)	Share of all unserved living in indicated region (percent)
Sub-Saharan Africa	288	42	27
Northern Africa	15	10	1

Source: Adapted from WHO/UNICEF JMP 2004.

Table 5.3: Access to improved sanitation in Africa, 2002

Region	Number of people in region lacking access (millions)	Share of regional population lacking access (percent)	Share of all unser living in indicat region (percen
Sub-Saharan Africa	437	64	17
Northern Africa	40	27	2

Figure 5.26: Water Supply and Sanitation Access Disparity in some African Countries



Source: Water Supply and Sanitation sector Assessment 2000, WHO African Region, Country Profiles, Africa 2000

Figure 5.27: Urban-rural Disparity of the Proportion of the Population Not Served with Adequate Water Supply and Decent Sanitation in Cameroon

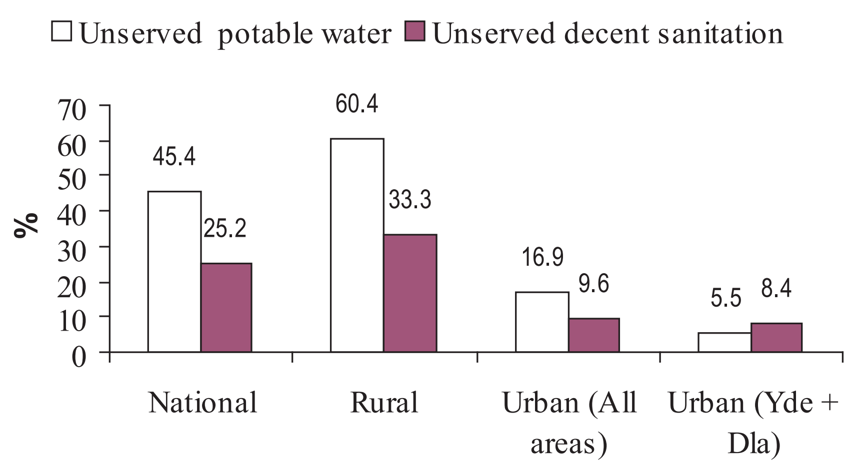


Figure shows the approximate distribution of the population not served in four geographical areas of the country as regards safe drinking water and decent sanitation services. About 45.4 % of the total population are not served, corresponding to about 6.9 million persons in the year 2000.
Source: AWDR National Report, 2003

Enhancing access for sustainable development

According to some reflections on water resources and some socio-economic indicators access to water supply for both the urban and rural people in Africa is not directly tied to water availability in countries or the respective subregions. For example, many North African countries, such as Algeria and Egypt, have provided water supply facilities to a large segment (over 90 per cent) of their population, whereas the Democratic Republic of the Congo, with more than 30 per cent of Africa's water resources can barely satisfy the water needs of 27 per cent of its population. The number of people in sub-Saharan Africa to whom access to water supply and sanitation must be extended by 2015 to meet target 10 of the MDGs is shown in table 5.4 below.

This shows that in many African countries, the problem is not one of physical water scarcity but rather of structurally induced water scarcity resulting from very low infrastructural and socio-economic development. Even in the face of water scarcity, if resources, technical know-how, planning and institutional capability are put in place and government commitment is strongly behind development, much progress could be made in this vital area. There is, therefore, the urgent need to build the social adaptive capacity of African countries and translate them into the ability of the State to implement policies to supply water to the people by harnessing the knowledge, financial resources and energy of all sectors of society and at all levels of decision making. This should be the goal towards which the various international and African regional water and socio-economic development policy declarations and targets must be directed.

Table 5.4: Number of people to whom access must be extended by 2015

	Number of people to gain access to improved water supply (millions)			Number of people to gain access to improved sanitation (millions)		
Region	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Sub-Saharan Africa	175	184	359	178	185	363

Source: MDG Task Force on Water and Sanitation, 2005 (Adapted from WHO/UNICEF JMP 2004).

African and International Water Supply and Sanitation Targets

+ + Africa Water Vision, 2025

- - 25% reduction before 2005 of the populations having no access to a hygienic and suitable system of drinking water supply and sanitation.
- - 75% reduction before 2015 and 95% before 2025 of the populations having no access to a hygienic and suitable system of drinking water supply and sanitation.

+ + UN Millennium Development Goal (2000)

'Reduce by half, by 2015, the proportion of people without sustainable access to safe drinking water.'

+ + World Summit on Sustainable Development, Plan of Action (2002):

'... we agree to halve, by the year 2015, the proportion of people who are unable to reach or to afford safe drinking water (as outlined in the Millennium Declaration) and the proportion of people who do not have access to basic sanitation.'

African countries have responded to the Africa Water Vision and the MDGs by adopting their own targets in accordance with their economic and financial capabilities as shown in table 5.5. Apart from Nigeria, which adopted more ambitious targets of full coverage by 2011, most other African countries mainly adapted the African and international targets.

The AWV calls for reduction of the proportion of the population without access to safe and adequate water supply by 25 per cent by 2005. Malawi, for example, has boost clean water supply by 62 per cent (85 per cent in urban areas and 58 per cent in rural areas). Of the 58 per cent of the rural people with access to water, 18 per cent are served by gravity fed piped water schemes 31 per cent by boreholes and 9 per cent by shallow wells. In 1992, access to potable water supply was only 48 per cent. This is an increase of 14 per cent, which is above target. It is also estimated that 64 per cent of the population has access to some form of sanitation, although only 9 per cent is served through sewer-connected septic tanks. With regard to access to waterborne sanitation, the discrepancy between the levels of the rural and the urban service is very wide. Comparison with 1992 figures is difficult as the statistics for that period are not available. However, progress is considered to have been very slow in the area of sanitation, and the target of reducing the proportion of the population without access to safe and adequate sanitation by 25 per cent by 2005 would not be met (AWDR National Report, 2005). Tables 5.6 and 5.7 show countries that have made significant progress in increasing access to water supply and sanitation by at least 25 per cent during the period 1990-2002.

Measuring effectiveness of water

Table 5.5: Some National WSS Targets

Benin	Republic of Congo	Burundi	Nigeria
For 2025, • Urban population: 326 million m3/year • Rural population: 122 million m3/ year	• Reducing 25% of pop. not served by 2005; • Reducing 75% of pop. not served by 2015; • Reducing 95% of pop. not served by 2025.	• Reducing 25% of pop not served by 2005 • Reducing 75% of pop. not served by 2015; • Reducing 95% of pop. not served by 2025.	Increase coverage from 40% to 60% in 2003 Increase coverage to 80% by 2007 Full coverage of 100% by 2011

Source: AWDR National Reports, 2003

Table 5.6: African countries making progress in Drinking Water Coverage

African countries making rapid progress in drinking water coverage, 1990–2002

FIGURE 5 Countries that increased coverage by at least 25% between 1990 and 2002*

Country	Drinking water coverage (%) 1990	2002	% increase 1990-2002
Tanzania, United Republic of	38	73	92
Chad	20	34	70
Malawi	41	67	63
Angola	32	50	56
Central African Republic	48	75	56
Ghana	54	79	46
Eritrea	40	57	43
Mali	34	48	41
Kenya	45	62	38
Namibia	58	80	38
Mauritania	41	56	37
Burkina Faso	39	51	31
Uganda	44	56	27
Cameroon	50	63	26
Rwanda	58	73	26

* Table includes countries that increased coverage by at least 25% between 1990 and 2002. Countries with coverage higher than 80% in 1990 were not included, even though they may have increased coverage levels significantly. Nor does it include countries that may have made significant progress but for which data were insufficient to estimate a trend.

Source: MDG Task Force on Water and Sanitation, 2005

Table 5.7: Progress in Sanitation Coverage in a developing country context

Countries making rapid progress in sanitation

FIGURE 13 Countries that increased coverage by at least 25% between 1990 and 2002*

	Sanitation coverage (%)		% increase
Country	**1990**	**2002**	**1990-2002**
Myanmar	21	73	248
Benin	11	32	191
Madagascar	12	33	175
India	12	30	150
Cameroon	21	48	129
Haiti	15	34	127
Nepal	12	27	125
Bangladesh	23	48	109
China	23	44	91
Viet Nam	22	41	86
Congo, Dem. Rep. of the	18	29	61
Kiribati	25	39	56
Mauritania	28	42	50
Senegal	35	52	49
Pakistan	38	54	42
Nicaragua	47	66	40
Honduras	49	68	39
Yemen	21	30	38
Bolivia	33	45	36
Ghana	43	58	35
Philippines	54	73	35
Paraguay	58	78	34
Sri Lanka	70	91	30
Côte d'Ivoire	31	40	29
Ecuador	56	72	29
Malawi	36	46	28
Egypt	54	68	26
Mali	36	45	25
Namibia	24	30	25

*Countries that increased coverage by at least 25% between 1990 and 2002 and that had at least 25% coverage in 2002. Table includes only countries for which data were sufficient to estimate trends.

Source: MDG Task Force on Water and Sanitation, 2005

management actions

Ensuring the safety and quality of water supplied to communities is an important consideration in protecting human health and well-being, but it is not the only factor that affects consumers. Access to water is of paramount concern and other factors, such as the population served, the reliability of the supply and the cost to the consumer must also be taken into account. The United Nations Conference at Mar del Plata in 1977 fully adopted the following philosophy:

"All peoples, whatever their stage of development and social and economic condition, have the right to have access to drinking-water in quantities and of a quality equal to their basic needs."

Access to water may be restricted in several ways, such as prohibitive charges, daily or seasonal fluctuations in availability or lack of supplies to remote areas. Most African countries face problems of this sort. In most communities where water is scarce and has to be transported over long distances by road or foot, the cost of drinking water may absorb a substantial proportion of the average daily income. Elsewhere, a combination of seasonal, geographical and hydrological factors may deny individual households or entire communities a continuous, reliable supply of drinking water. During the dry season, spring sources may dwindle, reservoirs may become exhausted and excessive demands by some groups of people may limit supplies to their neighbours. Such problems are not confined to poorer countries; they are also experienced with increasing frequency in industrialized countries where management of demand has failed or population growth has outpaced the development of water resources.

Box 5.5: Definition of some key concepts in the Republic of the Congo

1 - Direct access to drinking water or sanitation

The definition of the concept «accessibility» to drinking water or to sanitation has undergone a meaningful evolution these last years.
At the launching of DIEPA (1980), the accessibility was defined as the distance to cover on foot, or the time taken between one's home and the water point or sanitation facilities.
In the early 1990s (see Biblio.1), the notion of acceptable water quantity ranging from 15 to 50 litres/pers/day was included in the definition.
At the end of the 1990s, (see Biblio.2), the notion of financed accessibility linked to branching cost to the price to pay for water and the capacity for households to pay, has been added to the initial definition.
In the context of this report, two definitions will be used:

2 - Direct access in the urban environment: to have a point of water drawing (SNDE branching) at home/compound, or sanitation works.

3 - Direct access in rural area: to have a point of water drawing from a village hydraulic works or sanitation works at less than 500 m from home.

4 - Sanitation: This notion is limited to the drainage of wastewater, excreta and rainwater.
Therefore, only the following measures are considered as sanitation measures, in the framework of this rapport:
- Junction to main sewer network
- Junction to autonomous works (septic tanks, latrines with waterproof or improved pits)
- Junction to networks of open main sewer for the evacuation of rainwater.

5 Acceptable minimal water quantity: It is the minimal quantity of water considered as necessary to meet the priority and vital needs of humans. For the Republic of the Congo, the acceptable minimum quantity is 20 litres/day/person

In order to properly evaluate the performance of a community water-supply system, a number of factors must be considered. Some countries have developed national strategies for the surveillance and quality control of water supply systems and have adopted quantitative service indicators for application at community, regional and national levels. These usually include:

(a) Quality: The proportion of samples or supplies that comply with guideline values for drinking-water quality and minimum criteria for treatment and source protection;
(b) Coverage: The percentage of the population with a recognizable (usually public) water-supply system quantity: the average volume of water used by consumers for domestic purposes (expressed as litres per capita per day).
(c) Continuity: The percentage of the time during which water is available (daily, weekly or seasonally).
(d) Cost: The tariff paid by domestic consumers.

These service indicators provide the basis for setting targets for community water supplies. They serve as a quantitative guide to the comparative efficiency of water-supply agencies and provide consumers with an objective means of measuring the quality of the overall service and thus the degree of public health protection afforded. In Burundi, for example, general access to urban water supply is estimated at 97 per cent but when quality is considered, through improved assessment, the figure comes to about 76 per cent (AWDR National Report, 2003). In the case of sanitation coverage, the difference of about 67.7 per cent between access to general sanitation (89.4 per cent) and hygienic sanitation (21.7 per cent) is surprisingly large. Noteworthy is the fact that traditional latrines account for 87.49 per cent of the

coverage rate of the national population and 97.87 per cent of that of the population covered.

The vital link between low access to water and sanitation services with high incidence of water-related diseases has already been mentioned and need not be overstated. It is therefore important to identify vicinities where the need for quick action to improve domestic water supply and sanitation is greatest and focus on the links between water supply, sanitation, and health. This is because spending resources on locations with both low levels of access to improved services and high prevalence of water-related diseases is most likely to have a substantial public health impact. In assessing the link between water supply services and the incidence of diarrhoea, for example, nine countries were identified where water supply coverage is less than 50 per cent and diarrhoea prevalence 20 per cent - 40 per cent of households. Of these, eight are in Africa, namely, Angola, Burkina Faso, Chad, the Congo, Ethiopia, Eritrea, Guinea, and Mauritania. A similar analysis for sanitation services suggests a greater number of countries in need of urgent action; 15 nations have coverage rates below 50 per cent and diarrhea prevalence ranges from 20 per cent to 40 per cent. As with water supply, all "high-need" countries identified in connection with sanitation are in Africa and Asia. In Africa, these include Angola, Benin, Burkina Faso, Central African Republic, Chad, Congo, Ethiopia, Eritrea, Mauritania, Mozambique, Namibia, the Niger, and Togo (MDG Task Force on Water and Sanitation, 2005).

It is however encouraging to note that Africa has made a significant and steady progress in the eradication of the Guinea worm disease through improved drinking water and other actions. The number of people suffering from this disease has been reduced by 99 per cent, from an estimated 3.5 million cases in 1986 to less than 35,000 reported cases in 2003 (ibid).

Women and Water

The development of waterworks is of particular importance to women who, in most countries, do most of the water carrying and water-related housework such as cooking and washing. Furthermore, since women do housework and raise children, keeping their children clean and houses sanitary depends largely on their awareness. Development of waterworks benefits women the most and, therefore, without their cooperation, sustainable development of waterworks is difficult to achieve (Yamamura S. T. el al, 2002). In many rural areas, where communities maintain small-scale waterworks facilities, women are often responsible for the facilities, from the maintenance to usage. Water supply projects in rural areas are also considered Women in Development (WID) projects.

Large-scale waterworks or the construction of waterworks in urban areas are generally considered as part of infrastructure development and, therefore, seem to have little to do with women, although considering the primary object of WID and viewpoints of women themselves, women are obviously linked to every water project. It is women who primarily use water, and waterworks should benefit them the most. Therefore, women's opinions and experiences are very useful for basic research necessary for waterworks projects: How much they use water daily, how often they fetch water, the purpose, what kind of facilities are useful and whether or not they can afford the water charges are essential considerations.

There is no doubt that small-scale waterworks facilities in rural areas, such as utilization of shallow wells or spring water, are more deeply related to women. Recent water supply projects in rural areas have adopted community-participated methods in which development of water-supplying facilities, hygiene education, and WID are integrated (ibid). Box 5.6 states more on African initiatives on gender mainstreaming challenges in water resources management.

Box 5.6

Gender and Water Resources Management – Mainstreaming Gender in Africa's Water Policies, Programmes and Projects

Limited access to water and sanitation by women results in health hazards to the population. The time spent fetching water results in low school attendance for girls, limited income-generating opportunity for women and increased levels of food insecurity. The African Ministers' Council on Water (AMCOW) therefore recognizes the need to promote gender mainstreaming in water resources management[1] as part of the challenge to guarantee access to water for all and to reduce by halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation (target 10 of the Millennium Development Goals). During the Pan-African Implementation and Partnership Conference on Water in December 2003, in Addis Ababa, the Ministers committed themselves to ensuring that gender concerns are taken into account in policy formulation in all sectors of water, sanitation, human settlements, agriculture and food security, including the harmonization of policies and laws and the domestication of international treaties in order to create equity and equality by 2025.

Through the adoption of the Africa Water Vision 2025, they once more committed themselves to mainstreaming gender concerns in Africa's country water activities. Women are explicitly encouraged to take on key positions and functions in decision making on water issues and adequate stakeholder involvement, particularly by women and youth, in water resources management is encouraged. The Beijing Platform for Action, which was adopted by all United Nations member States during the Fourth World Conference on Women in 1995, further calls for the integration of women in decision making for sustainable resource management and the promotion of knowledge on the role, particularly of rural and indigenous women, in food production, irrigation, watershed management, and sanitation.

Within the context of these commitments, UN Water/Africa and ECA organized a seminar on Gender and Water Resources Management in Africa in March 2005 to translate these commitments into a 10-year Action Plan for Mainstreaming Gender in Africa's Water Policies, Programmes and Projects. The Action Plan coincides with the International Decade for Action 'Water for Life,' 2005-2015.

Within this decade, the African Water Ministers and their partners are called upon to mainstream gender in integrated water resources management:

(a) To develop and promote practical guidelines to mainstream gender in integrated water resources management;

(b) To assess the gender-sensitivity of current national, basin and (sub)regional water policies, programmes, projects, and legislation;

(c) To assess the degree of harmonization of water policies and legislation with other government policies and legislation that affect women and men;

(d) To review the gender-sensitiveness of national and (sub)regional water policies, programmes, projects, and legislation and to harmonize them with other government policies and legislation.

The Action Plan further calls for the promotion of information and knowledge management systems as these systems can support the mainstreaming of gender in the water sector by:

(a) Documenting best practices on gender and water resources management;

(b) Undertaking gender-sensitive research;

(c) Developing gender and water monitoring indicators and monitoring mechanisms;

(d) Collecting gender-disaggregated data on water and sanitation;

(e) Providing gender training to water experts and providing leadership training to female water experts to encourage their role in decision-making.

Contributed by Saskia Stevens. UNECA, Subregional Office, Lusaka

Making Water Safe in African Traditional Ways – Integrating Indigenous Knowledge

African rural communities have for long used simple and rudimentary treatment techniques to filter out visible impurities from water collected from local sources. Although these traditional methods are expedient and can remove certain types of particles in water, they do not necessarily provide water that would be considered as being of drinking quality. However, the water provided by these methods have quality acceptable to these rural communities and, in most cases, would require only a further simple step of disinfection, to become free of pathogens. Vigneswaran S. & Sundaravadivel M (2002) describe some of the traditional treatment methods as follows:

(a) Filtration through winnowing sieve (used widely in Mali).
(b) Filtration through cloth (commonly used in villages in Mali and the southern part of Niger).
(c) Filtration through clay vessels (used in Egypt).

Filtration through winnowing sieve: This type of filtration is used when the water source is polluted by wind-borne impurities such as dry leaves, stalks, and coarse particles. The raw water is passed through a winnowing sieve, and the impurities are filtered. This type of filter is widely used in villages of the Bamako area in Mali. This method cannot be used when the raw water is highly turbid or muddy, since the sieve cannot filter fine suspended particles in raw water.

Filtration through cloth: Thin white cotton cloth or a discarded garment is used as the filter medium. This filter can filter raw water containing such impurities as plant debris, insects, dust particles or coarse mud particles. Filtration of suspended particles present in water can be achieved only to a very small extent. Therefore, this type of filtration is not suitable for highly turbid water. It is most suitable for filtration of well water. The practice of cloth filtration is quite common in villages in India, Mali, the southern part of the Niger and many other parts of the developing world. In some Indian villages, if the raw water is muddy and highly odorous, wood ash of the Sal tree (*Shora robuta*) is mixed with the water which is subsequently filtered through cloth.

Filtration through clay vessels: Clay vessels with a suitable pore size are sometimes used to filter highly turbid water. Turbid water is collected in a big clay jar where it is allowed to settle down and to trickle through the porous clay wall of the jar. This trickled water is collected in a vessel (usually a clay pot) by placing it at the bottom of the porous clay jar. This method of water treatment is common in Egypt.

Major Problems of Sustainable Water and Sanitation Development

As described earlier, IWSSD's big strides in finding affordable technologies and developing participatory approaches helped those without access to improved water and sanitation services. The Global Water Supply and Sanitation Assessment 2000 presented the findings of the fourth assessment by the WHO and UNICEF Joint Monitoring Programme.

The Assessment identified the following constraints to improving water and sanitation systems in the world, with emphasis on the developing countries:

(a) Financial difficulties;
(b) Institutional problems;
(c) Inadequate human resources
(d) Lack of sector coordination;
(e) Lack of political commitment;
(f) Insufficient community involvement;
(g) Inadequate operation and maintenance;
(h) Lack of hygiene education;
(i) Poor water quality; and
(j) Insufficient information and communication (Yamamura S. T. el al, 2002).

In addition, there are many barriers to expanding access to improved sanitation services, including:

(a) Lack of political will;
(b) Low prestige and recognition;
(c) Poor policy at all levels;
(d) Weak institutional framework;
(e) Inadequate and poorly used resources;
(f) Inappropriate approaches;
(g) Failure to recognize defects of current excreta management systems;
(h) Neglect of consumer preference;
(i) Ineffective promotion and low public awareness; and
(j) Women and children (ibid.).

An understanding of the reasons for the apparent low demand is first required before it can be determined whether changes can be brought about through political, financial or technical means, or simply by improving information. People may sincerely want sanitation, but lack the financial or political capacity to obtain it. Some may want safe excreta management facilities, but not at the prevailing price. Others may not want the available "improvements" at any price.

Cultural beliefs have a strong impact on sanitation, and even the ability to discuss the subject. In many cultures, the handling of excreta is considered a taboo, disgusting or a dangerous nuisance that should not be talked about. No one wants to be associated with excreta. Association may stigmatize those who reduce its offensive characteristics for others. Problems cannot be solved if people do not want to talk about them and be associated with their solution. In many contexts, taboos including modern technological ones block the safe recovery of valuable agricultural resources from human wastes. In order to counter the excreta taboo, education is required to promote sanitation and hygiene which should link the value of excreta (feces and urine) with ecology and health protection. Three principles are fundamental to the creation of socially, economically and ecologically sustainable sanitation systems, namely:

(a) Equity. All segments of society have access to safe, appropriate sanitation systems adapted to their needs and means;
(b) Health promotion and protection from disease. Sanitation systems should prevent users and other people from contracting excreta-related diseases and should interrupt the cycle of disease transmission; and
(c) Protection of the environment. Sanitation systems should neither pollute ecosystems nor deplete scarce resources (ibid).

Four major challenges face the water supply and sanitation sector in the coming years. These are:

(a) Keeping pace with a net population growth of more than a billion people over the next 15 years;
(b) Closing the coverage and service gap, with emphasis on sanitation which lags far behind water supply;
(c) Ensuring sustainability of existing and new services; and
(d) Improving the quality of services.

Meeting the Basic Water Needs - Mauritius

Actual and total water supply coverage (urban, rural disparities)

To date, water supply coverage is 54% of the total population in the urban areas. Both surface and groundwater sources are being exploited to cater for demand in urban and rural areas.

Actual and total sanitation coverage (urban, rural disparities)

Both the urban and the rural people have access to proper sanitation facilities, either through connection to the sewer network (21% - 2004 figures), septic tanks or absorption pits. The 21% served by the under sewer network are mostly in the urban areas. However, the Wastewater Management Authority is planning to improve connection to 50% by the year 2010.

Percentage or number of people not served with improved drinking water and extension of piped water supply

A total of 85% of the people have access to piped supply within their housing premises, the remaining 15% get the water either from public fountains and water tankers operated by the Central Water Authority. The break-down is as follows:

In yard	14.5%
Public fountain & Water tanker	0.5%

Proportion of urban population with access to improved water supply and sanitation

Improved water supply:	Urban	100%
	Rural	85%
Improved Sanitation:	Urban	100%
	Rural	100%

Basic water needs in Botswana

Basic water needs are being met through two interrelated policies. Firstly, reticulated water supply systems are constructed, maintained and, where necessary, upgraded in all settlements with more than 250 inhabitants. The norm is that all persons should have access to a water point within 500 meters form their home. Secondly, water tariffs are set in such a way that basic water needs are affordable. For this reason, water from standpipes in rural villages is free, and in urban areas there is a nominal monthly fee that also includes other services. In addition, water charges for the lifeline band (up to 5 m^3) are low and sub-economic (through cross subsidization by large users, including government).

A comparison of the Population Census of 1991 and 2001 shows that the percentage of households with access to piped or tap drinking water increased significantly during the last decades: 1981: 56%; 1991: 77% and 2001 87.7% (Kelekwang and Gowera, 2003). The 2001 figures are as follows:

(a) Urban areas: 99.5% with access to safe piped and tap water;
(b) Large rural villages: 96.7% access with access to such water;
(c) Rural villages: 73.3% access.

Households without piped or tap water mostly rely on boreholes (5.1%), wells (1.8%), tankers (0.8%) or other water points (4.5%) (ibid). Boreholes, in particular, are considered safe and reliable water sources.

MEETING THE MDG DRINKING WATER AND SANITATION TARGET – WHAT INCREASE IS NEEDED IN AFRICA?

DRINKING WATER

Region	Coverage in 1990 (%)	Coverage in 2002 (%)	Projected coverage in 2015 (%)	MDG attained target (%)	Population served and unserved in 2002 (thousands)		Projected population served and unserved in 2015 (thousands)		Annual increase in people served 1990–2002 (thousands)	Annual increase needed in people served 2002–2015 to reach the MDG drinking water target (thousands)
					Served	Unserved	Served	Unserved		
Northern Africa	88	90	92	94	132 941	14 378	168 395	14 643	2 383	3 009
Sub-Saharan Africa	49	58	68	75	396 824	287 944	613,022	288 481	12 524	21 485

SANITATION

Region	Coverage in 1990 (%)	Coverage in 2002 (%)	Projected coverage in 2015 (%)	MDG attained target (%)	Population served and unserved in 2002 (thousands)		Projected population served and unserved in 2015 (thousands)		Annual increase in people served 1990–2002 (thousands)	Annual increase needed in people served 2002–2015 to reach the MDG sanitation target (thousands)
					Served	Unserved	Served	Unserved		
Northern Africa	65	73	82	83	108 485	38 834	150 091	32 947	2 632	3 341
Sub-Saharan Africa	32	36	40	66	247 544	437 224	360 601	540 902	7 011	26 727

AFRICA'S DRINKING WATER AND SANITATION COVERAGE ESTIMATES

Region	1990 population (thousands)				2002 population (thousands)			
	Total population	*Population served*	*Population unserved*	*% served*	*Total population*	*Population served*	*Population unserved*	*% served*
Northern Africa								
Urban water supply	57 853	54 960	2 893	95	76 606	73 542	3 064	96
Rural water supply	60 215	49 376	10 839	82	70 713	59 399	11 314	84
Total water supply	118 068	104 336	13 732	88	147 319	132 941	14 378	90
Urban sanitation	57 853	48 597	9 256	84	76 606	68 179	8 427	89
Rural sanitation	60 215	28 301	31 914	47	70 713	40 306	30 407	57
Total sanitation	118 068	76 898	41 170	65	147 319	108 485	38 834	73
Sub-Saharan Africa								
Urban water supply	141 223	115 803	25 420	82	239 669	196 529	43 140	82
Rural water supply	363 146	130,733	232 413	36	445 099	200 295	244 804	45
Total water supply	504 369	246 536	257 833	49	684 768	396 824	287 944	58
Urban sanitation	141 223	76 260	64 963	54	239 669	131 818	107 851	55
Rural sanitation	363 146	87 155	275 991	24	445 099	115 726	329 373	26
Total sanitation	504 369	163 415	340 954	32	684 768	247 544	437 224	36

Source: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Water for life: Making it Happen. World Health Organization and UNICEF, 2005

Country Estimates on Water and Sanitation in Africa (2002)

Countries, areas and territories	Year	Population: Total (thousands)	Population: Urban %	Population: Rural %	Improved Drinking Water Coverage: Total: Total %	Total: Household Connection %	Urban: Total %	Urban: Household Connection %	Rural: Total %	Rural: Household Connection %	Improved Sanitation Coverage: Total %	Urban %	Rural %
Algeria	1990	25,017	51	49	95	62	99	83	92	39	88	99	76
	2002	31,266	58	42	87	76	92	87	80	60	92	99	82
Angola	1990	9,340	26	74	32	1	11	1	40	0	30	62	19
	2002	13,184	35	65	50	5	70	13	40	1	30	56	16
Benin	1990	4,650	34	66	60	6	71	17	54	1	11	31	1
	2002	6,558	44	56	68	12	79	26	60	1	32	58	12
Botswana	1990	1,354	42	58	93	25	100	40	88	13	38	61	21
	2002	1,770	51	49	95	46	100	62	90	28	41	57	25
Burkina Faso	1990	8,921	14	86	39	4	63	25	35	1	13	47	8
	2002	12,624	17	83	51	4	82	23	44	0	12	45	5
Burundi	1990	5,609	6	94	69	3	96	31	67	1	44	42	44
	2002	6,602	10	90	79	4	90	41	78	1	36	47	35
Cameroon	1990	11,661	40	60	50	11	77	25	32	2	21	43	7
	2002	15,729	51	49	63	15	84	28	41	2	48	63	33
Cape Verde	1990	349	44	56	-	-	-	-	-	4	-	-	-
	2002	454	55	45	80	24	86	41	73	4	42	61	19
Central African Republic	1990	2,943	37	63	48	1	70	2	35	0	23	32	18
	2002	3,819	42	58	75	4	93	9	61	0	27	47	12
Chad	1990	5,822	21	79	20	1	45	6	13	0	6	27	1
	2002	8,348	25	75	34	5	40	19	32	0	8	30	0
Comoros	1990	527	28	72	89	18	99	32	85	12	23	41	16
	2002	747	34	66	94	25	90	47	96	14	23	38	15
Congo	1990	2,494	48	52	-	-	-	-	-	5	-	-	2
	2002	3,633	53	47	46	33	72	58	17	5	9	14	2
Congo, Democratic Republic of the	1990	37,370	28	72	43	25	92	89	24	0	18	56	3
	2002	51,201	31	69	46	10	83	32	29	1	29	43	23
Côte d'Ivoire	1990	12,505	40	60	69	24	74	52	66	5	31	52	16
	2002	16,365	44	56	84	33	98	65	74	9	40	61	23
Djibouti	1990	528	75	25	78	32	82	40	67	11	48	55	27
	2002	693	83	17	80	35	82	40	67	11	50	55	27
Egypt	1990	55,768	43	57	94	61	97	89	92	40	54	70	42
	2002	70,507	42	58	98	80	100	98	97	67	68	84	56
Equatorial Guinea	1990	354	35	65	-	4	-	12	-	0	-	-	-
	2002	481	47	53	44	8	45	17	42	0	53	60	46
Eritrea	1990	3,103	16	84	40	6	60	40	36	0	8	46	0
	2002	3,991	20	80	57	8	72	42	54	0	9	34	3
Ethiopia	1990	48,856	13	87	25	1	80	4	16	0	4	14	2
	2002	68,961	15	85	22	4	81	23	11	0	6	19	4
Gabon	1990	953	68	32	-	-	95	-	-	-	-	-	-
	2002	1,306	83	17	87	45	95	52	47	8	36	37	30
Gambia	1990	936	25	75	-	-	95	-	-	3	-	-	-
	2002	1,388	26	74	82	12	95	39	77	3	53	72	46
Ghana	1990	15,277	36	64	54	14	85	35	36	2	43	54	37
	2002	20,471	45	55	79	24	93	50	68	3	58	74	46
Guinea	1990	6,122	25	75	42	10	70	37	32	2	17	27	13
	2002	8,359	34	66	51	8	78	23	38	1	13	25	6
Guinea-Bissau	1990	1,016	24	76	-	-	-	-	-	0	-	-	-
	2002	1,449	33	67	59	5	79	15	49	0	34	57	23
Kenya	1990	23,585	25	75	45	22	91	58	30	11	42	49	40
	2002	31,540	38	62	62	29	89	56	46	12	48	56	43
Lesotho	1990	1,570	17	83	-	7	-	31	-	2	37	61	32
	2002	1,800	18	82	76	7	88	31	74	2	37	61	32
Liberia	1990	2,135	42	58	56	11	85	21	34	3	38	59	24
	2002	3,239	46	54	62	1	72	1	52	0	26	49	7
Libyan Arab Jamahiriya	1990	4,306	80	20	71	54	72	54	68	55	97	97	96
	2002	5,445	86	14	72	54	72	54	68	55	97	97	96

Country Estimates on Water and Sanitation in Africa (cont...)

Countries, areas and territories	Year	Population: Total (thousands)	Population: Urban %	Population: Rural %	Improved Drinking Water Coverage: Total: Total %	Improved Drinking Water Coverage: Total: Household Connection %	Improved Drinking Water Coverage: Urban: Total %	Improved Drinking Water Coverage: Urban: Household Connection %	Improved Drinking Water Coverage: Rural: Total %	Improved Drinking Water Coverage: Rural: Household Connection %	Improved Sanitation Coverage: Total %	Improved Sanitation Coverage: Urban %	Improved Sanitation Coverage: Rural %
Madagascar	1990	11,956	24	76	40	8	82	30	27	1	12	25	8
	2002	16,916	26	74	45	5	75	14	34	1	33	49	27
Malawi	1990	9,456	12	88	41	6	90	33	34	2	36	52	34
	2002	11,871	16	84	67	9	96	45	62	2	46	66	42
Mali	1990	9,046	24	76	34	2	50	8	29	0	36	50	32
	2002	12,623	32	68	48	10	76	27	35	1	45	59	38
Mauritania	1990	2,030	44	56	41	9	19	18	57	3	28	31	26
	2002	2,807	60	40	56	22	63	29	45	11	42	64	9
Mauritius	1990	1,057	40	60	100	-	100	98	100	-	99	100	99
	2002	1,210	43	57	100	78	100	74	100	82	99	100	99
Morocco	1990	24,564	48	52	75	41	94	75	58	9	57	87	28
	2002	30,072	57	43	80	57	99	92	56	12	61	83	31
Mozambique	1990	13,465	21	79	-	-	-	-	-	2	-	-	14
	2002	18,537	34	66	42	11	76	28	24	2	27	51	14
Namibia	1990	1,409	27	73	58	31	99	83	43	12	24	68	8
	2002	1,961	32	68	80	39	98	76	72	21	30	66	14
Nicaragua	1990	3,824	53	47	69	54	92	89	42	15	47	64	27
	2002	5,335	57	43	81	62	93	86	65	31	66	78	51
Niger	1990	7,650	16	84	40	3	62	19	35	0	7	35	2
	2002	11,544	22	78	46	8	80	35	36	0	12	43	4
Réunion	1990	604	81	19	-	-	-	-	-	-	-	-	-
	2002	745	91	9	-	-	-	-	-	-	-	-	-
Rwanda	1990	6,775	5	95	58	1	88	24	57	0	37	49	36
	2002	8,272	16	84	73	6	92	34	69	1	41	56	38
Sao Tome and Principe	1990	116	37	63	-	-	-	-	-	-	-	-	-
	2002	157	38	62	79	25	89	34	73	19	24	32	20
Senegal	1990	7,345	40	60	66	22	90	50	50	4	35	52	23
	2002	9,855	49	51	72	40	90	71	54	11	52	70	34
Seychelles	1990	71	50	50	-	-	100	100	-	-	-	-	100
	2002	80	50	50	87	87	100	100	75	75	-	-	100
Sierra Leone	1990	4,054	30	70	-	-	-	-	-	1	-	-	-
	2002	4,764	38	62	57	12	75	30	46	1	39	53	30
Somalia	1990	7,163	29	71	-	1	-	3	-	0	-	-	-
	2002	9,480	34	66	29	1	32	3	27	0	25	47	14
South Africa	1990	36,848	49	51	83	58	99	94	67	23	63	85	42
	2002	44,759	56	44	87	60	98	82	73	31	67	86	44
Sudan	1990	24,927	27	73	64	34	85	75	57	19	33	53	26
	2002	32,878	38	62	69	26	78	46	64	13	34	50	24
Swaziland	1990	847	23	77	-	-	-	-	-	-	-	-	-
	2002	1,069	23	77	52	26	87	67	42	13	52	78	44
Tanzania, United Republic of	1990	26,068	22	78	38	10	79	30	27	4	47	51	45
	2002	36,276	34	66	73	16	92	44	62	2	46	54	41
Togo	1990	3,455	29	71	49	4	81	14	37	0	37	71	24
	2002	4,801	35	65	51	4	80	12	36	0	34	71	15
Tunisia	1990	8,207	58	42	77	64	93	91	57	28	75	95	47
	2002	9,728	63	37	82	70	94	93	60	30	80	90	62
Uganda	1990	17,359	11	89	44	3	79	24	40	0	43	54	41
	2002	25,004	12	88	56	1	87	8	52	0	41	53	39
Western Sahara	1990	207	88	12	-	-	-	-	-	-	-	-	-
	2002	301	93	7	-	-	-	-	-	-	-	-	-
Zambia	1990	8,200	39	61	50	22	86	51	27	2	41	64	26
	2002	10,698	35	65	55	18	90	47	36	2	45	68	32
Zimbabwe	1990	10,467	29	71	77	33	99	95	69	8	49	69	40
	2002	12,835	34	66	83	35	100	91	74	5	57	69	51

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PROTECTING ECOSYSTEMS IN AFRICA

The previous chapter mentioned ecosystem health and advised that, in order to maintain environmental health, sanitation systems should not be allowed to pollute ecosystems and scarce resources should not be depleted. The Rio Declaration of 1992 and the Bonn Recommendations of 2001 stated in the box below uphold these views. This is a challenge that many African nations have to contend with as they face serious environmental problems, which do not only affect their socio-economic development, but also cause global concerns. The principal environmental problems are deforestation, land (soil) degradation, water resource degradation, unsustainable use of land and water resources, and loss of biological diversity (ECA, 1999). According to the United Nations Environment Programme (UNEP), the area prone to desertification worldwide is approximately 38 million km^2 and 6.9 million km^2, of which 23 per cent is in sub-Saharan Africa. Concerns have been expressed about Africa's huge natural resources, including the fact that Africa's soil resources are very fragile and sensitive to unwise use, that sub-Saharan Africa's fuelwood consumption runs 30 - 200 per cent ahead of the average increase in trees, that Africa loses an estimated 5 million hectares of tropical forest a year and that land degradation is estimated to affect about 230 million hectares annually (Nana-Sinkam, 1995*)*. As for water resources per se, the growing demand for water, the general diminution of atmospheric humidity and the environmental threats to climate variations and change pose challenges to the management of water resources and to meeting competing demands for basic water supply and sanitation, for food security and for economic development in the continent.

Rio Declaration of Environment and Development (1992):
'States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem.'

Bonn Recommendations for Action (2001):
'Water governance arrangements should protect ecosystems and preserve or restore the ecological integrity of groundwater, rivers, lakes, wetlands and associated coastal zones.'

Environmental and land degradation

During the past 30 years, a huge proportion of Africa's land has been and yet more is being converted for agricultural use. By 1999, about 202 million hectares (ha), nearly a third of it arable, was being cultivated. Many marginal areas or important natural habitats such as wetlands and forests are being cleared, leaving the land increasingly prone to erosion. About 25 per cent of the land is now subject to water erosion and about 22 per cent to wind erosion. Desertification is currently affecting over 45 per cent of Africa, 55 per cent of which is at high or very high risk (UNEP GEO-3, 2002).

One of the underlying causes of this situation is inadequate management of natural resources on which a large part of the economy is based, especially in areas with high population density and growth rates. In the tropical rain forest areas of the continent, for example, deforestation continues at an alarming rate, leading to loss of productivity, of the irreplaceable biodiversity that is of immense benefit to the global gene bank and of the vegetation needed for balancing the earth's climate. The impact of this poor management and conversion of land, including marginal areas, leading to increased runoff, erosion, sedimentation and ultimate loss of productivity is becoming increasingly felt in areas with dense human settlement and inadequate or inappropriate cul-

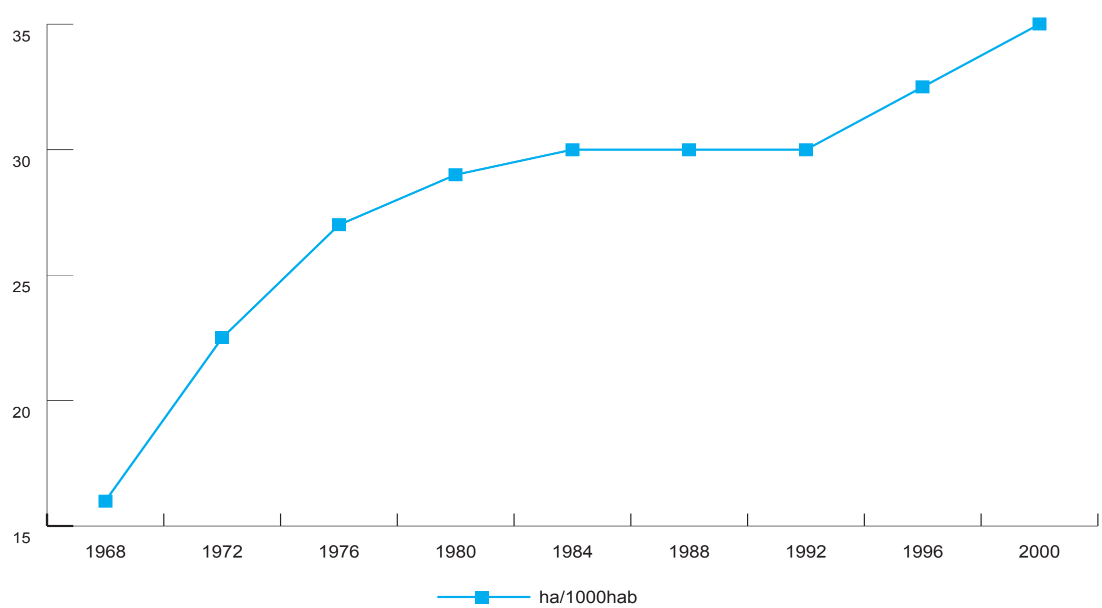
tivation methods. A chain action and reaction is going on with the productive capacity of the land falling because of shorter fallow rotations, low erratic rainfall, soil erosion, reduction of soil fertility by soil mining, declining soil organic matter content and overgrazing. It is estimated that Africa accounts for 27.4 per cent of the world's land degradation and that 500 million ha of land in Africa are moderately to severely degraded (UNEP, 2001).

The most serious effect of land degradation is soil degradation and it is estimated that 14 per cent of degraded soil results from vegetation removal, 13 per cent from overexploitation, 49.5 per cent from overgrazing and 24 per cent from agricultural activities (WRI, 1992). Soil losses are reportedly considerable in North Africa and East Africa. In Ethiopia and Uganda, soil erosion accounts for over 80 per cent of the cost of environmental degradation, estimated at about 1-4 per cent of GDP. Ethiopia is reportedly losing 1.9 billion tons of topsoil from the highlands annually, while Burundi is losing 80 to 150 tons/ha/year and Rwanda about 557 tons/ha/year (CT&E, 2000; CEDARE, 2000). In South Africa, soil losses are estimated to be as high as 400 million tons annually and in Malawi, soil losses range from 0 to 50 tons/ha/per/year (UNEP GEO-2000).

The water-retention capacity of soil is highly beneficial to agriculture. This capacity, which is also beneficial to groundwater levels that it helps to replenish, is removed by increased deforestation, mainly from harvesting of fuelwood, resulting in the lowering of groundwater levels in arid areas. Similarly, poor management of drylands in Africa, particularly in areas with high population growth rates, heightens the rate of desertification in these areas as more and more people and livestock encroach on the land. It is estimated that 72 per cent of the arable land and 31 per cent of the pastoral land in Africa are degraded (ECA, 2001).

Moreover, over-abstraction and/or over-regulation of the flow of surface waters affects the in-stream environment and downstream consumptive uses, exacerbates saltwater intrusion, affects the productivity of land in estuarine areas, and reduces the water's capacity for diluting waste discharges. Irrigation development, which is accompanied by the construction of numerous canals, is one way in which water is

Fig. 6.1: Evolution of per capita Irrigated areas in Morocco



abstracted and flow regulated. Irrigation requires large quantities of water and. there are, at present, more than 12.4 million hectares of irrigated lands in Africa, which require 140 km^3/year of freshwater. Much of this water is diverted from rivers, lakes and reservoirs and delivered to the fields by canals (Shiklomanov, 2002). The largest irrigated lands are in Egypt (more than 3.3 million hectares), the Sudan (1.9 million hectares), South Africa (1.3 million hectares), Morocco (1.2 million hectares) and Madagascar (1.1 million hectares). Irrigation development is intensive on the continent and has increased threefold during the last 30 years. There are sufficient reasons to assume that irrigation development will remain intensive in the future. The reasons are the rapid population growth, the ever-changing climate conditions, and the fact that increased agricultural production for food security cannot be achieved without irrigation in most African countries. (Shiklomanov, 2002). Using Morocco as an example, it can be seen from figure 6.1 that the extension of irrigated agriculture in Morocco steadily increased and more than doubled from 1968 to 2000 (National AWDR Report, 2005).

As in other dry regions, agriculture is the largest user of water in Africa, accounting for 88 per cent of total water use (WRI, UNEP, UNDP and WB 1998). However, with only 6 per cent of cropland under irrigation, the potential to increase food production through irrigation is considerable and, therefore, demand for water for irrigation will continue to grow in Africa. About 40-60 per cent of the region's irrigation water is currently lost through seepage and evaporation, adding to the other serious environmental problems of soil salinization and waterlogging, although water lost through seepage and evaporation may end up in aquifers where it can be pumped to irrigate nearby fields.

In many developing regions, traditional environmental health problems are now exacerbated by emerging problems of pollution from industry and agriculture. Chemical agents, particularly air-borne ones, are considered as major factors that cause and worsen tuberculosis, bronchitis, heart diseases, cancers and asthma. Tuberculosis, the single largest infectious killer of adults, was responsible for three million deaths in 1996, 95 per cent of which occurred in the developing world (WHO 1997). Exposure to pesticides, fertilizers and heavy metals poses health risks through soil, water, air and food contamination. Global pesticide use has resulted in 3.5-5 million acute pesticide poisonings per year (ibid. 1990).

Surface Water Ecosystems in Africa

Africa is a continent of contrasting landscapes. About half of its territory is made up of deserts and semi-deserts, with the Sahara Desert alone occupying an area of about 8 million sq. km. (Nana-Sinkam, 1995*)*. The central part of the continent, the Congo River Basin, is occupied by subtropical rain forests and the Congo River is the most full-flowing river in the Eastern Hemisphere. On the whole, Africa's runoff resources which account for its renewable freshwater sources are approximately 4050 cu. km/year. That is equal to 9.5 per cent of the total world river runoff. According to specific indices (per sq. km and per capita) Africa is one of the continents with the least river water availability, relating to Australia on aerial water availability and to Asia on river runoff per capita (Shiklomanov, 2002). The water availability of Africa is 2.4 times lower than that of the world land area (without Antarctica). Some characteristics of major natural lakes in Africa are shown in table 6.1.

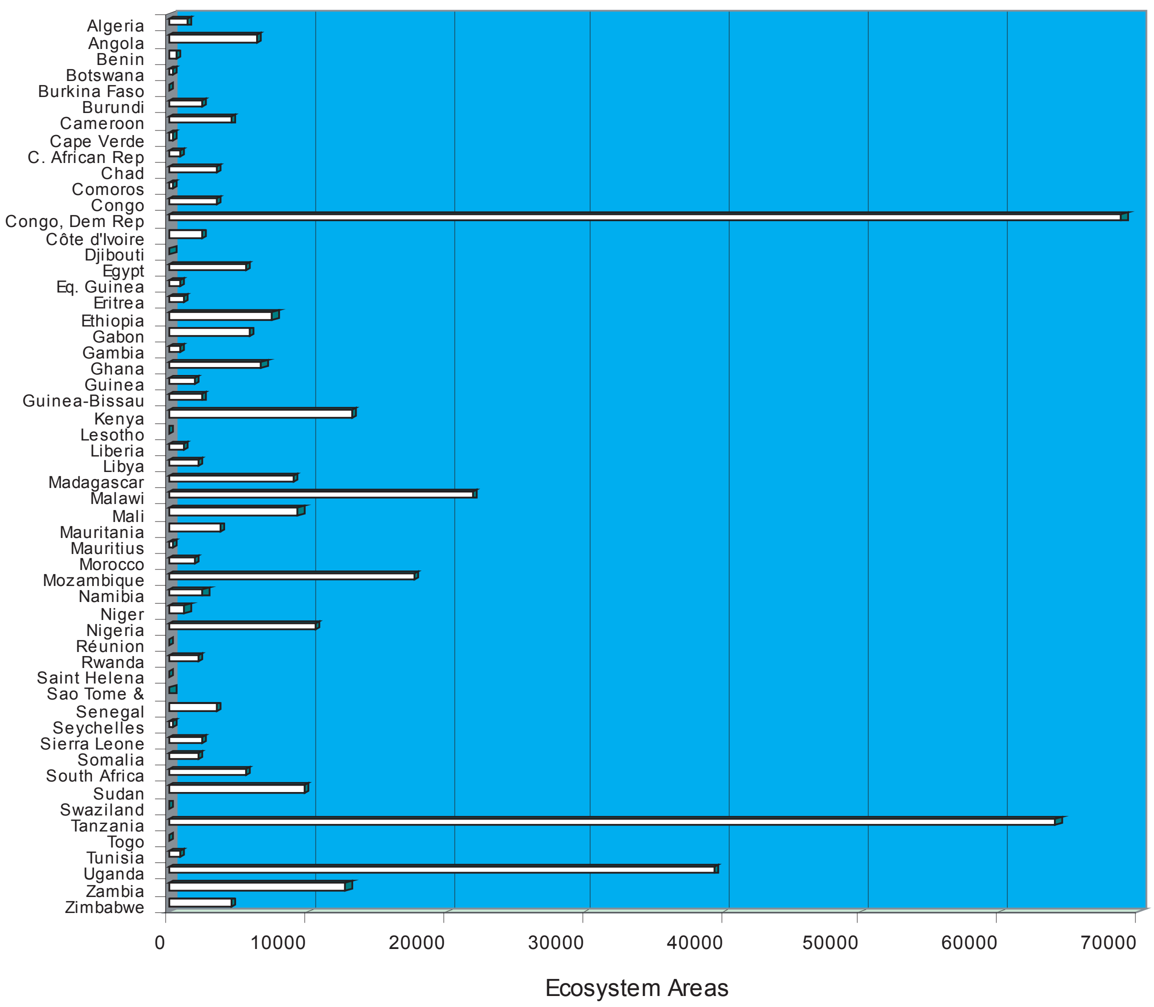
Table 6.1: Major Morphometric Characteristics of Large Natural Lakes of Africa

Lake	Volume, Km	Surface area, km^2	Max depth, m
Tanganyika	17800	32000	1471
Nyasa	8400	30900	706
Victoria	2750	68800	84
Kivu	569	2370	496
Albert	280	5300	58
Edward	78.2	2325	112
Chad	72.0	10000-25000	10-11
Shirva	45.0	1040	2.6
Shalla	37.0	409	266
Mweru	32.0	5100	15
Tana	28.0	3150	14
Katnit	14.0	1270	60
Abaya	8.20	1160	13
Bangweulu	5.00	4920	5
Langana	3.82	230	46.2
Fagibin	3.72	620	14
Hora-Abjyata	1.56	205	14.2
Avusa	1.34	130	21
Zwai	1.10	434	7
Upemba	0.90	530	3.5
Gjyer	0.64	213	7
Rudolf	-	8660	73
Rukwa	-	4500	-
Leopold II	-	2325	6

Source: Shiklomanov I.A., Regional Distribution of Rivers and Streams in Africa, 2002.

Wetlands are found in most African countries, the largest, including the Okavango Delta, the Sudd in the Upper Nile, the Lake Victoria and Lake Chad basins, and the floodplains and deltas of the Congo, the Niger and the Zambezi rivers. Despite being among the most biologically productive ecosystems in Africa, wetlands are often regarded locally either as wasteland, habitats for pests and threats to public health or as potential areas for agriculture. During the past two decades, for example, the Republic of Niger lost more than 80 per cent of its freshwater wetlands (GEO- 2000; Niger Ministry of Environment and Hydraulics 1997). Coastal wetlands in Egypt and Tunisia and freshwater wetlands in the Sudan are also under increasing threat. Freshwater ecosystems found in lakes, rivers and wetlands may be the most endangered of all ecosystems. The distribution of freshwater ecosystems in African countries is quite varied, with the Democratic Republic of the Congo, Tanzania and Uganda having the largest ecosystem areas, followed by countries such as Malawi, Mozambique, Kenya and Zambia (fig. 6.2).

Fig. 6.2: Freshwater Ecosystem Areas



Source: World Resource Institute; Loveland el al. 2000

Groundwater Ecosystems in the Congo

Geological characterization of the four main aquifer systems within the Congolese territory are roughly distributed as follows (AWDR National Report, 2003):

(a) Aquifers of the coastal sedimentary basin (Secondary, tertiary and quaternary): 6,000 km2;

(b) Aquifers of the sedimentary basin of the Congo River (Secondary, tertiary and quaternary): 224,000 km2;

(c) Aquifers of the series of old sedimentary (Upper precambrian) rocks: 68,000 km2;

(d) Aquifers of the crystalline and schistose crystalline (Middle and lower precambrian) rocks: 44,000 km2

Table 6.2: Water Balance of Large Aquifer Systems in the Congo

Aquifer Systems	P (mm)	ETR (mm)	P-ETR	Ie (mm)	Kr (%)
Coastal sedimentary basin	1280	895	385	367	5,5
Continental lands of the Congolese depression	1764	1102	661	640	1,2
Old sedimentary series	1510	1038	472	339	8,8
Crystalline and schistose crystalline rocks	1857	956	901	697	11,0

Source: AWDR National Report, 2003. Moukolo and al (1992) Note: P (mm): rainfalls in mm; ETR (mm): real evapotranspiration in mm; Ie (mm): effective infiltration in mm; Kr (%): percentage of runoff coefficient.

Depletion of Water Resources Through Human Action

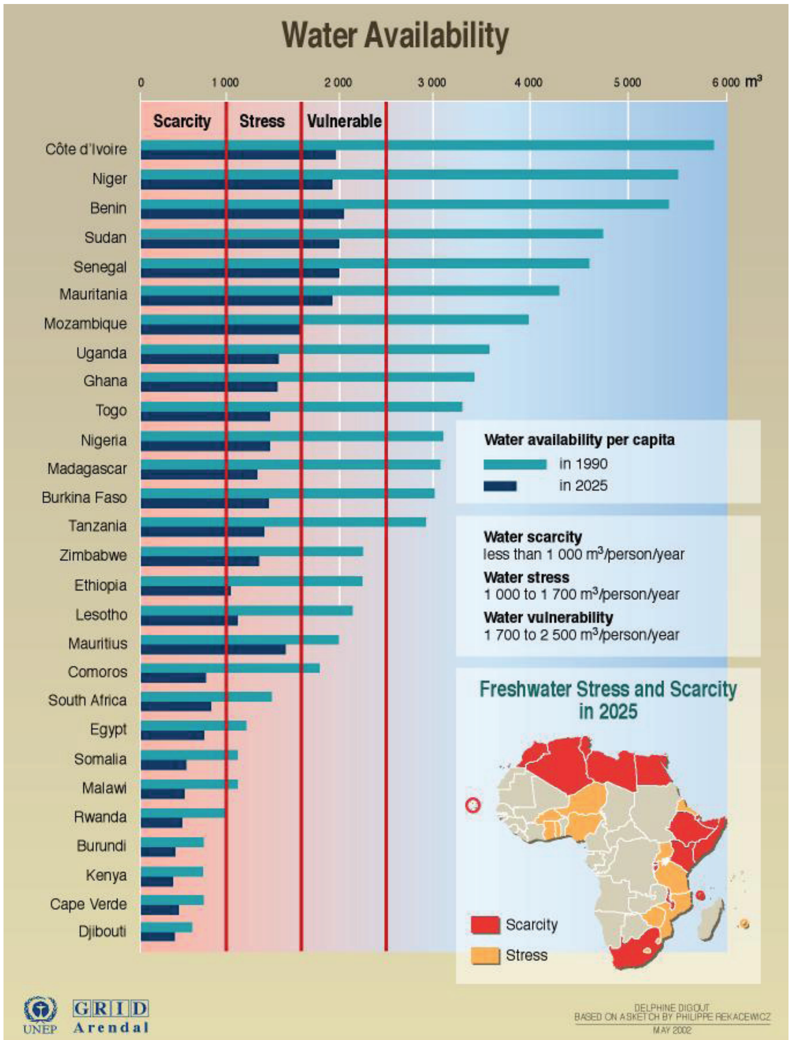
Available resources are being depleted through human action which reduce their quality as well as quantity. Water contamination is rife across the continent and result from industrial pollution, poor sanitation practices, discharges of untreated sewage, throwing of solid waste into storm drains and non-control of leachates from refuse dumps. A major problem is pollution from food processing waste and decay from aquatic life. These problems are compounded by poor land use and agricultural practices. As a consequence, concentrations of waste frequently exceed the ability of rivers to assimilate them, and water-borne and water-based diseases have become widespread. The consequent deterioration of water quality is a significant form of depletion since it reduces the availability of usable water resources, thus increasing the cost of their development and refinement and increasing scarcity. Figure 6.3 shows the dynamics of water availability and freshwater scarcity for the years 1990-2000.

The deterioration of the quality of water, especially surface waters, also results from eutrophication and the proliferation of invasive aquatic plants. Eutrophication is a factor mainly found in lakes. Water hyacinth has already seriously affected most water bodies like Lake Victoria, Lake Chivero and the Nile River. Future threats may include pollution from petroleum production and refineries, pollution from agricultural waste, such as fertilizer and pesticides, and pollution from small-scale industries dispersed in large urban areas. The impact of saltwater intrusion already mentioned is felt mostly along the Mediterranean coast and the oceanic islands such, as the Comoros, which are highly dependent on groundwater resources. It is due in part to overexploitation of groundwater resources.

Water Conservation in Africa

Human activity associated with the use of water bodies, through the construction of reservoirs, canals and various structures for water intake and discharge may cause great changes in the hydrographic network and river runoff regime. Reservoirs are an important component of the hydrographic network in Africa. There were no large reservoirs in Africa prior to the 1950s as most of Africa's large water projects started during the period 1954-1977. Four out of five of the world's largest reservoirs are in Africa. These include Lake Victoria at the Owen Falls Dam, lake Nasser on the Nile, Kariba lake on the Zambezi and Akosombo lake on the Volta (Shiklomanov, 2002). At present, about twenty reservoirs are under operation or construction, each having a capacity of more than 5 km^3. There are more than one hundred reservoirs in operation or construction have a capacity exceeding 100 mln m^3.

Figure 6.3: Water Availability and Freshwater Stress and Scarcity



Source: United Nations Economic Commission for Africa (UNECA), Addis Ababa ; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

The total capacity of the reservoirs in Africa exceeds 1000 km^3 which is about 20 per cent of the capacity of all reservoirs in the world. In terms of numbers, South Africa; Morocco and Algeria have constructed more reservoirs than the other African countries, but the reservoirs in these countries are not large; the largest reservoirs have been constructed in the countries shown in Table 6.3.

Most of the reservoirs developed in Africa are for power generation given the urgent need for cheaper energy and, also, the high hydroenergy potential of African rivers which are second only to Asia's in this regard, at the world scale. The Congo and Zambezi rivers have optimum resources for power generation. Large reservoirs greatly affect the hydrological river regimes, increasing possible use of river runoff and providing flood control. However, in a hot and dry climate, reservoirs may greatly reduce the total water resources in rivers due to intense evaporation from water surfaces. This is very significant for Africa where most large- and medium-sized reservoirs have been developed in plains and on plateaus where they have considerable water surfaces. Only the reservoirs in the countries mentioned earlier (South Africa; Morocco and Algeria) have been constructed in mountainous

areas. Most African reservoirs are of seasonal, weekly and daily storage regulation. Among the reservoirs of carry-over storage, the Nasser Reservoir on the Nile River should be mentioned. This reservoir which was built in the 1970s is of great importance for the economy of Egypt. The construction of multipurpose water management systems, including reservoirs and canals for river runoff redistribution in time and space (among various river basins), is the most effective way for man's impact on the hydrographic network (Shiklomanov, 2002). The largest multipurpose water management system in Africa, with water transfers is under operation in South Africa. This complicated hydraulic system consists of a reservoir, canals, tunnels, and pumping stations. It connects the Orange and Limpopo Rivers and other coastal rivers and is intended to improve water supply to industrial centres and for irrigation development. The amount of water transferred by this system equals 3 to 4 km^3/year; and stretches over a distance of several hundreds kilometres (Ibid).

Table 6.3: Principal Reservoirs in Africa

Reservoir	Country	Basin	Year of filling up	Capacity, km^3
Owen Falls (Lake Victoria)	Uganda, Kenya, Tanzania	River Victoria-Nile	1954	205
Nasser	Egypt	Nile	1970	169
Kariba	Zambia, Zimbabwe	Zambezi	1959	160
Volta	Ghana	Volta River	1965	148
Cabora Bassa	Mozambique	Zambezi	1977	62
Kossou	Côte d'Ivoire	Bandama	1972	28
Suanity	Guinea	Konkure	1961	17.2
Kainji	Nigeria	Niger	1968	15

Source: I.A.Shiklomanov, Regional Distribution of Rivers and Streams in Africa, 2002.

Pollution of Aquatic Bodies

The damage that eutrophication and the proliferation of invasive aquatic plants can do to the quality of surface water, such as rivers and lakes, has already been mentioned in the preceding paragraph, and includes pollution. Water hyacinth (Eichhornia crassipes) and Salvinia molesta weeds are the main culprits. These weeds which are yet to be effectively controlled also disrupt water transport, water supplies to urban areas, the fishing industry, power generation and the livelihoods of many local communities. Like them, poor sanitation and uncontrolled waste discharges increase the cost for downstream users and affect public health. In most African countries, the menace of water pollution emanates more from microbiological sources than from chemical due to uncontrolled human and animal faecal disposal. An example of the water quality status of water sources is shown for Cameroon in table 6.4, while the natural physical quality parameters of both surface and ground water sources are shown for Congo in table 6.5 (AWDR National Reports, 2003).

Table 6.4: Indication of the Microbiological Quality of some Water Sources in Cameroon

Locality	Origin of Water	Nature of Pollution					
		Mesophilic aerobic germs	No. of total flora (x1000)	Total Coliform	E. coli	Faecal Strepto-cocci	Anaerobic Sulphur reduc-ers
Abong-Mbang	Urban Wells	-	>10 to > 20	>100 to > 1000	20 to > 1000	>100	0 to 10 000
	Urban Springs	-	0 to > 30	>100	>100 to > 1000	> 100	0
	River Nyong	-	3	>100	0	20	10 000
Batchingou, Nde Division, West Province	Stream	> 750	-	> 100	0	> 25	0
	Village stand-pipe	> 150	-	> 100	0	> 10	> 1000
Tombel, South West Province	Catchment, Kupe	> 10 000	-	0	0	0	0
	Drinking points	> 10 000	-	> 100	0 to 100	> 100	0
Banfeko, West province	Village Spring	50	-	> 100	0	0	0
	Surface water	> 100 000	-	> 5 000	> 100	> 100	> 200
WHO Standard, # of micro-or-ganisms		< 20 per ml	< 20 per 100 ml	< 10 per 100 ml	0.0 per 100 ml	< 1 per 100 ml	< 1 per 20ml

Source: Compiled from Nang-Nang (2002), Mbida-Mbida (2003), Halleson (2003), and Ngamo (2003)

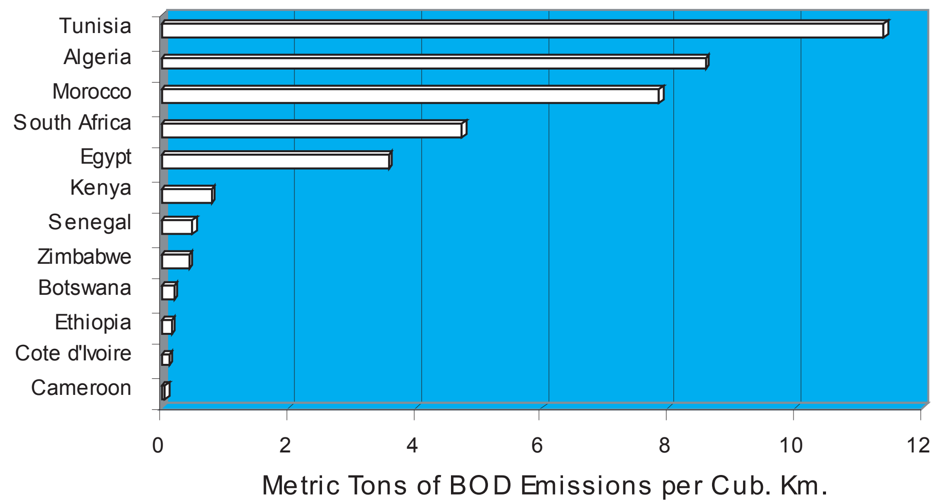
able 6.5: Quality of Surface and Ground Bodies in the Congo

Towns	Resources caught		Water quality		
	Surface water	Ground water	pH	Conductivity, ms.cm,	Dry residue, mg/l
Brazzaville	X		5	17.4	<30
Pointe - Noire		X	7.2	335	<30
Dolisie	X		7.5	>100	>200
Nkayi	X		7	>100	>40
Mossendjo	X		7.2	60	>40
Ouesso	x		7.5	68.2	>50

Source: AWDR NMational Report, 2003; SNDE and UREA

Industrial waste are still discharged untreated into rivers and lakes in most African countries, causing a major and persistent health problems. Even though this phenomenon is still low in quantitative terms, the spread of the practice is widening at an alarmingly rate, and fig. 6.4 below implicates some of the countries affected.

Fig. 6.4: Industrial Organic Pollutants per available Freshwater in African countries with major Industrial Effluents



Source: Africa Facts: http://www.nationmaster.com

The North African countries and South Africa are shown to have the highest industrial organic pollutants per available freshwater resources. For example, out of the total wastewater generated in Egypt (3.5 BCM/year) only approximately 1.6 BCM/year receives treatment (National AWDR Report, 2005). Environmental health and the health of urban settlements are seriously jeopardized by the lack of adequate solid waste disposal and sewerage systems. The result of an analysis carried out in Cameroon on the quality of effluents from a textile factory is shown in table 6.6.

Table 6.6: Physical and chemical analysis of effluent from a textile plant in the coastal region of Cameroon as compared to expected norms

Parameter	Values for effluent	Minimum Recom-mended Limit	Percentage deviation from max limit
Temperature (°C)	30	30	-
PH	12.2	5.5 – 8.5	43.5
Suspended Solids (mg/l)	34	30.0	13.3
COD (mg/l)	3400	120.0	2,733
BOD_5 (mg/l)	180	30.0	500
Total Hydrocarbons (mg/l)	10.2	5.0	104
Iron (mg/l)	6.7	5.0	34
Chromium (mg/l)	8.6	0.5	1,620
Zinc (mg/l)	0.2	0.1	100
Lead (mg/l)	0.3	0.1	200
Manganese (mg/l)	0.048	0.1	-
Nitrate (mg/l)	-	0.5	-
Phosphates (mg/l)	8.1	50	-
Dissolved Oxygen (mg/l)	6.9	-	-

Source: AWDR National Report, 2003; Fonteh, (2002)

Fertilisers are also a potential threat and although pollution from the use of agricultural fertilisers is still negligible. It can be seen from figure 6.5 that there is a general tendency towards increasing the introduction of fertilis ers into agricultural production in various countries, especially the Northern African countries of Egypt and Morocco, the Southern African countries of South Africa and Zimbabwe and, to a lesser extent, Ethiopia, Nigeria and Kenya. Dental and skeletal fluorosis, a condition related to saltwater problem, occurs in several areas, particularly Africa's east coast. All hope is not lost as some efforts are under way in Africa to fight pollution and monitor raw water sources; selected examples are given in boxes 6.1-6.3.

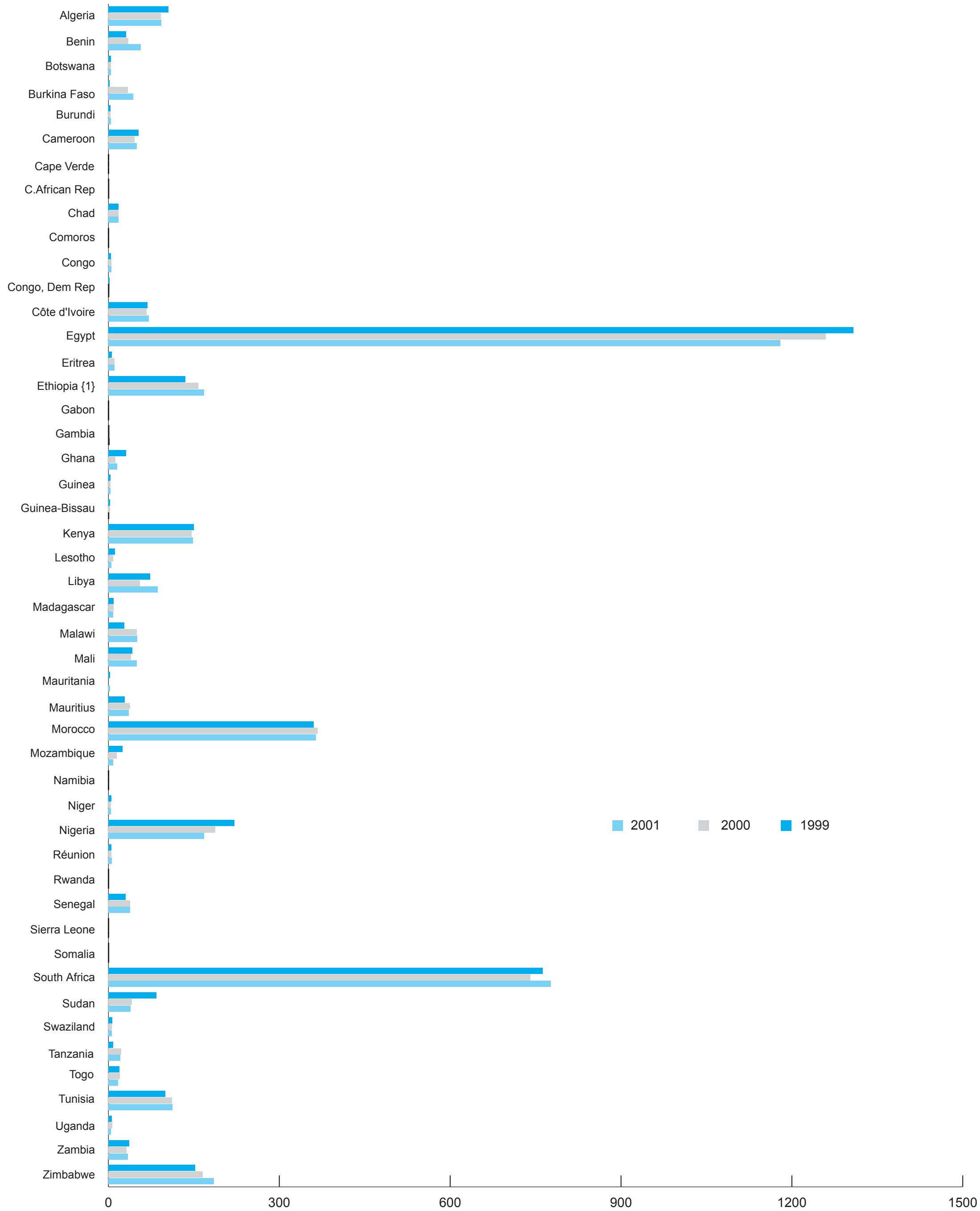
Box 6.1
Tracing Pollutant Sources in Cameroon

Feudjio (2002) and Tchinda (2002) carried out analyses on the wastewater management in the Dschang District Hospital and the University Teaching Hospital (UTH), Yaounde, respectively. At the District Hospital in Dschang it was found that a significant part of wastewater from laundry, and cleaning of wards is directed to drains and flow into the environment. In Yaounde, it was noted that the treatment station for the hospital was broken down and abandoned for years. About 67 m^3 of wastewater is produced daily in the heart of the capital from this hospital and discharged into the environment mainly without treatment. Physico-chemical and microbiological analyses of the water discharged into the environmental are shown in the table below. Compared to the recommended limit of pollutants, the effluents are hundreds to thousands of times beyond the level allowed.

Physico-chemical Analyses			
Pollutants	Dschang District Hospital	University Teaching Hospital	MINIMUM Recommended Limit
Chemical Oxygen Demand, (COD) mg/l	1960	643.3	120.0
Biological Oxygen Demand (BOD_5), mg/l	950	258.3	30.0
Suspended Solids, mg/l	2760	136.4	30.0
Phosphates, mg/l	122.5	17.6	50.0
Nitrates, mg/l	10.0	1.5	0.5
Microbiological Analyses			WHO Standard, No. of micro-organisms
Mesophilic aerobic Germs	$> 10^5$	$> 10^7$	< 20 per ml
Total Coliform	$> 10^4$	$> 10^6$	< 10 per 100 ml
Faecal coliform	$> 10^2$	$> 10^5$	
Faecal Streptococci	$> 10^3$	$> 10^5$	< 1 per 100 ml
Anaerobic Sulphur reducers		$> 10^5$	< 1 per 20ml
E coli		$> 3 * 10^4$ per 100 ml	0.0 per 100 ml

Source: AWDR National Report

Fig. 6.5: Dynamics of Fertiliser Consumption in Africa



Source: FAO, 2004

International Targets

- Action programmes to protect surface and groundwater resources prepared and in the process of implementation by 2003, and defined standards achieved by 2010 – Rio.

- National standards to ensure the health of freshwater ecosystems, established in all countries by 2005, and programmes to improve the health of freshwater ecosystems implemented by 2015.

Box 6.2
Pollution Control – The Ethiopian Experience

Cleaner leather production

A small number of cities and their immediate surroundings host most of Ethiopia's industrial facilities. Addis Ababa and a few neighboring towns generate approximately two thirds of the country's manufacturing value added. Industrial pollution – especially from tanneries, textile mills and soap factories – and urban waste are a serious threat to important water resources such as the Awash River and the Northern Rift Valley Lakes which are the lifeline of the environmentally sensitive cattle-raising region to the south of the capital.
With extensive assistance from the United Nations Industrial Development Organization (UNIDO), six tanneries, all but one (Dessie) operating I Addis Ababa and its vicinity, have made significant strides in pollution control. The three-steam effluent treatment plant (which includes a state-of-the-art chrome recovery system) commissioned recently at Awash Tannery, is one of Africa's most advanced pollution abatement facilities. Wallia, Dire and Dessie boast similar plants and the existing treatment facilities at two other tanneries, Ethiopia and Blue Nile, have been rehabilitated.

Benchmark benefits

African leather manufacturers are now well aware that, in addition to cost savings and improvements in environmental performance, the introduction of new technologies often allows an expansion in the range of their products. This has become crucial in recent years when rising prices of hides and skins have cut deeply into the profit margins of wet-blue and crust exporters and prompted them to shift more of their resources to the manufacture of finished leathers as well as footwear, garments and other leather products. To raise awareness with respect to such business opportunities and stimulate a wider acceptance of cleaner production standards, the assistance provided by UNIDO includes a continuous exchange of insights from practical experience as well as advice delivered by experts from leading European leather manufacturers and chemical companies.
A widely attended seminar held in Addis Ababa in March 2000, was a milestone in this process. Technology options aiming at reducing water consumption, improving energy efficiency, optimizing the dosage and fixation of chemicals and minimizing the organic pollutant load in spent liquors were the subject of eloquent presentations and lively debate. What emerged was a balanced review of cleaner production options for leather manufacturers in Ethiopia and elsewhere in the region – pollution-containment solutions that are viable in terms of both cost and product quality.

Source: UNIDO Regional Office, Addis Ababa, 2003

Box 6.3
Ghana Raw Water Quality Criteria and Guidelines Launched

The Water Resources Commission (WRC), in pursuit of its objectives, seeks to set water quality criteria and guidelines for raw water, assess the status of raw water and classify water bodies into various uses. The mandate of the WRC aims for the conservation of water resources through IWRM not constrained and limited by poor water quality resources. Reliable data on water quality is of importance for proper management and thereby the protection and development of water resources for the future. The Water Research Institute (CSIR) undertook the consultancy assignment. The final draft report on Ghana Raw Water Criteria and Guidelines has been submitted to the Commission.
Objectives: The overall objective of setting raw water quality standards is to characterize water resources of the country for various water uses, and for effective integrated water resources management.
The specific objectives of setting raw water quality criteria and guidelines are set to specify raw water quality parameters with specific guidelines for groundwater and surface water.
Scope of work
Preparation of Draft Report, including:
(a) Assessment of available raw water quality data in all the river basins;
(b) Assessment of existing system of other water quality standards in Ghana;
(c) Comparison of Ghana standards with other countries in Africa, Europe and elsewhere;
(d) Proposal of realistic standards and criteria; and
(e) Identification of gaps in water quality data.

Methodology: The water quality characteristics of all the river basins in Ghana were assessed using water quality data available. The data was statistically analysed, and a water quality index was used to classify the river basins, which were divided into upstream, midstream and downstream. Criteria and guidelines for water uses was based on existing water quality data available and on existing literature where no data was available in the country.
Ghana Raw Water Quality Criteria and Guidelines: Contain information for water uses and these have been classified as:
1. Domestic
2. Recreational
3. Industrial
4. Agricultural (Irrigation and Livestock)
5. Agricultural (Fishery and Aquaculture)
6. Aquatic Ecosystem

The criteria for various water uses are set for individual parameters such as: algae, aluminium, ammonia, arsenic, asbestos, atrazine, colour, lead, pH, total coliform, faecal coliform, and so on. The list of water quality parameters applied for the uses of water for each category was different.
Source: Adwoa Paintsil, Water Resources Commission, Ghana

Africa's biodiversity

Africa has a large and diverse heritage of plants, animals and microorganisms. It is home to more than 50,000 known plant species, 1,000 mammal species, and 1,500 bird species. The biological diversity found in any one area or country varies in complex ways, depending on the physical size, local climatic conditions, topography, vegetation, and soil types. The estimated number of mammals, birds, flowering and non-flowering plant species found in African countries is given in Table 6.7 below (ECA, 2001).

