

This Atlas is a visual account of Africa's endowment and use of water resources, revealed through 224 maps and 104 satellite images as well as some 500 graphics and hundreds of compelling photos. These visual elements vividly illustrate a succinct narrative describing and analysing Africa's water issues and exemplifying them through the judicious use of case studies. The Atlas tells the paradoxical story of a continent with adequate renewable water resources, but unequal access because water is either abundant or scarce depending on the season or the place. It explores the opportunities to develop Africa's untapped water resources and human capacities to deliver safe drinking water and sanitation services to achieve the water-related Millennium Development Goals, as well as hydropower and irrigation that help support livelihoods and boost economic development. It should serve as a baseline of information and analysis to help inform decision makers and water managers in their work to improve water availability and access across Africa.

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AFRICA WATER ATLAS

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WATER ATLAS

SUMMARY FOR DECISION MAKERS



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Introduction

The *Africa Water Atlas* is a visual account of Africa's endowment and use of water resources, revealed through 224 maps and 104 satellite images as well as some 500 graphics and hundreds of compelling photos. However, the Atlas is more than a collection of static maps and images accompanied by informative facts and figures: its visual elements vividly illustrate a succinct narrative describing and analyzing Africa's water issues and exemplifying them through the judicious use of case studies. It gathers information about water in Africa and its role in the economy and development, health, food security, transboundary cooperation, capacity building and environmental change into one comprehensive and accessible volume. UNEP undertook the production of this Atlas at the request of the African Ministers' Council on Water (AMCOW) and in cooperation with the African Union, European Union, US Department of State, United States Geological Survey and other collaborators.

The Atlas is a significant and timely contribution that can inform the implementation of commitments made in the Africa Water Vision 2025. Among other goals, the Vision indicates the minimum need to double the area under irrigation and develop 25 per cent of Africa's hydropower potential. Decision makers can also look to the Atlas for background information and tools to assist in fulfilling commitments made in other recent events and declarations. These include the 2008 Ministerial Conference on Sanitation at eThekwini, where ministers pledged to adopt national sanitation and hygiene policies within 12 months and to ensure these are on track to meet national sanitation goals and the MDGs by 2015; the organization of the First African Water Week and Ministerial Declaration in Tunis; the African Union (AU) Summit's dedication to water and sanitation in June 2008 at Sharm El Sheikh; and the Ministerial Meeting on Water for Agriculture and Energy at Sirte.

Hotspots to Hopespots

The nature of water issues in Africa is often contradictory: surplus and scarcity, under-development and overexploitation and challenges and opportunities. Africa has been identified as a global "hotspot" for water-constrained, rain-fed agriculture, but new research reveals that there are also "hopespots" in arid and semi-arid regions where there is enormous potential for expanding simple water-harvesting techniques. The hotspots, shown by the red hatching in Figure 1, are places with populations of 20 persons per km^2 or more in Africa's arid and semi-arid regions. Here, some 100 million people are disproportionately undernourished and experience food insecurity. On the other hand, there are many "hopespots" where substantial settlements in arid and semi-arid areas coincide with adequate rainfall for water harvesting. In these places, traditional and new ways to collect and store water, such as the widespread construction of small farm ponds, could be expanded

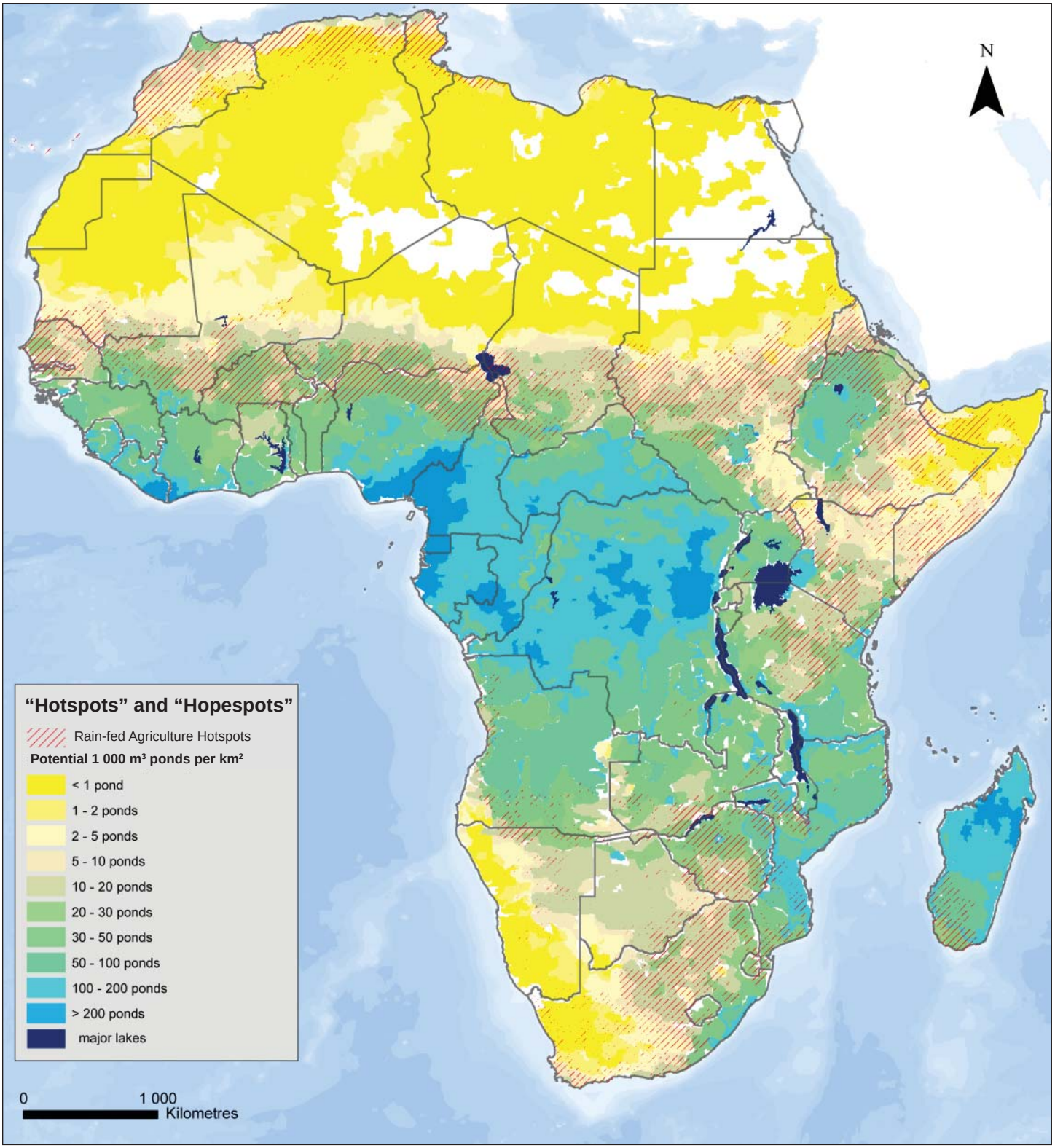


Figure 1: Areas of water-limited, rain-fed agriculture or "hotspots" (red hatching) are overlain on a map showing the potential for rainwater harvesting in terms of number of 1 000 m³ ponds per km². This map layer is derived from water balance data and the many places where "hotspots" overlap areas of significant water harvesting can be viewed as "hopespots" where rainwater harvesting may be able to improve food security.

to support fragile livelihoods, especially in light of the probable impacts of climate change. For the first time, the wide distribution of these hopespots has been overlain on a map (Figure 1) generated using datasets of rainfall, soil texture, potential evapotranspiration, topography, landcover and population.

Data from satellite images have been used to help calculate the potential for water harvesting by accurately

