1 Africa

Africa faces the toughest challenges of any continent. While most of the developing world has managed to reduce poverty, the rate in sub-Saharan Africa has not changed much since the 1980s. With 40% of the population living below the extreme poverty line of US$1 per day and 73% of the population below US$2 a day, according to World Bank figures, this continues to be the world's poorest region.

A heavy burden of disease (including the HIV and AIDS epidemic), poor capacity in almost every aspect and continuing social unrest are only some of the issues adding to an already heavy socio-economic toll and putting sub-Saharan Africa off track to meet the Millennium Development Goals.

This section contains five case studies, for countries ranging from one of the smallest in Africa (Swaziland) to the largest (Sudan). They reflect the highly complex real-life issues involved in addressing water-related challenges on this vast continent. Tunisia, the one country case study outside of sub-Saharan Africa, shows what might be achieved.

Cameroon

Although endowed with abundant freshwater resources, the country faces a lack of comprehensive information, an inadequate legal and institutional framework, weak enforcement capacity, poor coordination among agencies and other obstacles to sound, sustainable water management. Cameroon is lagging on the Millenium Development Goals, in part because its water sector is highly fragmented and underfunded.

Setting the scene

Cameroon is situated between West and Central Africa at the extreme north-eastern end of the Gulf of Guinea. It is bordered by Chad in the north-east, the Central African Republic on the east, the Congo, Gabon and Equatorial Guinea on the south, and Nigeria on the west. It has about 400 km of Atlantic coastline in the south-west, and shares Lake Chad with Chad in the north (Map 1.1). The country's total surface area is about 475,650 km^2, and the estimated population is 18 million (WHO/UNICEF, 2008), with more than half under age 25. The urban and rural populations are about the same size, although urbanization is increasing by 4.7% per year, on average. About 35% of the urban population lives in the economic capital, Douala, or the administrative capital, Yaoundé.[1]

The country's 1,200 km length, proximity to the sea and topography give it a varied climate with wide differences in rainfall and vegetation. The maximum rainfall of 10,000 mm occurs in the equatorial climate zone in the south, and the minimum of 500 mm in the extreme north on the edge of the Sahara. The average annual rainfall is about 1,684 mm.

Climate change and variability

Average rainfall has been declining since the 1950s. In the last three decades it has decreased by about 5%. Reduced flow rates have been more pronounced in areas with a Sahelian climate, where reductions ranging from 15% to 25% have been recorded. These changes have led to increased desertification in the north and a falling water table due to reduced recharge. In addition, previously permanent wells are drying up late in the dry season.

State of the resource and water use

Cameroon has a dense network of rivers, most of which arise on the central Adamawa plateau and flow north or south. These provide it with abundant water resources in relation to current demand. The six main basins are Sanaga, Sanaga West, Sanaga South, Benoue, Congo and Lake Chad. The Sanaga basin, located in the centre of the country, is the largest, covering about 29% of the territory. It and the Sanaga West and South basins constitute the Atlantic basin. Cameroon's total annual renewable water resources amount to some 283.5 billion m^3 or about 17,000 m^3 per capita, using 2006 population estimates (Aquastat, 2007). The groundwater resources have not yet been comprehensively evaluated, so their potential is not known precisely, but is estimated at 100 billion to 120 billion m^3. Due to the lack of comprehensive monitoring of water resources, consumption patterns are not known exactly. However it is estimated that about 1 billion m^3 of the total renewable water resources is withdrawn annually. Of this, roughly 74% is used in agriculture, 18% for municipal consumption and 8% in industry (Aquastat, 2007).

Agriculture is the backbone of Cameroon's economy, accounting for about 41% of GDP (World Bank, 2007) and 55% of the workforce (WRI, 2007). At about 69,750 km^2, arable land amounts to 15% of the overall surface area. About 29% of the arable land is cultivated, mostly in the west and south-west. The share of the population working in agriculture has been decreasing since the 1970s, but as productivity has increased over the same period, food security has not been directly affected. Irrigation has contributed substantially to productivity, making cultivation possible during the dry season. In 2000, irrigated area of about 224.5 km^2

Map 1.1 Cameroon

[1] Except where otherwise noted, information in this case study is adapted from Fonteh (2003).

(excluding 28 km^2 of spate irrigation, where floods are diverted from ephemeral rivers to cultivate crops) corresponded to around 8% of the potentially irrigable area. Large irrigation projects (more than 2 km^2) accounted for roughly 65% of the irrigated area (Aquastat, 2005). Some large state-owned systems were abandoned due to low performance, while others that were privatized succeeded in improving efficiency of banana production for export. Consequently, the government has been privatizing larger irrigation systems and supporting projects of less than 5 ha (0.05 km^2), aiming to increase irrigation efficiency and sustainability.

Although Cameroon has sufficient water resources, choices in water use have started to affect water availability and ecosystems. For example, plantation of eucalyptus in the western highlands to provide firewood and construction material induced a very high evapotranspiration rate, which has altered the ecosystem and greatly diminished groundwater recharge and the flow rate in the area.

The country's estimated hydroelectric potential is 35 GW. Even with only around 2% of this potential developed, hydroelectricity accounts for about 97% of electricity generation in Cameroon (EIA, 2004). Because there is no nationwide grid, 20% of the electricity produced is lost, even though the south is undersupplied. Also undersupplied are rural areas in general, where only some 20% of the population has access to electricity, compared with 80% in urban areas. Overall, about 8.7 million people, or 53% of the population, lack access to electricity (IEA, 2006). To improve the situation, the Rural Electrification Agency promotes micro hydro projects and has demanded an increase in the national budget for rural electrification. Cameroon's heavy reliance on hydropower leaves its energy sector extremely vulnerable to drought, however. Existing hydroelectricity capacity falls short of meeting current demand, and shortages are especially acute in the dry season. Pending further hydropower development, the National Electricity Company has begun building thermal power plants. Despite the country's weak industrial base, the main user of electricity is the aluminium industry, which accounts for about half of all electricity consumed in Cameroon.

Due to the absence of an effective monitoring system, data on industrial effluent emissions are patchy, and the extent of water pollution in Cameroon is not fully known.

Policy framework and decision-making

Water is considered to be public property in Cameroon, and thus water protection and management are government responsibilities. Several institutions are involved in water management. Under the 1998 Water Law, the National Water Committee coordinates their actions. The committee is also responsible for:

- proposing actions to the government to assure the conservation, protection and sustainable use of water resources;
- providing advice on water-related problems;
- making recommendations on rational water management, particularly concerning the development and implementation of sustainable water and sanitation projects.

Chaired by the minister in charge of water resources, the National Water Committee includes high-level representatives of major stakeholders involved in water management in Cameroon, including the ministries in charge of finance, public health, environment, land management, urban development and housing, agriculture, livestock and fisheries, commerce and industry, territorial administration and meteorology, as well as associations of mayors and concessionaires of public water and energy services. The National Water Committee was formed by decree in 1985 as a consultative body to coordinate activities in the water sector. It has met only infrequently and never fulfilled its intended role. Recently signed enabling decrees under the 1998 Water Law, however, could give the committee new impetus and allow it to function more effectively (UN Water/Africa, 2006).

Integrated water resources management (IWRM) is accepted in Cameroon as the starting point for policies that can enhance sustainable water resources management and development, and assure water security. However, conditions for effective use of the IWRM approach are not yet in place. Not only does Cameroon lack comprehensive information on water resources, but the distribution of water management authority is highly fragmented, and sectoral management approaches predominate. Moreover, the political will and commitment to enforce existing laws and regulations is inadequate, as are human and institutional capacity and investment for assessment and monitoring. Nevertheless, measures to improve water security have been carried out or are under way, including:

- public-private partnerships for electricity and urban water supply;
- an IWRM plan, expected by the end of 2009;
- transfer of some water management responsibilities to local levels following implementation of a law on decentralization.