Fig. 6.2: Freshwater Ecosystem Areas

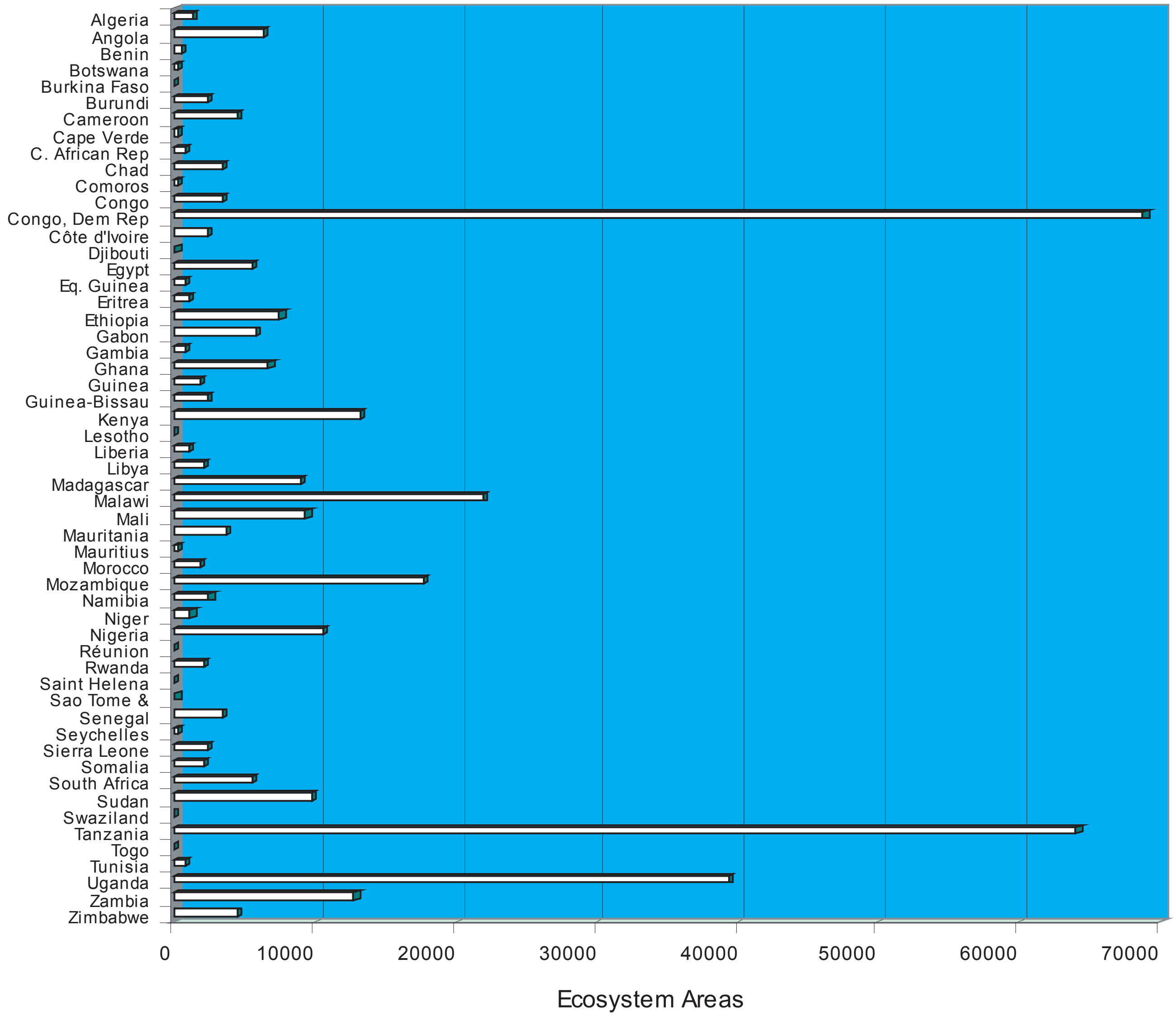


Table 6.7: Estimated Number of Mammal, Bird and Plant Species in African Countries

Region/Country	Mammals	Birds	Flowering Plants	Non-flowering Plants
A. NORTHERN AFRICA				
Algeria	92	375	3,100	64
Egypt	102	439	2,066	10
Libya	76	323	1,800	25
Mauritania	61	541	1,100	-
Morocco	105	416	3,600	75
Tunisia	78	356	2,150	46
Western Sahara	32	162	330	-
B. EASTERN AFRICA				
Djibouti	-	326	635	6
Eritrea	112	537	-	-
Ethiopia	255	813	6,500	103
Kenya	359	1,068	6,000	506
Somalia	171	649	3,000	28
Sudan	267	937	3,132	5
Tanzania	322	1,005	10,000	8
Uganda	338	992	5,000	406
C. CENTRAL AFRICA				
Burundi	107	596	2,500	-
Central African Republic	209	662	3,600	2
Congo	200	569	4,350	7
Democratic Republic of Congo	415	1,096	11,000	7
Equatorial Guinea	184	322	3,000	250
Gabon	190	629	6,500	151
Rwanda	151	666	2,288	2
D. SOUTHERN AFRICA				
Angola	276	909	5,000	185
Botswana	164	550	-	15
Lesotho	33	281	1,576	15
Malawi	195	645	3,600	165
Mozambique	179	678	5,500	192
Namibia	154	609	3,128	46
South Africa	247	790	23,000	420
Swaziland	47	485	2,636	79
Zambia	229	736	4,600	147
Zimbabwe	270	648	4,200	240
E. WESTERN AFRICA				
Benin	188	423	2,000	201
Burkina Faso	147	453	1,100	-
Cameroon	297	874	8,000	260
Chad	134	532	1,600	-
Côte d'Ivoire	230	694	3,517	143

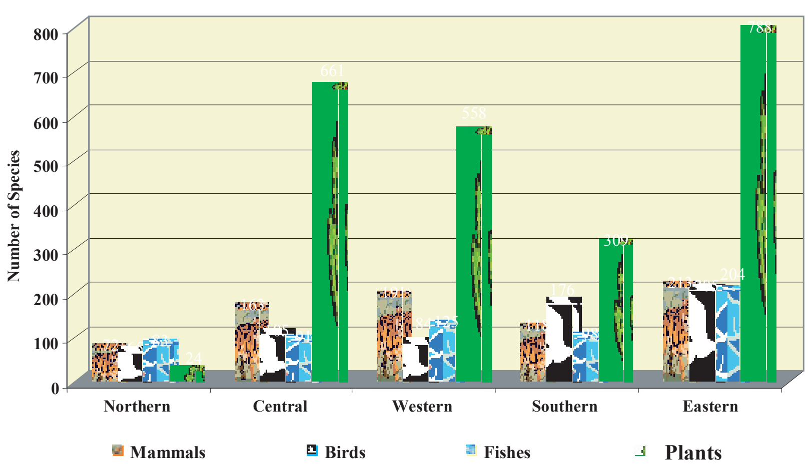
Region/Country	Mammals	Birds	Flowering Plants	Non-flowering Plants
Gambia	108	504	966	8
Ghana	222	725	3,600	125
Guinea	190	552	3,000	-
Guinea Bissau	108	319	1,000	-
Liberia	193	581	2,200	-
Mali	137	622	1,741	-
Niger	131	482	1,170	8
Nigeria	274	862	4,614	101
Senegal	155	610	2,090	24
Sierra Leone	147	622	2,090	-
Togo	196	558	2,000	201
F. ISLAND STATES				
Cape Verde	5	128	740	34
Comoros	12	91	660	61
Madagascar	105	253	9,000	505
Mauritius	4	81	700	178
São Tomé & Príncipe	8	111	744	151
Seychelles	-	170	1,139	1

Source: ECA, 2001; Groombridge, B. (Ed). 1994. Note: - Indicates lack of data

Biodiversity: Threatened species

Africa occupies about one-fifth of the global land surface and contains about one fifth of all known species of plants, mammals and birds in the world, as well as one sixth of amphibians and reptiles (Siegfried, 1989). About one fifth of Southern Africa's bird species migrate on a seasonal basis within Africa, and a further one tenth migrate annually between Africa and the rest of the world (Hockey, 2000). One of the main intra-Africa migratory patterns are those of waterfowls which spend the austral summer in Southern Africa and the winter in Central Africa. Analysis of the 2004 IUCN Red List shows that the eastern, western and central subregions of Africa have the highest number of threatened plant and animal species (Fig. 6.6).

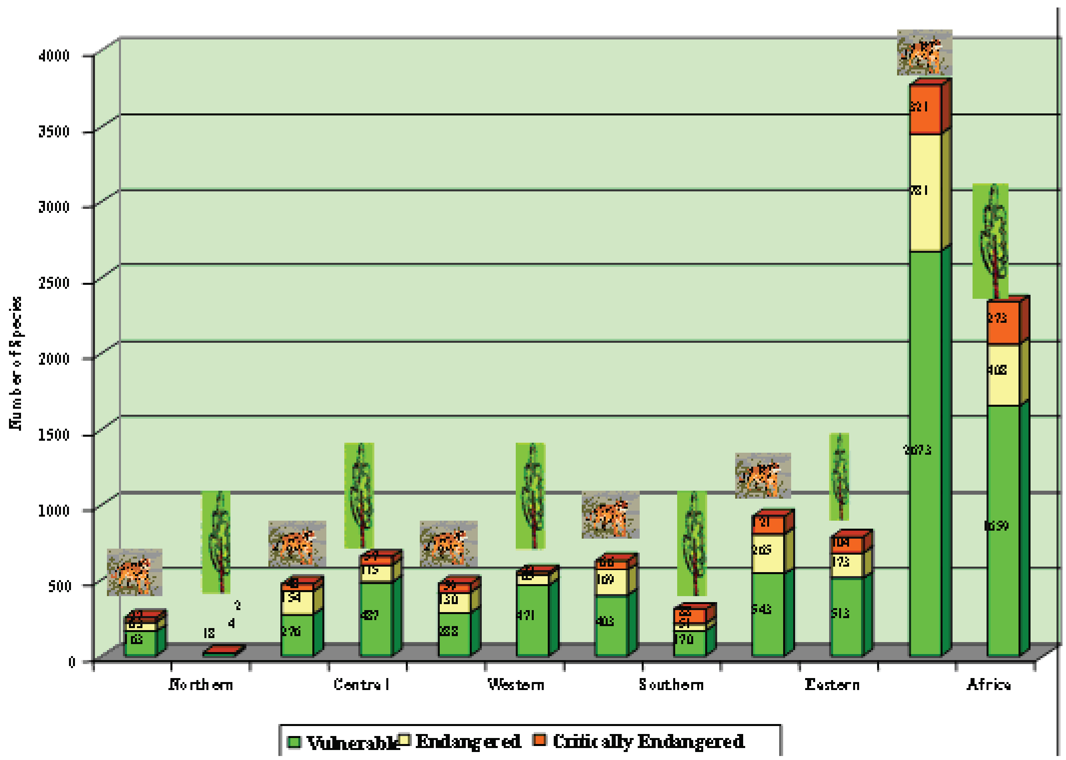
Fig. 6.6: 2004 IUCN Red List of Threatened Species by Subregion in African



Source: IUCN, 2004

From the 2004 IUCN Red List of threatened species in Africa there are about 321 and 273 critically endangered animal and plant species in the continent (fig. 6.7). The numbers vary from country to country within the subregions, and such countries as Madagascar, Tanzania, Cameroon, Gabon, Nigeria, Ghana and Cote d'Ivoire have the highest number of threatened animal and plant species (figure 6.8). The situation seems to be worsening in all the subregions where the number of threatened mammal, bird and fish species are increasing at an average rate of about 2, 2.5 and 5 times, respectively. The IUCN assessment of 1998 gave only one endangered fish specie in the North Africa subregion; this number jumped to 83 in the 2004 IUCN Red list.

Fig. 6.7: Threatened Animal and Plant Totals in Africa and Sub Regions



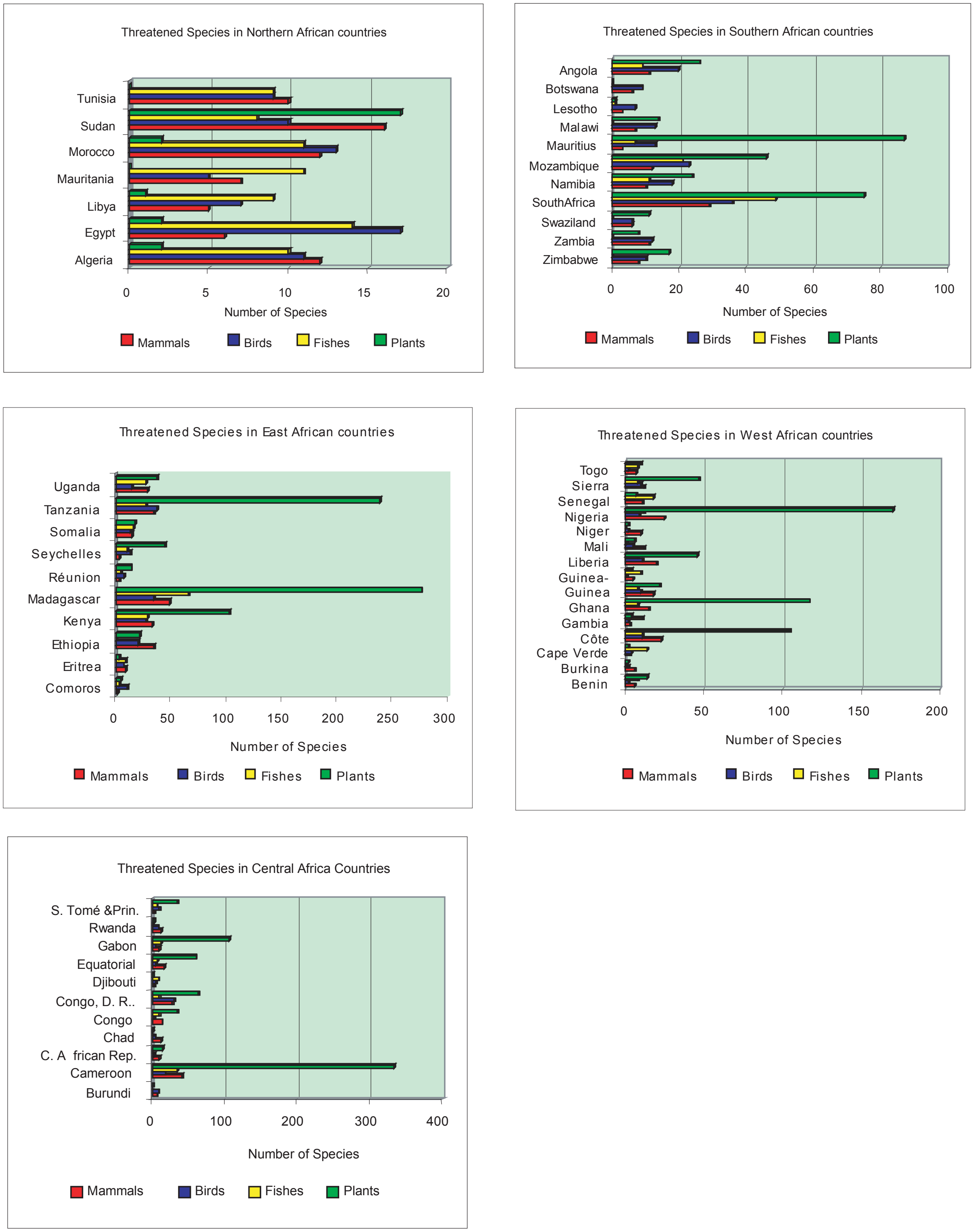
Source: IUCN, 2004

In South Africa, for example, palaearctic migrants spend the austral summer in locations such as the Langebaan Lagoon, near Cape Town, and the boreal summer in the wetlands of Siberia. If climatic conditions or very specific habitats at either terminus of these migratory routes change beyond the tolerance of the species involved, significant losses of biodiversity could result. Although the species involved have some capacity to alter their destinations, the probability of finding, in an increasingly intensively used world, sufficient areas of suitable habitat in the new areas is small.

Under the Ramsar Convention, the current system of protected habitats is based on present distribution of climate, raising the possibility of vast habitat types and quality being changed under climate change. Most African countries have become signatories to the Ramsar Convention and have designated important wetlands as protected areas (fig. 6.9). The major human-induced threats to ecosystems and biodiversity are unsustainable exploitation, habitat change, pollution, invasions by exotic species, and global climate change. Humans are using many of the world's natural resources faster than they can replace them, ir-

respective of the fact that some other species require large areas of land or water in order to meet their nutritional, migratory, shelter and breeding needs.

Figure 6.8: Threatened Species in African Subregions



Biodiversity and Protected Wetlands

Africa is home to five internationally recognized areas of particularly high species richness and endemism, referred to as "biological hot spots". These include the Western Indian Ocean islands, the Cape floristic region, the Succulent Karoo - the most species-rich desert in the world, the upper Guinea forest and the Eastern Arc Mountain forests of East Africa. Approximately 7 per cent of the land falls within protected areas. In total, Africa has 1 254 protected areas, including marine protected areas, biosphere reserves, wetlands of international importance and World Heritage sites. Almost all African countries have ratified the Convention on Biodiversity, and the Convention on International Trade in Endangered Species (UNEP GEO-3, 2002).

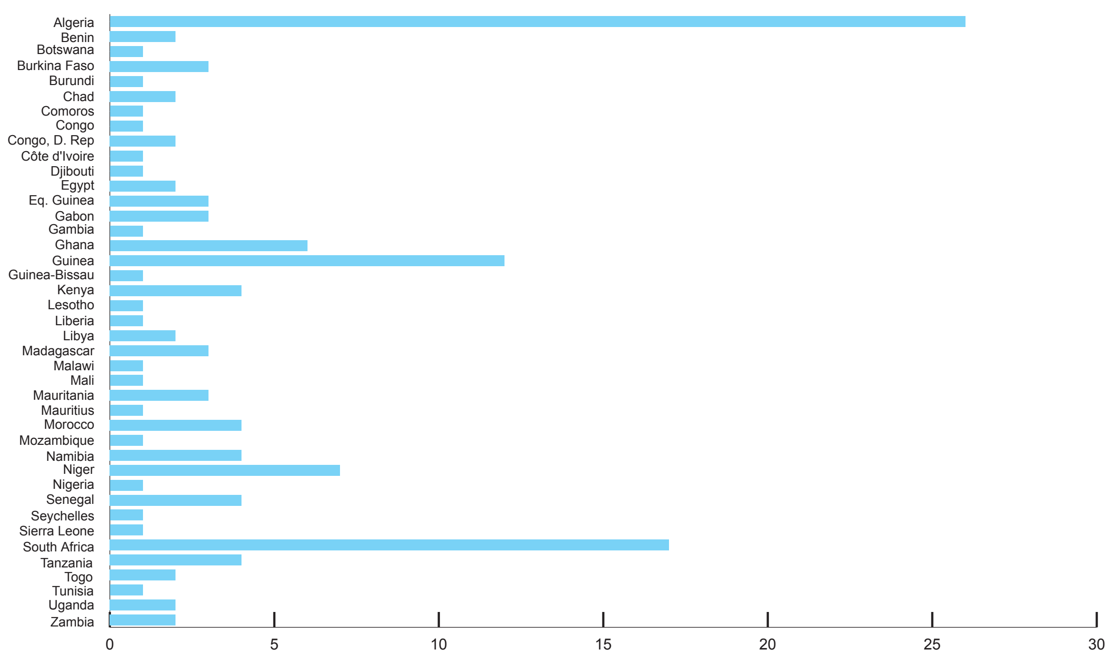
Biodiversity and Protected Wetlands

Figure 6.9 refers to the number of sites designated as Wetlands of International Importance, or "Ramsar sites", in African countries, as updated in January 2005. Wetlands of International Importance are defined under the Convention on Wetlands as having "international significance in terms of ecology, botany, zoology, limnology or hydrology."

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. When a country becomes party to the Convention, it agrees to designate at least one wetland for inclusion in the List of Wetlands of International Importance (the "Ramsar List") and to promote its conservation.

Though protected areas serve a vital function in protecting the earth's resources they face many challenges, such as external threats associated with pollution and climate change, irresponsible tourism, infrastructure development and ever-increasing demands for land and water resources. Moreover, many protected areas lack political support and have inadequate financial and other resources.

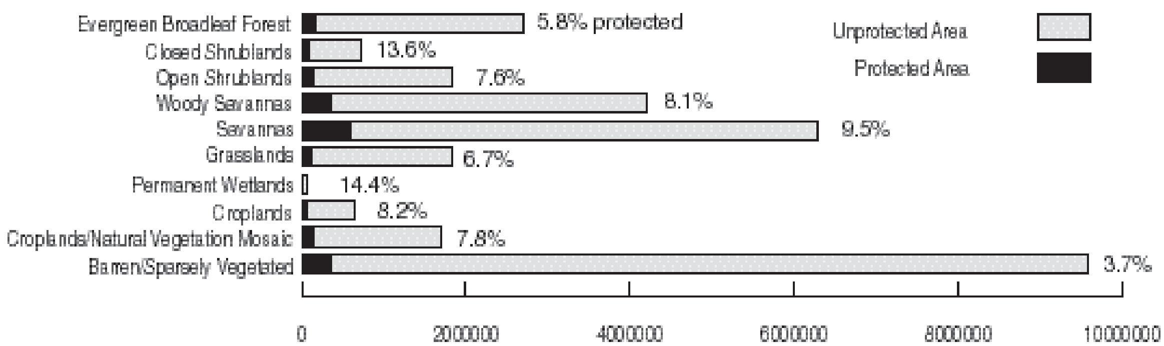
Note: see Box 6.4 for methodology



Source: World Resource Institute: The Bureau of the Convention on Wetlands 2005. The Ramsar List of Wetlands of International Importance. Available on-line at: http://ramsar.org/sitelist.pdf. Gland, Switzerland.

Protected areas in Africa occupy slightly over 2 million sq km or 7 per cent of the continent's surface area of 30 million sq km (fig. 6.10). Barren and sparsely vegetated lands comprise about 9.6 million sq km of the various ecoregions, whereas biodiversity-rich tropical evergreen broadleaf forests comprise about 3 million sq km. Of the barren and sparsely vegetated lands, about 4 per cent are protected. Closed shrublands, which are estimated at over 700,000 sq km in size, have the largest proportion of protected area, approximately 14 per cent. About 2 million sq km, or 8 per cent, of croplands and a mosaic of croplands mixed with natural vegetation are under protected status (Singh et al, 1998).

Figure 6.10: Degree of Protected Areas in Africa by Vegetation



Source: Singh A. et al.,1998

Box 6.4
Global Land Cover Characteristics (GLCC) Project Methodology for Ecosystem Areas

1. Water bodies are oceans, seas, lakes, reservoirs, and rivers. They can be either fresh or salt water bodies. The classifications reported here are published using the International Geosphere-Biosphere Programme (IGBP) definitions. Please consult the IGBP website (http://www.igbp.kva.se/) for further details. Water bodies area is the area, in hectares, of water bodies, as determined by the Global Land Cover Characteristics (GLCC) project. The project uses a framework of temporal and spatial patterns of satellite data, in conjunction with ancillary data, to assign a vegetation classification to each pixel.
2. Urban and built-up areas are covered by buildings and other man-made structures. Note that this class will not be mapped from the AVHRR imagery but will be developed from the populated places layer that is part of the Digital Chart of the World (Defense Mapping Agency, 1992).

The GLCC describes the method used to classify vegetation types as a "multitemporal unsupervised classification of NDVI data with post-classification refinement using multi-source earth science data." NDVI data are a measure of "greenness" derived from satellite data. The satellite data in this study were from the Advanced Very High Resolution Radiometer (AVHRR), and have a resolution of 1 X 1 km. The other data sets employed were a digital elevation model to help model ecological factors that govern natural vegetation distribution, ecoregions data to help determine where vegetation would be stratified by seasonal impacts, and maps of soils, vegetation, and land cover to help with the post-classification refinement.

The satellite data used to develop the Earth cover classifications were recorded over a 12-month period spanning April 1992-March 1993. The approach used to classify the satellite data into different land cover types was implemented and refined over the course of the following decade, with version 2.0 being released in 2001.

The GLCC study was able to arrive at 18 classifications of vegetation and other land cover types using these data product through the following steps:

1. AVHRR data preparation: In this step the daily satellite data are composited into one monthly value so as to provide higher-quality, cloud-free images. Masks are applied to screen out built-up areas, water bodies, permanent ice, and barren areas, all areas where NDVI is not a useful indicator of land cover type.
2. Unsupervised classification: Those areas not screened out are classified using an automated classification approach called unsupervised clustering, often used where location and characteristics of specific classes are unknown.
3. Preliminary Labelling: After clusters are determined, the characteristics of each are investigated to determine the land cover type or types falling within it. Statistics and graphs of each are generated and are then interpreted and a land cover type or types are assigned to each class.
4. Postclassification Stratification: This step separates classes containing two or more disparate land cover types. This step is important because disparate land cover types, usually natural and agricultural land cover types, are often clustered together due to spectral similarities.
5. Final Land Cover Characterization: The final step is to derive a collection of attributes that describe the characteristics of each seasonal land cover region. The classifications are then labeled according to various commonly-used schemes and published. WRI publishes the version labeled according to the International Geosphere-Biosphere Programme (IGBP).

Following publication of the GLCC database, a number of scientific teams assessed the accuracy of the GLCC's approach by comparing the results with higher-resolution satellite imagery. These teams found that the accuracy of the GLCC's approach was, depending on the assessment approach, in a range from 60 to nearly 80 per cent, meaning that the assessment teams' classification of a given area agreed with the GLCC's classification between 60 and 80 per cent of the time.

Source: Loveland el al. 2000

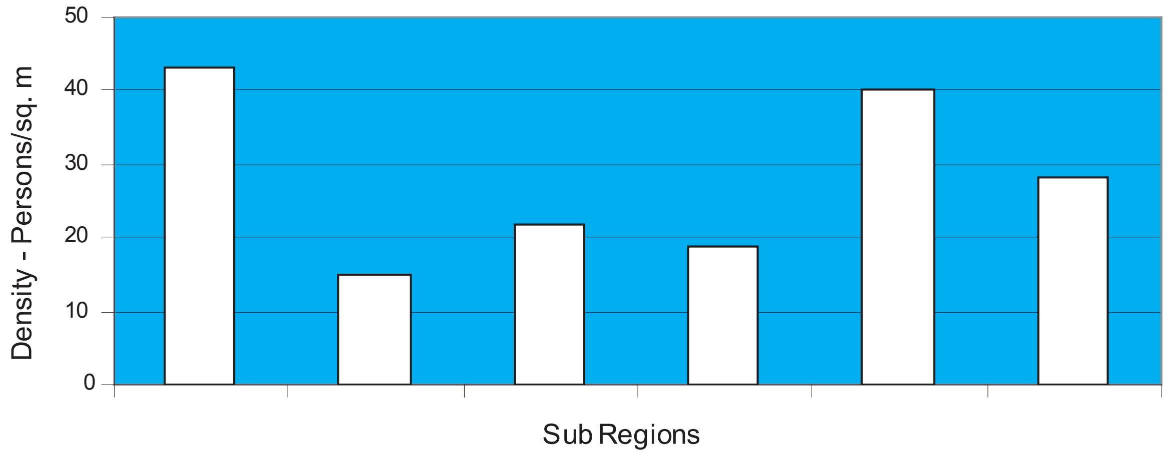
Human activities encroach on the natural habitats of many species. The loss, fragmentation and conversion of natural areas due to the spread of cultivation and pasture are a major factor contributing to the loss of Africa's biodiversity (ECA, 2001). While Africa currently makes a relatively small contribution to global climate change, it is extremely vulnerable to the results of it. A significant change in climate over the next 50 to 100 years is likely to result in conditions under which many natural populations of wild organisms may become incapable of existing within their natural ranges. Changes in temperature and precipitation are likely to seriously affect the present distribution of many species. Thus, climate change is an additional factor threatening the survival of species. Some species - such as mosquitoes and other disease vectors and some pests may flourish and expand their ranges (ECA, 2001).

Population, Urbanization and Ecosystem

Africa has undergone major social, economic and political transformations. At the turn of the 20th century, the total population was only 118 million, 7.4 per cent of the world population. By 1997, the population was estimated at 778.5 million, more than 13 per cent of the world population (UNEP GEO-2000; United Nations Population Division 1996). It is projected that by the year 2025, the population of Africa will almost double to 1 453 million, representing about 18 per cent of the projected world population (ibid). This high rate of population growth should be expected for the future and is a very important factor of the human impact on the hydrological regime of water bodies and on renewable freshwater resources. In spite of the seemingly intensive population growth of the

past few decades, population density is still low and distribution over land areas is uneven (See figure 6.11). Mean population density in 1995 was 24.8 per sq. km (for comparison, the population density in Europe exceeds 100 persons per sq. km). Population distribution mainly depends on physiography (e. g., deserts and tropical rain forests are poorly inhabited), and on historical and socio-economic conditions (Shiklomanov, 2002). In many countries, population density is less than 15 persons per sq. km; in some countries (Botswana, Namibia, Mauritania, Western Sahara) it equals 2-3 persons per sq. km. The highest density (200-600 persons per sq. km) is observed in small island countries (e.g., Mauritius), in small countries in East Africa (Burundi, Rwanda), in the coastal areas of the Mediterranean Sea, maritime plains and industrial mining regions in South Africa. Nigeria's population growth trend is shown in Table 6.8.

Fig. 6.11: Subregional Population Density



The high population density is also observed in rare oases in deserts; in the Nile River Valley it attains 1500 persons per sq. km. In the face of a growing population and ever-changing technological advances, pressures on biological diversity are mounting. Activities focusing on the sustainable management of biological diversity must therefore include socio-economic issues. This implies inter-sectoral cooperation and decentralization of management to the lowest level appropriate, equitable and gender sensitive distribution of benefits, and the use of adaptive management tools and policies to deal with uncertainties as modified in light of experience and changing conditions. A study of the carrying capacity of land in developing countries compared Africa's projected future population with its food production potential (FAO 1982). According to the study, the number of countries that will be unable to feed themselves from home production using the present low level of inputs will rise from 22 out of 49 in 1975 to 32 by the end of the 20th century and to 35 by the year 2025. In countries with limited cultivable land and high population growth rates - such as Kenya, Ethiopia, Malawi, Burundi, and Rwanda - fallow periods are no longer sufficient to allow soil fertility to be restored, with the result that crop yields have fallen. In response, farmers have been forced either to bring increasingly marginal lands into cultivation, or to migrate into tropical forest areas, exacerbating problems of land degradation and deforestation.

Today's agricultural systems are changing rapidly and must be able to draw on a wide range of higher inputs and genetic resources in order to develop harmoniously. Most countries of the Sahel and mountainous East Africa will face severe problems if new innovative inputs are not introduced into food production. Ethiopia's 1983

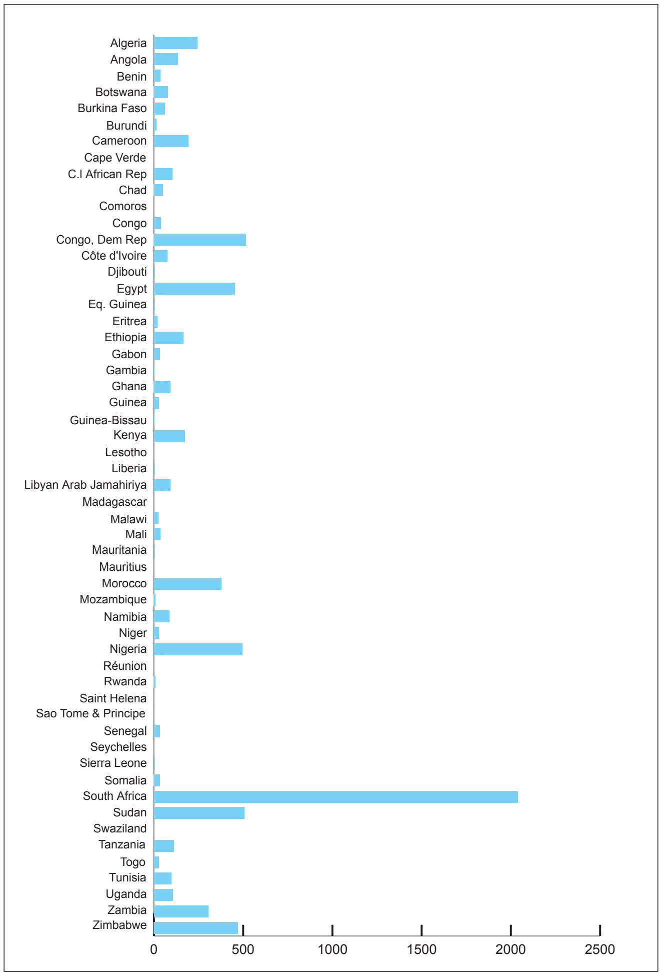
population of 36 million will more than triple to 112 million in 2025, forty-four million more than it can feed with intermediate inputs. By 2025, Nigeria's population is projected to reach 338 million, which will be 123 million in excess of its carrying capacity with intermediate inputs. Even with high inputs, Kenya's lands can support only 51 million people a total that will be passed by 2010. By 2025, there may be 83 million Kenyans, with as many as 111 million before the population reaches its plateau (Nana-Sinkam, 1995).

In the context of the general population pressure, the fast-growing urban centres in Africa, influenced mainly by rural migration, are making heavy demands on the environment, as urban residents generally consume more resources than rural dwellers, and generate large quantities of solid waste and sewage (table 6.9). Urbanization brings with it expansion of infrastructure which in turn transforms part of the land surface into built area (figure 6.12). In northern Africa, at least 20 per cent and as much as 80 per cent of the urban solid wastes are disposed of by dumping in open spaces. Rapid urbanization in Lagos increased solid waste generation sixfold to about 3.7 million tons a year in 1990, plus another half a million tons of largely untreated industrial waste, because 90 per cent of the industries in Nigeria lack pollution control facilities (UNEP Geo-2000, IMO 1995). The 1.3 million inhabitants of Lusaka produce 1 400 tons of solid waste daily, 90 per cent of which is not collected owing to the very poor staffing, finances and equipment of the local authority. As only 36 per cent of Lusaka's residents have sewerage services, most of the rest use pit latrines, a common situation throughout Africa (UNEP Geo-2000, Agyemang and others 1997). The concentration of industries in or near cities is also a major source of environmental pollution and resource depletion. In 1994, the spill of toxic chemicals from a pulp and paper company into the Usuthu river in Swaziland killed many fish (UNEP Geo-2000, Mavimbela 1995). In Mozambique, more than 126 factories in and around Maputo discharge their waste directly into the environment (UNEP Geo-2000, Couto 1995). In Tanzania, textile mills are reported to release dyes, bleaching agents, alkalis and starch directly into Msimbazi Creek in Dar es Salaam (UNEP Geo-2000, Bwathondi and others 1991).

Threats to environmental sustainability

The threat to environmental sustainability is due in part to failure to recognize the life-supporting functions of ecosystems (terrestrial and aquatic). In fact, the water quantity and quality requirements of ecosystems are not normally taken into account in the overall allocation of available water resources in much of Africa. Hence the important role played by wetlands in many rural economies (for the provision of highly productive agricultural land, dry season grazing for migrant herd, fish, fuelwood, timber needs and medicines) have, until recently, not been adequately recognized and reflected in national water policies. As a result, such wetlands are increasingly being endangered by poor cultivation, deforestation and overgrazing.

Fig. 6.12: Urban Ecosystem and Built Up Areas 1992-93



Source: Loveland el al. 2000
Note: See Box 6.4 for methodology

Table 6.8: Trends in Population Size and Growth in Nigeria

i) Population	1980	64,325,000
	1990	85,953,000
	2025	202,857,000
ii) Average Annual Rate of Population Growth.	1975	3.17
	1985	2.98
	199/95	2.88
	2020/25	1.93

Table 6.9: Solid waste production, wastewater treated and garbage collection

	solid waste per capita (kg/year)	wastewater treated (%)	households with garbage collection (%)
Abidjan	365	58	70
Ibadan	401	-	40
Kinshasa	438	3	0
Bujumbura	511	4	41
Lomé	693	-	37
By comparison:			
Toronto	511	100	100

Source: Habitat 1997

It is important to note that the Dublin Principles explicitly calls attention to the essential role of water, not only for development, but also for life and the environment. It is therefore urgent to recognize the legitimate use of water for sustaining the environment, especially the life-supporting functions of ecosystems. This recognition should be reflected in the generation of a broad-based support and a legal basis for ensuring that water for maintaining the sustainability of life-supporting ecosystems is adequate in quality and quantity. This requires recognising and integrating the cardinal roles played by water resources in economic development, sustaining the environment and meeting basic needs for sustaining life. This means going beyond the normal engineering exercise of environmental impact assessment of water projects to consider the environment and ecosystems as vital resources. Most African countries have slowly begun to initiate exercises of estimating ecological water needs as table 6.10 shows for Swaziland (AWDR National Report, 2005). Technological innovation and application can go a long way to make agriculture more sustainable without excessively occupying more lands. New technologies made it possible to double food production in the world in just over 25 years, with more than 90 per cent of this growth deriving from yield increases and less than 10 per cent from area expansion. Africa can also take advantage of the dissemination of Integrated Pest Management approaches which have enabled pesticide application to be cut dramatically without reducing productivity.

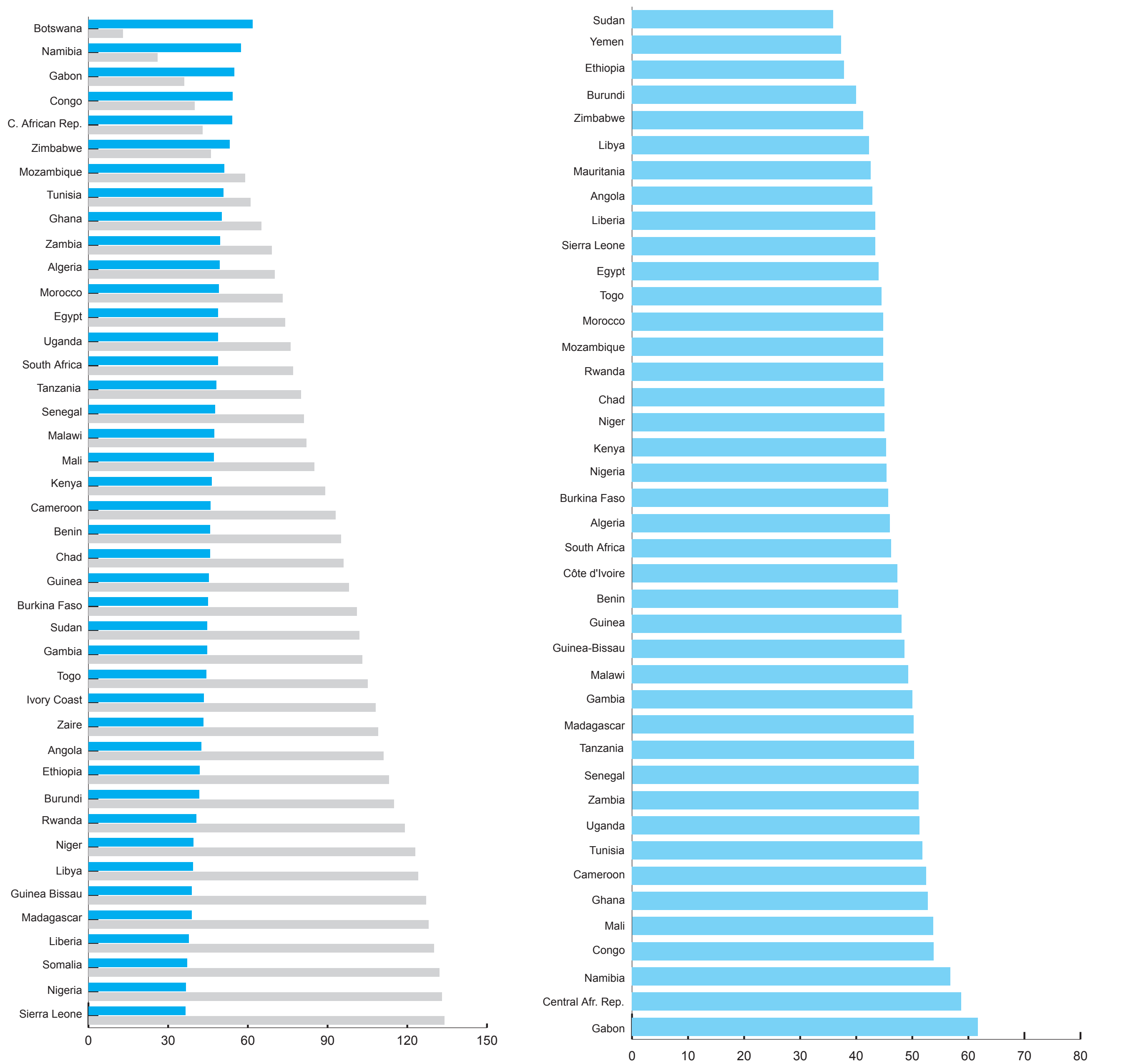
Table 6.10 Estimated stream flows required to meet environmental needs in various rivers in Swaziland

River	Key point	Interim target in-stream flow mean (10^6 m^3/yr)
Komati	Diepgezet (RSA*)	190
Komati	Mananga (GS30)	200
Pongola	Ndumo (RSA)	300
Ngwavuma	Border with RSA	50
Mkhondvo	GS 25	35
Hlelo	GS 22	35
Ngwempisi	GS 21	30
Usutu	GS 23	20
Usutu	Big Bend (GS 16)	520
Mpuluzi	Dumbarton	65
Lusushwana	GS 33	35

**Point on the Republic of South Africa (RSA) side nearest to the border with Swaziland*
(Source: AWDR National Report, 2005. (TPTC, 2002)

The Environmental Sustainability Index (ESI) is becoming a single indicator for monitoring the environment. The ESI is an innovative and pioneering attempt to bring systemic cross-country information to bear on the critical challenge of sustainable development. The computation of the ESI is based on 21 elements of environmental sustainability covering natural resource endowments, past and present pollution levels, environmental management efforts, contributions to protection of the global commons, and a society's capacity to improve its environmental performance over time. The ESI can therefore be a very useful tool for facing the challenges of resource depletion and the lack of capacity for pollution control which are becoming the dominant concerns in many African countries. Figure 6.13 shows the performance of various African countries in the world ranking of ESI in 2002 and the African ranking for 2005.

Fig. 6.13 Environmental Sustainability Index for African Countries



Pressures on Freshwater Ecosystems – The World Outlook

A wide range of human uses and transformations of freshwater or terrestrial environments can alter, sometimes irreversibly, the integrity of freshwater ecosystems.

Human Activity	Potential Impact	Function at Risk
Population and consumption growth	Increases water abstraction and acquisition of cultivated land through wetland drainage. Increases requirement for all other activities with consequent risks	Virtually all ecosystem functions including habitat, production and regulation functions
Infrastructure development (dams, dikes, levees, diversions)	Loss of integrity alters timing and quantity of river flows, water temperature, nutrient and sediment transport and thus delta replenishment, blocks fish migrations	Water quantity and quality, habitats, floodplain fertility, fisheries, delta economies
Land conversion eliminates key components of aquatic environment, loss of functions, integrity, habitat & biodiversity, alters runoff patterns, inhibits natural recharge, fills water bodies with silt	Natural flood control, habitats for fisheries and waterfowl, recreation, water supply, water quantity and quality	
Overharvesting and exploitation	Depletes living resources, ecosystem functions and biodiversity (groundwater depletion, fisheries collapse)	Food production, water supply, water quality and water quantity
Introduction of exotic species: Outdoes competition of native species, alters production and nutrient cycling, loss of biodiversity	Food production, wildlife habitat, recreation	
Release of pollutants to land, air or water	Pollution of water bodies alters chemistry and ecology of rivers, lakes and wetlands. Greenhouse gas emissions produce dramatic changes in runoff and rainfall patterns	Water supply, habitat, water quality, food production. Climate change may also affect hydropower, dilution capacity, transport, flood control

Source: UNESCO WWDR, 2003 (Extracted from the Executive Summary of the WWDR. IUCN, 2000. Vision for Water and Nature. A World Strategy for Conservation and Sustainable Management of Water Resources in the 21st Century - Compilation of All Project Documents. Cambridge).

Case Study: Sediment Control and Aquatic Weeds in the Nile Basin – Integrated Watershed Management Needed

At present, a limited number of sediment monitoring stations are operating. These are at El Deim, Wad Alais and Sennar on the Blue Nile and, Gawisi and Hawata on rivers Dinder and Rahad, respectively. The high sediment loads of the Main Nile, Blue Nile and Atbara rivers have a major influence on the design and operation of any river control and storage works on these rivers. The sediment which originates in the Ethiopian highlands is concentrated during the flood season, which lasts from about July to October. The highest sediment concentrations occur on the rising flood from about late July to the first ten days of August.

It can be noted from table 6.11 that there is a huge reduction in the original capacities of the reservoir in the Sudan due to sedimentation. This is because rain in the Ethiopian highlands falls on bare lands at the beginning of the rainy season in July, and brings high sedimentation load before the maximum runoff occurs in the area. The Sennar has lost 66 per cent, the Girba 60 per cent and the Roseires 30 per cent. Figures

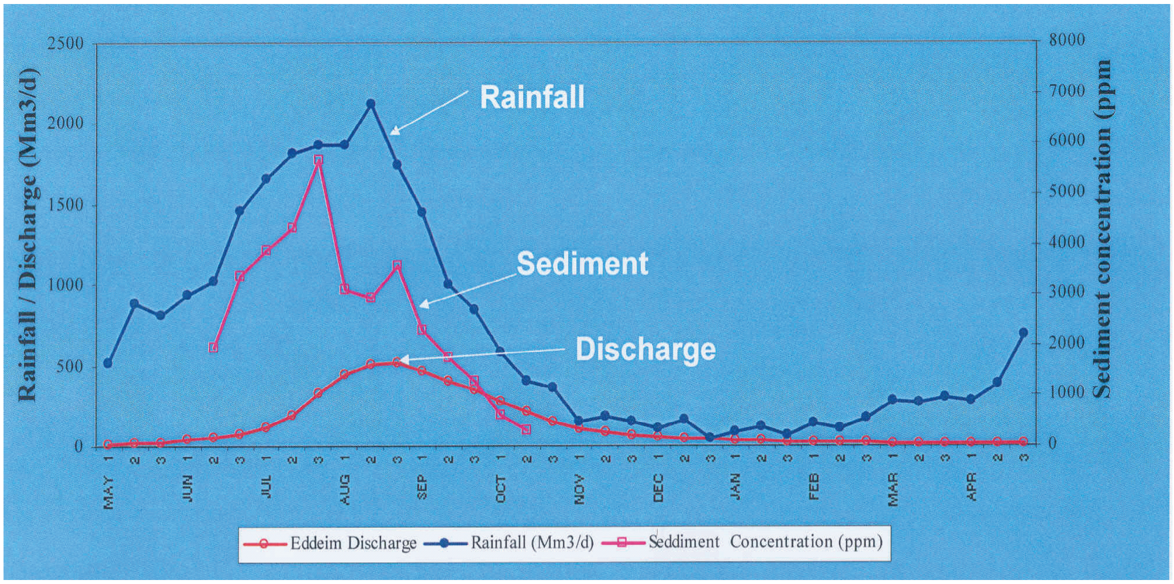
Table 6.11: Sudan's Water Storage Capacity

DAM	Date of commission	River	Ci Mm³	Cg Mm³	Vg Mm³	Purpose of storage
Sennar	1925	Blue Nile	930	370	560	Irrigation & power
ElGirba	1966	Atbra	1300	560	740	Irrigation & power
Roseires	1964	Blue Nile	3354	2227	1127	Irrigation & power
JebelAuilia	1937	White Nile	3500	3500	-	Irrigation & power
TOTAL			9084	6657	2427	

C_i = original storage capacity, C_g = present storage capacity, V_g = Volume of sediment deposits.

Source: AWDR National Report; Ahmed,2005

Fig. 6.14: Comparison of Rainfall, Discharge and Sediment Yield in the Blue Nile



Source: AWDR National Report, 2005

Table 6.12: Sediment Concentration entering Gezira main Canal (1995 – 2002) (ppm)

Period	1995	1996	1997	1998	1999	2000	2001	2002	Averg
JunII	178	-	-	-	286	216	-	-	227
JunIII	331	-	1677	582	551	504	1345	-	832
Jul I	1656	2549	1634	1460	1653	1064	1764	1879	1707
JulII	2660	6219	2560	7986	6356	6578	3348	7694	5638
JulIII	2508	2856	5464	6488	7728	6556	8251	9089	6120
AugI	2925	4831	3155	4857	4831	4725	4892	8904	4890
AugII	2865	5168	4156	5331	5130	6220	5489	7681	5255
AugIII	2738	4162	2748	6017	4233	5045	3422	3767	4017
Sep I	2142	1690	239	2472	3248	1765	3207	645	1926
Sep II	1012	860	215	2863	1765	1935	1454	607	1400
Sep III	281	237	51	1707	533	640	478	122	527
Oct I	293	158	21	531	292	244	134	69	247
OctII	285	-	-	218	476	386	100	36	217
Oct III	-	-	-	186	-	210	-	45	147

Sources: AWDR National Report, 2005; Hydraulics Research Station , Min. of Irrigation and Water Resources, Sudan

6.14 and 6.15 show the comparison between the discharge and sediment concentrations of the Blue Nile and the Atbara River basins, respectively. It is clear that in both graphs, the sediment peak occurs before the peak of the flow by more than one week for the Atbara and about two weeks for the Blue Nile.

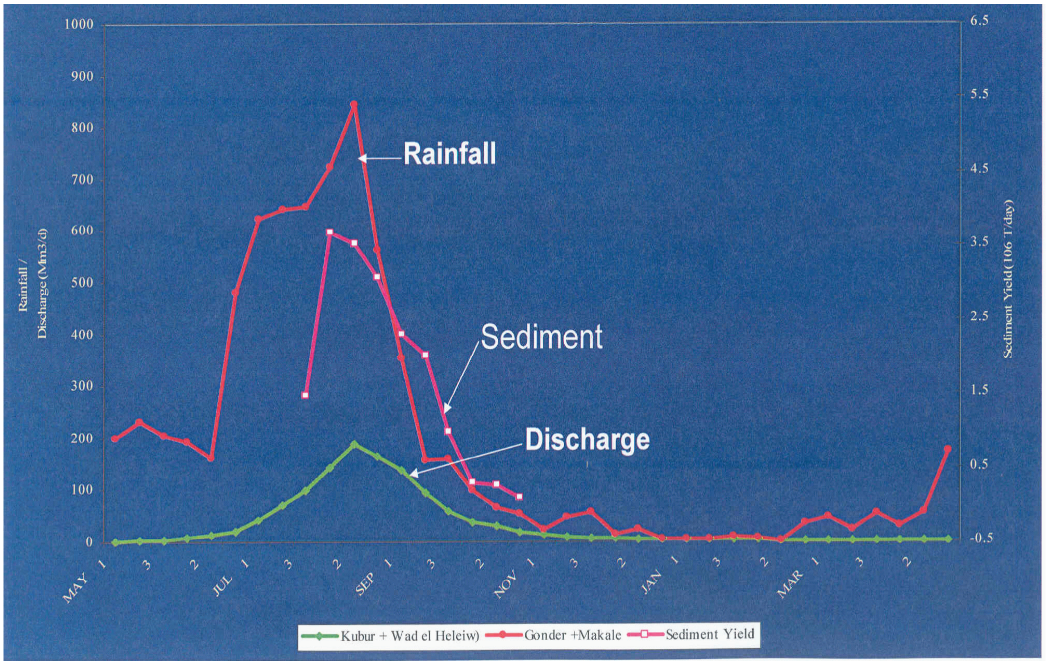
The Hydraulics Research Station (HRS) of MIWR carried out sediment concentration and discharge measurements in several locations of the Gezira scheme canal system and concluded that 5 per cent of the sediment settled in the

Table 6.13: Sediment Concentration in Managil Main Canal (1995 – 2002) (ppm)

Period	1995	1996	1997	1998	1999	2000	2001	2002	Aver
JunII	218	-	-	256	255	233	-	-	240
JunIII	345	-	1650	622	645	503	1634	-	900
Jul I	1482	2448	1835	1493	1519	1059	1670	1849	1669
JulII	1455	5216	5328	5434	4918	6380	3258	6446	4808
JulIII	2655	5007	5309	4847	7898	6259	6756	8099	5854
AugI	2803	4272	3565	4802	5070	5422	4639	8894	4933
AugII	2845	4839	3960	4522	4981	5769	5126	6622	4833
Aug III	2731	3215	2292	4319	4010	4341	3325	3698	3491
Sep I	2304	1472	355	2304	3047	1851	2770	597	1838
Sep II	988	583	312	1928	1609	1636	1338	440	1104
Sep III	237	158	138	1559	486	639	429	200	481
Oct I	176	-	81	456	167	211	110	98	185
Oct II	107	-	38	321	326	262	130	39	175
Oct III	-	-	-	227	419	199	-	60	226

Sources: AWDR National Report, 2005; Hydraulics Research Station, Min. of Irrigation and Water Resources, Sudan

Fig 6.15: Comparison of Rainfall, Discharge and Sediment Yield in the Atbara River Basin.



Source: AWDR National Report, 2005

main canals, 23 per cent in the major canals, 33 per cent in the minor canals and 39 per cent passed to the farm fields (tables 6.12 and 6.13).

Another serious problem is the growth of aquatic weeds along the irrigation network where it is aggravating the sedimentation rate. The sediment deposits in turn provide a good environment for weeds to grow. About 60 per cent of the O&M costs of the irrigation schemes management in the Sudan go to sediment and aquatic weeds clearance. This double problem creates many irrigation difficulties leading to reductions in crop yield and increasing the O&M cost. However, many measures have been applied to mitigate the problem, with some success (AWDR National Report – Sudan, 2005).

On the other hand, the hyacinth weeds in the White Nile started in 1957 in the Sudd area in the South, disrupting river traffic, inlet channels and river life. It is now spreading all over the equatorial lakes requiring regional and international efforts to combat it. However, both sedimentation and aquatic weeds require joint efforts by the Nile Basin countries. For example, although the sediment problem creates many difficulties and problems in the Sudan, it also has a negative impact on the Ethiopian highlands where it originates, eroding the land and therefore reducing much needed soil nutrients and, consequently, agricultural productivity.

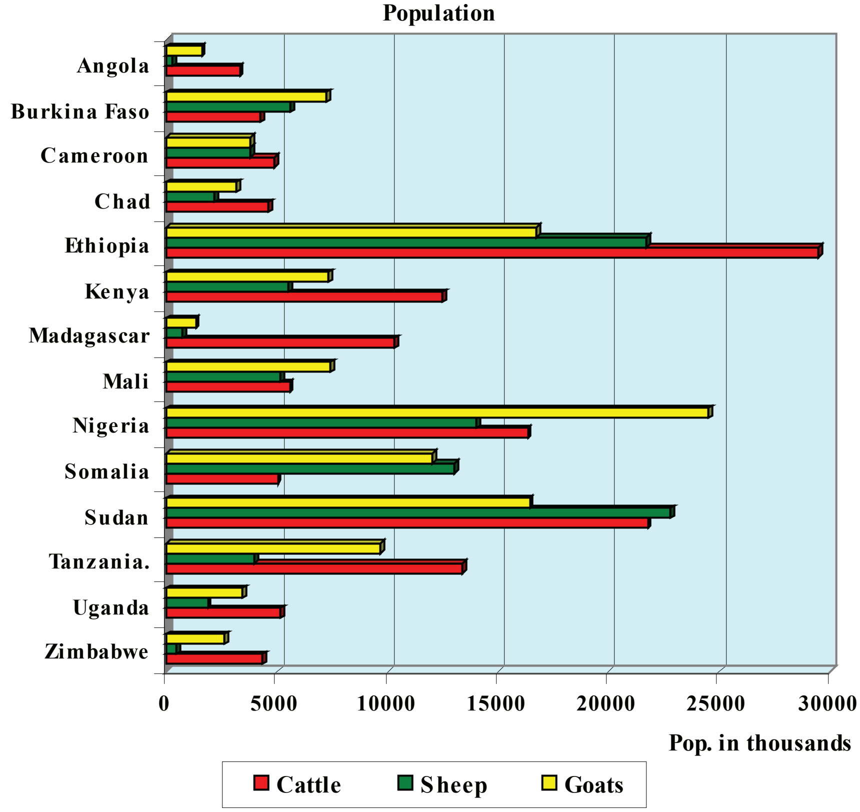
Desertification

About one third of the world's land surface is arid or semi-arid and vulnerable to desertification. Desertification is a process that turns productive land into non-productive desert as a result of poor land-management, mainly in semi-arid areas bordering on deserts, with an average annual rainfall of less than 600 mm. It is predicted that global warming will increase the size of the area with desert climate by 17 per cent in the next century. Desertification is rendering approximately 12 million hectares useless for cultivation worldwide every year. Desertification in Africa has caused the degradation of more than 105 million hectares since the 1970s. One

of the main causes of desertification is deforestation which lays bare top soils for erosion and earth crusting. Deforestation is a major concern, both for commercial timber and for agriculture. In Africa, forests are lost at an estimated rate of more than 5 million ha annually, higher than in any other region. From 1990 to 2000 alone, 60 per cent of the tropical forest areas cleared allover Africa were converted into permanent agricultural smallholdings (UNEP GEO-3, 2002). Inappropriate economic development strategies and lax implementation of forest protection regulations are the main causes of the pressure on forest resources. Almost three quarters of Africa's agricultural drylands are already degraded and 73 per cent of these drylands severely or moderately desertified. Grazing, particularly by cattle, has a serious impact on fragile lands in countries with a large livestock population (fig. 6.16). In the Sahel areas, for example, the desert extended 100 km southwards from 1950 to 1975 and is said to be extending at an annual rate of 5 km in the semi-arid areas of West Africa.

About half of Southern Africa is semi-arid and thus at risk of desertification. There, the areas known to have deteriorated this century are mainly on the edges of the southern Kalahari. The deterioration of the Karoo is less well established. It is possible that desertification of the Karoo began in the last century when sheep were first introduced, and before good records were available for the area. In recent years, the introduction of artificial water points into the Kalahari within Botswana, together with the widespread erection of veterinary fences, have led to the rapid desertification of huge areas. Similar schemes have had the same effect in the southern Kalahari within

Fig. 6.16: Sub Saharan African Countries with High Livestock Population



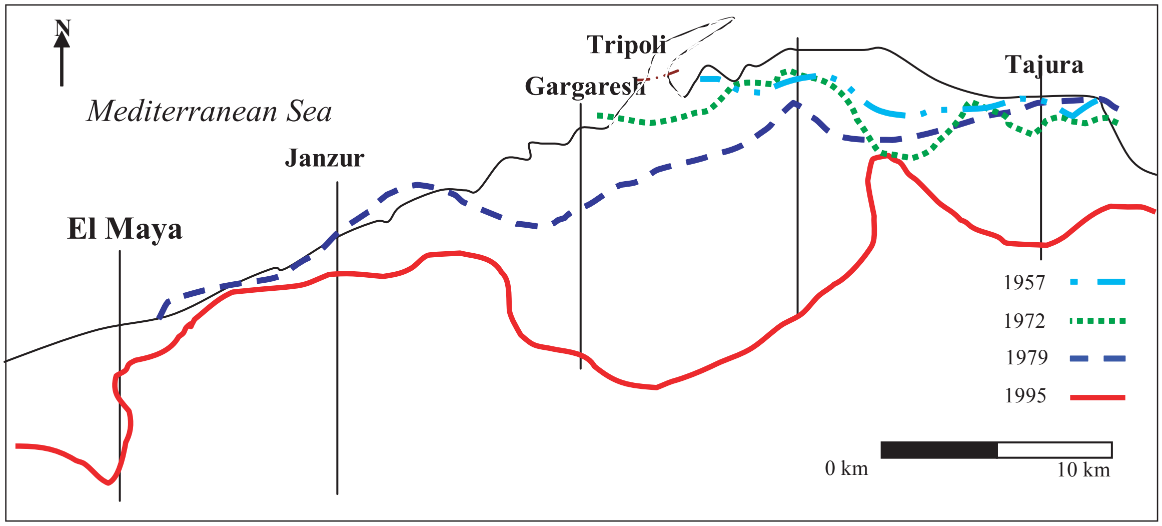
Extracted from FAO, 1997

South Africa and Bophuthatswana. (Desertification Enviro Facts, 2005).

In the northern parts of the continent Morocco is one of the countries affected by desertification. Here, desertification is caused by a combination

Box 6.5
Groundwater Over abstraction and Seawater Intrusion in Libya

In 1976, the Swani well field, consisting of 52 wells tapping the Quaternary aquifer south of Tripoli started operation and consequently resulted in the advance of the seawater intrusion front by more than 3 km southward by the year 1979 The. figure reflects the changes in salinity in the Swani municipal well field in the period from 1976 to 1993 before its closure.



From 1979 to 1995, high rates of population growth and fast urbanization, forced irrigated agriculture to move further south and necessitated the development of an additional well field consisting of 87 wells southeast of Tripoli, which also had to be abandoned after few years of operation. Sharp declines of the water table caused the advance of the seawater intrusion front by 6 km in Tajura, 9 km in Gargaresh, 2 km in Janzur and 5 km in El Maya and the total area affected by seawater intrusion reached 250 km2 (Al Fateh University 2002). The highest advance of the seawater intrusion front in the Tripoli area took place from 1979 to 1995. During this period, the advance rate was estimated at 200 to 400 m/yr especially in the central zone south of Tripoli, while the least advance was in the area of Janzur due partly to the high elevation and the existence of a forest belt to the south. Previous master plans recommended the reduction of pumped groundwater in the subregion to 250 Mm3/yr by adopting certain measures.

Source: AWDR National Report – Libya, 2005

The African Ecosystem at Risk (WWDR) formulated according to World Ecosystem at Risk (WWDR)

Main threats to ecosystems from human activities(UNESCO/WWDR, 2003)
• Population and consumption growth.
• Infrastructure development (dams, urban growth, highways).
• Land conversion (deforestation, agriculture, urban growth).
• Over-harvesting and over-exploitation (over-fishing, wasteful irrigation).
• Release of pollutants (human waste, agricultural and industrial chemicals).
• Introduction of exotic species (replacing and overwhelming indigenous species).

River pollution
• Most African rivers running through cities are badly polluted due to untreated domestic and industrial effluents
• Rapid urbanization in Lagos increased solid waste generation sixfold to about 3.7 million tonnes a year in 1990, plus another half a million tonnes of largely untreated industrial waste because 90 per cent of the industries in Nigeria lack pollution control facilities
• About 3 million people across the region die annually as a result of water-related diseases. 72 per cent of all reported cholera cases in the world in 1998 were in Africa (UNEP GEO3).
• The concentration of industries in or near cities is also a major source of environmental pollution and resource depletion.
• In 1994, the spill of toxic chemicals from a pulp and paper company into the Usuthu river in Swaziland killed many fish (Mavimbela 1995).
• In Mozambique, more than 126 factories in and around Maputo discharge their waste directly into the environment (Couto 1995).
• In Tanzania, textile mills are reported to release dyes, bleaching agents, alkalis and starch directly into Msimbazi Creek in Dar es Salaam (Bwathondi, Nkotagu and Mkuula 1991).

Impacts of waterways diversion and fragmentation
• Most of Africa's largest rivers are severely fragmented by dams, diversions and canals, leading to the degradation of ecosystems.
• Africa has at least 1,272 large dams with 39 situated in South Africa, 213 in Zimbabwe and 107 in Algeria (UNISDR, 2004).
• The Bakolori Dam in northwestern Nigeria on the Dokoto River reduced its average flood levels by 50%, leading to a 53% decrease of cropped area WWF (2004)
• Between 500,000 and 800,000 people no longer have access to productive floodplains that provided much of their livelihood due to the Manantali Dam on the Senegal River WWF (2004)
• About 25 per cent of the land is now subject to water erosion and about 22 per cent to wind erosion, leading to increased siltation of rivers and dams (UNEP GEO3).
• In the Sudan, for example, the total capacity of the Roseieres reservoir, which generates about 80 per cent of the country's electricity, has fallen by 40 per cent in the past 30 years as a result of silting from the Blue Nile (UNEP GEO3).

Wetlands loss:
• Studies show that more than 600 lakes in Africa have shrunk dramatically over the past decades, drained by deforestation, pollution and farming (David Stauth, 2005).
• A study by University of Wisconsin-Madison researchers, working with NASA's Earth Observing System program show that lake Chad is now 1/20th of the size it was 35 years ago due to increasing human need for water, mostly through massive irrigation projects and also significant decline in rainfall since the early 1960's. (NASA, 2001, afrol News, 2001).
• In 20 years, countries such as the Niger lost more than 80 per cent of their freshwater wetlands (David Stauth, 2005).

Biodiversity loss:
• At the African level, many species are highly threatened: over 2000 animal species and close to 2000 plant species being endangered (UNISDR, 2004).
• Lake Victoria, the second largest lake in the world, was declared by the Global Nature Fund (GNF) as the "Threatened Lake 2005". Of about 500 fish species 50 years ago, some 200 species are estimated to be on the verge of extinction.
• Over 45 per cent of Africa is affected by desertification, 55 per cent of which is at high or very high risk (UNEP GEO3)
• Madagascar has the most Critically Endangered and Endangered primates and has lost 90% of its original vegetation.
• The number of Kafue lechwe, a type of antelope endemic to the Kafue Flats, has decreased to a third of its originally estimated 1970 population of 100,000 and elephants, rhinoceroses, giraffes and wild dogs have disappeared from the area entirely due to change of flood patterns as a result of two dams on the Kafue river (WWF, 2004).
• Central Africa had lost about half of its wildlife habitats by 1986. During 1980-1995, the number of extinct plants in Southern Africa increased from 39 to 58. More than 700 vertebrate species, and around 1 000 species of trees are threatened with extinction (UNEP GEO3).
• Government statistics show that Nigeria loses 350,000 hectares of arable land per year. In the north of the country, 10 states have already been affected and each year, the desert advances another 600 metres further south (Anne Isabelle Leclercq, 2005).

Coastal and Marine ecosystems
• Africa's rich coastal and marine areas are under threat from pollution, an estimated 38 per cent of coastal ecosystems, such as mangrove swamps and coral reefs, are under threat from developments like ports and the growth of coastal settlements and their sewage discharges. (UNEP – GPA, 2001)
• The supply of phosphate and silicate nutrients to the coastal Nile Delta was reduced to 4% and 18% respectively after the Aswan High Dam was built, leading to significant reduction in productivity of coastal fisheries WWF (2004)
• The waters of the Western Indian Ocean are major sea routes for an estimated 470 million tonnes of oil every year. This comes with a high risk of disastrous oil spills. Several oil spills have affected African penguins and other marine life (UNEP GEO3).

of interdependent factors which advance desertification at a rate of more than 30 000 ha per annum, mainly in lost lands in the forest belts. One main factor is scarcity of water resources due to climatic changes which lead to decreasing moisture. This factor has reduced the area's water potential by almost 20 per cent in 30 years, about 7 per cent since 1992 (AWDR National Report, 2005). Other factors include:

(a) Excessive water abstraction, depriving the flora of the quantities which it usually receives;
(b) Overgrazing;
(c) Erosion of the soils caused by unsuitable agricultural techniques at the slopes and hill sides;
(d) Increase in the salinity of soils due to uncontrolled irrigation practices; and
(e) Abusive exploitation of forests.

Safeguarding Ecosystem Through Integrated Management Approaches

An analysis carried out within the framework of the UNEP Global Environmental Outlook (GEO2) report by a group of scientists under the auspices of UNEP, NASA, USGS, University of Maryland, and University of California at Santa Barbara on "Biodiversity-Rich Ecoregions in Africa Need Protection" (Singh A. et al., 1998) using geographic information system and remote sensing technologies, estimated that 85-90 per cent of all species can be protected by setting aside areas of high biodiversity before they are further degraded, without having to inventory species individually. According to Singh A. et al., 1998, the geographic analysis of relationships between protected areas and distribution of land cover types and population density clearly revealed that:

(a) This study, based on geographic information system techniques, estimates that approximately 7 per cent (2 million sq km) of the total land area of Africa is protected; this figure is based on measuring the spatial extent of protected areas provided by the World Conservation Monitoring Centre (WCMC);
(b) About 6 per cent of the area covered by biodiversity-rich tropical evergreen broadleaf forests in Africa is protected;
(c) In Africa, drier ecoregions have more protected areas than tropical evergreen broadleaf forests. This is contrary to the widely held belief that moist habitats, such as tropical rain forests, are generally better protected than drier zones, such as dry forests and grasslands;
(d) The presence of croplands in legally protected areas is an indicator that biodiversity cannot easily be preserved in the face of human competition for the same land;
(e) Lack of protection status and effective implementation of protection measures in the designated protected areas seems to pose a serious threat to forest biodiversity in Africa.

A shift in national and international policy formulation and planning processes, based on targeting biodiversity-rich areas, is needed in order to protect biodiversity more effectively in Africa.

From the above study, it can be inferred that the issue of ecosystem conservation goes far beyond international conventions since most African countries are signatories to environmentally-oriented international conventions like the Convention on Biological Diversity (CBD), the Ramsar Convention and the International Convention to Combat Desertification (ICCD). African countries urgently need to institute effective long-term enforcement measures taking into consideration the socio-economic factors associated with the protection of biodiversity in order to fully address the causes of encroachment and subsequent loss of biodiversity. In this direction, an institutional governance framework must be established, involving local stakeholders who must have a role and economic incentives to conserve biodiversity, and must generally include the following:

(a) An ecosystem approach that involves pro-

tection and sustainable use of ecosystems, such as wetlands, forests and sustainably managed soils which capture, filter, store and distribute water;

(b) An ecosystem approach to water supply and sanitation that agrees that it is impossible, even counter-productive, to consider freshwater and saltwater environments as separate ecosystems. No longer can freshwater and saltwater issues be considered in isolation, especially as the discharge of untreated wastewater is one of the most serious threats to the health of coastal populations and ecosystems;

(c) Further promotion of the concept of integrated coastal areas and river basin management, within the broader framework of Integrated Water Resources Management (IWRM) and facilitation of scientific, management and institutional links between freshwater management and coastal/marine management, taking into consideration the existing experience at the national and regional levels.

It is also necessary to take into consideration the ten key elements identified by the United Nations Millennium Development Goals Task Force on Environmental Sustainability, on which specific recommendations were made. These are:

1. To improve small-scale agricultural production systems.
2. To promote forest management for protection and sustainable production.
3. To combat threats to freshwater resources and ecosystems causing water scarcity in dry areas and flooding in wet ones, as well as pollution and salinisation.
4. To address the threats to fisheries and marine ecosystems brought on by the increasing demand for marine products and services and by the degradation of inland habitat.
5. To address the drivers of air and water pollution
6. To mitigate global climate change by stabilising greenhouse gas concentrations at 450-550 part per million carbon dioxide equivalent and support countries in adapting to its effects.
7. To strengthen institutions and governance in order to improve the design and implementation of strategies for achieving environmental sustainability.
8. To develop policy instruments to correct market failures and distortions and to align public and private incentives with the health and well-being of the poor.
9. To promote science and technology for environmental sustainability, and expand the use of scientific and indigenous knowledge related to environmental management by policy makers and the general public.
10. To build environmental sustainability into all development strategies across sectors, and increase funding for environmental management.

In order for African countries to achieve environmental sustainability it is vital for them all to increase their efforts to systematically monitor key environmental parameters such as air and water quality, biodiversity and land degradation in order to enable them to develop indicators for decision makers and all interested stakeholders. The number of transboundary basins existing in Africa makes regional and subregional cooperation necessary in establishing measurement stations and systems to collect and analyse environmental data with active participation from scientific advisory bodies.

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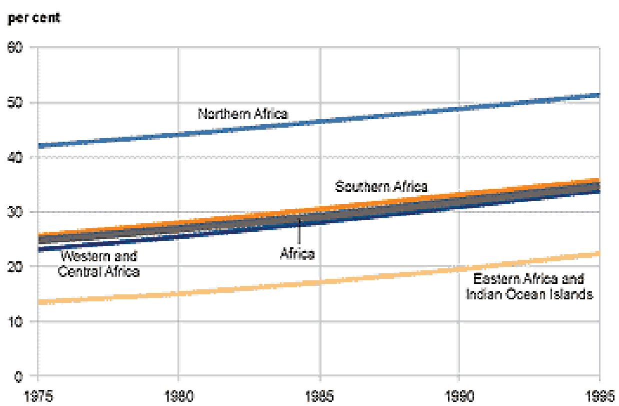
WATER AND URBAN ENVIRONMENTS

At the start of the 20th century, 95 per cent of Africans lived in rural areas. By the 1960s, Africa was still the least urbanized continent, with an urban population of 18.8 per cent. By 1996 this number had doubled. At the present rate of the urban population growth in the continent at least 43 per cent of the people are expected to live in urban areas by 2010 (United Nations Population Division 1997). Average annual urban growth rates in Africa from 1970 to 2000 were the highest in the world, at more than 4 per cent. Current estimates show that the number of urban inhabitants in Africa increased by an average annual rate of 4.3 per cent during the period 1950-2005, resulting in the rise in population from about 33 million to 353 million persons (Hassan Y, 2005).

With the continuous growth of African cities rapid urbanization is expected to continue for decades (GEO-2000). Figure 7.1 gives rates and projections on Africa's urbanization from 1950 to 2030. It shows that the share of the urban population in the total population increased from 14.9 per cent in 1950 to 39.7 per cent in 2005. Future prospects indicate these trends will continue unabated such that by the year 2025 about half of the population in Africa will be living in urban areas (UN 2004).

The pace of urbanization in Africa is reflected in rapid annual incremental change in the number of urban inhabitants from 1.6 million persons a year in 1950 to 5.2 million in 1975 and 13 million in 2005. It is expected to reach 16 million persons by 2015 and 19 million by 2025 (Fig. 7.2). With this pace, approximately 395 million inhabitants will be added to the urban areas in Africa over the next 25 years.

Figure 7.1: Urban Population Growth by Subegion in Africa



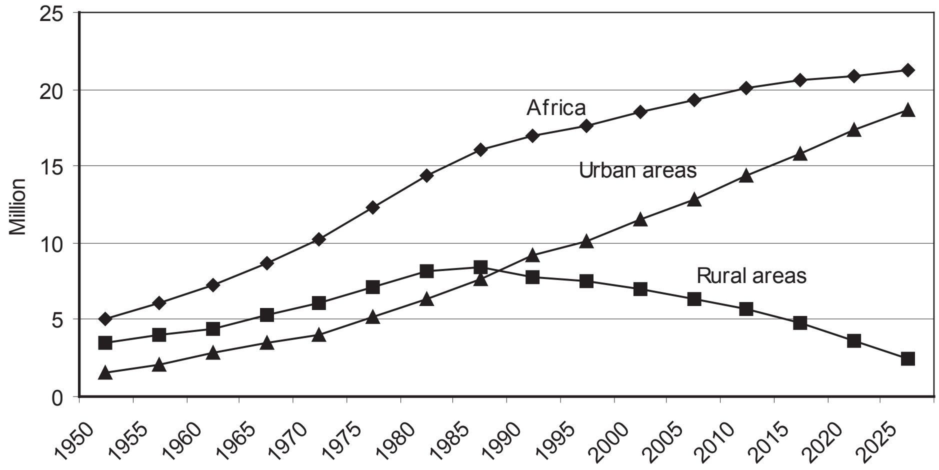
Source: GEO-2000

Table7. 1 Indicators of urbanization in Africa 1950-2030

	Urban population	Rate of urbanization	Urban growth rate
1950	33	14.9	4.4
1975	103	25.2	4.5
2000	296	37.2	3.6
2005	353	39.8	3.4
2015	489	45.1	3.0
2030	748	53.5	2.7

Taken from Hassan Y. (ECA) Source of data: World Urbanization Prospects: The 2003 Revision (UN 2004)

Figure 7.2: Dynamics of Urban and Rural Population Growth in Africa



Source: Hassan, 2005

The growth in urbanization means growth in demand for water and sanitation. An estimated 81 per cent of urban residents have access to safe water and 66 per cent to sanitation facilities. The situation is worse in the rural areas where only 47 per cent of the people have access to safe water (GEO-2000). However, the urban statistics combine the richest and poorest residents in a single average, thereby disguising the daily reality of the poor majority in large slums who lack reasonable access to safe water. For their small share of water, the urban poor pay an unfair price, usually at least four and sometimes as much as ten times more per litre than the metered rates of those living in the elite residential areas (GEO-2000).

"Improved" versus "Adequate" Provision of Water and Sanitation

Millions of urban dwellers have access to water, sanitation and drainage, but many lack access to the improved services provided to the richer inhabitants. This leaves them vulnerable to many diseases and the resultant premature deaths. Less than half of the people in most urban centres in Africa, Asia and Latin America have water piped to their homes, and less than one third have proper sanitation even though they often pay high prices for very inadequate water, sometimes purchased from vendors, and at a price 2–50 times the price per litre paid by higher-income groups, who receive heavily subsidized water piped into their homes (Water and Sanitation in the World's Cities, 2003). However, compared to the rural areas, people living in large cities are generally better served.

Targets
Millennium Development Goals

- Target 10: To halve, by 2015, the proportion of people without sustainable access to safe drinking water.
- Target 11: To achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers.

The World Summit on Sustainable Development in 2002

- To halve, by 2015, the proportion of people who do not have access to basic sanitation.

The problem is not necessarily caused by lack of government funds. In many cities and smaller urban centres, it is possible to improve water and sanitation provisions in low-income settlements while charging their inhabitants less than they currently pay for inadequate provision. Governments and international agencies need to recognize that the water and sanitation needs of urban

areas are distinct from those of rural areas, and that urban areas have particular advantages over rural settlements. Even so, what constitutes 'adequate' or 'improved' access to water can be applied to all urban and rural areas.

For instance, some Governments classify everyone with a water source within 200 metres of their home as having adequate provision of water, but having a public tap within 200 metres of your home in a rural settlement with 200 persons per tap is not the same as having a public tap within 200 metres of your home in an urban squatter settlement with 5000 persons per tap. Water in such cramped settlements are vulnerable to faecal contamination even without sewers or other means to remove household and human waste. Many urban households have so little space per person that they lack sufficient space to fit toilets. But urban settlements also provide more opportunities for high quality provision of water and sanitation, because unit costs are generally lower and urban dwellers often have more capacity to pay.

Yet in the scenario of the urban slums, it will be difficult to reconcile definitions of 'adequate' water and sanitation provision from a health perspective, while it would be easier to meet international targets for improving water and sanitation provision if the definition of 'improved provision' were to be set low. In a sense, 100 per cent of urban (and rural) dwellers already have access to water and sanitation. No one can live without water. No city develops where there is no water. Virtually all livelihoods (and the economic activities that underpin them) also depend on water, directly or indirectly. The issue is not whether they have water and sanitation provision, but whether they have adequate provision (Water and Sanitation in the World's Cities, 2003).

Table 7.2: Adequacy of Urban Water Supply in some Selected Capital Cities

	Urban Coverage	Direct Service	Continuous Service % Day
Angola	34	80	33.3
Benin	74	60	100
Congo Rep	71	72.5	100
Cote d'Ivoire	90	5.9	100
Dem. Congo	89	80	13
Ethiopia	77	60	33.3
Gabon	73	46	100
Gambia	80	90	100
Ghana	87	31	83
Kenya	87	41	75
Tanzania	80	12.4	58
Zambia	88	52	33.3
Zimbabwe	100	89	100

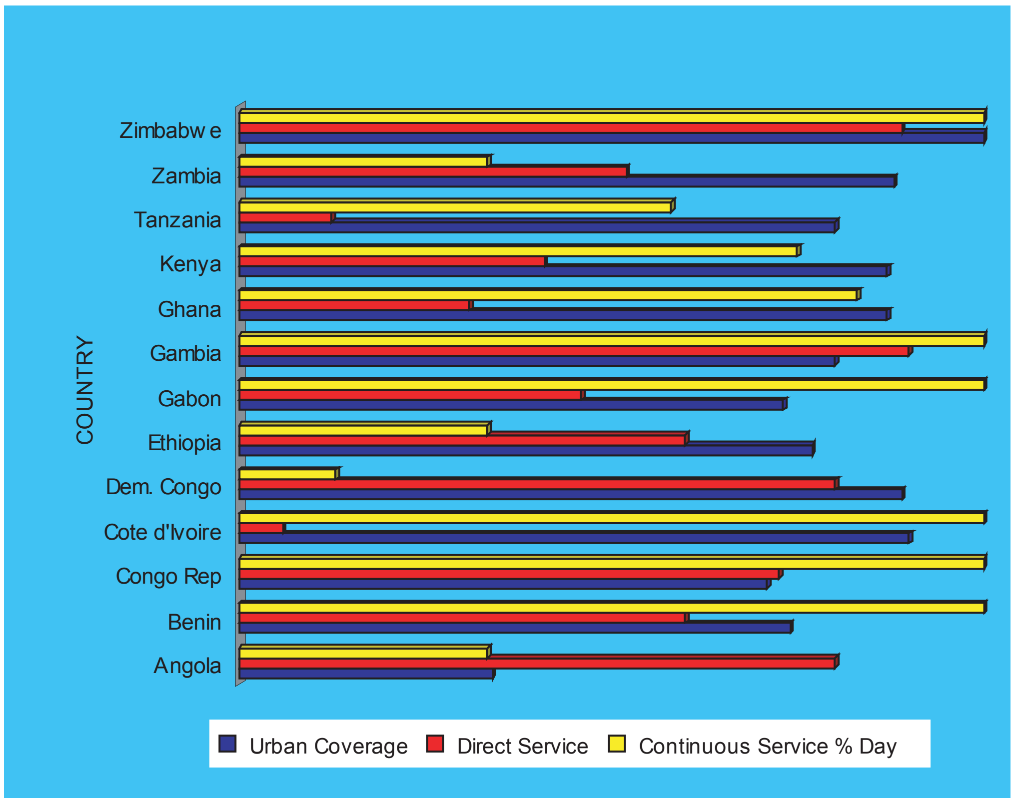
Source: *Water Supply and Sanitation sector Assessment 2000, WHO African Region, Country Profiles, Africa 2000*

Assessment of water and sanitation provision has to be based on some implicit understanding or explicit definition of 'adequate'. In urban areas in high-income countries, 'adequate' water is considered as water that can be safely consumed, piped into each home, distributed by internal plumbing to toilets, bathrooms and kitchens, and available 24 hours a day. 'Adequate sanitation means at least one water-flushed toilet in each house or apartment, a wash basin in the toilet or close by where hands can be washed, with facilities for personal hygiene – hot water and a bath or shower. And, of course, there must be an income level that allows all this to be paid for, or provisions to ensure supplies for those unable to

meet their bills. If these are used as the criteria for 'adequate provision', most of Africa's urban population would have inadequate provision going by table 7.2 and figure 7.3.

and many other water-related diseases which are significant causes of death. They also bring many other benefits – including healthier food, higher real incomes and more employment opportunities in their maintenance sector for many

Fig. 7.3: Adequacy Of Water Supply Coverage



Source: Water Supply and Sanitation sector Assessment 2000, WHO African Region, Country Profiles, Africa 2000

Indeed, most have levels of provision far below this standard. In many urban centres in these regions, no one has this level of provision, because even piped water supplies to the richest households are intermittent and of poor quality. Most urban centres in Africa and Asia have no sewers, and in most of those that do, only a small proportion of the population is connected (Water and Sanitation in the World's Cities, 2003).

It can be argued that every urban dweller has a right to a standard of water and sanitation provision that matches the standards in high-income nations which, no doubt have the greatest health benefits, as they virtually eliminate diarrhoeal

of the poorest urban households. It is, however, unrealistic to use this as the standard in most low-income nations, where limited resources and institutional capacities dictates making better provision for everyone more important than making very good provision for the minority. If the focus is put on making very good provision, the beneficiaries are likely to be the richer and more politically powerful groups. If 'adequate' water is taken to mean a regular piped supply available within the home or in the yard, at least half or more of the urban population of sub-Saharan Africa has inadequate provision; and if 'adequate' sanitation is taken to mean an easily maintained toilet in each person's home with

provision for hand-washing and safe removal and disposal of toilet waste, a very large proportion of the urban population of sub-Saharan Africa is likely to have inadequate provision (Water and Sanitation in the World's Cities, 2003).

Agenda 21

(a) By the year 2000, to have ensured that all urban residents have access to at least 40 litres per capita per day of safe water and that 75 per cent of the urban population are provided with on-site or community facilities for sanitation;
(b) By the year 2000, to have established and applied quantitative and qualitative discharge standards for municipal and industrial effluents; and
© By the year 2000, to have ensured that 75 per cent of solid waste generated in urban areas are collected and recycled or disposed of in an environmentally safe way.

Water and Cities

Rapid urbanization changes the size, growth, and progression of urban human settlements on the urban hierarchy. Most urban inhabitants in Africa live in small settlements of less than a million persons. With an annual average growth rate of 3.7 per cent, the inhabitants of small urban settlements in Africa grew from 67.1 million persons in 1970 to 242 million in 2005. They will reach 318.4 million by 2015 (Table 7.3). However, their percentage share of the total urban population in the continent declined from 81 per cent in 1970 to 68.6 per cent in 2005 and will further decline to about 65 per cent by 2015. This declining share is partly due to the progression of small urban settlements to urban agglomerations. About 27 of the small urban settlements in Africa in 1970 progressed very rapidly to the level of agglomerations of 1 million - 5 million inhabitants) by 2000 (Hassan Y., 2005).

Rapid urbanization in Africa is increasing the number of urban agglomerations with 1 million - 5 million inhabitants, and mega-cities with more than 5 million inhabitants. With an average annual growth rate of 6.1 per cent during 1970-2005, the inhabitants of urban agglomerations reached about 83 million in 2005 and are expected to reach 126.2 million by 2015. Their distribution by subregion changed significantly during 1970-2005, and will further change to a point where about 53.2 per cent of the inhabitants of urban agglomerations in the continent will be residing in East Africa and West Africa by about the year 2015.