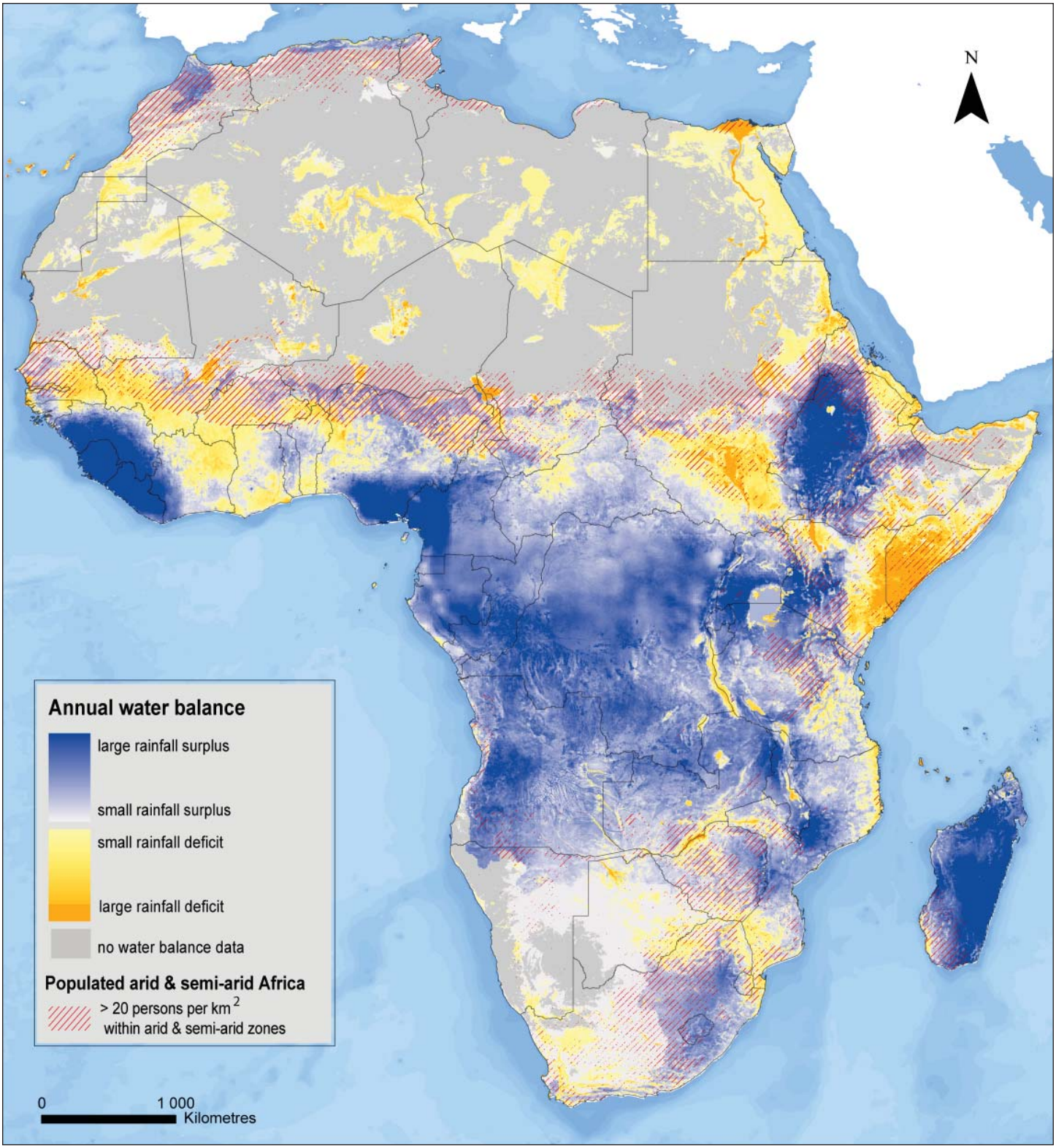


Figure 2: Annual water balance is an estimate of the available runoff after evapotranspiration—water that is potentially available for water harvesting. Yellow indicates areas of runoff deficit; blue indicates areas of runoff surplus. The red hatching overlaying the water balance map shows where population density of greater than 20 persons per km² coincides with areas defined as arid or semi-arid.

quantifying land-surface processes across the African continent. Evapotranspiration—an estimate of the sum of surface evaporation and plant transpiration—helps generate a more accurate water-balance map (rainfall minus the water lost to evapotranspiration) as shown in Figure 2. This information allows stream flow to be modeled and to examine the potential for dams and other forms of water harvesting.

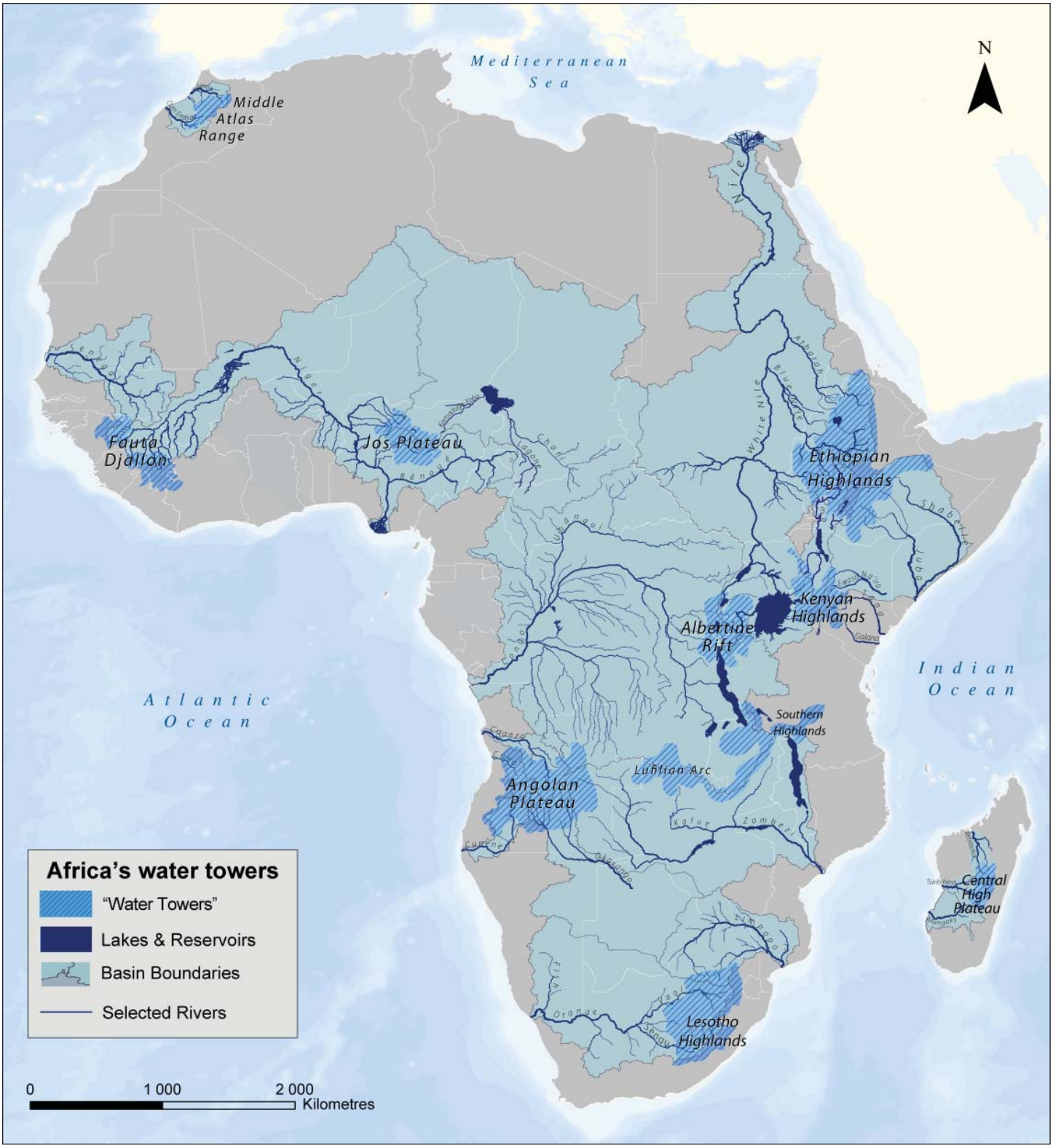


Figure 3: This map of Africa's "water towers" illustrates the interconnectedness of surface water systems at the scale of major basins. They have been identified by relative elevation (generally 200–800 m above the surrounding area); precipitation above 750 mm; and runoff above 250 mm. They were also selected for the contribution they make to water resources of populations beyond their delineated boundaries.

Since ninety-five per cent of sub-Saharan Africa's farmland relies on rain-fed agriculture, and agriculture is the single most important driver of economic growth, improving food security through water harvesting techniques could very broadly improve human well-being in many of Africa's drylands.

The water towers of Africa

Africa's "water towers" are forested uplands in several African watersheds, including transboundary basins. They store water and contribute disproportionately to the total stream flow of Africa's major rivers that supply water for hydropower, wildlife and tourism, small- and large-scale agriculture, municipalities, transportation and ecosystem services. They are thus extremely important to the economy and human well-being in many countries and regions, especially downstream areas that often benefit from the abundant runoff. Rivers such as the Nile, the Niger, the Senegal and the Orange flow from relatively rain-abundant areas to places that would otherwise be too arid to support much life. Figure 3 shows several of Africa's "water towers." It was generated especially for this Atlas by identifying areas of relatively high elevation (generally 200–800 m above the surrounding area), precipitation above 750 mm and runoff above 250 mm and a contribution to water resources for populations beyond their boundaries. Implementing Integrated Water Resources Management (IWRM) could help to protect these water towers and sustainably develop their concentrated water resources, especially when two or more countries share them and when upstream activities affect downstream water needs.

Key Facts

Renewable water resources are unevenly distributed among Africa's sub-regions

A combination of natural and human factors are responsible for wide differences in water availability between African countries

The physical context of water resource issues

After Australia, Africa is the world's second-driest continent. With 15 per cent of the global population, it has only 9 per cent of global renewable water resources. Water is unevenly distributed, with Central Africa holding



50.66 per cent of the continent's total internal water and Northern Africa only 2.99 per cent (Figure 4). In addition, Africa experiences remarkable variability in rainfall at inter-annual, decadal and longer time scales. The climate is highly variable over the year, with some regions experiencing pronounced and often extreme wet and dry seasons, while longer climatic cycles include years of drought.