The main challenges

Poor water services, rural-urban disparities: While Cameroon is not yet on track to meet the targets of the Millennium Development Goals (MDGs) for water and sanitation, it has made notable progress since 1990. In 2006, 70% of the population had access to safe drinking water. The coverage in urban centres is 88%, significantly better than the 47% in rural areas (WHO/UNICEF, 2008). Of Cameroon's 300 urban centres with 5,000 inhabitants or more, however, only 98 have water supply networks. Moreover, rapid urbanization in smaller towns has often rendered existing infrastructure inadequate, with frequent service interruptions. Many periurban dwellers

Box 1.1 Combating degradation of Waza Logone floodplains

The Maga Dam was built in 1979 on the Logone River to provide a continuous supply of water and to improve rice cultivation in the region. The project was carried out without a comprehensive environmental impact assessment. The dam led to reduced flooding of the plain, which in turn led to reduced groundwater recharge, less fish farming and a reduction in the production of sorghum and wild rice. Pastures on the vast floodplains were degraded and herdsmen in the region did not have sufficient grazing for their cattle. Wild animals, like the elephants of Waza National Park, were forced out of their normal grazing areas to search for food on nearby farms. The reduced flooding had disastrous consequences for the ecosystem and the lifestyle of the local people, who are among the poorest and most vulnerable in the country. To mitigate the effects of the dam and increase flooding in the plain, the Waza Logone project was carried out, at a cost estimated to be two to three times higher than that of building the dam.

also lack access to safe drinking water. Another problem is the amount of water unaccounted for: the average rate of loss rose from 25% in 1990 to 40% in 2000, clearly indicating an aging network and poor maintenance. Hence, in reality, the supply situation is worse than the figures imply.

Sanitation coverage is also poor. In urban areas only 58% of the population has access to improved sanitation facilities, and the rate in rural areas is 42% (WHO/UNICEF, 2008). Studies from different parts of the country indicate that many water resources used for household consumption are polluted to varying degrees because waste disposal infrastructure is insufficient in urban areas, and the capacity to enforce existing laws is very weak. Especially affected are areas where latrines and septic tanks, for example, are located near springs and shallow wells used without treatment for household water supply.

There is little information on the amount of pollution reaching surface and groundwater resources, or on the severity of the problem. Some studies have indicated that most industrial facilities discharge waste into the environment with little or no treatment. A 2002 study of the effluent from a textile plant in the coastal region indicated that some water quality parameters exceeded recommended limits by up to 2,700%. The company knows it is polluting, but because monitoring and enforcement are inadequate, it lacks any incentive to invest in wastewater treatment.

Water-related disease is quite common in Cameroon and particularly affects children. The main causes of death in children under 5 are diarrhoea, malaria and measles. Among children under 4, diarrhoea accounts for about 10% of all deaths. Malaria affects about 46% of the population. Health expenditure in Cameroon for 2001 2002 amounted to around US$110 million, which corresponded to 4.5% of the national budget and about 1% of GDP.

Poverty is another major issue in Cameroon. Although the poorest areas are in the far north, all regions suffer to varying degrees. The first national household survey in 1996 estimated that 51% of the population was living in poverty. The figure had fallen to 40% by the time the second survey was conducted in 2001. However, the decline mainly benefited urban dwellers. Just over 22% of people in urban areas are poor, compared with nearly 50% in rural areas (IFAD, 2008).

Decreasing biodiversity, wetland degradation: Cameroon has a wide variety of natural resources, including its forests, which occupy about 50% of the country's surface area. With its climatic and ecological variety, Cameroon is rich in terms of biodiversity. However, an inadequate legal and institutional framework, combined with insufficient political will and commitment to enforcement of regulations, has led to decreased biodiversity. Wetlands are also at risk because of various pressures, including overgrazing and pollution. Other activities that have resulted in degraded wetlands include drainage for agriculture and for construction in urban and periurban areas. In the past, some development projects were carried out without adequate environmental impact assessment (Box 1.1), which affected wetlands and other ecosystems. Today, however, environmental impact assessment is required for all major development projects in Cameroon.

Conclusions

The biggest problem in Cameroon is not the availability of water it is the poor management and development of the resources, coupled with inadequate political will and commitment for the long term. The patchiness of information available on the quality and quantity of water resources is a major constraint for successful water resources management and a handicap for poverty alleviation efforts. Although progress has been made in water supply and sanitation coverage, much more needs to be done to improve the situation, especially in rural areas. The enabling environment for application of the IWRM approach is weak, as are institutional frameworks. In this situation, Cameroon is lagging in meeting the MDG targets. Improving water information systems, as well as completion and implementation of an IWRM plan, would go a long way towards improving water security in Cameroon, in addition to contributing to poverty alleviation.

References

Aquastat. 2005. Rome, Food and Agriculture Organization. http://www.fao.org/nr/water/aquastat/countries/cameroon/tables.pdf#tab3 (Accessed December 2008.)

Aquastat. 2007. Rome, Food and Agriculture Organization. http://www.fao.org/nr/water/aquastat/data/query/index.html. (Accessed February 2008.)

Energy Information Administration (EIA). 2004. *Country Analysis Briefs: Chad and Cameroon*. EIA, U. S. Department of Energy, http://www.eia.doe.gov/emeu/cabs/Chad_Cameroon/Electricity.html (Accessed December 2008.)
Fonteh, M. F. 2003. Water for people and the environment: Cameroon water development report. Background paper for *African Water Development Report*, Addis Ababa, Economic Commission for Africa.
International Energy Agency (IEA). 2006. *World Energy Outlook*. Paris, IEA. http://www.worldenergyoutlook.org/2006.asp (Accessed December 2008.)
International Fund for Agricultural Development (IFAD). 2008. *Rural Poverty in Cameroon*. Rural Poverty Portal. http://www.ruralpovertyportal.org/web/guest/country/home/tags/cameroon (Accessed November 2008.)
UN-Water/Africa. 2006. *African Water Development Report*. Addis Ababa, Economic Commission for Africa. http://www.uneca.org/awich/AWDR_2006.htm (Accessed December 2008.)
WHO/UNICEF. 2008. *Coverage Estimates: Improved Sanitation, Cameroon*. Joint Monitoring Programme for Water Supply and Sanitation. http//documents.wssinfo.orgdownload?id_document=932 (Accessed December 2008.)
World Bank. 2007. *2007 World Development Indicators Online*. Washington, DC, World Bank. http://go.worldbank.org/3JU2HA60D0 (Accessed February 2008.)
World Resources Institute (WRI). 2007. EarthTrends: Environmental Information. Washington, DC, WRI. http://www.earthtrends.wri.org (Accessed February 2008.)

Sudan

Receiving most of its lifeline water supply from the Nile River, the country is suffering from water-related natural hazards, disease and conflict, which put a heavy toll on sustainable socio-economic development and have led to deepening poverty.

Setting the scene

Sudan is the largest country in Africa. It is bordered by Egypt and the Libyan Arab Jamahiriya on the north, Chad and the Central African Republic on the west, the Democratic Republic of the Congo, Uganda and Kenya on the south, and Ethiopia and Eritrea on the east. The Red Sea lies to the north-east and forms a coastline of 700 km (Map 1.2). Most of the country is part of the Nile River basin. Largely composed of a flat plain, it ranges from 200 to 500 metres in altitude except for isolated hills at Jabel Mera, the Nuba Mountains and the Red Sea Hills. Annual rainfall varies from 25 mm in the Sahara desert, in the north, to over 1,500 mm in the south. Temperatures generally vary from 4°C to 50°C. Surface features range from tropical forest and marsh in the south and centre to savannah and desert in the north, east and west. The population was estimated at 37.7 million in 2006 (WHO/UNICEF, 2008). About 25% of the inhabitants live in the capital, Khartoum.[1]

Climate change and variability

Sudan is so vast (about 2,000 km from north to south and 1,800 km from east to west) that it lies in multiple climatic zones. In the north, where the Sahara extends into much of the country, the climate is arid, while the south is influenced by a tropical wet-and-dry climate. This variation directly affects rainfall: a rainy season runs from April to October in southern Sudan, but the rainy period gradually diminishes in length towards the north, and rainfall is scarce in the far north. Overall, December to February is the driest period except on the Red Sea coast.

[1] Except where otherwise noted, the information in this case study is adapted from Ahmed (2005).

In addition to geographic and seasonal variability in rainfall distribution, there are indications of a decreasing trend in the amount of rainfall in the last 30 years, with the dry zone increasingly extending towards the south.