The inhabitants of mega-cities are also increasing as a result of urban growth and the progression of agglomerations. Africa had only one mega-city (Cairo) in 1970. This increased to two (Cairo and Lagos) in 2000 (Box 7.1) and to 3 cities (Cairo, Lagos and Kinshasa) in 2005. By 2015 there will be 4 mega-cities in Africa (Cairo, Lagos, Kinshasa and Khartoum). The mega-cities are located in three regions (North, West, and Central Africa). Their inhabitants increased five

Table 7.3: Inhabitants by classes of settlements in Africa 1970-2015

Size and class of settlement	Number of inhabitants in millions			
	1970	2000	2005	2015
Small urban settlements	67.1 81%	206.6 69.9%	242 68.6%	318.4 65%
Urban agglomerations	10.1 12.2%	69.7 23.6%	82.9 23.5%	126.2 25.8%
Mega-cities	5.6 6.8%	19.1 6.5%	27.9 7.9%	44.5 9.1%
Total Urban inhabitants	82.8 100%	295.4 100%	352.9 100%	489.1 100%

Source:Hassan Y., 2005 (World Urbanization Prospects The 2003 Revision (UN 2004)

> **Lagos**
> According to the World Urbanization Prospects: The 2003 Revision (UN 2004), the city of Lagos, Nigeria, was a small urban center with about 290000 inhabitants in year 1950. It became a large urban agglomeration with about 1.4 million inhabitants in 1970, 2.6 million in 1980, 4.8 million in 1990 and 6.4 million in 1995. By the turn of the century the inhabitants of Lagos city reached 8.7 million. They reached 11.2 million in 2005, and will reach 17 million in year 2015. By then, Lagos will outnumber Cairo by about 4 million inhabitants. Worldwide, Lagos will become the ninth largest city in 2015, up from the 24th rank in year 2000.

times form 5.6 million in 1970 to 27.9 million in 2005, reflecting an average annual growth rate of 4.6 percent during these years. By 2015 they will reach 44.5 million inhabitants.

The urban population in Morocco, for example, passed from 13 to 17 million inhabitants from 1992 to 2004 (the last figure still to be confirmed by the census in progress), with a rate of urbanization that increased from 50 to 57 per cent during the given dates. It is a rapid evolution that poses the usual problems posed by rapidly changing cities, namely the difficulty of accompaniment by adequate basic infrastructure due to the heavy financial investments involved. The state of urban water supply is indicated in table 7.4.

The consequences of domestic and industrial pollution of water bodies around Moroccan cities are considerable and include:

(a) 6195 recorded cases of cholera in 1993, most of which were located in zones downstream of the wastewater discharges of the urban centres;
(b) 4243 recorded cases of paludism in 1990, close to areas with a spread of waste water;
(c) Evidence of several sections of rivers show very small quantities of dissolved oxygen causing massive fish mortalities and decimating the flora;
(d) Stopping for several days of water treatment plants and stations fed by water pumped from rivers, owing to very strong pollution, beyond the industries' capacity to treat;
(e) Eutrophication in dam reservoirs caused by large quantities of nitrogen and phosphorus contained in the domestic waste effluents

With regard to safety of the services, efforts were made to diversify and improve supply and management of available water, making it possible to maintain steady supply to most of the city, even for 3-4 years of continuous scanty rainfall. Generally, microbiological pollution result from insufficient and/or lack of sanitation facilities for excreta disposal, especially in peri urban human settlements while chemical pollution comes from untreated industrial wastewater effluents channelled into water bodies. An example is shown in table 7.5 for Sudanese cities.

Table 7.4: Indicators of urban drinking water in Morocco

Years	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Water production (Mm3)	804	766	778	742	764	780	800	812	830	845	840
Subscribers x 1000	1546	1618	1727	1823	1932	2036	2140	2227	2428	2531	2769
Rate of connections (%)	78	79	80	81	82	83	84	85	86	87	88

Source: *AWDR National Report, 2005 (DRPE)*

Table 7.5: Contamination of water bodies by large cities in the Sudan

pits * No.	Région	city	No_3 mg/l	Bacterian colonies /100 ml	
				Total Coliforms	Coliforms fécaux
1	Western	Obaied	455	47	7
		Dilling	375	Uncountable	3
		Nyala	NA	14	10
2	Eastern	Kassala	19.8	40	5
		Gash	12.3	Uncountable	11
3	Northern	Dammar	NA	80	21
		Atbara	NA	36	23
4	Khartoum	Ryadh	NA	NA	37
		Burri	NA	NA	18
		Nasir	NA	NA	14

Source : Sudanese AWDR national report Note: NA: not available *: pit number used by the author

Management problems

One of the basic and essential services that any metropolitan city must offer is efficient water supply. Unless and until this service is effectively provided, the health of the community and its development activities will be seriously compromised. The services provided by many water supply agencies are very disorganized and unreliable due to factors identified by the O&M Working Group, 2002, which are stated below:

(a) Inadequate data on operation and maintenance;
(b) Insufficient and inefficient use of funds;
(c) Poor management of water supply facilities;
(d) Inappropriate system design;
(e) Low profile of operation and maintenance;
(f) Inadequate policies, legal frameworks and overlapping responsibilities; and
(g) Political interference.

Typical management problems include:

(a) Inefficient organizational structures;
(b) Absence of career structures for staff;
(c) Low salaries; and
(d) Poor relationships between the users and management.

The constraints identified as contributing to or causing the failure of water supply systems include:

(a) Poor organizational structures in the agency responsible;
(b) Lack of spare parts;
(c) Inappropriate technology;
(d) Lack of trained staff;
(e) Tied aid;
(f) Absence of career opportunities;
(g) Insufficient funds;
(h) Legal framework problems;
(i) Lack of motivation by sector personnel;
(j) Non-involvement of the users;
(k) Low profile of operation and maintenance in the sector in general;
(l) Inadequate tariff and collection systems;
(m) Negative political interference

For water supply and sanitation services to be sustainable, providers must:

(a) Ensure that good quality water is continuously availability in sufficient quantities in accordance with defined institutional frameworks; and
(b) Apply sound management practices, appropriate technologies, full-cost accounting, and effectively maintain facilities and equipment.

In developing countries, however, management of water supply and sanitation systems is often poor, resulting in interruptions in the provision of services and sometimes in the complete collapse of systems, which could oblige users to

resort to traditional water sources that may be contaminated. Contamination of distribution pipelines due to intermittent supply, low water pressure in the distribution network, inadequate wastewater collection systems and leaking pipes are also common problems in developing countries. If contaminated water penetrates distribution mains, water that has already been treated and disinfected may become re-contaminated (O&M Working Group, 2002).

Technical Problems of Urban Water Supply Systems in Africa

Unaccounted-for-water is a major water supply problem in many African cities (Table 7.4). A lagre part of this water is lost through leaking pipes or overflowing service reservoirs after abstraction, pumping or treatment, or during distribution. Those who suffer most from this inefficiency are people living in the impoverished, outlying urban areas; but if measures are taken to boost sustainability and improve organization of facilities, coverage can be extended to the fringe and poor areas of large cities. This would bring about considerable improvements in health and, at the same time, minimize the need to expand treatment and distribution facilities, thus releasing resources for other development activities. One of the crucial problems facing the sector is lack of sustainability of sanitation services. Despite huge efforts made in the past years, there is still a great need for further work to define principles, generate political will, formulate strategies and search for new technological, financial and institutional solutions.

Health impacts

Urbanization can be a major source of health problems: nearly half of the world's people will be living in urban centres by the end of the 20th century but, currently, 30-60 per cent of the urban population is in low-income countries and lack adequate housing with sanitary facilities, drainage systems, and piping for clean water (UNCHS 1996). This number is expected to increase since local and city authorities often lack the resources, knowledge, trained personnel and financial capacity needed to meet their responsibilities in providing services and amenities essential for healthy living. Increased exposure to biological and chemical health risks in urban areas is particularly harmful to children. Children suffer the greatest number of deaths from diarrhoeal diseases (2.5 million deaths per year). Prevalence of asthma, often exacerbated by air pollutants, has also increased among children (Woolcock and Peat 1997). Studies suggest a quantitative relationship between atmospheric carcinogen levels and lung cancer, and WHO has estimated that 50 per cent of the global burden of chronic respiratory illnesses is associated with air pollutants (WHO 1997b). As the global population continues to grow, there is increasing pressure to develop agriculture, roads and transportation systems in previously uninhabited areas. This kind of land conversion can encourage the spread of diseases harmful to human health. For example, leishmaniasis, an infectious disease transmitted through a sandfly bite, has increased to 12 million cases (WHO 1998) each year alongside increasing land development in Africa, Latin America and West Asia (WHO 1997b). Forest clearing, in particular, is associated with higher incidence of diseases such as malaria.

In search of performance indicators

A transition from traditional familiar terminology and methods is never easy to accomplish, and a commitment is needed from all water suppliers in Africa to effect some important changes. For example, the terms 'Non-Revenue Water' and 'Water Losses' should replace the familiar (but often vague) term 'Unaccounted-for-Water' – since, with modern techniques, it is now possible to account for virtually all water entering a water distribution system (Alegre, H et al., 2000). The production characteristics of urban water utilities in some African countries are shown in table 7.6.

Table 7.6: Production Characteristics of City Water Utilities in some African Countries

Country	Utility	Water Coverage %	Water Production lpcd	Water Production m3/c/m	Total Water Consump-tion m3/c/m	Unaccounted For Water %	Unac-counted For Water m3/conn/d	Metering Level %	Pipe Breaks breaks/km/yr
Benin	SBEE	36.94%	23.15	24.56				100.00%	0.27
Benin	SBEE	37.99%	25.33	24.08				100.00%	0.27
Burkina Faso	ONEA	18.83%	32.24	45.01	34.86	22.57%	0.33	100.00%	0.44
Burkina Faso	ONEA	18.90%	27.70	37.65	36.52	3.00%	0.04	99.99%	0.57
Burkina Faso	ONEA	18.97%	33.64	44.72	35.93	19.66%	0.29	100.00%	
Cote d'Ivoire	SODECI	36.54%	58.89	28.79	27.01	6.17%	0.06	100.00%	
Cote d'Ivoire	SODECI	37.82%	58.70	28.50	24.98	12.37%	0.12	100.00%	
Cote d'Ivoire	SODECI	39.34%	56.67	27.74	23.04	16.94%	0.15	100.00%	
Morocco	ONEP	48.89%	120.03	107.62	97.87	9.06%	0.32	100.00%	0.03
Morocco	ONEP	49.48%	125.09	101.27	91.11	10.04%	0.33	100.00%	0.03
Morocco	ONEP	52.00%	120.39	99.62	89.88	9.78%	0.32	100.00%	0.05
Namibia	WIND-HOEK	100.00%	290.76	45.18	41.01	9.23%	0.14	100.00%	0.06
Namibia	WIND-HOEK	100.00%	231.64	36.67	32.56	11.21%	0.14	100.00%	0.05
Namibia	WIND-HOEK	100.00%	194.00	31.55	27.33	13.38%	0.14	100.00%	0.06
Nigeria	KdSWB	35.00%	122.52	85.44	40.16	53.00%	1.49	3.13%	
Nigeria	KdSWB	35.00%	119.81	81.36	46.45	42.91%	1.15	3.79%	
Nigeria	KtSWB	17.59%	60.76	70.93	52.70	25.69%	0.60	1.05%	
Nigeria	KtSWB	17.73%	59.94	65.67	52.89	19.46%	0.42	0.95%	
Senegal	SDE	46.28%	69.85	34.94	24.45	30.03%	0.35	100.00%	7.08
Senegal	SDE	46.29%	65.65	31.57	22.71	28.06%	0.29	100.00%	8.24
South Africa	RAND WATER	94.74%	313.85	80,446.32	80446.32	0.00%	0.00	100.00%	0.04
South Africa	RAND WATER	94.87%	266.86	70,302.75	70302.75	0.00%	0.00	100.00%	0.04
South Africa	RAND WATER	95.00%	278.88	75,452.56	75452.56	0.00%	0.00	100.00%	0.02
Togo	RNET	30.70%	66.81	55.16	39.88	27.70%	0.50	100.00%	
Togo	RNET	29.47%	67.47	54.65	41.42	24.21%	0.43	100.00%	2.53
Togo	RNET	28.59%	58.14	46.25	34.61	25.16%	0.38	100.00%	3.15

Source: http://www.iwa.hq.org.uk/IWA performance indicators.htm

The use of percentages to express real losses is now also recognized internationally as being potentially misleading when used as a measure of the efficiency of managing real losses (leakage and overflows) from distribution systems with different levels of consumption (Asnake Berhane, 2003).

The simple traditional Technical Performance Indicators for Real Losses most widely used to make comparisons of the annual volume of Real Losses are, as O&M Working Group, 2002 maintains, expressed:

(a) As a % of Input Volume;
(b) As a figure per length of mains per day or hour;
(c) As a figure per service connection per day or hour;
(d) As a figure per property per day or hour; and
(e) As a figure per length of system per day or hour,
(Where length of system = length of mains + length of service connections up to the point of customer metering).

It is important to note that "number of connections" should be used, rather than "number of

properties". This is because the Real Losses occur on service connection, and it is not unusual for the service connection to split into several separate pipes serving individual properties at or after the first metering point. The Water Loss Task Force of the International Water Association (IWA) has recommended that percentages are unsuitable for assessing the efficiency of management of real losses in distribution systems (Alegre, H et al., 2000).

Technical Indicator for Real Losses (TIRL)

The IWA Task Force recommended that the basic TIRL should be the annual volume of Real Losses divided by the number of service connections (NC), allowing for the percentage of the year for which the system is pressurized, i.e.

TIRL = Current Annual Volume of Real Losses/ Nc

(Litres/service connection/day when the system is pressurized)

A more detailed interpretation of TIRL values can be obtained by comparing the TIRL value with a best estimate of Unavoidable Average Real Losses (UARL) that allows for local conditions of connections density, location of customers and average operating pressure, if all aspects of leakage control were being managed to the highest technical standards (Alegre, H et al., 2000).

Unavoidable Average Real Losses (UARL)

It is recommended that the calculation of the UARL in litres/service connection/day be based on the following equation (Alegre, H et al., 2000):

UARL = (A* Lm/Nc + B + C * Lp/Nc) * P
(Litres/service connection/day when the system is pressurized)
The equation and its parameters, A, B, C, are based on a statistical analysis of international data, including 27 different water supply systems in 20 countries. As a result, the IWA Task Force for Operation and Maintenance Work fixed appropriate values for **A (18), B (0.80)** and **C (25)**.

This approach recognizes the separate influences of Real Losses from length of mains (Lm in km), number of service connections (Nc), total length of service connections from the edge of the street to the customer meters (Lp in km), and average pressure (P in meters) when the system is pressurized. A schematic table for estimating UARL is given in table 7.7.

Possible Application: Apart from its relative advantage over the traditional unaccounted for water in differentiating the Infrastructure technical losses from the economic losses, these performance indicators could also be used in formulating contracts for private participation in the management of urban water distribution systems.

Table 7.7: Unavoidable Annual Real Losses (UARL) in litres/service connection/day for customer meters located at the edge of street

Density of Connections Nc/Lm (per Km mains)	Average Operating Pressure (P in Meters)				
	20	40	60	80	100
20	34	68	112	146	170
40	25	50	75	100	125
60	22	44	66	88	110
80	21	41	62	82	103
100	20	39	59	78	98

Source: *http://www.iwa.hq.org.uk/IWA performance indicators.htm*

*Note: where customer meters are located on underground pipes with an average length of 'M' meters per service connections after the edge of the street, add the term [0.025*M*P] litres/service connection/day to table 2 values, where P is the average operating pressure in meters.*

Setback: Most water supply networks in Africa are still not digitized to take advantage of fast, computer-oriented analyses on the state and function of the systems.

The intricate Situation of Urban Slums

> Target 11 of Millennium Development Goal 7 – to "significantly improve" the lives of at least 100 million slum dwellers by the year 2020

The world's slums are growing, with the number of people living in such dire conditions now at the 1 billion mark – making up 32 per cent of the global urban population. A report published in September, 2005 entitled, "The Challenge of Slums" (Habitat Debate, Sept. 2005), says the crisis is such that the world will see this figure double in the next 30 years unless a concerted effort is undertaken to alleviate the situation. "The locus of global poverty is moving to cities, a process now recognized as the urbanisation of poverty," says United Nations Secretary-General Kofi Annan, in a Foreword to the Report. "Without concerted action on the part of the municipal authorities, national Governments, civil society actors and the international community, the number of slum dwellers is likely to increase in most developing countries. And if no serious action is taken, the number of slum dwellers worldwide is projected to rise over the next 30 years to about 2 billion." In developing regions, slum dwellers account for 43 per cent of the population in contrast to about 6 per cent in

Table 7.8 Urbanization and urban poverty in Africa

Country/Subregion	Percentage of the population below the national poverty line				Urbanization rate in year 2005
NORTH AFRICA	Year	Total	Rural	Urban	
Algeria	1998	12.2	16.6	7.3	50.4
Egypt	1996	22.9	23.3	22.5	60.0
Mauritania	2000	46.3	61.2	25.4	64.3
Morocco	1999	19	27.2	12	58.8
Tunisia	1995	7.6	13.9	3.6	64.4
WEST AFRICA					
Burkina Faso	1998	45.3	51	16.5	18.6
Gambia	1998	..	61	48	26.1
Ghana	1998	39.5	49.9	18.6	46.3
Mali	1998	63.8	75.9	30.1	33.7
Niger	1993	63	66	52	23,3
Nigeria	1993	34.1	36.4	30.4	48.3
CENTRAL AFRICA					
Cameroon	2001	40.2	49.9	22.10	52.9
Chad	1996	64	67	63	25.8
EAST AFRICA					
Ethiopia	2000	44.2	45	37	16.2
Kenya	1997	52	53	49	41.6
Madagascar	1999	71.3	76.7	52.1	27.0
SOUTHERN AFRICA					
Mozambique	1997	69.4	71.3	62	38.0
Zambia	1998	72.9	83.1	56	36.5
Zimbabwe	1996	34.9	48	7.9	35.9

Source: Hassan Y., 2005 (World Bank Africa Database 2004)

more developed regions. The proportion of urban residents in slums is highest in sub-Saharan Africa and estimated at 71.9 per cent. The world's rural population has reached its peak, and almost all further population growth will be absorbed by urban settlements – a critical situation recognized by very few Governments, cities and other agencies. (UN-HABITAT's Global Report on Human Settlements 2003).

The impact of rapid urbanization on housing in Africa is manifested in increasing demand for decent shelter. The inability to meet this demand is reflected in the spreading of slums inside and in the vicinity of cities. According to the UN-HABITAT (2003) about 188 million slum dwellers lived in African cities in 2001. The great majority of them (166 million) lived in sub-Saharan Africa. As a percentage of the urban population, slum dwellers constituted about 72 per cent in SSA and 28 per cent in northern Africa in 2001. Slums in Africa grew at an annual rate of about 4.5 per cent during 1990-2001. With such a high rate, and unless action is taken, African cities will experience slums' population explosion (Hassan Y., 2005).

More than half of the urban inhabitants in Mozambique, Chad, Zambia, the Niger and Madagascar are living below the national poverty line (table 7.8). This suggests that poverty is higher in the cities of sub-Saharan Africa than in Northern Africa. In view of rapid urbanization and low income levels, urban poverty might actually be much higher than the rates shown in table 7.8. Therefore, addressing the urban challenges, such as developing urban-based social services, including health, education, electricity, water and transport, and upgrading slums is important for poverty alleviation in Africa (Hassan Y., 2005; Saches *et al* 2004).

The Global Urban Observatory of UN-HABITAT estimates that unless radical action is taken by Governments in sub-Saran Africa, the urban slum population would be doubled from about 199 million in 2005 to 393 million in 2020 (Habitat Debate, Sept 2005). Table 7.9 shows the estimated urban slum population growth in various regions of the developing world.

The problem of water supply and sanitation facilities for the urban poor is very complex. First and foremost, a distinction must be made between urban centres with declining water distribution systems due to inadequate, aging and overloaded networks and the issue of peri-urban dwellers. There is an obvious connection between the two. It is precisely the lack of such social amenities as water and electricity that drives the poor urban and rural youth to the larger, relatively prosperous urban centres for illusive job opportunities and better living conditions. At its initial stages, Governments, in an attempt to discourage such influx of people, either disregarded the phenomenon or intentionally refused to cater for their needs. These urban settlements are therefore devoid of any planning schemes. It is in this unplanned physical environment that water service providers are being called upon to supply water and sanitation amenities. For such an exercise not to fall into the usual trap of ad hoc interventions, there should be the political will to recognise these areas as part of the urban set up and hence initiate urgently needed physical and urban planning arrangements.

The level of unaccounted-for-water in most of the water supply distribution systems is very high in almost all urban centres in Africa, at best around 50 per cent. This loss has two components: the physical water losses and the non-revenue losses. The service providers can therefore extend services to the outlying peripheries where most of the urban poor reside by recovering the unaccounted for water and revenue. This task has become arduous in many countries due to lack of capital investment for modernization of the distribution network and for an effective metering system.

The urban poor population must not be considered as a static homogeneous social entity since it comprises people of different social groups. What

Table 7.9: Estimated urban slum population (without radical action by Governments)

	1990	2005	2015	2020
North Africa	21,719	21,224	20,901	20,741
Sub-Saharan Africa	100,973	199,231	313,419	393,105
Latin America and the Caribbean	110,837	134,257	152,559	162,626
East Asia	150,761	212,368	266,863	299,150
East Asia excluding China	12,831	16,702	19,911	21,739
South Asia	198,663	276,432	344,537	384,644
Southeast Asia	48,986	59,913	68,521	73,279
West Asia	28,641	46,288	63,747	74,808
Oceania	350	568	786	924
DEVELOPING regions:	660,929	946,529	1,202,597	1,355,543
WORLD	721,608	1,010,898	1,265,644	1,416,164

Source: UN-HABITAT, Global Urban Observatory, 2005. Figures are expressed in thousands.

should be born in mind is that the poor from the informal settlements are the hardest working and provide the labour in many industries, offices and services and yet, on getting back home, find no water and sanitation. A programme needs to be worked out for serving the urban poor bearing in mind the variability of their per capita water demand. Just a shower and a water closet may be all that a household needs to modify its requirements and still keep within reasonable tariffs, thus balancing cost and standard of living.

Box 7.2 Urban Slums of Kisumu, Kenya

Over 50% of Kisumu residents live in informal settlements. The existing municipal supply is inefficient. The production is less than it is supposed to be and the amount supplied covers only 40% of the demand. The sewerage system is also overloaded, as it is undersized. This water supply is not extended to the informal settlements with connections, for several reasons; some residents would not pay and would even harass the municipal workers who went there to disconnect the meters. Secondly, there are several water kiosks that are allegedly owned by very influential people. The water kiosk owners sell water to both vendors and individuals and will even go to the extent of inciting water shortages by damaging pipes. Thus, the urban poor resident is faced with two options, to purchase water from the vendor whose cost is 66% more than that of the municipal supply, or dig shallow wells which are common in many households as the water level is quite high. The danger with these wells is the water quality. Being that the slums are extremely crowded and sanitation facilities not far away, not to mention the groundwater pollution faced by industrial towns, the repercussions are devastating, with very rampant waterborne diseases, especially typhoid.

Sanitation facilities on the other hand are very few. Most landlords/ladies would rather build an extra housing room than a latrine. This leads to most tenants using the bush and/or open spaces.

As these informal settlements keep growing, the municipality to date has no clear plans for water supply to them. The water supply is not even sufficient for the town's core, considering that the system was set up in the 1970s mainly for domestic use and since then with industries coming up and more people settling in, the system has NEVER been expanded. Municipal water losses are abundant, both from leaks and illegal connections, and even for the metered connections, only 33% of what is billed is remitted to the council.

Privatization has been discussed, but there still remains the feeling of groping with no direction. Partnerships with existing NGOs could be an option that has not been regarded as no NGOs have seriously embarked on water and sanitation in urban Kisumu.

Source: *Yvonne Wangui, E-Conference on Toolkit for Improved Water Supply and Sanitation Services among the Urban Poor, 2002.*

Box 7.3 Domestic Water Purification for Small Settlements in Zambia

A field trial of a new household water treatment and storage intervention was implemented in Kitwe, Zambia, between March and June 1998. The intervention included three elements: water treatment at the point of use with sodium hypochlorite solution produced locally; safe water storage in 20 litre durable plastic containers referred to as special vessels with a lid and spigot; and community education. This intervention had been successfully implemented in Latin America and this project represents its first field trial in Zambia and indeed in Africa.

Two peri urban communities in Kitwe were selected for evaluation: Ipusukilo, for the intervention group and Luangwa, for the control group. Baseline surveys of demographic and socio-economic conditions in two communities. Water quality testing was performed in a sub-sample of the intervention and control groups. Active diarrhoea surveillance, consisting of weekly household visits to inquire about illness in the prior 7 days, was conducted from 16 March to 12 April 1998. The intervention was implemented in the week of 13 April. Special vessels were offered for sale at a discount to intervention families, who also received free bottles of sodium hypochlorite during the study. A follow up survey and a second round of water quality testing were performed at the end of the evaluation period. A field trial of a behaviour change intervention, involving a new technique called motivational interviewing, was also conducted during the study.

A total of 260 families with 1584 individuals, for a mean of 6.1 persons per family, participated in the study. There were 166 intervention and 94 control families, with similar family sizes, demographic and socioeconomic characteristics. All households used shallow wells as their source of drinking water. Water testing revealed that over 90% of the wells were contaminated with E. coli, a marker for faecal contamination. Stored drinking water samples had higher rates of faecal contamination than well water samples. There was no difference in source and stored water quality between intervention and control group.

During the intervention phase of the study, 67 (40.3%) of 166 families bought special vessels. Compliance with sodium hypochlorite use in drinking water measured as detectable chlorine in drinking water ranged from 72 to 90% during the course of the study. During the follow-up of water quality testing, stored water quality was significantly better in the intervention than in the control group, with 69% of intervention families having water free of E.coli contamination ($p<0.001$). During the baseline phase of the study, there was no difference in diarrhoea rates between intervention and control families. However, despite the fact that diarrhoea rates were low and declining as the rainy season ended, there was a borderline statistically significant difference in diarrhoea rates between intervention and control families, with intervention families experiencing 45% decreased risk of illness (relative risk =0.55, 95% confidence intervals, 0.3 0.99). Knowledge of diarrhoea transmission and prevention increased during the course of the study. To date, the micro enterprise at Ipusukilo Clinic has sold nearly 300 000 bottles of disinfectant.

Finally, this field trial showed a high rate of compliance with the intervention, with a marked improvement of stored water quality and a reduction in diarrhoeal disease. Underpinning this project was a social marketing programme that was commissioned the following year.

Note: *Case study presented by Chilufya Kaminsa on Domestic Water Chlorination for Peri-Urban Communities – The Zambian Experience, at the first International Advanced Course on Integrated Water Resources Management at WAAREDOC, Univ. for Foreigners, Perugia, Italy.*

Box 7.4: Best Practices identified by the Cities Alliance Secretariat relevant to Africa

The 60th session of the General Assembly will hear from member states what actions they have taken to address the world's most pressing development problems. In the wake of the summit of the Group of Eight industrialized nations, poverty, especially in Africa, will likely be brought into sharp focus. Of particular interest to members of the World Bank's Cities Alliance, will be the reports of national governments responding to Target 11, which called upon governments *by 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers.* Where city and national governments have increased their attention on the plight of slum dwellers, they have found that they have also had a significant impact across a range of Millennium goals – including those dealing with poverty, health, and the environment – because the world's slums are the locus of every deprivation and ailment associated with extreme poverty. As the Cities Alliance reported in its' 2003 Annual report, a number of member states have responded decisively to the Millennium Declaration, and implemented nationwide programmes to improve the conditions of slum dwellers and, in so doing, simultaneously increase the economic efficiency of their towns and cities.

- **Mauritania**, one of the poorest countries in the world, is demonstrating how a combination of political will, long-term policy and budgetary planning underwritten by good technical assistance can regularize and improve living conditions in slums, as well as provide options to avoid the growth of new slums in a rapidly urbanizing country.
- **Morocco** has established one of the most comprehensive approaches to slum upgrading anywhere in the world through its comprehensive and ambitious *villes sans bidonvilles* programme. Led by the King, the Government has set long-term national targets, provided significant budgetary allocations, engaged with the local governments, and obtained the support of a number of multilateral and bilateral development agencies. There are a number of other countries that have taken decisive steps to make progress in upgrading all slums.
- In **South Africa** the national government and major cities such as eThekwini (Durban), Ekuhurleni and Tshwane (Pretoria) have developed citywide plans for upgrading and city development, whereas Johannesburg has twice approached the local capital markets to fund its revitalization.
- Of all countries in the developing world, Tunisia has arguably come closest to achieving the vision of cities without slums, through a national upgrading programme that predates the Millennium Declaration and has spanned the last two decades.

  Since the publication of the Cities Alliance 2003 review, a number of cities have moved to the forefront with the introduction of comprehensive upgrading and city development strategies.
- **Mbabane,** capital of landlocked Swaziland, has recently introduced a programme to upgrade all slums within the city, aiming to become a city without slums by 2015. This challenge has also been taken up by Dar es Salaam, which was amongst the first African cities to set itself the goal of upgrading all of its slums, also by 2015.
- **Dakar** has designed a comprehensive city development strategy, while the Government of Senegal is also moving towards finalizing its own plans for a national villes sans bidonvilles (cities without slums) programme.

Extracted from: Best Practices identified by the Cities Alliance Secretariat (Mark Hildebrand, Manager of the Cities Alliance Secretariat. William Cobbett manages the slum upgrading portfolio of the Cities Alliance.)

Source*: Habitat Debate, UN-HABITAT, September 2005, Vol.11, No.3*

Urban Water Needs in Some Selected Countries

Republic of the Congo

In 1992, the urban population of the Republic of the Congo was estimated at 1,264.900 people. Water demand assessed on the basis of 50l/day/per capita was then 63 245 m3/day. The total annual production of the *Société Nationale de Distribution d'Eau* (SNDE) in the six urban cities that year was 36.400 million m3 or a daily production of 97 726 m3. Since 22 per cent of SNDE's total production was consumed by industries and trade and SNDE's technical output was 65 per cent, the volume directly consumed by the population was 49 550 m3, that is, 39 litres per capita per day. The evolution of the gaps between the volumes produced and those really sold until 1992 is shown in table 7.10 as unaccounted-for-water. Statistics on the sold volumes are not available. However, the estimated average technical output is 65 per cent. In 2002, the urban population was 1 796 300 inhabitants (Table 7.11) and the SNDE total production in the six urban cities was 39. 80 million m3. If technical losses are taken into account with an estimated level of 35 per cent, the consumed water volume was 39.5 litres per capita per day.

From the calculation of the volume that takes into account other water uses (industry and trade), it was found that in 2002 the overall water demand was far from being satisfied. The quantity of unaccounted-for water is not easily measurable because of the use of an all-in-one tariff system on the one hand and because of the lack of metering and water measurement on the other. The technical outputs currently admitted amount to 65 per cent. The evolution of domestic consumption is graphically shown in figure 7.4 while the industrial and commercial consumption of water is shown in Figure 7.5.

Table 7.10: Dynamics of Unaccounted-for Water in urban water supply systems

Year	1987	1988	1989	1990	1991	1992
Volume produced	28.205	29.720	37.400	30.845	32.553	36.400
Volume sold	21.290	19 320	24 310	20 050	21 160	23.660
Unaccounted for Water %	35	35	35	35	35	35

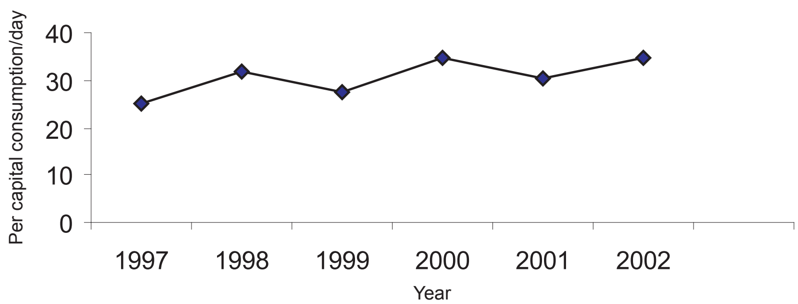
Source: AWDR National Report, 2003 (SNDE)

Table 7.11: Urban Cities Demographic Growth (million of persons)

Cities	Population 1995	Population 2000	Population 2001	Population 2002
Brazzaville	826 000	999 400	1 027 800	1 057 300
Pointe Noire	415 000	502 100	516 400	531 300
Dolisie	69 700	84 300	86 700	89 200
Nkayi	53 500	64 200	66 100	67 900
Mossendjo	21 900	26 500	27 400	28 200
Ouesso	17 600	21 200	21 800	22 400
Total	1 403 700	1 697 700	1 746 200	1 796 300

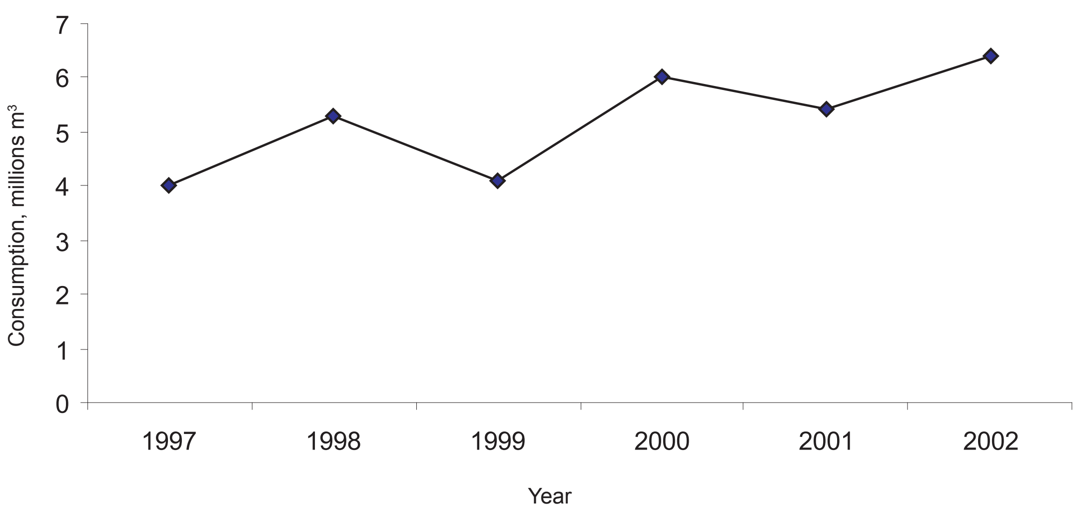
Source: *AWDR National Report (CNSEE)*

Figure 7.4 Evolution of Domestic consumption



Source AWDR National Report, 2003

Figure 7.5: Evolution of Industrial and commercial consumption



Source AWDR National Report, 2003

Nigeria

The population of Nigerian cities has increased tremendously, especially with the steady migration of unemployed youths from the rural areas to the major cities and towns. In the same manner, many semi- urban towns have grown into urban cities with the creation of new states and local governments. JICA (1995) defined cities or urban towns as towns that have a population of over 20,000. At independence in 1960, the major cities in Nigeria comprised mostly of the regional capitals of Enugu, Kaduna, Ibadan and Lagos as well as other subordinate urban towns. With the creation of the twelve state structures in 1967, the number of urban cities in Nigeria rose to over 250. Considering the present 36 state capitals, including the Federal Capital Territory (FCT), and the fact that each local government headquarter has a potential to develop into a city, Nigeria, for planning purposes, could be said to have up to 600 cities, a far cry from the estimated 250 cities at independence (Table 7.12).

Table 7.12: Number of Local Governments in Nigeria by State

S/N	State	No. of LGA	S/N	State	No. of LGA
1	Akwa Ibom	24	17	Ondo	26
2	Anambra	16	18	Oyo	25
3	Adamawa	16	19	Plateau	23
4	Bauchi	23	20	Rivers	24
5	Edo	14	21	Sokoto	29
6	Benue	18	22	Abia	17
7	Borno	21	23	Delta	19
8	Cross River	14	24	Enugu	19
9	Imo	21	25	Jigawa	21
10	Kaduna	18	26	Kebbi	16
11	Kano	34	27	Kogi	23
12	Katsina	26	28	Taraba	12
13	Kwara	12	29	Yobe	13
14	Lagos	15	30	Ogun	23
15	Niger	19	31	FCT	4
16	Ogun	15			

Source: *AWDR National Report (FGN Official Gazette No. 25 Vol.84, 1997).*

The 250 towns or cities housed about 22 per cent of the country's population in 1976. With the increase in the number of cities to about 600, the population should double and so should the water demand (Table 7.13). The development of most cities in Nigeria is associated with the establishment of commercial institutions and medium- and large-scale industries that obtain much of their water supply from the public sources. The daily water demand estimated to include the need of such establishments is about 150 liters per person per day.

Table 7.13: The Projected Urban Water Demand

STATE	Year 1991				2000				2020			
	X 1000 POP	Demand			Pop. X1000	Demand			Pop x 1000	Demand		
		MLD	Lcd	Service Pop. X 1000		MLD	Lcd	Serv Pop.		MLD	Lcd	Serv Pop
Rivers	2461	217.9	89	1230(49%)	3284	342.2	104	59.9% 1970	5429	988.7	182	4343 79.9%
Akwa Ibom	1246	99.2	80	623(50%)	1662	156.6	94	59.9% 1997	2748	458.2	167	2199 80%
Cross River	872	81.4	93	436(50%)	1164	129.0	111	59.9% 698	1924	363.8	189	1539 79.9%
Imo	1710	130.7	76	855(50%)	2282	202.8	89	59.9% 1369	3773	605.3	160	3018 79.9%
Abia	1318	128.9	98	659(50%)	1759	123.1	117	59.9% 1055	2907	571.3	197	2326 80%
Anambra	1836	167.8	91	918(50%)	2450	262.8	107	60% 1470	4051	751.1	185	3241 80%
Enugu	1989	186.9	94	995(50%)	2655	291.1	110	60% 1593	4389	823.3	188	3511 79.9%
Oyo	2269	33.8	147	1133(50%)	3025	541.7	179	60% 1815	5001	1424	285	4001 80%
Osun	1624	168.9	104	812(50%)	2167	256.7	118	59.9% 1300	3583	736.9	206	2866(79.99%)
Ondo	2457	226.0	92	1228(49%)	3279	360.8	110	59.9% 1967	5421	1003.7	185	4336 79.9%
Edo	1382	120.7	87	691(50%)	1844	191.1	104	59.9% 1106	3048	543.7	178	2438 79.9%
Lagos	5568	1048.7	188	2784(50%)	7430	1718	231	60% 44.59	12284	4435.4	361	9827 79.9%
Ogun	1645	185.1	113	823(50%)	2195	281.9	128	60% 1317	3630	807.1	222	2904 80%
Delta	1610	132.8	82	805(50%)	2148	218.6	102	60% 1289	3552	618.8	174	2841 79.9%
Benue	883	77.3	88	441(49%)	1234	128.3	104	60% 741	2226	397.9	179	1781 80%
Adamawa	995	84.8	85	497(49%)	1390	140.9	101	60% 834	2507	443.0	177	2006 80%

STATE	Year 1991				2000				2020			
	X 1000 POP	Demand			Pop. X1000	Demand			Pop x 1000	Demand		
		MLD	Lcd	Service Pop. X 1000		MLD	Lcd	Serv Pop.		MLD	Lcd	Serv Pop
Plateau	1669	169.6	102	835(50%)	2334	285	122	59.9% 1400	4210	856.5	203	3368 80%
Taraba	487	37.8	78	244(50%)	681	61.5	90	60% 409	2507	443	177	2006 80%
Kogi	767	63.6	83	383(49%)	1023	100.6 2285.7*	98	60% 614	1852	315.6	170	1482 80%
Kaduna	2737	291	106	1368(49%)	3652	466.9	128	59.9% 2191	6614	1412	214	5291 80%
Niger	1191	104.5	88	595(49%)	1589	165.4	104	59.9% 953	2878	516	179	2802 97%
Kwara	1033	132	128	516(49%)	1379	215	156	59.9% 827	2497	620	248	1998 80%
Bauchi	1496	118.6	79	748(50%)	1659	146.4	88	59.9% 995	2516	389.2	155	2013 80%
Yobe	391	33.1	85	169(43%)	434	44.5	103	59% 260	658	115.2	175	526 80%
Borno	1520	150.9	99	760(50%)	1686	203.9	121	60% 1012	2557	518.4	203	2046 80%
Kano	2615	315.3	121	1307 (49.9%)	2900	422.7	146	60% 1740	4399	1045.7	238	3519 79.9%
Jigawa	815	60.9	75	407(49%)	903	78.4	87	60% 542	1370	215.6	157	1096 80%
Katsina	1738	155.8	90	869(50%)	1905	202.6	106	60% 1143	2864	522.8	183	2292 80%
Kebbi	658	51.1	78	329(50%)	721	65.3	91	59.9% 432	1084	176.1	162	867 79.89%
Sokoto	1866	167.6	90	933(50%)	2045	217.3	106	60% 1227	3074	563.5	183	2460 80%
FCT	213	36.1	169	107(50%)	284	57.7	203	60% 171	515	164.7	320	412 80%
Total for Year		4978.8 MLD				7895,329				22846.1		

Source: *AWDR National Report*

As a result of the usual low coverage of potable drinking water, the urban population resorts to multiple ways of obtaining their daily supply as demonstrated in table 7.14.

Table 7.14: Percentage Distribution of Households by Source of Drinking Water and by State

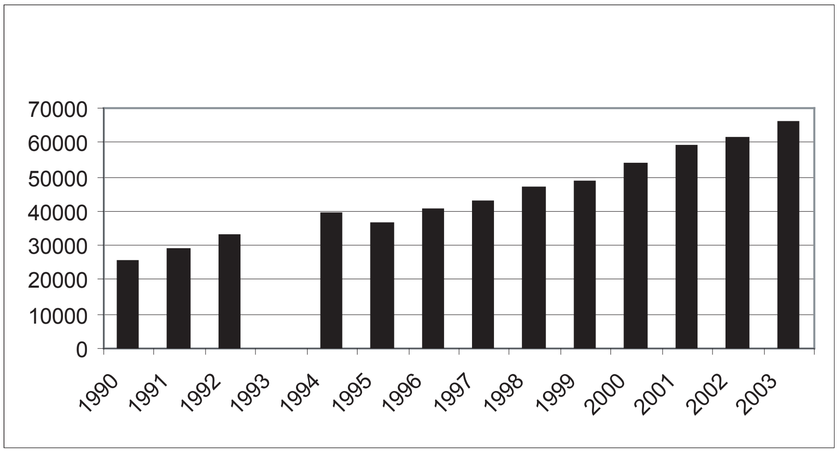
STATE	PIPED	PUBLIC TAP	HAND PUMP	PROT. D/WELL	UNPROT D/WELL	POND	VENDOR	OTHER	TOTAL
ABIA	5.0	9.0	37.2	0.5	3.4	36.6	7.3	1.1	100
ADAMAWA	6.3	4.4	14.4	19.6	2.7	51.5	0.0	1.0	100
A/IBOM	9.6	6.4	0.0	4.8	8.2	70.9	0.0	0.0	100
ANAMBRA	8.9	4.4	13.1	13.3	15.2	33.3	11.8	0.0	100
BAUCHI	2.4	0.4	14.8	31.1	38.6	12.2	0.6	0.0	100
BENUE	2.2	1.0	1.4	25.7	2.6	65.8	0.0	1.2	100
BORNO	4.7	26.2	19.7	0.0	40.6	7.9	0.4	0.4	100
C/RIVER	1.7	5.0	26.5	2.5	0.2	64.1	0.0	0.0	100
DELTA	9.4	12.6	18.2	28.1	20.4	10.8	0.5	0.0	100
EDO	28.8	10.3	1.8	31.6	11.4	16.0	0.0	0.0	100
ENUGU	5.0	12.3	17.6	2.3	10.0	47.2	5.5	0.0	100
IMO	3.8	15.0	3.6	1.0	18.0	48.1	3.8	6.8	100
JIGAAWA	11.3	18.3	25.4	6.2	33.1	5.6	0.2	0.0	100
KADUNA	29.4	5.0	1.2	48.4	6.9	8.5	0.6	0.0	100
KANO	9.9	8.2	9.3	13.6	47.2	7.8	0.2	3.7	100
KATSINA	8.1	9.6	1.5	48.5	23.4	8.4	0.5	0.0	100
KEBBI	3.5	0.3	2.3	57.1	25.7	10.3	0.5	0.3	100
KOGI	8.5	13.1	2.7	5.6	16.8	48.8	4.5	0.0	100
KWARA	25.6	25.0	19.0	3.7	8.5	17.3	0.8	0.0	100
LAGOS	11.6	33.2	38.4	1.7	0.7	0.0	11.4	3.1	100
NIGER	4.2	3.1	22.1	19.8	13.9	34.6	0.3	1.9	100
OGUN	7.9	13.1	29.5	14.4	2.0	33.1	0.0	0.0	100
ONDO	2.4	17.9	0.6	23.7	26.4	29.0	0.0	0.0	100
OSUN	14.9	25.0	4.6	23.3	14.8	16.6	0.9	0.0	100
OYO	14.1	22.8	7.2	37.2	5.2	12.8	0.7	0.0	100
PLATEAU	6.6	7.6	0.7	19.4	7.0	58.1	0.7	0.0	100
RIVERS	2.9	17.3	5.3	11.1	9.1	54.4	0.0	0.0	100
SOKOTO	0.8	2.0	3.9	11.3	70.1	11.3	0.2	0.4	100
TARABA	0.2	0.0	9.2	28.0	10.3	47.3	5.1	0.0	100
YOBE	6.7	14.2	1.0	25.3	43.1	9.5	0.0	0.2	100
ABUJA(FCT)	58.4	16.1	0.0	1.0	0.3	23.9	0.3	0.0	100
NIGERIA	9.4	11.4	11.6	18.6	17.4	29.2	1.8	0.6	100

Source: *AWDR National Report (UNICEF, 1995)*

Botswana

The country has two cities (Gaborone and Francistown) that are small by international standards (a population of 186 007 and 83 023 respectively). However, urbanization is high and a large part of the population now lives around both cities. The number of water connections has grown almost threefold since 1990 (Figure 7.6).

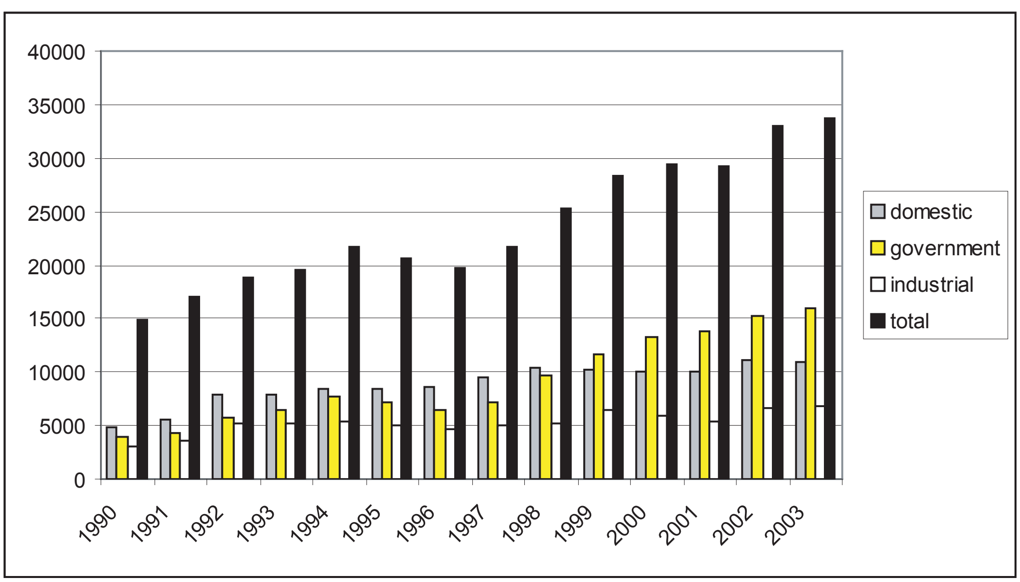
Fig. 7.6: No of connections in urban areas (WUC)



Source: AWDR National Report, 2005; WUC annual reports.

Both cities depend entirely on surface water from a series of dams (Gaborone, Shashe dam, Bokaa dam and Letsibogo dam). The water consumption for both cities was estimated from WUC annual reports (Figure 7.7). Domestic use is the highest followed by government and business/industry use.

Figure 7.7: Water consumption in Gaborone and Francistown by activity (1990-2003; in 000 m3).



Source: WUC Annual Reports.

The average per capita consumption for domestic use is 120/L/day/person in Gaborone and a lower 62.5 L/day/person in Francistown. Daily use by government and industry is estimated at 28 099 m3 and 11529 m3 in Gaborone. Comparable figures for Francistown are 9542 m3 and 3167 m3. Through water management measures, WUC has reduced its unaccounted-for-water losses (UAL), which represent leakages, non-payment and illegal abstractions. The losses are estimated to be 12 per cent compared to over 20 per cent previously. DWA estimate the average UAL of large villages at 30 per cent with losses in excess of 40 per cent in some villages (Mathangwane and Molale, 2004).

Swaziland – Impact of HIV/AIDS on Water Supply

The Swaziland Water Services Corporation, which provides water and sewerage services in urban centres, faces a number of challenges that tend to limit its success in providing water and sewerage services in these areas. The HIV/AIDS pandemic continues to be a major concern and challenge to the Corporation. The HIV/AIDS pandemic is having serious social and financial impact on the Corporation, as children are becoming the household owners responsible for paying the bills. The other challenges include unaccounted-for-water (UAW) which, in 2004, was around 47 per cent, the rapidly increasing production costs, increasing poverty, the general lack of acknowledgement and knowledge that water is a valuable resource requiring special attention for its conservation, the non-commitment of the share holder to investing in building a series of raw storage/dams and assisting in the provision of the necessary huge infrastructure for bringing water to the people regardless of their location, the scourge of HIV/AIDS which is reducing ability to pay for water services, the growing need for a reliable clean water supply whether in urban or rural areas, and the problem of having to ration water in some regions (particularly in Lubombo) where the raw water levels remain low due to inadequate rainfall (AWDR National Report).

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The Global Urban Observatory of UN-HABITAT estimates that without radical action by Governments in sub-Saran Africa, the urban slum population would be doubled from

about 199 million in 2005 to 393 million in 2020Habitat Debate, Sept2005). Table 7.9 shows the estimated urban slum population growth in various regions of the developing world.

WATER FOR FOOD SECURITY

Food security may have different meanings for different people. The International Conference on Nutrition (ICN), held in Rome in 1992, defined food security as "access by all people at all times to the food needed for a healthy life" (FAO, 1997). According to FAO (1997), in order to achieve food security a country must achieve three basic aims:

(a) Ensure adequacy of food supplies in terms of quantity, quality and variety of food;
(b) Optimize stability in the flow of supplies; and
(c) Secure sustainable access to available supplies by all who need them.

Adequate food availability at the national, regional and household levels, obtained through markets and other channels, is the cornerstone of nutritional well-being. At the household level, food security implies physical and economic access to foods that are adequate in terms of quantity, nutritional quality, safety and cultural acceptability to meet each person's needs. Household food security depends on adequate income and assets, including land and other productive resources. Food security is ultimately associated with access to nutritionally adequate food at the household level, that is the ability of households or individuals to acquire a nutritionally adequate diet at all times. It is well recognized that poverty is the principal cause of malnutrition (FAO, 1997). Indicators for food security in Burundi indicate a decreasing trend in the percentage of agricultural production to the overall gross domestic product and increasing food dependency (table 8.1).

Box 8.1 The Integrated Food Security Strategy for South Africa, 2002, declares:

"At the national level, South Africa is food secure. It produces its main staple foods, exports its surplus food, and imports what it needs to meet its food requirements. National food security indicators reveal that South Africa has been meeting the food needs of its growing population from domestic sources in the past 20 years."

But at household and intra-household levels:
"Currently about 35% of the total population, or 14.3 million South Africans, are vulnerable to food insecurity. Among these, women, children and the elderly are particularly more vulnerable."

Table 8.1: Indicators of Food Security in Burundi

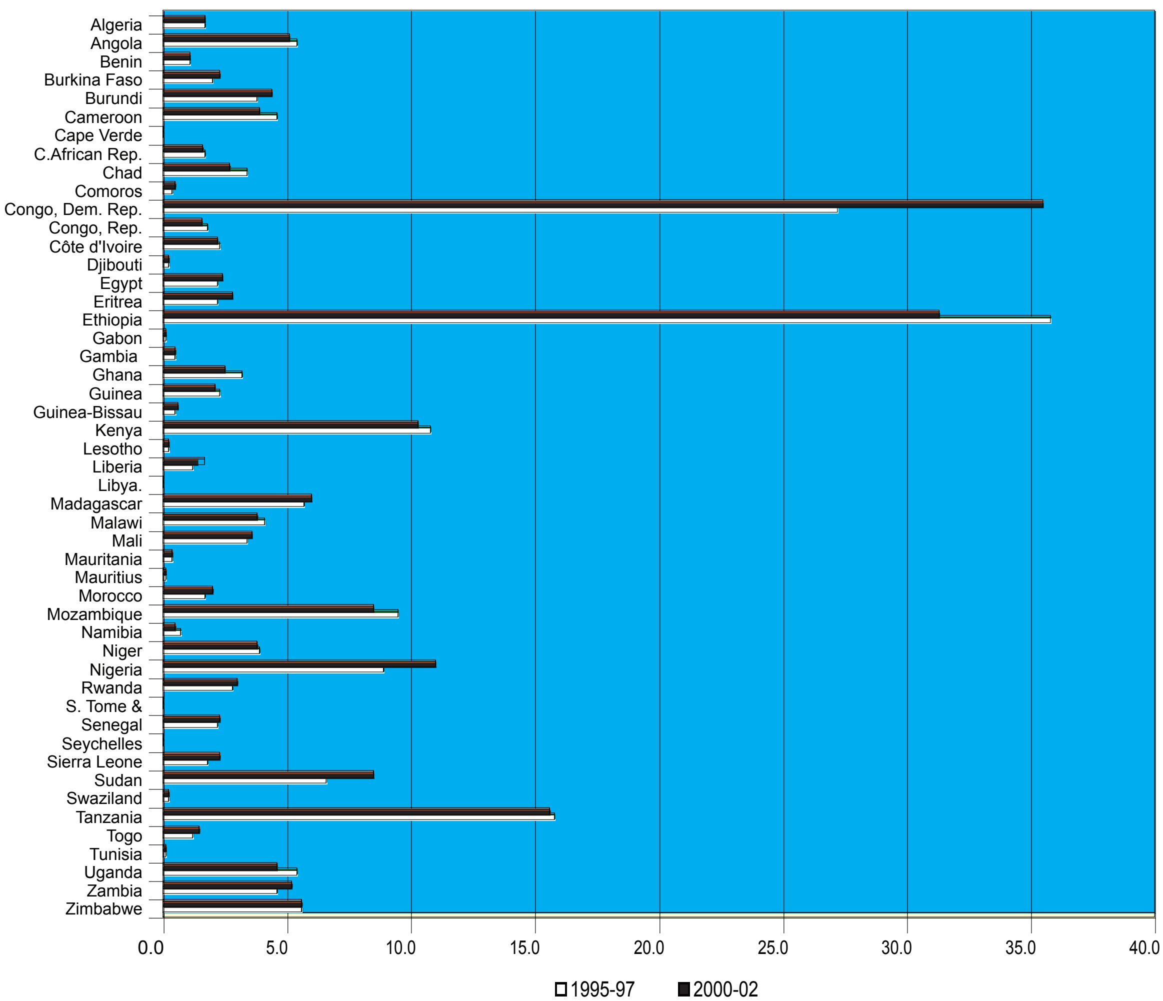
Indicator	YEAR										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
% of Agricultural Production to GDP	41,3	47,2	35,9	34,8	27,7	32,6	41,0	36,7	33,4	34,8	29,1
Daily supply of Calories as % of Needs	103,1	102,7	-	-	-	-	-	-	-	-	-
Coefficient of Food Dependency	3,1	4,0	3,2	4,5	17,4	10,0	7,7	9,1	11,1	13,23	18,9

Source: AWDR National Report, 2003 based on Data Base for Human Development Index: 1990-2000.

Acute and chronic under-nutrition and most micronutrient deficiencies primarily affect the poor and deprive people who do not have access to adequate food, live in unsanitary environments without access to sufficient and clean water and basic services and lack access to appropriate education and information. In sub-Saharan Africa, where approximately 70 per cent of the population lives in rural areas, crop and animal production, fisheries and forestry activities are direct sources of food and provide income with which to buy food. Figure 8.1 shows that in general incidents of malnutrition have decreased in many African countries with the exception of the Democratic Republic of the Congo, the Sudan and Nigeria, where the number has actually increased, and Ethiopia has substantially reduced the number of undernourished persons.

Increased and diversified production of food for family consumption or as a source of income is a basic prerequisite for improved household food security (FAO, 1997). Better home and community food processing, preservation and storage and access to marketing facilities can also contribute to household food security by alleviating seasonal shortages in food supply and stabilizing market prices. Lack of conservation techniques, allow most of Africa's perishable agricultural products, such as tomatoes, eggplant, cassava,

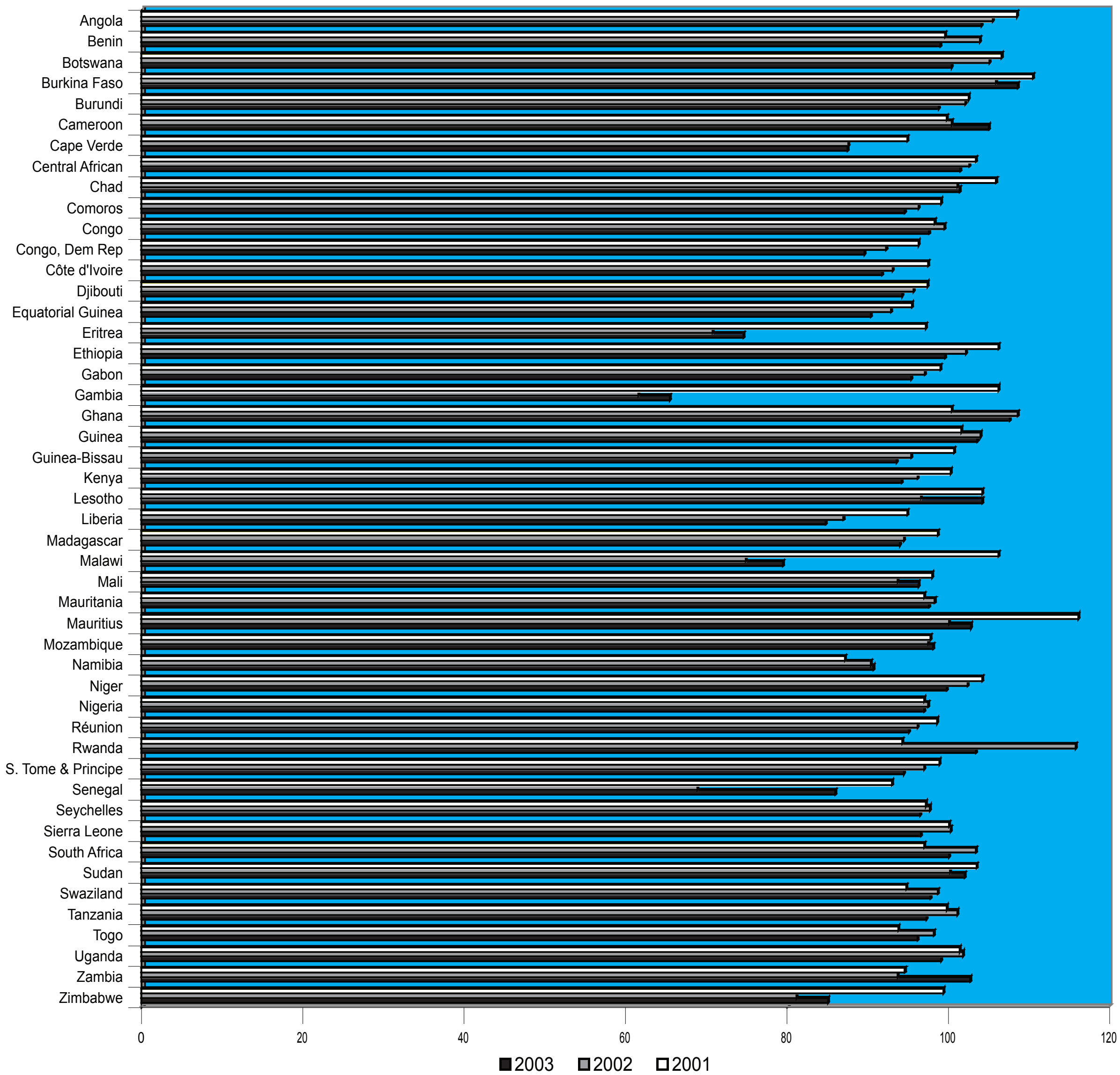
Figure 8.1: Number of Undernourished Persons in African countries (Millions)



Source: FAO Food Security Statistics Online.

plantains and many others to go to waste. FAO statistics show that Africa's per capita agricultural and food production indices were 99 and 100 in 2000 (1989-1991=100), much lower than the total production indices of 127 and 128. This fact attests that agricultural growth did not keep pace with population growth. Given disparities among countries, the little change in per capita food production combined with increasing inequalities in income and food distribution leads to the conclusion that there has been, at best, no change or worse, an increase in the number of food-insecure and malnourished people in most countries in recent years. In the period 2000 - 2003, the index of per capita food production is almost invariant in almost all the countries, with

Figure 8.2: Index of Per Capita food Production



Source: Food and Agriculture Organization of the United Nations (FAO), 2004. FAOSTAT online statistical service. Available online at: http://apps.fao.org, Rome: FAO.

Note: The per capita food production index shows the food output (after deduction for feed and seed) of a country's agriculture sector relative to the base period 1999-2001. The per capita food production index covers all edible agricultural products that contain nutrients; coffee and tea are excluded.

only Cameroon showing increased value in 2003 (Figure 8.2), even though in terms of values, Mauritius seems to maintain a very good level. Figure 8.3 shows the gross and per capita indices of agricultural and food production in Cameroon for the period 1990 - 2000.

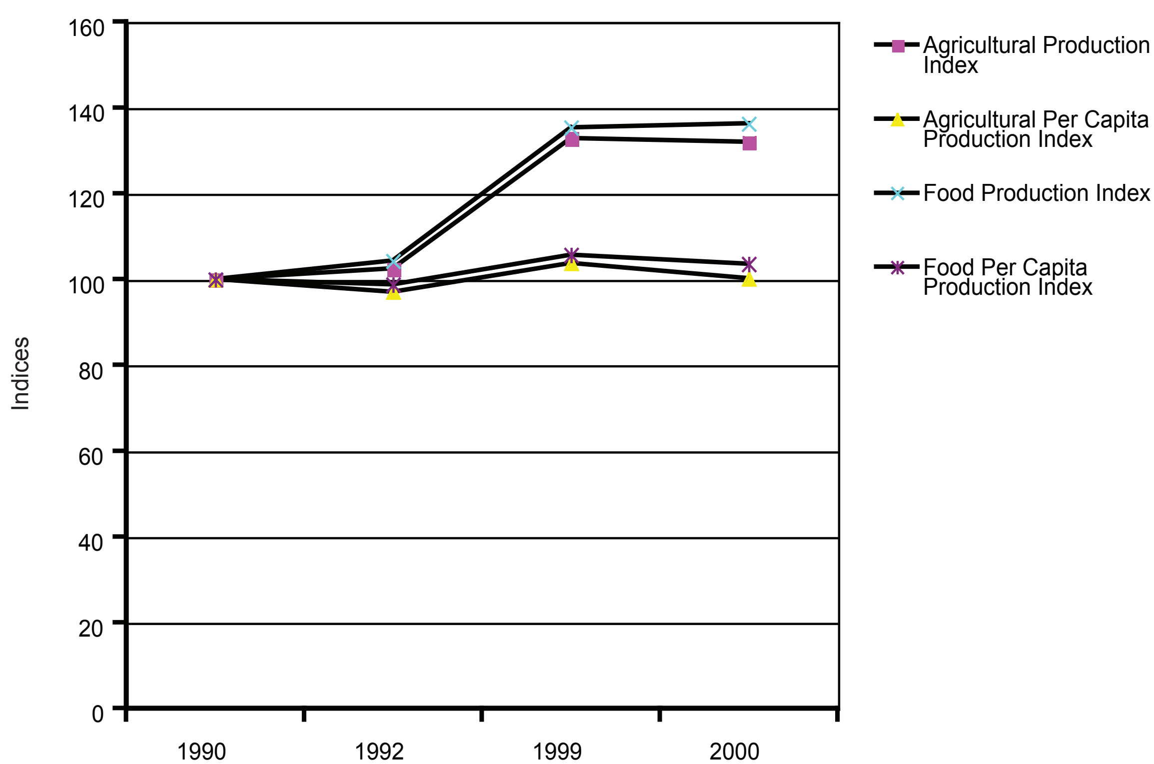
The Main Causes of Food Insecurity and Vulnerability

There are many natural and man-made factors that affect agricultural production and enhancement in Africa, leading to endemic malnutrition, persistent hunger and even famine in various subregions of the continent. Primary amongst them are the following constraints (FAO, 2000):

Political Constraints

The African continent, which is more familiar with the pangs of hunger than any other region in the world, is ravaged by an array of armed conflicts occurring within countries or between neighbouring countries (Angola, Burundi, Congo, the Democratic Republic of the Congo, Eritrea, Ethiopia, Guinea-Bissau, Rwanda, Sierra Leone, Somalia, Sudan, Uganda and so on). These troubles, which arise from political crises, not only cause terrible human suffering, including massive population displacement and the enforced recruitment of children, but also paralyse production structures and absorb virtually all of the national and international financial resources that should have been allocated to development programmes. Although the situation is improving in the Congo, Liberia, Rwanda and Sierra Leone, as a result of agreements between the warring parties, food supply is still a source of concern, especially for women, children and mutilated adults. In the Sudan, the percentage of needs met this year is far below that of 1998 (FAO, 2000).

Figure 8.3: Agricultural and Food Production Indices in Cameroon



Source: AWDR National Report, 2003.

Physical constraints

In many parts of Africa, irregular weather patterns (drought, floods), isolation of agricultural regions and environmental degradation all contribute to significantly reducing the rate of growth of agricultural and food production.

Social constraints

Social constraints restrict agricultural and rural development in sub-Saharan Africa: low level of literacy and schooling, insufficient access to safe water for humans and livestock, poor dietary habits, low health-care coverage, spread of malaria and HIV disease and uncontrolled population growth.

Financial and economic constraints

Serious financial and economic constraints hamper the development of the agricultural sector:

(a) Sizeable external debt;
(b) Disequilibrium of public finances and balance of payments;
(c) Low level of domestic savings;
(d) Limited proportion of national financial resources allocated to the agricultural sector;
(e) Low participation of basic infrastructure and the private sector in the economy;
(f) Export essentially confined to primary commodities;
(g) Stagnation or regression of the industrial sector; and
(h) Restricted markets, which, coupled with the serious difficulties of national institutions in formulating and implementing appropriate policies, exacerbate resource degradation and increase the level of unemployment, therefore fuelling social disruption.

Technical constraints

The technical constraints essentially translate as limited application of technology in production systems, inappropriate agricultural practices, low use of inputs and insufficient farmer training and advisory assistance. Agricultural production, especially food production, depends almost exclusively on natural factors (rains, soil, rudimentary tillage tools). The progress made in raising food production in certain countries is the result of an extension of cropped area rather than an increase in productivity.

Institutional and political frameworks

Poorly defined and poorly articulated legislative, regulatory and policy frameworks with little motivational impact contribute largely to raising the transaction costs of direct investments by nationals and foreigners (FAO, 2000).

The severity of the problem of food security varies from one African subregion to another. Although West Africa is more populated than any other African subregion, it has the lowest proportion of hungry inhabitants (about 18%), while East Africa, with a far smaller population, has more than twice as many (42%). The proportion is also higher in central and southern Africa, which are also far less populated. Some 44 per cent of the 340 million people living in the 26 countries that make up these three subregions are undernourished. Food production has made rapid progress in West Africa, notably in Burkina Faso, Côte d'Ivoire, Ghana, Mali, Nigeria, and a number of other countries, but two out of every five persons still do not have adequate food intake. The food situation in the other subregions has further deteriorated, primarily due to political instability in Angola, Somalia, Ethiopia, Eritrea, Congo (Brazzaville) and in the Great Lakes Countries, including the Democratic Republic of the Congo (FAO, 2000).

The State of Agricultural Production in Africa

In the past three decades, agricultural production has increased at an average of less than 2 per cent per annum, while the population has risen by about 3 per cent. Under current demand and supply trends, cereal imports are expected to rise from the current 10 million metric tons

per annum to 30 million metric tons in 25 years. Much of this can be explained by the fact that about one third of the people in the region live in drought-prone areas. In much of West Africa, average food supply (2430 kcal/day/person) is below what is regarded as the optimum level of nutritional supply, namely 2700 kcal/day/person. Nigeria seemed to sustain an increasing rate of agricultural production in the 1990's (table 8.2). In east and southern Africa, the number of food insecure people has almost doubled from 22 million in the early 1980s to 39 million in the early 1990s. It has been estimated that a 3.3 per cent increase in agricultural output per annum is needed to achieve food security objectives for the continent. Worse still, scenarios suggest that if the areas under irrigation were to grow by a factor of 3, to over 16 million hectares, this would only represent a 5 per cent contribution to the required three-fold food production increase needed by 2025. Finally, it is worth noting that despite the high levels of food insecurity in the region, most countries have substantial under-utilized potential for irrigation expansion (± 39.5 million hectares, not taking into account large-scale river diversion schemes). In fact, two thirds of African countries have developed less than 20 per cent of their potential (in all but four countries in the region, less than 5 per cent of the cultivated area is irrigated). The three countries with the most irrigation potential have each developed less than 10 per cent of their potential irrigated area. The scope for expansion of irrigation is, therefore, considerable; however, it is apparent that there is an even greater scope for expansion of rain-fed agriculture if agriculture is to make the necessary contribution to Africa's socio-economic development.

The continent's land and water resources are important for agriculture, which accounts for 34 per cent of Africa's GDP, 70 per cent of its labour force and 40 per cent of its exports. In 1998, Africa recorded a sustained growth rate of its economy of 3.3 per cent as compared to 2.9 per cent in 1997 and 4.0 per cent in 1996. The agricultural sector accounted for 19.4 per cent of total output in 1997, as compared to 22.3 per cent in 1980, and recorded a growth of 1.7 per cent and 3.5 per cent respectively in 1997 and 1998. Examples of the role of agricultural production within the general dynamics of national GDP are shown for Morocco in table 8.3 and in figure 8.4 for the Sudan with the evolution

Table 8.3: Dynamics of Agricultural Sector in the GDP of Morocco

Years	1998	1999	2000	2001	2002
GDP	133,7	133,6	134,9	143,6	150,1
Agricultural GDP	21,9	18,2	15,5	19,8	21,3
A GDP/GDP (%)	16,3	13,6	11,5	13,8	14,2

Source: AWDR National Report, 2005.

Table 8.2: Performance of the Agricultural Sector in Nigeria

Total in Million US $			Average Annual Growth Rate %			Share in Total GDP %		
1992/94	1995/97	1998/99	1992/94	1995/97	1998/99	1992/94	1995/97	1998/99
8,328	9,178	9,825	1.9	4.2	2.6	30.6	31.6	31.7

Source: AWDR National Report, Comment:

Figure 8.4: GDP and Agriculture Growth (1983-2001) in Sudan

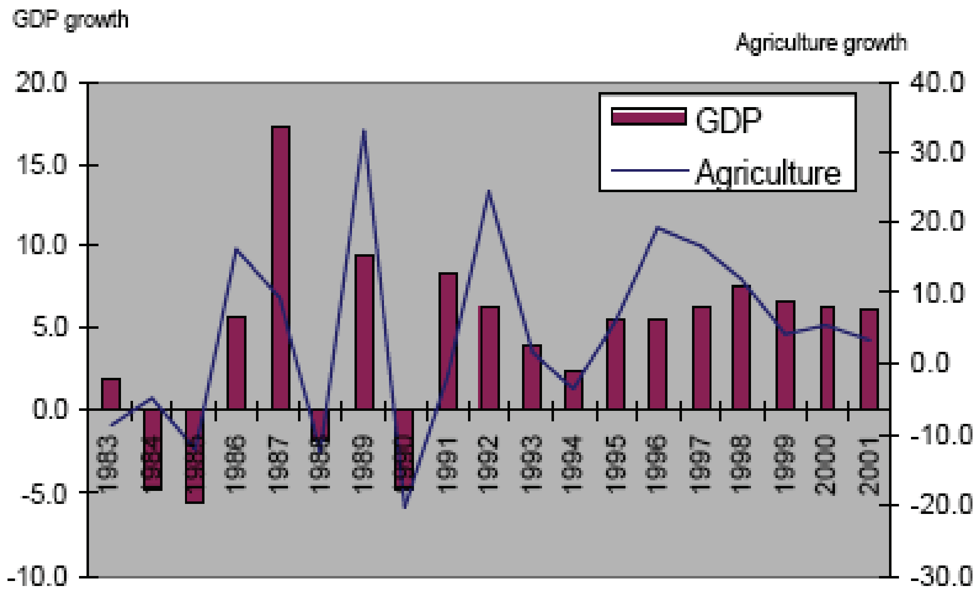


Table 8.4: Production of food crops in Mauritius (1994-2003).

Production of food crops, 1994 – 2003(Tonnes).										
Total food crops	81,466	97,533	89,629	101,442	92,215	86,083	114,484	129,119	103,876	103,455

Source: AWDR National Report, 2005.

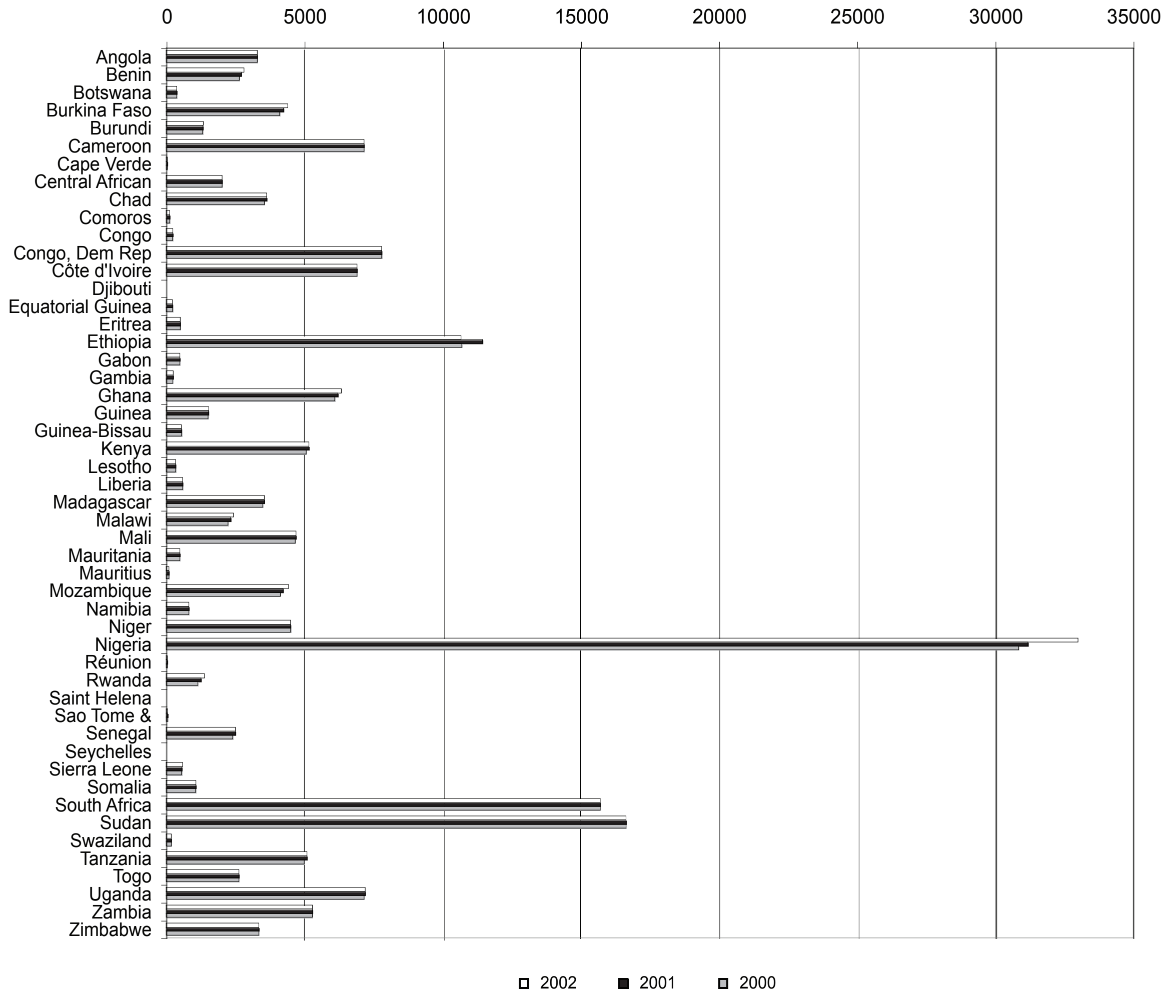
of food production in Mauritius shown in table 8.4.

There are several factors explaining the persisting food insecurity problem in Africa. Among them are:

(a) Continuous rapid population growth;
(b) Low agricultural productivity;
(c) Environmental degradation; and
(d) Weak science and technology infrastructure.

As a result of the high moisture variability over Africa from the north to the south, agricultural production differs from subregion to subregion and even within them. Tables (8.5-8.8) show the levels of food needs and agricultural production outputs in various countries. It must be noted that there is no single subregion in which food security is guaranteed without recourse to food imports or external food aid. Yet, most African countries have not taken full advantage of the available arable lands for agricultural production (figure 8.5).

Figure 8.5: Permanent and Arable croplands in Sub-saharan African Countries



Source: Food and Agriculture Organization of the United Nations (FAO), FAOSTAT on-*line*.

Table 8.5: Coverage levels of food needs by agricultural production in Morocco

	Cereals	Oil	Sugar
1970-74	85%	25%	50%
1975-79	74%	22%	53%
1980-84	62%	17%	60%
1994-98	62%	20%	51%

Sources: AWDR National Report, 2005; Ministry of Agriculture.

Consequently, many people in Africa lack adequate amounts of foods that are rich in the nutrients needed for health and a productive life. Chronic undernutrition affects some 215 million people in sub-Saharan Africa, or 43 per cent of the population (FAO, 1996b).

Table 8.6: Output of Main Agricultural Products in the Democratic Republic of the Congo of (tons/hectares)

Products/ Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Corn	0,8	0,8	0,85	0,81	0,81	0,82	0,81	0,81	0,83	0,83	0,8
Cassava	8,05	8,05	8,06	8,06	8,07	8,07	8	8	7,81	7,73	8,14
Rice	0,8	0,8	0,8	0,8	0,81	0,81	0,8	0,73	0,72	0,73	0,74
Peanuts	0,72	0,75	0,8	0,82	0,82	0,83	0,8	0,8	0,79	0,79	0,74
Bean	0,58	0,59	0,58	0,59	0,6	0,59	0,6	0,6	0,6	0,59	0,56
Sweet Potato	5	5	5	0,76	0,77	0,77	5	5	4,95	4,95	4,46
Plantain Banana	5	4,88	4,89	4,8	4,87	4,87	4,88	4,87	4,77	4,77	4,8
Banana	4	3,98	3,98	3,82	3,82	3,82	3,82	3,82	3,49	3,49	3,7

Source: DRC Report on Climate Changes.

Table 8.7: Agricultural Production in Cameroon from 1996 to 1999

Year	Annual Cereal Production, x1000 MT	Cereal Yield, kg/ha	Annual Root & Tuber Production, x 1000 MT	Root and Tuber Yield, kg/ha	Annual Pulse Production, x 1000 MT	Pulse Yield, kg/ha	Annual Meat Production, x 1000 MT
96-98	1222	1274	2588	5777	98	665	202
1999	1574	2107	4117	9950	284	1315	

Source: AWDR National Report (MINAGRI (1999), WRI (2001)).

Deficiencies of iron, vitamin A and iodine are also widespread; about 300 million people are affected every year, and a much greater number are at risk from these deficiencies. Malnutrition increases people's vulnerability to infections, causing numerous deaths. In the face of this bleak situation, major efforts are required by national governments and the international community to bring about reductions in malnutrition and micronutrient deficiencies through increased and diversified agricultural production.

Table 8.8: Statistics of Food Production in Burundi

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Cereals											
Production (000) T	306,1	299,7	224,7	269	272,6	304,7	260,5	264,5	245,3	271,7	276
Vegetables											
Production (000) T	385,9	376,6	258,5	357,9	326,7	310,6	313,5	261,9	219	284	320
Roots and tubers											
Production (000) T	1486	1263	1326	1364	1449	1322	1479	1458	1458	1615	1423,5
Bananas and plantains											
Production (000) T	1020	1580	1268	1564	1544	1527	1573	1495	1526	1516	1471,7
Meat (T)											
Beef	13130	13260	11440	10010	9360	8892	9880	9150	8600	9100	10627
Horse	4150	4412	4000	3800	3400	8600	2500	3350	2850	2850	3468

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Mutton	1344	1381	1512	1380	1200	1080	960	1008	1008	1020	1202
Pork	5120	5400	5200	4880	4600	4200	4400	4252	4880	4880	4899
Fowls	6480	6660	6570	6390	6300	6120	6295	6150	5485	5485	6174
Rabbits	552	600	408	372	324	288	312	296	184	198	376
TOTAL	30776	31712	29130	26832	25184	23180	24347	24206	23007	23533	26672
Milk (T)	46370	46820	41440	36950	34750	32600	35420	32110	27580	28290	37567
Eggs (T)	5494	5792	5512	5180	4600	3680	3460	4358	3858	3002	4597
Honey (T)	380	380	330	300	260	250	260	250	200	200	288
Fish (T)	24183	17055	22055	21151	3091	20346	13481	9254	17197	10609	16408

Source: AWDR National Report (FAO Statistics).

Fish supplies

The land area of Africa is the principal food supply source for crop and livestock products; the rivers, lakes and waters around Africa also have a role in the continent's food supply systems by providing fish. Fish and fishery products provide on average 3.8 per cent of the total dietary protein supply in sub-Saharan Africa. Table 8.9 is a food balance sheet for fish and fishery products of African countries for the period 1988 to 1990. Fisheries have an important role in food production, income generation and provision of employment. According to the International Centre for Living Aquatic Resources Management (ICLARM), the number of full-time fishermen in sub-Saharan Africa totals approximately 1.5 million. In addition, there are millions of part-time fishermen (FAO, 1997).