Generally, the pattern of vegetation in Africa largely mirrors its climatic zones, with areas of high rainfall producing the greatest volume of biomass, or primary productivity. Approximately 66 per cent of Africa is classified as arid or semiarid, with extreme variability in

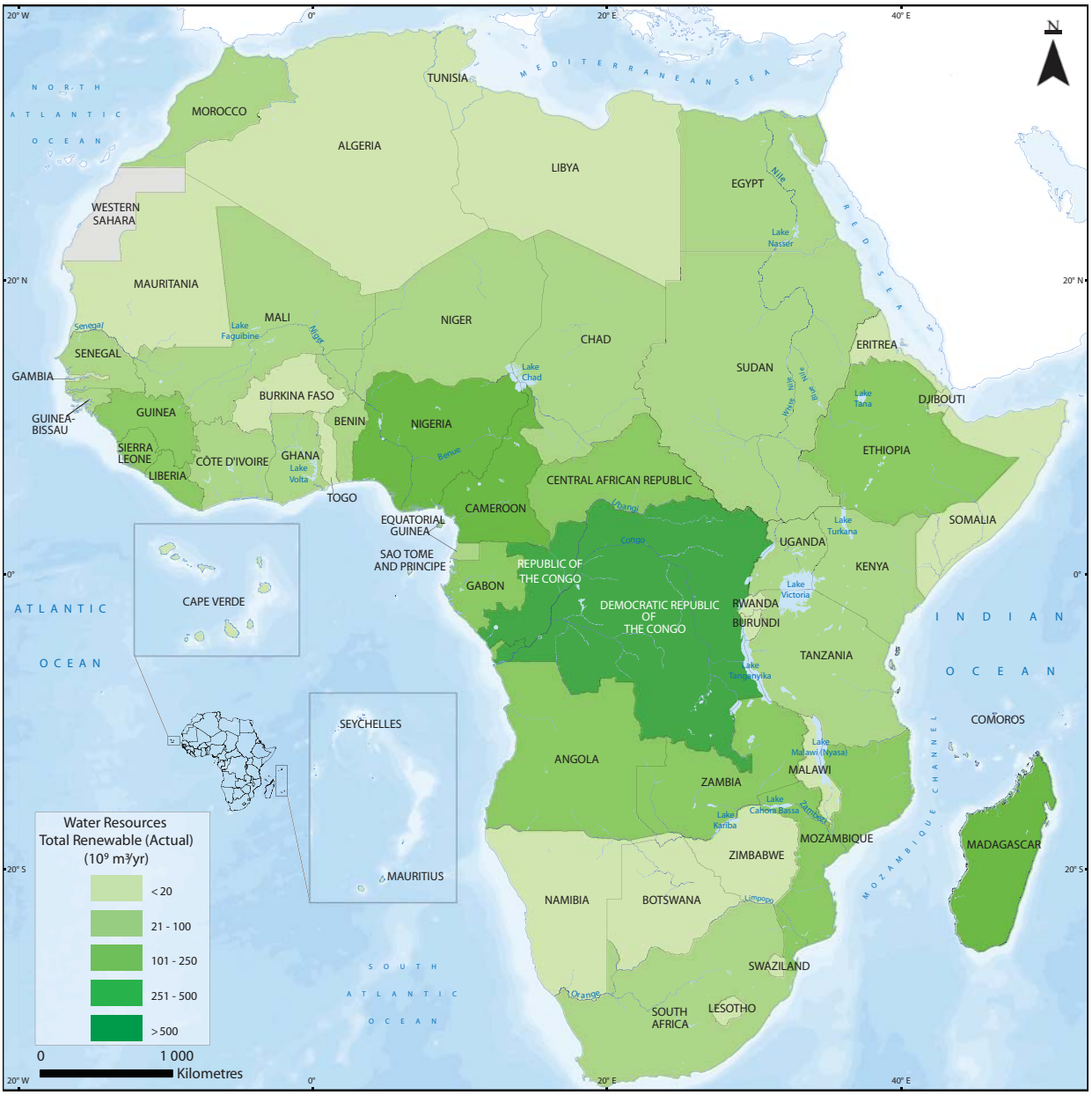
Key Facts

Africa's climate is characterized by an overall unreliability of rainfall

There are two rainfall extremes, ranging from near zero in dry regions such as the Sahara Desert, to extremely high rainfall in the Congo-Guinean rainforests

There are pronounced seasonal variations in precipitation in many African regions

Figure 4: Total renewable water resources



rainfall. There are three main deserts: the Sahara in the north, and the Kalahari and the Namib in southern Africa.

The nature of groundwater resources also constrains water availability. They represent only 15 per cent of total renewable water resources, but supply about 75 per cent of Africa's population with most of its drinking water. Per capita water availability is shown in Figure 5. In all regions except central Africa, water availability per person (4 008 m^3 in 2008) is under both the African and global averages and lower than that of all of other world regions except Asia, the most populous continent. These

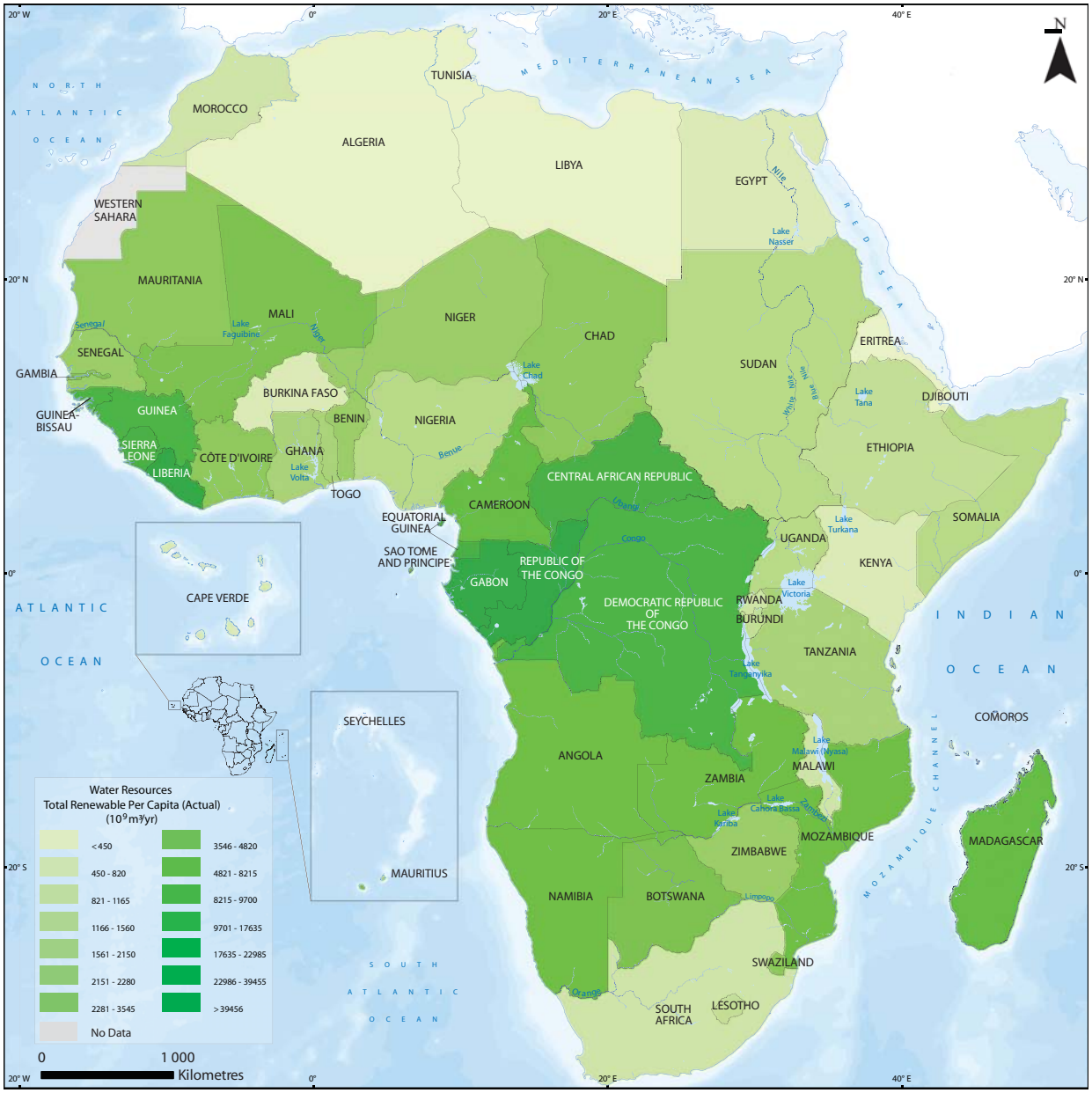
Key Facts

Arid lands cover about 60 per cent of Africa

Precipitation, primary productivity and biodiversity are correlated

More than 40 per cent of Africa's population lives in arid, semi-arid and dry sub-humid areas

Figure 5: Renewable water resources per capita





issues of timing and distribution of water are of particular concern in arid and semi-arid zones where rain-fed agriculture is marginal. Further on in this summary,

Key Facts

Africa's largest lakes are Lake Victoria, the world's second-largest freshwater lake, and Lake Tanganyika the second-deepest lake in the world

Some of the world's largest dams such as Volta, Kariba and Cahora Bassa are found in Africa

South Africa and Zimbabwe have the most dammed rivers and among the world's countries with large dams ranked 11 and 20 respectively

The Lake Chad basin is the largest endoreic basin (an area with terminal lakes and an interior drainage basin) in the world

Groundwater represents only 15 per cent of Africa's total renewable water resources, but about 75 per cent of its population relies on groundwater as the major drinking water source

Africa's important aquifers such as the Nubian Sandstone, the world's largest fossil water aquifer system, and the Lake Chad sedimentary basin, are losing more water than the rate of recharge

Table 1 (see page 31) provides a snapshot of per capita water availability in each of Africa's 53 countries.