State of the resource and water use

Almost 80% of the country falls in the basin of the Nile River and its two main tributaries: the White Nile, originating in the equatorial lake region (shared by Burundi, Kenya, Rwanda, Uganda, the United Republic of Tanzania and Zaire), and the Blue Nile, which rises in the Ethiopian highlands. The two join at Khartoum to form the Nile, which flows northwards through Egypt to the Mediterranean Sea. About 67% of the Nile River basin lies within Sudanese territory. Estimates of the availability of water resources in Sudan range from 36 billion m^3 (SNWP,

Map 1.2 Sudan

Table 1.1 Water availability estimates, 2002 and 1982

Water resources	Estimate by SNWP (2002) (billion m^3)	Estimate by Salih et al. (1982) (billion m^3)	Constraints and remarks
Sudan's share of the Nile River	20.50[a]	20.35[a]	Seasonal pattern, limited storage.
Non-Nile streams	5.50	8.00	Highly variable flows of short duration, difficult to monitor or exploit.
Renewable groundwater[b]	4.00	2.00	Deep water, entailing high pumping costs. Remote areas with weak infrastructure.
Water conserved through improved irrigation efficiency		2.00	Based on assumption of a 10% efficiency gain.
Subtotal	30.00	32.35	
Swamp reclamation	6.00	12.00	Capital intensive, with considerable social and environmental impact.
Potential annual availability	36.00	44.35	

a Measured at Sennar Dam in central Sudan b Salih et al further estimated that the non-renewable groundwater potential totalled 564 billion m^3

2002) to 44 billion m^3 (Salih et al., 1982) (Table 1.1). In both cases, the biggest and the most reliable source is the Nile.

Sudan has an agrarian economy: farming and animal husbandry are the mainstay of 80% of the population. Agriculture accounts for 34% of GDP. Livestock raising contributed about half the agricultural GDP in 1998 2001 (Central Bureau of Statistics, 2003). Industry generated 18% of GDP in 2001. Of an estimated 0.84 million km^2 of potentially arable land, some 0.17 million km^2, or 20%, was in use as of 2002. The irrigated area totals around 0.02 million km^2, or a modest 12% of the cultivated land area, but consumes about 20 billion m^3 of water approximately equal to Sudan's share of the Nile River flow (Box 1.2). Agricultural water consumption is expected to increase significantly, and likely to double by 2025. Although irrigation efficiency is high, a considerable amount of water is lost to evaporation and because of poor maintenance of irrigation systems. Water rates for irrigation are based on the extent of cultivated area rather than the actual quantity used. This approach, coupled with a lack of clarity about the role of farmers in the irrigation system, exacerbates the already high water consumption. Adoption of rainwater harvesting techniques could contribute significantly to improvement in agriculture and livestock production.

The incidence of rural poverty is quite high, an issue closely linked to national agricultural strategy. In the 1970s Sudan introduced large-scale mechanized farming and promoted expansion of the irrigated area to increase output, especially of cash crops. The new farming systems and land allocation policies led to displacement

Box 1.2 Cooperation in the Nile River basin

Creating a more cooperative environment for management of the Nile River has been an aim in the region for centuries. In recent years political conditions in basin countries have provided a window of opportunity for progress on cooperative development of the shared waters. With the support of external agencies, since the late 1990s nine of the ten Nile riparian countries have begun a process of institutional development that has cemented cooperation and charted a way towards future development in the Nile basin. Yet, the main issue remains to put this institutional development and cooperative thinking into practice through the development of projects of mutual benefit that are sustainable and can alleviate the worst poverty.

This key challenge is being faced by the parties to the Nile Basin Initiative (NBI). Based in Entebbe, Uganda, the NBI, with representatives of all basin states except Eritrea, is helping coordinate two programmes with broad development agendas. The implementation of these programmes is now paramount. Success in cooperation needs to be followed by a transition to development activities, which should become the mainstay of this initiative, aiming to move towards benefit sharing rather than water sharing. Meanwhile, a 1959 agreement between Sudan and Egypt is still the basis for allocation of the Nile River water resources. Accordingly, the average annual flow of 84 billion m^3 is divided between the two countries: Egypt receives 55.5 billion m^3 and Sudan 18.5 billion m^3 (measured at Aswan Dam in southern Egypt); some 10 billion m^3 is assumed to be lost to evaporation from the reservoir of Aswan Dam.

of subsistence farmers and nomads, and dismantled traditional systems of communal ownership and management (IFAD, 2008).

Sudan is rapidly urbanizing: the share of urban dwellers in the population increased from 27% in 1990 to 42% in 2006 (WHO/UNICEF, 2008). Household water consumption is estimated at 1.1 billion m^3. Safe water and improved sanitation coverage is biased towards urban settlements. In 2006, the percentage of population with access to safe water supply was 78% in urban areas and 64% in rural ones. The disparity is even greater for access to improved sanitation, which is available to 50% of urban dwellers but only 24% in rural areas (WHO/UNICEF, 2008). Consequently, water-related communicable diseases, particularly malaria and diarrhoeal illnesses, are among the leading causes of morbidity, especially in the north, and they are exacerbated by widespread malnutrition. Malaria is epidemic: some 75% of the population nationwide is at risk (WHO, 2008*a*). In 2007 alone, over 2.7 million cases were reported and nearly 6% of all hospital deaths were linked to malaria (WHO, 2008*b*).

Pollution from households, agriculture and industry seriously threatens the quality of freshwater resources. In many places, such as southern and western Sudan, where the groundwater table is only a few metres below the surface, sanitation practices (mainly on-site disposal systems such as septic tanks and pit latrines) and improper urban waste disposal have caused very high chemical and bacteriological contamination. Almost all disposal wells and pit latrines tap the water table, and they are often within 10 to 20 metres of wells used for drinking water.

Thanks to the Nile River and its tributaries, Sudan has an estimated hydropower potential of 9 GW, with development of 5 GW being economically feasible. Yet, the hydroelectric production capacity of the four existing multipurpose dams is only 0.335 GW. Sudan's total electricity production capacity (thermal and hydroelectric combined) of 1.2 GW (2004) does not meet demand, and in fact is greater than the country's limited distribution capacity. A major factor limiting the development of irrigation in Sudan is the poor storage capacity of existing dams. Furthermore, siltation has reduced the design capacity of the dams by one-third, from 9.1 billion m^3. Enhancing reservoir capacity is critical to assure food security, since about 85% of the annual water potential of the Nile River flows from July to September and for the rest of the year the flow is very low, especially in the Blue Nile, in whose vicinity 70% of the irrigated area is located.

The Nile and its tributaries have always been used for transport. At present, around 1,700 km of the waterways are navigated, but this could be substantially improved. Until 1977 the River Transport Corporation of Sudan had one of the largest fleets in Africa, but continuous deterioration since then has reduced the fleet to only about 10% of its former size (2005). Waterway navigation is not considered a priority; the service is mainly between the north and the south, and has never been significantly extended to other parts of the country. Moreover, a lack of coordination among relevant authorities has meant no consideration is given for navigation when major structures such as dams and bridges are built.

Policy framework and decision-making: Legal and institutional aspects of water management

Water resources management is fragmented in Sudan. In an attempt to address this problem, the Water Resources Act (1995) gave responsibility for managing freshwater resources to the Ministry of Irrigation and Water Resources. Four years later, a National Council for Water Resources was formed. It is headed by the ministry, with participation by central and state government representatives. Its objective is to formulate general policies and the outline of water resources development and management for the whole country, and to coordinate actions between the state and central levels. The main laws concerning water resources and their protection are the Environmental and Natural Resources Act (1991), the Water Resources Act (1995) and the Groundwater and Wadis Directorate Act (1998). They cover the entire spectrum of development, management and protection of freshwater resources.

These efforts have not been successful, however, as various dimensions of water resources management are still spread among different ministries and dealt with by many government organizations without integration or coordination. Thus, many aspects of the legislation are not enforced, with responsibilities ill defined and coordination lacking. Moreover, major gaps in the laws exist. For example, in irrigation development projects, protection of groundwater resources from agricultural pollution is not taken into consideration. Nor do mining projects or the newly introduced oil development include any provision for groundwater protection. Efforts to produce a national water policy are continuing.

The main challenges: increasing pressures on scarce resources

Cycle of poverty, droughts, floods and conflict: Sudan, like other countries of the Sahel, has long suffered from lengthy, devastating droughts. The most severe droughts of recent decades occurred in 1980 1984, 1989, 1990, 1997 and 2000, causing widespread population displacement and famine. In addition, floods in Sudan have caused extensive damage, especially around the Nile and its main tributary, the Blue Nile. Severe floods on the latter river in 1988 and 1998 caused property losses estimated at hundreds of millions of dollars. Flooding of the Nile proper in 2007 affected over 500,000 people and destroyed thousands of homes (WHO, 2008*a*). Seasonal rivers can also cause serious flood damage. In 2003, for example, heavy flooding along the Gash River affected 79% of the city of Kassala, leaving 80% of the population homeless, and inflicted heavy losses on agriculture in the region (NASA, 2008).