Table 8.9: Average Supply of Fish and Fishery Products, 1988-1990

Country or area	Production (tons live weight)	Imports (tons live weight)	Exports (tons live weight)	Per capita supply (kg/year)
Western Africa	1 389 092	927 143	330 327	11.3
Benin	40 263	4 052	122	9.8
Burkina Faso	7 649	8 930	0	1.9
Cape Verde	7 475	69	1 918	16.9
Côte d'Ivoire	82 584	227 253	76 503	20.2
Gambia	14 311	7 047	6 493	16.8
Ghana	371 835	31 946	18 392	26.4
Guinea	33 333	8 861	0	7.6
Guinea-Bissau	5 163	533	465	5.5
Liberia	16 337	17 805	618	13.4
Mali	66 087	2 211	1 860	7.4
Mauritania	90 247	412	70 975	10.1
Niger	3 538	1 365	0	0.7
Nigeria	298 473	541 366	5 525	8.9
Saint Helena	867	4	271	99.3
Senegal	282 867	35 837	144 779	24.4
Sierra Leone	52 154	3 340	2 199	13.6

Country or area	Production (tons live weight)	Imports (tons live weight)	Exports (tons live weight)	Per capita supply (kg/year)
Togo	15 909	36 1 14	206	15.1
Central Africa	458 316	343 787	11 827	11.6
Angola	104 594	97 426	1 963	22.4
Cameroon	79 272	75 307	5 020	13.4
Central African Republic	13 089	1 771	0	5.2
Chad	23 000	-	-	4.2
Congo (Republic of)	45 342	3 6545	3 618	36.1
Equatorial Guinea	4 000	2 681	99	19.1
Gabon	22 487	13 661	1 127	31.4
Sao Tome and Principe	3 200	544	-	32.2
Former Zaire	163 333	115 851	0	7.7
Eastern Africa	1 146 871	50 366	56 317	6.0
Burundi	13 278	349	0	2.6
Comoros	6 750	523	0	13.9
Djibouti	415	948	0	2.8
Ethiopia	4 435	41	13	0.1
Kenya	162 110	422	19 526	6.3
Madagascar	101 135	454	7 890	77
Malawi	84 300	404	275	9.5
Mauritius	16 335	10 949	6 999	19.4
Mozambique	37 714	12 647	5 323	3.2
Reunion	2 009	12 991	642	24.2
Rwanda	1 776	327	0	0.3
Seychelles	4 705	8 054	8 693	59.2
Somalia	17 967	5	4 359	1.6
Tanzania, United Rep.	382 352	343	988	15.4
Uganda	223 906	-	-	12.9
Zambia	63 933	618	1 576	8.0
Zimbabwe	23 750	1 291	33	2.6
Southern Africa	104 872	7 239	7 456	5.0
Botswana	1 900	4 607	789	4.6
Lesotho	30	2 632	0	1.5
Namibia	23 032	-	-	12.5
Swaziland	110	-	-	0.2

Source: FAO, 1997.

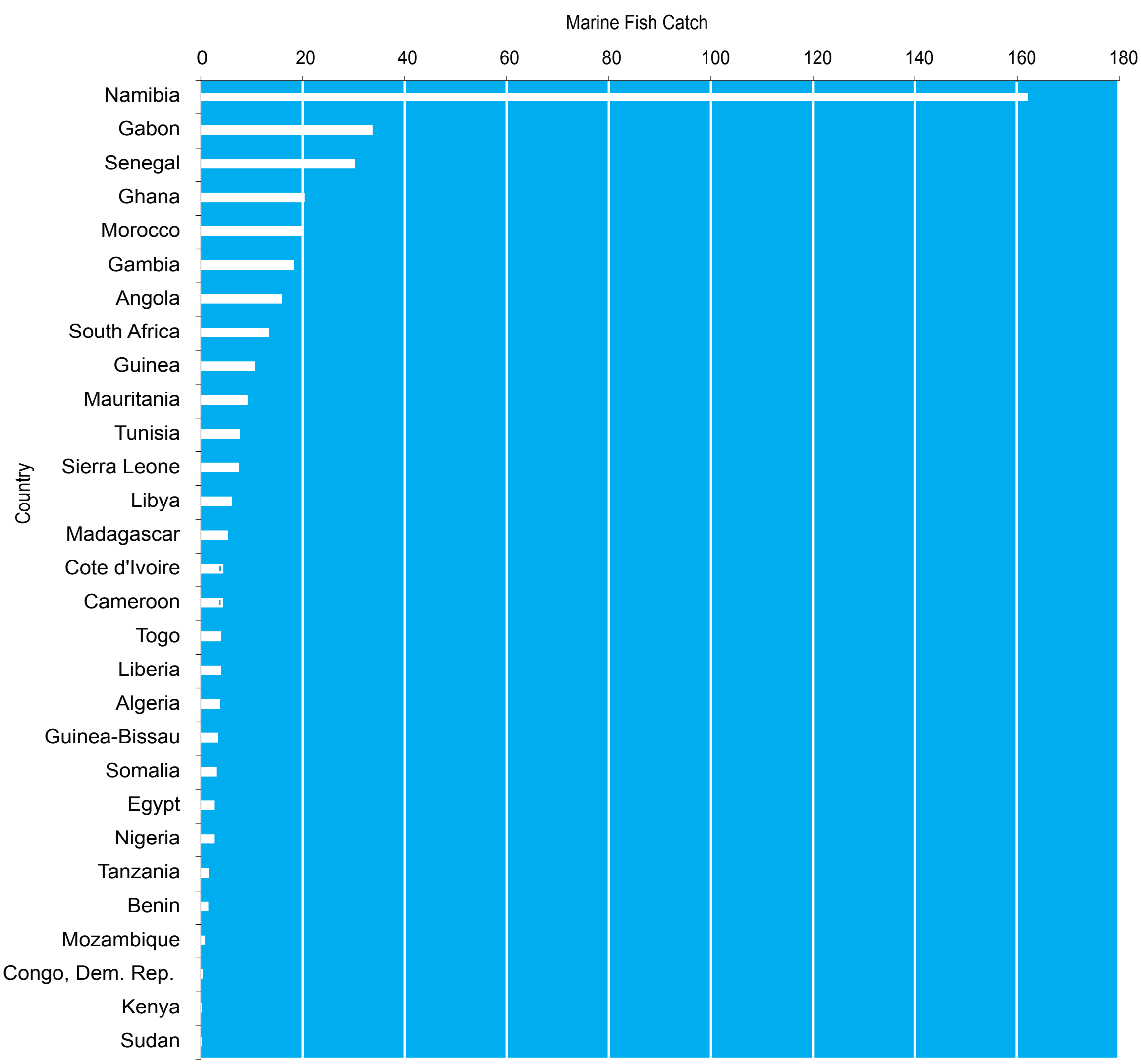
The level of total marine fish catch per 1000 persons in major fishing countries in Africa is shown in figure 8.5 with annual dynamics of fishing in the Republic of Congo, as shown in table 8.10.

Table 8.10: Evolution of Meat and Fish Consumption in the Republic of Congo

Produce	1993	1994	1995	1996	1997	1998	1999	2000	2001
Beef	13 098	14 968	11 391	3 666	3 831	3 725	-	-	3 937
Pork	3 536	2 973	2 517	2 993	1 310	3 560	-	-	115
Poultry	13 179	6 468	7 236	14 463	6 357	12 056	-	-	17 563
Mutton	9	31.5	57.9	52	6	26.5	-	-	21
Others	17.5	34	19	15.08	37.8	19.2	-	-	33
Fish	-	-	-	67 300	59 360	61 280	51 295	66 832	-

Source: AWDR National Report (Cattle Breeding Department and Fishery Department).

Figure 8.6: Total Marine Fish Catch per 1000 People



Source: FAOSTAT online database, http://apps.fao.org via ciesin.org.

Animal production and supplies

Livestock and their products contribute about 19 per cent of the total value of the production of agriculture, forestry and fisheries in sub-Saharan Africa (FAO, 1997). However, this figure underestimates the substantial contribution that livestock frequently make to crop production through draught power and manure. Ten countries account for 70 per cent of the value of animal production, and five countries, Ethiopia, Kenya, Nigeria, the Sudan and Tanzania, account for one half. Table 8.11 shows the population of selected livestock in sub-Saharan African countries in 1994 (FAO, 1997).

Table 8.11: Sub-saharan African Livestock Population, 1994 (selected countries and animals)

Country	Cattle	Sheep	Goats	Pigs	Chickens
Angola	3 280 000	255 000	1 570 000	805 000	6 400
Benin	1 223 000	960 000	1 190 000	555 200	20 000
Botswana	2 800 000	238 000	1 850 000	16 000	2 100
Burkina Faso	4 261 400	5 686 000	7 242 100	550 900	18 776
Burundi	420 000	350 000	920 000	80 000	3 800
Cameroon	4 870 000	3 780 000	3 770 000	1 400 000	20 000
Central African Republic	2 735 100	163 700	1 340 000	524 100	3 282
Chad	4 620 750	2 151 540	3 178 260	16 813	4 400
Congo (Republic of)	68 000	111 000	305 000	56 000	1 800
Côte d'Ivoire	1 231 000	1 251 000	978 000	403 000	26 919
Djibouti	190 000	470 000	507 000	-	-
Ethiopia	29 450 000	21 700 000	16 700 000	20 000	54 200
Gabon	39 000	172 000	84 000	165 000	2 600
Gambia	400000	121 000	150 000	11 000	500
Ghana	1 680 000	3 288 000	3 337 000	595 000	11 500
Guinea	1 780 000	475 000	580 000	38 000	13 500
Kenya	12 500 000	5 500 000	7 300 000	102 000	25 000
Lesotho	600 000	1 200 000	750 000	60 000	1 400
Liberia	36 000	210 000	220 000	120 000	3 500
Madagascar	10 288 000	740 000	1 300 000	1 558 000	23 000
Malawi	980 00	196 000	890 000	245 000	8 750
Mali	5 541 500	5 172 500	7 380 000	62 800	23 250
Mauritania	1 100 000	5 280 000	3 520 000	-	3 900
Mozambique	1 270 000	120 000	384 000	172 000	22 500
Namibia	2 035 790	2 619 520	1 639 210	1 7 843	2 000
Niger	1 968 100	3 678 400	5 565 760	38 500	20 000
Nigeria	16 316 000	14 000 000	24 500 000	6 926 000	122 000
Rwanda	453 827	280 000	950 000	90 000	1 400
Senegal	2 800 000	4 600 000	3 200 000	320 000	38 000
Sierra Leone	360 200	301900	165 800	50 000	6 000
Somalia	5 000 000	13 000 000	12 000 000	9 000	3 000
Sudan	21 750 000	22 800 000	16 400 000	-	36 000
Swaziland	626 356	27 000	428 000	30 000	1 000

Country	Cattle	Sheep	Goats	Pigs	Chickens
Tanzania, United Rep.	13 376 000	3 955 000	9 682 000	335 000	24 000
Togo	248 000	1 200 000	1 900 000	850 000	5 685
Uganda	5 150 000	1 850 000	3 450 000	910 000	22 000
Former Zaire	1 475 276	1 046 878	4 2 1 2 409	1 191 546	35 000
Zambia	3 300 000	69 000	620 000	295 000	22 000
Zimbabwe	4 300 000	450 000	2 580 000	246 173	13 500
Total	170 523 300	129 468 400	152 738 500	18 864 880	652 712

Source: FAO, 1997.

Enhancing nutritional status

International Targets
- ➢Reduce by half the number of undernourished people on earth by 2015 (Rome); and
- ➢Increase water productivity for food production from rain fed and irrigated farming by 30% by 2015.

The nutritional value of diets in Africa is enhanced by traditional vegetables, oilseeds, fruits and vegetables (tables 8.12 and 8.13). They add taste and flavour to the diet, improve palatability and help to balance protein, vitamin and mineral intakes. Vegetables and fruits supply vitamins A and C, iron, calcium and many other micronutrients. An estimated 80 per cent of vitamin A and more than one-third of vitamin C is supplied through traditional food plants (FAO, 1997). Nuts and oilseeds are also good sources of protein and energy, valuable supplements in children's diets and useful in preparing snack foods. Seasonal food scarcity accentuates the severity and incidence of malnutrition. In order to overcome such deficiencies, many urban residents often resort to backyard gardening.

Table 8.12: Some Sources of Food Nutrition in Africa

Energy	Fats and oils	Protein	Iron	Vitamin A	Vitamin C
Avocado	Avocado	Cacao bean	Amaranth	Amaranth leaves	Annona
Cacao bean	Locust bean	Cashew nut	Banana heart	Ampalaya fruits/leaves	Baobab fruit
Breadfruit	Groundnut	Cowpea	Cassava leaves	Carrot	Cashew apple
Cassava	Soybean	Hyacinth bean	Ceylon spinach	Cassava leaves	Citrus
Maize		Groundnut	Dried beans	Ceylon spinach	Guava
Potato		Pigeon pea	Dried fruits	Drumstick leaves	Mango
Sweet potato		Soybean	Drumstick leaves	Hot chilli pepper	Muskmelon
Yam		Watermelon seed	Green onion	Mango (ripe)	Papaya (uncooked)
			Mustard	Parsley	Potato (white, Irish)
			Spinach	Sorrel	Soursop
			Sweet potato leaves	Spinach	Sugar apple
				Squash leaves	Sweet pepper
				Sweet potato leaves	

Source: FAO, 1997 (Adapted from WHO/UNICEF, 1985).

Table 8.13: Specific Nutrients found in the Major Plant Groups

Plant group	Nutrient
Cereals	Carbohydrates, protein, dietary fibre, vitamin B complex, iron, calciuma
Roots	Carbohydrates, protein, some vitamin C
Legumes, oilseeds, nuts	Carbohydrates, protein, dietary fibre,a iron,a calcium,a vitamin B complexa
Fruits and vegetables	Vitamin C, vitamin A, iron, calcium, vitamin B complex, dietary fibre

Source: FAO, 1997.

Irrigation potential and water managed areas

The diversity of water management situations encountered in Africa requires the choice of a classification that would best represent the situation of irrigation in each country. The land on which water is used for the purpose of agricultural production has been referred to as water managed areas. The term 'irrigated areas' has been limited to the part of water-managed areas equipped with hydraulic structures: full or partial control irrigation, equipped wetland or valley bottoms and areas equipped for spate irrigation. The difference between the two categories is that they comprise cultivated wetland and valley bottoms without irrigation equipment or recession cropping areas. Water managed areas comprise 14.3 million hectares in Africa. There is a very heterogenous geographical distribution of water-managed areas: the North has more than 40 per cent of the total. Water-managed areas in national agriculture vary from less than 1 per cent of cultivated land (Democratic Republic of the Congo, Comoros, Ghana, Togo and Uganda) to 100 per cent in the most arid countries (Egypt and Djibouti, where agriculture is impossible without irrigation). This distribution of water-managed areas clearly shows the relationship between climate and the role of irrigation in agriculture (FAO, 1995).

In Equatorial Africa, where precipitation is greatest, rain-fed agriculture is dominant. Irrigation is used for winter crops and rice cultivation, or in wetlands and inland valleys, and to secure high value crops. In Madagascar, rice cultivation on the plateaus is highly developed, which explains the high percentage of irrigation in that country even though rainfall is relatively favourable. At the national level, the distribution of water-managed areas is very uneven. Five countries (Egypt, Madagascar, Morocco, South Africa and the Sudan), which cover 19 per cent of Africa, hold more than 60 per cent of the water-managed areas. By adding Nigeria, Algeria, Libya, Angola and Tunisia, more than 80 per cent of the water-managed area is controlled by 10 countries. In contrast, 28 countries, covering more than 30 per cent of Africa, share a mere 5 per cent of water-managed lands (Fig. 8.7).

Irrigation potential in Africa

As a result of its close relationship with water resources, irrigation potential is also unevenly distributed between the regions. It is significant to observe that this value is much less known and studied in countries benefiting from important water resources than in more arid countries. It should also be noted that the important transfers of water resources from humid to arid regions allow these latter to benefit from an irrigation potential much larger than their internal water resources would permit, notably Egypt. This is the case of the regions traversed by the Rivers Senegal, Chari and Niger in West Africa; Nile, Juba and Shebele in Eastern Africa; and Limpopo, Orange and Zambezi in Southern Africa, to name some of the most important. The existence of inter-regional rivers and water transfers hampers the computation of irrigation potential on a regional basis, since this may lead to double

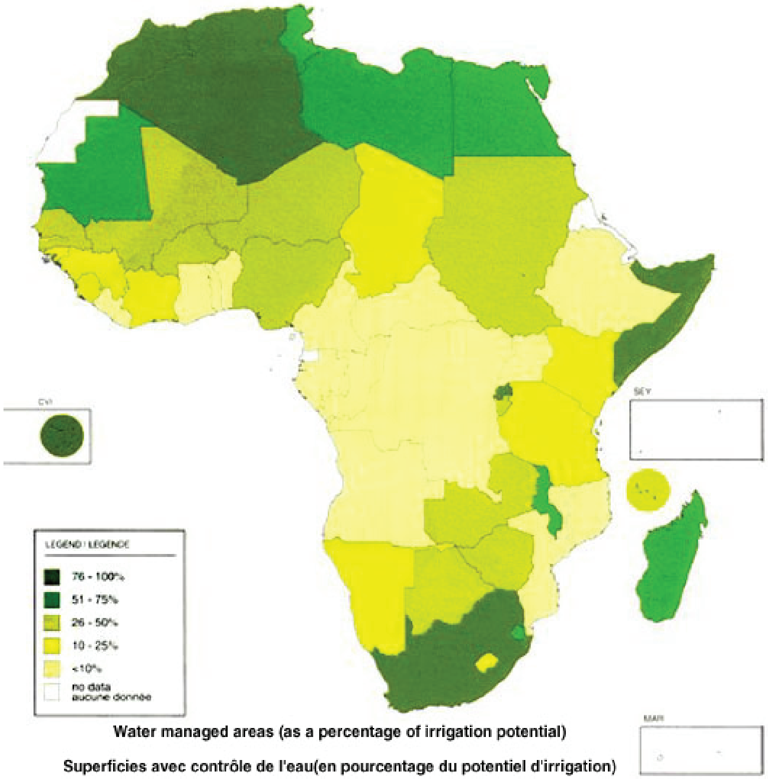
counting of parts of the shared resources, which could be avoided only through a river-basin approach (FAO, 1995). It should also be noted that the methods used in estimating irrigation potential vary from country to country, and that the choice of methods can significantly affect the result, especially in humid countries.

Box 8.2: Republic of the Congo

As part of the national water vision–2025, the following targets related to food security have been adopted:

- 10% increase before 2005, 30% before 2015 and 60% before 2025 of water productivity for rain fed and irrigated crops;
- 25% increase before 2005, 50% before 2025 and 10% before 2025 of irrigated soils acreage; and
- 5% increase before 2005, 100% before 2025 and 25% before 2025 the potential of agriculture, hydroelectricity, industry, tourism and transport at national level.

Figure 8.7: Water Managed Areas as Percentage of Irrigation Potential



Source: FAO AQUASTAT online.

Table 8.14 Actual and Projected Irrigation Surface Areas in Burundi (hectares)

Type of irrigation area	North Imbo	Central Imbo	Kabezi Plain	South Imbo	Rumonge, Lake Nyanza	South Mosso
Actual Irrigation Area (1990 -1994)	968	5.975	0	0	0	920
Actual Irrigation Area in 2000	5.995	900	0	0	0	920
Projected Irrigation Area in 2010	5.995	14.285	0	0	0	920
Irrigable Area	0	0	800	1.000	3.080	920

Source: AWDR National Report.

Estimates for the Democratic Republic of the Congo, for instance, vary from 1 to 40 million hectares and the irrigation potential of the Democratic Republic of the Congo, estimated at around 40,000 hectares in the literature, is probably only a small portion of the physical potential of the country. Bearing these uncertainties in mind, it can be noticed that about 60 per cent of the irrigation potential is concentrated within seven African countries (Angola, Sudan, Egypt, the Democratic Republic of the Congo, Ethiopia, Mozambique and Nigeria), while at the other end of the list, 18 countries share only 5 per cent of this potential (FAO, 1995).

Table 8.15: Estimated Net and Gross Irrigation Water Requirement in Cameroon

Irrigation Type	Area, ha	Irrigation requirement per year, m	Net consumption, km^3	Application efficiency	Gross consumption, km^3
Large-scale sprinkler for bananas	6,790	0.45	0.03	0.50	0.06
Large-scale irrigated paddy rice	15,000	1.00	0.15	0.30	0.50
Small-scale systems of various types used for different crops	18,000	0.50	0.09	0.50	0.18
Total consumption, km^3			0.27		0.74

Source: AWDR National Report.

area). Among the other classes of water management, cultivated wetlands, valley bottoms and recession cropping are a majority (15 per cent of the total). Apart from full and partial control irrigation, which is present in almost all countries, the other categories are usually concentrated in a few countries. Recession cropping is mainly used on the rims of Rivers Niger and Senegal and of their tributaries, or along the Logone, Chari, the Democratic Republic of the Congo, Molopo and Okavango. The *fadamas* of north-western Nigeria, classified here as recession cropping due to lack of detailed information on their degree of development, represent 70 per cent of that category. Spate irrigation is concentrated in the Maghreb and the Horn of Africa. When analysing irrigation techniques used in the full and partial control schemes, it appears that surface irrigation is by far the most widely used technique (more than 80 per cent of the total). How-

Water Management Methods of Irrigation

Among the five classes of water management presented in Table 8.16, full or partial control irrigation is the most widespread (81% of the

ever, more than one million hectares of irrigation by aspersion have been reported, most of it being concentrated in the North (table 8.17 - Libya, Egypt, Morocco, Tunisia), Zimbabwe, South Africa and, to a lesser degree, in Kenya and Zambia. In relative terms, aspersion represents the most widely used technique in Botswana, Zimbabwe and South Africa, which benefit from a relatively long tradition in this field. Finally, the most important areas under micro-irrigation are concentrated in Egypt and South Africa (FAO, 1995).

Table 8.16: Subregional Distribution of Water Management Methods in Africa

Subregion	Irrigation				Other cultivated wetlands/ valley bottoms	Flood recession cropping	Total		
	Full or partial control	Spate irrigation	Equipped wetlands/ valley bottoms	Total irrigation					
	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha	as % of total	as % of cultivated land
Northern	5 610 (95%)	305 (5%)	- (-)	5 915 (100%)	- (-)	- (-)	5 915 (100%)	41.5	24.8
Sudano-Sahelian	2 263 (79%)	212 (7%)	9 (-)	2 484 (86%)	97 (4%)	296 (10%)	2 877 (100%)	20.2	12.1
Gulf of Guinea	307 (22%)	- (-)	163 (11%)	470 (33%)	193 (14%)	730 (53%)	1 393 (100%)	9.8	4.0
Central	119 (25%)	- (-)	2 (-)	121 (25%)	352 (74%)	3 (1%)	476 (100%)	3.3	3.9
Eastern	428 (65%)	- (-)	6 (1%)	434 (66%)	222 (34%)	- (-)	656 (100%)	4.6	2.9
Islands (I.O.)	1 105 (100%)	- (-)	- (-)	1 105 (100%)	- (-)	- (-)	1 105 (100%)	7.7	40.3
Southern	1 645 (90%)	- (-)	- (-)	1 645 (90%)	182 (10%)	9 (-)	1 836 (100%)	12.9	8.1
Total	11 477 (81%)	517 (4%)	180 (1%)	12 174 (86%)	1 046 (7%)	1 038 (7%)	14 258 (100%)	100.0	9.9

Source: FAO, 1995

Table 8.17: Indicators of irrigated agriculture in the Northern Africa Subregion

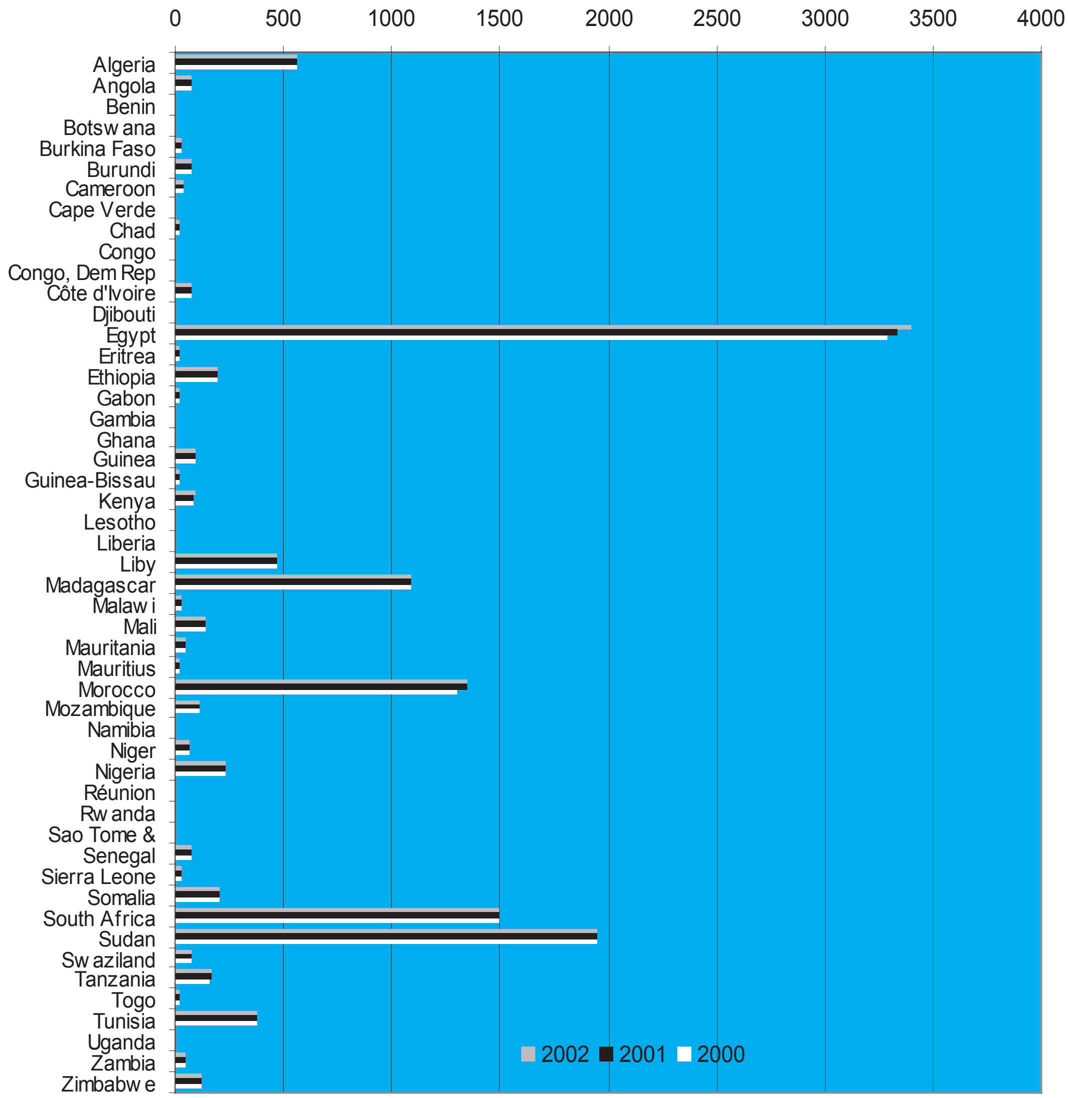
	Mauritania	Morocco	Algeria	Tunisia	Libya	Egypt	Sudan
Irrigated area (100ha)	40	1100	450	400	350	5800	1880
Ha per 1000inhab	15	36	14	40	62	85	56

Source: Draft Synthesis of AWDR National Reports of Northern Sub Region.

Irrigated Crops and Rate of Use of Equipped Areas

The information on agricultural equipped area given in figure 8.8 refers to physical areas, which is not the case for irrigated crops, which are measured in terms of harvested areas. The same plot can thus be counted several times if it is used for several crops in a year. The figures on crops in water managed areas are very incomplete and do not allow the establishment of statistical tables by country showing the distribution of the major crops under water management in Africa.

Figure 8.8: Agricultural Equipped Areas in African Countries



Source: Food and Agriculture Organization of the Source: United Nations (FAO), 2004.

However, by using all the information available, information can be obtained on about 10.5 million hectares of crops. This figure corresponds to 75 per cent of the physical area with water control and it can thus be considered as representative of the situation of crops in water-managed lands on the continent and in the major regions. Results are summarized in Table 8.14, in which the different crops have been grouped in six major categories (FAO, 1995).

The most widespread crop is rice, which alone represents more than one third of the water managed crop area. However, large discrepancies can be seen between the regions (Table 8.18). Cultivated mostly in wetlands and valley bottoms, rice is the predominant crop in the humid zones of the Gulf of Guinea and East Africa. It is also very developed on the plateaus of Madagascar. In the northern and southern regions, it represents only a small portion of the total crops under water management. Among the other cereals, wheat and maize are cultivated and irrigated mostly in the countries of the North (Egypt and Morocco) and in South Africa, Sudan and Somalia. Sorghum is cultivated in the Sudano-Sahelian region, mostly as recession cropping (FAO, 1995).

Table 8.18: Subregional Distribution of Main Irrigated Crops in Africa (partial information)

Subregion	Rice	Other cereals	Vegetables	Fodder	Industrial crops	Arboriculture	Total
	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha	'000 ha
Northern	538 (11%)	2221 (45%)	423 (9%)	1207 (24%)	80 (2%)	459 (9%)	4928 (100%)
Sudano-Sahelian	384 (22%)	839 (48%)	61 (3%)	4 (-)	471 (27%)	1 (-)	1760 (100%)
Gulf of Guinea	993 (80%)	52 (4%)	168 (14%)	- (-)	21 (2%)	6 (-)	1240 (100%)
Central	21 (29%)	- (-)	4 (6%)	- (-)	42 (59%)	4 (6%)	71 (100%)
Eastern	173 (38%)	80 (18%)	158 (35%)	- (-)	33 (7)	8 (2%)	452 (100%)
Islands (I.O.)	880 (97%)	- (-)	- (-)	- (-)	31 (3)	- (-)	911 (100%)
Southern	147 (13%)	358 (32%)	42 (4%)	353 (31%)	198 (17%)	32 (3%)	1130 (100%)
Total	3136 (30%)	3550 (34%)	856 (8%)	1564 (15%)	876 (8%)	510 (5%)	10 492 (100%)

Source: FAO, 1995.

Vegetables (in the table, root and tuber crops have been included in this category) are present in all regions and almost every single country. On the whole, they represent about 8 per cent of the cultivated areas under water management in Africa. In Algeria, Mauritania, Kenya, Burundi and Rwanda, they are in fact the most widespread crops under water management. Arboriculture, which represents 5 per cent of the total, is concentrated almost uniquely in the northern region and is mostly composed of citrus. Industrial crops are located mostly in the Sudan and in the countries of the Southern region (mostly cotton and oilseed crops). In this category, also features sugarcane, coffee, cocoa, oil and date palm, banana, tobacco and cut flowers. Apart from sugarcane, present in all regions except the northern, the other crops are generally concentrated in a limited number of countries. Finally, the category grouping fodder crops and irrigated pastures, although it concerns only a very limited number of countries (concentrated in the northern and the southern regions), represents an important part of the crops under water management (15 per cent). Berseem, cultivated almost exclusively in Egypt, represents the most widespread irrigated crop in that country (1 million hectares). Other fodder crops or irrigated pasture are found principally in Morocco (table 8.19) and South Africa, with the latter having most of the irrigated land (220,000 hectares). One of the most frequently used indicators to assess the rate of intensification of irrigated land is the cropping intensity, or the ratio between irrigated crops (including double and triple cropping) and areas equipped for irrigation. An example of the relationship between equipped non-irrigated and effectively irrigated areas in Morocco is shown in figure 8.9. The survey showed, however, that this figure was hardly available or not reliable enough at the country level. Another possible indicator is the rate of use of land equipped for irrigation, which is the part of the equipped areas actually used for production at least once in the year.

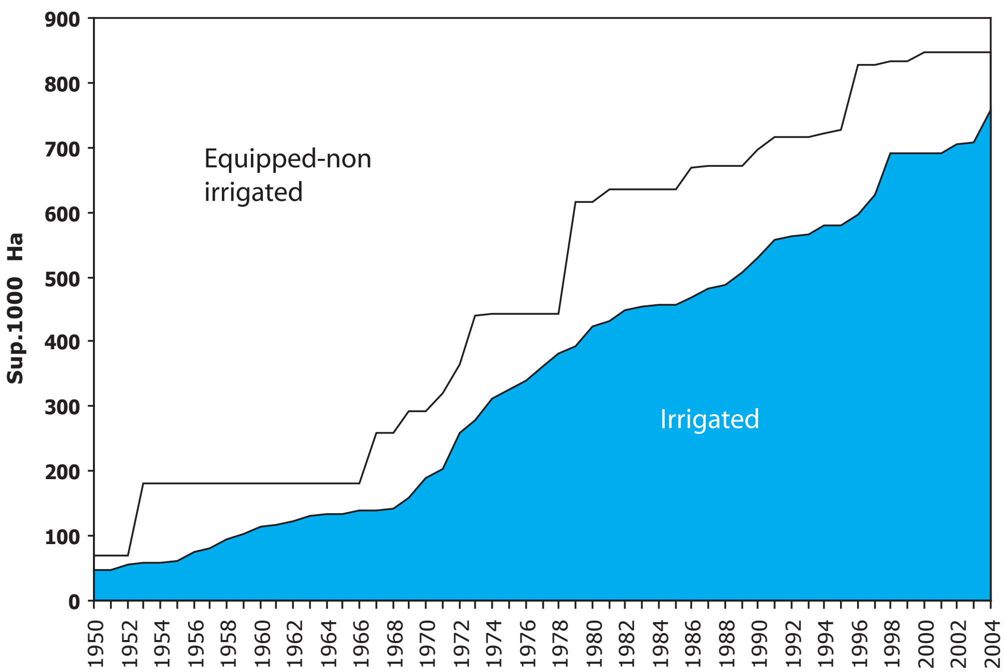
Table 8.19: Contribution of irrigated agriculture to the agricultural production in Morocco (situation in 2003)

Production	irrigated surfaces/useful agr surf %	Production: irrig/national %
SUGAR BEET	75	80
SUGAR CANES	100	100
COTTON	100	100
CEREALS	7	15
leguminous plant	18	26
MARKETGARDENING	74	82
FODDER	67	75
CITRUS	100	100
OTHERS	21	35
arboricultures	-	75
	-	26

Sources: AWDR National Report, 2005 (DRPE).

This figure can vary significantly from one year to another, particularly where irrigation schemes have problems of water availability. A regional analysis does not allow consideration of geographical trends in the variation of this value.

Figure 8.9: Evolution of equipped–non-irrigated and effectively irrigated areas in Morocco



Sources: AWDR National Report; DRPE.

This is probably because it is a factor that is more related to socio-economic conditions specific to individual countries rather than to criteria related to climate and geography. For eight out of thirty countries in Africa that report data, the rate of use of equipped areas is recorded to be 100 per cent. More than half of the countries report rates of use above 80 per cent. Conversely, countries like Lesotho, Benin, Angola, Mozambique and Eritrea show rates of use below 50 per cent , the causes of which are very diverse. Overall, the equipped areas of the 30 countries represent 8.3 million hectares. About 1.5 million hectares, or 18 per cent of the equipped area, is not irrigated (FAO, 1995).

Box: 8.2: The Food Supply System and its Nutritional Consequences for a Pastoral Family in the Malian Sahel

A Fulani "noble" family of six lives in round huts built of dried stalks, which when new, are rain-resistant. They have a herd of 24 cattle and ten goats; during the rainy season they grow a millet crop. During the wet season they camp around rain-filled ponds, which dry out by November, when the young men, in cooperative groups from several households, leave with the main herd in search of better pastures. The remainder of the household, with their goats, weaker animals and some milk cows, camp during the cold dry season (November to February) on the edge of a village, buying or bartering for cistern water; during the hot dry season they move to camp around a well.

The adult men are responsible for the main herd and for most of the millet cultivation, especially weeding. Boys tend the goats and calves. The women and girls collect fuel and water for domestic use, help with the harvest, pound millet and also prepare meals. The household's maximum dietary energy intake in October, after the harvest, is 14 700 kcal per day (65 per cent from millet, 35 per cent from milk); 9 105 kcal would cover the children's total requirements and allow the adults to maintain their body weights if they did no work, leaving 5 595 kcal for the adults' activities and weight gain. However, from December to June their intake is only from 7 840 to 8 820 kcal per day (9 to 20 per cent from milk), so that the family is in a negative energy balance. During the rainy season they supplement their diet with gathered food. Their intake in June/July is from 9 996 to 10 740 kcal per day (43 to 50 per cent millet, 8 to 12 percent milk and 42 to 45 per cent gathered food).

The man and the woman (172 and 163 cm tall, respectively) are at their heaviest in November/December, when they weigh 55.3 and 49.6 kg, respectively; the post-harvest period of abundant food and little work allowed them to gain 2.3 and 0.7 kg, respectively, since July/August. During the dry season, decreasing food and increasing distances to walk for water and pasture cause weight losses of 2.2 and 1.5 kg, respectively, by May/ June. Despite increased intakes during the rainy season, the labour demands of millet cultivation prevent their regaining weight until after the harvest.

The weight changes of the four children, aged 5 to 12 years, between July/August and November/December range from +0.6 to +1.5 kg; from November/December to July/August they range from -0.7 to +0.5 kg. Despite their poor growth during the dry season, their weight rarely falls below 80 percent of the standard for their height. Households with sufficient milk or grain for barter during the dry season are able to reduce livestock sales and their dependence on the market, but if a family's food supply runs out during the hot dry season, they may be forced to sell off young livestock below their full value. Livestock sales accounted for 93 percent of the family's 1982/83 cash income; 68 per cent of their total income was from barter of cereals and 5 per cent from barter of milk products. Some 50 per cent of the family's cash expenditures went to purchases of cereals, and of their expenditures in kind 55 per cent were for milk products. Recently, the situation has worsened because of deteriorating terms of trade resulting from poor rainfall. A prime steer that in 1982 was worth the equivalent of 1 300 kg of millet was worth only 520 kg a year later, grain prices having doubled while livestock prices fell.

In 1973, after five years of drought, grain prices soared to nearly 1,000 Malian francs per kilogram [426 MF = US$1 at 1 July 1973], while the emaciated livestock fetched only one-sixth to one-twelfth of their pre-drought prices. In that year alone, an estimated 100,000 people died, as did 40 to 60 per cent of the livestock. Many pastoralists, forced to sell their animals, were reduced to dependence. Currently, while the majority have rebuilt their herds sufficiently to return to pastoralism, some have never regained former herd sizes and so are in a weaker market position, while others work as paid herders, tending animals bought cheaply by profiteers during the drought.

Taken from: FAO: Agriculture Food and Nutrition for Africa - A resource book for teachers of agriculture. UNFAO, Rome, 1997.

Table 8.20: Irrigation water withdrawal in African countries

	Total renewable water resources (cubic km)	Irrigation water requirements (cubic km)	Water requirement ratio in percentages	Water withdrawal for agriculture (cubic km)	Water withdrawal as percentage of renewable water resources
Algeria	14.32	1.45	37%	3.94	27%
Angola	184	0.04	20%	0.21	0%
Benin	24.8	0.06	30%	0.19	1%
Botswana	14.4	0.02	30%	0.06	0%
Burkina Faso	12.5	0.21	30%	0.69	5%
Burundi	3.6	0.06	30%	0.19	5%
Cameroon	285.5	0.22	30%	0.73	0%
Chad	43	0.07	35%	0.19	0%
Congo, Rep.	832	0.00	30%	0.00	0%
Congo, Dem Rep.	1283	0.03	30%	0.11	0%
Côte d'Ivoire	81	0.17	28%	0.60	1%
Egypt	58.3	28.43	53%	53.85	92%
Eritrea	6.3	0.09	32%	0.29	5%
Ethiopia	110	0.56	22%	2.47	2%
Gabon	164	0.02	30%	0.05	0%
Gambia	8	0.01	30%	0.02	0%
Ghana	53.2	0.06	26%	0.25	0%
Guinea	226	0.41	30%	1.36	1%
Kenya	30.2	0.30	30%	1.01	3%
Libya	0.6	2.56	60%	4.27	712%
Madagascar	337	3.58	25%	14.31	4%
Malawi	17.28	0.20	25%	0.81	5%
Mali	100	2.06	30%	6.87	7%
Mauritania	11.4	0.44	29%	1.50	13%
Morocco	29	4.28	37%	11.48	40%
Mozambique	216.11	0.22	39%	0.55	0%
Namibia	17.94	0.07	40%	0.17	1%
Niger	33.65	0.62	30%	2.08	6%
Nigeria	286.2	1.65	30%	5.51	2%
Rwanda	5.2	0.01	30%	0.03	1%
Senegal	39.4	0.43	30%	1.43	4%
Sierra Leone	160	0.12	33%	0.35	0%
Somalia	13.5	0.98	30%	3.28	24%
South Africa	50	2.34	21%	11.12	22%
Sudan	64.5	14.43	40%	36.07	56%
Swaziland	4.51	0.12	16%	0.76	17%
Tanzania	91	0.56	30%	1.85	2%
Togo	14.7	0.02	30%	0.08	1%
Tunisia	4.56	1.21	54%	2.23	49%
Uganda	66	0.03	30%	0.12	0%
Zambia	105.2	0.26	19%	1.32	1%
Zimbabwe	20	0.67	30%	2.24	11%

Source: FAO, AQUASTAT online.

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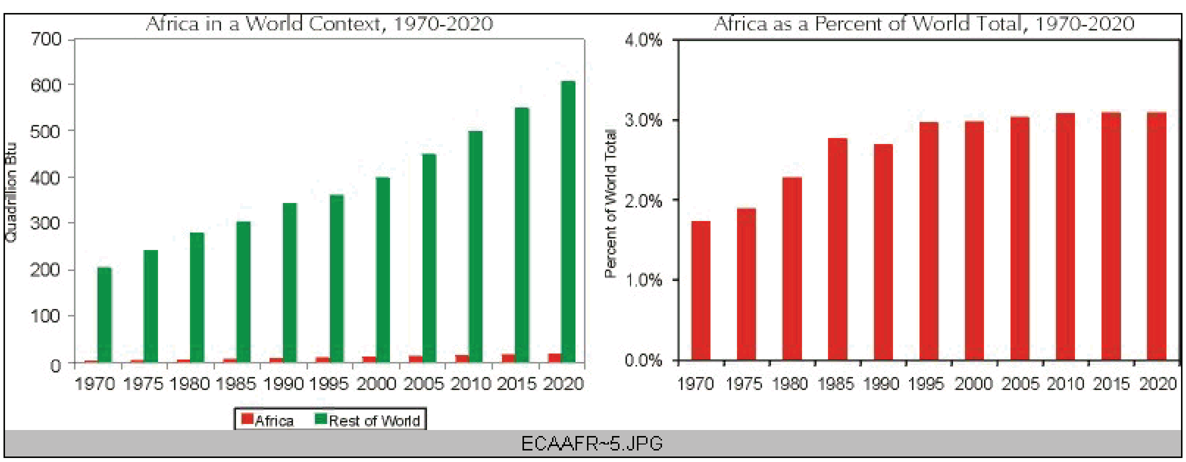
HARNESSING ENERGY FOR DEVELOPMENT

Overall, Africa is a major net energy exporter, as each of its subregions, except East Africa, exports substantial amounts of energy. North Africa is the largest exporter, with significant quantities of its oil and gas exports going to Europe and other markets. West Africa's exports are almost exclusively oil, and from one country - Nigeria. Southern Africa's net energy exports are oil (from Angola) and coal (from South Africa). Central Africa is an oil-exporting region whose exports are mainly from Cameroon, the Congo and Gabon. North Africa alone produces slightly less energy than the rest of Africa combined. Taken individually, the major energy exporting countries in Africa include Nigeria, Algeria, Libya, South Africa, Egypt, Gabon, and the Congo.

There are no significant net energy importers in Africa, with the vast majority of African nations importing very small (i.e., 0.3 quads or less) amounts of energy (Energy in Africa, 1999). Most of the energy consumption in Africa (about 80 per cent of the total) is either in North or Southern Africa. In 1997, only five countries (South Africa, Egypt, Algeria, Nigeria, and Libya) accounted for 78 per cent (8.9 quads) of all energy consumption, and 84 per cent (22 quads) of all energy production in Africa. East Africa is a tiny net energy importer (mainly of oil).

An overview of energy in Africa by USDOE (1999) reveals that, despite the abundance of its commercial energy resources, Africa still accounts for a small fraction (about 3 per cent) of world commercial energy consumption. Energy demand growth in Africa averaged 2.7 per cent annually from 1980 to 1997, and a slightly higher 3.1 per cent annual average from 1990 to 1997. During the period 1970-1997, Africa's commercial energy consumption (not including "non-commercial" fuels like firewood, charcoal, animal waste and agricultural residue) increased by about 220 per cent from 3.6 to 11.4 quadrillion Btu (10^{15} Btu) or quads. Africa's share of world commercial energy consumption increased slightly from 2 per cent in 1970 to 3 per cent in 1997. Commercial energy consumption in Africa is expected to remain approximately constant as a share of the world total (at about 3 per cent) through 2020 (see figure below). Africa's share of world commercial energy consumption is small for a variety of reasons, including low per capita incomes, levels of industrialization, ownership

Fig 1: Africa Commercial Energy Consumption in World Context, and as a Percentage of World Total, 1970-2020



Source: ECA – ARIA, 2003 (Energy Information Administration)

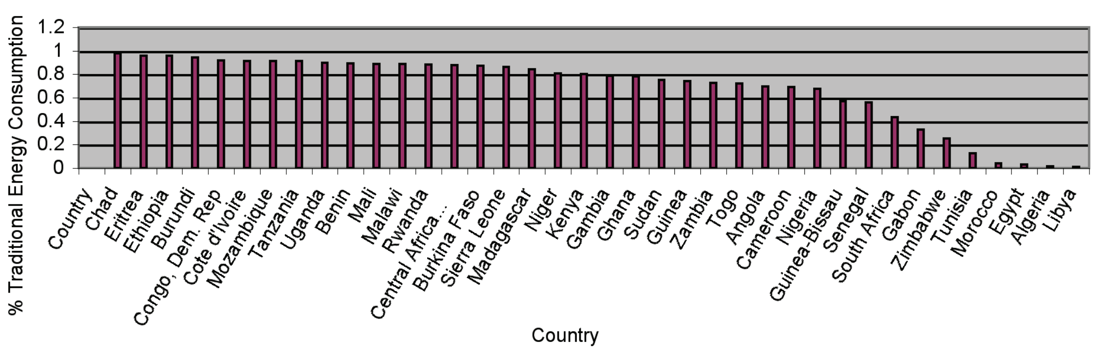
and usage of automobiles (between 20 cars per 1000 people), and penetration of appliances such as refrigerators, freezers, air conditioning, and so on. Africa is a heavy user of "traditional" (non-commercial) fuels - primarily biomass (Energy in Africa, 1999).

Traditional Energy Consumption

Although Africa accounts for a tiny share of world commercial energy consumption, it has a lion's share of the world's biomass energy consumption (firewood, agricultural residues, animal waste, and charcoal), calculated as a percentage of overall energy consumption. Biomass accounts for as much as two thirds of the total African final energy consumption. According to the International Energy Agency (IEA), the biomass energy consumption of countries of the Organization for Economic Co operation and Development (OECD) is about 3 per cent of final energy consumption, estimated to be equivalent to 205 million tons of oil (Mtoe) and 136 Mtoe of conventional energy in 1995. Most of Africa's biomass energy use is in sub-Saharan Africa. Biomass accounts for 5 per cent of North African, 15 per cent of Southern African, and 86 per cent of sub-Saharan Africa consumption (minus South Africa). Wood, including charcoal, is the most common and the most environmentally detrimental biomass energy source. Firewood accounts for about 65 per cent of biomass use, and charcoal accounts for about 3 per cent (Energy in Africa, 1999).

Women and children suffer disproportionately from the negative health effects of the smoke generated by fuelwood used for cooking (smoke is a carcinogen and causes respiratory problems). About 75 per cent of wood harvested in sub-Saharan Africa is used for household cooking. Production of traditional fuels is often insufficient to meet rising demand. Fuel available to the poorest communities is expected to decline, thereby intensifying environmental degradation in those communities. End-use efficiency for most traditional fuels is low. A high concentration of fuels is needed to produce a low level of energy, and a significant share is wasted. South Africa is unique in sub-Saharan Africa as biomass accounts for only 15 per cent of its energy consumption. There is a range of energy options available in South Africa: biomass, kerosene, coal, liquefied petroleum gas (LPG),

Traditional Fuel Consumption as a Percentage of Total Energy Use



Source: World Bank. 2002. World Development Indicators 2002. CD-ROM. Washington, DC.

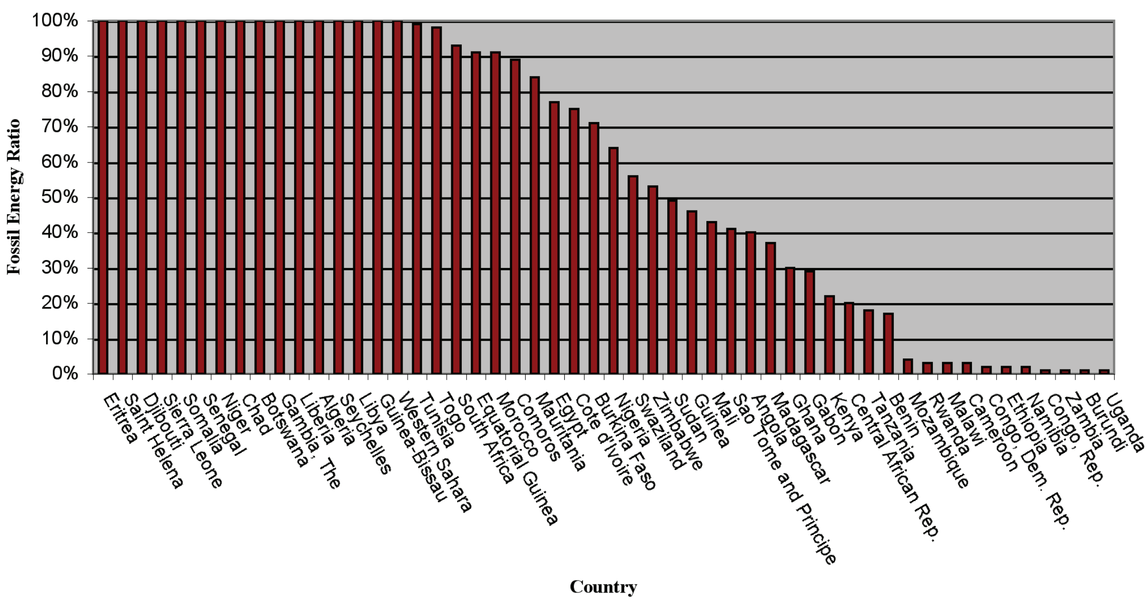
electricity, and solar power. This range of choices reflects the country's high level of economic development relative to other African countries. Traditional fuel consumption is about 66.52 per cent of the total energy consumption in Africa (Energy in Africa, 1999).

Within Africa, some regions consume more "traditional" fuel than others. North Africa, for instance, consumes very little biomass, mainly due to lack of wood in the desert climate. Central and East Africa, on the other hand, consume large amounts of biomass. Generally, the consumption of "traditional" fuels is highly labour intensive, inefficient, polluting, and destructive to the environment, resulting in deforestation and desertification.

Fossil Fuel Consumption

Every African country consumes at least some petroleum, regardless of the availability of domestic supplies. Fewer than half of African countries have a domestic refining capacity, and many of these that do have very small facilities. Oil, as a relatively easily transportable and usable ("fungible") fuel, is consumed throughout Africa. Coal and gas, on the other hand, are not as fungible as oil. Their use, therefore, depends heavily on the availability of either domestic or nearby resources and the extent to which these resources - along with the necessary transportation infrastructure - have been developed. Natural gas is consumed almost exclusively by countries with gas reserves/production. Algeria, Egypt, Libya, and Tunisia (all in North Africa), which together with Nigeria (in West Africa), account for 94 per cent of total African natural gas consumption. The absence of natural gas consumption in most African countries results largely from a lack of pipeline infrastructure. This, in turn, is a result of several factors, including cost, terrain and political factors (Energy in Africa, 1999).

Ratio of Fossil Energy to Total Energy Consumption by Country



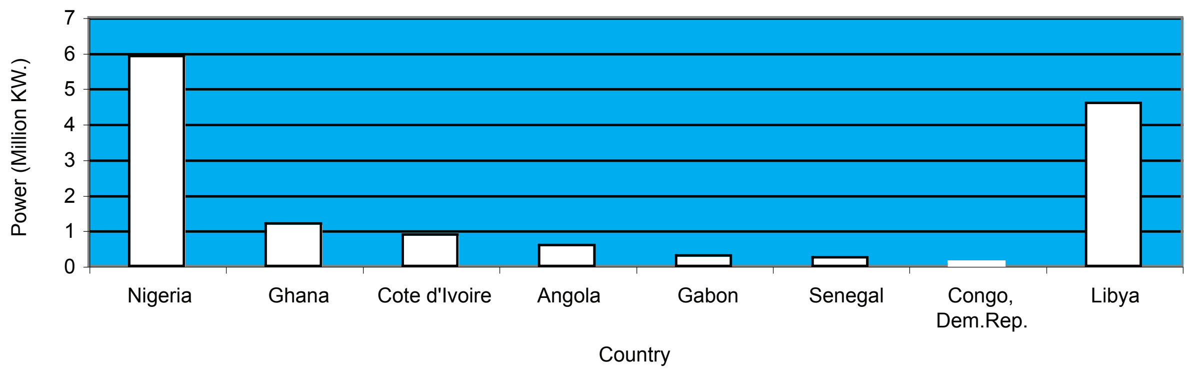
Source: *Energy Information Administration* / US Department of Energy. http://www.nationmaster.com

South Africa, with its own large reserves, is the only country in Africa to consume significant amounts of coal. Oil and natural gas are concentrated heavily in North Africa and West Africa, especially Algeria, Libya, and Nigeria. Other countries with large oil and/or gas reserves include Angola, Egypt, Gabon, and the Congo. Countries with smaller, but still significant, oil and gas reserves include Cameroon, the Sudan, and Tunisia. Mozambique and Namibia (and, to a lesser extent, Tanzania) have significant natural gas reserves, but no oil (Energy in Africa, 1999).

Electric Power in Africa

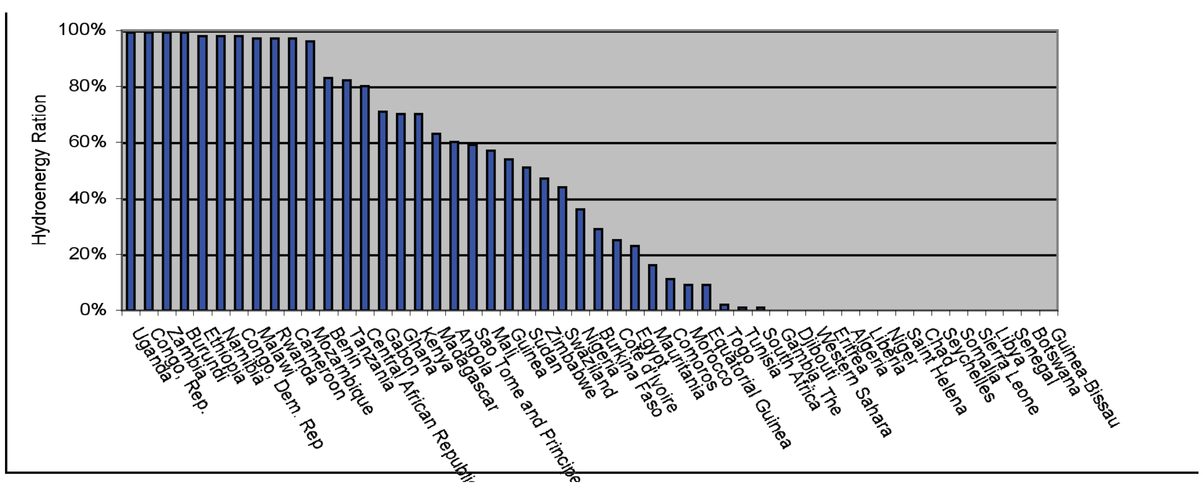
At the beginning of 1997, electric-generating capacity in Africa totaled nearly 94 gigawatts, about 3 per cent of the world's total. Most of Africa's generating capacity (76 per cent) is thermal. This is particularly the case in North Africa (88 per cent) and Southern Africa (81 per cent). In North Africa, thermal capacity is a mix mainly of oil and natural gas. In Southern Africa, it is mainly coal and oil (Energy in Africa, 1999).

Electric Generation Ability of some Countries



Source: Energy Information Administration, US Department of Energy. http://www.nationmaster.com

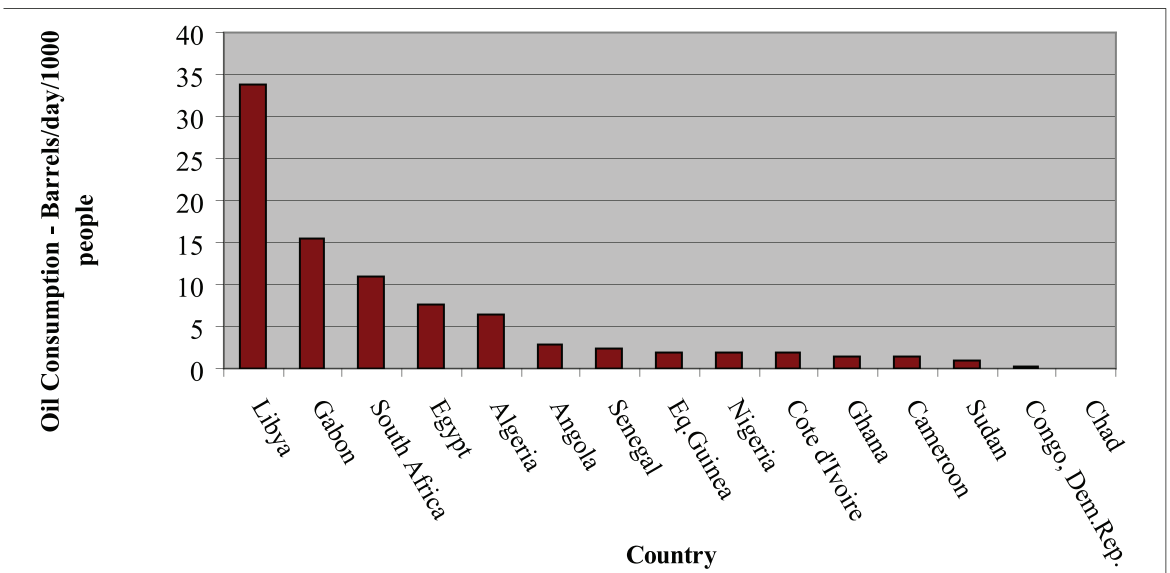
Ratio of Hydroenergy Production by Country



Source: Energy Information Administration, US Department of Energy. http://www.nationmaster.com

Hydroelectric capacity accounts for about 22 per cent of the total electric-generating capacity in Africa. Hydroelectricity represents the primary source of electricity in East Africa and Central Africa (and nearly half in West Africa). Reliance on hydropower is 80 per cent or greater in Cameroon, the Democratic Republic of the Congo, Ghana, Mozambique, Rwanda, Uganda, and Zambia. Hydropower reliance is greater than 70 per cent in several other African countries. Nuclear power accounts for only 2 per cent of Africa's total electric-generating capacity, and is located in only one country, South Africa.

Per Capita Consumption of Oil in some Selected Countries



Source: Energy Information Administration, US Department of Energy. http://www.nationmaster.com

Geothermal generating plants make up only about 0.1 per cent of total electric-generating capacity in Africa. Ethiopia and Kenya account for the entire capacity. Access to a central power grid is a major challenge for Africa. Outside of Southern Africa (and to a lesser extent, North Africa), electrification rates are very low (Energy in Africa, 1999).

As a result, per capita electricity consumption is extremely low in Central, East, and West Africa. In those regions, the use of biomass has largely taken the place of electricity from a power grid.

Commercial Energy Consumption

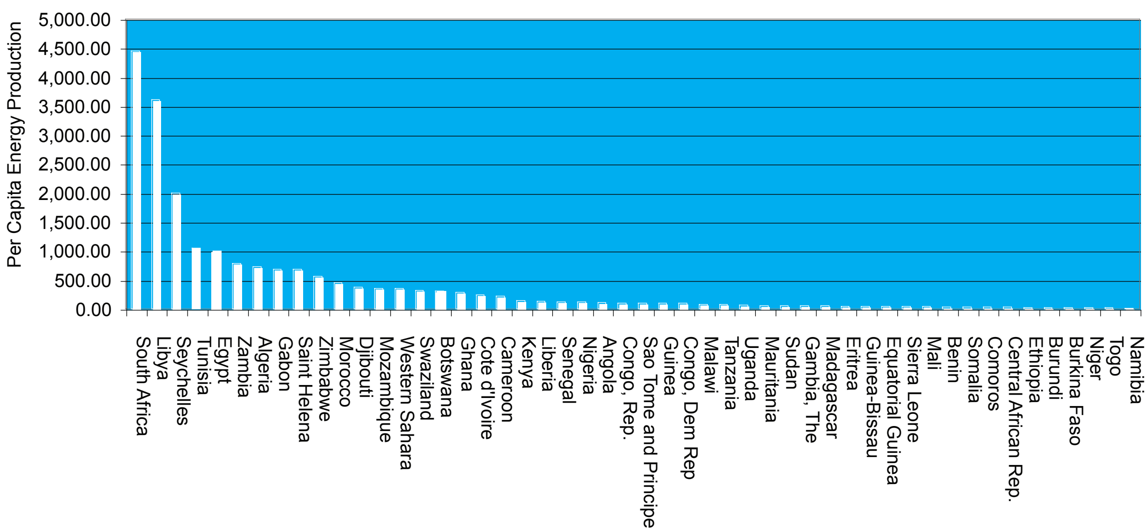
Commercial energy consumption is increasing throughout Africa. Energy demand in Africa grew by an average rate of 2.7 per cent per annum from 1980 to 1997, and a little faster (an average 3.1 per cent per annum) from 1990 to 1997. During the period 1970-1997, Africa's commercial energy consumption (excluding "non-commercial" fuels such as firewood, charcoal and animal waste) increased by about 220 per cent (from 3.6 to 11.4 quadrillion Btu). The continent's share of world commercial energy consumption increased slightly, from 2 per cent in 1970 to 3 per cent in 1997 (Energy in Africa, 1999). Commercial energy consumption in Africa, as a share of the world total, is expected to remain virtually constant (at about 3 per cent) up to 2020. Africa's share of world commercial energy consumption is small for a variety of reasons, including low per capita income, level of

industrialization, ownership and usage of automobiles (about 20 cars per 1,000 people), and penetration of appliances such as refrigerators, freezers, and air conditioners. In addition, Africa also consumes large amounts of "non-commercial" energy. Added to this is the availability of and use of "non-commercial" fuels. Furthermore, Africa's enormous "commercial" energy resources are massively underdeveloped and the energy infrastructure are also poorly developed for commercial energy distribution to consumers through pipelines and electricity grids. Widespread and severe poverty also means that people cannot afford to pay for "conventional" energy resources, and must instead rely on biomass or and suchlike sources. The fact that many African countries are landlocked makes the import of commercial energy by those countries even more difficult and expensive (Energy in Africa, 1999).

to 26.5 Btu in 1997, and is forecast to reach 45.5 quads in 2020.

Natural gas production grew the most, by 3.9 quads, followed by growth in oil and coal (3.8 and 3.6 quads, respectively), hydroelectricity (0.4 quads), and nuclear power (0.1 quads). Oil accounted for over 86 per cent of Africa's commercial energy production in 1970, coal stood a distant second at 11 per cent, followed by hydroelectricity at 2 per cent, and then natural gas at 0.5 per cent (Energy in Africa, 1999). As of 1997, oil had declined to 63 per cent, while coal had increased to 19 per cent, natural gas to 15 per cent, hydroelectric to 2.3 per cent, and nuclear power to 0.5 per cent. Africa's share of world commercial energy production has remained relatively constant since 1970 at 7 per cent, and is expected to remain at about this level up to 2020. The distribution of Africa's commercial energy production throughout the continent is very uneven. For example, about 99 per cent of Africa's coal output is in Southern Africa (mainly South Africa). Natural gas production, on the other hand, is overwhelmingly concentrated in North Africa (mainly Algeria and Egypt). Crude oil production is concentrated in North Africa (Algeria, Egypt, and Libya), West

Per Capita Energy Production by Country



Source: Energy Information Administration, US Department of Energy. http://www.nationmaster.com

Commercial Energy Production

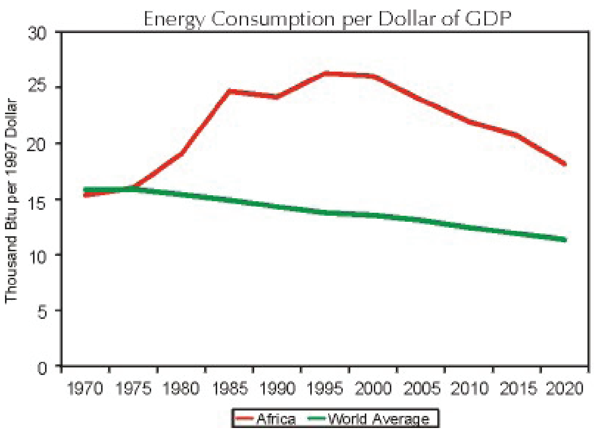
Commercial energy production in Africa has nearly doubled since 1970, and is expected to increase by another 68 per cent by 2020. Production has remained flat (at around 7 per cent) as a share of the world total. African commercial energy production grew from 14.8 Btu in 1970

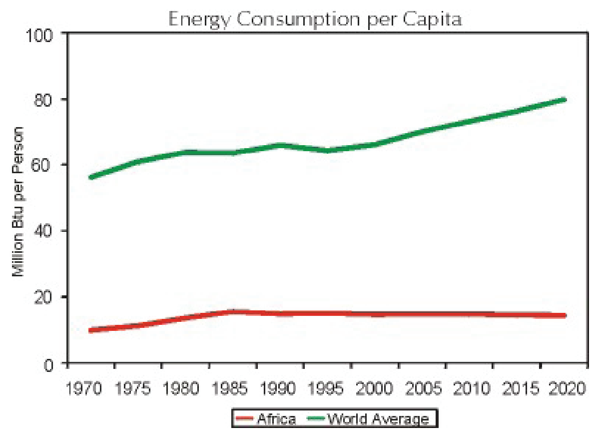
Africa (Nigeria), Central Africa (Gabon), and Southern Africa (Angola). East Africa hardly produces any oil, gas, or coal (Energy in Africa, 1999).

Per capita Commercial Energy Consumption

As of 1997, Africa was consuming about 26,300 Btu of commercial energy per 1997 dollar of GDP and 14.9 million Btu per person. This compares to world averages of about 13,600 Btu per 1997 dollar of GDP and 65 million Btu per person, respectively. Africa's energy intensity (energy consumption per 1997 dollar of GDP) rose by 71 per cent during 1970-1997. This compares to a decline of around 28 per cent in the world average energy intensity. Africa's energy intensity rose steadily during 1970-1985, leveled off in the mid-1990s, and is projected to decline slowly up to 2020 (Energy in Africa, 1999). Energy consumption per person in Africa increased somewhat during the 1970s and early 1980s, but since then has mainly leveled off, and is expected to decline only slightly up to 2020. While African energy consumption per dollar of GDP has been consistently far higher than the world average, the continent's energy consumption per capita has been consistently far lower. Therefore, although the average African uses far less energy than the world average per person, producing a dollar's worth of GDP uses more energy in Africa than does the world average (Energy in Africa, 1999).

Energy Consumption per Dollar of GDP/Energy Consumption per Capita Graphs





Source: Energy Information Administration / US Department of Energy

African Regional Primary Energy Consumption, Production and Net Exports, 1997

Country	Consumption	Production	Net Exports*	Country	Consumption	Production	Net Exports*
Cameroon	0.08	0.30	0.22	Angola	0.09	1.55	1.46
Central African Republic	0.005	0.001	-0.004	Botswana	0.04	0.02	-0.02
Chad	0.003	0	-0.003	Comoros	0.001	0.0002	-0.001
Congo	0.02	0.56	0.54	Lesotho	0.01	0.00	-0.01
Dem. Rep. of Congo	0.13	0.13	0	Madagascar	0.02	0.01	-0.02
Equatorial Guinea	0.002	0.10	0.098	Malawi	0.02	0.01	-0.01
Gabon	0.06	0.81	0.75	Mauritius	0.04	0.00	-0.04
São Tome & Príncipe	0.001	0	-0.001	Mozambique	0.02	0.00	-0.02

Country	Consumption	Production	Net Exports*	Country	Consumption	Production	Net Exports*
SUBTOTAL-C. Africa	0.29	1.89	1.6	Namibia	0.03	0.00	-0.03
Burundi	0.01	0.001	-0.009	South Africa	4.30	5.18	0.88
Djibouti	0.02	0	-0.02	Swaziland	0.02	0.00	-0.01
Eritrea	0.02	0	-0.02	Zambia	0.10	0.09	-0.01
Ethiopia	0.05	0.02	-0.03	Zimbabwe	0.25	0.16	-0.09
Kenya	0.15	0.04	-0.11	SUBTOTAL-S. Africa	4.95	7.03	2.09
Rwanda	0.01	0.002	-0.008	Benin	0.01	0.01	-0.004
Seychelles	0.01	0	-0.01	Burkina Faso	0.01	0.001	-0.009
Somalia	0.01	0	-0.01	Cape Verde	0.002	0	-0.002
Sudan	0.07	0.02	-0.05	Côte d'Ivoire	0.16	0.08	-0.09
Tanzania	0.05	0.02	-0.03	Gambia	0.003	0	-0.003
Uganda	0.02	0.01	-0.01	Ghana	0.11	0.07	-0.04
SUBTOTAL-E. Africa	0.40	0.113	-0.307	Guinea	0.02	0.002	-0.02
Algeria	1.32	5.68	4.36	Guinea-Bissau	0.004	0	-0.004
Egypt	1.80	2.61	0.82	Liberia	0.01	0.002	-0.01
Libya	0.59	3.39	2.8	Mali	0.01	0	-0.01
Morocco	0.36	0.02	-0.34	Mauritania	0.05	0.003	-0.05
Tunisia	0.32	0.31	-0.01	Niger	0.02	0.005	-0.01
Western Sahara	0.003	0	-0.003	Nigeria	0.86	5.27	4.41
SUBTOTAL-N. Africa	4.393	12.01	7.627	Senegal	0.06	0.002	-0.058
				Sierra Leone	0.01	0	-0.05
				Togo	0.01	0	-0.01
				SUBTOTAL W.Africa	1.349	5.445	4.08
				Total Africa	11.39	26.47	15.08

**A negative number indicates consumption exceeds production, with the deficit made up from stocks and/or imports; a positive number indicates production exceeds consumption, with the difference either added to domestic stocks or exported.*

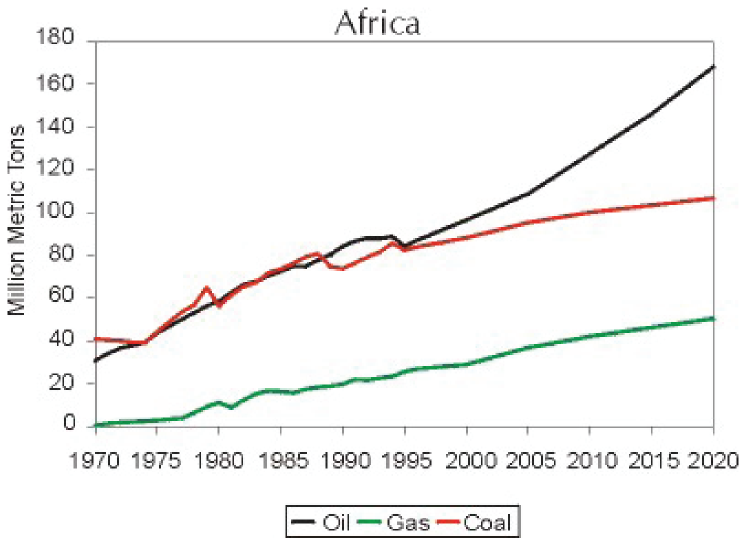
- *1 quadrillion Btu or quad is equal to about 0.5 million barrels per day of oil equivalent*

Source: Energy Information Administration Note: Units in quadrillion British thermal units - quads

Environment and Energy

Deforestation is now one of the most pressing environmental problems faced by most African nations, and one of the primary causes of deforestation is the use of wood for fuel. Deforestation has negative implications for the local environment (increased erosion) and the global environment (fast climate change, threatened biodiversity). Many African nations have had over three quarters of their forest cover depleted. Of the 159 signatories to the Convention to Combat Desertification, 52 are African. Of those 52, nearly all have ratified the Convention which entered into force in 1997.

Carbon Emissions by Fuel Type in Africa



Source: Energy Information Administration, US Department of Energy

African carbon emissions from fossil fuel consumption (excluding natural gas flaring) are growing rapidly, although from a very small base. Carbon emissions in Africa roughly tripled, from 72 million metric tons (Mmt) in 1970 to 202 Mmt in 1997, and are projected to reach 325 Mmt by 2020. Africa's share of world carbon emissions has increased slightly from 2 per cent in 1970 to around 3 per cent in 1997, and is expected to remain almost constant through 2020. Africa as a whole emitted about the same amount of carbon in 1997 as Germany or India. Africa has the lowest level of carbon emissions from fossil fuel consumption of any continent in the world. From 1970 to 1997, carbon emissions increased for all fuels in Africa. Carbon emissions from natural gas increased 50-fold, while emissions from oil consumption tripled and from coal doubled (Energy in Africa, 1999).

Oil is responsible for about 44 per cent of carbon emissions in Africa, followed by coal (42 per cent) and natural gas (14 per cent). Carbon emissions by all three fossil fuel types (oil, gas, and coal) in Africa grew during 1970 - 1997, and are projected to continue to grow through 2020. Oil's share of total carbon emissions is expected to increase from 44 per cent in 1997 to 52 per cent in 2020. The share of carbon emissions from consumption of natural gas is expected to increase slightly, from 14 per cent in 1997 to 16 per cent in 2020. Coal's share of African carbon emissions is expected to fall from 42 per cent in 1997 to 33 per cent in 2020 (Energy in Africa, 1999).

Developing Energy for Regional Integration

There are good signs of cooperation and interdependence in Africa's energy sector in the form of power pools, electricity interconnections, gas and oil pipelines, technology transfer, human resource development, research and development, indicating that regional cooperation is a practical reality. The Regional Economic Communities (RECs) can also learn much from one another regarding best practices such as preventing the under-utilization of physical assets e.g. improving plant availability/reliability and reducing the real costs of electricity, which are focal areas of the New Partnership for Africa's Development (NEPAD).

Box 9.1: Choose between new energy source or desertification -call

Guardian Monday, September 02, 2002

*B*y Deodatus Mfugale, Johannesburg

The Tanzanian delegation at the Global People's Forum called on developing countries to focus on alternative sources of energy that would be cheap, affordable for the rural population and could conserve the environment. Contributing to a discussion on alternative energy sources for sustainable environment, Simon Mmakasa of the Same and Mwanga Environmental Conservation Trust Fund explained that developing countries must now come up with new energy sources or rural areas where many such zones have developed desert-like conditions due to excessive use of forest products.

" An alternative source of energy will be a relief to women and children who spend many hours everyday in search of fuelwood," he said.

"We cannot talk about sustainable development if there is no sustainable environment, and this can only be attained if there is a sustainable energy system in place," he said.

He added that such alternatives must also aim at reducing environmental pollution, particularly, non-toxic

Mmakasa advocated for the use of the Non-Petroleum Green Heat cookers that are fuelled by gelfuel, which is derived from plants. The technology is already in use in some African countries, including Malawi.

Talking about Tanzania, Mmakasa said the technology could easily be adopted because the cookers can be fabricated by any artisan in rural areas where welding facilities are available.

"On the other hand, the gelfuel is an ethanol mixture that can be made from a wide range of completely renewable agricultural products like sugarcane, bananas and other similar products," he said.

Highlighting the social aspects of the gelfuel technology, he said that the introduction of the system would boost agricultural activities through the establishment of energy farms for sugarcane, bananas and sweet potatoes.

These would not only create employment for youths but also in the long run alleviate hunger through large-scale farming of bananas and sweet potatoes.
A delegate from Malawi, Richard Franz, explained that there had been a good response from the rural population in his country.
"Once this energy is adopted, the cost of using kerosene, fuelwood and charcoal will be greatly reduced. Our target is to spread the use of this system to as many parts of the country as possible so as to reduce deforestation," he said, 'It is also advantageous to low income earners as it is cheaper than kerosene."
Franz works with the GELFUEL Company in Malawi, which is responsible for supplying the technology to rural areas. He explained that so far, Uganda and Kenya have shown interest in the project and pilot projects would start in the two countries early next year. Tanzania is yet to show interest in the new energy system.

Progress made by the different RECs towards regional integration in the energy sector could be assessed based on the following objectives (ECA-ARIA, 2003):

(a) Formulation of regional energy policies/ programmes, including preparation of a regional energy/power development master plan;
(b) Joint development of hydropower resources and national hydropower projects with regional dimensions;
(c) Energy pooling through interconnection of electricity grids;

(d) Energy pooling through development of cross-border gas pipeline networks;
(e) Promotion of cross-border energy trade through expansion of oil pipeline networks; and
(f) Promoting regional cooperation in selected overarching issues.

The Southern African Development Community (SADC) Energy Protocol which was approved in 1996 and has already entered into force commits member States to cooperate and harmonize their national and regional energy strategies, policies and programmes on the basis of common interest. Annex 1 of the Protocol provides that the SADC Energy Cooperation Policy and Strategy in support of SADC regional integration and socio-economic development encompasses, among other things, energy trade, integrated resource planning, energy efficiency and conservation, pricing and demand-side management, NGO and private sector involvement, training and organizational capacity building, research and development, energy investment and funding, environment, and collection/processing and dissemination of information and experience. An Energy Sector Action Plan has been developed to implement the SADC Cooperation Policy and Strategy (ECA-ARIA, 2003).

The energy objectives of the Economic Community of West African States (ECOWAS) include cooperation in the coordination and harmonization of member States' national policies and programmes. In December 1999, the Authority of Heads of State and Government of ECOWAS approved a master plan for the development of energy production facilities, the interconnection of electricity grids of member States and the establishment of the West African Power Pool (WAPP).

This plan includes:
(a) Development of new hydroelectric dam sites;
(b) Construction or rehabilitation of thermal power plants;
(c) Interconnection of national electricity grids;
(d) Implementation of the West African Gas Pipeline (WAGP) Project; and
(e) Development and implementation of a regional renewable energy programme.

(ECA-ARIA, 2003)

The West African Economic and Monetary Union (UEMOA) Council of Energy Ministers, at its first meeting held in Bamako, Mali in April 1997, reshaped, in a "Common Energy Programme," the objectives for energy cooperation as provided for in the Additional Protocol II to the Treaty establishing UEMOA, which are, among others, to "ensure the security of energy supplies of member States, and ensure the optimal management of energy resources through systematic interconnection of electricity grids and the promotion of new and renewable energies". Since UEMOA member States are also ECOWAS members, it was deemed necessary to harmonize the energy policies and programmes of the two RECs. Thus, the UEMOA Council of Energy Ministers adopted the "UEMOA Common Energy Policy" at its meeting held in Ouagadougou, Burkina Faso, in November 2001 (ECA-ARIA, 2003).

The East African Community's (EAC) objectives for the energy sector include adoption of policies and mechanisms to promote efficient exploitation, development, joint research and utilization of various energy resources available within the region. EAC member States have agreed to cooperate in promoting the development and transmission of electric power, the development of integrated policies on rural electrification, and the interconnection of their electricity grids. A Committee on Energy has been established within the EAC institutional framework and is preparing an East African Energy Master Plan covering the three key areas of power, fossil fuels, and new and renewable sources of energy. The World Bank has secured funding for the preparation of an EAC Power Master Plan (ECA-ARIA, 2003).

Although UMA does not have specific energy-related objectives, it has endorsed a policy that urges cooperation among member States in energy development and mineral resources management. Given the importance of the energy sector in the economies of UMA countries, in 1990, the energy ministers of UMA countries created committees with the aim of developing and strengthening integration efforts. In 1995, the General Planning and Energy Conservation Committee, in cooperation with the European Commission, commissioned a study on "Energy Planning in UMA Countries". This study showed the importance of energy integration, particularly in electricity generation, between UMA countries and stressed the need for more information exchange and the introduction of regulatory measures to enhance integration in the energy sector with the aim of establishing a Maghreb Energy Market (ECA-ARIA, 2003).

Joint development of hydropower projects and hydro projects with regional dimension is an idea that is catching on. The objective of regional cooperation through joint development of hydropower projects is shared by a number of countries within the different RECs. However, few are the projects that can be considered as having been jointly developed by two or more countries. These according to ECA-ARIA (2003) include:

(a) Kariba South Power Station in the SADC region between Zambia and Zimbabwe, with a total installed capacity of 666 MW which is being upgraded to 750 MW;
(b) Ruzizi II Hydroelectric Station in the Economic Community of the Great Lakes Countries (CEPGL) between Burundi, Rwanda, and the Democratic Republic of the Congo, with a total installed capacity of 40 MW (the third 13.5 MW unit is currently being installed);
(c) Nangbéto Hydropower Station of the Communauté Electrique du Benin (CEB) comprised of Benin and Togo in the ECOWAS/UEMOA region with a total installed capacity of 65 MW; and
(d) Manantali Hydropower Project of the Senegal River Basin Development Organization (OMVS) in the ECOWAS region between Mali, Mauritania and Senegal, with a total installed capacity of 200 MW.

Although some hydropower projects were carried out with the prime objective of meeting energy requirements at the national level, they have proved to be playing an important role in cross-border electricity trade on the subregional energy scene. This has been the case for:

(a) Uganda's Owen Falls Dam, which has been supplying power to Kenya's grid since 1958, and which expanded electricity supply to Bukoba in northwestern Tanzania in the EAC region in 1993, and more recently to Rwanda in the CEPGL region;
(b) Ghana's Akosombo Hydropower Station which has been supplying electricity to the grids of Benin and Togo through the CEB and to Côte d'Ivoire in the ECOWAS/UEMOA region;
(c) Inga I & II Hydropower Stations in the Democratic Republic of the Congo, which have been supplying electricity to Congo Brazzaville in the CEMAC region and to Zimbabwe through Zambia in the SADC region;
(d) Ruzizi I Hydropower Station in eastern Democratic Republic of the Congo which has been supplying electricity to Bujumbura in Burundi and to Rwanda in the CEPGL region;
(e) Mozambique's Cahora Bassa Hydroelectric Dam which was initially built by the Portuguese Government to supply bulk power to South Africa, but has expanded its electricity supply to Zimbabwe and southern Mozambique; and
(f) Nigeria's Kainji Hydropower Station, which has been supplying electricity to the Niger in the ECOWAS region.