Africa's water is held in large rivers and impoundments, widespread aquifers, lakes and wetlands as well as in atmospheric water vapour and soil moisture (Figure 6).

The socioeconomic and political context of water access

Africa's geography and climate, including periodic drought and highly variable rainfall, are not the only—or necessarily the most significant—reasons for the situations of water scarcity that exist on the continent. They are influenced by the number of people using that water and compounded by increased water demand because of growing populations. Most of the urban population growth has taken place in peri-urban slum neighbourhoods, overwhelming the capacity of water supply networks and resulting in an overall decline in piped water coverage. Between 2005 and 2010, Africa's urban population grew at a rate of 3.4 per cent, or 1.1 per cent more than the rural population. At the same time, improving standards of living are increasing the demand for water in some population segments.

Water access is also affected by weak city planning and water and sanitation management, a lack of resources, and competition for available freshwater between sectors such as industries, municipalities,

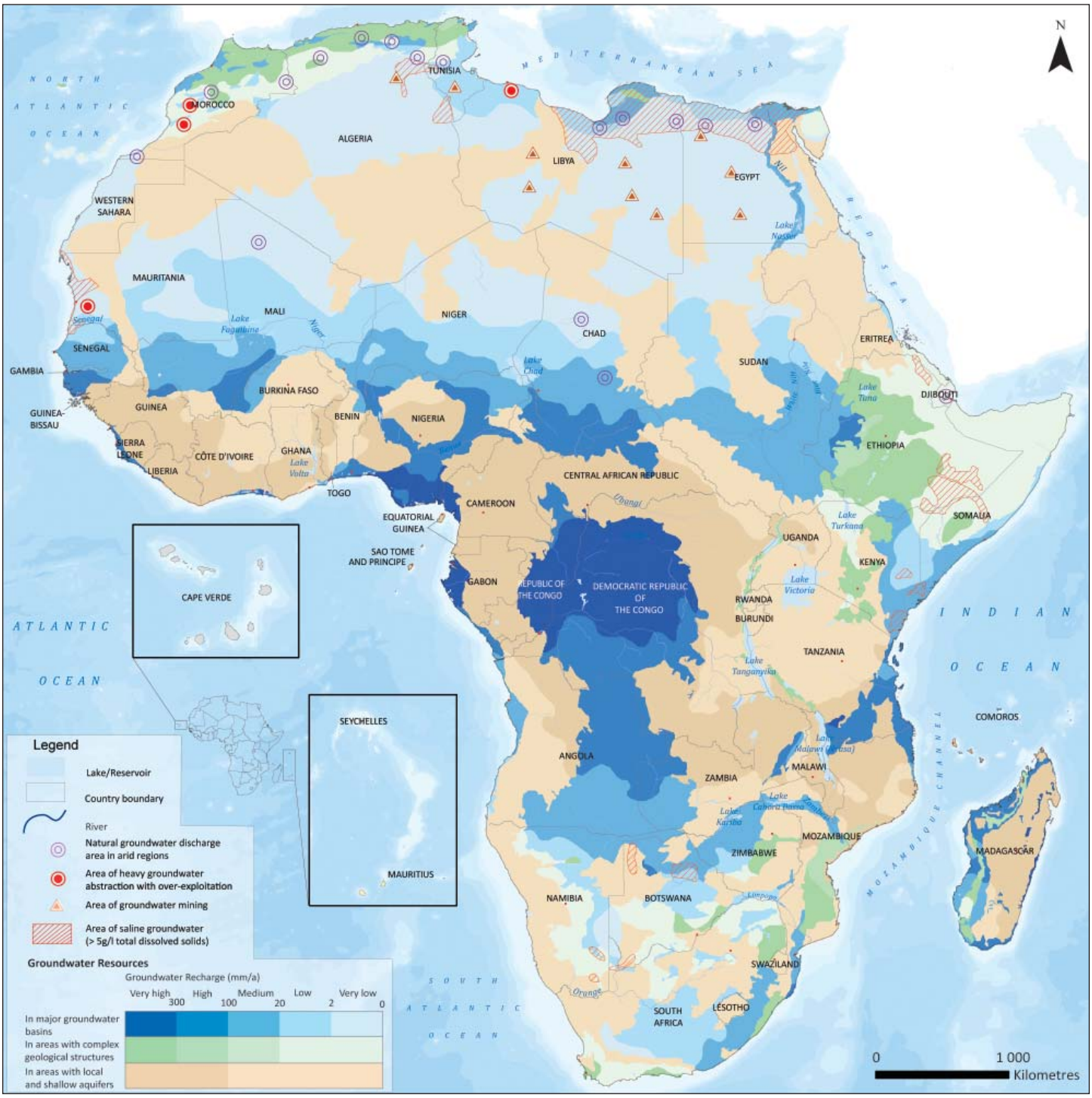


Figure 6: Surface and groundwater features

agriculture and tourism and often between upstream and downstream users.

These have resulted in water stress or water scarcity conditions where the quantity and quality of water may not be enough to adequately provide safe drinking water, food and hygiene, may limit economic development and can severely constrain environmental resources. These factors mean that people suffer from a lack of safe drinking water and access to proper sanitation facilities.

Key Facts

Africa's population growth rate of 2.3 per cent from 2005 to 2010 was the world's highest

Over that time, Africa's urban population grew at a rate of 3.4 per cent

Key Facts

Millions of people in Africa suffer water shortages throughout the year

Water scarcity is not simply due to geography: population growth, rapid urbanization, poor planning and poverty are significant factors

Most urban population growth has taken place in peri-urban slum neighbourhoods, overwhelming municipal water services

Sixty-four per cent of people in Africa use improved drinking water sources

Only 38 per cent of Africa's population has access to improved sanitation facilities

Increases in access to improved drinking water sources and sanitation facilities are not keeping pace with population growth

Widespread poverty constrains many communities' ability to address water issues even when significant opportunities such as irrigation, rain-water harvesting, groundwater exploitation or sanitation infrastructure exist. There is also an important relationship between water and gender in Africa. The burden of water collection falls disproportionately on women and girls (Figure 7), who in some cases spend as much as 40 per cent of their caloric intake carrying water.

Key Facts

Agriculture—largely rain-fed—is the main source of income for 90 per cent of the rural population

Compared to other sectors, stimulating economic growth through agriculture is four times more effective in raising incomes of poor people; investing in agricultural water has even higher potential multipliers

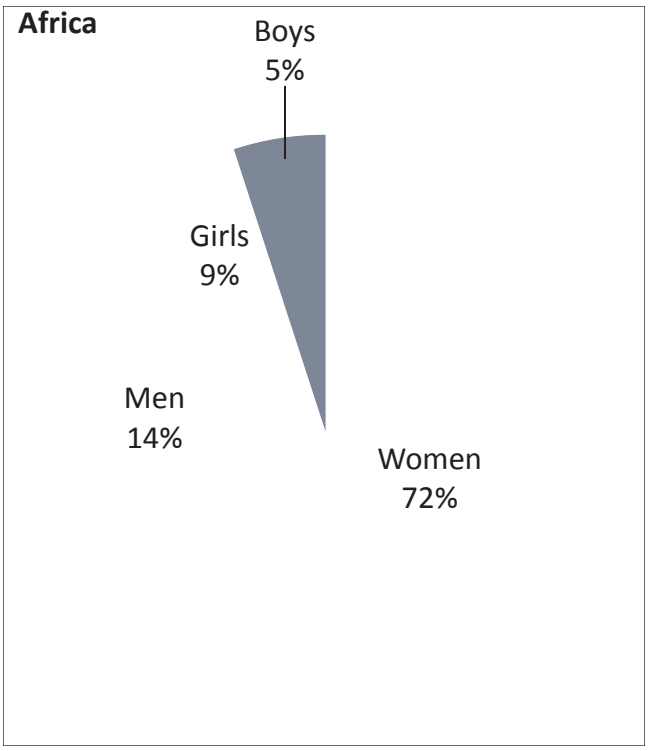


Figure 7: Women in Africa shoulder a greater share of the burden of collecting water.

Water for agriculture is especially important on a continent where farming—largely rain-fed—is the main source of income for 90 per cent of the rural population. Thus, compared to other sectors, stimulating economic growth through agriculture is four times more effective in raising incomes of poor people, while investing in agricultural water has even higher potential multipliers.