It is estimated that 85% of Sudan's rural population lives on less than US$1 per day. Overall, some 20 million people were living in extreme poverty in 2002 (IFAD, 2008). The incidence of poverty varies considerably

because economic growth is geographically uneven and conflict has devastated parts of the country. Severe regional inequalities exist in access to even the most basic services, such as education, sanitation, safe drinking water and job opportunities. For example, health services in southern Sudan reach only about 25% of the population. People living in areas that have been or continue to be affected by drought and conflict particularly the south and Darfur are the most vulnerable to poverty (IFAD, 2008). As of late 2007, 4.2 million people were affected by conflict, including 2.4 million internally displaced as a result of the conflict in Darfur (WHO, 2008*a*).

Biodiversity: There is little public awareness or political sensitivity about ecosystem protection in Sudan. Since the 1970s, expansion of large-scale rain-fed agriculture, urbanization and other types of development have caused the destruction of over 5,000 km^2 of forest, and the extent of reforestation amounts to just 300 km^2. Many wildlife species have been lost for similar reasons, as well as because of the conflict in the south, and numerous other species are endangered or vulnerable. Pasture lands have been destroyed or degraded by overgrazing, droughts and fires.

Conclusions

In spite of substantial land and water resources, Sudan is seriously handicapped by floods, droughts and the burden of disease. Agriculture, which provides the livelihoods of 80% of the population, currently claims about 55% of available freshwater resources. Given that the water use in this sector may as much as double by 2025, water saving through better irrigation methods will become a critical factor for meeting the needs of other sectors in a sustainable fashion. A decreasing rainfall trend associated with climatic variability and likely climate change might further limit water availability and lead to serious scarcity. Overall, the lack of accurate assessment of water resources and of a national water policy are the major obstacles hindering effective management of water resources. A fragmented water sector, lack of coordination among bodies responsible for water management, gaps in legislation and poor enforcement are other issues further aggravating the situation. These challenges, combined with social unrest, have led to deepening poverty, which affects a majority of the rural population. However, there is considerable potential for improvement through adoption and implementation of better policies on water and land resources.

References

Ahmed, A. A. 2005. *Sudan National Water Development Report*. Contribution to *African Water Development Report*. Addis Ababa, UNECA.

Aquastat. 2005. *Sudan*. Rome, Food and Agriculture Organization. http://www.fao.org/nr/water/aquastat/countries/sudan/index.stm (Accessed December 2008.)

IFAD. 2008. *Rural poverty in Sudan*. Rural Poverty Portal, http://www.ruralpovertyportal.org/web/guest/country/home/tags/sudan. (Accessed December 2008.)

National Aeronautics and Space Administration (NASA). 2008. Earth Observatory. http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=12099 (Accessed January 2009.)

Nicol, A., with Shahin, M. 2003. *The Nile: Moving Beyond Cooperation*. Paris, UNESCO International Hydrological Programme and World Water Assessment Programme. http://unesdoc.unesco.org/images/0013/001333/133301e.pdf (Technical Documents in Hydrology, PC-CP Series, No. 16, accessed December 2008.)

Salih M. A. et al. 1982. *Water Resources in Sudan*. Report submitted to the National Council for Research, Khartoum.

Sudan National Water Policy (SNWP). 2002. Khartoum, Ministry of Irrigation and Water Resources.

World Health Organization (WHO). 2008*a*. *Emergency Preparedness and Humanitarian Action: Sudan, From Emergency to Sustainability*. http://www.emro.who.int/sudan/pdf/Sudan_Generic_donor_report.pdf (Accessed December 2008.)

World Health Organization (WHO). 2008*b*. *World Malaria Report*. http://malaria.who.int/wmr2008/malaria2008.pdf (Accessed December 2008.)

WHO/UNICEF. 2008. Joint Monitoring Programme for Water Supply and Sanitation. http://www.wssinfo.org/pdf/JMP_08.pdf.zip (Accessed December 2008.)

Swaziland

Relying on transboundary rivers, Swaziland would benefit from continued cooperation with its neighbours as well as strengthened water resources management legislation at home. These would help alleviate the heavy burden of poverty and disease as well as the country's reliance on external funding in the water sector.

Setting the scene

Swaziland, one of the smallest countries in Africa, is almost enclosed within South Africa, sharing just the northern half of its eastern border with Mozambique.[1] Its population of 1.13 million (2006) is distributed over an area of 17,370 km^2. From west to east, the country is divided into four well-defined regions: the Highveld, Middleveld and Lowveld, and the Lubombo plain and escarpment. The altitude ranges from 150 metres in the east to 1,800 metres in the west. The climate varies accordingly, though a generally subtropical climate with summer rains prevails. Between 75% and 83% of the annual rainfall comes from October to March. Precipitation ranges from 500 mm in the south-east to 1,500 mm in the west, the average being 1,200 mm.

Climate change and variability

Swaziland is situated at a transition of major climatic zones. Consequently, the country is prone to extreme events, such as cyclones and droughts. The latest and longest drought occurred over 1989 1994, while the most recent severe cyclone, designated Domonia, hit in 1984.

[1] Except where otherwise noted, information in this case study is adapted from Mwendera (2005).

Climatic models assessing the impact of climate change in the Great Usutu River basin reveal higher temperatures and more intense rainfall in early summer (October to January), dissipating in late summer and winter (February to September). The projections also indicate a maximum reduction in annual runoff of up to 12.6% or 133.6 million m^3. The combined effect of high temperatures and low runoff, especially in winter, could adversely affect groundwater recharge, particularly in the Lowveld, and aggravate existing groundwater salinity. Taken together, these changes are very likely to negatively affect the agriculture-based economy as well as ecosystems. The Great Usutu River basin locally often called the Lusutfu is considered fairly representative, as about three-quarters of the population lives within and is supported through it (UNFCC, 2004).

State of the resource and water use

Swaziland has five principle river basins (the Lomati, Komati, Mbuluzi, Great Usutu and Ngwavuma) whose total annual renewable water resources amount to 4.5 billion m^3. Of this, 42% or 1.87 billion m^3 originates in South Africa. The seasonal nature of the rainfall makes discharge of surface waters extremely variable. In dry areas such as the Lowveld, while the larger rivers are through-flowing, most watercourses tend to flow only after heavy local rainstorms. Hence, development of groundwater resources is crucial. Although no quantitative assessment of groundwater resources has yet been undertaken, the annual potential is estimated at 0.66 billion m^3. The Middleveld and Highveld have the highest potential for groundwater exploitation, but the number of wells in the Highveld is limited due to the greater depth needed to reach the water table. In the Lowveld, where the potential recharge is the lowest and the need for groundwater is the highest, installed wells tap about 42% of the estimated potential. Nationwide, only about 6% of the potential is exploited.

As Table 1.2 shows, agriculture is the main consumer of freshwater resources, accounting for almost 97% of withdrawal. Of this, over 90% is used in growing sugarcane as the main cash crop. The country is split between largely rain-fed subsistence production by smallholders and cash cropping on large private estates. Smallholders constitute some 70% of the population and occupy 75% of the crop land, but their productivity is low, accounting for only 11% of total agricultural output. Poor availability of water for irrigation is a major constraint to smallholder production; in years of low rainfall, harvests plummet and further aggravate the food crisis (New Agriculturist, n.d.).

Table 1.2 Water demand by sector, 2002

Sector	Demand (million m^3/year)	% of total demand
Households	30	1.7
Animal husbandry	14	0.8
Industry	17	0.9
Other agriculture	1,734	96.6
Total	1,795	100.0

Source GOS, 2002

Map 1.3 Swaziland

Note The principal basins in Swaziland are those of the Lomati, Komati, Mbuluzi, Great Usutu and Ngwavuma rivers This map shows the Lomati and Komati grouped into the Incomati basin, and the Great Usutu and Ngwavuma forming the Maputo basin

Grazing is the predominant land use in Swaziland: about 67% of the total land area, or 11,630 km^2, is used solely for this purpose. During the dry season an additional 2,500 km^2, which is under cultivation during the summer, is used for grazing. Rangelands on communal land, as opposed to commercial ranches, appear to be deteriorating (WSSD, 2002).

The population of Swaziland is predominantly rural. In 2006, 24% of the population lived in urban areas, which have significantly better water supply and sanitation coverage than do rural areas. About half the urban population is concentrated in the main cities Mbabane, the administrative capital, and Manzini, the main commercial centre. Overall, 60% of the population has access to safe water supply and 50% to improved sanitation (WHO, 2008).