Energy Pooling through Interconnection of Electricity Grids

The creation of the Southern African Power Pool (SAPP) in 1995 to link the SADC member States to a single electricity grid can be considered a major achievement of SADC in the energy sector integration. The utilities currently participating in SAPP are Angola's Empresa Nacional de Electricidade (ENE), the Botswana Power Corporation (BPC), the Democratic Republic of the Congo's Société Nationale d'Electricité (SNEL), the Lesotho Electricity Corporation (LEC), Malawi's Electricity Supply Commission (ESCOM), Mozambique's Electricidade de Mocambique (EDM), Namibia's NamPower, South Africa's Eskom, Swaziland Electricity Board (SEB), Tanzania's Electric Supply Company Ltd (TANESCO), Zambia's ZESCO Ltd and the Zimbabwe Electricity Supply Authority (ZESA). SAPP's Coordination Centre, located in Harare, Zimbabwe, commenced operations in February 2000 (ECA-ARIA, 2003).

Completion of the Matimba-Insukamini interconnector linking South Africa's Eskom and Zimbabwe's ZESA grids in October 1995 was a major accomplishment in operationalizing SAPP as it initiated the first linkage of system operations between the northern and southern systems in Southern Africa. The northern system is primarily composed of ZESA, ZESCO and SNEL, and the southern system is primarily composed of Eskom, BPC and Nampower. Although the power grids of Angola, Malawi and Tanzania are not yet connected with other SAPP member grids, interconnection plans for the three countries are in varying stages of development (ECA, 2003).

SADC has a surplus electricity generating capacity estimated to be as high as 11 000 MW in 1999. This capacity was reduced to about 7 700 MW in 2000 (allowing for a 20 per cent reserve margin and excluding non-interconnected countries), mainly due to the increase in the Eskom peak demand to 29 188 MW in 2000, which was 1 375 MW above the 1999 peak demand (see table below). At a conservative estimate of $US 1 million per megawatt (MW), the capital tied up in surplus capacity is considerable in the region ($US 7.7 billion). This highlights the importance of SADC having a strong interconnected power system to transfer power from areas with surplus capacity to where the demand exists (ECA-ARIA, 2003).

Surplus Generating Capacity in Southern Africa in 2000

Utility	Maximum demand SAPP Year 2000/01 (MW)	Required Capacity (MW)	Installed Capacity (MW)	Capacity Surplus or (Shortage) (MW)
Eskom, RSA	29188	35026	39125**	4099
NamPower, Namibia	320	383	393	10
BPC, Botswana	316	379	132	(-247)
EDM, Mozambique***	212	254	307	53
SEB, Swaziland	154	185	50	(-135)
LEC, Lesotho	85	102	72	(-30)
ZESCO, Zambia	1085	1302	1632	330
ZESA, Zimbabwe	1986	2383	1990	(-393)
SNEL, DRC	243	292	2360	2068
HCB, Mozambique	21****	25	2000	1975
Total Surplus				7730

*Allows for a 20% reserve margin
** Net maximum capacity, including generators in reserve storage
*** Includes Central & Southern System
**** Estimated at ± 1% of capacity
Note: Capacities for non-interconnected countries of Angola, Malawi and Tanzania are not shown.
If interconnected, a further ± 437 MW surplus generating capacity could potentially be added.

Source: ECA, 2003. Data Sources: SAPP Annual Report 2001 & Eskom Annual Report 2000

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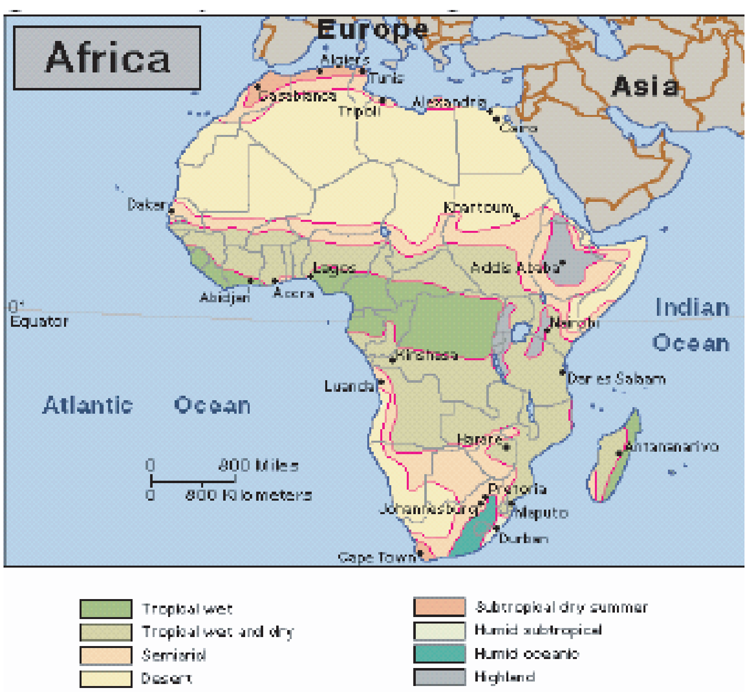
MANAGING RISKS

Interrelationships, reactions and interactions among climate, landforms and the socio-economic environment in a given physical milieu determine the impact of flood and inundation on the territory concerned. Floods are caused by either extreme precipitation events, changes in the drainage channel morphology, environmental changes or a combination these factors. Droughts on the other hand are considered as non-events controlled by regional or global large-scale atmospheric circulations in response to environmental conditions. The task before the scientific hydrological community is how to accurately identify the causative mechanisms of floods and droughts in order to reduce the uncertainties inherent in their prediction and forecasting, thus improving preparedness and ways of mitigating hazards resulting from them. The traditional hydrological forecasting methods have been found to be insufficient for forecasting flash floods and need to be augmented with advanced meteorological forecasting. Floods are carriers of large amounts of sediments which when combined with the hydraulics of the flow could change the characteristics of their channels and more often increase the flood peaks. Water-related hazards can also be induced by certain water management practices such as flooding from dam breaches. Moreover, floods sometimes wash down into river systems pollutants that impair water quality, and persistent low river flows reduce the self-purification of rivers. Strong alternations of floods and droughts intensify solute dynamics.

The foregoing facts indicate that there is a need, on the part of geophysical scientists, to carry out research on appropriate actions to take, and in good time, in the event of a climate change that is accompanied by catastrophic occurrences. This means building knowledge on these phenomena in order to develop early warning systems and capability for timely and more accurate forecasts of their occurrence and magnitude, giving ample lead time for implementing mitigation interventions (Andah, 2002).

Fig 10.1: Map of Africa showing showing various Climatic Areas



Source: World Book, Inc., 2003

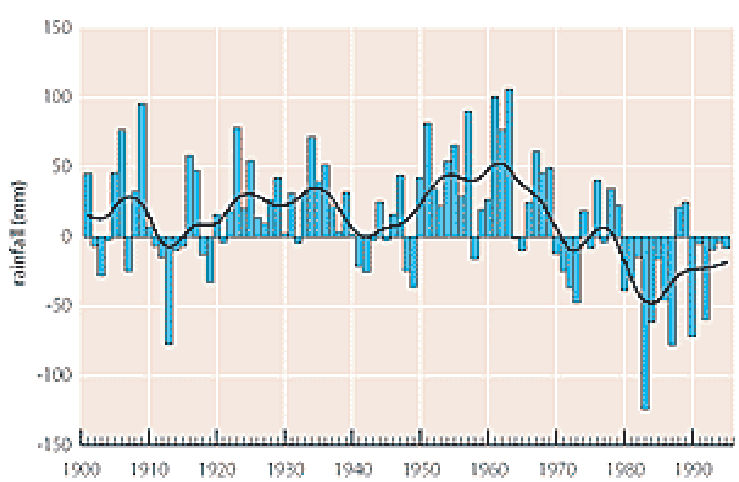
Most African countries also experience extremes of rainfall (periodic flooding or drought). There is some evidence that both droughts and floods have increased in frequency and severity over the past 30 years (OFDA 2000). The Sahelian zone, in particular, is now experiencing a continued decline in rainfall compared to pre-1960s averages, and Lake Chad has shrunk to 5 per cent of its size 35 years ago (NASA Global Earth Observing System 2001). Severe droughts were experienced in 1973 and 1984 when almost all African countries suffered reduced rainfall which particularly affected several million people in the Horn of Africa, the Sahel and Southern Africa.

In contrast, the northern and eastern parts of Africa are subject to occasional floods, the most significant recent example being in 1999–2000 when excessive rains affected Mozambique, Botswana, Zambia, Zimbabwe and South Africa, flooding some 200 000 ha of cropland and affecting more than 150 000 families. The estimated cost of recovery is millions of US dollars (Mpofu 2000). Although the SADC Early Warning System was able to predict the heavy rains, most of the countries affected were ill-prepared for the magnitude and duration of the floods. The result was investigation and revision of response strategies.

Rainfall Patterns over Africa

Most of Africa has a warm or hot climate, but the humidity and amount of rainfall vary dramatically from area to area. Rainfall is distributed very unevenly in Africa. Most areas receive either too much or too little rain. In parts of the west coast, for example, annual rainfall averages more than 100 inches (250 centimetres). In Monrovia, Liberia, an average of more than 40 inches (100 centimetres) of rain falls during the month of June alone. In contrast, more than half of Africa receives less than 20 inches (50 centimetres) of rainfall yearly; the Sahara and the Namibian Desert receive an average of less than 10 inches (25 centimetres). In parts of the deserts, rain may not fall for six or seven years in a row. Rain falls throughout the year in the forests of the Congo Basin and the coastal regions of western Africa. But almost all the rest of Africa has one or two seasons of heavy rainfall separated by dry periods. In some regions of Africa, the amount of rainfall varies sharply from year to year rather than from season to season. Inter-annual variations can be extremely high, and drought and/or flooding is common in most African countries. The cost of such extreme events runs into millions of dollars every year, a price that many Af-

Figure 10.2: Rainfall fluctuatins in Africa 1900-2000



Sources:: FAO; http//www.unep.org/dewa/Africa

rican countries cannot afford either to incur or to prevent. Since the late 1960s, droughts have caused much suffering in Africa. Millions of Africans have died of starvation and related causes. The hardest-hit areas include Ethiopia and the Sahel region on the southern edge of the Sahara. (World Book, Inc., 2003).

Anomalies and Trends in Rainfall Patterns

The variability of the climatic flux over the continent has been based on the continental air

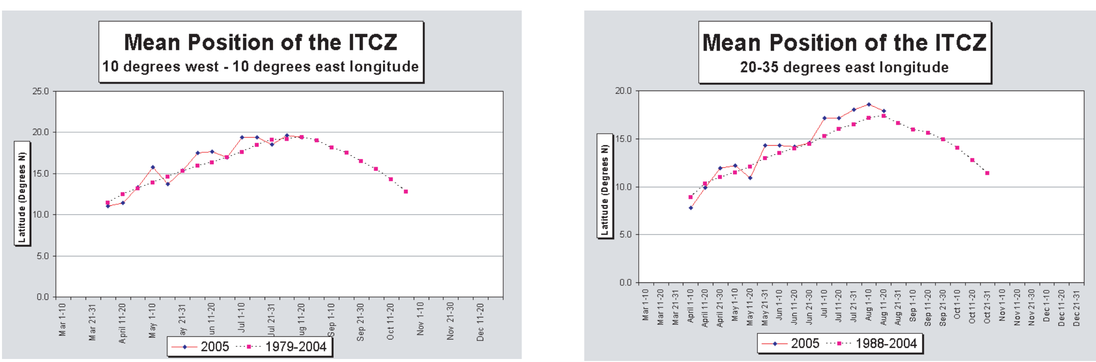
(El Sayem ,1986; Zahran, 1986).

Surveys on African rainfall carried out by Klaus (1977) and Nicholson (1985, 1986) have indicated a marked coherence of rainfall variations over large portions of the continent, a characteristic found to be especially strong in the semi-arid regions south of the Sahara. With this approach, Nicholson (1986) identified various patterns of rainfall anomaly fields that illustrate a strong tendency for synchronous fluctuations along the tropical and temperate margins of the Sahara.

From the foregoing analysis, it can be inferred

Figure 10.3: Mean Position of the Africa Intertropical Convergence Zone ITCZ

West Region **East Region**



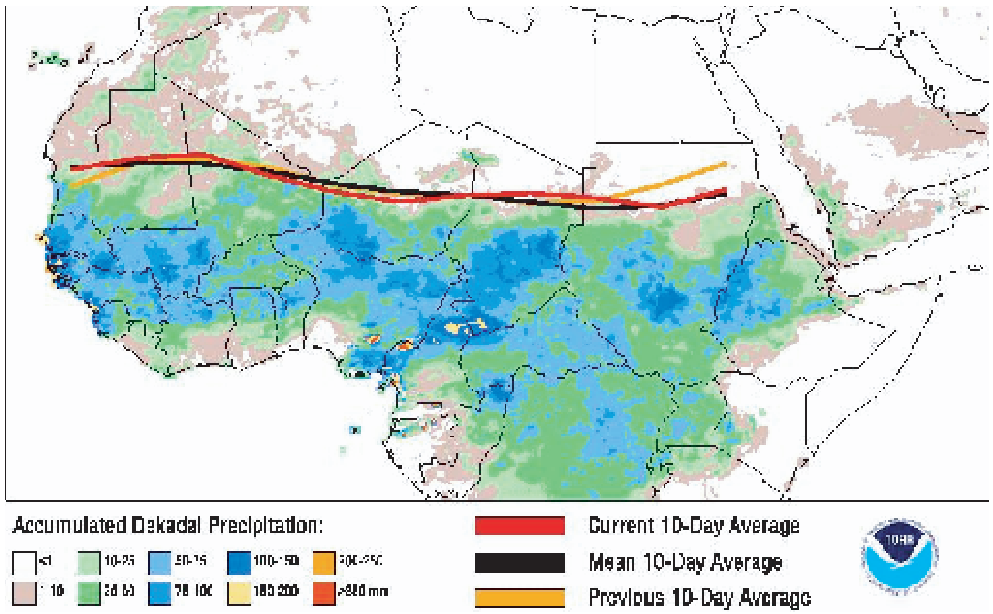
Source: NOAA, 2005

mass circulation controlled by the Inter Tropical Convergence Zone. As a result, areas below Lat 10°N receive rainfall around March - April while those up to Lat 20°N receive rain in June through September. Nicholson (1986), however, points out that variations in Sahel rainfall are generally related to changes in the intensity of the rainy season rather than to its onset or length as the ITCZ hypothesis would claim. This means that, in this case, extreme rainfall events cannot be meaningfully predicted through the anomalous excursions of the ITCZ as proposed by Kraus (1977), which has been used quite extensively for analysis of rainfall variations in tropical Africa

that the rainfall pattern over Africa exhibits very high variabilities over time and are quite often accentuated with positive and negative anomalies. Positive anomalies occur when there are significant departures of rainfall above the long-term mean and negative when below. This variability assumes higher dimensions, especially in areas lying in the transition from tropical climate to the arid conditions of the North. It becomes apparent that investigations into the behavioural patterns of rainfall must be directed toward the climatic and atmospheric mechanisms at small synoptic scales and mesoscales that could trigger

this type of anomalies. Here, special attention must be paid to the work of Nicholson (1986) on spatial coherence of African rainfall anomalies which needs to be further enhanced in order to evolve some index of anomaly that could be employed as a predictor of possible anomalous rainy seasons based on advance knowledge of rainfall anomalies in other climatic areas of the continent, especially within intra hemispheric regions of Africa (Andah, 1988).

Figure 10.4: Current vs Mean Position of the Africa ITCZ, as analyzed by the NOAA Climate Preditction Center



Note: The migration of the inter-tropical convergence zone (ITCZ) in Africa affects seasonal precipitation patterns across that continent. The blue shading on the map shows the areas of highest cloud reflectivity, which correspond to the average monthly position of the ITCZ.

Table 10.1: 2005 10-Day Mean ITCZ Position

	15W	10W	5W	0	5E	10E	15E	20E	25E	30E	35E
April 1-10	10.2	11.9	12.6	12.7	10.6	7.6	6.9	7.1	7.0	7.8	9.3
April 11-20	5.1	8.1	11.8	13.4	12.8	10.9	11.4	10.1	8.5	9.4	11.6
April 21-30	9.6	12.1	13.6	14.3	13.9	12.6	12.2	12.1	11.5	11.8	12.4
May 1-10	12.7	14.6	16.1	16.7	16.4	15.2	14.3	13.2	12.1	11.4	12.0
May 11-20	13.4	14.2	15.0	15.0	13.2	11.3	11.1	11.0	9.9	10.3	12.4
May 21-31	10.5	13.3	15.4	17.3	16.4	14.5	13.6	13.5	13.2	14.5	16.2
June 1-10	10.7	16.1	17.3	18.1	18.3	17.6	16.1	14.8	13.3	13.5	15.5
June 11-20	15.0	17.0	17.8	17.6	18.5	17.5	15.8	13.9	12.9	13.9	15.9
June 21-30	16.4	17.1	17.2	17.4	17.0	16.0	15.4	14.1	13.7	14.0	16.5
July 1-10	17.0	18.5	19.8	19.7	19.3	18.6	18.4	17.4	16.1	16.9	17.9
July 11-20	18.7	20.0	20.9	20.5	18.4	17.1	16.1	16.2	16.6	17.3	18.6
July 21-31	17.2	18.3	19.5	19.2	18.0	17.5	17.7	18.0	17.0	17.6	19.5
August 1-10	18.7	20.4	20.8	20.1	18.8	18.1	18.1	17.4	17.6	18.8	20.4
August 11-20	19.9	20.8	21.1	19.5	18.3	17.5	18.0	18.2	17.8	17.1	18.5

Source: NOAA, 2005

Box 10.1: Africa Intertropical Convergence Zone

Latest Text Summary

What a ride for the western region of the African ITCZ during the period from August 11-20 2005! Though Figure 10.4 shows a near constant latitude, compared to the previous dekad, the region averaged from 10 degrees west to 10 degrees east, this is highly misleading for the fact that the position is averaged for the ten day period. The fact is that two strong Easterly Waves that passed through the region, beginning on 14 August, brought rainfall to much of western Africa, and caused a very large daily fluctuation in the ITCZ. For example, the ITCZ near 5 degrees west longitude fluctuated from nearly 28 degrees north on 16 August to around 18 degrees north on 17 August. Strong northerly winds accompanied this movement, with dry air plunging southward to southern Burkina Faso on the 16th. For the record, the ITCZ was located near 18.8N during the dekad, compared to a normal position of around 18.7N, and a position last dekad of 19.0N. From the latest analysis, it appears that the ITCZ has reached its maximum northerly peak, at least in the eastern parts of Africa, though it is yet to be determined if such is the case in the west.

Climate Prediction Center, National Weather Service, NOAA

ENSO and African Rainfall Anomalies

Climate variability over Africa is also determined by prevailing patterns of sea surface temperature, atmospheric winds, regional climate fluctuations in the Indian and Atlantic Oceans, and by the El Niño Southern Oscillation (ENSO) phenomenon. An El Niño condition occurs when the sea surface temperature changes by at least 0,50C above normal while a La Niña event occurs when the sea surface temperature changes by at least 0,50C below normal. El Niño conditions bring droughts in some parts of the world and floods in others just as does La Niña. This, together with the strength of the Trade Winds, force warm water to move eastwards towards the North and South American western coasts (El Niño) or westwards towards Asia (La Niña). During the past 50 years of monitoring sea-surface temperature changes related to the El Niño /La Niña events, the cycle has created El Niño conditions 31 per cent of the time and La Niña conditions 23 per cent of the time. Indian and Atlantic Oceans Sea Surface Temperatures are part of the global ENSO teleconnection and are generally found to correlate to El Niño and La Niña events.

Over West Africa, El-Niño events tend to result in enhanced north-easterlies / reduced monsoon flow, coupled to weakened upper easterlies, and hence dry conditions over West Africa close to the surface position of the ITCZ, in July-September as well as January-March. For instance, a strengthening of the African Easterly Jet, or northerly wind anomalies across the Sahara, are shown to be related to drought conditions in the Sahel (July-September) and gulf of Guinea area (January-March), once the remote effect of SST anomalies is removed.

The ENSO also influences Southern Africa's climate bringing either heavy rains often accompanied by severe floods as in 1999/2000, or drought as in 1982/83 when much of Southern Africa was severely affected (NDMC 2000). Four of the most powerful El Niño events in the past century occurred since 1980 and the SADC region experienced a dry cycle during those periods. In the case of an El Niño condition, Southern/South Eastern Africa has less rainfall and is warmer than usual, while in the case of a La Niña condition, there is more rainfall and it is cooler than usual. Floods and Droughts in Southern Africa

are normally linked to the fluctuations in frequency-magnitude relationship of the climatic fluxes over the subregion, attributed to the anomalous behaviour of the ITCZ and SST's over the Indian Ocean, induced by the El Niño Southern Oscillation (ENSO). El Niño /La Niña events commence 8-10 months prior to changes in the Atlantic and Indian Oceans and this can provide some long-range forecasting lead-time.

La Niña appears to have the greatest influence on rainfall in Southern Africa and wet episodes tend to occur throughout the subcontinent during the first few months of the post-La Niña year. The strongest La Niña signals occur in Southern Africa and in extra-tropical North Africa. Some influence also appears along the Guinea. Strong positive anomalies occur toward the end of the La Niña year and/or the beginning of the post-La Niña year and the positive anomaly is evident throughout a six to eight-month period. This is roughly the timing of the maximum negative anomaly in these regions during the El Niño cycle.

Unlike the positive anomalies, the negative anomalies are generally relatively weak and are not temporally persistent. The strongest negative anomalies generally occur toward the end of the La Niña year or the end of the year preceding it. As with El Niño, the La Niña signal is strongest during the second half of the episode (i.e. the cold phase), but in contrast to El Niño, rainfall is abnormally high. La Niña's influence on rainfall occurs most consistently in southwestern Africa (Namibia and western South Africa, from 15°S to 32°S), with increased rainfall occurring in the first few months of the post-La Niña year in 14 of 17 events. Further east, in a sector stretching from southern Tanzania (10°S) to South Africa (32°S), positive anomalies occur at roughly the same time but less consistently. In the two northern African sectors, positive anomalies occurred in this same season just as consistently, but were generally weak. In the western highlands of equatorial Africa positive anomalies also occurred in the second half of La Niña episodes, but during the summer season.

Potential Hazards in Africa

The people of Africa are exposed to a wide range of disasters that ahve seriously aggravated the Continent's economic situation. Economic losses and human sufferings from floods, drought, desertification, locust infestation, infectious diseases, epidemics, and armed conflicts are the dominant disasters that the people in the African countries face, and they have rendered the people utterly vulnerable. Disasters have aggravated Africa's economic situation. The cumulative effect of disasters include loss of property, injury, death, mounting food import bills, health hazards, environmental degradation, backward economic development, displaced people, refugees, and nutritional deficiency. Today, 175 million Africans out of a total population of 744 million (23.5 per cent) are suffering from chronic hunger; this is an increase of 50 per cent from 25 years ago. In many African countries, up to half of the population suffers from absolute poverty. It is projected that Africa will be the only Continent to remain at the current level of poverty for another decade. More than 50 million Africans have been affected by disasters such as drought, floods, fire, war, epidemics, industrial and transport accidents during the last decade. The main natural disasters, Africa-wide, are related to climatic extremes. Droughts are endemic in both Southern Africa and the Sahelian region of western and northern Africa. In some cases droughts are exacerbated by human-induced changes in land cover. "Climate change is projected to increase the risk of drought over much of Southern Africa in the 21st century, partly through altering the frequency of El Niño events," Floods can occur in arid areas as well as humid areas. In tropical, near-coastal regions, they generally result from cyclones that can drop a year's worth of rainfall in a day. Because coastal zones are flat and densely populated, and cyclones are large in extent, hundreds of people can be affected. Africa is generally not very windy, but tropical cyclones can have a destructive force, and severe convective storms sometimes generate tornadoes in the humid interior. "Dust storms are a feature

Table 10.2: Potential natural hazards in Africa

	Country	Potential Natural Disasters
1.	Mayotte	cyclones during rainy season
2.	Comoros	cyclones possible during rainy season (December to April); Le Kartala on Grand Comore is an active volcano
3.	Swaziland	Drought
4.	Gambia	Drought (rainfall has dropped by 30% in the last 30 years)
5.	Ghana	dry, dusty, northeastern harmattan winds occur from January to March; droughts
6.	Sierra Leone	dry, sand-laden harmattan winds blow from the Sahara (December to February); sandstorms, dust storms
7.	Sudan	dust storms and periodic persistent droughts
8.	Djibouti	earthquakes; droughts; occasional cyclonic disturbances from the Indian Ocean bring heavy rains and flash floods
9.	Tanzania	flooding on the central plateau and south-eastern coastal areas during the rainy season; drought
10.	Burundi	flooding, landslides, drought
11.	Togo	hot, dry harmattan wind can reduce visibility in north during winter; periodic droughts
12.	Libya	hot, dry, dust-laden ghibli is a southern wind lasting one to four days in spring and fall; dust storms, sandstorms
13.	Mauritania	hot, dry, dust/sand-laden sirocco wind blows primarily in March and April; periodic droughts
14.	Western Sahara	hot, dry, dust/sand-laden sirocco wind can occur during winter and spring; widespread harmattan haze exists 60% of time, often severely restricting visibility
15.	Guinea	hot, dry, dusty harmattan haze may reduce visibility during dry season
16.	Guinea-Bissau	hot, dry, dusty harmattan haze may reduce visibility during dry season; brush fires
17.	Benin	hot, dry, dusty harmattan wind may affect north from December to March
18.	Central African Republic	hot, dry, dusty harmattan winds affect northern areas; floods are common
19.	Chad	hot, dry, dusty harmattan winds occur in north; periodic droughts; locust plagues
20.	Mali	hot, dust-laden harmattan haze common during dry seasons; recurring droughts; occasional Niger River flooding
21.	Algeria	mountainous areas subject to severe earthquakes; mudslides and floods in rainy season
22.	Lesotho	Periodic droughts
23.	Congo, Democratic Republic of the	Periodic droughts in south; Congo River floods (seasonal); in the east, in the Great Rift Valley, there are active volcanoes
24.	Nigeria	Periodic droughts; flooding
25.	Egypt	Periodic droughts; frequent earthquakes, flash floods, landslides; hot, driving windstorm called khamsin occurs in spring; dust storms, sandstorms
26.	Botswana	Periodic droughts; seasonal August winds blow from the west, carrying sand and dust across the country, which can obscure visibility
27.	Rwanda	Periodic droughts; the volcanic Virunga mountains are in the northwest along the border with Democratic Republic of the Congo
28.	Niger	recurring droughts
29.	Burkina Faso	recurring droughts
30.	Zimbabwe	recurring droughts; floods and severe storms are rare
31.	Somalia	recurring droughts; frequent dust storms over eastern plains in summer; floods during rainy season
32.	Zambia	tropical storms (November to April)
33.	Cameroon	Volcanic activity with periodic releases of poisonous gases from Lake Nyos and Lake Monoun volcanoes
34.	Saint Helena	active volcanism on Tristan da Cunha
35.	Cote d'Ivoire	coast has heavy surf and no natural harbours; during the rainy season torrential flooding is possible
36.	Liberia	dust-laden harmattan winds blow from the Sahara (December to March)
37.	Eritrea	Frequent droughts; locust swarms

Table 10.2: Potential natural hazards in Africa

	Country	Potential Natural Disasters
38.	Ethiopia	geologically active Great Rift Valley susceptible to earthquakes, volcanic eruptions; frequent droughts
39.	Seychelles	lies outside the cyclone belt, so severe storms are rare; short droughts possible
40.	Angola	locally heavy rainfall causes periodic flooding on the plateau
41.	Senegal	lowlands seasonally flooded; periodic droughts
42.	Bassas da India	maritime hazard since it is usually under water during high tide and surrounded by reefs; subject to periodic cyclones
43.	Morocco	Northern mountains geologically unstable and subject to earthquakes; periodic droughts
44.	Indian Ocean	occasional icebergs pose navigational hazard in southern reaches
45.	Juan de Nova Island	Periodic cyclones
46.	Madagascar	Periodic cyclones
47.	Glorioso Islands	Periodic cyclones
48.	South Africa	prolonged droughts, floods
49.	Namibia	prolonged periods of drought
50.	Kenya	recurring drought; flooding during rainy seasons
51	Mozambique?	Floods?

Source: CIA World Factbook 2002 www.natiomaster.com

of the arid parts of West Africa. Natural disasters and human-made disasters are often linked. A natural disaster such as drought is often aggravated by certain food policies, or alternatively, a human-made disaster such as armed conflict could again wreak havoc on the environment and contribute to a natural disaster.

Disasters Triggered by Natural Hazards

The majority of disaster incidents to which the Office of US Foreign Disaster Assistance (OFDA) has responded in sub-Saharan Africa since 1970 were triggered by natural hazards. While natural disasters are responsible for only 28 per cent of disaster-caused deaths, they accounted for 57 per cent of all those affected by disaster and 66 per cent of all disaster-caused homelessness. The most common natural disasters in Africa are: drought, floods, cyclones, food shortage, and pest infestations.

Drought is the deadliest natural disaster. It accounts for over three quarters of all those affected by natural disasters and 98 per cent of disaster-related mortality. During the past ten years, three quarters of the droughts in the world have occurred in Africa. Drought is a condition of life for many residents of Africa, especially those of the Greater Horn region. The countries in Africa reporting the highest frequency of drought include: Ethiopia, Chad, Botswana, Burkina Faso, Kenya, Mozambique and Mauritania.

Other natural disasters in Africa such as infestations, floods and cyclones contribute to the overall disaster burden in Africa. Of the greatest number of infestation incidents in the world, 87 per cent have occurred in sub-Saharan Africa since 1970 but little mortality has resulted from them. Drought and infestation-caused crop failures result in weakened food security conditions for millions. As a result, from 1970 to 1994, nearly 28 million Africans were recorded by OFDA as having experienced food shortages requiring international response. Floods also have affected millions of people, as have cyclones, storms and fires, but again, they account for a small number of those affected and **almost none of those who lost their lives.** Natural disaster threats therefore remain frequent in the region but are being much more effectively managed by African people and the international community. They have been included in this discussion because so much has been learned about their management. The

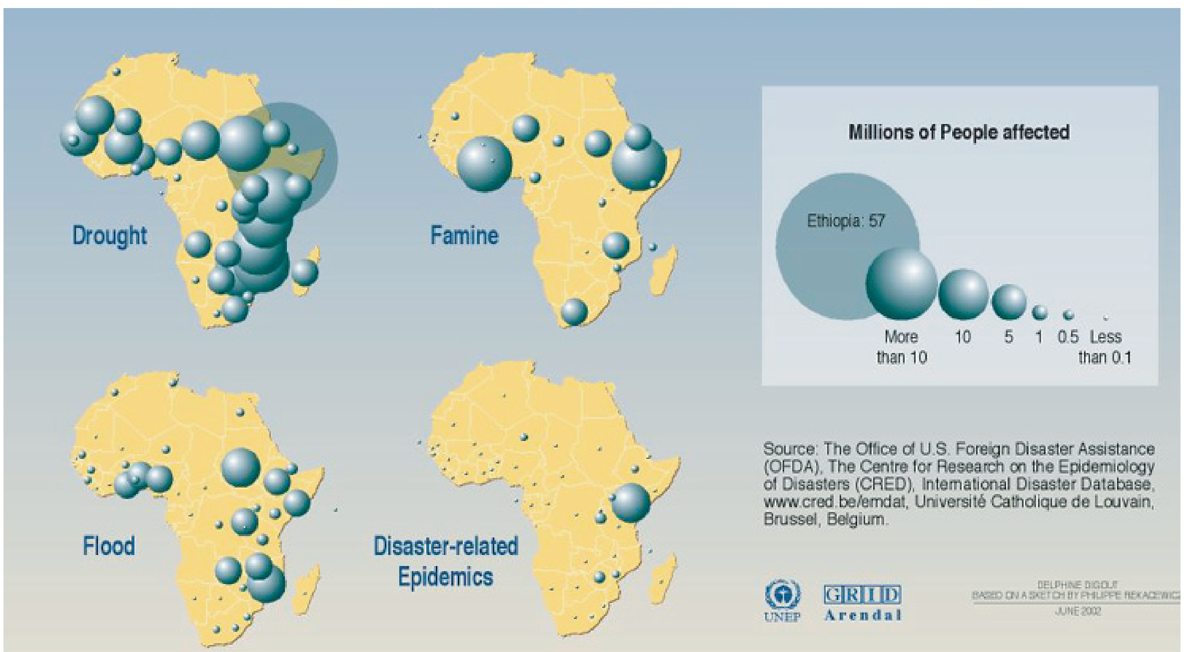
fact that in recent times drought-related mortality has been almost non-existent in the absence of conflict, speaks for the success of international and local efforts to mitigate drought.

Vulnerability to Risk

Extreme hydrometeorological events such as flooding and drought are common across Africa, while geophysical events such as earthquakes occur predominantly in Northern Africa, along the Atlas mountain range, and in the African Rift Valley which also experiences volcanic activity. The ENSO causes significant climatic disturbances in most parts of Africa, either inducing drought or flooding or increasing sea temperatures, leading to cyclones. These natural events become disasters where large numbers of people or infrastructure are affected, as has occurred over the past 30 years due to high population growth rates, especially in urban centres and drought-prone areas - 34 per cent of Africa's population lives in arid areas, compared to just 2 per cent of Europe's population (Findlay 1996).

Most cities and population centres in Africa lie in flat terrains and hence are generally devoid of natural drainage systems. Urban drainage systems, where existent, are left unattended to making most parts to malfunction, especially during long spells of droughts. One other important feature of the physiographic conditions of the population centres is that they are mostly surrounded by highlands sometimes accentuated by unidentifiable and un-gauged ephemeral stream channels which in times of intensive rainfall conduct torrential flash flows towards residential areas. The devastating effects of the floods caused by direct rainfall superimposed on the torrential flows in ephemeral stream channels on population centres are responsible for most of the direct damages caused in urban centres during extreme events (Andah, 1988).

Figure 10.5: People affected by natural disasters between 1971-2000



Source: UNEP – Vital Water Graphics, 2005

Flood Management

Much of Africa is vulnerable to flooding: flood is the most prevalent disaster in North Africa, the second most common in East, South and Central Africa, and the third most common in West Africa. Episodes of flood accounted for 26 per cent of total disaster occurrences in Africa during 1971-2001 (Vordzorgbe 2003 B) with devastating effects. In North Africa, the 2001 disastrous flood in northern Algeria resulted in about 800 deaths and economic loss of about $400 million. In East Africa, the El Niño-related flood in 1997/1998 destroyed infrastructure and property worth about $1.8 billion in Kenya. In Mozambique, the 2000 flood, (worsened by two cyclones) reduced the annual economic growth rate from 10 per cent to 4 per cent, caused 800 deaths, affected almost 2 million people of which about 1 million needed food, displaced 329,000 people and destroyed agricultural production land, among other negative effects. The single worst episodes of flood in Africa occurred in East Africa: one in 1997 which killed 2,311 people in Somalia and the other in 1999 which affected 1.8 million people in the Sudan.

Structural and non-structural measures for managing the direct effects of floods, includes, as stated by Vordzorgbe, S. D(2003):

(a) Risk assessment of floods and early warning: these are essential in determining the likelihood and duration of occurrence of floods, as well as the extent and location of damage. Subregional systems for early warning of flood exist in the SADC and Sahel subregions and are being developed in the Great Horn. However, water resource variability, river flow and hydrological models are at various stages of development at the national and subregional levels throughout Africa to serve as precursors to comprehensive flood early warning systems;

(b) Integrated development, including land use and disaster response planning to minimize the damaging effects of floods, particularly flash floods. However, this is one of the areas of flood control in Africa in which action is weakest;

(c) Development of physical flood control structures, mainly as part of public investment programmes. This is an essential flood-protection measure, but the high level of investment required has made the development of these structures grossly inadequate, particularly in disadvantaged urban locations;

(d) Development of flood maps to provide information on the past, likely or potential extent of flooding which (sometimes in combination with other related information) help in making decisions on various aspects of integrated management of floods;

(e) Incentives to encourage people to construct safe structures;

(f) Risk awareness to induce people to be increasingly responsible for their own safety and to improve their compliance with warning advice and response recommendations;

(g) Environmental management to minimize environmental factors that exacerbate floods.

Box 10.2: FAO GLOBAL INFORMATION AND EARLY WARNING SYSTEM ON FOOD AND AGRICULTURE

SPECIAL ALERT No. 300 SOUTHERN AFRICA

Date: 22 February 2000

FLOODS AND ERRATIC RAINS CAUSE EXTENSIVE DAMAGE IN PARTS OF SOUTHERN AFRICA

The worst floods for four decades have devastated parts of Southern Africa, leaving thousands homeless and seriously threatening food supplies. Damage to housing, property and infrastructure has also been extensive, which will require substantial assistance to rehabilitate. The situation varies from country to country, but the rains have generally been erratic since the beginning of the season. In some areas, excessive rainfall was received, whilst in others there were prolonged dry spells. Torrential rains in the first dekad of February in Mozambique, South Africa, Botswana and Swaziland, resulted in loss of life and severe damage to housing and infrastructure. An assessment of crop damage is not yet available but significant losses are anticipated in the worst affected areas.

Mozambique has borne the brunt of severe floods, where some 300 000 people have already been affected. However, this number is expected to rise substantially, following cyclone "Eline" which has just hit the country. The Government of Mozambique has appealed for US$ 2.7 million in international assistance to cope with the emergency. WFP is currently distributing emergency food aid to 150 000 people in the country. In South Africa, the number of people left homeless is provisionally estimated at 100 000 and in Botswana at 4 000. No assessment is yet available for Swaziland. In Lesotho, abundant rains in early February brought relief to crops stressed by previous dry weather but may have been too late to prevent a reduction in yields. In contrast, more rains are needed in Malawi, Namibia, Madagascar and Zambia, where precipitation in February has been below average. In Zimbabwe, while growing conditions are satisfactory due to favourable rains since the beginning of the season, maize production is likely to be affected by a reduction in area planted due to diversion of land to more profitable crops. The food supply situation is tight for large numbers of vulnerable people in the urban areas of the country, due to high levels of inflation and fuel shortages. The food situation remains extremely serious in war-affected Angola, where emergency food aid continues to be necessary for some 1.1 million displaced people, as well as for large numbers of Angolan refugees in Zambia and Namibia.

Although it is too early to estimate the impact of floods and insufficient rains on regional crop production, there are fears of a significant drop in cereal production and the emergence of food shortages in the worst affected areas. FAO's Global Information and Early Warning System is closely monitoring the situation and will mount in April 2000, jointly with WFP, Crop and Food Supply Assessment Missions to the most seriously affected countries.

Box 10.3: Floods have ravaged much of Mozambique.

Map courtesy of the BBC

At least 70 people have died in the flooding in Mozambique, according to reports. More than 300,000 people have been forced from their homes by two weeks of torrential rains. Officials say the homeless are now at risk for outbreaks of water-borne disease, such as cholera, malaria and meningitis. United Nations officials in Maputo said they had had no official reports of cholera deaths, but South African radio reported that between 15 and 18 people were dying of the disease every day in the central town of Beira.

In addition to flood damages, Cyclone Eline, which hit the coast on Tuesday near Beira with winds of up to 260 kmh (160 mph), left widespread destruction along the coastline. From Inhambane to Beira, the storm cut power and water supplies, tore corrugated-iron roofs from houses, and uprooted coconut palm trees and telegraph poles. The Mozambican Government estimates that a total of 800,000 people across the country have been affected by the dual disasters. Most of them are in urgent need of food aid and assistance, according to the U.N.

Disasters Steal Hope from Growing Economy

Aid workers worry that the disaster could have devastating effects on the Mozambique's struggling, yet growing, economy. The country's war ended less than a decade ago, but its economy has grown at a rate of more than 10 percent in each of the past three years - a seemingly impossible feat in Africa.

But Mozambique's worst flooding in 50 years has caused more destruction to infrastructure than the war itself, setting the country back at least two years, aid workers say. Farmers and government officials in the region say floods have destroyed crops probably worth millions of dollars, pushing the country into an increased dependence on aid. Throughout Southern Africa, flooding has taken more than 200 lives. In addition to Mozambique, torrential rains and flooding have ravaged nearby Zimbabwe, Botswana, South Africa and Namibia, destroying homes, toppling power lines and submerging cropland. Renewed flooding across northern parts of South Africa has killed at least 12 people in recent days, South African police said on Thursday, taking the toll to more than 55 this month.

In Zimbabwe, Eline also left a trail of destruction. The cyclone passed over the east and south of the country, knocking down bridges, sweeping away homes and causing dams to collapse. The state news agency Ziana reported that air force helicopters and fleets of government trucks are moving stranded flood victims to higher ground. Zimbabwe has appealed for international help and declared three of its most flooded provinces disaster areas.

Felecia, downgraded to a tropical depression, is now moving west, prompting flood warnings as far away as Botswana. The country is still trying to recover from last week's deluge, when the normally arid nation received 75 percent of its average annual rainfall in three days. Floods swept away 10,000 homes and some areas still remain cut off. Now Botswana finds itself on alert again as the government evacuates flood-prone areas in preparation for the coming storm (Kriner S, 2000).

Drought Management

Drought is the result of interrelationships among varied complex natural and anthropogenic factors that are yet to be fully understood. It is the third most common disaster by occurrence in Africa, accounting for 31 per cent of all natural disaster events in the continent during 1975 – 2002 (Vordzorgbe 2003 B). Droughts differ from other natural hazards because they are slow-onset phenomena, their occurrence and effects cover wide spatial areas, and their impacts are largely environmental and human but non-structural. Droughts exert environmental, economic and social impacts that retard sustainable development in Africa.

Table 10.3:The Deadliest Natural Disasters of the 20th Century in Africa

	Country	Year	Day	Month	Disaster	Region	Continent	Killed
17	Ethiopia	1972			Famine	E.Africa	Africa	600,000
28	Ethiopia	1984	14	October	Drought	E.Africa	Africa	300,000
32	Ethiopia	1974		April	Drought	E.Africa	Africa	200,000
33	Uganda	1901			Epidemic	E.Africa	Africa	200,000
35	Sudan	1984			Drought	N.Africa	Africa	150,000
43	Ethiopia	1973			Drought	E.Africa	Africa	100,000
44	Mozambique	1985			Drought	E.Africa	Africa	100,000
45	Niger	1923			Epidemic	W.Africa	Africa	100,000
49	NA	1972			Drought	W.Africa	Africa	62,500
50	NA	1973			Drought	W.Africa	Africa	62,500
51	NA	1974			Drought	W.Africa	Africa	62,500
65	NA	1943			Drought	E.Africa	Africa	35,000
67	Cape Verde Is	1946			Drought	W.Africa	Africa	30,000
72	Niger	1931			Famine	W.Africa	Africa	26,000
74	Cape Verde Is	1920			Drought	W.Africa	Africa	24,000
78	Niger	1910			Drought	W.Africa	Africa	21,250
79	Niger	1911			Drought	W.Africa	Africa	21,250
80	Niger	1912			Drought	W.Africa	Africa	21,250
81	Niger	1913			Drought	W.Africa	Africa	21,250
85	Somalia	1974			Drought	E.Africa	Africa	19,000
93	Morocco	1960	29	February	Earthquake	N.Africa	Africa	12,000
98	Cape Verde Is	1900			Drought	W.Africa	Africa	11,000
100	Nigeria	1991		January	Epidemic	W.Africa	Africa	10,391

Source: EM-DAT: The OFDA/CRED International Disaster Database – www.md.ucl.ac.be/cred HTML and other Copyrights; The Disaster Center

Droughts aggravate environmental degradation by degrading ecosystems and worsening climatic effects alongside such phenomena as deforestation, livestock overgrazing, soil erosion, wild land fires, biodiversity loss and water pollution. Social effects include reduced potable water supplies with negative health and sanitation consequences, especially for the vulnerable groups, and increased drudgery for women in collecting water for household consumption. Droughts also have an impact on the environmental disease incidence and increase the likelihood of food shortages leading to malnutrition and hunger.

The single worst drought disasters are the ones that killed 300,000 people in Ethiopia in 1984 (table 10.3) and the one that affected 14.3 million people in the same country in 2002. In economic terms, the cost of droughts in Africa is enormous. For example, the economic impacts of the 1991/92 drought in Southern Africa included GDP reduction of $3 billion, reduced agricultural production, increased unemployment, further heightened government expenditure burden and reduced industrial production due to curtailed power supply (Clay et. al. 2003, Vordzorgbe 1992). A decade later, the 1992-2001 La Niña-related drought in East Africa cost the Kenyan economy alone about $2.5 billion.

Box 10.4: CASE STUDY - MOROCCO

PROGRAM TO FIGHT AGAINST THE EFFECTS OF DROUGHTS

The droughts of the period 1998-2001 reduced the contributions of water by 60%; its impact was particularly felt in the rural area which, as underlined previously, is concerned with poverty.

The measures taken by the Moroccan Government, as illustrated by the case of the programme adopted for the year 1999, detailed below, related to not only actions of restoration of the basic services like drinking water, but also that of creation of jobs to compensate for the losses of incomes, and the programmes for the safeguard of livestock and the forest, and the injection of funds for spreading out the debts of farmers.

Financial structure for the campaign against the effects of the droughts of the year 1999

	MDH	
Creation of job	3274.3	47%
Works of drinking water	674.6	9,7%
Safeguard of livestock	1339.0	19.2%
Protection of the forest	287.9	4.1%
Subsidy of corn	1800	25.8%
Spreading out debts	1200.0	17.2%
Subsidy of corn	4.0	-
Total	6961.5	100%

These amounts show that the efforts of the authorities are not directed any more, as for the preceding droughts, exclusively towards the solution of the problems of water shortage; but quite to the contrary, the maintenance of the economic activities in the rural world receives full priority. With new policy, the problems of water supply of the populations and livestock could be solved, and the rural migration, usually caused by the droughts, could be attenuated.

The nature of a drought episode determines its effects and the appropriate response. Meteorological drought, an extended deficiency of normal precipitation, often precedes agricultural drought, which is marked by deficiency of water availability for plant growth and is mainly due to deficiency in soil moisture. Hydrological or water supply drought, is due to deficiencies in the normal flow and off-take from water sources and is the most difficult to mitigate. All types of drought interact with climate variability, management practices and physical factors to cause land degradation that, if unchecked, results in desertification.

Adjusting or postponing water use through effective water supply and demand management can often address meteorological drought. Mitigating agricultural drought requires more efficient soil moisture availability and use, while addressing hydrological drought often calls for structural and management measures to protect surface water sources. It should be noted that shortage of underground water supply often exerts greater

pressure on settlement populations dependent on that source than deficiencies in precipitation, but is not conventionally considered in defining drought.

In general, addressing the problem of drought involves actions in the following areas:

(a) Drought hazard and vulnerability monitoring through risk assessment and early warning of droughts. However, drought and desertification warning system are not operational anywhere in the world. In Africa, efforts to develop drought warning have centred on strengthening subregional initiatives in West Africa, South Africa and the Horn of Africa;

(b) Water supply management, including improving storage (e.g. construction of reservoirs), processing and distribution, to preserve normal off-take from water sources during periods of deficient precipitation. Here, water harvesting and other low-cost storage mechanisms are relevant;

(c) Water demand management, including voluntary restraints and enforced water saving;

(d) Improving effective water use, through such measures as improving soil moisture management, often by means of existing traditional practices and mechanisms;

(e) Protecting and enhancing water sources through sound environmental management and effective compliance with regulatory measures;

(f) Sound planning for drought prevention and mitigation measures, including in non-drought years, given the strong role of preparedness in reducing drought risks. The multifaceted nature of drought makes it necessary to apply to it an effective management based on a planned and developmental approach rather than a crisis-management approach.

One main problem with mitigating the effects of droughts through conventional water transfer schemes is that most of the drought-prone areas of Africa are water-deficit. This makes it unfeasible to ameliorate water stress in drought areas through transfers from large river basins to address meteorological drought. Also, several rivers are not drought reliable as they shrink during drought periods and therefore do not lend themselves to use as alternate sources of water to surrounding lands during stress periods of hydrological drought. In-depth analysis on source rivers is very necessary in order to avert negative impacts during lean rainfall seasons.

Owing partly to the difficulties in drought mitigation worldwide, the status of combating drought is not encouraging: even developed countries have only recently designed and begun to implement drought management plans. For example, in the USA, Congress passed the National Drought Policy Act in 1998, the Australian National Drought Policy was formulated in 1992 while China established its first integrated operational drought monitoring system during 1996-2000 (Vordzorgbe 2003). In Africa, nearly all countries have prepared national drought mitigation action plans, while ECOWAS and IGAD have prepared subregional plans within the ambit of UNCCD.

Water Pollution Prevention and Control

It will be difficult to meet the varied demands on water systems without effective management involving the protection of water quality and the preservation of ecosystems and biodiversity. This is why the trend of declining water quality in Africa is a worrisome development that can affect water availability, use and access. The chemical, physical and microbial factors that generally affect water quality are listed by Vordzorgbe, S. D, (2003) as follows: pollutants, nutrients, heavy

metal, microbial contamination, toxic organic compounds, salinization, acidification, suspended particles and temperature.

The algae eutrophication that is polluting several water bodies in Africa is caused by increased nutrient levels from poor agricultural practices and discharge of untreated wastes. Groundwater resources are becoming polluted by three main causes: (a) leaching of pollutants from agriculture, industry and untreated sewage, (b) salinization through saltwater intrusion and irrigation water seepage, and (c) natural hydrogeochemical pollution. There are very few studies on groundwater quality in Africa and, currently, there is no comprehensive programme of groundwater quality monitoring on the continent. Industrial pollution, effluent discharge and other forms of pollution, are contaminating freshwater lakes, wetlands and dams leading to various forms of water body degradation, including quality reduction and biodiversity loss. These seriously impair the ability of freshwater systems to filter and purify water. Changes in lake water condition, as a measure of lake water quality, from the 1960s to the 1990s, show that conditions in 40 per cent of the lakes in Africa have worsened while 5 per cent improved (UNESCO and Bergham Books 2003).

African countries have undertaken a wide range of measures to prevent and control water quality, including:

(a) Integrated land and water management;
(b) Improvement of freshwater storage, treatment and distribution;
(c) Control of watershed degradation through measures such as site protection, environmental regulations and public awareness;
(d) Urban sanitation interventions, including waste treatment;
(e) Establishment of potable water quality standards and effluent controls;
(f) Abstraction management;
(g) Improving the institutional framework for water supply management, including deepening participation through community water and sanitation schemes and water users associations;
(h) Ratification of relevant regional and transboundary water management conventions; and
(i) Removal of aquatic weeds.

The importance of a particular water quality issue depends on the context: the definition of water quality is not objective but is socially determined, depending on the use of the water. Hence, the establishment, monitoring and enforcement of compliance with standards for water quality, water abstraction and watershed use are crucial in preventing and controlling water pollution. Enforcing compliance with planning and regulatory provisions often requires the twin approach of using incentives and deterrents. The former includes economic incentives, such as pollution charging, based on the polluter pays principle, and discharge permits, but their effect is not much felt in Africa, largely due to information deficiency. To improve results, the approach to achieving compliance should strike an appropriate balance between enforcing compliance with regulations and adopting participation-oriented approaches based on self-consent. Nonetheless, one important lesson is that key institutional factors may be in place for consultation and cooperative approaches to help ensure successful water quality management, but regulatory bodies must continue to enforce regulations (World Bank 2003).

Dam Failure Risks

There are at least 1,272 large dams in Africa, mainly for irrigation and water supply, followed by hydropower generation. South Africa has the highest number of dams (539) followed by Zimbabwe (213) and Algeria (107). Overall, Africa has 2.4 per cent of the world's large reservoirs, including dams. Most of the major river basins in Africa have been dammed, resulting in significant backflooding. However, reservoir develop-

ment has disrupted the benefits of downstream flows for traditional agriculture, caused water pollution and increased disease incidence.

Dams, and other reservoirs affect water resources at various aggregation levels. The primary effects relate to blocking of rivers and altering their flow dynamics, the secondary ones are due to changes in river, watershed and ecosystem characteristics and productivity and the tertiary effects concern impacts on the biological life of ecosystems. The modification of the hydrological features of many rivers through damming has negatively affected floodplain livelihoods through loss of vegetation, habitat, species populations, biodiversity, fisheries, wetlands and related riverine and marine ecosystems. Also, greenhouse gases are emitted as a result and cause some health problems. In addition, locating a number of large dams on the same river exerts cumulative impacts on flooding, water quality and other aspects of river system ecosystems (Vordzorgbe, S. D, 2003).

Specific examples of risks from dams abound in Africa. Fish production has significantly reduced in several river basins in Africa due to dams, such as on the Niger below the Kainji dam, on the Zambezi in Mozambique and in the Nile delta. Damming also affects marine fisheries as in shrimp fishing in the Zambezi delta, and in the Mediterranean due to the Aswan High dam. Stabilizing river flows by eliminating high discharges from dams has resulted in increased infestation by aquatic weeds, including water hyacinth, ferns and reeds, and increase of black fly infestation, as in the case of the Orange river in South Africa. The impoundment of River Nile, by constructing various dams on it, has led to the degradation of the downstream delta, through reduction of sediment movement, thereby leading to erosion of the delta coastline by up to 5-8 metres a year, and the Akosombo dam on the Volta river in Ghana is causing coastal erosion of Togo and Benin by up to 10-15 metres a year.

Options for addressing dam safety risks in Africa are limited. A first approach is to accept the risk and manage it, through measures such as improved telemetry, improved dam design, operational procedures and maintenance, warning systems, and, evacuation planning. Another option is to avoid the risk by removing problematic, old or unsuitable dams. This, however, is not a usual practice in Africa. Similarly, a third option of risk transfer through dam insurance is not common in Africa. Overall, mechanisms for reducing risk from dams are not well developed in Africa. Therefore, it is important to develop analytical models to simulate downstream effects of sudden failure of dams under different hydrological and hydraulic scenarios. The key is to realize that there will always be residual risks associated with dams, no matter how well they are designed and operated. Hence, the key to effective dam risk reduction is to constantly assess those risks and plan to mitigate them. Above all, it is prudent to observe the precautionary principle in dam development since information is uncertain, unreliable or inadequate to effectively address all issues of risk from dams.

Monitoring of Hydroclimatic and Socio-economic Processes

Currently, both scientific and observational information point to an imminent global climate change with possible differential periods of inception at regional and global scales. Even though scientific evidence is not yet conclusive as to when such a change would occur, it is advisable to institute demanding measures against the possible negative effects on the hydrological cycle and consequently on the global or regional water resources in time and space. While climatic variability may modify the frequency-magnitude relations of the hydrological elements within a relatively short period, a climate change would bring new and different qualitative relationships expressed in anomalous climatic events at larger temporal and spatial scales - that is to say, when old trends fail and new ones emerge (Andah, 2002a).

In water resources terms, a climate change signifies a drastic modification in the planning, design, operation and management of water resources systems to match the changes in the climatic and hydrological variables. Expected diminution of global moisture would reduce the production capacities of hydropower installations, water supply and irrigation systems. Higher flood peaks would change the operational regime of hydraulic structures designed with assigned T-flood, render flood protection structures ineffective and consequently make vast areas vulnerable to flood hazards. On the other hand, persistent droughts would reduce reservoir yields, increase the drying effects of crops and vegetation and speed up soil crusting and desertification processes. A climate change towards increased atmospheric temperatures and evaporation would inevitably increase the general water demand in a situation of diminishing water supply. In case of an increase in the frequency of alternation of positive and negative climatic anomalies as a result of a climate change, an increase in operational stress of water resources systems should be expected. Timely prediction and forecasting of hydrological extremes are therefore essential to effective management of water resources systems and rational development of water resources in order to ensure sustainable development and protection of life and property. Institutional and human capacities are needed for understanding the dynamics of climate fluxes, their regional and continental teleconnections and general circulation models. Knowledge about the impact of socio-economic activities on land use patterns and soil infiltration capacities is necessary for understanding and mitigating desertification processes as well as for modifying water management practices due to changes in surface water and groundwater relationships (Andah, 2002a).

Looking Forward

Water risks, including disasters, will increase unless and until firm and urgent actions are taken to roll back effects. Even if the effects of climate change are not drastic, the momentum of human development activities will generate increasingly unsustainable demands on water resources. Hence, if no corrective urgent action is taken to address water sector risks, business as usual regarding management of water resources will land Africa into doom, as the situation is indeed dire. Meeting the main water policy and management challenge in Africa means addressing issues relating to: water management (availability, demand, distribution, access, quality, pollution), risk management (including climate change and variability effects) and developmental resources including such aspects as level and mode of development, resources, technology, institutions, policy and planning, information, and capacity.

Overcoming the challenge of achieving the Africa Water Vision requires as Vordzorgbe, S. D (2003) states: (a) improved water resources management, including investment in water storage and watershed management, (b) enhanced community participation and grassroots support, (c) improved governance in water sector, (d) improved knowledge and understanding of water-related issues through increased information generation, access, use and exchange as well as increased participation, (e) committed financial and political resources for sustainable long-term water development, and (f) increased partnership, cooperation and coordination within and between countries.

Prospects for success are mixed and uncertain due to the following:

(a) Challenges in financing water development are high and investment funds are lacking;
(b) Development of the human resource base for water management is stagnating;
(c) An increasing global, regional and national trend towards establishing disaster management capabilities at all levels; in particular, the design of the NEPAD disaster risk management strategy will provide further

momentum towards addressing issues of water risk in Africa;

(d) Governance in the water sector is improving, but there remains major constraints of capacity weaknesses, exacerbated by the human resource tragedy of HIV/AIDS;

(e) A growing trend towards regionalization which bodes well for enhanced transnational cooperation in addressing water issues.

To enhance the chances of success, any successful approach to meeting Africa's water challenges will have to be based on principles which Vordzorgbe, S. D, (2003) also lists as follows:

(a) Meeting human and ecosystem needs;

(b) Comprehensive water resource development and management, including giving higher priority to non-structural means of meeting demand;

(c) Giving a key role to science and technology in water resource development and use, particularly smaller scale local technical innovations;

(d) Putting emphasis on disaster risk reduction, outlook, framework and institutional mechanisms, including increasing the importance assigned to comprehensive and cumulative risk assessment, and, risk transfer and pooling mechanisms;

(e) Meeting stakeholder interests through participation, cooperation, coordination, decentralization;

(f) Ensuring a knowledge-based development and management of the institutional framework for the water sector, including more frequent application of economic principles;

(g) Implementing sound overall economic and social development policies in recognition of the strong role of other sectors in promoting water policies;

(h) A conducive foreign policy; and

(i) National political will.

Lest we forgot - East Africa also felt effects of the Asian tsunami

The most powerful earthquake in decades generated the Indian Ocean tsunami of 26 December which killed more than 150,000 people and made millions homeless in Sri Lanka, Indonesia, Thailand and India and believed to be the most destructive tsunami in history. These killer waves of the tsunami travelled as far as 5,000 kilometers to strike Africa's eastern coastline with sufficient force to kill people and destroy property. More than 300 people were reportedly killed on the continent - 298 in Somalia, 10 in Tanzania and one in Kenya. Three people were reported dead in the Seychelles where damage was also done to roads, bridges and ports estimated at $30m. In Somalia, the worst affected country along the east coast of Africa, especially the village of Harfun near the northern tip of the country, some 80 per cent of the homes and all of the water sources and sanitation facilities were destroyed (UNICEF; 2005). Also, according to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA-Somalia), a season of drought, affecting the Sool Plateau and parts of South Central Somalia, was the key humanitarian emergency in 2004.
The cumulative effects of four years of poor rainfall in the Sool plateau and surrounding areas in Somaliland and Puntland caused massive livestock losses, rendered many pastoralists destitute and resulted in increased vulnerability and further displacement (UNICEF; 2005).

In countries stretching from the Horn of Africa, down to Tanzania and out into the Indian Ocean, lowland flooding and irregularly fast tidal changes were reported. In the Seychelles, low-lying coastal roads were flooded by a 2-metre (six-foot) surge and power was knocked out from hundreds of homes. At the airport, fire brigades were forced to wash dozens of fish off of the runway each time high tides sent water crashing onto the airfield. Residents and tourists were warned to be ready to move to higher ground if need be. Beaches at tourist resorts around Kenya's coastal

town of Mombasa were closed because of the extreme tidal movements set off by the earthquake. Ten people drowned in Tanzania and more than 1,000 people were made homeless in Madagascar. Three people died in the Seychelles, where a bridge linking the main airport and capital, Victoria, was destroyed while a village in northern Mauritius was submerged for almost three hours following the surges; about 15 fishing boats were damaged in the French territory of Reunion (BBC News, 2005).

So, What is a Tsunami?

A tsunami is a series of great sea waves caused by an underwater earthquake, landslide, or volcanic eruption. More rarely, a tsunami can be generated by a giant meteor impact with the ocean. Tsunami (pronounced soo-NAH-mee) is a Japanese word. Tsunamis are fairly common in Japan and many thousands of Japanese have been killed by them in recent centuries. An earthquake generates a tsunami if it is of sufficient force and there is violent movement of the earth causing substantial and sudden displacement of a massive amount of water. A tsunami is not a single wave but a series of waves, also known as a wave train. The first wave in a tsunami is not necessarily the most destructive. Tsunamis are not tidal waves. Tsunami waves can be very long (as much as 60 miles, or 100 kilometers) and be as far as one hour apart. They are able to cross entire oceans without great loss of energy.

Historically, the most damaging tsunami on record before 2004 was the one that killed an estimated 40,000 people in 1782 following an earthquake in the South China Sea. In 1883 some 36,500 people were killed by tsunamis in the South Java Sea, following the eruption of Indonesia's Krakatoa volcano. In northern Chile more than 25,000 people were killed by a tsunami in 1868. The Caribbean has been hit by 37 verified tsunamis since 1498. Some were generated locally and others were the result of events far away, such as the earthquake near Portugal. The combined death toll from these Caribbean tsunamis is about 9,500.

Somalia: 298, Tanzania: 10, Kenya: 1, Seychelles: 1

Beaches along East Africa were buffeted by huge waves

Source: BBC News, 2005

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SHARING WATER FOR REGIONAL INTEGRATION

IWRM'S overriding principle is the adoption of a holistic approach to combine water resources management with ecosystem conservation needs, using the river basin as the base unit (Andah, 1987, 2003). The question is what type of river basin? Is it the physically observable one whose boundaries are geographically delineated or the inseparable form-process interactive unit? The river drainage network is therefore a complex system with inseparable attributes of form and process necessary for the management of water resources in harmony with the environment. In all scientific works in which the systems analysis is applied to morphology, physical geography and hydrology, the river network system is the closest to the principle of structural development in which an elementary water system continuously develops into a complex large river system of networks of branches, tributaries and streams. This explains why water basins are said to know no ethnic, regional, national or international boundaries as well as the concept that transboundary river basins must be considered and analyzed using an integrated framework (Andah, 2002).

Transboundary Water Basins in Africa

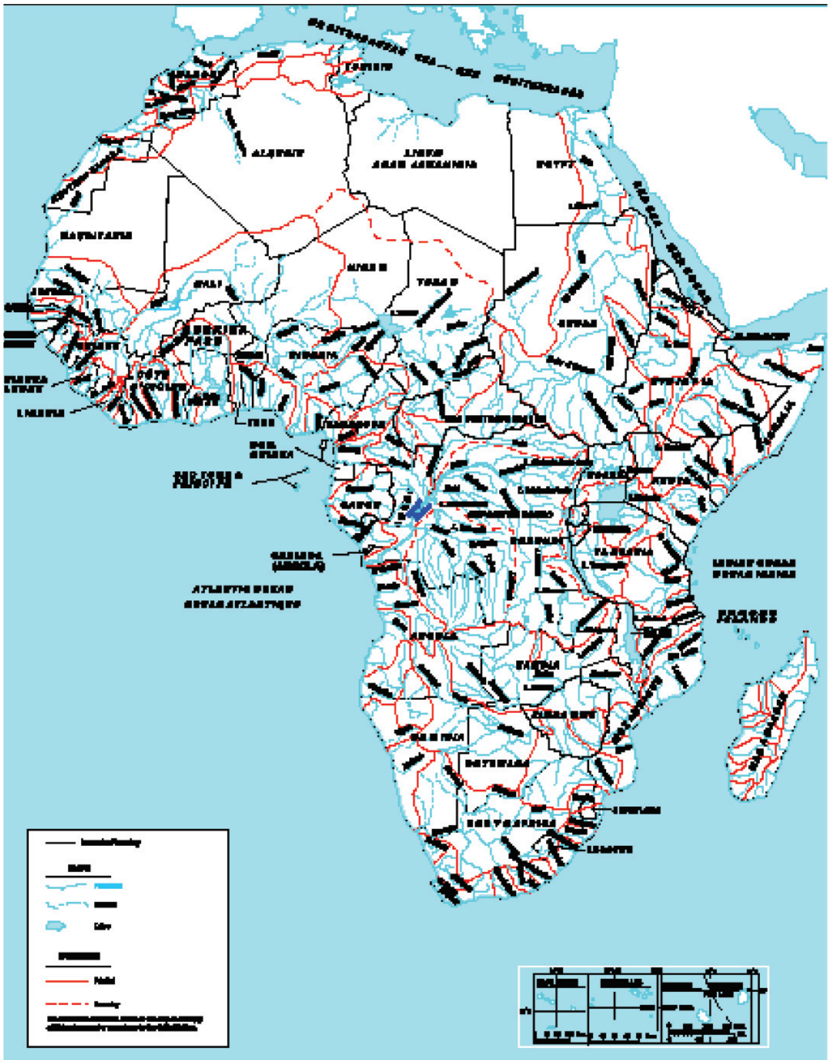
Most of the fresh surface water resources of Africa are found in a number of major transboundary river/lake basins – some shared by as many as ten African countries. The continent has over 80 major transboundary river/lake basins, some of which are among the largest in the world. About 55 of the world's 200 major international rivers are in Africa - a number greater than in any other continent. Some of these basins are shared by as many as ten or more African countries, and ten major river basins are shared by more than four African countries. The political boundaries of fourteen African countries almost entirely fall within the catchment areas of one or more transboundary river systems.

Table 11.1 lists some major transboundary river/lake basins in Africa and the Map below shows approximate boundaries of some of these transboundary river/lake basins. Twelve African countries are linked to four or more river basins – a good example is Cameroon as shown in table 11.2. Some of the shared water basins contain a tremendous amount and variety of natural resources potentials, including cross-boundary hydropower generation, large-scale multi-country irrigation schemes, inter- and intra-country navigation, joint inland fisheries development, joint use of water supply sources, environmental protection, wildlife conservation, recreation and eco-tourism development. The Congo River Basin alone holds almost 30 per cent of Africa's total fresh surface water reserves and the world's largest hydropower potential in any one single river basin (see Box 11.1). Not only will integrated development of these transboundary natural resources contribute substantially to the socio-economic development of the riparian countries sharing them, it will also promote and enhance subregional and regional cooperation for economic integration in Africa. Such an integrated development of resources for the benefit of all requires enhanced cooperation among the riparian countries sharing them.

The Second Principle of the Rio Declaration:

"States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and development policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

Figure 11.1: Transboundary River Basins in Africa (ECA, 2000)



A common vision of riverine countries is needed for the effective, efficient and environmentally sustainable management of transboundary water resources. Growing tension mandates a promotion of cooperation in order to ensure the equitable sharing of the world's water resources. It has been demonstrated that cooperation, rather than conflict, is the norm for transboundary waters, a trend that should continue. *(Third Global Environmental Outlook Report-GEO 3).*

Table 11.1: Some Major Transboundary River/Lake Basins of sub-Saharan Africa with Catchment Area in Excess of 100,000 km2" (ECA, 2000)

Name of Basin	Catchment Area (000 sq.km)	Average Annual Discharge (billion m^3)	Numberof States Sharing the basin	Countri es Sharing Catchment Area
Congo	3690	1250	9	Congo (Brazzaville), Central African Republic, DRC, Angola, Cameroon, Burundi, Rwanda, Tanzania, Zambia
Nile	2850	84	10	Egypt, Sudan, Ethiopia, Rwanda, Uganda, Kenya, Tanzania, Burundi, DRC, Eritrea
Niger/ Benue	1990	180	9	Niger, Nigeria, Mali, Guinea, Burkina Faso, Cote d'Ivoire, Benin, Cameroon, Chad
Zambezi	1290	230	8	Zimbabwe, Zambia, Angola, Namibia, Botswana, Mozambique, Malawi, Tanzania*
Volta	390	37	6	Ghana, Burkina Faso, Togo, Cote d'Ivoi re, Benin, Mali
Lake Chad	2370	IDB	6	Chad, Cameroon, Niger, Central African Republic, Niger, Sudan*
Lake Rudolph	500	IDB	4	Ethiopia, Kenya, Sudan, Uganda*
Senegal	490	25	4	Senegal, Mauritania, Mali, Guinea
Limpopo	400	NA	4	Botswana, Zimbabwe, Republic of South Africa, Mozambique
Ogadugue	220	NA	4	Gabon, Congo, Equatorial Guinea, Cameroon
Okavango	320	8	4	Botswana, Angola, Zimbabwe, Namibia
Orange	800	9	2	Namibia, Angola
Juba-Shebelli	827	9	3	Somalia, Ethiopia, Kenya
Ruvuma	140	NA	3	Tanzania, Mozambique, Malawi
Cunen	100	NA	2	Namibia, Angola
Awash	120	3	2	Ethiopia, Dijbouti
Sabie	103	NA	2	Mozambique, Zimbabwe

Water Resources Management and Water Conflict Resolution

Water resources management involves a range of activities: monitoring, modelling, exploration, assessment, design of measures and strategies, implementation of policy, operation and maintenance, and evaluation. It also involves support activities such as institutional reform (Box 11.2) as well as local, national, and international activities with short- or long-term goals (Savenije H. and Hoekstra A. 2002). This makes water resources management multidimentional, involving a whole range of scientific, technical, institutional, managerial, legal, and operational activities required to plan, develop, operate, and manage water resources (Table 11.3).

Table 11.2: Transboundary river basins in Cameroon

Name of Basin	Total area of basin, km^2	Countries in Basin	Area of Cameroon in basin, km^2	% of basin in Cameroon
Akpa	4,900	Cameroon Nigeria	3,000	61.65
Benito/Ntem	45,100	Cameroon Gabon Equatorial Guinea	18,900	41.87
Congo Basin	3,691,000	13 countries	85,200	2.31
Cross	52,800	Cameroon Nigeria	12,500	23.66
Lake Chad	2,388,700	9 countries	46,800	1,96
Niger (Benoue in Cameroon)	2,113,200	11 countries	88,100	4.17
Ogooue	223,000	Gabon Congo Brazzaville Cameroon Equatorial Guinea	5,200	2.34
Total			**259,700**	

AWDR National Report, 2003

Box 11.1
The Congo Basin

This is the largest basin in Africa with an area of about 3.7 million km^2 and shared by 13 countries. These countries are: Democratic Republic of the Congo (Kinshasa), the Central African Republic, Angola, the Congo (Brazzaville), Zambia, Tanzania, Cameroon, Burundi, Rwanda, the Sudan, Gabon, Malawi, and Uganda. About 2.3 % of the basin area falls within Cameroon where it covers about 20% of the surface area. There is no agreement between the thirteen riparian States on the use of the resources of the basin. This is probably because the per capita available water in the basin is quite high and as such most of the water flows into the sea. For example, in Cameroon, the per capita available water of the inhabitants in the Congo basin was estimated at 41,300 m^3 in 2000 and projected to be 20,700 m^3 in the year 2025. With sparsely populated areas, high rainfall and low economic activities, the amount of water abstracted from the basin is very low and hence there have so far been no problems of equitable distribution requiring treaties or agreements.

Some sub-basins of the Congo have agreements ,e.g. the Great Lakes Region, between 3 states mainly for power generation.

Source: AWDR National Report of Cameroon

Table 11.3: Types of Management Instruments

Types of management instrument	Examples
Structural measures	
• Production of goods	Construction of dams, water supply systems, sewer systems, sanitation facilities
• Production of services	Operation of structures Maintenance of structures
Non-structural measures (incentives)	
• Regulation instruments	Legal and administrative regulations on water use or discharge Permit structures Fish quota Allocation of water rights Water quality standards Land use zoning; earmarking of regions for certain purposes
• Economic instruments	Water taxes or subsidies Water tariff structures Charging for wastewater disposal and treatment Creation of water market
• Communicative instruments	Provision of information, awareness raising Education
• Covenants	Agreements with major industries on water-use efficiency

Box 11.2:
Guiding Principles in Water Resources Management

Principles related to sovereignty:

Absolute territorial sovereignty. According to the so-called Harmon Doctrine, States can do what they want with the natural resources within their territory.

Absolute territorial integrity. No State is allowed to alter the natural conditions of its own territory to the disadvantage of the natural conditions in a neighboring State.

Restricted territorial sovereignty. States can use their own territory in whatever manner they chose, but they are not allowed to cause harm to other States (for example, downstream States).

Principles related to resource use:

Rule of minimum flow. There should be sufficient water left for downstream users.

Prior appropriation doctrine. First in time, first in right.

Priority of use doctrine. Some types of water use deserve priority.

Basic need principle. Each individual has the right of access to resources for his or her basic needs.

Water-as-an-economic-good principle. Users should pay the full economic value of the water used, provided that the price of water is affordable.

Intergenerational equity principle. Future generations should not be deprived of access to an adequate resource base, although the resource base itself may change in composition (for example, knowledge, technology, infrastructure).

Principles related to the environment:

Prevention principle. If there is scientific proof that a certain activity causes a problem, measures must be taken to prevent it.

Precautionary principle. Preventive action should not be delayed, particularly if the problem is likely to be irreversible, even if there is not yet incontrovertible evidence that the suspected cause activity is to blame.

Stand-still principle. The quality of the environment should at least remain at its present level.

Best-available-technology principle. People should use the best available technology, in order to minimize the

pressure on the environment.
Polluter-pays principle. The individual or organization that inflicts damage on the natural resources system should pay for rectifying the damage.

Principles related to organization and procedure:

Prior notification. If people plan to carry out activities that may harm others, notification should be given.
Prior consultation. If people plan to carry out activities that may harm others, consultation should be organized at an early stage.
Prior impact assessment. Activities that may seriously affect the functioning of society or the environment should be preceded by a thorough social and environmental impact assessment.
Interest-taxation-representation principle. A principle that establishes a link between the right of stakeholders to have a say in planning and management, and their duty to pay for the services provided.
Subsidiarity principle. For a government to be efficient, decisions should be taken at the lowest appropriate level; if a task can be decentralized to a lower level of government, one should do so. Central government should retain those tasks that properly belong to that level, however.

(Source: Savenije H. and Hoekstra A. 2002)

Management of Transnational Basins

The main thrust of the management of shared river basins is to find ways of turning potential conflicts into constructive cooperation, and to turn what is often perceived as a zero-sum predicament - in which one party's gain is another's loss - into a win-win proposition. The foundation for the sharing of international rivers is the recognition that the management of water resources should be done in a fully integrated fashion. The foundation has three pillars that support the sharing of international waters, taken to be the roof:

- The central pillar is technical cooperation, which may also be called the operational pillar.
- The two side pillars are:
  - The political pillar, responsible for an enabling environment; and
  - The institutional pillar, responsible for laws and institutions.

All three pillars are necessary for a balanced and equitable sharing of international waters based on a common strategy for integrated management of shared river basins, incorporating demand-and-supply management, public participation and regional integration. The basis of such a strategy is the principle of "unity in diversity". The differences among riparian countries calls for complementarity between them and foster cooperation to their mutual benefit. The sharing of international waters may be a consequence of this cooperation, and also a crucial factor in further strengthening it.

General Principles and Critical Issues

At the national level, governments appear to base their policy for resource management on "emerging principles" that are often compatible with international policies. Box 11.3 below briefly describes some important management principles. In international law, more specific principles are used with regard to international river basins (Savenije H. and van der Zaag P. 2002).

As further pointed out by Savenije H. and van der Zaag P. (2002), a number of critical facts emerge with respect to the sharing of international watercourse systems. These include the fact that:

(a) River basins do not respect village, district, provincial, and national boundaries. Too often, we have attempted to fit the water into these administrative and institutional boundaries, rather than to design institutions that fit the physical and spatial characteristics of the resource. As a consequence;

Box 11.3
Emerging Principles Underlying Management of International Water Resources

- *Sovereignty principle:* Each nation has the right to develop its own policies, laws and institutions and their own strategies for natural resources development and utilization
- *Trans-boundary principle:* Upstream water users have a responsibility towards downstream water users, and vice-versa; this principle is in a sense the extension of the equity and precautionary principles across national borders
- *Equity principle:* All people have basic rights of access to resources for their survival and development; no groups in society should be put at a serious disadvantage in this respect
- *Intergenerational principle:* Future generations should not be deprived from access to an adequate resource base, although the resource base itself may change in composition (e.g., knowledge, technology, infrastructure)
- *User-pays principle:* Users should pay the real cost of water services, taking into account the ability to pay. A different, and more contentious, principle is that water is an economic good, and that users should pay the economic value of water, provided that this principle does not conflict with the equity principle.
- *Polluter-pays principle:* Whoever inflicts damage on the natural resources system should pay for the damage
- *Precautionary principle:* Governments should provide security to the people, including safety, food security, health care, protection against disasters, risk avoidance, conservation of natural resources, a healthy environment and merit goods.

(Source: Savenije H. and van der Zaag P. 2002).

there is often an administrative/institutional void when dealing with the management of water resources. This is especially true at the transnational level;

(b) Management of water resources has generally concentrated on surface water, while insufficient attention has been given to groundwater, soil moisture ("green water") and related aspects;

(c) Perhaps the biggest problem in sharing an international water resources system is its sheer scale and the opaqueness of system interactions over large distances (upstream and downstream). For example, it is difficult to see, let alone quantify, the consequences of upstream land use changes on downstream flood levels. This opaqueness may result in unforeseen negative consequences of human interventions, which are difficult to correct and may give rise to tensions between riparian countries sharing the basin.

The sovereignty dilemma:

To what extent may individual countries develop and use resources found within their territories, and to what extent do they have to consider interests of riparian countries, and the "common interest" of the river basin as a whole?

The legal institutional aspects

The institutional framework for water resources management is discussed under the chapter **GOVERNING WATER WISELY** which recommends reconciling the interests of water users at all times and facilitating proper water policy and programme implementation by striving to increase available supplies through proper planning using the physical water basin as the basis for water management; and regulation of international costs and boundaries, that is, all activities for adequate quantity and quality of water supply for various transboundary uses through international agreements on water allocation and pollution control.

Savenije H. and van der Zaag P. (2002) give the three important systems of water rights as:

(a) Riparian rights, which link ownership, or reasonable use of water, to ownership of the adjacent or overlying lands. These rights are

derived from Common Law as developed in England. As a consequence, the principle is mainly found in countries that were under the influence of the British Empire;

(b) **Public allocation,** which involves administered distribution of water, and seems to occur mainly in so-called "civil law" countries, i.e., countries that derive their legal system from the Napoleonic Code, such as France, Italy, Spain, Portugal, the Netherlands and their former spheres of influence; and

(c) **Prior rights,** which are based on the appropriation doctrine, under which water right is acquired by actual use over time. This system is developed in the western part of the USA, a typical (semi-arid) "frontier zone."

The essential functions of international institutions and basin organizations, include:

(a) Reconciling and harmonizing the interests of riparian countries;
(b) Technical cooperation;
(c) Standardization of data collection;
(d) Exchange of hydrologic and other information;
(e) Monitoring water quantity and quality;
(f) Submission for examination and approval proposed activities, schemes or plans which could modify the quantity and quality of the waters;
(g) Development of concerted action programmes;
(h) Enforcing agreements; and
(i) Dispute resolution (ibid).

Technical and operational issues: The case of flood management

Since much of the second half of the twentieth century, one major feature of water management in Africa has been the construction of large dams. The resulting reduction in flooding downstream was seen as a benefit and thus constructing a dam capable of making flood releases was never contemplated. More recently, the great value of natural floods to fisheries, recession agriculture and groundwater recharge has been realized; so much so that many authorities are now examining the possibility of creating artificial floods (ibid).

The example of the Cahora Bassa Dam is a case in point. Whereas the shrimp fisheries in the mouth of the Zambezi river were never contemplated when the dam was designed, the income in foreign currency from shrimp fisheries has been far more important for Mozambique than the export of power. However, the way the Cahora Bassa Dam is operated affects the shrimp stock negatively. The shrimp stock "depends on a natural seasonal variation in the runoff, both a marked dry and wet season. This seasonal runoff regime has been completely destroyed by river regulation." By changing operation procedures of the Cahora Bassa Dam, substantial increases in shrimp catches may be achieved without additional investments or labour (ibid).

Dam operations may affect a large number and wide variety of users and stakeholders who should, therefore, participate in formulating alternative scenarios. Taking as an example the case of River Senegal on which the Government adopted an artificial flood scenario after 10 years of lobbying by flood-recession farmers, it was the expression concerns by the farmers that led the Government to finally recognize the legitimacy of the concerns which it took seriously in weighing the advantage of alternative flood scenarios. This should not be interpreted as "benevolence" on the part of the Senegalese Government because sheer economic common sense indicates that if an appropriate flood scenario were not developed, grain production from flood recession agriculture would have been severely affected.

Allowing local stakeholders to have a voice in decision making concerning river management may make them to change their position from opposition to active cooperation. As in Senegal, a similar situation occurred in the South African side of the Phongolo-Maputo River Basin. The construction of the Phongola Port Dam in

the 1950s severely disrupted traditional agriculture further downstream. The authorities did not properly inform the people in the plain in advance about water releases from the Dam. However, in the mid-1980s the department responsible for the river's management changed its approach, after research shown the adverse effects of the way the dam was operated. Committees were instituted in each of the wards, with elected representatives of five different user groups: farmers, fishermen, livestock owners, women and health workers. These "Combined Water Committees" sent representatives to the Liaison Committee in which the water authorities was also represented. The Liaison Committee finally decided on flood size, duration, flooding date and related issues. An elaborate procedure was accepted allowing all the Committees have input into how much and when an artificial flood was required. This has facilitated information flow between the water authorities and communities on the extent and timing of the flood. Much emphasis is given to hydrologic monitoring, and post-flood feedback meetings are held in order for all involved to better understand how the river reacts to human manipulation. The major issue remaining to be solved in the Phongolo-Maputo River Basin is bringing Mozambique to participate actively in the flood operation (ibid).