Water is also extremely important for transportation for many communities, especially for moving goods. There are extreme navigation problems on most of Africa's major rivers. There is also uncoordinated development between different water-use sectors and inadequate funding to develop or make improvements to the important river navigation systems. Only a few of the waterways, mainly in the Congo, the Nile and Zambezi basins, are internationally navigable.

Transboundary water resources

Africa's many borders and its geography pose a challenge to equitably sharing and developing its water resources. The continent's 63 international river basins cover about 64 per cent of its land area and contain 93 per cent of its total surface water resources (Figure 8). They are also home to some 77 per cent of Africa's population.

In Africa, groundwater is an important source of freshwater and it is essential to supplement the surface water resources in a region that is increasingly affected by recurrent drought. Africa is endowed with large and often under-utilized aquifer resources, predominantly in the large shared sub-regional sedimentary systems of the Sahara and Central and Southern Africa. There are also significant shared coastal aquifer resources that supply the large urban populations concentrated in rapidly growing coastal areas (Figure 9). The largest aquifer systems are predominantly located—and are of highest importance—in the continent's arid and semi-arid

Figure 8: Africa's major transboundary river basins



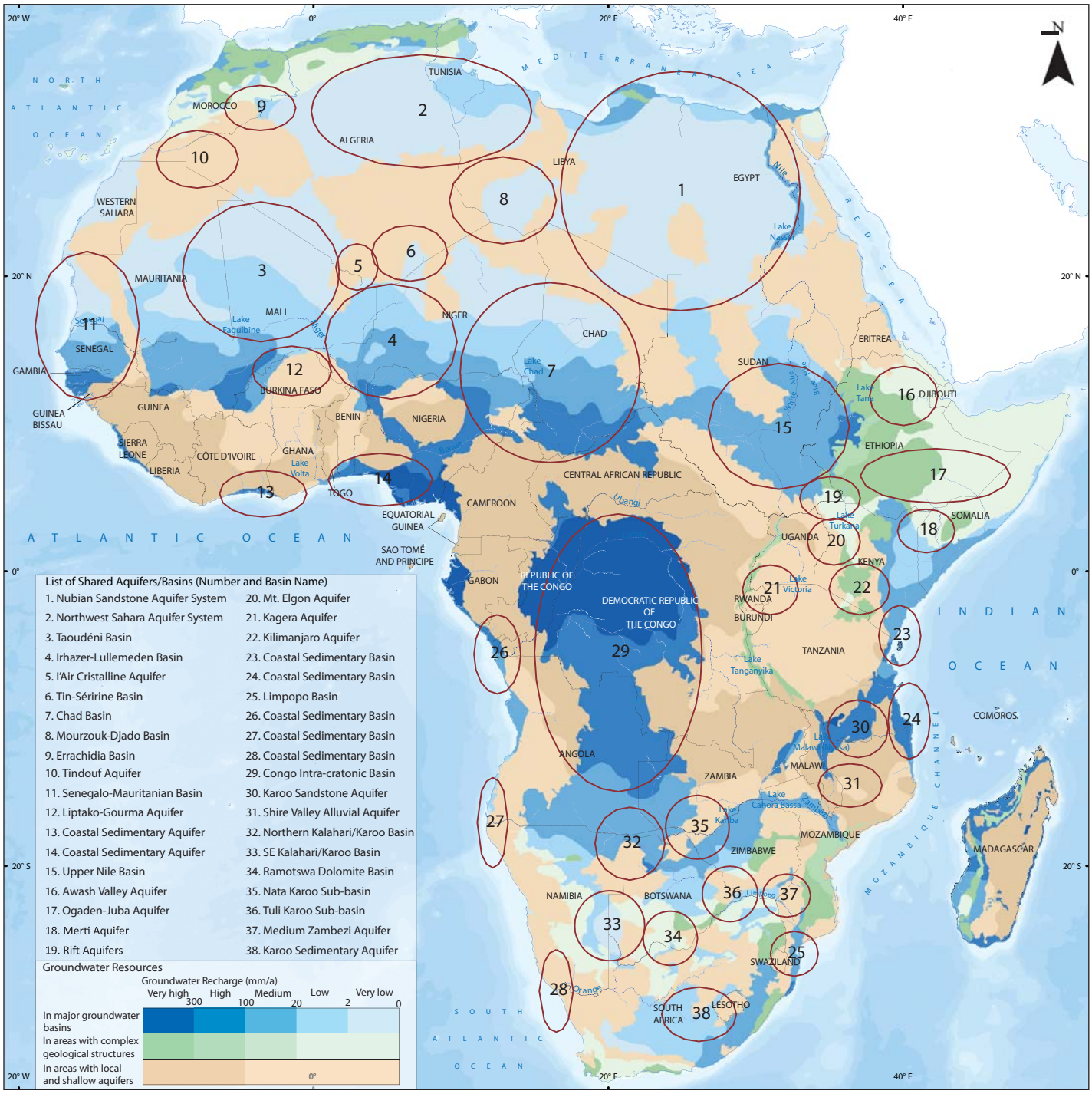


Figure 9: Transboundary aquifers

dryland zones, which are continuously threatened by accelerated land degradation, loss of productive land and human-induced desertification. Thus, management issues and the transboundary implications extend beyond water balance and control of the hydraulic systems to include land use and protection in recharge and discharge areas.

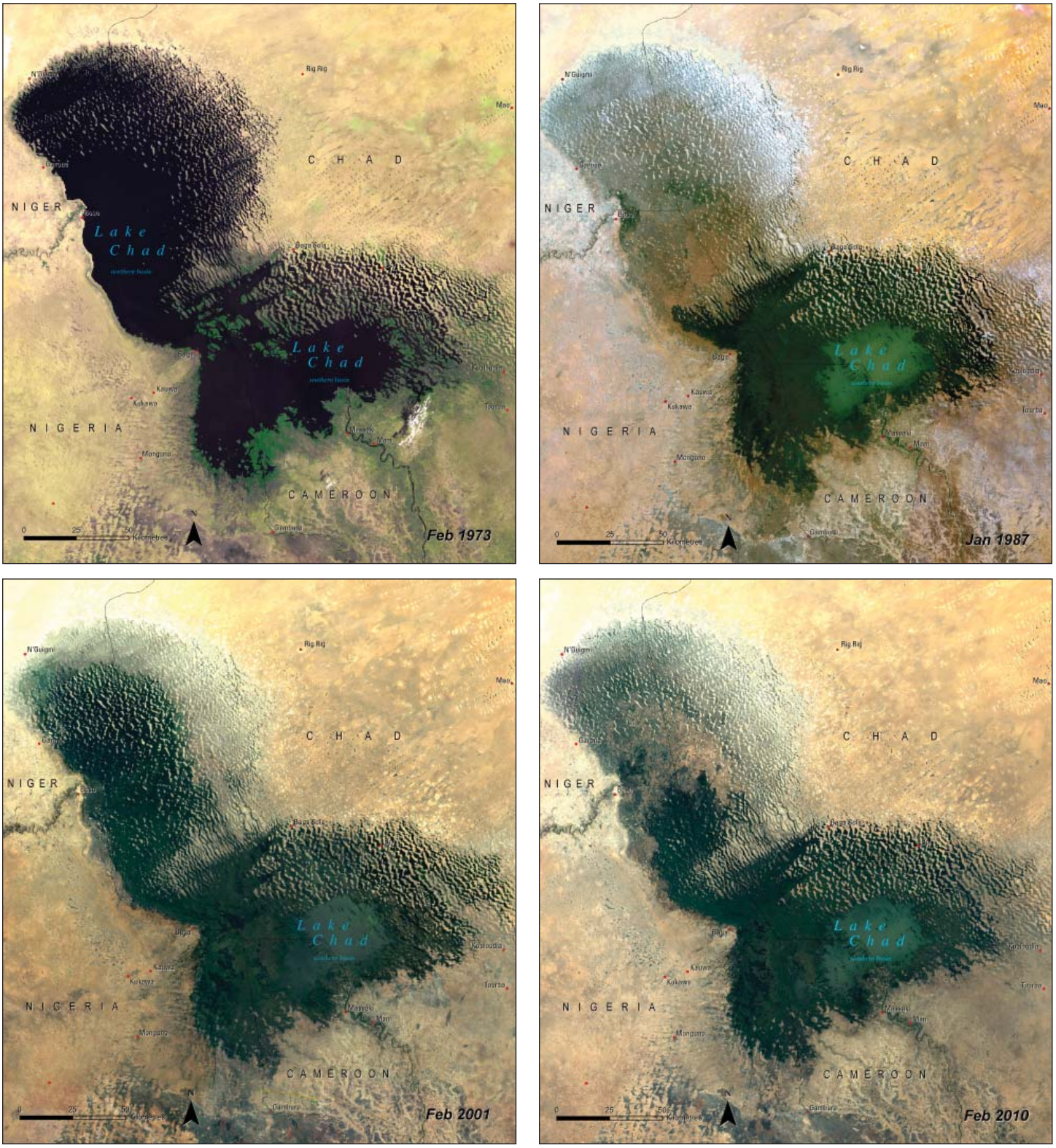
Satellite images in time series show striking cases of environmental change within Africa's transboundary surface basins and aquifers over the past several decades, as illustrated by selected examples below.