Commercial forestry and the related wood processing industry form an important part of the economy, contributing about 15% to GDP, mainly through exports. The sector employs some 8,000 people, amounting to 8% of formal employment in Swaziland. The sugar industry is another major economic player, providing between 17% and 22% of total export revenue and employing 16,000 people directly and 80,000 indirectly. Sugarcane represents more than half of all agricultural output and

30% of agricultural employment. Industrial pollution is a problem. Most companies do not report on their environmental records or their use of energy and natural resources (WSSD, 2002).

Policy framework and decision-making

In the past, ad hoc management of water resources prevailed in Swaziland. Carried out by several ministries and by institutions outside the government, it involved multiple laws aimed at solving disparate issues. They included the Water Act of 1967, the Water Services Act of 1992, the Komati River Basin Water Resources Development and Utilization Act of 1992, the Joint Water Commission Act of 1992, the Swaziland Environmental Authority Act of 1992 and the Swaziland Administrative Order of 1998 (Aquastat, 2005).

Today the 2003 Water Act provides guidelines on how the water sector in Swaziland is coordinated. It establishes the National Water Authority, which is the highest policy-making body responsible for the development and management of the national water sector. The Act also provides for the formation of river basin authorities and water user associations to enhance public involvement in water resources management. In addition, the Act includes the private sector as a partner in water development (Aquastat, 2005). One objective of the Act is to guide the development of policies on water allocation and pricing, pollution control, water storage and basin management.

A draft national water policy (2001) has been harmonized with the regional policy and strategy that the South African Development Community (SADC) adopted in 2007. The national policy has since been reviewed by the National Water Authority and is being finalized in consultation with stakeholders.

The National Development Strategy was launched in 1999 to provide guidelines on equitable allocation of resources for socio-economic development in the next 25 years, strengthen government planning and management capacity on development and seek national consensus on the direction of development. The strategy includes several recommendations on water resources development, such as formulating an overall policy to cover all water uses, expanding smallholder irrigation within a national irrigation development plan while encouraging farmers to make use of all available water resources, and building small and medium-sized dams to provide a reliable source of water for small-scale irrigation, livestock, fisheries and municipal use (Aquastat, 2005).

The Swaziland Environmental Authority Act of 1992 addresses the issue of pollution control for water and the environment and includes provisions for the establishment of standards. The National Development Strategy also highlights environmental management as a key policy area, and stresses the importance of tackling major environmental issues, such as soil erosion, deforestation, waste disposal and industrial and urban pollution, especially as regard the livelihoods of rural people. Nevertheless, the country needs to strengthen integration of environmental concerns in all sectors and examine the potential environmental implications of economic policies (WSSD, 2002).

The main challenges

Poverty and infectious diseases: The country suffers from a heavy disease burden. The main causes of Swaziland's high rate of infant mortality diarrhoea, malnutrition and infectious diseases can be linked to constraints on access to safe water supply and improved sanitation. Malaria remains a major health problem, especially in the Lowveld, the Lubombo plateau and parts of the Middleveld. The disease occurs mainly during or after the rainy season. It is estimated that 30% of the population resides in malaria risk areas and 38% in malaria receptive areas (Aquastat, 2005).

Box 1.3 Combating HIV and AIDS: a heavy toll in sub-Saharan Africa

Thanks to a sixfold rise in this decade of financing for activities to fight HIV in low- and middle-income countries, the annual number of AIDS deaths worldwide declined from 2.2 million in 2005 to 2.0 million in 2007, partly as a result of a substantial increase in access to HIV treatment. In a number of heavily affected countries, such as Kenya, Rwanda, Uganda and Zimbabwe, dramatic changes in sexual behavior have been accompanied by declines in the number of new HIV infections, contributing to stabilization in the percentage of HIV-positive adults (people aged 15 to 49).

However, sub-saharan Africa still bears the burden of the HIV/AIDS epidemic. An estimated 1.9 million people were newly infected with HIV in sub-Saharan Africa in 2007, bringing the number of people living with HIV to 22 million. Alarmingly, 67% of the 33 million people worldwide with HIV live in the region, and 75% of all AIDS deaths in 2007 occurred there.

In Swaziland, the number of persons affected by HIV increased from 160,000 in 2001 to 190,000 in 2007. The total includes 15,000 children below age 14. The HIV prevalence rate appears to have stabilized. A national population-based survey in 2006 put the rate at 26% the highest prevalence ever documented in such a survey anywhere in the world (Central Statistical Office [Swaziland] and Macro International, 2007). On the positive side, the country has made marked progress in expanding coverage for HIV-positive pregnant women in recent years: between 2004 and 2006, coverage of prevention of mother-to-child transmission increased from 5% to 67%. In addition, donor funding for child-focused initiatives has increased, with care and support services now provided for 100,000 children orphaned as a result of HIV (Global Fund, 2008).

Source Adapted from UNAIDS, 2008

Table 1.3 Recurrent expenditure in the water sector

Sector	2002/2003		% of total	2003/2004*		% of total	2004/2005*		% of total
	emalangeni (thousands)	(US$) (thousands)		emalangeni (thousands)	(US$) (thousands)		emalangeni (thousands)	(US$) (thousands)	
Water resources management	24,483	2,310	0.8	26,274	3,457	0.8	24,139	3,713	0.8
Other expenditure	2,932,434	276,644	99.2	3,282,145	431,861	99.2	2,907,404	447,293	99.2
Total	2,956,917	278,954	100	3,308,419	435,318	100	2,931,543	451,000	100

* Estimates

Note Average exchange rates used for calculations: 2002, US$1 E 10 6; 2003,US$1 E 7 6; 2004, US$1 E6 5

Source: GOS, 2004

According to the Central Statistics Office (GOS, 2005), 69% of the country is affected by poverty. The incidence of poverty is much higher in rural areas (75%) than in urban settlements (49%). About 84% of the country's poor people live in rural areas, where per capita income is one-fourth of the urban average, and people consume half as much food. About 66% of the population cannot meet basic food needs, and 43% live in chronic poverty (IFAD, 2008).

Productivity at both household and national level is increasingly affected by the high rate of HIV and AIDS infection (Box 1.3). It is estimated that 26% of people aged 15 to 49 have the virus (UNAIDS, 2008), and that HIV and AIDS cause 47% of deaths among children under age 5 (WHO, 2006). Over 10% of households are headed by children who have lost both parents, and a significant number by very old grandparents who cannot do physical work (WSSD, 2002).

Limited investment in water sector: The share of government spending allocated to the water sector has averaged less than 1% in recent years (Table 1.3). To improve water supply and sanitation coverage, the level of government funding needs to be raised. Meeting the national target of providing water and sanitation services to all rural people by 2022 would require a tenfold increase in investment.

The majority of funds for the sector come from external sources. In fiscal 2003/2004, nearly two-thirds of estimated capital expenditure was in the form of international grants (Table 1.4). Current trends, however, show external donors in the water sector reducing their assistance to Swaziland. Thus, the government will need to allocate a greater share of the national budget for improving water and sanitation coverage, and increase the efficiency of investment.

Improving regional cooperation: Although located in a generally arid part of southern Africa, Swaziland is considered well situated because it is traversed by several large rivers (the Komati, Mbuluzi, Great Usutu and Ingwavuma) flowing from or into South Africa and Mozambique. Given that 58% of overall water potential is derived from Swaziland and the rest originates in South Africa, upstream water resource development could reduce the water supply availability for Swaziland as well as downstream Mozambique.

Table 1.4 Estimated capital expenditure in the water sector by source of funds, 2003/2004

Source of funds	Amount emalangeni (thousands)	Amount US$ (thousands)
Local funds	20,831	2,740
Foreign grants	35,348	4,650
Total capital	56,179	7,390

Note The average interbank exchange rate in 2003 was US$1 E7 6

Source GOS estimates, 2004

In recognition of the importance of a coordinated approach to the use and preservation of water resources, a technical committee was formed under the SADC framework to stimulate development and cooperation in the region. The SADC member states, including Swaziland, signed a Protocol on Shared Watercourse Systems in 1995, which was reinforced in 2000 by a revised protocol seeking to foster closer cooperation for sustainable management, protection and use of shared watercourses.

In 1983, Mozambique, South Africa and Swaziland established the Tripartite Permanent Technical Committee to advise the three governments on water use and policy-related issues concerning the Incomati and Maputo rivers (as the Komati and Great Usutu are known in Mozambique). Swaziland signed treaties with South Africa in March 1992 to establish a Joint Water Commission and the bilateral Komati Basin Water Authority, which is responsible for the design, construction and management of the Driekkopies and Maguga dams. A treaty establishing a Joint Water Commission between Swaziland and Mozambique was signed in July 1999. Mozambique, South Africa and Swaziland signed the Tripartite Interim Agreement for Cooperation on the Protection and Sustainable Utilisation of the Water Resources of the Incomati and Maputo Watercourses in August 2002, and are undertaking studies into the possible elaboration of a comprehensive water sharing agreement for the two rivers.