Operational conditions for artificial floods

The experiences of the Senegal Basin (shared by Mali, Senegal, and Mauritania), the Yobe River (shared by Niger, Nigeria, and Chad), the Kafue River in the Zambezi Basin, (shared by Angola, Zambia, Namibia, Botswana, Zimbabwe, Tanzania, Malawi, and Mozambique), and the Phongolo River in the Phongolo-Maputo Basin, (shared by South Africa and Mozambique), show that it is environmentally beneficial, and economically feasible, to simulate artificial floods by manipulating releases from existing dams. There is, however, an important technical prerequisite. Apart from the obvious fact that the design of the dams should allow for sufficiently large releases, artificial floods require that all operational decisions across the entire basin should be coordinated (ibid). Moreover, artificial floods require sophisticated, real-time monitoring of hydrological and climatological phenomena. This is because artificial flooding is only feasible if properly timed, such that it "surfs" on top of the limited natural flood streams that still occur.

Water scarcity – risk of conflict

Africa suffers from the most unstable rainfall regime and freshwater distribution. For example, more than 30 per cent of the total surface water resources in Africa are in one single river basin, the Congo River Basin, although this Basin covers only 10 per cent of the total population of the continent. Furthermore, 75 per cent of the total continental water resources are concentrated in eight major river basins: the Congo, the Niger, the Ogadugne (Gabon), the Zambezi, the Nile, the Sanga, the Chari-Lagone and the Volta. Only 4 per cent of Africa's available surface water resources are currently exploited, although the continent suffers from chronic drought and desertification. Africa's water resources, especially the transboundary water resources, are less developed than those in other parts of the world. The continent also suffers from chronic seasonal water supply fluctuations. For example, most sub-Saharan rivers have high flows during the rainy season and much-reduced flows during the dry season. Therefore, dams and large storage reservoirs are required for regulating their annual flow variations as well as for irrigation and power generation. Most of these large projects have transboundary implications because most are shared by two or more countries.

The task of managing the process of adapting to water scarcity mainly requires learning how to deal with:

(a) The conflicts caused by the natural resource scarcity itself (both international and internal conflicts on the distribution of the resource); and

(b) The conflicts caused by the social measures applied to overcome the natural resource scarcity (internal conflicts, often directed at the State and, therefore, a dangerous impetus for external conflict).

Countering the widely held opinion that water scarcity entails prime risks of international conflicts over shared water resources, it is argued that the risk of conflicts within countries is in fact larger, and that the risk of international conflict is derived from the necessity to avoid conflicts within countries, caused not by water scarcity itself, but by the institutional change required to adapt to water scarcity. The potential risks of conflict are thus better analyzed as caused by a social resource scarcity, rather than by a natural resource scarcity of water (Ohlsson L., 2002). Scarcity by definition entails increased competition for a resource with increased economic value, and implies diminishing resources and/or pressure on the supply of available resources from an increasing demand. Attempts to overcome scarcities can be sought through two distinct mechanisms: supply-side regulation and demand-side regulation, in order to avoid competition, which is a potential source of conflict. Two levels of conflict are easily identified: national and international.

This simple analytic framework supports this chapter's argument, as Ohlsson L. (2002) states that:

(a) Attempts to increase supply are the driving force for water conflicts between countries;
(b) Attempts to manage demand will, by definition, alleviate this pressure;
(c) The driving force for conflicts within countries at present are attempts to increase supply, resulting in competition between different sectors of society and different population groups;
(d) But that attempts to increase supply will by necessity be superseded by demand regulation.

In order to develop appropriate policy responses, there is a need for an understanding of how water scarcity will develop in the medium term - up to around 2025.

Availability of water resources

There is general awareness that water is a scarce resource. At the same, time there is also a common perception that an abundance of water could be mobilized if socio-economic and technological constraints could be overcome. It will be beneficial to both science and policy to have a clearer perception of how much annual water flow over the continent is actually appropriated and how much is left for future demand increases. From a conflict-analysis point of view, however, evapotranspiration (through rain-fed agriculture) is not a cause of conflict. Conflicts are about getting more water for societal use, particularly for irrigated agriculture. Of more immediate policy interest therefore is the calculation of available runoff, that is, the renewable flow replenishing all rivers, lakes, and groundwater reservoirs, from which all water for irrigated agriculture, societal use and industrial needs are taken.

Three categories of water use can be identified. According to Ohlsson L. (2002), these are:

(a) Withdrawals or abstractions, that is, water taken from rivers, lakes, and aquifers, for human activities (also known as water demand or water use);
(b) Consumption; water that is withdrawn in such a way that it cannot later be reused (mainly by agriculture but also as a result of, for example, pollution);
(c) Human needs; for what is known as "instream purposes" (mainly to maintain wetlands and aquatic eco-systems, water-courses as transportation routes, or for aesthetic and recreational purposes).

Water scarcity

As a rule of thumb, hydrologists use the level of

1000 to 2000 cubic meters (m3) per person per year to designate danger of water-stress. When the figures drop below 1000 m3 per person per year, nations are considered water scarce, which means that lack of water becomes a severe constraint on food production, economic development, and protection of natural systems. Today, 26 countries with 232 million people belong to this group. The key word here is the sharing of a common water resource. The problem lies at the nexus between what essentially is a zero-sum game, and the peculiarities of the upstream-downstream dilemma: when the sum of the riparian States' water withdrawals from a shared river approaches the finite flow of the river, any further withdrawals from an upstream State will mean less water for the downstream ones. Conflicts between countries over such shared water resources occur in all parts of the world. Most often, they are about dividing the quantity of water in a river between riparian States, but they may also be about water quality (pollution means a scarcity of usable water for downstream recipients), and about groundwater withdrawals (aquifers know no borders). It is important to understand the limitations of attempts to overcome the zero-sum game by attempts to increase supply (ibid).

Confidence-building

There are in fact ways to increase the supply (flow) of a river. The clue lies in minimizing the large evaporation losses that follow whenever water is spread out over a large area in a hot and arid climate. Such spreading-out may occur naturally (a prime example is the Sudd Marshes on the Nile in southern Sudan), or more commonly, through the building of dams in flat areas (such as the Aswan Dam). The Aswan Dam is actually situated in a singularly bad position from the point of view of evaporation losses. Residing on Egyptian territory close to the border with the Sudan, it covers an enormous area in order to capture an amount of water sufficient to maintain the flow of the Nile through Egypt even during several dry years in a row. The same amount of stored water, and the same regulatory function, could, in principle, be obtained from building a dam on the Blue Nile, in the Ethiopian mountain gorges, but with a much lower cost of evaporation losses, since a dam of similar volume there would have much less surface area (ibid).

A joint Egyptian-Sudanese-Ethiopian project in Ethiopia thus would result in more water to be shared among the riparian States. The problem, of course, is that to the Egyptians, such a solution is unacceptable on two grounds: as things stand at present, they could never leave the fate of their agricultural production capability to the goodwill of Ethiopia. Secondly, they could never trust Ethiopia not to use the Dam for irrigation projects of their own, thus diverting potentially larger amounts of water from the upper Nile than now (ibid). The same, unfortunately, applies to the now-aborted project to dry up the Sudd Marshes by building the Jonglei Canal. Any attempt by the Sudanese to use the canal to divert water for irrigation would be a threat to downstream Egypt, since it could potentially mean larger water withdrawals than present evaporation losses. Two lessons could perhaps be derived from these examples. The extra amount of water to be obtained from attempts to increase the supply in rivers may not be that large (particularly compared to the magnitude of steadily rising demands), and realizing what potential there is crucially depends on creating enough confidence between the riparian States (ibid). The present institutional framework of the Nile Basin Initiative (see Box 11.4) is expected to move in this direction. In fact, the pressures on riparian States to cooperate in managing shared water-resources are so strong that in many cases, pragmatism tends to overcome a less-than-perfect international legal framework. Towards this objective the Nile Basin Initiative has designed sub-basin cooperative projects among the relevant riparian countries as Subsidiary Action Programmes (SAP). An example is the Eastern Nile project involving Ethiopia, Sudan, and Egypt to be implemented within Ethiopia (Table 11.4).

Table 11.4: ENSAP Projects to be implemented in Ethiopia

Area of Cooperation	Sub-Projects
Integrated Water Resources Management	Baro-Akobo Multi-purpose Water Resources Development
Irrigation & Drainage	Angar-Didessa, Lake Tana Shores and Humera Projects
Hydropower Development and Regional Power Trade	• Ethiopia-Sudan Transmission Interconnection Sub-Project • Eastern Nile Power Trade Investment Program – Karadobi Project – Baro Project – Mendaia Project – Mabil Project – Border Project
Watershed Management	Baro, Abbay and Tekeze catchments watershed management projects

Box 11.4
Nile Basin Initiative – A Process of Confidence Building

In 1998, all riparian countries of the Nile River (except Eritrea) joined in a dialogue to design a transitional institutional mechanism until a permanent cooperative framework is in place. The transitional mechanism, launched in 1999, comprised the Nile Commission (Nile-COM), a Technical Advisory Committee (Nile-TAC), and a secretariat (Nile-SEC). The overall process is known as Nile Basin Initiative (NBI).

The NBI provides an agreed basin-wide framework to fight poverty and promote economic development in the region. The NBI also provides a process to facilitate investment in the Nile Basin to achieve regional socio-economic development. The Initiative is guided by a shared vision "to achieve the sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin Water Resources". The primary objectives of the NBI being:-

- To develop the Water Resources of the Nile Basin in a sustainable and equitable way to ensure prosperity, security and peace for all its peoples;
- To ensure efficient water management and the optimal use of the resources;
- To ensure cooperation and joint action between the riparian countries, seeking win-win gains;
- To target poverty reduction and promote economic integration;
- To ensure that the program results in a move from planning to action.

To translate its shared vision into action, the NBI has launched a Strategic Action Program, which includes two complementary components: (1) a basin-wide Shared Vision Program (SVP), and (2) Subsidiary Action Program (SAP).

An NBI Secretariat has been established with its headquarters originally located in Entebbe, Uganda, and now moved to Kigali, Rwanda). The Nile Basin Initiative Secretariat is the umbrella organization mainly engaged in the implementation of the "Shared Vision Program" which consists of overall projects of basin-wide nature in order to create an enabling environment within the Nile riparian countries for cooperative programs in water resources development and management. Within the basin-wide framework, Subsidiary Action Programs will comprise actual development projects at sub-basin level, involving two or more countries.

This will allow the move from planning to action. The Nile riparians have formed two SAPs. The Eastern Nile (EN-SAP) includes Egypt, Sudan and Ethiopia; while the Nile Equatorial Lakes Region (NEL-SAP) includes the six

countries in the southern portion of the Basin, i.e. Burundi, D.R. Congo, Kenya, Rwanda, Tanzania and Uganda, as well as the downstream riparians, Sudan and Egypt. The EN-SAP and NEL-SAP have established Coordination offices in Addis Ababa and in Entebbe, Uganda, respectively. The coordination offices are to prepare actual projects proposed by the individual countries benefiting two or more basin countries.

At this time the Eastern Nile Group is working on advancing projects towards implementation mostly in the Ethiopian highlands for the benefit of the sub-basin riparian countries. Projects are also proposed by Sudan and Egypt. The projects proposed by Ethiopia are for the implementation of some of the major planned dams on the Blue Nile, Baro and Tekeze rivers as well as other dams on tributaries of the Blue Nile for irrigation, hydropower and flood management. The creation of reservoirs on these rivers in Ethiopia will have a significant effect on controlling floods and providing controlled flow for Sudan and Egypt. Retention of floods in Ethiopian highland reservoirs has the additional advantage of reducing evaporation and increasing available water for use by downstream riparian countries.

Source AWDR National Report of Ethiopia

Environmental Scarcity and Social Conflicts

A growing mass of empirical evidence and theoretical work points to a link between environmental degradation or scarcity of natural resources and social conflicts. The concept of "environmental scarcity," introduced by the work of Homer-Dixon et al, has proved to be an extremely powerful tool with which to analyze the challenges ahead, and is used here to get a conceptual grip on the risk of conflicts within countries as a result of water scarcity.

Environmental scarcity is defined as the sum (or product) of a particular environmental impact, population increase, and societal inequality. Simply put, the environmental impact (over pumping of aquifers) will make the resource pie smaller, population increase will make the slices (per capita allotments of finite water resources) smaller, and societal inequality will make an inordinate number of slices end up in the hands of the wealthy, while the less powerful will get fewer slices of the already shrinking pie than they are entitled to (Ohlsson L. 2002).

A typical example would be increasing water scarcity in a farming community from over-pumping groundwater boreholes or farming on steep mountainsides. The driving forces would be the environmental impact per se (lowering of water-tables or less infiltration of rain into the ground). At the same time, demand-induced scarcity will probably be in operation, stemming from population increase, and possibly also from increased affluence and economic activity (more people demand more and better food, placing still greater demands on water resources) (Ohlsson L. 2002).

In a situation of growing scarcity, the more powerful sectors within a local society would tend to monopolize access to diminishing water resources (resource capture), leading to marginalization of poorer segments. Structurally induced scarcity may be reproduced on a larger societal level, through competition over water from more powerful sectors (cities and industries), thus further marginalizing the agricultural sector in general, and poorer farmers in particular. Marginalized people in turn will tend to sustain themselves in ways that by necessity rather than choice are unsustainable, that is, result in increased environmental impacts. Conflict would not be a predetermined outcome of such a vicious circle (ibid). Contrary to common wisdom, there is no clear-cut connection between poverty and conflict. For conflict to occur, several conditions must be fulfilled, among them that impoverishment is pervasive to the degree that the legitimacy of the State is threatened. The existence of ethnic or religious cleavages within a society, acting as a channel for organizing resentment, is a common exacerbating factor. Finding the

appropriate policy tools for dealing with water scarcity and the risk for these complex causes of conflict within countries is a task that has only recently begun to take form.

Policy Tools for Adapting to Water Scarcity within Countries

The analysis has so far pointed to three great challenges for water policy makers: to manage conflicts, get more use out of the same amount of water, and get better use out of the available water. As Ohlsson L.(2002) observes, the policy goals for dealing with water scarcity within countries could be formulated as follows:

(a) Managing the competing water demands from different societal sectors and population groups in order to achieve a distribution of the scarce resource that is perceived as equitable;
(b) Facilitating technological changes to achieve greater end-use efficiency; and
(c) Facilitating socio-economic changes to achieve greater allocative efficiency.

There is an increasing awareness that scarcity of resources, especially renewable resources, constitutes a risk for conflicts within countries, rather than between them. The causal link, however, is indeterminate and the causal chains hard to track. At the stage at which a conflict breaks open, the causal links may be buried under several layers of intermediate links and links to other causes of conflict. It is nevertheless considered an urgent policy research task to understand the mechanisms behind the pervasive conflicts now threatening the stability and welfare of people in an increasing number of developing countries. These mechanisms are thought to be population increase, frustrated development expectations, and a lack of adaptive capacity to manage shrinking per-capita allotments both of income and of renewable resources, prominently water. Dealing with water scarcity under such conditions entails strengthening the capacity for institutional change in order to create the new societal tools needed to manage water scarcity (ibid). The debate on whether these tools should be founded on an economic incentive approach or a traditional administrative approach is gradually converging into the understanding that suitable market conditions cannot be created without substantial inputs of both administrative regulation and government intervention. The challenge to undertake these large-scale societal processes of change, without at the same time creating new sources of conflict that may threaten the very adaptive capacity needed, has only begun to be understood.

Technical Cooperation for Regional Integration

The following is a number of technical issues considered by Savenije H. and van der Zaag P. (2002 as necessary for cross-border cooperation,. They are presented in a sequence indicating levels of cooperation:

(a) *Information*. Exchange hydrological and other relevant data on water use between the Departments of Water, Hydropower, Agriculture. Update data series, calibrate data collection systems and agree on data formats. Establish joint databases and develop rules for swift information exchange in case of (impending) crises such as floods, droughts, and pollution. Finally, exchange of relevant national water policy plans and basin action plans, and information on revisions made to relevant laws and regulations;
(b) *Crises procedures*. Establish procedures to manage crises, including monitoring, warning and evacuation plans in case of natural or man-provoked disasters, such as floods, tropical cyclones, droughts, accidental pollution, etc;
(c) *Human resources development*. Let staff of one country follow relevant courses in a neighboring country, and let experts give guest-lectures at educational institutions. In so doing, strive for balancing the capacities

to manage water resources among riparians. If a university in one riparian country has a renowned expertise in, for example, hydrology, whereas another riparian is strong on water quality, exchange staff to take (short) post-graduate courses. Thus regional differences become an impetus for cooperation and exchange, not only between government departments but also between educational institutions.

(d) *Joint research*. Once educational linkages exist, a logical step would be to strengthen and stimulate regional research on a variety of topics related to river basin management. This and the previous activity could be suitably embedded in a network of institutions consisting of universities, non-governmental organizations and relevant government departments;

(e) *Joint plans*. Prepare joint river basin plans, including compatible strategies for water conservation. Jointly developed plans have more credibility, and hence are more effective, than plans developed by individual states. Jointly prepare operational rules for large dams that impact on more than one riparian country. Jointly revise the legal systems so as to harmonize them. Prepare action plans for demand management, water pricing, for joint water use, for inter-basin transfer;

(f) *Joint ventures*. When two or more countries develop joint ventures (such as the Lesotho Highlands project and the Kariba dam), a large step has been made towards the "community of interest" of individual countries in a shared resource. However, joint ventures by a few riparians should not jeopardize the other riparians of a basin. Such joint ventures should thus fall within the scope of a truly basin-wide organization.

South Africa, for example shares the Orange/Senqu, Limpopo, Incomati and Maputo river basins with its neighbours. These basins:

(a) Are where 72 per cent of the population resides;
(b) Contribute 77 per cent of the total gross geographic product;
(c) Cover 65 per cent of the country's land area; and
(d) Contain 40 per cent of the water resources

At the subregional level, South Africa has entered into various cooperation agreements with relevant riparian countries under the auspices of the Southern African Development Community (SADC) within the framework of the Revised Protocol on Shared Water Courses in SADC.

Some of the multilateral agreements at project level directed at the implementation of international projects for the river basins it shares with its neighbours include, according to the AWDR National Report, 2005:

(a) The Lesotho Highlands Water Project consisting of dams, tunnels and pipelines for transferring water from rivers in Lesotho, through the divide, into the Vaal river catchment in South Africa;
(b) The Komati River Development Project currently consisting of the Maguga and Driekoppies Dams for storing water mainly for irrigation development in Swaziland and South Africa;
(c) The Noord-Oewer Irrigation Project that uses South African infrastructure for a development project in Namibia;
(d) The Barberton Water Supply Project that draws water from the Lomati River in Swaziland for the South African town;
(e) The Phongolo Port Dam where Swaziland has granted South Africa a storage servitude; and
(f) The Gaberone Water Supply Project that transfers water from South Africa to the capital of Botswana.

River Basin Organizations (RBOs)

African leaders recognized such needs for inter-country cooperation as early as the 1960s and

1970s, soon after most African countries gained independence. As a result, a number of inter-country cooperation mechanisms in the form of transboundary river/lake basin organizations (RBOs) were set up in the 1960s and 1970s. In such major river/lake basins as the Nile, Zambezi, Congo and Lake Victoria basins, where such mechanisms do not exist, efforts are presently underway to set them up for cooperation among their riparian countries. Yet, the number of such mechanisms existing and/or emerging is still low when compared to the number of major transboundary river/lake basins in Africa. (over 80). For example, there are fewer than ten transboundary river/lake basin organizations in Africa and serious efforts are underway to set them up only in two or three others.

Most of the existing RBOs set up in the 1960s and 1970s initially had considerable political support from their member countries and substantial technical and financial support from the international communities and donor agencies. Some of these RBOs prepared ambitious development plans and strategies and some like the Senegal River Basin Organization, the Mano River Union, the Niger Basin Authority (Box 11.5), the Lake Chad Commission (Box 11.5) and others were initially successful in mobilizing resources and implementing a number of such development programmes and projects. Some basic features of the existing transboundary River/Lake Basin organizations in Africa are shown in table 11.5.

However, over the years, some of these RBOs faced multiple problems, including lack of political and financial support from their member countries and reduction in technical and financial support from donor agencies. Some of these RBOs even had their headquarters temporarily relocated because of political instability in their host countries. These problems severely affected their performance, especially in the implementation of development projects in their respective subregions.

Box 11.5
The Niger Basin Authority

The most important tributary of the Niger is the river Benoue, which takes its rise from Chad, flows through Cameroon with a number of tributaries in Cameroon. Cameroon is a signatory of the November 25th, 1964 agreement with eight other countries (Benin, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Burkina Faso) creating the River Niger Commission charged with fostering the promotion and co-ordination of studies and programmes relating to the utilization and development of the resources of the River Niger Basin (UN, 1984). This agreement came into effect in 1966 but due to the poor performance of the Commission the agreement was superseded by two conventions in 1980, creating the Niger Basin Authority (NBA) and a Niger Basin Development Fund. The aim of the NBA is to promote the co-operation among member states and to ensure an integrated development of the resources of the Niger Basin particularly in the fields of energy, water resources, agriculture, animal husbandry, fisheries, forestry exploitation, transport, communication and industry.

Problems the NBA has faced include:

(a) Lack of adequate political and financial support from member countries. For example, the head of state summit scheduled to hold every year in ordinary session has only met 5 times in the last 20 years and only 2 out of the nine members are up to date with their financial contributions (UNECA, 2000). The financial problems are partly due to the irregularity of summit meetings. Donors view the lack of frequent meetings as an indication of lack of interest on the part of member states. In 1987, the Summit of Heads of States agreed and signed an agreement creating a development fund to provide the NBA with the means to initiate major capital programs. Till date, this decision has not yet been implemented;

(b) The NBA has institutional weaknesses (administrative, managerial), which have not been fully addressed as the mission of the NBA has evolved. This led to frequent changes in leadership of the NBA, which did not inspire confidence in member states and donors and contributed to the financial problems of the NBA with late or

non-payment of financial dues. Some of these problems have been addressed and things started improving after the 1998 Council of Ministers meeting in Abuja, Nigeria;

(c) The equipment available to the HYDRONIGER, a major project of the NBA is obsolete and this reduces the quality of the data collected and hence the value of the forecasts made. There is therefore a need to modernize the equipment in use.

Despite its problems, the NBA has had some major achievements, including:

(a). Providing a forum for discussion which has helped to minimize conflicts in the sharing of the water resources of the basin;
(b) Execution of the HYDRONIGER project for hydrological monitoring and forecasting using real time data transmitted by satellites;
© Initiating the Agrymet Project for training and research in hydrometeorology and agro-meteorology;
(d) Carrying out a desertification control project to enhance the living conditions of people living in desertified areas;
(e) Establishment of a documentation center;
(f) Carrying out of a sedimentation study;
(g) Development of a mathematical model of the river Niger;
(h) Conducting studies in the area of navigation, hydroelectricity, pollution control, and sedimentation.

Source: AWDR National Report of Cameroon

Box 11.6
Lake Chad Basin Commission

Achievements and failures

The commission has made significant contributions in the area of agriculture, fisheries and livestock with the establishment of five agricultural development centres in the member S tates (UNECA, 2000). Other achievements include:
(a) Addressing the problem of the shrinking of the lake area;
(b) Studies on road transportation and telecommunication;
© Preparation of a master plan for the development of the natural resources of the basin;
(d) Studies on planning and managing the water resources in the basin;
(e) Creation of a data bank of socio-economic and hydrological data'
(f) Rehabilitation of the documentation center;
(g) Creation of a remote sensing unit.

The main problem that has plagued the LCBC was the disruption of its activities in 1981 and 1986 due to political instability in the host country, Chad. This led to the temporal relocation of the head quarters to Cameroon. This problem has since been resolved but others remain like:

(a)The lakeshore forms the boundary for countries that border it. However, the lakeshore boundary is not fixed and is greatly affected by the amount of precipitation. Hence the political boundaries of the countries tend to shift with the water.
(b) Water rights: The question of who has the right to the water in lake Chad and to how much has not been addressed. With the droughts in the 70's and 80's in the region and with less reliable rainfall in the basin in recent years (Isiorho et al., 2002) the water resources in the lake Chad basin have reduced. With most of the lake inflow coming from Cameroon, does she have more rights to the waters in the lake than her neighbours? What role does Nigeria, which uses a large share of the lake water for irrigation, have in insuring the sustainability? Can one nation decide to construct a dam on the River Chari/Logone?

Source: AWDR National Report of Cameroon

Table 11.3: Some Intercountry Water Agreements and Treaties in Sub-Saharan Africa (ECA, 2000)

Name of Basin	Date of Treaty	Number of Countries	Functions
NIGER	1963 1986	9	Assembly of data produced by member States and planning (implementation of projects is carried out by member States).
VOLTA	1962	6	Provision of energy to neighbouring States. (Cote d'Ivoire, Togo and Benin). Agreements on water use with Burkina Faso, Mali and Niger.
MANO	1964	3	Co-ordination of water use, planning, project implementation and operation and maintenance for joint power production projects.
GAMBIA	1978	4	Implementation by an accord relating to the use of the waters of Gambia river and navigation on its waterway. Promotion and co-ordination of studies and works for the development of the basin. Execution of technical and economic studies at the request of member States, including resource mobilization. Implementation of common works and the direction of agencies responsible for their operation and management.
CHAD	1973 (based on 1964 agreement)	5	Planning and execution of river basin projects of both regional and national character. Collection and dissemination of data. Supervision of the execution of studies and works. Regulation of navigation. Preparation, execution and operation and maintenance of specific projects. Co-ordination of financial planning.
NILE	1929 and 1959	2	Essentially water sharing and the supervision of water allocations between two of the ten riparian States. (Egypt and Sudan). Provisions for the reduction of losses in the Sudd region with commitments of finance and execution of works to reduce losses. Technical collaboration through a Joint Technical Commission (PJTC)
KAGERA (A sub basin of the Nile	1977 and 1981	4	Planning with wide multi-sectoral scope - including water, agriculture, animal husbandry, minerals, wildlife, fisheries and environmental protection.
GREAT LAKES REGION (A sub basin of Congo basin		3	Basically electric power generation under the umbrella of a regional power utility.
CUNENE	1969	2	Creation of a permanent Joint Technical Commission with advisory, study and reporting function. Execution of works by one riparian with water sharing and financial participation by the other.
KARIBA (CAPC)	1963	2	Vested power previously held by Federal Power board in the Central African Power Co-operation (CAPC) with tasks of implementing new works and the general operation and maintenance of existing works. For its international (bilateral) functions. CAPC is now superceded by the Zambezi River Authority.
KOMATI	Treaty in Draft Stage	2	Aims to create a Joint Permanent Technical Committee to plan and regulate the sharing and use of Komati basin waters and to create an operating agency that will execute and operate major works on behalf of the two riparian states.
SENEGAL	1964 1972	3	Creation of an organization for development of the Senegal basin and other substantive issues (OMVS)

Table 11.5: Some Basic Features of Existing Transboundary River/Lake Basin Organizations in Africa (ECA, 2000)

	Name of RBOs	Number of Countries	Names of Member States	Year Established	Secretariat Location	Major Activities
1.	Senegal River Basin Organization (OMVS)	4	Senegal, Mali, Guinea, Mauritania	1972[1]	Dakar, Senegal	River flow control, irrigation, hydro power generation, construction of dams and anti-salinity barrage, navigation etc.
2.	Gambia River Basin Organization (OMVG)	4	Gambia, Guinea, Guinea-Bissau, Senegal	1978[2]	Banjul, The Gambia	Dam and storage reservoir construction, topographical and hydrographical studies, anti-salinity barrage environmental protection and conservation, agriculture, irrigation, hydropower
3.	Niger River Basin Authority (NBA)	10	Benin, Burkina Faso, Tchad, Cameroon Cote d'Ivoire Guinea, Mali, Niger, Nigeria	1980[3]	Niamey, Niger	Environmental damage prevention and control, promote human health, conservation of flora and fauna, multiple purpose hydroelectric power projects, electric grid, water resources assessment, modelling, agriculture
4	Lake Chad Basin Commission (LCBC)	5	Cameroon, Tchad, Central African Republic, Niger, Nigeria	1964	Njamena, Tchad	Lake flow conservation, promotion of rational use of water, agriculture, irrigation, road transport telecommunication, fisheries, livestock, etc.
5	Kagera Basin Organization (KBO)	4	Burundi, Rwanda, Uganda, Tanzania	1977[4]	Kigali, Rwanda	Agriculture, technical education, environment conservation, hydroelectric projects, transport and communication, documentation and information dissemination
6.	Okvango Basin Commission (OBC)	3	Angola, Botswana, Namibia	1994	Secretariat functions shared by all three countries	Provide technical support and advisory services, water resources conservation, equitable allocation, conflict resolution environmental protection, alleviation of short term water shortage
7.	Mano River Union (MRU)	3	Liberia, Sierra Leone, Guinea	1973	Freetown, Sierra Leone	Transportation and Communication, promotion of interstate trade and commerce, customs, excise and tariff harmonization, forestry, marine, hydropower generation, irrigation.
8.	Zambezi River Authority[5] (ZRA)[5]	2	Zambia and Zimbabwe	1987	Lusaka, Zambia	Water flow control at Kariba dam, water quality monitoring

- two of the eight Zambezi river riparian countries.

1. Interstate Committee for Development of Senegal River was founded in 1963 and the Organization of Senegal Riparian States was created in 1968. These led to the establishment of OMVS in 1972.
2. Gambia and Senegal Joint Commission for Development of The Gambia river basin was formed in 1964. A Treaty of Association was signed in 1967.
3. Niger Basin Authority is the transformation of the Niger River Commission which was established as early as 1964.
4. The agreement to establish KBO was signed in 1971 which was promoted by the Technical Committee set up by Burundi and Rwanda in 1970.
5. Not a basinwide organization. ZRA is a bilateral arrangement between Zambia and Zimbabwe two of the eight Zambezi RRC countries

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VALUING WATER

The facts given in the other chapters of the present report show that the water resources of Africa have yet to be sufficiently harnessed to meet basic water needs for domestic, agricultural, industrial and other uses, including energy production, while many African countries are already facing water stress and environmental degradation. The endemic poverty in which the majority of Africans live is made manifest in their poor access to water and sanitation which results mainly from the low level of water resources development. Lack of access to good quality drinking water and sanitation, leading to environmental health hazards, contribute largely to the very low life expectancy in many African countries. In fact, life expectancy in more than two thirds of African countries is below the regional average of about 52 years. However, the report of the WHO/UNICEF Joint Monitoring Programme (2004) shows that some progress has been made in rural areas in sub-Saharan Africa where 69 million more people (over 9 per cent) gained access to water supply during the period 1990-2002. The number of people served in urban areas during the same period increased by 82 million, but the percentage difference was offset by the demographic growth in towns which is hastened by urban-rural migration. Northern Africa has made some progress in rural areas by increasing coverage by 2 per cent (from 82 per cent to 84 per cent). Sub-Saharan Africa too made some progress, with the percentage of the population served with improved sanitation facilities during the period 1990-2002 increasing by 4 per cent (figs. 5.24 and 5.25). About 85 million more people gained access to sanitation, most of them in urban areas where the increase was over 57 million. All these increases were drained away in terms of percentage by the huge demographic increase of over 181 million people (ibid).

In sub-Saharan Africa, where the rural areas account for about 70 per cent of the total population, crop and animal production, fisheries and forestry activities are direct sources of food for family consumption or sources of income with which people can buy food. Increasing and diversifying these food production sources is a prerequisite for improved household food security. According to FAO statistics, Africa's per capita agricultural and food production indices were 99 and 100, respectively, in 2000, much lower than the total production indices of 127 and 128. In East and Southern Africa, for example, the number of food insecure people almost doubled from 22 million in the early 1980s to 39 million in the early 1990s. The estimated rate of agricultural output increase needed to achieve food security in the continent is 3.3 per cent per annum. The potential for meeting this estimate exists as two thirds of African countries have developed less than 20 per cent of their agricultural production and less than 5 per cent of the cultivated area is under irrigation in all but four countries. Water-managed areas in national agriculture vary from less than 1 per cent of cultivated land in such countries as the Democratic Republic of the Congo, Comoros, Ghana, Togo and Uganda to 100 per cent in the most arid countries such as Egypt and Djibouti where agriculture is impossible without irrigation. Furthermore, it should be noted that, currently, no single subregion in Africa can boast of food security without recourse to food imports or external food aid.

Yet, the amount of water withdrawn in Africa as a whole for the three major uses is only 3.8 per cent of the internal renewable resources, reflecting a low level of development and use of water resources in the continent. In the context of this contradiction of water availability and yet lack of access to it, it becomes necessary to raise the issue of valuing water, including its market and non-market values which must be defined, in order to reconcile the economic, social and environmental values of water.

Real and Perception Values

From the point of view of the two indispensable attributes of water, i.e. water as an economic good and water as a good of social value, views differ as to what water is really worth given that its value in its totality encompasses the complex interactions between human beings and water as a natural resource which makes it to mean different things to people from different societal and cultural backgrounds and in different climatic setups. People living in drought-prone and arid areas, like in the North African countries such as Egypt, Libya, Morocco and Tunisia, would place a higher value on water than those in the wetter Central African countries such as the Congos and Cameroon. Moreover, water has a prominent figure in all the major religions of the world as a sacred gift of God. Understanding the religious interpretations and the rules governing what amounts to ethically adequate use of water is therefore imperative since these factors can heavily influence water management endeavours in Africa where religion still plays an important role in the everyday life of societies (see Box 12.1).

Modern enlightened politicians and experts, including researchers and engineers, tend to undermine the religious dimension of the value of water. This again can easily lead to conflict when it comes to water management under conditions of water stress (UNESCO IHP, 2004). Another factor that influences the value that people attach to water is the level of water service they receive. This can be misleading because those who already enjoy the benefits of something easily forget or cannot imagine what it would be like to live without it. The more successfully a good or service is delivered, the more likely it is that beneficiaries will take it for granted (Jack Moss el al, 2003). For example, even though ability to pay for services is essential in economic terms, it can lower the value given to water, resulting in uncontrolled water misuse and wastage. Very often, the value of water is tied to the economic and financial investments put into its development and management and hence leads to cost recovery considerations; but water per se, even drinking water, is not a product in the real sense of the word, and also not a normal article of trade, but a heritage and an element of the water cycle (UNESCO IHP, 2004). Water has therefore been involved in one of the most famous intellectual conundrums in the history of economic thought: the water-diamond paradox. This problem was resolved in the eighteenth century with the concept of a distinction between value in-use and value in-exchange. Although its price is low, water has an enormous value in-use to humans since it is a necessity for survival, while diamonds have a high value in exchange (Borgoyary M., 2002).

Historically, water was available in ample supply and therefore was treated as a free good, and has remained so even with increases in population and economic growth. Unfortunately, with this growth, many rivers and groundwater sources have become polluted and water is now a scarce resource. Water has been traditionally provided to meet demand, but it is becoming very expensive to resort to large-scale infrastructural solutions for providing water to meet ever-increasing demands.

The range of value perspectives will generally vary to some extent on a case-by-case basis and on the stakeholder groups involved. (Note that value perspectives are not the same as stakeholder perspectives and, in fact, are often shared across stakeholder groups) Below are some examples of value perspectives given by Jack Moss el al, 2003:

(a) Environmental Values;
(b) Social Values;
(c) Public Health Values;
(d) Economic Values;
(e) Production (including Agriculture) and Product Use Values;
(f) Political Values;
(g) Gender Values.

Effective water resources management requires that water be treated as an economic good. Ac-

cording to the 1992 Dublin Statement at the United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro, in June 1992, "water has an economic value in all its competing uses and should be recognized as an economic good". There is still a debate on the theoretical and operational implications of this concept and the economic impact on the poor. In contemporary water management endeavours in less-developed countries, the modern western approach, which is meant to bring "development" to "underdeveloped" regions, only too often clashes with pre-modern traditional concepts of "value of water" that are deeply embedded in the customary life of local communities (**UNESCO IHP, 2004**). Whereas in the context of the modern State and economy an instrumental technocratic and utilitarian approach to water

Box 12.1 Water and Islam

The value of water in Islam is reflected in the Holy Quran which states that "from water every living creature was created". In addition, Prophet Mohammed (Peace be upon him) declared that all people have free access to water. The wells were protected by not allowing digging new wells within the vicinity of the old wells, and this area was referred to as "harim". The same applies to other water sources. Prophet Mohammed established a religious institution which was declared as collective property, known as "waqf". In this context, some of the water resources and wells were declared as "waqf" and all the public had the right to use them (ISESCO 2001).

Islam views water both as a social and an economic good, and water equity as a combination of water quantity and quality. According to the Islamic principles, water is a public property. Access to water should be free, and all persons have rights to water resources. The legal system of rights in Islam recognizes market institutions for water transactions, and trade in water is allowable as for any other good. But water cannot be charged for in its natural state since it is a gift from Allah, but the services for collecting, treating, storing and distributing water can be priced, as it is being done in many Muslim countries (IWRA, 1998). The Prophet encouraged people to use water sparingly even for very important purposes, such as washing and ablutions.

Another major issue is that Islam does not forbid the use of wastewater, provided it is treated sufficiently to render it safe. Water is therefore a vital social good and a fundamental human right in Islam, and water conservation was explicitly encouraged by the Prophet (Raghida Haddad, 2002)

Generally, Islamic principles concerning water laws are based on two rights which are, according to ISESCO 2001: (a) the right of thirst where all people have the right to quench thirst or to water animals and (b) the right of irrigation where water can be used to water land and plants.

The laws are deduced from:

(a) Holy Quran: The Holy Quran contains 500 Ayats concerning water which are reflected in Islamic water laws

(b) Sunna or Hadiths: When Islam spread over very large areas whose geology, hydrology and meteorology were different, many new problems arose in the water sector. This led to plenty of problems which were not known before due to the simplicity of life. This made it inevitable to use Prophet Mohammed's instructions and explanations of certain problems as guidelines to solve new problems, namely:

  (i) Ijma: This is when all Muslim community has consensus of opinion on a matter. This principle is based on Prophet Mohammed's Hadith which states that "my people will never agree on an error".

  (ii) Qiyas: This means the deduction by analogy or legal analogy. Qiyas is not accepted in the domain of fundamental principles of Islam.

  (iii) Custom: The customs are respected in Islam and can be used provided that they are not contrary to the fundamental principles of Islam.

The first States to establish water laws under the rule of foreign powers are Algeria, Tunisia and Morocco. Egypt has used local regulations for the management of its water resources since the nineteenth century.

as an exploitable and marketable economic good has become the hegemonic societal concept, the view in traditional African societies is that water and natural resources in general are integral elements of a holistic world. For traditional societies, water is not only of economic and social importance, but also of cultural and spiritual value (ibid**)**. It is therefore necessary to reconcile the modern utilitarian perception of an economic good with the non-economic values and meanings, including the spiritual dimension.

Water as an Economic Good

The last 10 years of the twentieth century saw an increased emphasis on the economic aspects of water resources use and development. The New Delhi Statement emphasized the importance of sound financial practices with respect to drinking water supply and sanitation. The Dublin Statement further developed this point. The last of the four Dublin Principles reads: "Water has an economic value in all its competing uses and should be recognized as an economic good."

Internationally, this Principle is widely accepted, but what it implies for the price of water is not at all clear. Even, in Dublin, there was considerable confusion about what this principle meant. Considering water as an economic good relates to making the right choices about the utilization of water in the broadest socio-economic context. This is something completely different from water pricing. Water pricing has to do with cost recovery and demand management. The only relationship with economics is that the price charged should not be higher than the economic value. That water is an economic good has everything to do with setting priorities in view of the public interest. Economics is about making the right choices, and not about setting the appropriate price for water, as believed in certain circles (Borgoyary M., 2002).

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The Economic Value of Water

"Whoever has some water available has the choice between using that water or offering it to the highest bidder among alternative users. If he decides to use the water himself for whatever activity he is engaged in (household, agriculture, industry, or using the water as a sink for residuals from production or consumption activities), he abstains from an income he could have earned by selling this water to someone else in the community or downstream. This means that the user decides that the value of the water to him is higher than the income foregone. By not selling the water, he abstains from an income opportunity; thus the concept opportunity income or opportunity cost."

(ibid).

This misinterpretation of "water as an economic good" led to a serious misunderstanding in the general debate, both at the Dublin Conference and at the Earth Summit in Rio de Janeiro. Some people feared that the adoption of this Dublin Principle would lead to economic pricing of water, which would damage the interests of the poor and make irrigated agriculture virtually unfeasible. As a result, a number of disclaimers were added to the 4th Dublin Principle, stating that water is also a "social" good and that water should be affordable to the poor.

What "water as an economic good" implies is that decisions on the optimum use of water and its allocation to different potential uses should be taken on the basis of the socio-economic trade-off analysis that is independent of the ability to pay. If a society values environmental, cultural, sustainability and social considerations sufficiently, then it will be giving a high economic importance to water, even if there is a low ability to pay. In other words, considering water as an economic good implies that Governments should subsidize those uses of water that have a high value but a low ability to pay. On the other

hand, where an economic interest has a direct ability to pay (e.g., industry, urban households and trade), water should preferably be priced at its economic value, which may exceed the production cost of the water, for demand management purposes. The revenue thus generated can be used to subsidize interests, which have less ability to pay.

Charging the economic value of water is, however, a complex issue. In the case of urban water supply, the corporation supplying the water is normally a monopolist. The role of government should thus be to check the levies, and to ensure that water is supplied to the poorer neighbourhoods. In the case of irrigation, charging economic prices presupposes the possibility for some irrigators to refrain from using "their" water and "sell" it to a fellow farmer instead, but water laws frequently disallow such a transaction, especially those water laws that are based on the principle of "beneficial use". Water users will only be willing to pay more for water and invest in water-saving technologies if they perceive their rights to water as sufficiently secure, and if supplies are sufficiently reliable. Concepts such as "cost recovery," "user pays," "asset transfer," thus have their limitations, despite their popularity among many donors. Some questions that arise about these concepts are "Would it work in situations where the physical infrastructure is dilapidated, user ability to pay is severely constrained by macro-economic factors, market concepts and institutions are absent or in their infancy, water law and property rights are inadequately defined, capability in both management and regulation is limited and the social and environmental risks of getting it wrong are considerable?"

The Ministerial Declaration of the 2nd World Water Summit at The Hague (2000)

"Valuing water: To manage water in a way that reflects its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable."

Valuation and Price of Water

To argue for water to be treated as an economic good does not necessarily imply that a market price must be paid for it. What it means is that water is a scarce and valuable resource that should not be wasted, and that proper pricing (valuation) will ensure efficient utilization (ibid). But the terms 'value' and 'values' can be confusing. In economics, there are two levels of value which are 'market' values and 'non-market' values. In many water decisions and discussions, non-market values often play a much bigger role than people really recognize. The difference between market values and non-market values is extremely important for practical reasons. Market values are revealed in exchanges of goods and services and can influence people's values to some extent in their market behaviour. Willingness to pay a great amount for something indicates that it is valuable. Unwillingness to part with something even when offered a substantial sum of money for it also indicates that it is valuable. Market value should not be confused with 'price'. Price represents the marginal value or exchanges in a particular market – the value at which the last (or next) exchange occurs. In contrast, market value refers to the total value of goods and services exchanged in each market (Jack Moss et al., 2003). For example, the first units of water a person purchases may be of much greater value than the price they pay, even if the value of the last units purchased is just equal to the price they pay. Similarly, the first units of water a supplier sells may cost much less to deliver than the price re-

ceived, even if the last units delivered cost about the same as the price received. The total value received by purchasers above the total amount they pay is called "consumer surplus (CS)." Similarly, the value received by a service provider is the difference between total revenue and the (presumably lower) total cost of service. Economists call this producer surplus (PS). The sum of consumer and producer surplus in each market is the value in that market (ibid).

Non-market values are like the entire iceberg, while market values are like the part of the iceberg that is visible above water level. Non-market values are a category within what economists refer to as preferences (or tastes). But unlike common preferences or tastes, non-market values of water can be of "deep" preferences due to its intrinsic and cultural values. Much of the tension around the value of water is due to this deeper level of values, and to the fact that people hold very dearly to the non-market values that they fear will get lost if water systems are managed through market approaches (ibid).

Borgoyary M. (2002) makes an analysis that offers a useful framework of the economic rationale for implementing water pricing (or water valuation) reforms, as follows:

Relative value of water: Like other goods, water also has a value that any consumer will be willing to pay as long as the marginal benefit of consumption exceeds the costs. Water must not be assumed to have zero value, an idea that persists, particularly in Africa.

Cost of water: While the value of water depends on its use, the cost of water is usually associated with the infrastructure of storing and delivering it; the user cost. However, one important cost component that is often ignored due to the difficulty of measuring it is the "opportunity cost" of having the water in its present use. As water becomes scarce (both in terms of quantity and quality), its opportunity cost increases and becomes more important to consider.

Balancing water values and costs: All over the world, users pay only a part of the full economic cost of water. For example, in most industrialized countries and in some developing countries, only the full average financial costs are recovered from urban water users, while for the majority of urban water users in developing countries, cost recovery is even lower.

In a nutshell, treating water as an economic good or ensuring proper valuation of it will provide powerful decision and management tools. At a macro level it will ensure efficient use of water at both the user and project levels, thereby allowing for sustainable water resources management. In specific terms, treating water as an economic good will help:

(a) Measure the costs and benefits from water and sanitation investments and policies;
(b) Assess the demand for water and wastewater services and evaluate their relationship to price, income, and other variables;
(c) Inform decisions regarding the use and targeting of public subsidies, and how to reform tariffs and improve utility finances;
(d) Evaluate sanitation alternatives and their tradeoffs;
(e) Assess the costs and benefits of water demand management options, including pricing, leakage reduction, and metering;
(f) Evaluate the desirability and feasibility of intra- and inter-sectoral water reallocation;
(g) Assess the efficiency of various modes of service provision (for example, public versus private, centralized versus decentralized);
(h) Design regulatory and legal frameworks for public sector participation; and
(i) Evaluate the impacts of projects or reform on the different sectors and stakeholders, and devise ways to strengthen institutional frameworks (ibid).

The total economic value of water can be considered to be the maximum amount the user would be willing to pay for the use of water. People ob-

tain many types of value and benefits from water. These can generally be classified into two categories, namely:

(a) Use values:
(ii) Commodity benefits (for drinking, cooking, sanitation, and leading to productive activities on farms and industries); and
(b) Waste assimilation benefits (to carry away wastes, dilute wastes, and aid in processing waste into less undesirable forms).

(b) Use values:
(i) Public and private aesthetic and recreational benefits;
(ii) Species and ecosystem preservation; and
(iii) Social and cultural values. (ibid).

The non-use value is difficult to measure, but can be subdivided into existence value (value from knowledge of continued existence) and bequest value (the willingness to pay in order to ensure that future generations will be able to use the resource).

Valuation Techniques for Different Water Uses

The two main approaches to the valuation of natural resources are direct valuation and indirect valuation. Direct valuation attempts to use survey and experimental techniques to obtain information directly. The techniques include contingent valuation and contingent ranking. In the indirect technique approach, values are based on actual, observed market-based information. Different indirect methods are used to measure the value of water in various sectors, such as the:

(a) **Value of water in the municipal sector.** In this sector, the demand for water can be domestic, public or other. Given the heterogeneity of demand for water in this sector, its marginal value depends upon how much of it is already available, and the quantity can range from negligible to infinite, depending on the extremes of abundance and scarcity. In urban utilities in developing countries, the price of water only reflects the average financial costs such as capital, operation and maintenance costs, while for urban utilities in developed countries the price of water reflects only the average financial costs with capital costs computed as replacement costs;

(b) **Value of irrigated water.** To measure the value of irrigated water, crop-water production function analyses and farm crop budget analyses are used. In the former, application of all other inputs in agriculture are assumed to be constant, and the marginal value of each volume of water used is the marginal price times the price of the crop. This method is based on the assumption that the application of different amounts of water incurs the same labour, fertilizer, and other input costs. In the farm crop budget analyses, the total crop revenue less the non-water input costs is considered to be the maximum amount the farmer could pay for water and still cover costs of production. It thus reflects the on-site value of water.

(c) **Value of water used in industry.** Given that water costs are a small fraction of the total costs of industries in general (the cost of water is very low when compared to other inputs like raw materials, technology), water use is of secondary importance to industry for profit maximization. The primary decisions on technology and output determine the amount of water demand per unit of output in the specific industrial production process. Therefore, the importance of water lies mainly in the role of water reuse in industrial processes. Thus the internal cost of water re-circulation is often used to estimate the value of water in industry. Another less direct measure is by using the alternate cost framework of providing the same water quality through pre-treatment of effluent; this cost is assumed to be the value of water for that industry;

(d) Recreational and aesthetic value of water. To estimate the recreational and aesthetic

value of water, the travel cost approach is used. Value is inferred from the value that users place on a recreational experience from their travel behaviour. It is assumed that the average cost that the person incurs to visit a waterfall, a lake, or a river is the minimum amount that the person is willing to pay for the recreational and the aesthetic value of water.

Direct Methods of Water Valuation: Some African Examples

Aside from the indirect approaches mentioned above, the direct approach of asking people how much they are willing to pay for a resource (known as the contingent valuation method (CVM)) is also used to estimate the value of water. This method can be used to estimate the value of water used for agriculture, municipalities, industries, or even for recreation and aesthetic purposes. Questionnaires and surveys are conducted to elicit rank or value. In the contingent valuation method, people are directly asked to state or reveal what they are willing to pay (or accept as compensation) for good quality water, assured supply of water for irrigation, and other uses. The reliability of the CVM method depends on the design of the questionnaire. Despite the shortcomings of the CVM method, including problems of designing, implementing and interpreting questionnaires, the results of the various applications within the continent and other developing countries suggest that it is possible to do a contingent valuation survey among the poor, illiterate population and obtain reasonable and consistent answers – a way of integrating the values of the poor and marginalized in the decision-making process (Ampomah, 2004).

The World Bank's programme on the economic valuation of water supply has adopted two approaches: dichotomous and contingent valuation. The dichotomous choice makes it possible to observe how people choose between alternative means of water supply evolving over time (Borgoyary M., 2002).

Kenya

There have been several other applications of CVM to water resource management issues in developing countries. In Ukundu, Kenya, villagers can choose between water from vendors who visit the home, water from kiosks in the villages, and water from the well. In terms of collection time, relative to use of the well, house delivery saves the most time and collecting from kiosks, the least amount of time. In terms of expenditure, household vending costs the most, kiosk water second and well water is the cheapest. The Ukundu study shows that users of vendors and kiosks were revealing high willingness to pay (WTP) for time saving, to the tune of about eight per cent of their income.

Ghana

A contingent valuation study of household demand for improved sanitation in Kumasi, Ghana in 1993 estimated that on average households without water connection were willing to pay $US 1.52 for a water connection and $US 2.57 per month for both a water connection and a toilet. Households with private water connections but without a toilet were willing to pay seven per cent more for a toilet than for the Kumasi ventilated improved pit latrine (KVIP). Households using public latrines were willing to pay about 37 per cent more for a KVIP than households with bucket latrines. In another study (1989), the water quality of Barbados and Uruguay was estimated using the contingent valuation method.

It is clear from the above discussions that water as a scarce resource has been undervalued and overexploited, especially in developing countries. Practical implementation of the Dublin Statement implies proper valuation of water so as to reflect the actual value of this scarce resource and thus guide policies that are favourable to the sector's development.

Impact of New Valuation of Irrigation Water on Water Use in Morocco

El Yacoubi Z. and Mohamed Belghiti M (2002) assessed the financial viability of water supply Regional Offices for Agricultural Development. These are public institutions whose budget is split into investment and operating budgets, the first in accordance with the Law of Finance and the second approved by the Board of Directors of the Offices. Where there is a deficit in the operating budget, a balancing subsidy is allocated by the Ministry of Finance. Since the earnings of the Offices come mainly from water fees paid by users as well as from State subsidies, they need to be able to recover their operating, maintenance and renewal expenses if they are to remain financially viable. How they achieve this can be seen in the balance of earnings report and the report on State budgetary transfers.

Water Supply Earnings Report

The Offices' establishment of an accounting system similar to that of a corporate body helps it to calculate the overall water supply costs recovered through proceeds from water sale (invoiced amounts). The development of this system since 1994 is shown in the table 12.1.

The irrigation water tariff adjustment that was made and applied resulted in a surplus balance of water supply earnings (excluding depreciation) in the 1996/1997 agricultural season despite an increase in the costs of water supply. The adjustment also increased total water earnings despite a drop in the rate of recovery of water fees. It made it possible to achieve average earnings of about DH 540 million during the last three agricultural seasons. Even with this, budgetary transfers in favour of water supply were limited to about DH 50 million per annum, although water supply costs increased by more than 26 per cent during the period 1995-2000.

Budgetary Transfers for Water Supply

The earnings from water sold (including arrears recovered), were more than 90 per cent of the supply costs (excluding depreciation and including indirect expenses). Budgetary transfers to the Offices for operating and maintenance expenses were steady during 1994-2000 despite an increase in tariffs since 1996. The impact of this tariff increase was offset by a drop in water fees recovery rates.

Table 12.1: Earnings report and budgetary transfers in the ORMVA

(Amounts in DH million)	1994	1995	1996/97	1997/98	1998/99	1999/00
Water supply costs (1)	462	467	514	532	646	584
Proceeds of water supply (2)	409	434	554	588	655	609
Balance of water supply earnings report (2)-(1)	-53	-33	40	56	9	25
Water supply proceeds/expenses	89 %	93 %	108 %	111 %	101 %	104 %
Water earnings (3)	423	415	480	490	594	532
W.S.budgetary transfers (1)-(3)	39	52	34	42	52	52
W.S. earnings/expenses	91.6 %	88.9 %	93.4 %	92.1 %	92.0 %	91.1 %

(1) Expenses excluding depreciation and including indirect expenses

(2) Corresponds to turnover (volume sold x tariffs applied)

(3) Earnings from the sale of water during the fiscal period

Efficient Utilisation of Water Resources

The two case studies presented below show the cause and effect relation between water tariff adjustment and more efficient use of water:

The Case of sub-sector A of Rmel in Loukkos area:

This is a sub-sector of an area of about 1,500 ha, irrigated by sprinklers and subjected to a restructuring aimed at individualizing water intakes and meters under the Project. As part of the reorganization, the Sector A estates were regrouped and arranged in belts parallel to secondary pipes allowing each farmer to have his own individual intake and meter, the combined results of increased water tariffs and individualization of water meters have a considerable impact on the behaviour of farmers towards irrigation water. The 21 per cent increase in tariffs that followed led to a 5 per cent drop in water consumption and a 38 per cent increase in farming intensity. The result was a 32 per cent increase in water saving which enabled the farmer to enhance farming intensity and, consequently, his income.

The Case of Souss Amont area:

In this plot of an area of about 6,100 ha irrigated by sprinklers, the scarcity of water combined with the increase of irrigation water tariffs led farmers to resort to water-saving irrigation techniques, particularly through drip irrigation by parcel. Thus, with the implementation of the tariff adjustment plan, a considerable increase of areas equipped with drip irrigation has been noted, as shown in table 12.2.

In the two pilot cases presented above, irrigation water tariffs were accompanied by rehabilitation and modernization of equipment owned by the farmer, especially for proximity services (terminals and meters) which helped to substantially enhance water supply. The projects also show that irrigation water valuation induces a behaviour of economy towards water, and has the positive impact of enhancing efficient use of water, especially when it is accompanied with measures aimed at improving water supply and measurement.

Pricing of Water

To treat water as an economic good does not necessarily lower its social or ecological importance. It rather complements the social and environmental perspectives. Price signals have successfully helped to achieve social and economic equilibrium for most goods. However, in the case of water resources, this is not the case because water is perceived as too vital and basic a commodity to be left to market forces and, also, because there is no conventional market for water. In Algeria for example, until the mid-1980s, the cost of drinking water for users was well below the cost of supply. However, after 1984, the tariff was redesigned to

Table 12.2: Development of areas equipped with drip irrigation, and irrigation water tariffs in the area of Souss Amont

	Area equipped with drip irrigation		Water tariffs	
	Area (ha)	Rate of increase per year (%)	Tariff (DH/ m^3)	Rate of increase per year (%)
1996	153	-	0.38	-
1997	183	20	0.42	10
1998	306	67	0.46	9
1999	428	40	0.46	-
2000	612	43	0.49	6
2001	735	20	0.54	10
2002	857	16	0.54	-

increase cost recovery for water systems. In terms of irrigation prices, the fixed charge (per litre per second per hectare) decreased from $US 3040 in 1985, to $US 48 in 1995. In terms of volumetric charges, it remained the same, at $US 0.02-0.03 in 1995. In Botswana, in 1994/1995, 44 per cent of the total operational and maintenance costs of water supply were recovered, compared to 33 per cent recovery in 1988/1989. These examples help to show that in the absence of working markets for water and in the presence of growing conflicts over water use, there is a pressing need to understand the underlying economics of water demand and value in various economic sectors, especially in the context of Africa (Borgoyary M., 2002).

In Africa, where access to safe drinking water is still low, especially in the rural areas, the question of water being an economic good is topical since it involves the relevant issue of ability and willingness to pay. However, since the 1990s, it has become obvious that it will be difficult to mobilize the financial, engineering and physical resources required to supply clean water to those without it if water is not used more efficiently and if national water priorities and policies are not rethought Jack Moss el al, (2003). Moreover, there is an urgent need to update distribution systems in order to retrieve much needed water from the very high level of unaccounted-for-water. All such actions require large sums of money which are not readily available in many African countries. The potential benefit of the principle of economic good is that increasing economic efficiency means increasing the size of the economic "pie" (Jack Moss el al, 2003). That being the case, many countries now recognize water pricing as a strategy for releasing capital for investment and reducing waste (Box 12.2).

In Libya, water is provided almost free of charge due to the fact that municipalities are unable to supply water of acceptable quality and pressure. By Law, however, municipal water is metered and charged using a rising tariff block system. The tariff is not intended to recover the investment cost for the water supply system, but rather to minimize wastage and partly compensate for the operation and maintenance costs. A new tariff system has recently been introduced, based on O&M cost recovery and for agricultural, industrial and municipal water uses. The billing system is still irregular and sometimes non-existent, which implies that water will continue to be a free commodity provided by the State for some years to come. No charges are imposed on irrigation water, as water is extracted through privately constructed wells. At present, farmers only pay for the cost of energy used for the production of water, which is also subsidized (AWDR National Report, 2005).

In the Sudan, raw water is treated as a substance and a free commodity. Water pricing is therefore based on the cost of services to reach the users. These services are estimated using many variables such as: availability, transferability, quantity and quality. In large-scale irrigated schemes managed by the public sector, water rates are based on cost recovery. The private sector uses the water source free and the operation and maintenance costs are covered by individuals or cooperatives. Water prices for irrigation, for example, are based on cultivated area and not on actual quantity of water used which depends on type of crop. One hectare of cotton costs more than one hectare of groundnut or sorghum (almost twice), as per the length of growing season which consequently determines the number of watering. In 2003, the cost of irrigating one hectare of cotton was about US$50, while for sorghum, it was US$.25 It is worth mentioning that these costs cover the irrigation services from source to farm level. The domestic water supply rates vary widely between urban and rural areas. Urban localities are categorized as first class, second class and third class. Water rates are based on a flat rate system in each category. For example, in Khartoum the drinking water supply rates for the first class areas are about US$ 16 per month and the third class areas about US$ 8. These water rates are set to cover operation, maintenance and the system upkeep. In the rural areas domestic water sup-

Box 12.2: Cost Recovery for Irrigated Agriculture - Egyptian Experience

The objective of the Valuation of water for irrigation in Egypt is to recover from beneficiaries the financial cost of providing water-related services, encourage efficient use of water resources and provide water services at a reasonable cost.

Areas of Application of Cost Recovery

- Irrigation Improvement cost recovery .
- Subsurface Drainage cost recovery.
- Cost Recovery in the new lands.
- Cost Recovery for operation and maintenance.
- Cost Recovery on new projects.

Mesqa improving costs consist of:

- Investment costs for the mesqa (Tertiary canals) pumps, the repayment over a period not exceeding 5 years.
- Investment costs for civil works including mesqa remodeling, PVC pipes, lining ,..etc.
- Costs are paid to government over a period not more than 20 years without interest.
- Farmers pay O& M costs directly to WUAs

Payment for mesqa investment: It is expressed as a proportion of incremental income attributed to irrigation improvements and varies between 12% and 25 %.

Subsurface Drainage Cost Recovery

- An increase in crop yield by more than 20% due to installation of the drainage system has encouraged farmers to participate in the programme and pay for it.
- Cost Recovery has been made over more than five million feddan during the last 30 years.

Cost Recovery in the new lands

- The policy with respect to capital cost recovery is to recover no charges above the delivery point and a proportion of the investment costs below the delivery point.
- Settlers on new lands are given a period of ten years before they are subject to any taxes. The average yearly land taxes range from less than 10 L.E. / feddan to no more than 35 L.E. /feddan.

Cost Recovery for operation and maintenance

- Farmers pay L.E. 18 per feddan per year for mesqa maintenance in the old land, either to the government or as a contribution of labor cost recovery for O & M above the mesqa.
- Farmers pay L.E. 18 per feddan per year for mesqa maintenance in the old land, either to the government or as a contribution of labourr cost recovery for O & M above the mesqa.
- The capital costs for mesqa improvements under IIP are to be recovered over not more than 20 years, while the costs of pumping units and land leveling are to be repaid over three years.
- Water service fees like volumetric charging would not be economically, socially, or politically feasible.
- The basis for irrigation service charges should be crop-based and reflect crop water consumption.

Source: Official Egyptian Presentation: Cost Recovery for Irrigated Agriculture - Egyptian Experience WATER DEMAND MANAGEMENT FORUM, Beirut, LEBANON – June 2002

ply is either free or nominal to cover operation, maintenance and system upkeep carried out by the community. Planning and development of domestic water supply and irrigation systems and infrastructures are undertaken by the Government (AWDR National Report, 2005).

According to the AWDR National Report, 2005, the cost of potable water in Botswana depends on the level of urbanization. A household in Gaborone, the capital, pays an average unit price of P 4.69/ m^3 for a monthly consumption of 20 m^3., In smaller towns supplied by the National Water

Supply Company the cost is P 4.04/ m^3 while in other villages it is P 2.71/ m^3. The average unit cost increases by more than 50 per cent if the monthly consumption doubles (except in rural villages).

In South Africa (AWDR National Report, 2005), water use charges are based on demand side strategy of integrated water resource management which allows for:

(a) Funding water resources management;
(b) Funding water resource development and use of waterworks; and
(c) Achieving equitable and efficient allocation of water.

The Government has therefore introduced a policy for the pricing of potable water making the first $6m^3$/household/month free.

Predominant Types of Water Supply Block Tariffs in Africa

Many African countries have adopted the block tariff system with the aim of reconciling the economic good status of water with its social value. The main problem is how to determine what can be considered as the socially necessary volume of water per person to cover household needs and personal hygiene on the basis of which Governments should fix the minimum value. From the AWDR national reports, apart from Mauritius which uses a multiple step block tariff system, the systems more widely used are the two and three block systems (tables 12.3, 12.4 and 12.5). Botswana and South Africa use the two block system while Cameroon and Mauritania use the three tier tariff.

Table 12.3: Two Block Tariff System

Average unit tariff for two monthly consumption levels (Pula/m3; 2004 tariffs). Botswana

	Domestic- business $20m^3$	Domestic- business $40m^3$	Government $20m^3$	Government 40 m^3
Gaborone	4.69	7.60	9.59	15.38
Rural villages NSWC supplied	4.04	6.92	12.26	21.03
Rural villages	2.71	4.66	12.05	12.05

National Potable Water Tariff Survey in South Africa

Tariff 20-60 kl/month			Tariff > 60 kl/month		
Av.	Min.	Max.	Av.	Min.	Max.
R 3.60	R 0.00	R 15.57	R 3.94	R 0.00	R 15.57

NOTE: The tariffs reported here are population-weighted averages of municipal retail tariffs adjusted/escalated to 2004

SOURCE: DWAF Annual report. 2003/04 Table 3.1

Table 12.4: Three Block Tariff System

Price of urban water supply for different users in Cameroon since 1995 - Cameroon

Type of subscribers	Consumption	Price per m^3 without taxes, FCFA	Price per m^3 with taxes of 18.7 %, FCFA
Private	1-10 m^3 per month	271	271
	>10 m^3 per month	337	400
Administration, public taps, community buildings, washing points	Unlimited M^3 per month	354	420
Industrial and Commercial	1-10 000 m^3 per year	354	420
	10 001-50 000	339	
	50 001-100 000	324	
	100 001-250000	312	
	> 250 000	298	354

Mauritania

Tariff 0-20 m^3/bimonthly	Tariff 20-40 m^3/bimonthly	Tariff more than 40 m^3/bimonthly
93.50 UM/ m^3	185.24 UM/ m^3	232.65 UM/ m^3

Source: Djeuda-Tchapnga et al., (2001)

Table 12.5: Multiple Block Tariff System

Water tariffs for different users in Mauritius

Water consumed (m^3)	Rs/m^3
First 10 cubic metres	4.50
Next 5 cubic metres	5.50
Next 5 cubic metres	7.50
Next 10 cubic metres	9.50
Next 20 cubic metres	13.50
Next 50 cubic metres	18.00
Next 150 cubic metres	24.00
All additional cubic metres	30.00
Minimum charge per Month	45.00
Meter Rent per Month	10.00

Water Pricing by the Addis Ababa Water and Sewerage Authority (AAWSA): An Ethiopian experience:

Conveyance of water through pipes started in Addis Ababa in 1901. At that time, water was delivered at no cost to the residents. In 1945 a tariff was set at a rate of 0.50 Birr/m^3 and it remained without any change for a period longer than almost half a century. According to Lisanework A. A. (2003) a new water tariff system was initiated from July 1995 at a selling price fixed as follows:

0.50 Birr/ m^3 /month for the first 15m^3
0.75 Birr/ m^3 /month for the next 16 - 40m^3
1.50 Birr/ m^3 /month for any consumption greater than 40m^3 and
0.50 Birr / m^3 / month for all public taps

To assess the effect of water tariff increments, a sample survey was conducted by AAWSA which found that about 77 per cent of the respondents knew about the increase of water tariffs whereas 23 per cent did not. Out of the respondents who knew about the increase, 32.9 per cent felt that it was too high, and 36.3 per cent said it was a little higher than the previous and 30.8 per cent did not state their views. The result of the sample survey ascertained that more than 68 per cent of the interviewees consume the same amount of water as before the tariff increase. From the above fact, it can be concluded that the tariff did not result in decrease in consumption and was affordable.

Furthermore, even though the tariff was increased, the water production and distribution expenditure of the authority did not decrease. This was due to the increase in the prices of pipes and fittings, maintenance, chemical, fuel and other expenses. Earnings from the current tariff rate covers only 70 per cent of the operation and maintenance expenses of the authority. In order for the authority to cover its expenses with the tariff incomes a new tariff system was studied (table 12.6). This study was based on increase in population, per capita consumption and unaccounted-for-water. As a result of the shortage of water, the current per capita consumption is very low. The tariff rate was fixed taking into consideration the current per capita consumption of 75 l/day, expected to increase to 100 l/day in the coming 20 years as well as the expected reduction of the present 35 per cent unaccounted-for-water to 25 per cent.

The main objectives of the latest tariff are:

(a) To develop and implement a policy of financial self-sufficiency for AAWSA operations;
(b) To ensure regular supply of water and sewerage services at a rate affordable to the urban poor;

Table 12.6: The New Water Tariff System of Addis Ababa

Water Consumption by Customers	1st year Tariff rate 2001/2002 Birr/m^3	2nd year Tariff rate 2002/2003 Birr/m^3	3rd year Tariff rate 2003/2004 Birr/m^3	4th year Tariff rate 2004/2005 Birr/m^3	5th year Tariff rate 2005/2006 Birr/m
Public Water Taps	1.15	1.30	1.45	1.60	1.75
Domestic 0 – 7 m^3	1.15	1.30	1.45	1.60	1.75
7 – 20 m^3	1.60	1.85	2.10	2.35	2.60
Above 20m^3	2.30	2.60	2.95	3.25	3.25
Industrial (all consumption)	2.30	2.60	2.95	3.25	3.25

Source: Lisanework A. A.: Water Demand Management Perspectives: Concepts and Applicability to the City of Addis Ababa, Case Study, WARREDOC, Perugia, 2003

(c) To bring the selling price of water at or near the marginal cost; and
(d) To facilitate access of the low income sections of the population to safe drinking water (ibid).

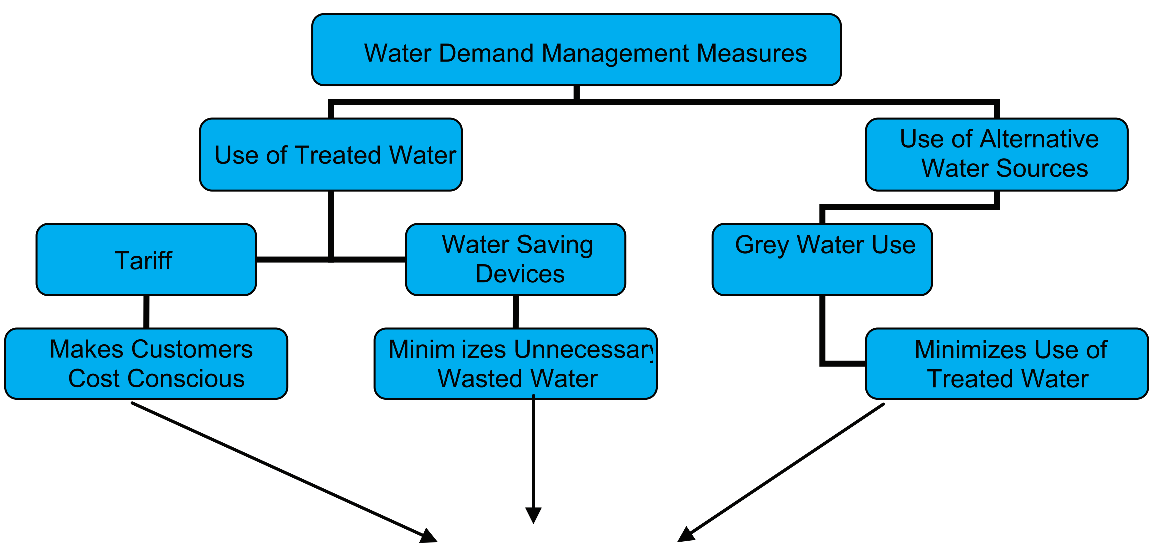
Valuing Water Through Demand Management

A wider concept than water pricing and cost recovery is "demand management." Demand Management is the use of economic and legal incentives, awareness raising and education to improve consumption patterns for water distributed between sectors and water consumed while improving reliability of supply. Although economic incentives are important instruments for demand management, they are by no means the only ones. In fact, in demand management emphasis should lie on educational, administrative, legal and political actions to influence demand while safeguarding equity principles. The use of economic instruments to enhance efficiency of water use and to promote financial sustainability should remain subordinate to these considerations. The major issues confronting developing countries are, as Borgoyary M. (2002), notes:

(a) Large numbers of poor people who do not have access to clean, safe and sufficient water supply;
(b) Underestimated price of water vis-à-vis the actual value, and poor cost recovery;
(c) Water policies that encourage inefficient and overuse of resources sometimes leading to environmental problems such as salinity and clogging);
(d) Government subsidies not being targeted to benefit the poor; and
(e) Ineffectiveness of Public authorities responsible for services;.
(f) Water policy that focuses more on coverage than on providing improved and regular supply.

Water resources accounts should be established at the national level to reflect the status of the resources and allow for their sustainable development.

Figure 12.1: Issues involved in Water Demand Management



Source: Lisanework A. A: Water Demand Management Perspectives: Concepts and Applicability to the City of Addis Ababa, Case Study, WARREDOC, Perugia, 2003

The main objective of water demand management is to achieve efficiency and equity in the provision of water and sanitation services. In order to attain this objective, a number of instruments have been developed. These instruments are interdependent and mutually reinforcing and the ability to apply them effectively will depend on the prevailing local conditions. In cities, the different income groups (high, middle and low) and the different types of urban areas they live in can be distinguished, making it possible to identify the various water demand management measures that are applicable. A broad range of approaches and instruments exist for Water Demand Management. Those identified by Lisanework A. A (2003), ranging from economic to socio-cultural and technical approaches can be divided into:

(a) Water conservation measures:
- (i) Leakage detection;
- (ii) Reduction of illegal connections;
- (iii) Use of water saving devices;
- (iv) Out-of-house water saving measures;

(b) Water pricing measures:
- (i) Water metering;
- (ii) Tariff structures;

(c) Information and educational measures:
- (i) Awareness raising;
- (ii) Public involvement;
- (iii) In-school education;

(d) Legal measures
- (i) Rules and regulations that form the basis of WDM policy;
- (ii) Regulations on resale of water;

Water Demand Management in Zimbabwe: A success Story

The City of Bulawayo successfully implemented a water demand management system starting in 1999. The motivation for this was the experience gained during the 1991/92 drought when the city had very little water available. Water losses in the distribution system amounted to 22,000 m3/day or 23 per cent of the water supplied from the water treatment works. This programme involved developing the awareness of water users about the need to conserve water, which is now well established. A rising block tariff system was introduced to discourage excessive water usage. Pressure management and leak detection systems were put in place. Improvement in the operation and maintenance of water infrastructure and training of personnel were also undertaken. The city has managed to reduce water consumption in low-density suburbs to an average of 75 litres/capita/head, in comparison to 200 to 300 litres/capita/day in similar suburbs in Harare. After investing Z$5 million/year, the benefits in reducing water losses are equivalent to about Z$28 million/year (AWDR National Report, 2005).

Box 12.3: An Integrated Approach to Water Demand Management - Addis Ababa

The Addis Ababa Water & Sewerage Authority (AAWSA) is the sole government organization responsible for the supply of potable water and provision of sewage collection, treatment and disposal services for the residence of the capital. Population growth, improved living standard and other related factors have resulted in widening the gap between the services rendered and the demand of the population. To narrow this gap, especially in water supply provision, AAWSA has embarked on Water Demand Management (WDM) activities since 1999 in collaboration with the UN-Habitat's Water for Africa Cities (WAC) Program. In line with the inter-linked objectives and complementary priorities of the Water for Africa Cities Phase I Program, the City of Addis Ababa through AAWSA and the Addis Ababa Education Bureau has been actively engaged in and successfully implemented WDM activities and inter-related issues of awareness raising, catchment management, and pollution prevention & control Some of the activities performed in Phase I of the program with regard to WDM include the following::
densely populated areas.

STRATEGIES	ACTIVITIES
Water Demand Management WDM Strategy Document has been prepared and implemented for both demand and resource side	➢ Establishment of a water demand management department in the structure of AAWSA ➢ System development for determination of Unaccounted for Water in the supply network ➢ Identification of high consumers for WDM /Retrofitting activities ➢ Bulk meters assessment for purpose of water audit in branch offices ➢ Patrolling the network for illegal connections and visible leaks ➢ Counter Checking of production figures with flow meters monitor efficiency ➢ Meter reading on monthly basis (used to be bi-monthly) ➢ Improved billing errors
Awareness Raising, Advocacy and Capacity Building	➢ Strengthening of the Public Relations Service ➢ Awareness creation among the staff involved in the implementation of WDM activities ➢ Five primary schools and one senior secondary school were selected to conduct pilot testing of VBWE ➢ Teachers of all pilot schools were trained on how to integrate VBWE in the daily lesson plans of the core subjects taught in schools ➢ Awareness to consumers on water demand management concept in collaboration with the Ethiopian Consumers Association through information exchange events and non-formal education orientation program ➢ Construction of a Water Classroom Building to be used as a center of excellence for educating the public as well as school children on the Value of water At the moment 90% of the construction is completed.
Catchment Management Water Catchments Management Master Plan has been prepared.	➢ Water Quality Assessment Project for Addis Ababa and its Environs is undergoing ➢ Warning Sign posts for the purpose of protecting the environment of the water sources are erected around dam sites, Treatment plants, groundwater sources, etc ➢ Design of Cattle trough around Dire Dam to avoid encroachment on the impounding reservoir ➢ More than 30,000 seedlings planted in Dire Sanitary zone ➢ Design of fence to isolate the sanitary zone of Dire & Geferssa dams is completed and construction is to be commenced soon
Pollution Prevention & Control Pollution Control Strategy and Implementation Document has been prepared.	➢ Community-based pollution control by promoting small-scale De-slugging technology for pit latrines in densely populated areas. ➢ Data collection and analyses for reuse of back wash water and sludge at Legedadi treatment plant ➢ Four staff of AAWSA have attended a training on low cost waste treatment technologies ➢ Two Staff of AAWSA are trained on Sulabh's low cost sanitation technologies ➢ Based on the Sanitation Technologies training, demonstration project proposal for construction of a model Public Toilet Complex is prepared.

In the second phase of the program, the Addis Ababa Education Bureau, the Environmental Protection Authority, and the Sanitation, Beautification & Parks Development Agency are actively participating with AAWSA.

No	Planned Activity	Implementing Institution	
		Primary Responsibility	Collaborators
1.	Pro-poor Water Governance and Follow-up Investment	AAWSA	Water Aid Eth, World Bank
2.	Water Demand management	AAWSA	Addis Ababa Education Bureau
3.	Urban Water Catchments Management	AAWSA	Addis Ababa Environmental Protection Authority
4.	Sanitation for the Urban Poor	Sanitation, Beautification & Parks Development Agency	Addis Ababa Education Bureau AAWSA
5.	Water Education in Schools and Communities	Addis Ababa Education Bureau	AAWSA
6.	Advocacy, Awareness Raising and Information Exchange	All Implementing Institutes	Sub - Cities

Contributed by: Eng Azeb Asnake, Research and Water Demand Management Dept., AAWSA, Addis Ababa

Privatization or Public-Private Partnerships

For the proponents of market-oriented water services the first thing is the establishment of agreements on what types of functions and decisions can best be made and at what level. The next policy option is that of privatization. The drive towards privatization forces makes the following questions imperative: Which functions should be retained by government organizations, by constituencies (organized water users at certain levels in the river basin), and which functions can best be executed by private bodies and companies?

Here it is expedient to distinguish the caretaker function of government from its production function. The caretaker function is concerned with safeguarding the national interests and assets, and may include monitoring water rights, providing storage, ensuring flood protection, undertaking multipurpose works, monitoring water quality, and ensuring catchment protection. This caretaker function is a typical role of government not suitable for privatization. The production function may involve the provision of specific services in such water sub-sectors as irrigation and drainage, water supply and sanitation and energy. The production function may, in principle, be privatized; but only if the nature of the good (or service) is prepared, and if there is no threat of monopoly formation or other market failures. The experience so far with privatization of water companies in a country such as the UK is not reassuring. In practice, it means that pure privatization is rarely an option in water resources management. "A greater role for the private sector in many ways also requires a stronger role for government". A better term for privatization may thus be "public-private partnership." Most arguments for involving the private sector in water management activities are centred on the need to improve delivery efficiency through the infusion of private capital (Andah K. 2002).

The level of unaccounted-for-water in most of the water supply distribution systems is very high in almost all urban centres in Africa, as high as 50 per cent in some cases This loss has two main components: the physical water losses and non-revenue losses. The task of recovering the unaccounted-for water and revenue has become arduous in many countries due to lack of capital investment for modernization of the distribution network and also for an effective metering system. This situation has led to the call for either private participation in or privatization of the water supply system as the ongoing debates in Ghana amply testify (Andah K. 2002). The

Ghana Water Company, after futile attempts at improving the efficiency of the distribution network with World Bank support of about $US 6 million, came to the conclusion that an urgent need existed for capital investment that could only be found through private participation in water distribution. There is, however, a strong opposition to this recommendation from some political parties, NGOs and some sections of the urban population.

It is now generally accepted that water is not only an economic good but also a social good. This means that any new strategy must not only be based on pure economic and financial considerations but should also take account of the need for equity and the basic needs of the poor and vulnerable and therefore recognising the intrinsic value of water. One of the bones of contention in the Ghanaian debate regarding tariffs is on how to define the socially necessary water demand. While the NGOs prefer a geographical approach based on level of affluence, the official sources opt for a fixed monthly volume of water to be socially priced within a rising block tariff system. It must be noted that due to lack of data on African residential households, this type of tariff system more often leads to the poor subsidizing the more affluent households (Andah K. 2002). In the absence of an effective control and regulatory body for monitoring water supply and sanitation provision by public and municipal institutions, the question arises as to which body would defend the poorer sections of the society from a privatized system.

Sustainable Water Use in Africa

As said earlier, the value of water becomes complex when viewed from an African perspective, where modern economic values are interspersed with traditional values and, more importantly, from a socio-economic point of view. Two cardinal issues of sustainable development of Africa concern: (a) universal access to safe drinking water and sanitation and food security and (b) their attendant impacts of health burden and famine. It must be emphasised that, in Africa, the lack of access to and control over water is both a primary indicator and a primary cause of poverty. From these emerge various value perspectives which have to be taken into consideration when considering sustainable use of water in Africa, including, as Jack Moss el al. (2003) outlines:

(a) The environmental value of healthy aquatic ecosystems and the things that depend on them such as fisheries, tourism, recreation, survival of all species including humans;
(b) The social values of water the substance, water resources, and water services. This includes sub-categories such as the value of universal water supply service (100 per cent coverage) or subsidized water supplies for the poor. These issues are also clearly related to the concept of a human right to water;
(c) The value of public health which, in Africa, becomes an intersection between the social and economic values of water and, therefore central to social and economic development and the quality of human life;
(d) Economic values such as operational and allocational efficiency as regards wastage in water supply and irrigation;
(e) The value of water in production and product use, especially for water-dependent industries and agriculture;
(f) The value of low-priced water (and other basic services) to politicians whose re-election or continuation in power depends on the perception that they are serving their constituencies.
(g) Values relating to gender.

This calls for bridging the value divide between those who by valuing efficiency over equity tend to support development of water markets and those who by valuing equity more tend to oppose extension of water markets. In Africa, when water the substance is readily available and agriculture, domestic and other water uses are economically efficient, the resultant improvement in food security and public health would go a long way

to serve the social concerns of the vast majority of the rural and peri-urban populations of Africa, referred to as the “ecosystem people” by Reed and Wackernagel (Swatuk L.A. (2005). There is a general consensus that universal water supply and sanitation services are socially desirable and valuable because they represent a civilized way of living collectively, and are important for human dignity. For example, in Ghana, poor rural communities became more confident in receiving visitors and talking to government officials when they are able to provide clean cups of water to their visitors as the traditional Ghanaian hospitality requires and, in Tanzania, access to water allowed people to meet their religious duties when they can wash up before praying (Jack Moss, 2003).