Some lakes, deltas and wetland areas are declining

- Lake Chad, which fluctuates considerably with the seasonal rains, has shrunk significantly since the 1960s due to a combination of severe droughts and irrigation-water abstraction. It is one of the Sahel's largest freshwater reservoirs, makes up just over

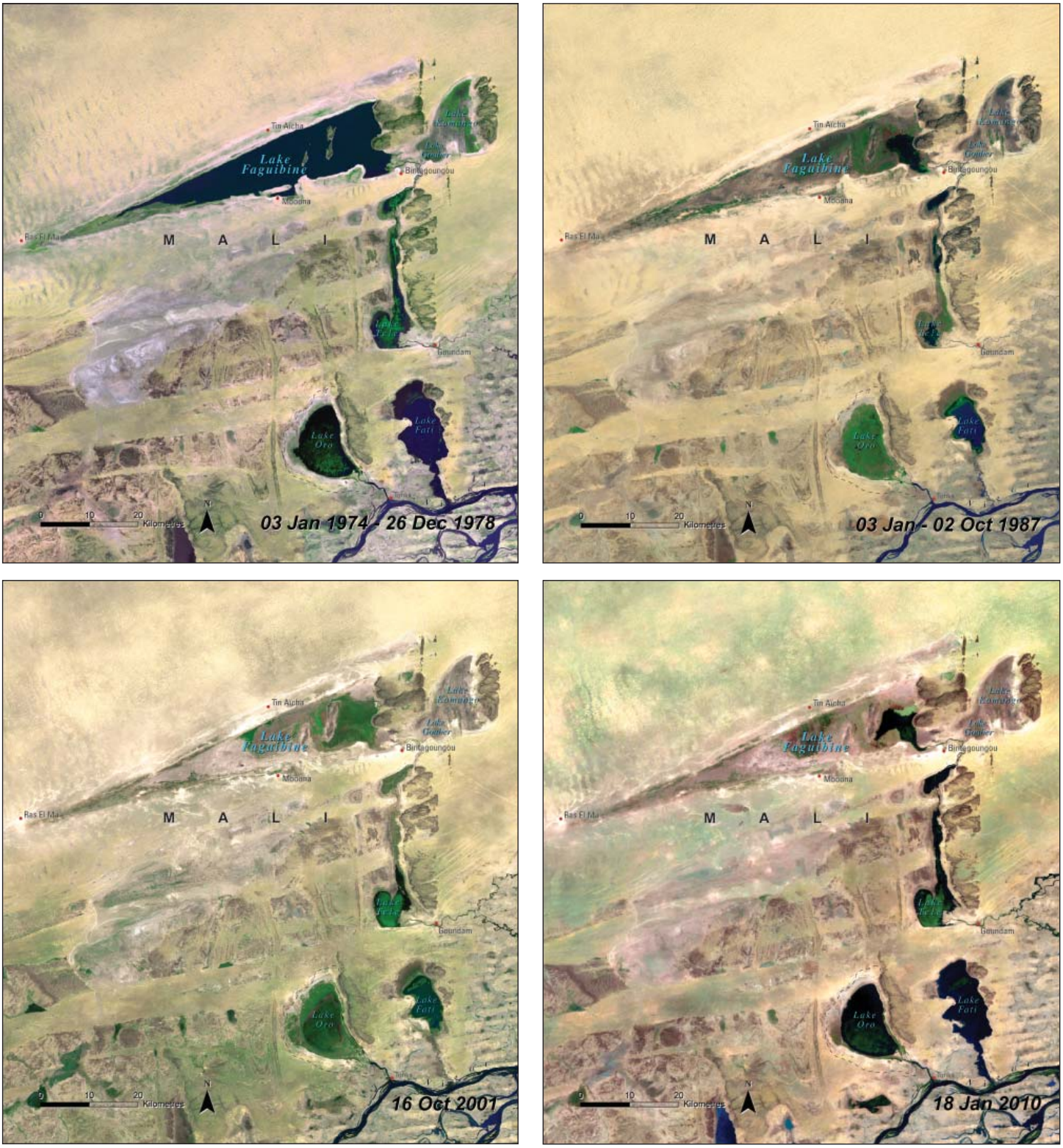
eight per cent of the surface area of Africa and falls across the boundaries of eight countries—Algeria, Cameroon, Central African Republic, Chad, Libya, Niger, Nigeria and Sudan. In the 1960s, Lake Chad was about 25 000 km^2 in surface area, but it experienced a rapid shrinkage in the early 1970s and has since been fluctuating between 2 000 and 15 000 km^2, depending on the season (Figure 10).

Figure 10: While Lake Chad's surface area fluctuates considerably with the seasonal rains, these dry-season images of Lake Chad show the long-term trend since the 1960s. Changes in rainfall during this period have been a major factor as has diversion for irrigation.



- When Lake Faguibine in the Niger River Basin is full, it is among West Africa's largest lakes, covering approximately 590 km^2. During the great droughts of the 1970s and 1980s, however, it began declining and by the 1990s was completely dry (Figure 11), with significant impacts on local livelihoods. Although some pooling has occurred since then, Lake Faguibine has not refilled significantly. Work is underway to clear debris from channels that feed the lake.
- Examples of other water-area declines in transboundary water basins and groundwater

Figure 11: After drying up in the 1990s Lake Faguibine has not refilled significantly, however some pooling has occurred during wet years. Work is underway to clear debris from channels that feed the lake.



sources include the reduction in the Inner Niger Delta's annual floods, which were dramatically reduced during the great droughts of the 1970s and 1980s, although by 2009, precipitation and flooding were more normal; and water abstraction from the Nubian Sandstone Aquifer, which has grown ten-fold since 1960, leading to related growth in agriculture.

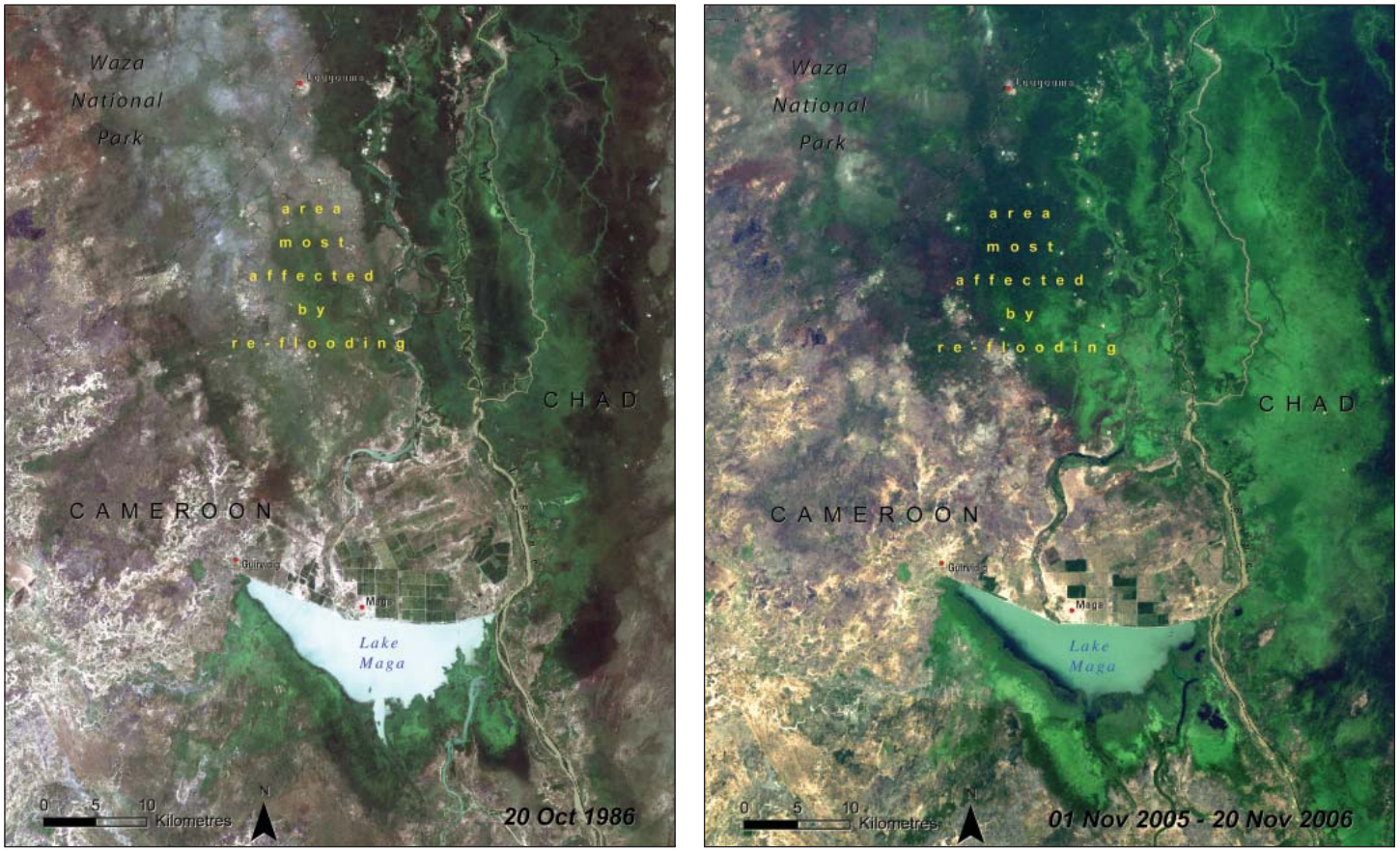
Dams have created huge reservoirs or artificial lakes

- The Tekezé Dam, Ethiopia, and the Merowe dam in north-central Sudan, both in the Nile River Basin, provide needed electricity, but like most other large-scale dams in Africa, they led to concerns about their social and environmental impacts.
- Overflow from the Lake Nasser spillway created the Toshka lakes, which have since largely disappeared due to evaporation and to a lesser degree, by infiltration.
- The Cahora Bassa Dam was constructed in 1974 in western Mozambique. Due to its social and ecological costs, studies suggest that flow management could restore some of the river's pre-impoundment functions by simulating natural flow variations.