The development, finalization and satisfactory implementation of such agreements are important to foster cooperation in the region and minimize water-related conflicts that might arise as water needs increase.

Conclusions

Swaziland is well endowed with freshwater resources. As more than 40% of the water potential originates in South Africa, and the water requirements of downstream Mozambique need to be considered, functional cooperation agreements on the use of transboundary waters are vital to the sustainable socio-economic development of Swaziland and its neighbours. Swaziland

needs to strengthen its own legislation to improve the management of water resources, as well as raise the level of investment in the water sector, in order to alleviate the excruciating poverty and heavy disease burden that its people suffer.

References

Aquastat. 2005. *Swaziland*. Rome, Food and Agriculture Organization. http://www.fao.org/nr/water/aquastat/countries/swaziland/index.stm (Accessed December 2008.)

Central Statistical Office and Macro International Inc. 2007. *Swaziland Demographic and Health Survey 2006 2007: Preliminary Report*. Calverton, Md., Macro International.

Global Fund to Fight AIDS, Tuberculosis and Malaria. 2008. *Monthly Progress Update 31 January 2008*. http://www.theglobalfund.org/en/files/publications/basics/progress_update/progressupdate.pdf (Accessed January 2009.)

Government of Swaziland (GOS). 2002. Prioritised Action Programme on Poverty Reduction. Mbabane, Ministry of Economic Planning and Development,

Government of Swaziland (GOS). 2002. Swaziland's National Report on the World Summit on Sustainable Development 2002. Mbabane, Swaziland Environmental Authority.

Government of Swaziland (GOS). 2004. Medium Term Expenditure Framework, Budget 2005/05-2007/08. Mbabane, Ministry of Natural Resources and Energy.

Government of Swaziland (GOS). 2005. Swaziland Household Income and Expenditure Survey (SHIES) 2000/01. Mbabane, Central Statistical Office, Ministry of Economic Planning and Development.

International Fund for Agricultural Development (IFAD). 2008. *Rural Poverty in the Kingdom of Swaziland*. Rural Poverty Portal. http://www.ruralpovertyportal.org/web/guest/country/home/tags/swaziland (Accessed November 2008.)

Joint United Nations Programme on HIV/AIDS (UNAIDS). 2008. *Report on the Global AIDS Epidemic*. Geneva, UNAIDS. http://www.unaids.org/en/KnowledgeCentre/HIVData/GlobalReport/2008/2008_Global_report.asp

Mwendera, E. J. 2005. *Swaziland Country Water Status*. Contribution to *African Water Development Report*. Addis Ababa, Economic Commission for Africa.

New Agriculturist. No date. *Country Profile: Swaziland*. http://www.new-ag.info/02-6/countryp.html (Accessed December 2008.)

United Nations Framework Convention on Climate Change (UNFCCC). 2004. *Swaziland's First National Communication*. http://www.ecs.co.sz/unfccc/chapter4_3.htm (Accessed December 2008.)

World Health Organization (WHO). 2006. *Country Health System Fact Sheet 2006: Swaziland*. http://www.afro.who.int/home/countries/fact_sheets/swaziland.pdf (Accessed December 2008.)

World Summit on Sustainable Development (WSSD). 2002. National Assessment Report: Swaziland. http://www.ecs.co.sz/wssd/wssd_swaziland_national_assessment_2002.zip (Accessed December 2008.)

Tunisia

Amid economic growth and urbanization, this developing country has made big gains in water and sanitation coverage, as well as a shift towards long term sustainable practices, but faces mounting tensions between competing users.

Setting the scene

Tunisia, located in North Africa, is bounded by Algeria to the west, by the Libyan Arab Jamahiriya to the south-east, by the Sahara to the south and by the Mediterranean (with a 1,200 km coastline) to the north (Map 1.4). The country covers 164,420 km^2 and has a population of 10.25 million (2007). Its landscape is diverse, ranging from mountains in the north-west to the arid south and the Sahara. In 2006, 66% of the population lived in urban areas (WHO/UNICEF, 2008). Urbanization is expected to continue, largely through migration to coastal areas. On current trends, by 2025 some 75% of the population will live in urban areas.[1]

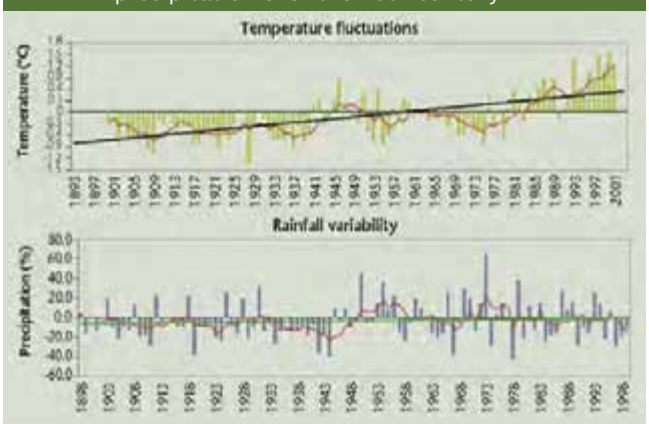
The predominant climate types are Mediterranean in the north and Saharan in the south. Four climatic subregions can be identified: subhumid in the far north, semi-arid in the north-west and at Cap Bon, arid in the centre and hyper-arid and desert in most of the south. Over 40% of the country lies in the hyper-arid zone. Although average annual rainfall amounts to 220 mm, geographic variation is substantial, with regional averages ranging from 1,500 mm in the north to 50 mm in the far south, in the heart of the Sahara.

The arid plains that mark the northern limit of the Sahara include many depressions, locally called *chotts* and *sebkhats*, which fill with water in winter and dry up in summer. Their water is highly saline. The largest *chott*, Jerid, is a 500 km^2 salt lake.

Climate change and variability

Analysis of changes in average temperature and rainfall in Tunisia over the 20th century (Figure 1.1) indicates that while temperatures have risen significantly, by 1.2°C, no trend in rainfall is apparent, although greater variability can be observed in 1961 1990 than in 1901 1930 or 1931 1960 (King et al., 2007).

Figure 1.1 Anomalies in average temperature and precipitation over the 20th century



Source King et al , 2007

[1] Except where otherwise noted, information in this case study is adapted from the draft *Tunisia Case Study Report*, prepared in 2008 (in French) by Besbes et al.

Map 1.4 Tunisia

Since 2006, studies have been undertaken in Tunisia to aid in elaboration of a national climate change adaptation strategy. The aim is to move from reaction to crises, such as droughts and floods, to management of risk associated with climate change (early adaptation). Projections for 2030 and 2050 form the basis of this effort. Models for 2030 indicate a slight increase in the frequency and intensity of dry years, though the north-west might benefit from a slight increase in precipitation in wet years. However, by 2050 the average annual temperature could rise by between 0.4°C and 1.2°C, and the variability of rainfall could increase, especially in spring and autumn (MARH/GTZ, 2006).

State of the resource and water use: storage is essential

Tunisia has a dense hydrographic network in the north, whose river basins account for 81% of the national surface water potential. Oued Mejerda, which rises in Algeria, is the biggest river, with an annual water potential of around 0.8 billion m^3. The south is characterized by large, deep aquifer networks whose low recharge rates make them barely renewable. Tunisia's annual water potential is estimated at 4.8 billion m3, with groundwater amounting to about half (2.1 billion m^3). In 2005, the exploitation rate was roughly 80% for deep aquifers and an unsustainable 108% for shallow aquifers. (These averages are approximations, as the figures for withdrawal and exploitable resources used in calculation are quite uncertain.)

The high variation in rainfall, amount of arid land and overuse of groundwater resources make storage of freshwater a vital necessity in Tunisia. In 2005, there were 27 large dams, 200 small hillside dams and 660 hillside lakes, with a combined capacity of 1.8 billion m^3 per year, amounting to 66% of the total surface water potential. Despite the number of dams, Tunisia lacks major hydroelectric generation capacity. Modest projects carried out since the 1950s have allowed it to exploit 40% of its hydropower potential. Even so, hydroelectricity represents barely 1% of overall energy production. Given the long term rise in fuel prices, however, hydroelectric production is expected to expand.