The aim of achieving economic development and growth has led to overuse and misallocation of scarce resources, leading to escalating environmental costs. The increasing gap in demand and supply of water in the face of growing population and economic development has thus become a challenge for sustainable development in developing countries, especially Africa .The awareness of this situation and the consistent calls on African Governments to initiate actions to meet various international (MDG) and regional (Africa Water Vision) targets have led most African countries to adopt integrated water resources management strategies within national water policies. This is a decisive turn from the fragmented way of facing water problems to an integrated vision which will surely take into consideration the value aspects of water the substance, the resource and water services.

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ENSURING THE KNOWLEDGE BASE

Since ancient times, water harnessed from water bodies such as rivers, lakes, seas and others, using various scientific and technological methods, have hugely influenced the development, including socio-economic development, of the human society. All the ancient civilizations were distinctly and predominantly hydraulic in nature since they owed their establishment to the availability of water resources to meet their consumption, agriculture and inland transport requirements. Examples of prominent ancient river valley civilizations that flourished during the period 2000-3000 B.C. were the Mesopotamian civilization in the valley of Rivers Euphrates and Tigris, the Harappan civilization in the Indus valley and the Chinese civilization in the Huang-Ho River valley; the Egyptian civilization is the most relevant to Africa. The original Nile valley in Egypt consisted of an uninterrupted swamp subjected to seasonal floods and surrounded by deserts. There are indications that under Menes, the legendary founder of the first dynasty, the first stone filled dam was constructed in Menphi (the ancient capital of Egypt) as far back as 4000 years B.C. This made it possible to cultivate a large expanse of the surrounding arid area. By 2500 B.C., a canal for potable water had already been constructed between Cairo and Suez. Successive attempts were also made to construct a navigation canal between the Mediterranean Sea and the Red Sea, following almost the same layout as the present Suez Canal. An extensive system of canals and impoundment basins was constructed during the reign of Ramsey II in the fourteenth century B.C. In the years 1319-1304 B.C., Egyptians constructed a stone-filled dam six metrers high and 2000 metres long on River Asi (now River Oront) and it is still in use today.

Generally, water is used in a wide variety of human activities which can broadly be classified into three main categories. Thus, water can be seen:

(a) As an indispensable physical substance for drinking, for the daily necessities of people, for agricultural production and animal husbandry, for the production of many industrial products and for the technological processes of production;
(b) As a necessary medium for fisheries, water transport, recreational and suchlike activities;
(c) As a mass, used (by creating a fall in water level) for producing mechanical energy which in turn is transformed into electrical energy in most cases.

In its relationship with human societies, water if excessive also causes destruction to life and to domestic and industrial installations through floods and storms. When scarce, it can bring devastation to agricultural production and famine.

> Knowledge is the engine that drives economic growth, and Africa cannot eliminate poverty without first increasing and nurturing its intellectual capital.
>
> *From the keynote speech by Philip Emeagwali at the Pan African Conference on Brain Drain, Elsah, Illinois, October 24, 2003.*
>
> Source: The Sub-Saharan Informer, Vol. II, No.044, Nov. 07-13, 2003.

The level of water resources development in almost all the water use sectors in many African countries is still very low. The available knowledge base could be profitably applied if accompanied by proper policy frameworks for planning, development, and management of water resources, taking advantage of advancements in water science and technology as well as lessons from the achievements and setbacks of the developed countries. through appropriate knowledge and technology transfer mechanisms. It can therefore be inferred that ensuring the knowledge base for Africa's water resources development and management boils down to knowledge and information transfer within the general framework of technology transfer. The dynamic relationship

between water resources technology and development does not lie with technology per se but with the organization of water and land management. This raises the question of appropriateness of technology in a given socio-economic milieu. If technology is to be considered as a tool (hardware or software) then the question of its appropriateness is simply a matter of choice which is a human responsibility. For technology transfer to African countries to be effective, it must be accompanied by a long-term process of human and institutional capacity building in an enabling environment with the necessary general infrastructure, professional climate and incentives. It is not sufficient to adopt and adapt knowledge bases developed in other physical and climatic regions to Africa's needs. Such a knowledge must be infused into local knowledge and experiences within Africa in order to take full advantage of traditional wisdom. It is interesting to note that two United Nations Agencies have been supporting projects in Africa involving local and indigenous knowledge systems. The International Fund for Agricultural Development (IFAD) is involved in a series of projects on soil and water conservation (SWC) with emphasis on local techniques and the Food and Agricutural Organization (FAO) has also sponsored an information research on knowledge and management systems used mainly by African herders.

Some Examples of African Indigenous Knowledge Systems

A policy document of the International Fund for Agricultural Development on SWC in sub-Saharan Africa has identified and analyzed a range of issues for designing SWC and planning strategies. The document states, "The first step in the design process of a new SWC programme should be the identification of indigenous farming systems, and the next step should be to determine whether and how these conservation techniques can be used as starting points or building blocks for a new programme, and how their efficiency can be improved." (Chris Reij, 1993). No fewer than 21 countries in East, West and Southern Africa have benefited from the special programme for sub-Saharan countries affected by drought and desertification in the period 1988-1993 (table. 16.1)

Local knowledge of natural resources is made up of three types of information: (a) accumulated cultural knowledge, (b) knowledge modified through contact with other cultures, and (c) progressive learning of the environment. In almost all cases discussed in the previous sections, the knowledge of natural resources, whether, climate, plants, water or disease, is accurate and sometimes similar to formal science. The classification and nomenclature of soils, geomorphology and vegetation shows detailed knowledge of micro-variation in resources, and sources of environmental risk. The classification systems depend on the complexity and diversity of the local environment, but will also indicate patterns and priorities of use. The same resource may have different names, and conversely, different things may have same name because they share an underlying concept. For example, the Ikale of southwest Nigeria have the same name for fertilizer, pesticide, and witchcraft because all three connote power and control over the environment. In addition, vernacular names are often of restricted local use, even from one village to the next. Classification systems, at least for plants, also appear to be more detailed among pastoralists than farmers living in the same area, although more comparative studies are needed before this point can be generalized. For example, the Amhara farmers of Ethiopia lump more plants together into generic names than the Somali pastoralists who use the same area (FAO CF Note 4, 1990).

The process of environmental degradation is another ecological feature that is known in detail. For example, the Fulani of northern Burkina Faso perceive degradation by changes in plant composition and decrease in soil cover, and have names for all types of soil degradation that formal science recognizes[134]. Both the Fulani and Twareg believe certain rangelands are "dirty" or

polluted due to overgrazing, and certain forages are "weak" due to excessive animal pressure[135]. The Dinka of the Sudan look at the quantity of manure left by livestock in order to detect overuse of the range (FAO CF Note 4, 1990).

The building of small barrages and dams has been observed among a few pastoral groups. "Hafirs" or small stone walled barrages are common in northern Sudan, Somalia, and among the Zaghawa of Chad. Unfortunately not much has been written on their management such as organization of the construction and management tasks, design and location. The use of surface catchment basins appears to be more widespread in North Africa and elsewhere than in Sub-Saharan Africa. For example, in Tunisia many different types of water harvesting systems are used to irrigate crops and forage, to recharge aquifers, and to create stock ponds and reservoirs (FAO CF Note 4, 1990).

Box 16.1: Indigenous Knowledge on Soil Types

The Bambara agropastoralists of Mali have one of the most complete soil classification systems. They distinguish 7 major soil types, which very regularly correspond to western soil texture types. The level of classification is not equally detailed for all soil groups. The most detailed division is for the sandy soil, due to the fact that these are used for cultivation. They also distinguish soil colour - not just hue but also greyness/brightness and darkness/lightness (similar to formal science). They also classify soils according to their inundation potential, ease of cultivation and potential for certain crops.

Indigenous Knowledge on Vegetation Types

The Maasai of Kenya differentiate between pastures and the "wilderness" (the former used for grazing, the latter for hunting), and divide pastures into lowland (wet season) and highland (dry season) areas. The Fulani of northern Burkina Faso recognize 4 major vegetation communities, each divided into different range types. The Zaghawa distinguish many different range types, depending on their forage value (coarse, tender, salty, poisonous, etc.) and effect on livestock (constipating, irritating, nutritious, etc.). The Mbozi of Southern Tanzania have several broad vegetation types, but in the same type will have different names according to the density of vegetation. The Wodaabe categorize plants according to the type of soil they grow on and in which they are best suited to. The Twareg distinguish many different woodlands, e.g. "efei" is a large area with big trees, "afara" is an area with a mixture of trees, bushes and herbs, "taferfera" is a dense thicket, "agoras" is a line of riparian trees, "abatol" is a small, isolated wooded area, "amesekni" is an isolated, remarkable tree in the middle of grassland/desert, or an isolated tree of one species in the middle of a forest which is used as a point of reference.

Source: FAO CF Note 4, 1990 Community Forestry: Herders' Decision-Making in Natural Resources Management in Arid and Semi-arid Africa

Table16.1: Best Practices on Indigenous Knowledge (IFAD supported projects)

Type of Intervention	Indigenous Knowledge		Country/Parner
Soil and water conservation (SWC) techniques and cultivation practices	Indigenous techniques of soil and water conservation, like rows of stones and traditional planting pits (tassa) to rehabilitate degraded plateaus	In 1994 - a year with enough rain - the millet yield was 296 kg/ha without intervention. With the SWC technique and manure, the yield was 969 kg/ha. Adding fertilizer brought the yield to 1486 kg/ha.	Mali Chris Reij Vrije Universiteit Amsterdam
Dynamics in Indigenous Knowledge: innovation in land husbandry in Ethiopia	Riverside wall locally known as seytan madewa (devil's tie) using the force of the river's own water to press one stone against the other and, in effect, to 'tie them together'	The practice of placing stones in the devil's tie below dams and building riverside walls has spread throughout the neighbourhood areas	Tigray Region of Ethiopia Fetien Abay ISWC Ethiopia Coordinator Mekelle University College P.O. Box 231, Mekelle Tigray Ethiopia
A semi-quantitative spatial assessment of water erosion based on limited information using expert knowledge and real-valued observations	The hypothesis is that local people have an institutionalized memory of the hazard of soil erosion under various land-use systems. Local experts show remarkable consistency and accuracy in their assessments of erosion hazard which can be used to prevent the natural resources degradation	• Soil erosion can be assessed on the basis of relatively little data. • By combining "scientific" and indigenous assessments of soil erosion, it is possible to make an adequate diagnosis of the erosion hazard in areas where data is lacking but quick action is required.	Ethiopia Ir. B.G.J.S. Sonneveld Vrije Universiteit Amsterdam Faculty of Economic Sciences and Econometrics Centre for World Food Studies

Box 16.2: Indigenous Knowledge on Climate Prediction

The Turkana of Kenya say that several birds (ground hornbill, green wood hoopoe, spotted eagle owl, and night jar) and frogs are prophets of rain. In western Kenya people use indicators of frogs, birds, white ants, lightening and rise in swamp waters to forecast rainfall. In Zaria, Nigeria, certain birds indicate a drought. In northeast Tanzania, the indicators of beginning of rains are (in order of frequency of response): increase in temperature, lightening, change in patterns and behaviour of birds, insects and mammals, and three different types of plant changes (flowering, new leaves, grass wilting). In the same area, forecasts of end of rains depends mostly on meteorological factors (ie. drizzling or steady rainfall, wind strength, temp change, etc.), but also fauna (e.g. bee swarms, birds changing colour) and flora (ripening of seeds, decline in bamboo fluid, etc.).

The Fulani of Mauritania predict seasons by the position of the stars; for example, when the big dipper “jungo niiwi” is directly above (ie. August) then it is time for the most abundant rains, and when its tail is pointing to the top then it is the end of the rainy season. In western Nigeria, farmers start planting when the new leaves of the baobab tree (Adansonia digitata) and Chlorophora excelsa appear, and when the “konkoto” bird stops singing. The quality of the rainfall (i.e. its quantity and distribution overtime and space) is usually evaluated after the end of the season, based primarily on meteorological factors. For example in north-eastern Tanzania, some factors are the distribution of rains, fogs, sunshine periods, etc.. Only one record was found of the prediction of the quality of rainfall; namely, the Kamba farmers of Kenya believe that a rainbow means no or little rain will follow.

Indigenous Knowledge on Water

The treatise of A.S. Ba (1982) provides a rare but detailed look into the “water lore” of the Fulani of Mauritania. They have a detailed art of detecting ground water. Their indicators are based on topography (e.g. shallow aquifers can be found near natural ponds or in depressions of mountains), on plant species (especially tap-rooted trees such as *Bauhinia rufescens, Tamaris senegalensis, Capparis decidua,* and *Acacia albida,* but also perennial grasses, such as *Vetivera nigritana,* and *Panicum anababtismum*), and the health or vigour of the plants, such as the greenness of leaves during the year. Other indicators are based on fauna (e.g. wild boars only live where they can dig and find moist soil; other animals that prefer to stay around moist places are caimans, amphibious lizards, tortoise, band of butterflies, some bird species, and many termite hills). The Fulani also are familiar with the geological strata in their area, and that they must dig through the whole layer of red or grey clayey soil and arrive at the sandy layer before finding ground water. A good quality ground water that is clear, sweet, and has a good mineral content, is indicated by the presence of *Guiera senegalensis, B. rufescens,* termite hills, and the depth of wells (the deeper, the better quality). The best quality natural ponds are indicated by the presence of water lilies, followed by *Acacia nilotica,* and *Mitragyna inermis.* Bad, diseased water, is indicated by the presence of the grass *Echinochloa pyramidalis.* Water quality is also tested by immersing a leather container in it. The best water does nothing to the leather, and as the quality of water deteriorates, the intensity and duration of the colour of the leather will change to white, black, red or finally yellow/orange. Water quality is also evaluated by its effect on livestock, especially their behaviour after drinking (whether they are content or not) and the yield of milk.

Indigenous Knowledge on Well Management

Among the Wodaabe of Niger, wells are owned by lineage segments, but others are allowed to use them according to strict rules (“buto”). In addition, the dry season camps are dispersed and as tar away as 70 km, and are moved every 20-30 days around the well, to avoid overgrazing. The northern Somali manage communal wells through an elected committee of 3-20 people, called “guddiya warta”. The members of the committee are the water managers, “sagaale”, who allocate water to the community and guests, guard the well, enforce and devise rules of use, charge fees if any, and maintain the well. The Borana of southern Ethiopia have an elected elder of the clan, “abba ela”, who supervises the well according to Borana laws. A council of elders supervises the Abba ela, and appoints a caretaker if the Abba ela is temporarily absent. The users of the well also form a council, “Cora ela” who have ultimate authority over the Abba ela and the council of elders. A “father of the watering order” appointed by the Cora ela regulates daily use of the well by appointing two men to supervise the livestock, a man to sweep and clean out the dung, a man to coordinate the action of the line of men and women (also chosen by the father of order) who draw water with containers and pass it along to a basin. This line can be 15-20 persons long. The basins are plastered with clay every morning, and the well maintained after every rainy season.

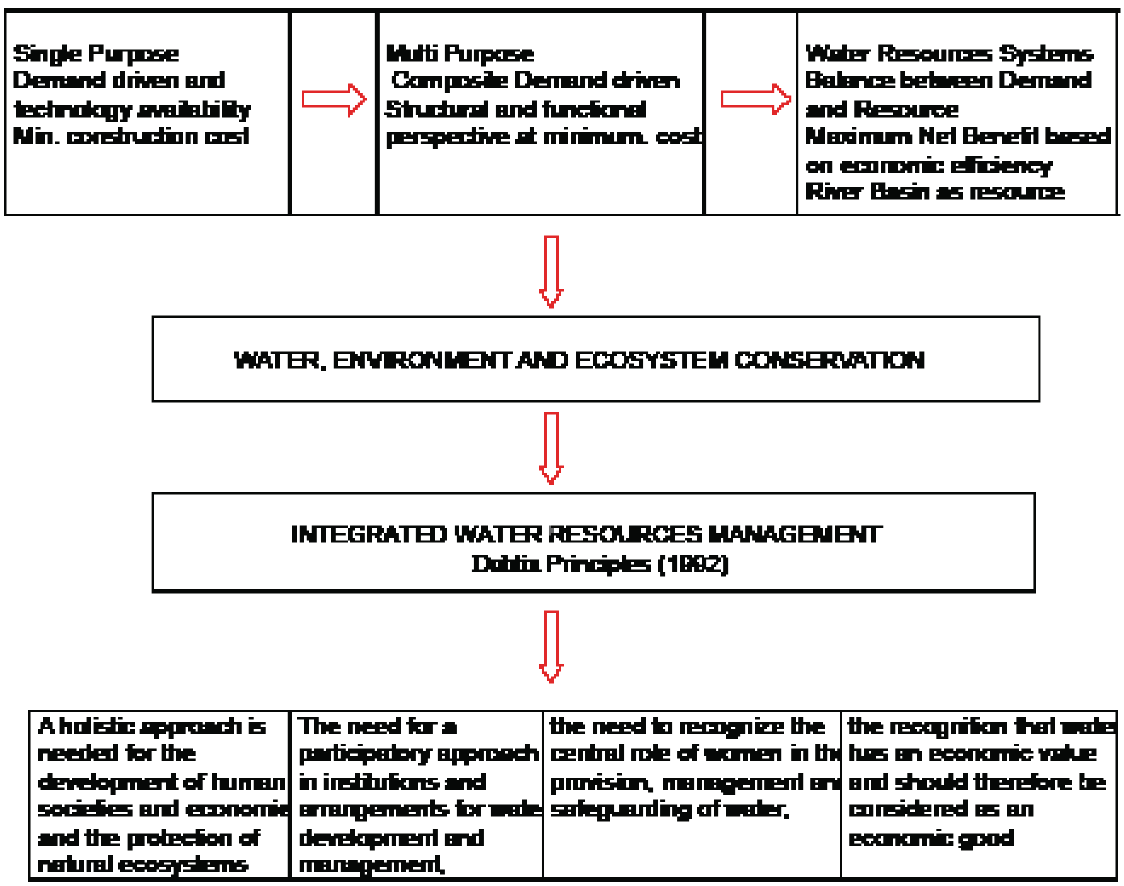
Source: FAO CF Note 4, 1990 Community Forestry: Herders’ Decision-Making in Natural Resources Management in Arid and Semi-arid Africa

Water Resources Development and Management – The Knowledge Process

Water resources development was initially envisaged as mainly a demand driven process of satisfying a water need be it for energy, irrigation, domestic water supply or even flood control at the expense of water as a resource. For many decades the availability of water was taken for granted. With the technological advances of the mid-1950s, the multipurpose basin-wide concept became prevalent and environmental impact assessment was integrated into the planning stage.

The development of water resources has therefore passed through various phases from single purpose to multi-purpose projects, gradually crystallizing into what is now generally referred to as water resources systems (Fig. 16.1). As demand on water resources increased and became more complex and the problems of water pollution and water quality control also began to increase, there emerged the awareness and the need to shift from the minimization of construction costs to the maximization of net benefit from well-developed water projects, leading to a more complex project evaluation criteria mostly based on economic efficiency.

Figure 16.1: Evolution of Water Resources Development and Management



The present day call for integrated water resources management (IWRM) is based on the further realization that water is both an economic and a social good and its development and management must be carried out in harmony with the environment. Integrated Water Resources Management (IWRM) therefore calls for a holistic approach and has initiated. a process which aims to ensure the coordinated development and management of water, land and related resources to optimize economic and social welfare without compromising the sustainability of environmental systems.
Up-to-date knowledge bases and modern technologies are needed for:

(a) The development of an integrated perception of the interconnected processes involved in the hydrological cycle;
(b) The quantification of the elements of the hydrological cycle at all scales and their interrelations, much needed for the planning, design and operation of water resources projects and for various applications in agricultural and environmental activities;
(c) Hydrometeorological data collection, management and network design, and also for the monitoring of processes such as climate change, desertification, freshwater availability, environmental degradation and natural disaster prevention;
(d) Information communication aimed at enhancing the growing role of the public in water decision making.

The multidisciplinary nature of water resources makes it highly dependent on the development of other branches of science and technology such as: Mathematics, Physics, Biology, Chemistry, Geography, Fluid Mechanics, Electronics, Hydraulics, Hydrology, Computer Science and other social sciences. The invention of computers and their subsequent developments have contributed immensely to the development and advancement of science and technology in the field of water resources development and management. Many hitherto unresolved theoretical formulations in hydraulics and hydrology have now found cheaper and faster solutions. Specifically, water resources technologies needed for an effective integrated water resources management should include the following:

Data Collection and Management

An effective water resources development and management depends on the sufficiency, quality and management of data on the various components of the hydrological cycle and the environment. Boxes 16.3 and 16.4 give some information on water-related databases in Ethiopia and Mauritius. Technologies are still needed to overcome the differences between the temporal and spatial scales of such physical phenomena as rainfall and discharge as well as the mode of their measurement. For example, rainfall is a spatial process while its measurement is at a point, and it is still difficult and expensive to have a continuous measurement of discharge in the form of time series, which is mostly needed. Even though there are software technologies to effect the necessary conversions, further development of the radar and satellite technologies (though expensive) is expected to augment data resolution and coverage. The more innovative modern technologies include:

Remote Sensing

In contemporary scientific circles, it is recognized that remote sensing can help provide a better understanding of the space-time behaviour of such conditions as potential evaporation, rainfall, nebulosity, surface temperatures in oceans and continents, land surface conditions and vegetative conditions. In the hydrology and water resources sector in particular, many positive results of research have been achieved to date in the area of remote sensing of various hydrological variables, and some of these are already in operational use. This technology in hydrology and water resources can be potentially used particularly in: pre-

Box 16.3: Water Resources Information Centre (WRIC) - Ethiopia

{Water Resources Information and Natural Resources and Environmental Metadata Base Centre)
The centre was incorporated in the current structure of the Ministry of Water Resources in 2003 in fulfilment of the requirements of Article 2.2.4 of the Ethiopian Water Resources Management Policy. The centre provides the following services:

(a) Metadata: Administration of the metadata base created jointly with six other government institutions and which information on all existing natural resources of the country;
(b) GIS and Remote Sensing: The overall expected service under this category is to provide to all users with geo-information. The type of services in this regard include, extracting digital information from existing study reports; digitizing mapping information; preparing analysed information for the benefit of users; compiling information to assist decision makers; preparing geo-technical presentations for meetings such as workshops and conferences and to publicize existing data and information to potential users;
(c) Information System and Technology: The service expected is to introduce information systems and technology in the institution and bring up to date all users with the existing technology, to the extent that resources allow. Some of the services included are: to train staff in IT; to computerize services of the different departments and services; to develop and administer the Ministry's Website; and to administer the Ministry's Local & Wide Area Network;
(d) Library and Documentation: The service under this is essentially a library service. The Ministry has one library with a modest collection of technical books and literature relating to water resources development and management. Copies of all study reports are deposited in the library and are available for reference. The library gives service to all users interested in water resources development and management

Box 16.4: Inventory of water-related databases in Mauritius

The CWA Master Plan update (1990) has a whole chapter on the available hydrological data over the island. According to the report, the setting up of hydrological stations and data collection dates back to the 18th century. Presently the CWA and the Meteorological Services have compiled in tabular, digital and mapped format the following information:

1. Digital maps of the water supply network, surface water abstraction and groundwater abstractions at the Central Water Authority.
2. Digital maps of the surface and groundwater resources (aquifers boundaries) at the Water Resources Unit.
3. Digital maps of the topography of the island have been produced by the Ministry of Land and Housing.
4. The MSIRI has produced pedological and soil maps for the island, and these are available in hardcopy format.
5. The Water Resources Unit publishes daily river flow data at selected river gauging stations and minimum and maximum groundwater levels at selected observation wells in hydrological reports every 2 to 3 years since 1967 (CWA Master Plan, 1990).
6. The Central Water Authority (CWA) data bank contains annual and monthly rainfall for 140 stations for the period 1951-1988, as well as daily rainfall for the same period regarding about thirty raingauges; West, North and GRSE basin essentially (CWA Master Plan, 1990).
7. The CWA compiles monthly abstractions from rivers and aquifers for domestic, agricultural and industrial uses.
8. The CWA has compiled a set of geological logs for large, medium and small diameter coreholes.
9. The Meteorological Services operate weather stations over the island, and they have compiled a digital database for these information.

The Ministry of Environment is currently developing Environmental Information Systems which will compile as much information available on water quantity and quality for the whole island (GWP, 2005).

Source: AWDR National Report, 2005

cipitation monitoring; determination of surface water extent; monitoring surface water balances, soil moisture status; monitoring sediment load in rivers and lakes; groundwater exploration; soil erosion; estimation of evapotranspiration; and the extraction of physiographic and basin characteristics for hydrological and water resources purposes.

Geographical Information Systems in Water and Land use Planning

In the last few decades, the development of earth science disciplines such as geology, geography, hydrology and soil sciences, and the ever-increasing demand for a rational use of natural resources such as water, land and mineral deposits, have greatly enhanced both the collection of spatial data, and the production of a variety of general-purpose or special-purpose maps. Maps are, indeed, the best method for reducing very large-scale spatial relations so they can be easily perceived and analysed. Thus maps can be very useful in obtaining geo-environmental data (such as geology, geomorphology, hydrography, land use/cover data) and social data (such as population density, distribution, transportation facilities and water works) based on ground surveys, aerial photography, and possibly high-resolution optical satellite imagery.

From Knowledge to Technology: Water Resources Systems Design and Management

Generally, the mode of development of software technologies also determines their transfer modality. Those developed by mainly professional firms are normally covered by patent and author licenses and can therefore be acquired through purchases, which make them less affordable to African practitioners. In contrast, those technologies developed by academic and research institutions are transferred through research and development processes.

Professionally oriented water software technologies are available in such areas as:

(a) *Urban storm-water management:* In which a package of sub-programmes is usually used to determine:

- (i) Urban runoff quantity (some kind of rainfall-runoff analysis, for example, using hydrographs);
- (ii) Transportation through drainage networks (flood routing);
- (iii) Storage and treatment; and
- (iv) Water quality effects on receiving waters.

(b) *Rainfall-runoff analysis:* In which sub-programmes are used to simulate the response of watersheds and stream networks to given rainfall and, sometimes, snowmelt conditions. A methodology followed in some of the packages is the standard United States Soil Conservation methodology;

(c) *Water supply network design:* For looped pipeline networks, flows and pressures in the network which can be calculated in an iterative manner. The method of Hardy-Cross is used to solve the resistance equations, which can be the Hazen-Williams, Darcy-Weisbach, or Manning formulation;

(d) *Flood frequency analysis:* In which packages are set up for flood frequency analysis using a distribution such as the log-Pearson Type 111 or the Gumbel, or sometimes giving the user a choice of distributions;

(e) *Flood routine:* whereby an inflow hydrograph already calculated using rainfall-runoff analysis can be routed through a hydraulic channel and/or a reservoir (detention pond) to obtain the outflow hydrograph. The methodology is generally that of quasi-steady flow, using the Chezy equation with either the Manning or Darcy-Weisbach formulation for friction coefficients; and

(f) *Data management:* The software for this function is often patterned after United States Environment Protection Agency database systems which may contain programmes to:
(i) Screen the input data;
(ii) Fill in missing data, using regression techniques;
(iii) Carry out statistical analysis of the data;
(iv) Generate synthetic series; and
(v) Simulate hydrological processes.

Research variety water software: Most of these programmes are developed by universities, government research institutes, or large consultancies, often for a specific research project, and not for general use. Organizations like the United States Army Corps of Engineers, the Delft Hydraulics Laboratory, or the Danish Hydraulic Institute, just to name a few, routinely use a large number of computer models that could be classified as "research-related packages". These include:

(a) *Watershed management and water balance*: Most watershed models are composed of a set of the following elements depending on the particular application:
(i) rainfall-runoff;
(ii) evapotranspiration;
(iii) energy balance (if snowmelt is important)
(iv) erosion;
(v) runoff routing;
(vi) transport of chemicals (nutrients, pesticides), and/or
(vii) crop growth;

(b) *River-basin simulation and optimization:* Watershed models deal with the part of the hydrological cycle from rainfall to the time when the water ends up in rivers or lakes. River-basin models deal with the different ways water can be used in a river-basin. They usually include some kind of storage in reservoirs, routing through a hydraulic network, and some representation of different uses, at the very least, agricultural and domestic water use. Another important distinction between various river-basin models is whether they are simulation models or optimization models;

(c) *Flood control and floodplain management:* There are two types of formulation of such models which can be presented purely in physical terms as hydraulic/hydrological programmes to determine the change and extent of flood patterns and also as economic or planning models that deal with the effect of flooding on the floodplain users;

(d) *Reservoir operations:* For reservoir operations models, as for river-basin models, the distinction between simulation and optimization is important. The objective of reservoir models is to get the maximum amount of benefits out of a reservoir, given a time series of upstream inflows and downstream demands;

(e) *Ground-water models:* Ground-water models are generally large, and most are of the research variety. Some of the less complicated packages are offered commercially, usually costing more than $US 1,000 to start with. Ground-water models are either two-dimensional or quasi-three- dimensional;

(f) *Systems management:* In recent years there has been an increased interest in computerizing the operation and maintenance of complex systems such as irrigation systems or water supply networks. A large number of component elements generally make a system complex;

(g) *Dynamic programming:* Dynamic programming (DP) is a rather sophisticated optimization technique that can handle prob1ems that change over time or involving stochastic processes. In contrast, linear programming is more adaptable to deterministic

processes and situations or to an optimization at a particular point in time. The dynamic optimization in DP is done through evaluation of a number of time steps.

Appropriate Technology or Effective Technology

Ensuring the knowledge base in Africa through the creation and dissemination of knowledge on water resources development and management can be facilitated through technology transfer. Here technology boils down to know-how. The term appropriate technology sometimes has misleading connotations not only in African countries but also to those producing substitutive technologies at cheaper prices. It has therefore assumed more socio-economic implications than the actual problem-solving necessity that the technology must address, thus becoming mostly confused with affordability. Unlike in other fields, the object of study in hydrology and water sciences is not created by society but exists according to its own laws of occurrence, undergoing continuous transformations due to the impact of man in a changing environment. The appropriateness of a technology has to be measured and evaluated on the basis of how much knowledge and benefits could accrue from its application. In water resources, the concept of first class and second class products must not exist since a water project not adequately designed and executed could procure more damages than the expected benefits.

Most failures in water projects in Africa are not due to improper technological application but to lack of knowledge and skills that must accompany the selection and use of a given technology. The other problem, not secondary, is the problem of data collection, archiving and retrieval which until just a few years ago was still done manually.

Almost all African countries are now gradually acquiring personal computers for data management, most often through bilateral aid and grants. With the increasing awareness of the global nature of hydrological processes, gradually moving from narrow catchment hydrology into a global one, the choice of technologies should not transfer the unequal socio-economic levels of development onto the physical hydrological scale. For example, the general lack of climatic and hydrological data sets in African countries is impeding research into climatic teleconnections and climate change studies at both the continental and global scales.

The effectiveness of technological use in water resources assessment, development and management must be measured by the efficiency of prediction of water availability and the general reduction of the uncertainties inherent in the quantitative perception of the water cycle elements. An example can be cited of the general low water use efficiency in irrigation systems and in water supply distribution networks in most African countries. In order to reduce the large component of unaccounted-for-water in water supply networks there is the need to infuse modern technologies for the effective control and real time monitoring of pressures in the distribution pipes which could offset further capital investment in water supply. One other issue of technology transfer centres on the suitability of labour-intensive technologies to the socio-economic situations in African countries. Labour-intensive technologies require more time-consuming and complex management systems, whereas modern technologies simplify management practices and are more effective in solving the required water problem.

The Problems of Knowledge Assimilation in Africa

Expected developments still elude African countries in spite of the substantial efforts put into knowledge acquisition through education and training and also the importation of foreign technology, most often at very high per capita

costs. This is mainly due to the failure to assimilate the technology into their specific physical and socio-economic entities as a result of which there seems to be little or no diffusion of imported technology into their local conditions. It is now clear that the mechanism of vertical technology transfer which is point to point relocation of technology is not feasible in African countries, rather, a horizontal approach in which technology transfer is accompanied by long-term capacity building initiatives would be more appropriate. This will then create the necessary conditions to absorb new technologies both as product-related and as process-related technologies. This implies the adaptation of a new technology to a different environment through creative transformation and application. There is therefore the need to establish specific organizational structures, policy programmes and conscious planning for the infusion of new technologies to back up the efforts at rational water resources development and management in a sustainable environment. It is also recognized that the capability of a country, a region or a water sector to exploit a particular technology is determined by its overall technological level, and this is very low in most African countries. It therefore becomes essential for Africa to give due priority to the establishment of effective infrastructure on which efficient adaptation and diffusion of technology can be based.

Specifically, water resources technologies are more process-oriented than product-related since their application is not only to develop and manage water projects but also to improve the general perception of the dynamic interaction between the elements of the water cycle, human society and the natural ecosystem. Research and development is therefore considered as one of the key tools for an effective technology transfer to developing countries as part of the general human and institutional capacity building process. A programme of capacity building in water is shown in Box 16.5 for Ethiopia

Box 16.5: Capacity Building Activities in Ethiopia

Water Technology Institute: established for the water sector to train engineers in civil, hydraulic, irrigation and water supply engineering, as well as sub-professionals in all sub-sectors of water resources development, including hydrographers and water laboratory technicians.

Groundwater Development & Water Supply Training Centre: a specialized training centre run by the Ministry of Water Resources with assistance from Japan which provides short-term training for hydrogeologists, water supply engineers, drillers, mechanics and similar personnel of Regional Water Bureaus.

Grassroots Training for Water Development and Management: The Ministry of Water Resource has opened training centres, starting in 2002, in four regions of the country for training of trainers. The target training groups are recruited by the regional water bureaus from high schools. The trainers trained in these centres are to train farmers and other community members responsible for managing water supply schemes, including basic sanitation measures in handling water up to consumption. The training also covers small-scale irrigation management.

Manpower Training for Water Resources Assessment: To cope with the volume of hydrometeorological data collection and analysis as a result of the expanded gauging network, qualified professionals and support sub-professionals are to be trained. Also the planned extensive groundwater survey and mapping will need specialists in the field to be trained. During the fifteen-year plan of the WSDP period, 20 hydrologists, 35 hydrogeologists, 11 geophysicists and 5 computer analysts are to be trained for the hydrology and groundwater programmes.

Source: AWDR National Report, 2005

Capacity Building in Africa

From the analysis above, it becomes clear that water resources technology transfer and capacity building are two indispensable activities, but the two inseparable sides of the same coin, necessary for sustainable water resources development and management. In the developed countries, these two processes are taken for granted due to the availability of appropriate infrastructure, adequate scientific knowledge bases compatible with technological levels and proper mechanisms for information dissemination and exchange. In African countries, however, there is the need for conscious and systematic efforts to create and develop such conditions which are necessary for the transfer, adaptation and assimilation of new technologies into their socio-economic environments. The capability of a country, a region or a water sector to exploit a particular technology is therefore determined by its overall legislative structures, technological level and scientific and technical know-how.

Capacity building should therefore encompass the human, scientific, technological, organizational, institutional and resource capabilities of a region, a country or a water sector to receive, update and create knowledge necessary to keep pace with the ever-increasing water development and management needs, including the present pressures for sustainable development. It is only when an enabling environment is guaranteed within the society that the human and institutional capacity building would be effective in enhancing the skills and competences needed for integrated water resources management. The capacity building process therefore should consist of the following:

(a) Creation of an environment with appropriate policy and legal frameworks;
(b) Institutional development, including community participation;
(c) Human resources development and strengthening of managerial systems;
(d) Sustainable funding.

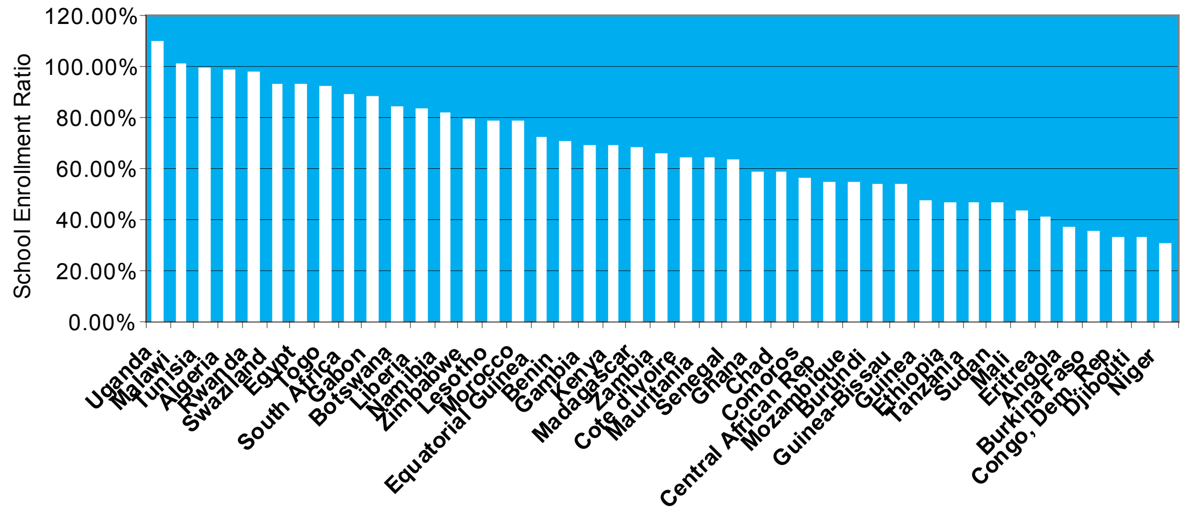
Enabling Environment

In order to achieve the institutional and human capabilities necessary for integrated water resources management there is the need to create an enabling environment within which water-related institutions, professions and the public at large would operate in an interactive manner and in harmony. It is clear from the experiences of the developed world that the enabling environment is the total capacity of a given society to absorb and assimilate knowledge and technology for the betterment of its citizens through adequate and effective legal, administrative and financial institutional set-ups.

The experiences of modern Japan and the rapid industrializing Asian countries like South Korea, Taiwan and Singapore indicate that an effective long-term strategic planning is indispensable, and this in turn requires diverse efforts including:

(a) Raising the level of schooling of the general public (figs. 16.2-3);
(b) Increasing the proportion of the population with higher education;
(c) Raising the proportion of scientists and engineers;
(d) Emphasizing research and development;
(e) Creating an environment which encourages research and development in the operational and private sectors;
(f) Strengthening state-university-industry collaborative efforts; and
(g) Creating an enabling environment and incentives for professional practice.

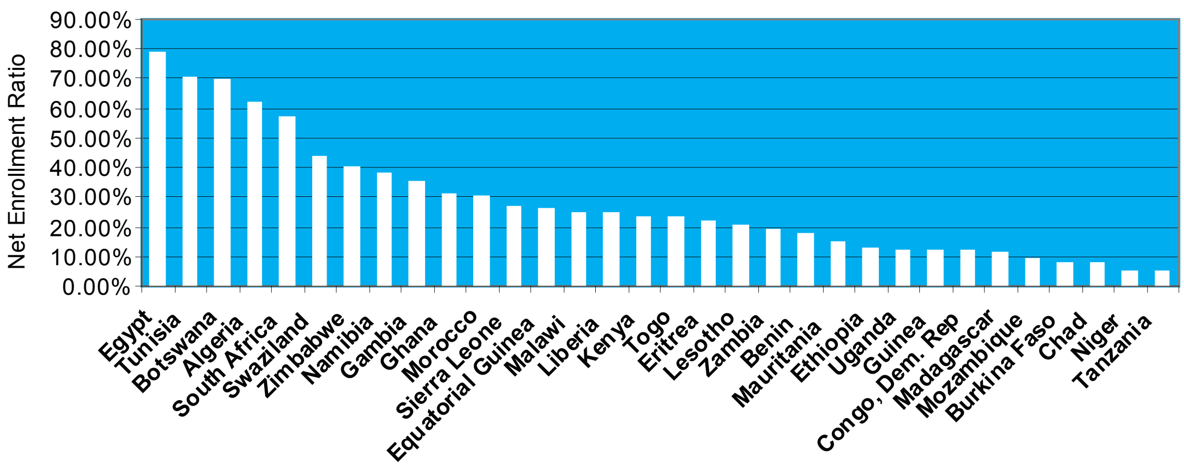
Figure 16.2: Ratio of Primary School children of official school age



Data Source: Based on the International Standard Classification of Education, 1976 (ISCED76) and 1997 (ISCED97).

In order for water-related institutions and stakeholders to grasp the complex issues of water resources in a growing situation of freshwater stress, Governments must rise up to the occasion to consider water as a scarce resource and an economic good which must be managed in its own right. This would involve the institution of appropriate legal water rights, regulations and policies which would promote integrated water resources management to meet the wider social and economic development objectives of the society. Thus, the enabling environment encompasses general infrastructure development, water-related institutions and the legal instruments that govern them.

Figure 16.3: Secondary School Net Enrolment Ratio



Data Source: Based on the International Standard Classification of Education, 1976 (ISCED76) and 1997 (ISCED97).

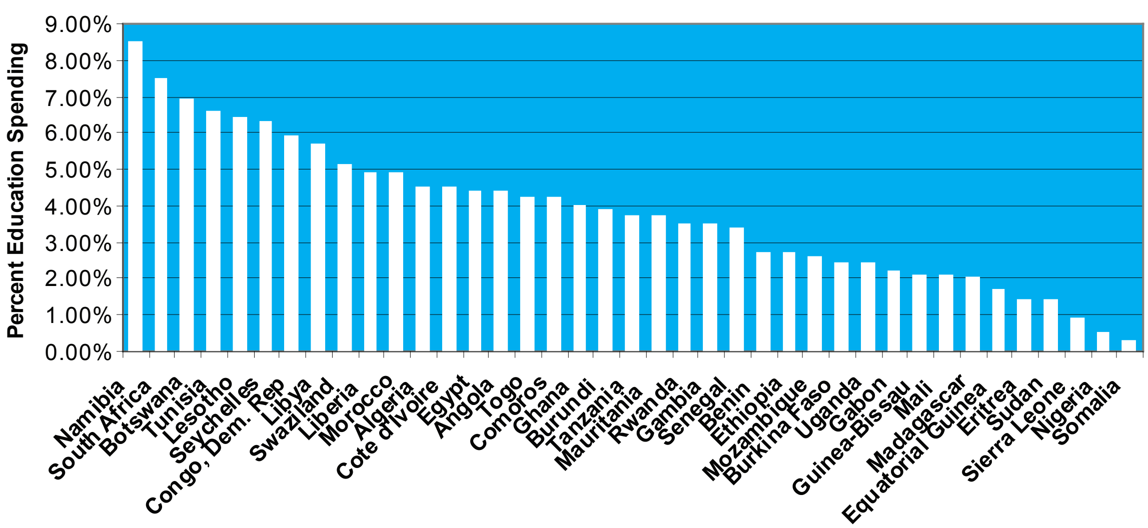
The requisite enabling environment as regards the general infrastructure level capable of encouraging the assimilation of technology transfer and information dissemination includes the following:

(a) A high level of general schooling for the public (fig. 16.4);
(b) An effective human resources management system with motivation and incentives;
(c) A relatively large number of engineers and scientists;
(d) A system for updating and evaluating the knowledge and skills of professionals;
(e) A good level of telecommunication and energy technologies with ample national coverage;
(f) Committed allocation of funds for water resources activities.

For any technology to be effective, its transfer must be backed by a process of capacity building which can be defined as the sum of efforts to enhance and utilize the skills and capabilities of people and institutions at local, national, regional and global levels, aimed at sustaining development. This would involve the building of knowledge and information bases and their subsequent dissemination among all stakeholders at all levels. Information contributes to awareness and can lead to proper perceptions while knowledge provides skills and hence contributes to competence. Moreover, strategic use of available information needs knowledge and to develop and maintain information systems requires competence. In addition to the capacity needs discussed above. The tools for technology transfer and the means of effecting capacity building more often than not converge within an enabling environment which promotes the establishment, adaptation and assimilation of technology, knowledge and information in a given society according to its political, cultural and socio-economic structures. The combination of requirements in this regard would include:

(a) Improvement in the general educational level and set-up;
(b) Opportunities for professional education and training both formal and informal;
(c) Applied research activities both at the national level and in partnership and coopera-

Figure 16.4: Government Education Expenditure (% of GDP, 1990-1999)



Data Source: United Nations World Statistics Pocketbook and Statistical Yearbook

tion with regional and international institutions;

(d) Participation in networking mechanisms;
(e) Commitment to and participation in international water resources activities;
(f) Development and divulgation of public awareness programmes; and
(g) Sustainable funding of water resources activities

Manpower Needs and Skills

One of the key limitations to a harmonious development and management of water resources in Africa is the lack of human and institutional capacity to assimilate the modern advances in science and technology necessary to deal with the complex interactions between the hydrological cycle and the societal needs, while conserving the environment. Therefore, there is an urgent need for human expertise and institutional capacity if this goal must be achieved. In Africa, especially sub-Saharan Africa, there is a general lack of specialists in hydrology and water resources planning, systems analysis and modelling. The continent lacks an adequate number of highly motivated and highly skilled water professionals who can effectively deal with the complex issues of water scarcity, climate variability and joint management of international waters.

The main problems hindering harmonious water resources management for sustainable development in Africa, as defined in the "Strategies and Action Plan for Water Resources in Africa" (UN-ECA, 1995), include those summarized as follows:

(a) Lack of provision of adequate and accurate data and information needed for water resources management at the national and/or river basin levels;
(b) Continuous depreciation of water in many African countries;
(c) The disastrous impact of excess water (floods), erosion and sedimentation, deterioration of water quality and water pollution on the sustainable development of Africa;
(d) Fragmentation of water resources management among different sectorial interests with weak overall coordination and quality control of data;
(e) Weak cooperation arrangements between riparian countries of international river basins; and
(f) Limited participation of trained indigenous personnel in the actual decision-making and management processes due to over-dependence on external experts.

Below is list showing the type of water resources concerns identified in the Africa Water Vision as specific key resource and demand issues whose resolution requires human and institutional capacities:

(a) Resource Side Issues
- (i) Multiplicity of transboundary water basins;
- (ii) High spatial and temporal variability of rainfall;
- (iii) Growing water scarcity;
- (iv) Inadequate institutional and financing arrangements;
- (v) Inadequate data and human capacity;
- (vi) Inadequate water resources development; and
- (vii) Depletion of water resources through human actions;

(b) Demand Side Issues
- (i) Access to safe water supply and sanitation services;
- (ii) Water for food and energy security;
- (iii) Too much water wastage; and
- (iv) Threats to environmental sustainability.

Apart from the lack of professionals, there is also a lack of technicians, in terms of numbers and of skills, to operate and maintain instruments and other technological needs of the water sector.

Furthermore, the introduction of new technologies and the acquisition of the skills and expertise that this requires implies financial costs that

African countries can obviously not absorb by themselves As these new technologies are, as has been said, mostly needed for the monitoring and management of hydro-climatic data and for rationalising water resources development in a situation of diminishing resources and general lack of human skills (Box 16.6), there is an urgent need to device a mechanism based on international cooperation to facilitate education and training and reduce the related costs within the wider context of technology transfer.

Modalities for Water Technology Transfer and Information Dissemination

The low level of development and exploitation of water resources in African countries versus the growing demand for water in response to population growth and socio-economic development necessitates urgent infusion of the needed technologies into water resources development and management. The aim of any technological use or transfer is to effect a given action either for water use development or for water resources assessment and management.

Obviously, a rich store of scientific and technological knowledge and information on water resources exist in the developed world, but are lacking in Africa. The problem is how to develop an effective mechanism for their transfer to the needy African countries. Water resources development had already attained a very high and saturated level even before scientific and technological methods and tools reached the pres-

Box 16.6: Scientific Basis of International Cooperation

There are strong physical and socio-economic bases for international cooperation in water technology and knowledge transfer in order to enhance the monitoring of the hydrological cycle, freshwater resources, climate change dynamics and hydrometeorological extreme events. Andah (1992) summarizes the global interconnections in water resources as follows:

Physical

(a) **Catchment hydrology to global hydrology:** The complex interaction of the hydrological cycle with the environment including the feedbacks which exist between the components of the atmosphere, lithosphere and biosphere of the planet earth;

(b) **Regional and continental teleconnections between climatic anomalies:** Analysis of spatial and temporal teleconnections of atmospheric anomalies such as the Southern Oscillation phenomenon like the El Niño;

(c) **Climate change:** Development of Atmospheric General Circulation Models and their coupling mechanisms with the regional and local hydro-climatic processes;

Socio-economic

(a) **National water resources to global water resources:** The interaction of local and regional water use with the global water needs and the import/export of Africa's "green water", what is generally referred to as "virtual water";

(b) **Land use and environmental change:** The control of land use practices like deforestation and desertification which have negative repercussions on both the regional and global climate and the hydrological cycles;

(c) **Disparity in technological and socio-economic development:** the North-South disparity means different levels of water resources development, of scientific and technological knowledge and of data collection coverage both in time and space and the urgent need for their global harmonization.

Specifically, international cooperation efforts should be directed at:

(a) Technology transfer through aid programmes and grants;

(b) Promotion of exchange of information, experience and knowledge regarding water resources; and

(c) Identification and development of joint activities in the areas of training, research and development.

ent level of sophistication. Consequently, water resources management in developed countries is now directed more towards correcting the imbalances between the physical and the social aspects of water resources development and management. In African countries, where the process of harnessing water resources for national development is at its early stages, the efforts of water resources management are to be directed more towards effective and rational planning and development of available water resources. However, in Africa, apart from the obvious problems of finance, the problem of manpower to deal with the diverse forms of water resources systems and their interaction with the environment and society necessitates maintaining a system of continuing education.

Three of the main ways of knowledge dissemination and transfer are formal and informal education, applied and joint research and networking between water institutions. Together, these mechanisms and the others also constitute the means of achieving capacity building. Through research and development, in particular, the necessary conditions for adapting and assimilating new technologies by building the necessary human and institutional capacity for integrated water resources management can be created. Thee main means of doing this are discussed below.

Education and Training

As already mentioned African countries (like most developing countries) lack the high-level academic facilities and infrastructure (including programmes) for highly advanced postgraduate training in sustainable water resources development and management. Yet in the present age of globalization, global aspects of education and training should not be ignored. The concepts of global climatic and hydrological teleconnections, and also of the impending processes of a climate change all call for international cooperation to monitor and develop water resources from a global perspective. Technologically, hydrology and water resources activities have, in recent years, been largely influenced by developments in computer and telecommunication technologies. Methodologies for hydrological and water resources assessment and modelling involve extensive use of computers and such other tools as the radar and satellite systems. Obviously, continuing education should include the dissemination of critical information on the use of these technologies: remote sensing, satellite imagery, telemetry, computer-based water resources management and decision support systems for irrigation, water supply, environmental control and others.

Formal Education: The main mechanism of technology transfer is knowledge acquired through formal educational at the vocational and university levels. At each level, students are introduced to state-of-the-art hydrological sciences and water resources systems as well as the accompanying basic technological and infrastructure requirements. Vocational training for technicians is normally done in technical institutions; specialized higher technical training within public works, civil engineering and agricultural schools. Technicians are trained on how to set up and maintain new and existing technologies. Water professionals are normally drawn from different disciplines of university education like civil, agricultural or mining engineering and other fields of physical sciences like geology, geography and physics. First degree courses in hydrology, hydro-meteorology, and water resources engineering are available only in large countries with enhanced water resources activities whereas most countries depend more on post-graduate training courses to prepare professionals in hydrology and water resources. With respect to postgraduate studies and with special reference to the UNESCO-sponsored training courses, an attempt is made at this stage to filter out background biases towards creating professional hydrologists, water resources engineers and managers. It is also at this level that attempts are made to concretize hydrological and water resources concepts and more specifically the advances in

the science and technology of the sector. Generally, the curricula are based first and foremost on the experiences of the host country and may not amply reflect specific regional and national hydrology and water resources situations of the recipient participants. At all the educational levels, the students are introduced to available hardware and software technologies and are encouraged to carry out comparative analysis of methodologies and techniques through course projects and case studies in order to adapt them to their specific problems.

Some of the considerations on which postgraduate training could focus are summarized as follows:

(a) Non-uniformity of university curricula;
(b) Diversities of professional backgrounds;
(c) Different course emphasis at various training institutions;
(d) Diverse physico-climatic environments that require specific top-up knowledge.

Continuing Education: This as a system of direct and indirect instruction aimed to reduce the lag time between professional activity and the advances in science and technology in the field of hydrology and water resources. Continuing education must be directed at monitoring the dynamics of change in the hydrological and water cycles and providing skills for detecting and managing any change. In a world, in which the physico-climatic ecosystems are continuously changing under human influence and the advances in science and technology moving at an ever-increasing pace, training cannot be static. Thus, training should be dynamic, providing knowledge that can stand the test of time, including contemporary ideas of natural disasters, the effects of an impending climate change and necessary strategy for minimizing them. Moreover, training needs would differ from country to country depending on the socio-economic level of development. The complex matrix of physico-climatic and socio-economic environments within which professionals operate requires a transversal format which could serve as a guide to national employers and employees alike.

The role of continuing education in technology transfer is to help build human and institutional capacity through a continuous process of updating knowledge with a view to adapting and assimilating technologies developed in different environmental set-ups to meet the exigencies of the receiving environment. It is in response to the progress of science and technology, the increasing demand for development and the ecological-environmental challenges of our age, all of which are calling for a larger number of highly trained water experts. The training framework should blend the multidisciplinary and multi-objective requirements of a modern water resources development for sustainable development. Continuing education could take various forms e.g. apprenticeship, short courses, distant learning, correspondence courses, seminars and workshops..

Research and Development: The role of research in technology transfer is fundamental since it creates the necessary methods and bases for discovering, understanding, updating and adapting a given technology to the new environment. Research can be basic or applied and more often than not both are intertwined. Basic research aims to increase knowledge, creating new methodologies and techniques whereas applied research is more concerned with adapting available methodologies to specific objectives and local conditions and hence facilitating their application by users, in our case by water resources institutions (Boxes 16.7, 8 and 9). Research contributes substantially to the development of both software and hardware technologies for assessment and management of water resources and also contributes to the design of water projects. Research needs vary from country to country depending on the climatic, geographical and land use conditions; the socio-economic level of development also influences research needs in water resources.

Box 16.7: Research and training Facilities in Cameroon

The Centre for Hydrological Research is the only institution in the country whose sole mandate is the assessment and monitoring of the country's surface water resources. The responsibility for ground water has been conferred to a department in MINMEE. As concerns training, the Faculty of Agronomy and Agricultural Sciences (FASA) of the University of Dschang, is the only one that offers a programme in water management. The two-year programme converts graduates from water-related disciplines into water managers in three options; agriculture, water supply and environment. The Higher National Engineering School (ENSP) of the University of Yaounde I, has an option in sanitation, and conducts research in urban water supply and management. Some NGOs like the Cameroon Environmental Watch (CEW) conduct research on water-related issues and also offer short courses in the area. The Departments of Geography in the Universities of Dschang, Buea and Yaounde, also carry out some research on water and sanitation.

Source: AWDR National Report, 2003

The dissemination and transfer of research results is one way in which the process of technology transfer between various researchers and most importantly from developed countries to developing ones effectively takes place, especially if accompanied by joint research efforts. Partnership in applied research facilitates the transfer of methodologies and techniques of proven validity in one environment to a new one through actual testing and validation using physical and socio-economic data of the receiving environment Boxes 16.10 and 16.11).

Box 16.8: The Water Research Commission (WRC) – South Africa

The WRC was established in 1971 to generate new knowledge on water and to promote the country's water research purposefully. The mandate of the WRC is:

(a) Promoting, coordination, cooperation and communication in the area of water research and development;
(b) Establishing water research needs and priorities;
© Stimulating and funding water research according to priority;
(d) Promoting effective transfer of information and technology; and
(e) Enhancing knowledge and capacity building within the water sector.

The WRC is funded by a charge levied on all abstractions of raw water. In 2003/04 the WRC spent R51 million on 395 current research projects and a further R5 million on technology transfer. This was diistributed as follows:

KEY STRATEGIC THRUST	% SHARE
Water resources management	31
Water-linked ecosystems	13
Water use and waste water management	40
Water utilization in agriculture	14
Other	2

Box 16.9: Research Institutions in South Africa

Environmentek is the water-related institute within the CSIR umbrella. It undertakes a wide range of water-related research being funded mainly from contract research but also from own resources and government and other grants. Other water and environment related research is located in various academic institutions, like:

(a) The Institute for Water Research at Rhodes University in the fields of water quality, hydrological modelling and reserve determination;
(b) The African Water Issues Research Unit at the University of Pretoria in the field of policy;
(c) The School of Bio-resources Engineering and Environmental Hydrology at the University of Natal in the fields of hydrological modelling and environment;
(d) The Institute for Groundwater Studies at the University of the Free State in the field of groundwater;
(e) The Freshwater Research Unit at University of Cape Town in the field of environmental flows;
(f) The Centre for Waste and Wastewater Research at the Durban Institute of Technology in the field of waste management;
(g) The Water Systems Research Group at the University of the Witwatersrand; and
(h) The National Institute for Water and Sanitation at the University of Limpopo in the fields of community water and sanitation issues.

Box 16.10: Bringing Research near the People

The International Water Management Institute (IWMI)

The IWMI is a non-profit scientific research organization which is engaged in knowledge base development through applied research and the subsequent transformation of the results into tools for the effective management of water and land resources in agriculture and other uses in developing countries. IWMI's research is coordinated through regional offices located in Sri Lanka, India, Pakistan, South Africa and Thailand. The Institute has resident offices in China, Nepal, Ghana, Senegal, Kenya and Uzbekistan and operates in a non-resident mode in some 20 countries, across Asia and Africa. The research activities are centred around five thematic areas which address crucial issues in the water sector of developing countries, namely:

(a) Integrated Water Management for Agriculture
(b) Sustainable Smallholder Land and Water Management Systems
(c) Sustainable Groundwater Management
(d) Water Resources Institutions and Policies
(e) Water, Health and Environment.

The professional team, comprising economists, agronomists, hydrologists, engineers, sociologists, management specialists and health researchers, guarantees a multidisciplinary approach to water management research.

The specific objectives of IWMI are:
(a) To identify the larger issues related to water management and food security that need to be understood and addressed by governments and policymakers;
(b) To develop, test and promote management practices and tools that can be used by governments and institutions to manage water and land resources more effectively, and address water scarcity issues;
(c) To clarify the link between poverty and access to water and to help governments and the research community better understand the specific water-related problems of poor people;
(d) To help developing countries build their research capacities to deal with water scarcity and related food security issues.

Box 16.11: The German GLOWA Research Cooperation Programme

The aim of GLOWA is to develop strategies for sustainable and future-oriented water management at the regional level, taking into account global environmental changes and socio-economic conditions

The Research programmes focus on case studies on large river basins where simultaneous research is carried out in a collaborative framework on interrelationships between changes in the hydrological cycle and

(b) the large-scale climate and precipitation variability;
(c) changes in the biosphere (in particular caused by land use changes); as well as
(d) the effects on water availability and related conflicts of use..

The initiative was launched by the Federal Ministry of Education and Research (BMBF) of Germany which is also the main funding institution. A GLOWA project combines up to 15 natural and socio-economic disciplines and ensures both multi- and inter-disciplinary frameworks, necessary for the development of research scenarios and tools.

The initial GLOWA programmes launched in 2000 include:

(a) The GLOWA IMPETUS: An Integrated Approach to the Efficient Management of Scarce Water Resources in West Africa – case studies in the catchment areas of Rivers Dràa (Morocco) and Ouémé (Benin);
(b) The GLOWA Volta: Sustainable management of Water Resources: intensive land use, precipitation variability and water need in the Volta basin – case study in Ghana and Burkina Faso.

Capacity Building Content of GLOWA: The programmes are formulated within the concept of a learning process in which the vital elements of knowledge and information exchange and technology development and transfer are given special emphasis. Specifically, students from both European countries and the project areas are offered the opportunity to carry out Masters and Doctoral studies using the methodological tools and techniques of these projects as part of their thesis. The partner institutions also benefit in the use of modern technological inputs of the projects and are the final users of the decision support systems being developed.

Diffusing the Knowledge Base

Generally, hydrological and water resources software have been developed in temperate climates and more advanced socio-economic conditions. Their transfer to the tropical climatic areas, where most of the African countries are, necessitates knowledge and skills for updating and adapting them to the physical and socio-economic conditions of the receiving environments. To facilitate this, much effort has been put into the creation of technology transfer systems by various organizations and institutions in the form of pools or toolkits. The concept of creating thematic toolboxes to facilitate water-related technology transfer and knowledge dissemination to the developing countries, especially Africa, is catching on fast among many international and non-governmental institutions.

WMO Hydrological Operational Multi-purpose System

The most notable and extensive of them is the Hydrological Operational Multipurpose System (HOMS), established by the World Meteorological Organization for the transfer of technology in operational hydrology. This is a pool of technologies which have been made available for inclusion in the system by the Hydrological Services of member countries of WMO based on techniques which they themselves use in their normal operations. The technology available through HOMS is provided as separate HOMS components which, for easy reference, are classified into sections according to their subject matter. Almost all African countries have established national reference centres in a relevant institution.

Global Water Partnership Toolbox

The purpose of the IWRM ToolBox developed by the Global Water Partnership on Integrated Water Resources Management, is to make available to water management professionals the rich store of experience acquired by water practitioners, specialists and decision makers worldwide. The ToolBox builds on this experience and seeks to provide a forum for sharing knowledge and experience. The ToolBox has therefore been designed by the Global Water Partnership to support the development of Integrated Water Resources Management (IWRM) worldwide.

The structure for the Tools in the ToolBox is based on the following tree fundamental elements of IWRM:

(a) The enabling environment or rules of the game created through legislation, policy and financing structures;
(b) The institutional roles of resource managers, service providers, irrigation agencies, utilities, river basin authorities, regulators and other water sector stakeholders. Capacity building supports for the functions required in the various roles;
(c) Management instruments: water resources assessment, demand management, public information and education, conflict resolution, regulatory devices, economic measures and information and communications.

Professional Bodies, and Scientific and Technical Publications

As a result of the multidisciplinary and interdisciplinary nature of water resources, water professionals belong to one or several professional bodies. They usually begin with membership of the body pertaining to their first graduation and as they progress professionally join others of relevance. Sometimes the number of bodies indicates the level of diversification that a professional has gone through. In terms of knowledge and technology transfer, professional bodies set up platforms in the form of periodic congresses and assemblies on which the progress and advances in science and technology are discussed and compared through presentation of scientific and technical papers. These presentations are normally published as proceedings for general circulation. Generally professional bodies can be:

(a) National and Regional;
(b) International Specialized Societies; or
(c). Interdisciplinary bodies.

Publications on scientific and technological developments in water resources have since time immemorial served as one of the most effective means of knowledge and information diffusion and transfer (Box 16.12). They have passed through the manuscripts of ancient times to the present day electronic publishing. The invention of the printing technology in the mid-fifteenth

Box 16.12

Some of the most diffused international water related journals and bulletins, including their respective publishers and institutions are listed below::

(a) International Journal for Development Technology, published by International Centre for Technical research;
(b) International journal of Nordic Hydrology, published by Nordic Association for Hydrology..
(c) International Journal of Water Resources Management, published by Kluwer Academic Publishers for the European Water Resources Association.;
(d) International Journal on Hydrological Processes, published by Wiley Interscience;
(e) Journal of American Water Resources Association
(f) Journal of Hydrological Sciences published by the International Association of hydrological Sciences
(g) Journal of Natural Hazards, published by Kluwer Academic Publishers on behalf of the International Society for the Prevention and Mitigation of Natural Hazards
(h) Journal of Water Resources Research, published by the American Geophysical Union

The African Water Journal

Figure 16.5: Front Cover of African Water Journal

The pilot edition of the African Water Journal was launched during the Pan-African Partnership and Implementation Conference on Water held from December 8-13, 2003 in Addis Ababa, Ethiopia.

Subsequent publications are in the pipeline. Papers are hereby invited from all water sector professionals and practitioners for publication in the next editions of the Journal. All contributed papers to the Journal shall be peer-reviewed according to the following criteria:

(a) Quality of Analyses;
(b) Quality of Data;
(c) Completeness of Information;
(d) Consistency in use of Indicators
(e) Quality of Writing;
(f) Adherence to adapted structure.

Thematic Areas

To ensure that the Journal contributes effectively to future versions of the African Water Development Report, the following thematic areas have been adopted in consonance with the World Water Development Report (WWDR):

1. Meeting Basic Needs – for safe and sufficient water and sanitation.
2. Securing Food Supply – especially for the poor and the vulnerable through more effective use of water.
3. Protecting Ecosystems – ensuring their integrity via sustainable water resource management.
4. Sharing Water Resources – promoting peaceful cooperation between different uses of water and between the States concerned, through such approaches as sustainable river basin management.
5. Managing Risks – to provide security from a range of water-related hazards.
6. Valuing Water – to manage water in the light of its different values (economic, social, environmental, cultural) and to move towards pricing water to recover the costs of service provision, taking account of equity and the needs of the poor and vulnerable.
7. Governing Water Wisely – involving the public and the interests of all stakeholders.
8. Water and Industry – promoting cleaner industry with respect to water quality and the needs of other users.
9. Water and Energy – assessing water's key role in energy production to meet the rising energy demands.
10. Ensuring the Knowledge Base – so that water knowledge becomes more universally available.
11. Water and Cities – recognizing the distinctive challenges of an increasingly urbanized world.

To be considered, papers must be written in English or French and address any of the above thematic areas.

century gave a boost to publications on water science and technology. Scientific and technical publications on water resources can be disciplinary, multidisciplinary or inter-disciplinary.

Constraints on Intellectual Rights: Publications as a means of knowledge and information transfer are not free from intellectual property right control in the form of copyright. It is interesting to note that although such publications are produced by organizations and institutions dedicated to knowledge and information exchange and transfer for capacity building in water resources, they adhere to copyright laws at different levels of strictness. Three examples are given below for demonstration purposes:

(a) Journal of Hydraulic Research: All rights reserved. No part of this publication may be reprinted, reproduced, or utilized in any form or by any electronic, mechanical or other means now known or hereafter invented, including photocopying and recording or in any information storage or retrieval system without permission from the publisher. ISSN-0033-1686;

(a) Journal of Water Resources Research: Permission is granted to individuals to make copies for personal use in research, study or teaching and to use short quotes, figures, and tables from this journal for publication in scientific books and journals. There is no charge for their uses. AGU requests only that the source be cited appropriately. The appearance of the code at the bottom of the first page of an article indicates the copyright owner's consent that copies of the article may be made for personal or internal use or for the personal or internal use of specific clients. This consent is given on condition that the copier pay the stated per-copy fee through the Copyright Clearance Centre. Inc. for copying beyond what is permitted by section 107 or Section 108 of the United States Copyright Law. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising, or promotional purposes, for creating new collective works or for resale. The reproduction of multiple copies, the use of full articles, or the use of extracts for commercial purposes require specific permission;

(b) **Hydrological Sciences Journal:** This publication may be reproduced in whole or in part in any form for education and non profit uses, without special permission from the copyright holder, provided acknowledgement of the source is made. As a courtesy, authors should also be informed of any use made of their work. No use of this publication may be made for resale or other commercial purposes without the prior written permission of IAHS Press.

Networking of Water Sector Institutions

The active exchange of knowledge and information on water resources is a necessary condition for comparing the complex nature of technology transfers in water resources activities since there are no two water problems that are absolutely identical. This means that experiences of successes and failures of technological applications are to be discussed and compared at all levels, national, regional and global. To this end a number of collaborative efforts in the form of institutional and thematic networking are used for knowledge and information transfer at regional and worldwide levels. They include international education and training institutes, 'train the trainers' programmes through inter-university partnerships, global and regional networks, public-private partnerships, and public awareness raising programmes. Examples of such networking systems are given below.

The Global Water Partnership (GWP): This is a working partnership involving all those concerned with water management: government agencies, public institutions, private companies, professional organizations, multilateral development agencies and others committed to the Dublin-Rio principles. This initiative is aimed at promoting and implementing integrated water resources management through the development of a worldwide network that could pool financial, technical, policy and human resources to address the critical issues of sustainable water management. Today, this comprehensive partnership actively identifies critical knowledge needs at global, regional and national levels, helps design programmes for meeting these needs, and serves as a mechanism for alliance building and information exchange on integrated water resources

management. The mission of the Global Water Partnership is to *"support countries in the sustainable management of their water resources,"* and is articulated under the following objectives:

(a) To clearly establish the principles of sustainable water resources management, ;
(b) To identify gaps and stimulate partners to meet critical needs within their available human and financial resources;
(c) To support action at the local, national, regional or river basin level that follows principles of sustainable water resources management; and
(d) To help match needs to available resources.

The Partnership is globally managed by the Technical Committee TEC which promotes the creation of regional and country partnerships and networks. Regional Technical Advisory Committees RTACs. are independent regional groups which promote the application of integrated water resources management as a critical approach to managing the world's water resources. RTACs have been established in the following identifiable regions:

(a) Mediterranean;
(b) Southern Africa; and
(c) West Africa.

The RTACs also in turn promote the formation of regional partnerships of competent national water-related institutions and, subsequently, country partnerships which aim at fostering cooperation and dialogue among water institutions and stakeholders, including the civil society within countries.

This important network can be consulted at the website: http://www.gwpforum.org.

International Network for Capacity Building on Integrated Water Resources Management CAP-NET: As an Associated Programme of the Global Water Partnership, Cap-Net fosters human resources development for IWRM. It focuses on education, training and applied research, and encourages partnerships and networking at national, regional and global levels. Cap-Net results from a UNDP/IHE Conference on Capacity Building for the water sector, held in 1996. The objectives of Cap-Net are to be achieved through networking, awareness creation, training and education, and development of relevant materials/tools. In order to facilitate these activities an International Advisory Committee has been set up to manage the initiative. The organizational development plan of Cap-Net covers:

(a) Partnership Development
(i) Regional Networks
(ii) Collaborating Partners
(b) Awareness raising on Capacity Building
(c) Information Management
  (i) Web Site Development
  (ii) Materials and Tools Development.

Apart from the existing regional Technical Advisory Committees of the Global Water Partnership which are leading the global efforts at coordinating activities and disseminating information on integrated water resources management, its associated programme "International Network for Capacity Building on Integrated Water Resources Management - CAP-NET is encouraging and supporting the creation of subregional capacity building networks.

WA-Net (West Africa Capacity Building Network

Network Coverage: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, the Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, the Niger, Nigeria, Togo, Senegal and Sierra Leone.

Objectives: To improve delivery of capacity building support for IWRM

Key Outputs: The first steps for the three founding members is to compile a list of capacity building institutions in the region as a basis for expanding the network.

Network for Building Capacity for Water Resources Management in Southern Africa WaterNet

Network Coverage: Botswana, Kenya, Lesotho, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe

Objectives include:

(a) To strengthen the overall human and institutional capacity of the water sector in the Region in order to contribute to the wise use of water resources;
(b) To stimulate regional cooperation in the field of education in IWRM;
(c) To increase access to training and education in IWRM for participants from the Region;
(d) To stimulate, regionalize and strengthen research in the field of IWRM in the Region.

Key Outputs cover:
(a) Training;
(b) Education;
(c) Research;
(d) Outreach by sharing the complementary expertise of its members

Nile Basin Capacity Building Network for River Engineering NBCBN-RE

Network Coverage: Burundi, the Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, the Sudan, Tanzania and Uganda.

Objectives: To strengthen the human and institutional capacity of the Nile riparian States to manage the water resources in the Nile River Basin in an effective and environmentally sound way. This by strengthening human resources development capacity and research capacity in a specific field of IWRM, namely River Engineering. Through its capacity building operations in River Engineering, the project aims at increasing cooperation among training and research institutes in the Nile Riparian States so as to level the playing field, create mutual understanding and build confidence among scientists and politicians from different countries sharing the same resources.

Key Outputs include:

(a) To make optimal use of existing capacities in the field of River and Hydraulic Engineering by connecting specialized institutes and experts
(b) To enhance communication between these experts and institutes;
(c) To improve the accessibility of education and training in River Engineering in the region.

Network of UNESCO Chairs

The establishment of chairs at academic institutions based on actual scientific needs of the area is a vivid example of thematic networking which creates an interdisciplinary research and teaching teams around a selected theme of interest. The programme combines thematic networking under university twinning cooperation with applied research and is managed by the Education Sector of UNESCO. Two types of closely related and interdependent activities have become the chief tools used in carrying out the programme: inter-university networks and the international UNESCO Chairs. A success story of this approach is the involvement of many UNESCO Chairs in the project on the theme '*Environment and Development in Coastal Regions and in Small Islands*' - CSI which has rallied diverse but complementary areas of expertise, to address this complex problem in a holistic and all-encompassing manner. It has created a platform for in-

tersectoral cooperation and fostered cooperation among stakeholders in Member States, among scientists from diverse intellectual traditions, and among complementary programmes and projects within UNESCO's areas of activities. This pooling of expertise and experience provides the necessary foundation for developing integrated solutions to challenging coastal problems based on the combination of scientific practices with traditional practices. It is only when scientific and technological knowledge in water management takes into consideration traditional wisdom that 'wise practices' can emerge and contribute to a water cultural awareness. The main aim of the UNESCO Chairs programme, an international inter-university network established in 1991, is to halt the "brain drain" from developing countries and promote the development of university networking and other cooperation agreements. The other objective is to link institutions of higher education at the interregional, regional and subregional levels. Special attention is paid to establishing cooperation among higher education institutions in developing countries (South-South cooperation) particularly in Africa. The UNITWIN/UNESCO Chairs programme, is seen as specially suitable for Africa and has been constantly expanding ever since its establishment. The number of UNESCO Chairs established in Africa is constantly on the increase. There are at present 63 of them, some of them coordinated by European inter-university networks. A full list of Chairs involving all types of disciplines may be consulted at the website.

(see www.unesco.org./education/educprog/unitwin/index.html).

Examples of projects undertaken by the UNESCO Chair at the university of Dakar to promote 'wise practices' include:

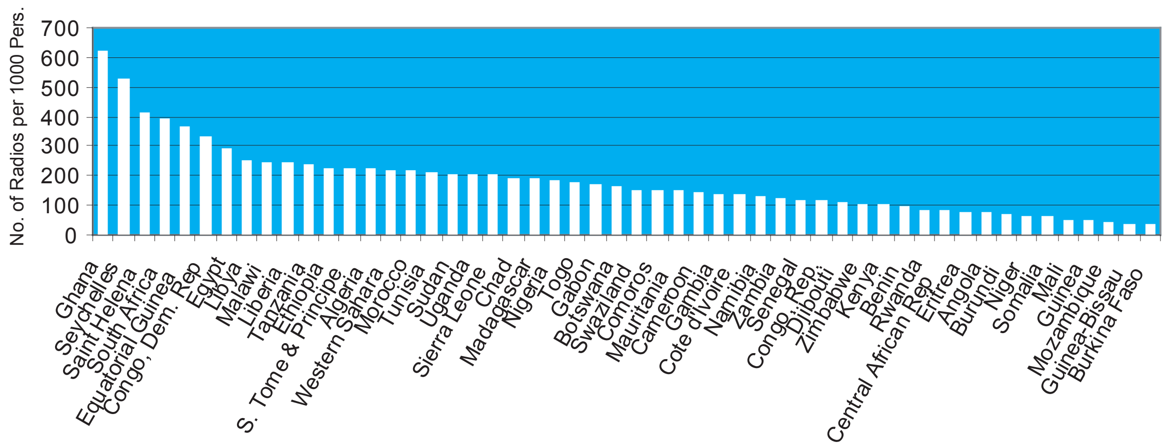
(a) Conservation and restoration of the mangrove ecosystem at the Saloum Delta Biosphere;
(b) Reserve, Senegal;
(c) Improvement of hygienic and environmental conditions, Yeumbeul, Senegal;
(d) Socio-cultural issues in a traditional coastal community, conservation of biological and cultural diversity, Yoff, Senegal.

Public Awareness through Water-related Periodical Campaigns

One of the most important events, if not the most important, of the last century was the launching of the International Hydrological Decade (1965-1975) which laid the foundation for hydrology to develop into what is now recognized as the scientific basis of any rational development and management of water resources. The decade encouraged decision makers in developing countries to allocate resources for the instrumentation of some selected river basins and, for the first time, automatic rainfall and water level recorders were introduced into such countries. The successive phases of the International Hydrological Programme have also gone a long way to sensitize the water resources communities to acquire and share the knowledge bases being generated through these programmes. Effectiveness of public awareness initiatives will largely depend on information communication technologies in the countries (figs 16.6 and 7).

In terms of awareness creation among water professionals, decision makers, politicians and the public at large, the World Day for Water which is observed on every 22nd day of March, proclaimed by the United Nations General Assembly in 1992 is the most popular water event, especially in most African countries. The resolution calls on all States to devote the Day, as appropriate in the national context, to concrete activities such

Figure 16.6: Number of Radios per 1000 people within a Country

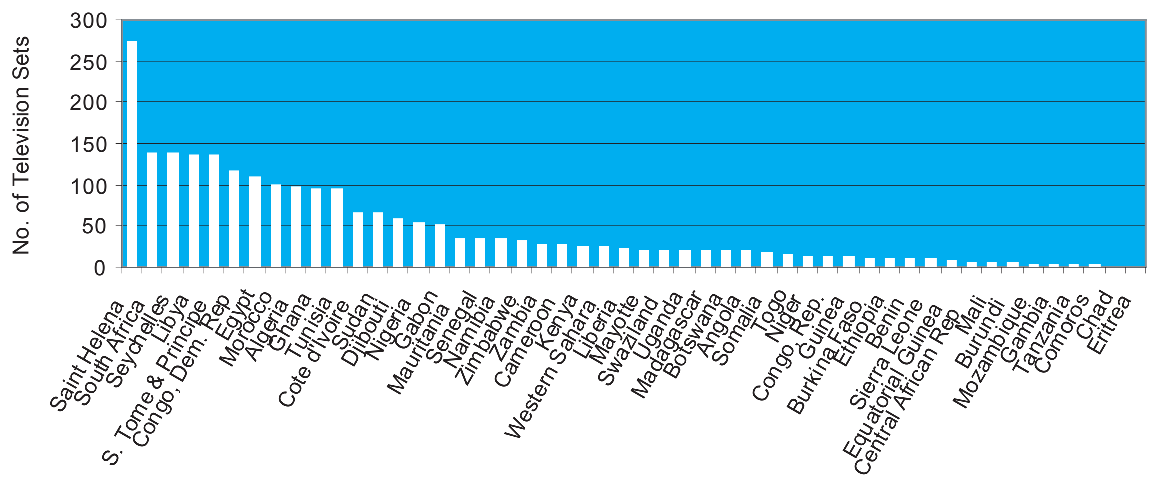


Data Source: CIA World Factbook 2002

as the promotion of public awareness through the publication and diffusion of documentaries and the organization of conferences, round tables, seminars and expositions related to the conservation and development of water resources.

There is actually a need to institute regular awareness programmes in African countries to explain pertinent contemporary issues on water with special emphasis on the water supply-sanitation-disease cycle. Effectiveness of awareness programmes would depend largely on telecommunication networks available and their areal coverage such as radios, telephones, televisions

Figure 16.7: Per Capita Number of Television Sets by Country



Data Source: CIA World Factbook 2002

and of course the modern internet systems.

Another occasion that was expected to have reverberations in African countries is the International Year of Freshwater – 2003, which was proclaimed by the United Nations General Assembly by a resolution, adopted on 20 December 2000. It encourages Governments, the United Nations system and all other actors to take advantage of the Year to increase awareness of the importance of sustainable freshwater use, management and protection. It also calls upon Governments, national and international organizations, non-governmental organizations and the private sector to make voluntary contributions and to lend other forms of support to the Year.

Factors Affecting Information Transfer to African Countries

There are many factors which hinder free flow of information to water professionals in African countries. With the top-down mechanism for information dissemination, even when such information arrive they hardly reach the professionals who actually need them for their professional practice. The difference between the technology needs in developed and less developed countries due to unequal levels of socio-economic development also has influence on the relative relevance of materials published in international journals. It is generally felt that experts from Africa have to struggle hard at the international competitive publication avenues to have their research results published even though reference publications are needed to support their occupational advancement. The poor level of remuneration and salaries of professionals in most African countries also does not allow them to seek individual avenues for information such as subscription to international journals and payment of membership fees of their respective professional associations. Moreover, lack of foreign exchange in most of these countries hinders water professionals' access to international services and events such as technical information, conveyed through journals, textbooks, current awareness services, computer data bases of bibliographic information and attendance at professional and scientific meetings. Generally, lack of foreign exchange in these countries hinders:

(a) Access to technical information, conveyed through journals, textbooks, current awareness services, computer databases of bibliographic information and attendance at professional and scientific meetings and so on;
(b) Payment of affiliation fees to various international professional institutions;
(c) Payment of high costs involved in the acquisition of new instruments and data processing equipment, repair of existing instruments and maintenance of data archives and information systems.

The above-cited difficulties kills motivation and morale which are necessary for professional innovation. Motivation and recognition are two cardinal elements that can stimulate high- level research results. In the absence of a socio-economic enabling environment as is the case in most African countries, a scientific or professional recognition at national or regional level for a significant and important contribution to the water and environmental sciences and practices would go a long way to give some satisfaction to water-related professionals. It is also time to promote subregional or continent-wide journals in Africa in order to promote an active exchange of information on water resources development and management practices among practitioners in different subregions, thus allowing for information flow among practitioners in different hydro-climatic environments, on the one hand, and also policy makers and the public at large, on the other. Specific aims of such journals include:

(a) To provide a forum for the discussion of technologies relevant to IWRM practices in developing countries, including their identification, development and applications in different physical and climatic zones;
(b) To publish good quality papers that are of

particular relevance to data collection and analysis, water resources assessment, water resources planning, development and management in an IWRM framework; and

(c) To publish high quality research papers on water resources technologies as a process of reducing the gap between the developed and developing countries and also to promote south-south technology transfer from one developing region to another.

The envisaged journal can be a periodical, depending on availability of funds, covering all aspects of Integrated Water Resources Management with the purpose of enhancing knowledge and information dissemination among water-related experts, policy and decision makers and the general populace. If properly managed, it can surely contribute to capacity building and the access of professional enhancement of research and technical personnel in the water sector.