Managed releases from some dams have helped to restore a number of ecosystems

- An example of flow management is the Maga dam and the Waza Lagone floodplain in the Lake Chad Basin. Damming of the Lagone River in the 1970s coincided with a period of drought that reduced overbank flooding and disrupted local livelihoods on the Waza Lagone Floodplain. Managed releases from the dam beginning in the 1990s restored some of the natural flooding, bringing improved grazing and the return of other valuable ecosystem functions (Figure 12).
- The Manantali and Diami dams built in the Senegal River Basin in the 1980s, along with years of drought, helped to reduce the Djoudj and Diawling wetlands

Figure 12: Damming of the Logone River in the 1970s, coincided with a period of drought, which reduced overbank flooding, disrupted local livelihoods on the Waza Logone Floodplain. Managed releases from the dam beginning in the 1990s restored some of the natural flooding, bringing improved grazing and the return of other valuable ecosystem functions.



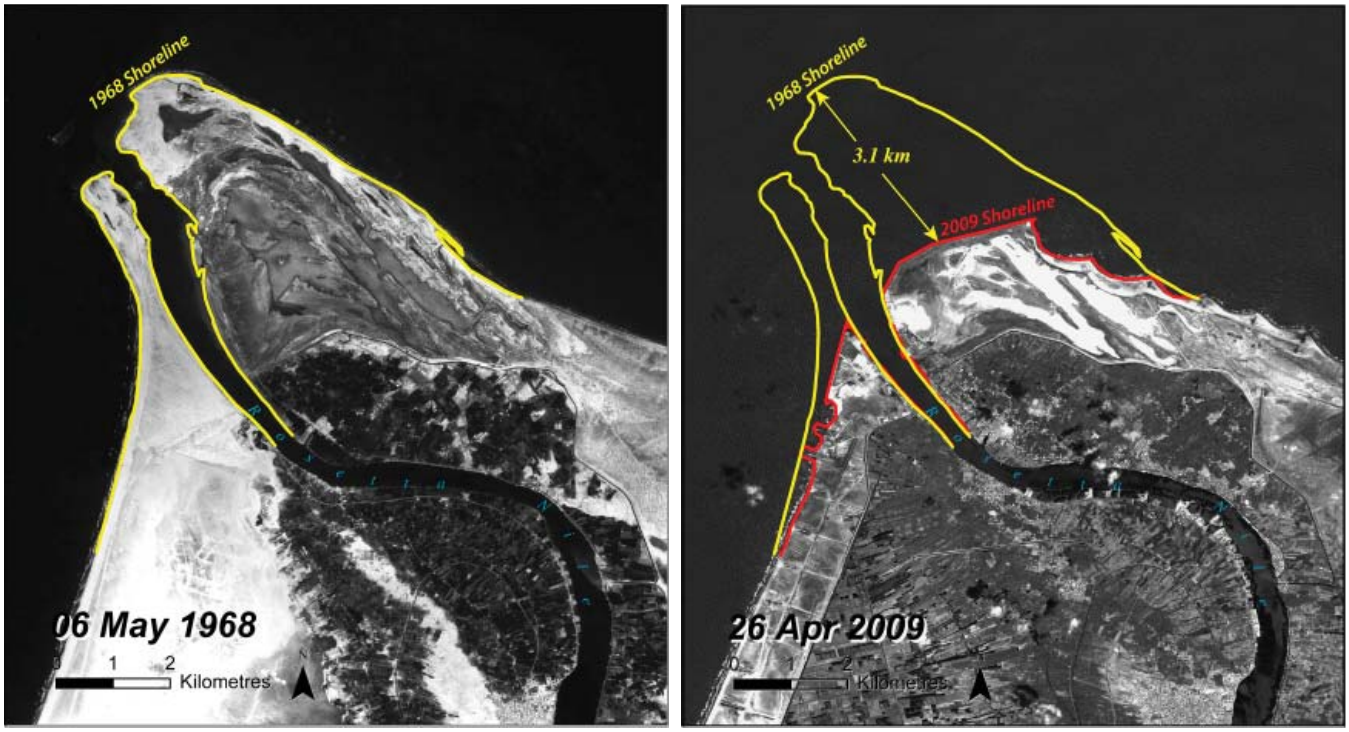
to a low point in the 1980s. After changes in artificial impoundments and water flows to better mimic previously existing conditions, the wetlands rebounded.

- As it passes between the Itezhi-tezhi dam and the Kafue Gorge Dam, the Kafue River, one of the Zambezi's main tributaries, creates the Kafue Flats, a broad floodplain roughly 255-km long. Managed releases have improved the extent of annual floods during the wet season.

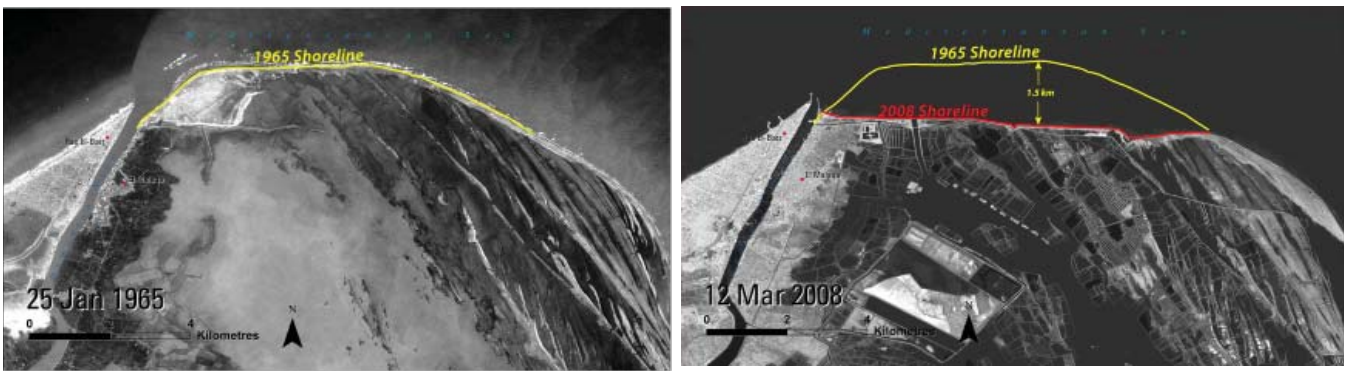
The Nile Delta is eroding and sinking

- The Nile Delta is built of sands carried to Egypt's Mediterranean coast by the Nile River, primarily since the end of the last ice age. Dams along the river and sediment trapped in a vast network of irrigation canals have led to a dramatic decrease in the flow of water and sediment to the delta's edge and the forces of erosion have outstripped the balancing effect of sediment deposition. The Rosetta Promontory lost over 3 km to erosion between 1968 and 2009, while the Damietta Promontory (Figure 13), eroded 1.5 km between 1965 and 2008. In addition, the delta is sinking as new deposits of soil no longer offset the natural effect of soil compaction.
- Sudan's massive Gezira Irrigation Scheme, built in the early 20th century, and other schemes such as Rahad,

Figure 13: Coastal erosion and the sinking Nile Delta



Rosetta Promontory lost over 3 km to erosion between 1968 (left image, yellow line) and 2009 (right image, red line).



Damietta Promontory, formed by one of the two principle outlets of the Nile River, eroded 1.5 km between 1965 (yellow line) and 2008 (red line).

New Halfa and the Kenana Sugar Plantation, which were built in the 1960s and 1970s, help rank Sudan second in Africa after Egypt in terms of land under irrigation.