Of the country's approximately 110,000 km^2 of arable land, only 49,000 km^2 is currently in use, mainly producing grain and olives. In 2006, agriculture accounted for 81% of overall water consumption. Although its share of GDP is gradually decreasing, agriculture still plays an important role in the economy. It employs 25% of the workforce, and was the third biggest contributor to GDP in 2006 at 11%, behind industry and mining (29%) and services (60%).

In urban areas, drinking water coverage had reached almost 100% by 1993. Tunisia achieved this by transferring large amounts of water from the humid north to the arid south, and by installing desalination facilities to treat brackish water in the tourist areas of the south-east. In rural areas, access to drinking water expanded from 62% in 1990 to 84%, on average, in 2006. Over the same period, coverage for the country as a whole advanced from 82% to 94% (WHO/UNICEF, 2008).

The share of urban households connected to sewerage was 96% in 2006. In rural areas, where sanitation relies on more traditional methods such as septic tanks and field disposal, access to improved sanitation is around 64% (WHO/UNICEF, 2008). Efforts are also being made to minimize health risks by altering hygiene practices through education.

Industry consumes around 0.1 billion m^3 of water per year, of which almost 60% is abstracted from deep aquifers. In the absence of incentives for conservation, water-efficient production processes and water recycling are seldom if ever used.

Tourism is a big source of income in Tunisia with a modest water footprint: the whole sector consumes only

Box 1.4 Water resources management in Tunisia

Tunisia's 1975 Water Code introduced the principles of 1) protection of water resources as a public good; 2) government responsibility in supplying water and in planning and monitoring water use; 3) the necessity of water conservation to alleviate scarcity throughout the country; 4) recyc-ling of treated wastewater in agri-culture; 5) the possibility of stake-holder involvement in water resources manag-ement through community assoc-iations; and 6) private sector involvement in managing non-conventional resources. The Ministry of Environment and Sustainable Development is responsible for pollution reduction and wastewater recycling, while the Ministry of Agricul-ture and Water Resources has broad responsibilities covering everything else.

Basing the institutional framework on the principle of stakeholder involvement has allowed Tunisia to manage its limited water resources effectively. The fact that the water management system is centralized has facilitated the trade-offs necessary to balance supply with demand while reconciling the needs of various users. Having furnished itself with appropriate tools for integrated resources management and begun planning for the day when demand will outstrip availability, the country is well placed to avoid many problems it might otherwise have encountered.

25 million m^3 per year, or 1% of the total exploited resource. The rate is slightly higher in the south, where tourism is expected to be developed intensively in the future.

Policy framework and decision-making

Since 1970, as both knowledge about water resources and demand from various sectors have increased, plans and directives concerning water management have been developed in Tunisia (Box 1.4).

A master plan for water use has been implemented for each of the country's three natural regions the north, the centre and the south. The master plans include provisions on the transfer of surface and groundwater and on flood protection for large urban centres. These guidelines have allowed water resources to be allocated in terms of present and expected demand from the different users. They have also helped identify the areas where irrigation makes the best use of available resources. The national strategy for water resources mobilization is now in its second decade (2001 2010), and the aim is to mobilize 95% of conventional resources by building dams, reservoirs and flood runoff infrastructure, and to develop non-conventional resources such as recycled and desalinated water.

These plans and strategies have helped Tunisia make several reforms since the early 1990s. The most important of these was a transition from supply-side management towards a strategy of demand-driven management. Thus, the emphasis is on institutional, regulatory and technical practices that are likely to change water users' behaviour, encourage more efficient use of resources and maintain a sustainable consumption level. Measures have also been taken to reduce the environmental impact of water policies, particularly by protecting the most fragile ecosystems and limiting the sources and effects of water pollution.

The main challenges: promoting sustainable use of scarce resources

To promote economic growth, past policies encouraged water use through preferential rates or subsidies. The low value thus imputed to water gave users the mistaken impression that resources were abundant. This led to overexploitation of water resources especially groundwater resources, from which 75% of irrigation water is abstracted. Because of the large share of agriculture in water consumption, efforts have been made since the late 1980s to increase efficiency of water use by charging a user fee for irrigation water. From 1990 to 2000, the price was increased by 9% per year. The total of user fees collected quadrupled between 1991 and 2003, permitting recovery of much of the cost of running and maintaining the water system. In 1995, a vast irrigation rehabilitation programme was begun, involving a generous incentive package in which small agricultural holdings were offered subsidies of up to 60% of the cost of modernizing installations. As a result, by 2007 some 80% of the irrigation system had been improved with sprinkler systems, drip irrigation and the like. This strategy has allowed Tunisia to stabilize demand for irrigation water despite the growing extent of the area under irrigation (Figure 1.2).

To maximize freshwater availability, other methods, such as recycling of treated wastewater and desalination of brackish water, are also being adopted. Desalinated water is reserved for essential uses such as drinking water, meeting the needs of tourist facilities and certain industrial uses (chiefly in food processing and the chemical and pharmaceutical industries) in regions where local water resources are insufficient or of poor

Figure 1.2 Trends in agricultural water use and the extent of irrigated land, 1990 2006

quality. However, tariffs are identical for all water, regardless of whether it is desalinated or not. Although the official policy is to provide access to clean drinking water for all, which has bolstered the principle of social equity, the approach to tariff-setting does not necessarily favour protection and appropriate valuation of the resources.

Conclusions

Tunisia is a semi-arid country with limited water resources in which desertification is reducing the availability of arable land. Modern irrigation techniques, promoted since 1995, have allowed optimum utilization of water resources. In recent decades, water and sanitation coverage has increased, especially in rural areas. Increasing water demand in various sectors has led to increasing tension, with each trying to satisfy ever-increasing demand for water. Application of integrated water resources management has helped create an enabling environment for a flourishing and productive economy driven by the service sector. To retain its competitive edge, it remains essential for Tunisia to continue implementing policies geared towards sustainable socio-economic development by reconciling user needs with the social and environmental value of water.

References

Besbes, M., Hamdane, A., Chahed, J. and Hamza, M. 2008. *Tunisia Case Study Report* (in French), executive summary. (Draft.)

King, L., Nasr, Z , Almohamad, H. and Maag, C. C. 2007. Le Climat. *Stratégie nationale d'adaptation de l'agriculture tunisienne et des écosystèmes aux changements climatiques*, Ch. 7.2. Eschborn, Germany/Tunis, GTZ/MARH.

Ministry of Agriculture and Water Resources (MARH)/GTZ. 2006. *Elaboration d'une étude nationale d'adaptation de l'agriculture tunisienne et des écosystèmes aux changements climatiques.* Tunis/Eschborn, Germany, MARH (Direction Générale des Etudes et du Développement Agricole)/GTZ.

WHO/UNICEF. 2008. Latest JMP Country Files. Joint Monitoring Programme for Water Supply and Sanitation. http://documents.wssinfo.org/resources/documents.html (Accessed December 2008.)

Zambia: the Zambezi and Congo river basins

Zambia is facing difficult challenges such as persistent poverty and increasing climatic variability. Although it has sufficient land and water resources, its success in addressing its problems depends largely on how it implements its plans and strategies for water resources.

Setting the scene

Zambia is a landlocked country in southern Africa surrounded by Angola, Botswana, the Democratic Republic of the Congo, Malawi, Mozambique, Namibia, the United Republic of Tanzania and Zimbabwe (Map 1.5). The country lies mainly in the Zambezi River basin, and partially in the Congo River basin in the north. Zambia has a population of 11.7 million (2006) and a surface area of 752,614 km^2. It sits on the high plateau of Central Africa at an average altitude of 1,200 metres, and enjoys a mild, subtropical climate. Annual average rainfall ranges from 600 mm in the south to 1,500 mm in the north.[1]

Climate change and variability: increasing frequency of extreme events

A 2007 survey concluded that in the previous nine years, local communities had been exposed to extreme climatic variation that included droughts, floods, increased rain intensity, extreme heatwaves and a shorter rainy season. In fact, between 2000 and 2007 Zambia experienced unusually unstable weather, with a sequence of two flood years, two drought years and two years with normal rainfall. Figure 1.3 shows fluctuations in rainfall in Zambia between 1975 and 2006. Because of a lack of data, it is difficult to assess how such climate change will affect the country's water resources.

State of the resource: future competition among sectors

Zambia's surface water potential totals some 100 billion m^3, with the Zambezi River contributing over 60% of the runoff. Consequently, as a major stakeholder in the Zambezi River Authority, along with Zimbabwe, Zambia is helping establish the Zambezi Watercourses Commission. Groundwater is also a major resource, especially during the dry season. Although no accurate assessment is available, the average renewable groundwater potential is estimated to be 49.6 billion m^3.