The Role of United Nations Agencies and Non-Governmental Organizations

Various UN agencies are actively engaged in knowledge and information transfer to the developing countries. They serve as a pool of expertise contributing to the creation of knowledge bases and also collect and collate information and experiences of water resources worldwide and disseminate them. These are in the form scientific and technical documents of knowledge bases in the relevant fields as well as guidelines on water resources practices for dissemination in developing countries. These documents are prepared through consensus by international experts and professionals based on valid specific knowledge and technological practice. The channels of knowledge and information dissemination are semi-governmental national committees or bodies. Such information dissemination mechanisms are however weak owing to the strict top-down institutional framework which often hinders the divulgation of such knowledge to researchers and to implementers of water resources programmes. Below are some UN agencies highly engaged in water and environmental related activities:

United Nations Educational, Scientific and Cultural Organization

The launching of the International Hydrological Decade (1965-1975) by UNESCO, for the first time in water resources practice, gave vent to world-wide concerted efforts to recognize the indispensable role of hydrology in water resources development and management. The IHD was followed by the International Hydrological Programme (IHP) in 1975 which has continued since then and it is now in its 6th phase. The themes and orientations of the various programmes are summarized as follows:

(a) The first phase, IHP-I, lasted from 1975 to 1980. IHP-II, on the other hand, was of a shorter duration (1981-1983). This was to enable the Programme to fit in with the timing of the Medium Term Plan of UNESCO. The IHD was mainly research-oriented. IHP-I, which followed on from the IHD, maintained much of the research orientation;

(b) The next phases were oriented to include practical aspects of hydrology and water resources in response to the concerns of member States. Hence IHP-II (1981-1983) and IHP-III (1984-1989) were planned under the theme Hydrology and the Scientific Bases for Rational Water Resources Management;

(c) The theme chosen for IHP-IV (1990-1995) was: "Hydrology and Water Resources Sustainable Development in a Changing Environment";

(d) The just ended cycle, IHP-V, (1996-2001), was devoted to the theme: "Hydrology and Water Resources Development in a Vulnerable Environment";

(e) The present phase of IHP, IHP-VI, cov-

ering the period 2002-2007, is devoted to "Water Interactions: Systems at Risk and Social Challenges".

World Meteorological Organization

For over 65 years, the World Meteorological Organization (WMO) and its predecessor, the International Meteorological Organization, have supported National Hydrological Services, River Basin Authorities and other institutions responsible for water management in a wide range of activities which together form the Hydrology and Water Resources Programme of WMO. The programme provides for the collection and analysis of hydrological data as a basis for assessing and managing freshwater resources, for example, for human consumption, sanitation, irrigation, hydropower production and water transport, and for flood forecasting systems and the prediction of droughts. The overall objective of the Hydrology and Water Resources Programme is to apply hydrology to meet the needs for sustainable development and use of water and related resources; to mitigate the impact of water-related disasters; and to effectively manage the environment at the national and international levels.

The Programme is implemented through five mutually supporting components, namely:

(a) Basic Systems in Hydrology (including HOMS and WHYCOS);
(b) Forecasting and Applications in Hydrology;
(c) Sustainable Development of Water Resources;
(d) Capacity Building in Hydrology and Water Resources;
(e) Water-related Issues.

Food and Agricultural Organization

The water-related activities of FAO are carried out by the Water Development and Management Service, and are dedicated to sustainable use and conservation of water in agriculture, including:

(a) The assessment of water resources and monitoring of agricultural use;
(b) Assistance in water policy formulation and promotion of irrigated agriculture and efficient water use through management innovations, modernization and institutional reforms.

The Service is responsible for the conceptual design and the technical backstopping of the water development projects in field, and for the operation of inter-regional, water related field projects. Organizationally, the service articulates its activities through four thematic working groups:

(a) Water Information, Policy and Resource Management;
(b) Water Development, Technology and Small-Scale Irrigation;
(c) Water Management and Irrigation Systems; and
(d) Water Quality and Environment

With regard to knowledge and information dissemination, the aims of the Water Development and Management Service are:

(a) To create awareness and contribute to the international debate on food security, sustainable water development and resource conservation;
(b) To promote appropriate water policy and integrated water management in river basins including information sharing and conflict resolution in shared river basins;
(c) To promote an integrated and multi-disciplinary approach to water management, taking into account the major land-water interactions. It also provides mechanisms to ensure benefit sharing by all stakeholders;
(d) To promote efficient use and conservation

of water in agriculture through improved irrigation and water harvesting technologies, effective crop water management and training;
(e) To develop appraisal tools and specific measures for wetland development and conservation;
(f) To support irrigation systems improvement and modernization, through institutional reforms, technical innovations, management tools and building the capacity of technical staff and managers of irrigation systems and water user associations;
(g) To advise on standards and guidelines on water quality management, safe use of wastewater, mitigation of environmental effects and mitigation of health hazards related to water development;
(h) To promote improved preparedness and national planning to recurrent droughts, floods and climate variability;
(i) To maintain a database on rural water use and as a recognized point of reference on the state of land and water for food and agriculture in the world through the water information database (AQUASTAT). Contributes to the World Water Development Report.

United Nations Environment Programme

The United Nations Environment Programme (UNEP), established in 1972, works to encourage sustainable development through sound environmental practices everywhere. Its activities cover a wide range of issues, from atmosphere and terrestrial ecosystems, the promotion of environmental science and information, to an early warning and emergency response capacity to deal with environmental disasters and emergencies. The present priorities of UNEP include:
(a) Environmental information, assessment and research, including environmental emergency response capacity and strengthening of early warning and assessment functions;
(b) Enhanced coordination of environmental conventions and development and development of policy instruments;
(c) Fresh water;
(d) Technology transfer and industry;
(e) Support to Africa.

The Global Environment Facility (GEF) was established as a joint international effort to help solve global environmental problems. The GEF Trust Fund was established by a World Bank resolution on 14 March 1991, and formally established in October 1991 as a joint programme between the United Nations Development Programme, UNEP and the World Bank. The GEF was initially established for a three-year period known as the Pilot Phase. This phase ended in June 1994 and was later extended for three years in what is termed the Operational Phase or GEF I, covering four focal areas, namely:

(a) The protection of biological diversity;
(c) The reduction of greenhouse gases;
(d) The protection of international waters; and,
(e) The protection of the ozone layer.

INTERNET – Information Highways

The emergence of the internet has opened new and revolutionary frontiers in communication and information dissemination. The electronic mail system has created an unprecedented rapid and effective channels for communication among professionals, facilitated organization of scientific and professional meetings, preparation and exchange of documents as well as video and electronic conferencing. The internet is also serving as an effective basis for networking activities, notably among which is Global Water Partnership and its associated programmes. Water professionals in African countries are even unable to take full advantage of the era of information technology to access the various water portals and water-related toolboxes which are being developed by United Nations agencies such as

UNESCO, WMO, FAO, UNECA and UNEP as well as many non-governmental organizations, especially GWP. Ironically, internet access is more expensive in developing countries than in developed countries where living standards are much higher. Internet providers in many African countries are limited (fig. 16.8) and also not readily available at affordable costs and hence limiting its use (fig. 16.9). This situation confirms the affirmation that until the general infrastructure in African countries improve, technology transfer cannot have a meaningful expression in its fragile socio-economic environment.

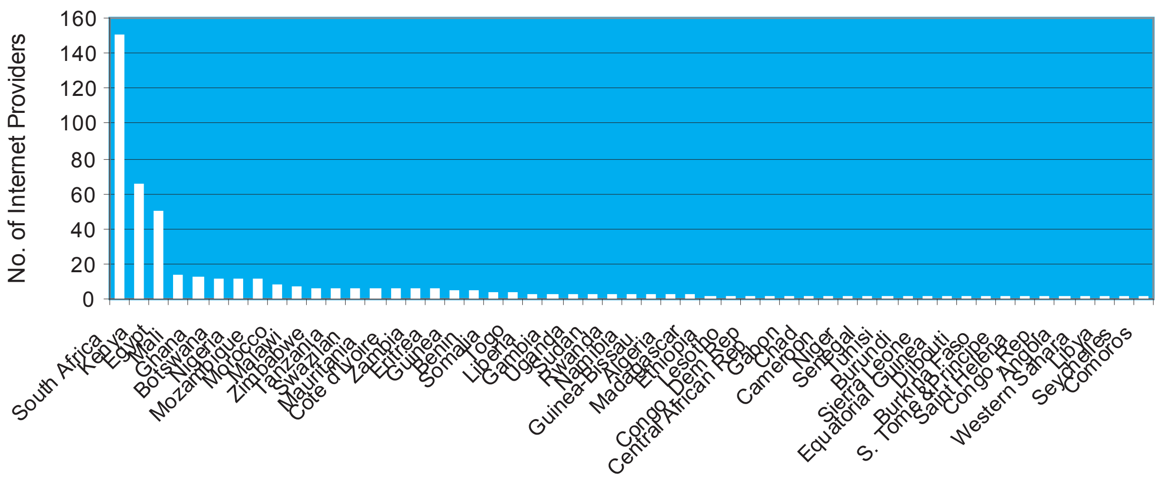
As regards information and knowledge dissemination, special mention must be made of the water gateways and portals of various international organizations. The home website (www.wmo.ch/web/homs/hwrpframes.html) of the Hydrology and Water Resources Programme - HWRP of WMO can in all ways be considered as a water portal. Examples of water portals of UNESCO and FAO are given below.

UNECA: African Water Information Clearinghouse – AWICH

http://www.uneca.org/awich

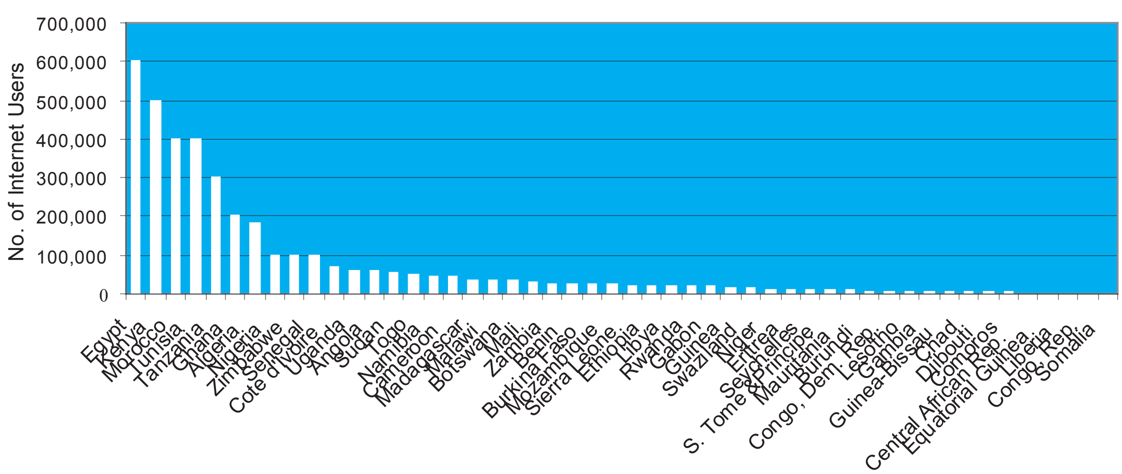
UNESCO Water Portal www.unesco.org/water/:

Figure 16.8: Number of Internet Providers in African Countries



Data Source: CIA World Factbook 2002

Figure 16.9: Number of Internet Users Within Country



Data Source: CIA World Factbook 2002

The UNESCO Water Portal is intended to enhance access to information related to freshwater available on the World Wide Web. The site provides links to the current UNESCO and UNESCO-led programmes on freshwater and will serve as an interactive point for sharing, browsing and searching websites of water-related organizations, government bodies and NGOs, including a range of categories such as water links, water events, learning modules and other on-line resources. Surfers can also add or modify links to help maintain an accurate online resource. The main gateways lead to the following:

(a) IHP – International Hydrological Programme;
(b) WWAP - World Water Assessment Programme;
(c) Water Events;
(d) Water Links;
(e) Water Celebrations;
(f) IN FOCUS on pressing current issues on water related problems;
(g) RESOURCES

FAO Water related Portals

In order to promote and diffuse information on the efficient use and conservation of water resources to achieve food security and sustainable agriculture and rural development, the Water Resources, Development and Management Service of the FAO has developed thematic portals on various key activities of the organization which include:

(a) Water Information and Statistics Portal:
- (ii) AQUASTAT - Statistics and Information on Water and Agriculture;
- (iii) Land-water Linkages in Rural Watersheds;
- (iv) Web publications on selected water issues;
- (v) On-line documents - Water;
- (vi) Water Harvesting training course;
- (vii) International Email Conference on Irrigation Management Transfer (IMT)

(b) **Irrigation Portal:**
- (i) Database on Education and Training Courses in Irrigation, Drainage and Flood Control;
- (viii) IES - Irrigation Equipment Supply Database;
- (ix) International Email Conference on Irrigation Management Transfer (IMT);
- (x) IPTRID - International. Programme for Technology and Research in Irrigation and Drainage;
- (xi) Participatory Training and Extension in Farmers' Water Management; and
- (xii) SIMIS - Scheme Irrigation Management Information System

Box 16.12: IWRM Initiative: Postgraduate Training Course for Sub Sahara Africa – 2002/2003

Following the unfolding worldwide events leading to the declaration of the United Nations Millennium Development Goals for water supply and sanitation and the crosscutting role of water in the other development goals, The Water Resources Research and Documentation Centre (WARREDOC) of the Perugia University for Foreigners, Italy, proposed a training course on Integrated Water Resources Management (IWRM) for sub-Saharan African countries. The proposal was presented to the General Directorate for Cooperation and Development and the General Directorate for sub-Saharan Africa, both of the Italian Ministry of Foreign Affairs for financial support. The course proposal reflected the cardinal ideas enshrined in the Africa Water Vision 2025 which was developed to stimulate a shift in approach toward a more equitable and sustainable use and management of Africa's water resources for poverty alleviation, socio-economic development, regional cooperation and the environment. That is to guarantee, in a sustainable way, Water for people, Water for food security and Water for nature. The course programme was therefore based on the documents of the World and Africa Water Visions and their respective Frameworks for Action, the 2nd World Water Summit and the Global Water Partnership. In view of the urgent need for human expertise and institutional capacity towards the achievement of this vision and the Millennium Development Goals, the Ministry of Foreign Affairs approved the proposal with due financial support, and the course was held from 23 September 2002 to 23 March 2003.

The Course Programme covered, amongst others things, the following:

Introduction: Introduction to IWRM Principles, Hydro-Climatic Processes, Basic Hydraulics.
Tools for (multisectoral) environmental data management: Principles of Geographical Information Systems: spatial data, attributes, metadata, GIS Database management.

Engineering Hydrology and Hydraulics: Analysis of Hydrological Processes, Groundwater Hydrology, Hydraulics of Water Distribution Systems.

Irrigation and Drainage: Computation of Agrometeorological Characteristics, Optimization of Irrigation Systems, Modern Techniques for the Minimization of Irrigation Water

Water Supply and Sanitation: Sanitation and Freshwater Resources, Water and Wastewater Treatment Plants, Water Distribution Networks in Fast Growing Urban Centres, Rural Water Supply and Sanitation

Environmental monitoring: Hydrometeorological and agrometeorological measurements, Optimization of Hydrometeorological Data Networks, Principles of remote sensing and image interpretation, Hydrological Data Assimilation and Information Systems

Water Resources and Environmental Management: Territorial and River Basin Water Resources Assessment, Demand Management in Water Supply and Irrigation, Environmental and Social Impacts of water Resources Development, Control and Management of Erosion, Sediment Transport and Reservoir Siltation.

Water Resources Administration: Water Law and Administration, Institutional Aspects of Water Resources Planning, Conflict prevention and management, Governance and Leadership skills.

Projects and Case Studies on relevant water-related problems chosen by the participants in their home countries.

Technical Visits to Selected Water Resources Projects and Agencies in Italy

The course was attended by 25 water personnel from nine countries and distributed as follows:

IWRM Course Participants according to Countries and Backgrounds

No	Country	Number of Participants	Some Professional Profiles
1	Nigeria	6	Hydrogeology, Water resources engineering, Irrigation engineering, Agronomy, Chemical Engineering, Civil Engineering
2	Ghana	3	Hydrology, Physics, Civil engineering
3	Senegal	1	Rural water resources engineering
4	Ethiopia	5	Civil engineering, Water resources engineering, Soil science
5	Sudan	1	Hydraulic engineering
6	Rep. of Congo	2	Geology, Energy engineering
7	Tanzania	3	Civil engineering, Water quality, Water engineering
8	Mozambique	2	Hydraulic engineering, Agronomy
9	Zambia	2	Environmental science, Public health

Box 16.13: CASE STUDIES ON AFRICAN WATER ISSUES

1st International Advanced Course on Integrated Water Resources Management

September 23, 2002 – March 23, 2003

Hydrology and Water Resources Assessment

1. Ebenezer Adjei Osekre (Ghana), 2003: Analysis of Water Resources Management in the Kakum River Basin for Improved Water Supply in Cape Coast, Ghana

2. Rufus Abiodun Iyiola (Nigeria), 2003: Analysis of Surface Water Resources in Surrounding Catchment to Supplement Water Supply to Ibadan, Nigeria

3. Lumor Mawuli (Ghana), 2003: Analysis of Extreme Flood Peak Response of the Odaw Basin in Accra

Groundwater Resource Assessment

1. Habu Hasan (Nigeria), 2003: Major Non-Technical and Technical Challenges in Borehole Construction in Nigeria

2.. Dr. Abubakar G. Iliya (Nigeria), 2003: Preliminary Groundwater Resources Assessment of Semi Arid Region A Study of South-West Chad Basin in Nigeria

3. Minta A. Aboagye (Ghana), 2003: Estimated Groundwater Recharge and Implication for Sustainable Exploitation in the Densu Basin in Ghana

Agrometeorology, Irrigation and Drainage

4. Irene Maria Pechico (Mozambique), 2003: A Study on the Efficiency of Current Irrigation Practices in Safola Province

5. Nicolau Martins Luis (Mozambique), 2003: Improving Productivity on Small Scale Irrigation Farms in Nampula Province, North of Mozambique

6. Dickson Agbonhese Ahagbuji (Nigeria), 2003: Optimal Options for Irrigation Water Supply System towards the Rehabilitation of Tungan Kawo Irrigation Project

Water Supply and Sanitation

1. Gladys C. Ukala Nwosah (Nigeria), 2003: Management Decision Support Strategies (Mdss) for Nigerian Small-Town Water Supply and Sanitation for Sustainable Development- using Mbiri, Delta State, Nigeria, as Case Study

2. Addis Ababa Lisanework (Ethiopia), 2003: Water Demand Management Perspectives: Concepts and Applicability to the City of Addis Ababa

3. Chilufya Kaminsa (Zambia), 2003: Domestic Water Chlorinatiuon for Peri-Urban Communities – The Zambian Experience

4. Bouckoulou-Polo Sthalgard Francois And Mavoungou Julien (Rep. Congo), 2003: The Problematic of Drinking Water Supply in Congo

5. Mama Diakhoumpa (Senegal), 2003: Transfer of the Management of Rural Water Supply from Government to Community in Senegal

6. Damian Isdor Massenge (Tanzania), 2003: Possible Solutions to Contaminated Water Supply System of Dar Es Salaam Region towards Reduction of Water-Borne Diseases

7. . Asnake Berhane (Ethiopia), 2003: Holistic Approach to Control Unaccounted for Water in Addis Ababa Water Supply Distribution System

8. Chuchu Ono (Ethiopia), 2003: Water Distribution Modeling and its Application to Addis Ababa Distribution Network

9. Melisew Belay Asfaw (Ethiopia), 2003: Investigation of Alternative Sources of Water Supply to Debre Berhan-Ethiopia

10. Gonsalves Rwegasira Rutakyamirwa (Tanzania), 2003: Improvement of Dar Es Salaam Water Supply System Management through Isolated Localized Distribution Networks

Water Resources Development, Management and Administration

1. Abdelaziz A. Eljonid (Sudan), 2003: *Sediment Monitoring Programme in Gezira Main Channel and Km57*

2. Yusuf Funmilayo Musilmat (Nigeria), 2003: *Flood Routing Approach to Mitigate Frequent Flooding of Tada-Shonga Irrigation Scheme*

3. Chitaku Greenford Mucheleng'anga (Zambia), 2003: *Analysis of User Perceptions on Value for Water from Selected Zambian Communities*

4.. Fredrick Innocent Mayanda (Tanzania), 2003: *Analysis of Operational Problems and Conflicts on Reservoir Management, a Study at Mindu Dam, Morogoro Region, Tanzania*

5.. Alemayehu Tafesse (Ethiopia), 2003: *Erosion/Sedimentation Problems in Reservoirs: The Case of Koka Dam in Ethiopia*

Note: This is the list of Case Studies identified and carried out by the participants at the above-mentioned course held at the Water Resources Research and Documentation Centre, University for Foreigners of Perugia, Italy.

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Global Water Partnership: GWP Official Website: http://www.gwpforum.org/servlet/PSP [served to download sources of information on IWRM issues such as Technical Advisory Committee (2000): Integrated Water Resources Management, Stockholm, which contributed to the formulation of the general principles and requirements of IWRM]

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Governing Water Wisely

The institutional framework for water management should include the policy-making bodies that establish the rules or legislation on the development and use of water resources and the legislative bodies and agencies with regulatory and political functions and responsibilities. These bodies should strive to reconcile the various interests of water users at any given time and to ensure that policies and programmes on water resources are properly implemented. In general, the framework should include:

(a) Specific rules and laws governing the assessment, development and use of water resources;
(b) The bodies responsible for policies and decisions on the exploitation and use of water resources; and
(c) The communication and information links between decision-making agencies, groups directly affected by water management programmes and the general public, at various levels.

The institutional structure for water management in any country is shaped not only by political and administrative bodies but also by the historical role of water in national development and the perceived desires, needs and value of water. Institutional involvement in water management takes various forms and is often dictated by the prevailing types and levels of water management problems such as irrigation management, drainage control or pollution control problems. The diversity also reflects the historical, political, economic, social, administrative, geographical, physiographical and climatic conditions of the territory concerned.

The increasing demands for and on water caused by population growth and the obvious reduction in water availability in time and space due to both natural and man-made causes such as pollution, call for regulatory actions considered the basis for water management. According to Gonzalez Villarreal F.J (1980), such actions could include:

(a) Regulation at the water system by taking measures aimed at increasing available supplies;
(b) Regulation at the boundaries between the water system and user system, covering the phases of planning, construction and operation of the water infrastructure necessary to ensure adequate natural supply to meet the demand of the whole user system; assessing the impact of water consumption and groundwater use on the water system and minimizing such impact through erosion and pollution controls;
(c) Regulation at the physical boundaries between inter-related users, especially in water stress regions. This could be by subjecting such users to a prioritization scheme in the form of differential pricing and allocation for different uses. It could also involve conflict resolution. Such a regulation is normally better effected if the physical water basin is taken as the basis for water management; and
(d) Regulation of international costs and boundaries water activities to ensure adequate quantity and quality of water supply for various transboundary uses through international agreements on water allocation and pollution control.

The most recommended forms of water regulation include utilization concessions, waste discharge permits and tariffs. These must be established prior to water use. In fixing tariffs, the aim must not only be to recover capital and operating costs but also to promote efficient and beneficial use of water. The principle of compelling a polluter to bear the cost of de-pollution should be the economic basis for pollution control.

Institutional Capabilities for Integrated Water Resources Management (IWRM)

From an administrative point of view, the institutional (legislative, organizational and decision-

making) framework for water resources management must, according to Andah (2002a), strive to include:

(a) Preparing an inventory, both quantitative and qualitative, of surface and groundwater supplies;
(b) Policy-making on water;
© Administration of water rights;
(d) Planning of water use;
(e) Launching projects for the improvement, use and conservation of water;
(f) Operation, maintenance and supervision of water works;
(g) Settling conflicts and disputes;
(h) Coordination of water resources activities; and
(i) Water resources research and technology transfer.

National and institutional capacities are needed for an integrated water resources management. This should include the capacity to produce knowledge and information bases through research and development in order to ensure timely availability of the skills and competences needed for:

(a) Continuous collection of data on the relationship between the hydrological cycle and the environmental dynamics while maintaining a modern data base management system for archiving, control and retrieval of the data;
(b) Assessment of water resources for the design and sustainable management of water resources projects in a way that is friendly with natural ecosystems;
(c) Monitoring freshwater availability, desertification processes, environmental change and degradation, and hydrological disasters such as floods and droughts, taking into consideration predictions on climate change;
(d) Development and dissemination of knowledge bases commensurate with the growing demands on water and the advances in science and technology;
(e) Development of new technologies and adapting them to local conditions;
(f) Creation of modern information communication systems for use at all levels of decision making, and further increasing public role in water management.

Proper assessment of the water resources of nations, regions or basins, in time and space, is of crucial importance to rational and sustainable development of global water resources. It allows for proper use and control of water resources right from the sources, providing knowledge about the quantity, extent, supply reliability and quality of the water. Through proper assessment and collection of reliable and adequate data and information on water resources status and trends, sound decisions can be made on how best to develop and manage these resources.

With the above facts in mind, the framework for water resources assessment includes the following:

(a) Resource supply assessment to evaluate the quantity and quality of surface and ground water physically available;
(b) Demand assessment to determine water requirements for different uses and development alternatives, often in conflict with natural ecosystems;
(c) Environmental impact assessment to evaluate the impact of water resources development projects on natural and physical ecosystems;
(d) Social impact assessment to examine how social and institutional structures affect water use and management; and
(e) Risk or vulnerability assessment with regard to floods and droughts to provide information on the frequency and magnitude of their occurrence, ways of mitigating them and subsequently incorporating them into the general water resources management system.

Enabling Institutional Environment

The importance of an institutional framework for rational and effective water resources development and management has been growing in the last few decades following deeper perceptions about the physical and socio-economic variables controlling this vital resource and the complex interactions between these variables. As already mentioned good water management depends on good water quantification. It also depends on good water resources planning which likewise depends on assessment, in our case, of the hydrological and water cycles. From the hydrological point of view, water resources institutions can be grouped into two: those engaged in physical quantification of the components of the hydrological cycle e.g. the meteorological and hydrological services, and those managing the user systems, such as irrigation, water supply and hydropower development.

The nature of the water resources institutions in a country is influenced by many factors, including climate and the level of water resources development. As can be seen, countries with semi-arid and arid climatic water flows, such as Egypt and the Sudan, have central irrigation bodies such as ministries or authorities for the development of their water resources, whereas in the tropical humid regions that do not have oil resources, the main body is an authority for hydropower development. However, in any given country, many are the institutions and agencies responsible for water legislation and management. The result is conflicts of jurisdiction and inter-institutional rivalries which are detrimental to the rational development and management of water resources. A water authority may exist at the national, regional, or local level or function at the political, executive, technical, or legal level. This makes it indispensable to legally specify the functions of and relationships between the various authorities responsible for water.

Legal Bases for Preparing Water Legislation

Any water use that is not properly planned and managed on the bases of water law and administrative procedures may cause problems not only for the water body itself, but also for other natural resources and the environment. There is an increase in the complexity of the problems associated with water use and development, including the social conflicts caused by a growing imbalance between fixed or diminishing water supply and an ever-increasing water demand. This, combined with the impact of water-utilizing technologies on the resource itself, call for an adequate response from lawmakers. In this connection, while the developed countries have concerned themselves more with modernizing legislation, the developing countries are mainly at the stage of establishing the necessary legal framework for proper administration of water resources.

Two main considerations are necessary for the legal administration of water resources. Firstly, all water distribution and use must reconcile quantitative and qualitative requirements with acquired rights and long-established practices. Secondly, the legal arrangements must take into account existing and future water variations, excesses and shortages, in order to avoid conflicts and disasters.

Box: 15.1

Existing Legal Acts on water resources management in the Republic of the Congo

1. Law n° 05/07 of 5 July 1967 establishing the Société Nationale de Distribution d'Eau.
2. Law n° 23/82 of 7 July 1982 on Mining Code.
3. Law n° 52/83 of 21 April 1983 on State and Land Code.
4. Law n° 003/91 of April 23 1991 on the protection of the environment.
5. Law n° 021/88 of 17 September 1988 on town planning.
6. Law n° 014/92 of 29 April 1992 instituting the National Sanitary Development Plan (PNDS).
7. Law n° 16–2000 of 20 November 2000 on the forest Code.

Law n° 13-2003 of 10 April 2003, a comprehensive new water law establishing a Consultative Council on Water

Source: National AWDR Report, 2003

According to Caponera D (1988), the legal framework must include:

(a) Ownership of or other legal authority for water resources, covering surface water, groundwater and all other water resources;
(b) Distinguishing between private and public ownerships. The latter can also be subdivided into national, regional or local as and when applicable;
(c) Granting rights for the use of water through authorizations, permits, licenses, or concessions subject to some regulations that vary from country to country;
(d) Modern water rights flexible enough to introduce functional criteria for the use of water by giving the water authority concerned sufficiently wide discretionary powers;
(e) Ordering of water use on a priority basis and including this in the legal framework for municipal, agricultural, industrial, hydropower, aquaculture, navigational and recreational uses, especially in water stress areas;
(f) Making the legal ordering flexible enough to allow for alterations and modifications in response to national economic, social, and environmental changes;
(g) Grouping beneficial uses of water under a unified code as against the present practice of specifying them under their respective water uses;
(h) Incorporating in a basic water code or a coordinated list of provisions, the adverse effects of both natural and man-induced water, such as flood damage, submergence of riverbanks, soil erosion and siltation and salinization, as an integral part of the general water management.
(i) Formulating legal provisions on water quality and pollution control possibly as part of a central water code to cater for water wastage and wrongful use, water recycling and reuse, sanitation and protection against pollution and the environment in general;
(j) Making groundwater resources an indivisible component of the water cycle through special provisions and legislation covering drilling of boreholes and aquifer risk to depreciation and pollution;
(k) Including protection of waterworks and hydraulic installations in legislation on operation, maintenance and general protection of the water system;
(l) Making special legislation for protected regions or zones such as drainage basin boundaries and smaller zones such as land development units, flood protection or drought emergency zones, national parks and reserves and areas of pollution;
(m) Modernizing water legislation to provide for enforcement procedures to protect water rights. Such procedures could even include the use of sanctions and other legal measures in case of infringement of the water code.

Box 15.2
The National Water Act of South Africa

The most important of these acts, from an environment and water point of view, includes Section 2(g): *protecting aquatic and associated ecosystems and their biological diversity;* and Section 2 (h): *reducing and preventing pollution and degradation of water resources.*

It also includes recognizing the need for an integrated management of all aspects of water resources and, where appropriate, delegating management functions to a regional or catchment level *so as to enable everyone to participate.*

Perhaps the most important provision in the National Water Act is that for the "Reserve", defined as: *"the quantity and quality of water required (a) to satisfy basic human needs … and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource".*
A water use licence may not be granted unless there is sufficient water for the reserve.

The nature of water resources institutions in a country is influenced by many factors, including climate and the level of water resources development

Organizational Structure

The institutional structure for water management in a country is shaped by the country's political and administrative organization, the historical role of water in national development and the perceived desires and needs for or value of water. In addition to such factors as climate and level of water resources development mentioned earlier on, historical and cultural link with water (as in semi-arid and arid regions) also influences, markedly, the structure and evolution of water institutions. The organizational structure of these institutions is expected to be more decentralized in a federal or region-conscious State, but not in a unitary state with differing levels of coordination. The prevailing water policy also plays a major role in shaping these institutions.

The activities of many decentralized institutional water management structures are linked to water-basin finance agencies and coordinated at the national and regional levels by public and private technical and research bodies as well as representatives of bodies with water-related economic interests as in the case of the Volta River Authority of Ghana. Institutional structures can also be based on territorial divisions defined by the main water basins with some form of integrated water resources administration.

Centralized institutional structures are normally found (with separate terms of reference) within State ministries, such as the Ministry of Public Works (Ghana) and the Ministry of Irrigation (Egypt and the Sudan). Other countries place their administrative structure for water management in accordance with the degree of importance attached to water problems in ministries, in which case they can be in the Ministry of Internal Affairs, the Ministry of Health or the Ministry of Environment and Agriculture. In some countries, a centralized administrative function is exercised through a national water resources authority or commission, composed of representatives of all sector interests. This has been practised in Ethiopia and is presently being practised in Ghana and the Niger. Another form of a centralized water administration is through the formation of an actual Ministry for Water Resources as in Kenya, Ethiopia and Nigeria. Some existing types of water resources institutions are shown in table 15.1.

In practice, the institutional structures for water resources management are generally a mix of centralization and decentralization. The distribution of authority either from the centre or amongst the sub-national structures varies from country to country, depending on the individual circumstances of these countries. It is important to note that limiting government authority on centralized water resources management and planning

Box 15.3
Organization of the Ministry of Water Resources and Energy of Mauritania

This Ministry is fully responsible for:

(a) Defining national policies on water;

(b) Water prospecting and extraction, notably through:
(i) Geophysical and hydro-geological studies;
(ii) Village and pastoral water projects such as wells, boreholes and other sources;
(iii) Urban water projects involving water production, adduction, distribution of drinking water and setting up of purification stations and networks;

© Conservation of water resources by establishing schedules and rules for water resources exploitation and by drafting legislations and legal texts while monitoring the application of the water laws and regulations in force.

The Water Department is responsible for research, identification and management of water resources, mainly by:

(b) Undertaking hydro-geological and hydro-geophysical studies;
(c) Examining the establishment of hydro-geological networks and their operations;
(d) Establishing schedules for exploiting water resources;
(e) Promoting village and pastoral water projects such as wells, boreholes and other water sources and seeing to their maintenance;
(f) Undertaking surveys necessary for the production, transportation and distribution of drinking water and for water purification in farming and urban centres.

Box 15.4:
Advantages and Disadvantages of a Centralized Institutional Framework

Centralization of water administration has advantages as well as disadvantages which also depend on the degree of flexibility and involvement of water resources activities. In listing its advantages and disadvantages, Andah (2002c), maintains that centralization:

(a) Unites sectoral interests and multi-level decision-making in a legal and institutional framework consistent with national aims and objectives;
(b) Enhances allocation of human and financial resources for the evaluation and control of water programmes and policies;
(c) Provides a national framework for the estimation of supply and demand and programmes for overcoming future imbalances;
(d) Facilitates the adoption of standards and procedures for water activities, including types, installation and maintenance of equipment and common bases for comparison of different project feasibility studies;
(e) Harmonizes inter-regional and international problems with national interests;
(f) Evolves models common to different regions towards better use of technical capacity and expertise;
(g) Establishes a hierarchical order of projects in accordance with national priorities;
(h) Develops training and research programmes within a national policy of capacity building and enhancement, taking into consideration the scientific and technological requirements;
(i) Avoids duplication of work of regional and sectoral agencies through the establishment of information systems and analytical tools for common use;
(j) Provides a central framework for minimizing local pressures in resource allocation and hence guarantees a more equitable and efficient use of the resources;

But that centralization, if excessive and without regional and sectoral feed-back can, on the other hand, result in:

(a) Standard policies that are too restrictive and hence inappropriate for tackling particular regional and local problems;
(b) Limited participation of users in project formulation, decision-making and the financing of measures;
(c) Loose contact with users, local exigencies leading to decisions based on incomplete information, and ineffective execution and operation of projects;
(d) A large, central bureaucracy which can result in slow decision making and inefficiency in programme execution;
(e) Formulation and execution of multi-sectoral regional plans which can be hampered by central authority obstacles;
(j)Restriction of regional negotiating capacity in the absence of proper reconciliation of national interests with prospects for regional development.

structures can lead to a more expeditious re-allocation of existing resources among uses and/or users as conditions change and facilitate the execution of water development projects as it will reduce state, regional or local claims of authority over the resources. On the other hand, preparing plans at the central level without proper consultation with and participation of the regions and users could result in failure to fully take into account the specific needs and aspirations of the latter. Furthermore, centralized structures could, like decentralized ones, suffer from the organizational diffusion that results from scattering centrally held governmental authority for water management and planning among a number of ministries, departments, or agencies, without institutional coordination.

All countries have some sort of central authority, permanent or ad hoc, that implicitly or explicitly coordinates water resources activities. Such institutional frameworks function in different ways in different environments, such as:

(a) Playing a critical role in identifying the socio-economic determinants of water development policy and objectives;
(b) Acting as an advisory body with a limited power to harmonise and coordinate actions; and

Table 15.1: Types of Water Resources Institutions in Some African Countries

TYPE	CHARACTERISTICS	COUNTRIES
Loose or Uncoordinated Institutions	Policies fragmented in various ministries with water interests	Ghana Sierra Leone Niger Cameroon Tunisia Botswana
Water Commission / Board	Overall policy-making and coordination with agencies, public corporations and departments of ministries being subordinated or affiliated	Ghana Niger Sudan Congo Republic Nigeria Zimbabwe
Ministry with mixed authority (Ministry of Water Resources, Forestry and Fisheries) Ministry of Mines, Water and Energy	Partial or overall policy-making or coordinating body for water	Gambia Uganda Zambia Malawi Cameroon South Africa Ginea Liberia Burkina Faso Benin Ghana Mali Niger Senegal Sierra Leone Togo Togo
Ministry of Water Resources	Solely responsible for planning and coordination of water resources activities	Sudan Egypt Burkina Faso Ethiopia Kenya Nigeria Algeria
River Basin Authorities	Responsible for coordinating development projects within basins	Nigeria Ghana Algeria Ethiopia Zimbabwe

(c) Performing a major executive and administrative role, such as following up the execution of water plans.

It has been noted that State intervention in water management increases as the need for proper coordination of planning, development and control of water administration grows. Such an intervention becomes more effective if water users and beneficiaries are involved in the administration of water and are interested in paying for its development.

Since Rio (1992), many African countries have

Box 15.5
The National Council for Water Resources (NCWR) – Nigeria

The NCWR is the highest policy organ on water resources in Nigeria. It is chaired by the Federal Minister of Water Resources and Rural Development and has as members State government Commissioners responsible for water resources development and the Chairpersons of DFRRI and the Federal Capital Territory (FCT) Water Resources Agency. The Council was established in 1980 as a technical arm of the National Technical Committee on Water Resources (NTCWR), which meets biannually.

Other members include: Federal General Managers of RBDAs, NWRI, NEPA and State Water Boards/Corporations; Federal Department Directors of Inland Waterways and Meteorology; ADP Management Unit/Project Manager; representatives of universities, the National Society of Engineers and the consulting industry. The NTCWR meets to take decisions, to advise the NCWR, to deliberate on strategies or to adopt and implement the decisions of NCWR.

The six sub-committees established for detailed implementation of the NTCWR decisions comprise water experts brought together to discuss and exchange ideas on pressing problems of water resources development promotion. They often set up working groups to carry out field studies and submit recommendations. They are:

(a) The Sub-Committee on Hydrology and Hydrogeology;
(b) The Sub-Committee on Irrigation and Drainage;
(c) The Sub-Committee on Manpower;
(d) The Sub-Committee on Dams; and
(e) The Sub-Committee on Erosion and Flood Control.

The policy issues originate from proposals made by the various specialized agencies responsible for water resources development. These proposals are then considered by the relevant Sub-Committees of the NTCWR and subsequently sent to the NTCWR for critical and technical analyses after which they are passed on to the NCWR for consideration and adoption. The adopted policies are sent to the Federal Ministry of Water Resources where they are packaged as a memorandum to the Federal Executive Council which discusses them for inclusion as a national policy.

been working, through ministries, to establish national coordinating institutions in the form of water commissions or directorates, as in Ghana, Cameroon, the Republic of the Congo, South Africa, Mauritius, Egypt, the Sudan and, to some extent, Ethiopia.

Decision-making structure

Given the diversity of water resources use, it is almost impracticable for decisions on water management to be made by a singe body. Decisions on water supply and development affect various interests and cover sectoral, organizational and regional issues. The sectoral interests involve water supply for domestic use, irrigation, hydropower generation, transport and recreation while the organizational interests concern the bureaucratic bodies dealing with water use and development. An example of a structure based on sectoral interests is shown in figure 15.1 for Mauritius. Both types of interests even exist side by side in some cases. Regional interests are usually manifested through identifiable physical entities or political divisions. Decisions that favour specific interests over others can lead to imbalances and conflicts. Hence the need for water management decisions to be made through the interaction of several bodies and interest groups which should work collectively to balance the benefits and disadvantages to each and every party. Experience has shown that establishing a national or regional authority does not necessarily unify the process since, as already mentioned, no one body can alone cater for all facets of water management. Rather, decision-making on water is easier under a multi-purpose planning of water development based on coordination.

Since institutional structures generally vary from country to country and sometimes even within the same country, the following criteria should

Box 15.6
Advisory and Consultative Institutions in Cameroon

Cameroon has two inter-ministerial committees responsible for coordinating various aspects of water and sanitation in the country. These are:

1. The National Water Committee (NWC)

This committee was set up in 1985 as a State consultative body to define and establish a water policy for Cameroon. The 1998 law on water and the subsequent decrees of May 2001 specify the following roles for the Committee:

(a) To study and recommend to the State all necessary measures for the conservation, protection and sustainable use of water;
(b) To advise the State on matters relating to water;
(c) To make proposals to the State on water management in Cameroon. The Minister of Mines, Water and Energy chairs the Committee and the Director of Water is its secretary.

All the ministries involved in water management are statutory members of the committee. Other members are: the president of the Chamber of Agriculture, a representative of the Association of Mayors, representatives of public utility companies (one for water and one for energy). Since its establishment in 1985, the committee has met very infrequently and has failed to live up to the role defined for it in its constitutive decree. It is hoped that the recently signed decrees to reactivate the water law will give a new impetus to this organ to play its role effectively.

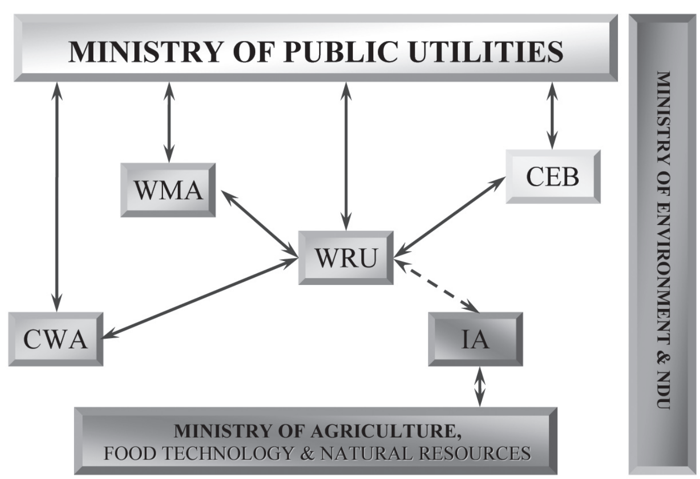
2. National Committee on the Environment (NCE)

This Committee is responsible for coordinating environmental policies with the Ministry of Environment and Forests which plays the leading role. The committee is expected to assist the Government in formulating, coordinating, implementing and monitoring environmental policies. The decree establishing this Committee has just been signed, six years after the enactment of the law on the environment. Like its sister inter-ministerial committee, this organ exists only on paper and has not fulfilled its role.

be considered in designing institutional structures for water planning and administration:

(a) Ability to apply a broad range of alternatives in solving problems;
(b) Ability to combine efficiency and fairness in water administration, consistent with the national policy;
(c) Embodiment and provision of continuity by adapting plans to changing local, regional and national priorities;
(d) Involvement of all stakeholders concerned with specific development and management plans; and
(e) Ability to continue the learning process through project and post-project analysis in order to improve effectiveness.

Figure 15.1: Institutional Setting for Water Resources in Mauritius



Note: Water Resources Unit (WRU), the Central Water Authority (CWA) Wastewater Management Authority (WMA), Irrigation Authority (IA). **Source:** AWDR National Report, 2005

The institutional structures must ensure compliance with construction and operational plans and be able to link planning to resource allocation. It must see to it that the implementation stage includes arrangements for adequate supply of good quality water as well as the services needed by other structures to continue to operate and to undertake repairs and maintenance. The structures must be dynamic to enable them to adjust to national and regional changes.

These multifaceted actions and responsibilities justify, once again, the need for a coordinating mechanism, rather than a single body, to unite efforts, ensure consistency of decisions and employ an integrated or balanced approach to problems and activities in pursuing a nation's water policy.

Box 15.7
Fragmentation of Water Competence among Ministries - Cameroon

Cameroon serves as a good example of how responsibility for water management is distributed among various authorities. It has 12 ministries that can be placed under this category, as follows:

1. Ministry of Mines, Water and Energy (MINMEE): This ministry is responsible for the definition and application of water policies in Cameroon and is the country's main water coordinating institution.
2. Ministry of Town Planning and Housing (MINUH): This ministry is responsible for planning of water and sanitation networks in urban areas with a population of less than 100,000 persons, and controls the construction of urban water supply projects in such towns.
3. Ministry of Towns (MINVILLE): This ministry plays the role of MINUH in towns with a population exceeding 100 000 inhabitants. It defines water supply and sanitation policy in such towns and is the ministry in charge of the Cameroon Housing Cooperation (SIC), which manages secondary water supply and sanitation programmes in its housing estates.
4. Ministry of Agriculture (MINAGRIC): It acts through the Directorate of Agricultural Engineering (Génie Rural) and community development especially for irrigation, and provision of water supplies and adequate sanitation in rural areas.
5. Ministry of Livestock, Fisheries and Animal Industries (MINEPIA): This ministry is concerned with water management in fisheries, and water supply for livestock.
6. Ministry of Environment and Forests (MINEF): This is the executing, planning and control institution as concerns management of the environment (air, water and soil). The functions of this ministry relating to water, a key element of the environment, therefore overlap with that of MINMEE. Among other functions, MINEF is responsible for the preparation of the National Environmental Action Plan and proposes measures for the rational and sustainable management of natural resources and protection of the environment.
7. Ministry of Public Investment and Territorial Development (MINPAT): This ministry controls and approves public investment in water and sanitation programmes in Cameroon.
8. Ministry of Public Health (MINSANTE): is responsible for drawing up government policies on hygiene and sanitation in urban and rural areas, ensures environmental cleanliness and is responsible for identifying and resolving all major sanitary problems in the country.
9. Ministry of Commercial and Industrial Development (MINDIC), controls the mineral water sector in Cameroon. This includes authorization to bottle water, quality control and collection of taxes. This ministry fixes the price of domestic water in cooperation with other ministries.
10. Ministry of Territorial Administration and Decentralization (MINAT): This ministry manages municipalities, which ensure cleanliness in their areas of jurisdiction, the collection and treatment of wastes, and the maintenance of drainage networks. MINAT also has a Directorate of Civil Protection responsible for managing all disasters in the country including those relating to water e.g. floods, droughts and epidemics.
11. Ministry of Economy and Finance (MINEFI): This ministry acts through the directorate of treasury in the financing of projects with funds from the Public Investment Budget (BIP).
12. Ministry of Transport (MINTRANS): This ministry is involved in water management since the meteorological service is under its jurisdiction.

This recalls the role of national water commissions, boards or authorities, in other words, the Consultative Council on Water in the case of the Congo (Table 15.1).

Towards an Effective Institutional Framework for Water Management

Given the complexity and multi-disciplinary nature of water resources management and planning worsened by the problems of pollution and environmental degradation a centralized institutional structure is required for an effective and integrated management of water and land resources. What is important about centralization is the fact that it helps this type of management as it facilitates coordination or execution of projects.

Water resources planning and administration is part of national economic planning and activities and should include national water management institutions whose responsibilities must include:

(a) Unifying perceptions about national water concerns and interests to allow for adjustments in the legal and institutional framework;
(b) Establishing a national framework for water management, including evaluation and control that can allow regional and national programmes to be carried out bearing in mind national socio-economic and environmental objectives;
(c) Changing rules and procedures for programming water management activities;
(d) Provision of estimates on water supply and demand and forecasting needs and problems;
(e) Creation of conditions for efficient and effective water resources management at all levels, especially the lowest levels;
(f) Setting up of administrative and coordinating mechanisms to deal with inter-regional and international water management problems;
(g) Coordination and promotion of national information, research, and training programmes for information and technology transfer; and
(h) Participation, when necessary, in the execution of regional and/or river basin projects or programmes.

Table 15.2: Organisational Structure of Water Institutions in Ethiopia

Institution	Competence
Ministry of Water Resources (MOWR)	Established as the highest water organ in 1995, this ministry has the power and duty to optimise the allocation and use of trans-regional water. It drafts laws for its protection and use; issues permits to construct, operate and regulate waterworks; conducts water tariff studies and collects bulk charges; underta kes studies for the use of transboundary waters and monitors their implementation; prepares plans for the proper use of water resources and for monitoring implementation; provides necessary assistance in water resources development; signs international agreements in relation to transboundary rivers; prepares water quality standards for various purposes; and undertakes supervision to ensure that meteorological services are adequate.
River Basin Authorities	River Basin Authorities are to be established in due time and will take over all the duties of planning and management of water resources within the various river basins. For the Awash River Basin, which is the most developed, an agency called "Awash Basin Water Resources Administration Agency" was established in 1998 to coordinate, administer, allocate and regulate the use of the surface water resources of the Awash River Basin.
Regional Water Bureaus	With the new Federal Government system, water supply activities and small-scale irrigation have been decentralized and handed over to regional states. The regional states have their "Regional Water Bureaus", which are responsible for all their individual water activities

Extracted from AWDR National Report, 2005

For countries with decentralized institutional frameworks as referred to in table 15.2, recent experience shows that water management tends to be most efficient if regional agencies operate within the limits of water basins and are made responsible for regional water planning and for the administration of both water resources and water services. There are three broad categories of administrative agencies in water basins and the classification is based on their terms of reference and functions, as follows:

(a) Those with only planning and coordination authority;
(b) Those with coordination and finance responsibilities; and
(c) Those with powers to draw up development plans execute them and operate the systems within the basin.

River basin management in Africa seems to be based on specific sectoral focuses, as in the case of the Volta River Authority in Ghana, dominated by hydropower generation, and the Awash Basin Authority in Ethiopia, with predominance of irrigation (Andah, 2002c). It is important to emphasize that in Africa, the presence and powers of purely regional water agencies, if they exist, are very limited as water resources are often under national control and use. However, there are a wide variety of functions for regional institutions which makes it necessary to consider the following recommendations:

1. The national water institution should have the necessary authority to guide, integrate and coordinate efficiently all water resources activities at the regional and basin levels, bringing together all sectoral interests in water management.
2. The institutional relationship between regional or water basin agencies and the national authority must be well defined. In order to facilitate gradual integration of water management into the management of the environment, a close link must be established between water resources management and general regional planning.

The characteristics and jurisdiction of the water basin agencies and their responsibilities to water users must be defined in a legal and administra-

Box 15.8
Legal Basis for IWRM in Zimbabwe

The Water Act of 1998 which replaced the 1976 legislation was drafted after a long process of stakeholder involvement. Several consultative workshops at the local, provincial and national levels were conducted to capture the views of stakeholders. The drafting of the 1998 Water Act was guided by the following principles which incorporate the Dublin Principles and those of the Africa Water Vision:

1. Ownership of all surface and ground water is vested in the State.
2. Stakeholders have to be involved in decision-making during water resources planning and management.
3 Water resources planning and management have to be undertaken on a catchment or river basin level, and not using political or administrative units. Surface water and groundwater were regarded as part of a single hydrological system/cycle, and there should not be a distinction in the management of water irrespective of the state in which it water occurs.
4. Water resources planning and management has to be environmentally sustainable, and the environment is a legitimate user of water.
5. There has to be equity in terms of access to water by all water users.
6. Water prices have to be based on the user pays and polluter pays principle, and water prices have to socially acceptable to the different water users.
7. Water is an economic value in all its competing uses and should be recognized as an economic good.

By adopting the Dublin Principles, and those of the Africa Water Vision in reforming the legislation, Zimbabwe can be considered as having achieved one of the targets of creating a legal and institutional framework aimed at achieving equitable distribution of water.

tive framework, and could include the formulation of up-to-date databases on the region's water supply and use, the operation and maintenance of hydro meteorological networks, planning, design, construction and operation of water installations as well as the establishment of a charging and tariff system to recover capital investment and operational and maintenance costs.

Box 15.9: Statement of the African Ministerial Council on Water (AMCOW)

Water – A Key to Sustainable Development in Africa - 12 May 2003

Towards achieving the targets set at the Millennium Summit and the World Summit on Sustainable Development (WSSD)

Introduction

We, the Members of the Steering Committee of the African Ministerial Council on Water (AMCOW), having met in Dakar, Senegal, from 20 to24 May 2003, adopt the "NEPAD Statement on International Solidarity with Africa for the achievement of the water-related targets in the Millennium Development Goals and the outcomes of the World Summit on Sustainable Development". Our meeting is part of our quest for implementation actions in line with the expectations of the Johannesburg Summit.

For over 30 years, numerous conferences and international agreements have built the framework for today's water resource policies and decisions. The international community, in both the millennium goals and the outcomes of the World Summit on Sustainable Development, underlined that the global water crisis is a threat to economic development, poverty reduction and the environment, and hence to peace.

I. Time for Action: Towards a new regional and global compact for achieving the targets on water in Africa

We note that the supply and quality of freshwater in Africa remains one of the most critical issues of the twenty-first century.

In Africa close to 40 per cent of the population are without access to safe water supply and even more lack adequate sanitation. A number of partnership initiatives as well as a new water policy framework were announced at the WSSD, including the recent reform of EU water policy and the new Water Framework Directive of the EU. The need to integrate sustainable water management in national and regional development strategies is now widely recognized as a prerequisite for achieving the MDGs on water in Africa.

We welcome the international community's recognition that, in Africa, over 40 per cent of our people have no access to water. We call on the international community, in conformity with the NEPAD goals, to work with Africa in addressing the myriad challenges inherent in long-term water management. They should support regional efforts to develop coherent water management strategies, set up appropriate bodies at the national, regional and local levels, and attract the necessary public and private investment.

In this regard, we applaud the solidarity of the EU with Africa in the water sector, as manifested in the launch, on the occasion of the World Summit on Sustainable Development in Johannesburg, of a major initiative to help achieve, in our region, the targets set at the Millennium Summit and in Johannesburg to reduce by half the number of people without access to drinking water and sanitation by the year 2015.

We recognize that the achievement of those targets calls for measures and initiatives of a very special character on the part of all concerned, including our countries and civil societies as well as bilateral and multilateral agencies, the private sector and other stakeholders, if we are to mobilize the resources needed. We also fully realize the urgent need for innovative mechanisms to enable us to mobilize significant sources of financing from public, private and international resources.

As part of our commitment to the achievement of the targets on water in the Millennium Development Goals and the Johannesburg Action Plan, the African Governments along with representatives of the international community will convene the Pan-African Implementation and Partnership Conference on Water, in Addis Ababa, 9 – 14 December 2003.

At the Conference, we shall agree on a roadmap to expedite the translation of commitments into action, through a series of concrete measures and initiatives in the water sector. In this regard, the Conference will address the implications of the WSSD on regional water initiatives, and the continent's role in the implementation of the Summit's outcomes. The Conference will provide a unique opportunity to determine how to collectively meet the WSSD targets on water and to achieve the Millennium Development Goals. Our objective is to focus attention on the implementation requirements as well as the means of implementing, in Africa, the many regional and international targets in the water sector. The Pan-African Conference will seek to secure inter/intra African commitments to the implementation of targets, and build international solidarity in the form of meaningful partnerships.

Under the aegis of NEPAD/AMCOW, we shall, at the Pan African Conference launch:
- The African Water Development Report;
- A regional initiative for integrated water resources management in each country;
- A master plan for trans-boundary basins management;
- An innovative programme for strengthening national and sub-regional water policies, laws, institutions and other instruments;
- Specific modalities for the effective implementation, at the national, subregional and regional levels, of the EU-Africa strategic partnership on water;
- Modalities for the full implementation of the African Water Facility for mobilization of public and private as well as international financing essential to the achievement of the targets in the water supply and sanitation sector at the national and subregional levels; and
- *A regional initiative for financing groundwater assessment and management.*

II. Support to Africa by the Group of Eight Industrialized Countries (G 8)

At its Summit in Kananaskis, Canada in 2002, the G8 Group of Industrialized Countries noted that the importance of water spans over a wide range of critical uses – from drinking water, to sanitation, to food security and agriculture, to economic activity, to protecting the natural environment. The G8 Leaders also noted that water management is sometimes at the centre of threats to regional peace and security. The African Ministerial Council on Water notes the measures taken by the Kananaskis Summit to encourage efforts to improve water resources development and management in Africa. That Summit laid a firm basis for supporting Africa's water-related initiatives.

Nine months ago, at the World Summit on Sustainable Development, the international community committed itself to specific goals, targets and time-bound measures aimed at accelerating the transition to sustainable development. While some of these targets constitute a reaffirmation of the Millennium Development Goals, most represent new commitments.

As the G8 Leaders met in Evian-les-Bains, France, at their first Summit since Johannesburg, a key question demanding urgent attention was the partnership needed to help Africa achieve specific time-bound measures, particularly within the context of the following water and sanitation targets agreed to at the WSSD:

- *Establishment of a world solidarity fund to eradicate poverty and promote social and human development, making community level water and sanitation projects eligible for funding;*
- *Elements for a programme of action on sanitation;*
- *A mandate to launch a programme of action, with financial and technical assistance to achieve the MDG on safe drinking water and the additional target on sanitation;*
- *Development of integrated water resource management and water efficiency plans by 2005 with support to developing countries;*

- *Support to activities for the International Year of Freshwater in 2003 and beyond; and*
- *A call for effective coordination among the various international and intergovernmental bodies and processes working on water-related issues.*

The international community has underlined that the global water crisis is a threat to economic development, poverty reduction and the environment and hence to peace.

We invite the leaders of the G8 Countries to build a new compact with our region in the field of water - a key to sustainable development in Africa. We call on the leaders of the G8 group of Countries to endorse, at its 2003 Summit, an action plan on support to the water sector in Africa.

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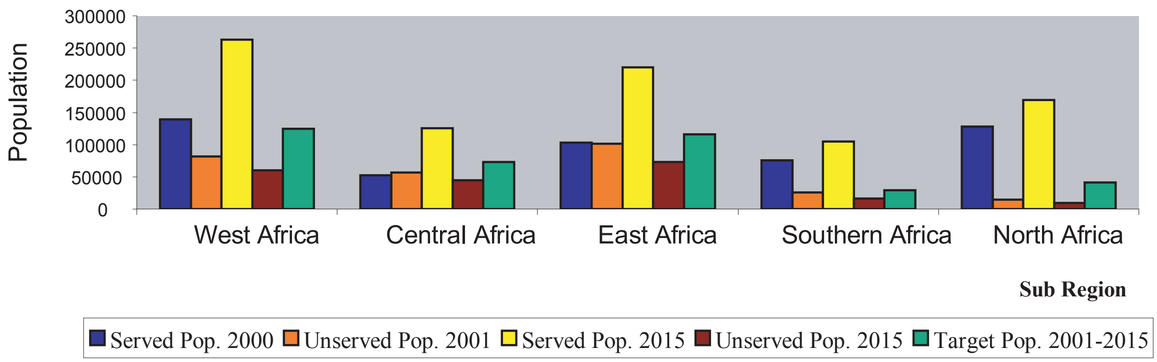
IMPLEMENTATION OF TARGETS UNDER THE AFRICAN WATER VISION AND THE MILLENNIUM DEVELOPMENT GOALS

African countries are more than ever before involved in tackling the issue of integrated water resources management which they are resolved to improve in line with the targets of the MDGs, at both the national and subregional levels and through international partnerships. In doing this, they have given a pride of place to water and sanitation in their socio-economic development strategies, and expressed their determination at the Pan African Implementation and Partnership Conference on Water, held in Addis Ababa from 8 to 13 December 2003 under the auspices of the African Ministers' Council on Water (AMCOW) and the UN Water/Africa. The conference brought together 45 Ministers in charge of water, environment and housing and about 1000 national delegates and participants representing key stakeholders, intergovernmental organizations, cooperation development partners and non-governmental organisations (NGOs).

The Conference provided a platform for African countries, the international community and UN agencies to reaffirm their commitment to solving Africa's water crisis and to collectively implementing the actions proposed on water by the Africa Water Vision, the Water Agenda of the New Partnership for Africa's Development (NEPAD), the WSSD targets and the Millennium Development Goals (MDGs). The actions include such targets as reducing by halve the proportion of people without sustainable access to safe drinking water and without access to basic sanitation by 2015, and developing integrated water resources management (IWRM) and water efficiency plans by 2005. Figures 15.1 and 15.2 show the targets set for water supply and sanitation (UNEP, 2003).

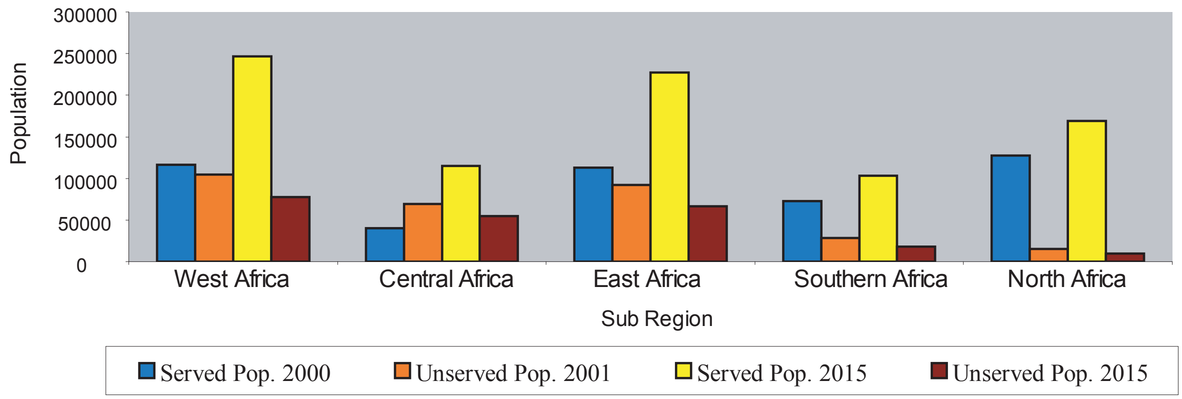
The thematic sessions were dedicated to the challenge areas, including: water, sanitation and human settlements; water and food security; protecting ecosystems and livelihoods; water and climate; financing water infrastructure; integrated water resources management (IWRM); water allocation; water wisdom; and water governance. Each session came out with recommendations which were discussed at joint plenary sessions of ministers and stakeholders. One of the main outcomes of the conference was the presentation to and adoption by the ministerial segment of the conference of subregional project portfolios. These projects were prepared through national and subregional consultations and meetings to follow-up on the recommendations of WSSD

Fig. 15.1: Improved Water Supply Target in Africa by 2015



Data Source: UNEP, 2003

Fig. 15.2: Improved Sanitation Targets in Africa by 2015



Data Source: UNEP, 2003

on regional water initiatives and to draw up an agenda for concretely implementing the targets of the Africa Water Vision and the Millennium Development Goals with special emphasis on water supply and sanitation and the strategic application of IWRM.

Subregional Project Portfolios

The subregional priority projects focus on concrete water resources issues relating to the prevailing climatic conditions and the status of water resources development. The most important element is AMCOW's patronage at both the subregional and regional levels. The specifics are given below.

Southern Africa Subregion

The programme for this subregion (and largely owned by SADC members) is referred to as the Regional Strategic Action Plan for Integrated Water Resources Management and Development (RSAP/IWRMD), was developed through a highly consultative process through which all the member States participated in the Plan's design, formulation and adoption. The Programme is comprised of over 32 areas of action with focus on 6 strategic priorities in the subregion's water sector. The framework for action is based on full and extensive analysis and review of constraints within the subregion and identification of actions to overcome these constraints. These actions were organized into a systematic collection of strategic objectives and intermediate objectives aimed directly at the major types of constraints identified. The framework provided a course of action for implementing future decisions and directives of the representatives of SADC member States. The subregional programme was developed under the following seven strategic objectives:

(a) To improve the legal and regulatory framework at the national and regional levels;
(b) To improve national and transboundary river basin management, planning and coordination;
(c) To strengthen linkages among macro-economic, social and environmental policies;
(d) To improve information acquisition, management and dissemination;
(e) To support awareness building, education and training;
(f) To promote public participation; and
(g) To invest in infrastructure

The projects were classified into the six groups shown below, in line with their thematic relationships, in order to enhance synergies by harmonizing implementation:

(a) Legislation, Policy and Strategic Planning;
(b) Capacity Building and Training;
(c) Awareness Creation, Consultation and

Public Participation;
(d) Information Collection, Analysis, Management and Dissemination and improvement of national and transboundary river basin management, planning and coordination;
(e) Infrastructure Investment; and
(f) Stand Alone (Special Priority) Areas

The projects are largely envisaged for soft infrastructure, meant to create an enabling environment in the subregion for further development of solid infrastructure projects. The total estimated cost of the Programme is US$ 138,276, 000, of which 21 per cent (about US$ 28, 372, 855) has been secured, living a balance of US$ 109,903,145 which is being needed.

West Africa Subregion

The approach pursued by the West Africa Subregion was directed at creating an Action Plan for Integrated Water Resources Management, codenamed WARAP-IWRM. The projects under the action plan were selected through national and subregional conferences on IWRM. Some of the priority areas identified were:

(a) Implementation of an IWRM process as part of the National Water Plan of each country of the subregion;
(b) Setting up of a framework for regional cooperation on IWRM, aimed at harmonizing policies and legislation on water issues and for exchange of experience;
(c) Re-activation of the framework for consultation between riparian countries for joint management of shared basins; and
(d) Drawing up of national and subregional strategies for mobilizing financial resources required for integrated water resources management.

The finalization of the project selection was informed by the conclusions of the first and second National Focal Points workshops and after a regional synthesis had been done; the following are the thematic programme areas:

(a) To support national IWRM plans;
(b) To provide specific support to countries emerging from civil wars in the reconstruction of their water sector;
(c) To build the capacity of their people and institutions;
(d) To undertake regional coordination of IWRM and WARAP;
(e) To establish or reactivate a common framework for riparian countries to jointly manage shared water basins; and
(f) To finance the water sector.

The total cost of the identified projects amounts to about US$ 24 million and the projects are expected to last one to three years.

East Africa Subregion

The process of identifying portfolio projects in the East Africa subregion was carried out under the auspices and direction of the AMCOW- EA Technical Committee, while the responsibility for national reports fell on the National Focal Persons appointed in individual countries.

As part of the process:

Each country prepared:

(a) A national report on the implementation of chap. 18 (Agenda 21 and other WSSD and MDG water targets);
(b) A portfolio of water-related projects/programmes for inclusion in the East Africa subregion's portfolio of projects/programmes.

The AMCOW-EA Secretariat was mandated to synthesize the above National Reports into AMCOW-EA Subregional Reports and Portfolio of Projects to be prepared and presented to AMCOW bearing in mind the following recommendations:

1. There should be a good mix of projects addressing all key areas i.e. Water Supply and

Sanitation, Water Resources Management, and Water for Production.

2. In preparing the projects, there should be a clear link with the MDG and WSSD targets and National Strategies to ensure consistency.
3. Project scopes should be broadened to capture cross-cutting issues which may otherwise be missed e.g. Projects on Ground water and Surface water mapping should also include aspects of water resources assessment and valuation and development of management tools as stipulated in the MDGs.
4. Emphasis should also be given to projects on Water for Production as this directly relates to food security, rural industrialization, increased exports and poverty reduction.
5. Care should be taken to avoid "stand-alone projects". The projects prepared should be linked to ongoing projects and programmes and should be seen as filling existing gaps rather than being completely new initiatives.
6. Efforts should be made to capture the transboundary aspects in all the proposed projects so as to bring in some regional dimension since AWCOW is a regional initiative.
7. Countries should avoid the temptation of coming up with long "shopping lists" of projects but should instead concentrate on a few (maximum 5) but comprehensive projects.

The final portfolio of 14 projects was proposed by five countries, namely,. Kenya, Tanzania, Uganda, Ethiopia, and the Sudan. The total financial requirement for the fourteen projects is estimated at US$ 2,661,650,000 (Two billion six hundred and sixty one million six hundred and fifty thousand United States Dollars).

Central Africa Subregion

The Central African AMCOW oversaw the process of establishing an Action Plan by identifying priority projects in the subregion in response to the WSSD and MDGs water targets. The objective of the Action Plan is to improve the socio-economic situation in the subregion by improving its water resources management.

The portfolio projects under the Action Plan were formulated to meet the following specific objectives or strategies:

(a) Managing water resources in a responsible manner and with wisdom;
(b) Mitigating water-related disasters and risks;
(c) Creating an appropriate framework for the management, development and operation of water resources systems;
(d) Improving hydrological information management;
(e) Improving access to appropriate water supply and sanitation services; and
(f) Developing the necessary infrastructure for water resources development.

The portfolio of projects consists of 34 projects distributed among the countries of the subregion, and is expected to cost about US$5.8 billion.

North Africa Subregion

The process of identifying and formulating portfolio projects in the North Africa subregion was not indicated in their presentations. The priority projects therefore seem to be more country specific than subregional.

The annexes to this chapter contain more detailed description of the Action Plans and Portfolio of Projects for individual subregions of Africa.

African Regional Synthesis of Portfolio Projects

Harmonising the subregional portfolio projects for the implementation of the Africa Water Vision, the WSSD and MDG water targets with a strategic application of IWRM and actions to overcome the areas of challenge would produce

a regional framework for Africa as a whole. The priority projects are therefore broken down by programme area with the estimated cost and the financial requirement, as shown in table 15.1. From the table, it can be seen that the emphasis on challenges varies from subregion to subregion and that the financial requirements are generally high, except for the Southern Africa subregion which indicated financial amounts already mobilized and, to a lesser extent, the East Africa subregion. The process of prioritizing subregional projects and harmonizing them into an African regional portfolio of projects is yet to be undertaken under the auspices of AMCOW. It is only when this stage has been completed that AMCOW can use its offices to mobilize funds from donors and partners to cover the foreseen funding gaps.

Table 15.1: Summarised African Regional Implementation Programmes towards the Africa Water Vision and the Millennium Development Goals

Programme	SubRegion	Estimated Costs Mil. US$	Covered Costs Mil. US$	Funding Gap Mil. US$
Integrated water Resources Management – IWRM	Central	-	-	-
	West	5.770	-	5.770
	South	10.200	1.170	9.030
	East	0.100	-	0.100
	North	45.000	-	45.000
	Sub Total	61.070	1.170	59.900
Freshwater Resources	Central	5.200	-	5.200
	West	2.203	-	2.203
	South	35.825	10.345	25.480
	East	12.850	0.700	12.150
	North	70.000	-	70.000
	Sub Total	126.078	11.045	115.033
Meeting Basic Needs	Central	4207.500	-	4207.500
	West	4.710	-	4.710
	South	0.120	0.120	0.000
	East	1785.100	153.600	1631.500
	North	2812.205	-	2812.205
	Sub Total	8809.635	153.720	8655.915
Protecting Ecosystems	Central	2.983	-	2.983
	West	0.800	-	0.800
	South	12.260	0.260	12.000
	East	0.500	-	0.500
	North	106.850	-	106.850
	Sub Total	123.850	0.260	123.133
Water for Urban Environments	Central	-	-	-
	West	-	-	-
	South	-	-	-
	East	26.000	-	26.000
	North	1100.490	-	1100.490
	Sub Total	1126.490	-	1126.490
Water for Food Security	Central	453.400	-	453.400
	West	-	-	-
	South	-	-	-
	East	689.900	50.500	639.400
	North	33.250	-	33.250
	Sub Total	1176.550	50.500	1126.050
Harnessing Energy for Development	Central	-	-	-
	West	-	-	-
	South	-	-	-
	East	-	-	-
	North	544.000	-	544.000
	Sub Total	544.000	-	544.000
Managing Risks	Central	26.333	-	26.333
	West	-	-	-
	South	0.250	0.090	0.160
	East	350.000	12.400	337.600
	North	-	-	-
	Sub Total	376.583	12.490	364.093

Programme	SubRegion	Estimated Costs Mil. US$	Covered Costs Mil. US$	Funding Gap Mil. US$
Sharing Water	Central	1.750	-	1.750
	West	1.500	-	1.500
	South	8.500	5.364	3.136
	East	-	-	-
	North	-	-	-
	Sub Total	11.750	5.364	6.386
Valuing Water	Central	-	-	-
	West	-	-	-
	South	2.150	0.260	1.890
	East	-	-	-
	North	7.250	-	7.250
	Sub Total	9. 400	0.260	9.140
Ensuring the Knowledge Base	Central	9.250	-	9.250
	West	5.160	-	5.160
	South	31.700	3.445	28.255
	East	-	-	-
	North	16.250	-	16.250
	Sub Total	62.360	3.445	58.915
Governing Water Wisely	Central	2.789	-	2.789
	West	2.360	-	2.360
	South	45.156	8.360	36.796
	East	-	-	-
	North	-	-	-
	Sub Total	50.305	8.360	41.945
TOTAL	African Region	12477.614	246.614	12231.000

CONCLUSIONS AND RECOMMENDATIONS

Most reports and documents written to date on Africa's water resources development indicates that the level of water application in the general socio-economic development efforts of African countries is very low. Thinking scientifically and technically, such a situation calls for timely concerted efforts to holistically analyse the hydrological and climatic fluxes over Africa in order to assess the water resources available over time and space to cater for the ever-increasing competing water demands, without impairing the environmental resources and ecosystems of the continent. The rich store of knowledge and information about water resources development and management in the developed economies, including the achievements and failures in this field continuously inform international water policies which can be used as a launching pad for Africa's integrated water resources management efforts.

Africans have indicated their resolve to embark on a forward-looking and integrated approach to water resources management. Through the Africa Water Vision 2025 they have set out the goals and scheduled the programmes for matching demand with supply over a given time and across a given geographical spread, bearing in mind quantitative and qualitative requirements in developing the resources.

The present African Water Development Report is an initiative of UN-Water/Africa that aims to provide vital data and information in connection with the objective of monitoring Africa's progress in implementing the strategies and targets defined to meet the challenges of its water Vision. The analysis made in the report confirms the views generally expressed that there is a lack of consistent and reliable data on both the physical and socio-economic aspects of water resources in Africa. This is a fact that becomes even more evident and distressing when the inconsistencies in data sources and the lack of harmonization of data definitions hamper comparative analysis of the water situations of various countries. Examples of this abound when considering a range of definitions on what access to safe drinking water and hygienic sanitation facilities means in various countries.

The Global Water Supply and Sanitation 2000 Report can be considered as a benchmark database for Africa's water supply and sanitation coverage, through which progress in the Africa Water Vision can be monitored. It must, however, be noted that the report is not explicit on the two most important issues of safety and adequacy of water and sanitation services, which are vital for the social well-being of the African populace in the context of poverty alleviation and the burden of water-related illnesses. The report gives mixed impressions about Africa's commitment to international water policy declarations as it considers progress in water supply and sanitation coverage in the continent during the period 1990-2000.

It highlights the point that although, in absolute figures, water supply and sanitation facilities were extended to many more Africans during the period, the percentage coverage was minimal for water supply and negative for sanitation due to relatively higher population growth rates in the continent. Almost half of all the countries for which data were available had less than 50 per cent coverage for sanitation, and few are the countries whose total water supply coverage exceeded 75 per cent. Ten African countries have less than 50 per cent coverage both for the current national water supply and for sanitation.

These countries are Angola, Burkina Faso, Chad, the Democratic Republic of the Congo, Eritrea, Ethiopia, Madagascar, Mauritania, Rwanda and Sierra Leone. The disparities between water supply and sanitation coverage comes in two forms. One is that sanitation lags far behind water supply at all levels and the other is that rural services for both lag far behind urban services. Furthermore, in spite of the low level of wa-

ter extraction for various uses in the continent, freshwater resources seem to be dwindling due to various factors, including:

(a) Population growth incommensurate with economic growth;
(b) Uneven distribution of rainfall over the continent in both space and time;
(c) Diminishing natural humidity due to climatic variability and, possibly, the influence of climate change;
(d) Depletion of groundwater aquifers due to uncontrolled use; and
(e) Pollution of both surface and groundwater bodies.

The growing demand by socio-economic development, population pressure and fragmented water resources development are paving the way to very serious environmental problems, such as deforestation, land (soil) degradation, water resource degradation, unsustainable use of land and water resources and loss of biological diversity. These processes, which go almost unnoticed in most African countries, are already posing challenges to the management of water resources in the continent and to meeting the competing demands for basic water supply and sanitation, food security, economic development and environmental protection. Thus, as the economic performance of African nations improve, more wealth is created and the pace of urbanization quickens, making it difficult for the administrative authorities in most urban centres to match the population growth with commensurate urban planning regulations, affordable housing policies and the provision of safe water supply and decent sanitation facilities. Also, many new migrants attracted by this urbanization are unable to pay amounts quoted as rent, not to mention the bloated rent advances demanded which can be as high as two years rent and so make do with any available space, resulting in the growth of urban slums. Very few Governments in Africa recognise the critical situation of these unplanned urban settlements whose rate of propagation is highest in sub-Saharan Africa where it is estimated at 71.9 per cent. With the necessary political will, the urban poor can be catered for with water and revenue resources retrieved from the very high unaccounted-for-water being lost in urban water supply systems of African cities, estimated at about 50 per cent. After all, it is now well established that the urban poor pay more for water and sanitation services than the affluent urban residents to whom most of the government subsidies go.

The link between water and agricultural/food production does not need explanation, and the problem of food security in Africa has become chronic, especially in the eastern and southern subregions. Acute and chronic under-nutrition and most micronutrient deficiencies primarily affect the poor and deprived people who lack adequate food, live in unsanitary environments, lack access to sufficient and clean water and basic services and lack access to appropriate education and information. Increased and diversified production of food for family consumption or as a source of income is therefore a basic prerequisite for improved household food security. In this situation of food scarcity, agricultural production in Africa is still far below the potential resources available in terms of land use and application of irrigation to enhance production.

The importance of water as a vital source of energy is well known, especially in the field of hydroelectricity production and the development of this form of energy will go a long way in reducing Africa's energy needs. Currently, Africa is the world's leading consumer of biomass energy which accounts for as much as two thirds of the continent's total energy consumption. Firewood is the most common and environmentally detrimental biomass energy source, accounting for about 65 per cent of biomass use. The smoke generated in the use of fuelwood for cooking causes indoor pollution which negatively affects health, particularly, of women and children. Hydroelectric capacity accounts for about 22 per cent of the total electricity-generation capacity in Africa and represents the primary source of electricity

in East Africa, Central Africa and nearly half of West Africa. SADC countries of the south have taken the lead in pooling energy resources for regional integration by establishing a regional electrical energy grid system. ECOWAS countries are also advanced in their plan for a West African Energy grid system.

Water-related natural disasters is among the commonest natural disasters in Africa where drought, floods, cyclones, food shortages, and pest infestations frequently occur, with drought being the deadliest. Over three quarters of the areas affected are the victims of drought which is responsible for 98 per cent of mortality from these disasters. The hardest-hit areas include Ethiopia and the Sahel region on the southern edge of the Sahara. Inter-annual rainfall variations that are sometimes extremely high cause drought and/or flooding in most African countries which are vulnerable to flooding, especially North Africa where it is the commonest, followed by East, South and Central Africa, where it is the second most common, and then West Africa. From 1971 to 2001 episodes of flood accounted for 26 per cent of total disaster occurrences in Africa, with devastating effects. It is therefore important to direct research into the behavioural patterns of rainfall to the small synoptic scales and mesoscales of climatic and atmospheric conditiions that could trigger frequent rainfall anomalies in Africa. Special attention must be given to further enhancing study of the hypothesis on spatial coherence of African rainfall anomalies in order to evolve an index of anomaly that could be used to predict possible anomalous rainy seasons based on advance knowledge of rainfall anomalies in certain climatic areas of the continent. This will also enhance knowledge of the time necessary to begin and complete disaster mitigation.

Sharing resources and knowledge

Most of the fresh surface water resources of Africa are found along major transboundary river/lake basins, some of which are shared by as many as ten countries. This fact, which is generally considered as a threat to water management in Africa, has to be turned into a resource and an ingredient for regional cooperation. Since river basins know no boundaries, be they ethnic, regional, national or international, they must be considered, analysed and administered from this perspective through an integrated institutional framework, by means of data collection and dissemination, planning of water allocation, pollution control and water resources systems development and management. Sharing knowledge about the value and uses of water as well as collaborative action hold the key.

No doubt, concepts about the intrinsic value and attributes of water are still varied, but the resource is mainly associated with two of its most indispensable attributes, namely, being an economic good and a good of social value. As an economic and social good, decisions for optimal use of water and its allocation for various potential uses should be based on a socio-economic trade-off analysis principle that is not tied to ability to pay. This would enable Governments to subsidize those essential uses of water with a low ability to pay – an action. more suitable and favourable to the African socio-economic reality. In fact, even the rising block tariff system which works well in advanced countries results in the poor living in traditional African extended family households paying more than the richer sections of society.

In Africa, sharing knowledge and building it would also help in the development of the necessary regional and local infrastructure for adapting and assimilating the most needed technologies, knowledge and information indispensable for the development of the water resources of African countries in order to address the urgent questions of food security, access to clean and adequate water and sanitation facilities while conserving the environment. The strategic adoption of IWRM principles for the implementation of the Africa Water Vision does not only mean going beyond the traditional description of

the resource and integrating or balancing it with demand but also embracing the new concept of integrating it across sectors, integrating its use, integrating demand for it, integrating it with the environment and integrating it with the people. Currently, progress in science and technology, rising demands for development in African countries and the ecological or environmental challenge of our age requires an increased number of highly trained water experts, but these are not widely available in Africa. Massive capacity building is therefore needed to produce male and female water professionals highly skilled in IWRM principles and practices. At present, most sub-Sahara African countries lack the academic potential and infrastructure to establish advanced postgraduate training of a duration and intensity necessary to produce the skills needed for sustainable water resources development and management. The UN Water Africa and AMCOW are therefore called upon to find ways of establishing such training through international cooperation.

The sum up is recognizing the strong need to harness and put into productive use Africa's land and water resources potentials and basing development on sound policies, strategies and planning, taking into account the interface and linkage of these resources with national socio-economic development perspectives. Doing this entails ensuring the interplay of the nexus issues of population, environment and food security with the crosscutting elements of water resources, capacity building and gender issues. The exercise should seek to harmonize and reconcile sectoral objectives with national development targets at the macro-economic level.

As for the present African Water Development Report itself, it should be noted that regional and subregional syntheses were difficult to make owing to lack of homogeneity of the presentations in the national reports, especially as regards the use of indicators and references. It is therefore recommended that for subsequent editions of the Report the UN Water Africa should establish a data preparation programme with special emphasis on leading indicators and their definitions as well as reference standards.

Collaborating Agencies

ECA UNEP WMO UNESCO FAO

unicef UNDP UN-HABITAT

Non-UN Partner

AU NEPAD