By far the largest user of water is hydropower generation. Of about 38.5 billion m^3 of overall water withdrawal, 36.3 billion m^3 is used to generate electricity for internal use and export to neighbouring countries. Some 70% of the country's hydropower potential awaits development. There is as yet no real competition for water among the various sectors (Table 1.5). However, with irrigation expanding and awareness on environmental issues growing, water released from hydropower stations will need to be regulated so that the needs of agriculture and the environment are both served. The government recognizes the role of integrated

Figure 1.3 Annual rainfall variation, 1975 2006

[1] Except where otherwise noted, information in this case study is adapted from the draft *Zambia National Water Resources Report*, prepared in 2008 by Imasiku A. Nyambe and Miriam Feilberg.

water resources management (IWRM) in meeting the needs of all users, but successful application of the IWRM approach will require prioritizing investment and strengthening the capacity to manage national and transboundary water resources.

Around 40% of Zambia's population lives in urban settings. The capital, Lusaka, and the Copperbelt region in the north-west are the most densely populated areas. In 2005, 86% of people living in towns had access to safe water, compared with only 37% in rural areas. For the same year, just 13% of the rural population had access to improved sanitation, whereas there was 41% coverage in urban areas.

Map 1.5 Zambia

Zambia has good agricultural potential, with 56% of its surface arable. Only 14% of the arable land is farmed, and most cultivation is rain fed. Irrigated crops cover only about 1,000 km^2. The government established an Irrigation Development Fund in 2007 and is encouraging farming operations by making loans available at concessionary rates. However, agricultural development is hampered by insufficient financing, a lack of accurate data and capacity information on water resources, and inadequate market services and infrastructure.

Policy framework and decision-making: towards integrated and participative approaches

The Water Act of 1948, the foundation of Zambia's water legislation, deals with ownership, allocation and regulation of the nation's surface water resources without covering groundwater or the transboundary aspects of rivers such as the Zambezi which constitute international boundaries.

Table 1.5 Water use by sector, 2008

Sectoral use	Water consumption (billion m^3)	Share in overall water consumption (%)
Agricultural	1.8	4.67
Industrial and municipal	0.4	1.03
Hydroelectric	36.3	94.30
Total	38.5	100.00

To address these shortcomings, reforms have been undertaken since the early 1990s, including the adoption of the National Water Policy in 1994. It recognized water as an economic good, highlighted the important role of the water sector in overall socio-economic development, promoted water resources development through an integrated management approach and defined institutional responsibilities of stakeholders in the sector so as to achieve effective management and coordination. The policy also provided for adequate, safe and cost-effective water supply and sanitation services while assuring environmental protection.

In carrying out its reforms in the water sector, the Government of Zambia started with the water supply and sanitation subsector, enacting the Water Supply and Sanitation Act in 1997 (Box 1.5). It later turned to the water resources management subsector with the Water Resources Action Programme in 2001. The programme developed a Water Resources Management Bill, a new Water Resources Institutional Framework, an improved Water Resources Management Information System and a draft action plan on addressing challenges related to water resources. Moreover, the Fifth National Development Plan (FNDP, 2006 2010) is specifically geared towards applying IWRM nationwide. To assist in carrying out the water-related programmes in the FNDP, in 2008 the government adopted an IWRM and water efficiency implementation plan, with crucial stakeholder participation (which also took place when the FNDP was being drawn up). These processes are intended to help Zambia plan and manage its water resources to further socio-economic development.

Box 1.5 Institutional arrangements for urban water supply and sanitation

The 1997 Water Supply and Sanitation Act obliges local authorities to provide water and sanitation services using various arrangements, such as partnerships with private firms for build-operate-transfer models as well as for concessions and management contracts. They may also create organizations known as Commercially Viable Water Supply and Sanitation Utilities, or CUs. All these institutional arrangements must undergo viability testing in order to be licensed by the regulator, the National Water Supply and Sanitation Council (NWASCO).

CUs operate as commercial businesses within a framework regulated by NWASCO. They are expected to deliver efficiencies meeting private sector standards and to be self-financing, though the government may help modestly with initial working capital and infrastructure investment. CU managers are recruited under competitive private sector conditions.

The CUs have made significant progress even though government investment in water and sanitation infrastructure has been limited. Though many struggled to meet the wage bill when first established in 2000, some CUs averaged 102% recovery of operation and maintenance costs in 2007/2008. It is hoped that by 2010 more than half the CUs will reach a similar level of effectiveness. Although performance and quality of service had been on a downwards trend, today an upwards trend is evident in a number of service indicators.

Stakeholder participation was also secured through the formation of the Water Sector Advisory Group, which consists of four subsector advisory groups: (a) water supply and sanitation, (b) water resources management, (c) water resources infrastructure development, and (d) monitoring, evaluation and capacity building. The subsector groups provide for inclusion of stakeholders from outside the water sector, such as the Ministry of Finance and National Planning, which chairs the subgroup on monitoring, evaluation and capacity building. Inclusion of outside stakeholders in planning and decision-making is important for achieving an integrated approach to water management and for long term sustainability of decisions (see Chapter 15, Section 5 in the third edition of the *World Water Development Report*).

The main challenges

Combating poverty: Zambia is among the world's least developed countries, ranked by the United Nations Development Programme as 163rd out of 179 countries on the Human Development Index. Since 2005, under the Heavily Indebted Poor Country Initiative, Zambia has received debt relief equivalent to some US$6 billion. This has had a positive impact on the national budget and hence on poverty. Nevertheless, 63.8% of the population still lives on less than US$1 a day, and 46% of Zambians are undernourished. Conflicts in neighbouring countries have caused movement of refugees into Zambia, further aggravating the situation. Extreme poverty is especially significant in rural areas, where the majority of households depend on subsistence farming.

Meeting public health needs: Water-related diseases such as malaria and diarrhoea are major health problems in Zambia. The toll of malaria alone is nearly 4 million clinical cases and 50,000 deaths per year: it accounts for as much as 20% of maternal mortality and 23% of all deaths. Diarrhoea accounts for 6.9% of all illness reported (2003). Zambia has also been affected by HIV and AIDS, with about 9% of the population being HIV positive (2000). The 2008 Health Survey indicated that HIV and AIDS affected 14% of people aged 15 to 49 the country's prime workforce. Another issue is that increasing environmental degradation, affecting forests, wildlife and fish populations, especially hurts the livelihoods of the poor, who depend the most on these resources. Wealthier communities are less affected.

Addressing environmental concerns: Copper mining is an important source of income in Zambia, but it involves pumping water out of mines and into natural waterways, which degrades the environment and water quality. For example, Konkola Copper Mine discharges some 300,000 m^3 of water per day into the Kafue River, which supports most of the country's economic activities and over 40% of the population. The Copperbelt Environment Project has aimed at addressing environmental consequences of mining. Stronger regulation is needed for mines and other industries whose effluents affect the environment. Although there are some positive effects from mine discharges, such as making more water available in the Kafue River for downstream users, particularly in drought years, these have not received much attention. Furthermore, the effects of mine pumping on groundwater have not been studied in detail yet.

Deforestation in Zambia is advancing at a rate of 3,000 km^2 per year. It has resulted in localized flooding, increased erosion, reduction in surface and groundwater availability and loss of aquatic life. Accurate estimates are hampered by the lack of an updated forest resources inventory.

Decreasing surface and groundwater quality, due to an increasing nutrient load, industrial and agricultural pollutants and a falling groundwater table, is a growing problem in highly populated urban areas. Sanitation and solid waste management are also major concerns. Waste collection and management are inadequate, posing a serious threat to groundwater quality, particularly in periurban areas and informal settlements, where between 40% and 80% of the urban population resides.

Conclusions

Zambia is a country with enough water and land resources to facilitate development. However, inadequate data and capacity, in every dimension, seriously impair the government's ability to address many challenges, most notably poverty and hunger. Increasing the share of the population with access to safe water and improved sanitation, especially for people living in periurban and rural settings, would help curb the spread of preventable diseases that claim too many lives and reduce productivity. Application of IWRM, which is awaiting the necessary legal and institutional structure, will help combat poverty and malnutrition while assuring sustainable socio-economic development and preserving a healthy ecosystem.

References

Nyambe, I. A. and Feilberg, M. 2008. *Zambia National Water Resources Report*, executive summary. Lusaka. (Draft.)