- The New Valley Irrigation Project uses water from Lake Nasser to grow crops in the desert including wheat, tomatoes, grapes and citrus. The goal is to irrigate over 3 300 km^2 of desert land and attract settlers away from the densely populated Nile Valley.
- Along the Senegal River, irrigation schemes beginning in the 1940s and other large investments in the 1980s, including the construction of the Manantali Dam in Mali and the Diama Dam in Senegal, have increased irrigation potential within the Senegal Basin.
- The Great Man-Made River Project in Libya, which began roughly 30 years ago, is among the largest civil engineering projects in the world. The project brings water from well fields in the Sahara to Libya's growing population. The majority of the system's water comes from Libya's two largest groundwater resources—the Murzuq and Kufra groundwater basins. The satellite image pair (Figure 14) shows a large increase in c

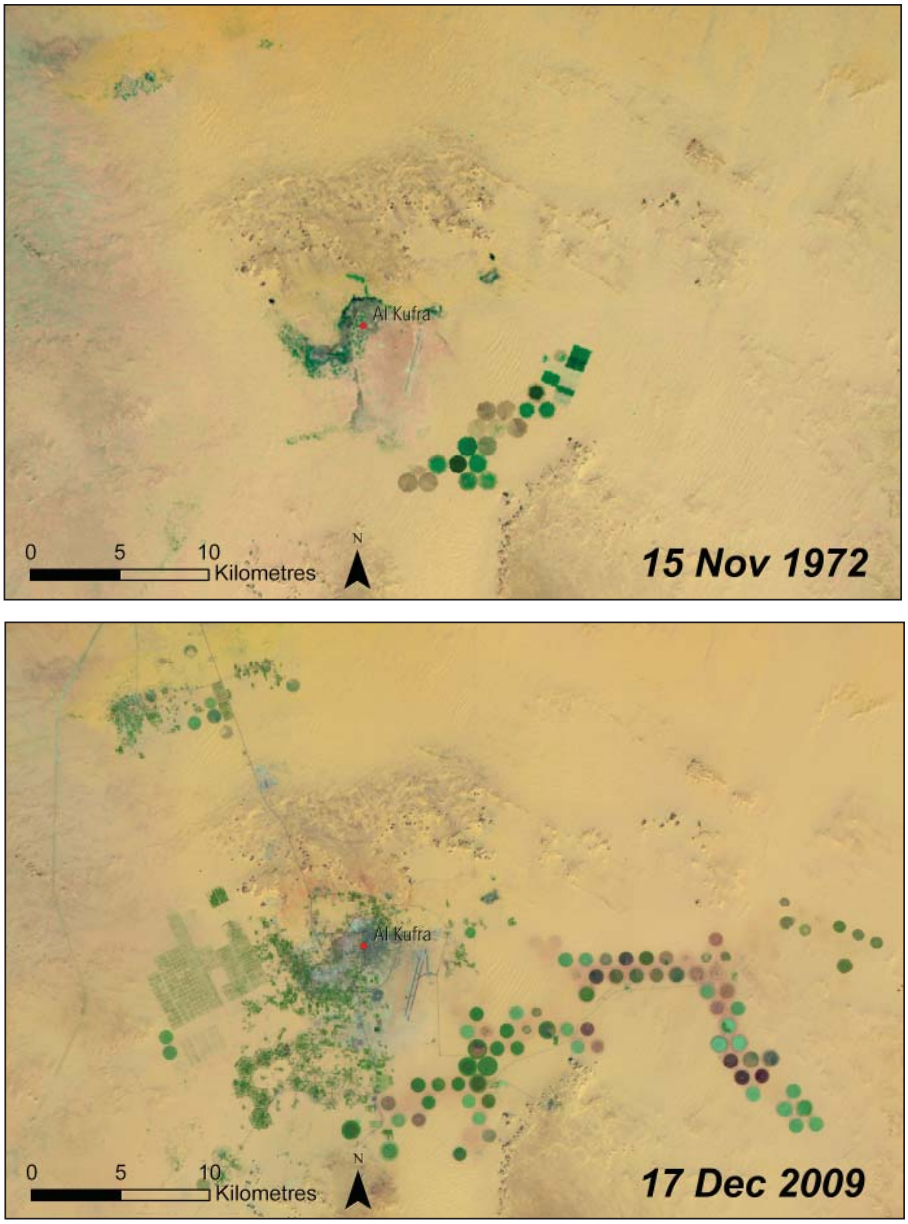


Figure 14: Irrigated agriculture in parts of southern Libya, such as Kufra Oasis shown here, has expanded dramatically since the 1970s by pumping fossil groundwater from aquifers deep under the desert.

irrigation in the Kufra Basin. The majority of Libya's groundwater, as much as 80 per cent, is used f agricultur





Effluents have polluted some water bodies and coastal areas and introduced species have invaded some freshwater resources

- Surface runoff from the Entebbe area south of Kampala shows up as greenish clouds expanding out into the water as eroded soil, agricultural runoff and domestic waste runs into Lake Victoria, degrading water quality.
- Large floating mats of water hyacinth occupied the waters in Winam Gulf, Kenya in early 2007, but they declined during the 1990s.

Seasonal changes in water expanses are evident in numerous basins

- Green and brown images show the difference between wet and dry seasons in the Sudd Swamp in southern Sudan in the Nile River Basin. Annual overbank flooding creates this enormous wetland that is an integral part of the local ecosystem as well as the livelihoods of local people.

These transboundary case studies, which analyze past and present conditions, the drivers of change, environmental and social impacts of water development schemes and aspects of transboundary water management, also show how fragile and transient water in Africa can be, and how central it is to people's livelihoods and survival. The need to share water among riparian nations, however, is often a catalyst for effective water management, and the emergence of transboundary basin organizations in many of Africa's large watersheds may provide a powerful opportunity to build an enabling environment as a foundation for cooperation on numerous fronts.

Water challenges and opportunities

Africa faces numerous challenges as it strives to improve the quantity, quality and use of its water resources, but the problems can be matched with emerging opportunities that could help overcome them. The challenges and opportunities can be linked to high-level policy commitments made by leaders in African countries.



Figure 15: Africa's water challenges



Challenge 1: Provide safe drinking water

The Challenge: *Attain the MDG water provision target: By 2015, reduce by half the proportion of the population without sustainable access to safe drinking water.*

The Situation: *Africa as a whole is not expected to meet this MDG drinking water target; of its 53 countries, only 26 are on track to meet it. The high incidence of water-related and waterborne diseases related to the lack of safe drinking water is a drain on human and financial resources.*

The Constraints: *Exploding peri-urban and slum areas; economic growth and higher demand; geographical isolation; dearth of public utilities and regulation; and high costs of water provision.*

The Opportunities: *Improve financing; encourage privatization through concessions; subsidize connections; target informal settlements; institute or improve regulation; target rural communities; and employ simple solutions.*

One of Africa's key challenges is to attain the MDG water provision target of reducing by half the proportion of the population without sustainable access to drinking water by 2015. Africa as a whole will not reach this target and only 26 of the 53 countries are on track to attain it.

In 2006, 341 million people in Africa lacked access to improved drinking water sources. Because of population growth, that number is increasing even though the proportion of people without such access in Africa as a whole decreased from 44 per cent in 1990 to 36 per cent in 2006. In other words, increases in coverage are not keeping pace with population growth. Generally, the drinking water situation is worse in rural areas than in urban ones: the average urban drinking water coverage in Africa is 85 per cent while only 51 per cent of people in rural areas have access to improved drinking water.

Opportunities to address this challenge include targeting informal and rural settlements and adopting and expanding simple but proven technologies such as a water-disinfection system that already provides drinking water to about four million people.

Challenge 2: Ensure access to adequate sanitation

The Challenge: *Attain the MDG sanitation target: By 2015, reduce by half the proportion of the population without sustainable access to basic sanitation.*

The Situation: *Africa as a whole is not expected to meet this MDG sanitation target; of its 53 countries, only nine are on track to meet it. The high incidence of water-related and waterborne disease related to unsanitary conditions is debilitating to African economies and human livelihoods and well-being.*

The Constraints: *Exploding peri-urban and slum areas; economic growth and higher demand; geographical isolation; dearth of public utilities and regulation; and high costs of water provision.*

The Opportunities: *Recognize the potential to generate revenues from sanitation technologies; revolutionize toilets so they are as desirable as mobile phones; learn from the extraordinary expansion of mobile phones; encourage and support simple solutions from entrepreneurs; introduce urban water tariffs; increase sanitation's share in total aid; adopt system financing; build partnerships between the government and civil society for educational campaigns; and seek international funding.*

Improving access to clean water will help achieve the second challenge, which is to reduce by half the proportion of the population without sustainable access to basic sanitation by 2015. Of Africa's 53 countries, only 9 are expected to attain this target.

In 2006, an average of only 38 per cent of Africa's population had access to improved sanitation, which represents an increase from 33 per cent in 1990. The African population without access to sanitation increased by 153 million over that time, which shows that the increase in coverage fails to keep pace with population growth. Rural areas are less well served than cities, with urban sanitation coverage in Africa at 53 per cent but only 29 per cent in rural areas.

Opportunities to address the woefully inadequate access to improved sanitation include the potential to encourage and support simple entrepreneurial solutions



and to embark on a new drive to revolutionize toilets so they are as desirable as mobile phones. The number of mobile cell phone subscribers in Africa reached 448.1 million in 2009, representing an increase of 75 million new users since the previous year and an impressive growth of 20 per cent in the customer base since 2008. The adoption of improved sanitation, on the other hand, has grown at a much slower rate (Figure 16). The vast improvements being made in access to communications technologies provides an example of how innovation and entrepreneurship in sanitation technologies could also reap economic benefits in addition to improving health and well-being.

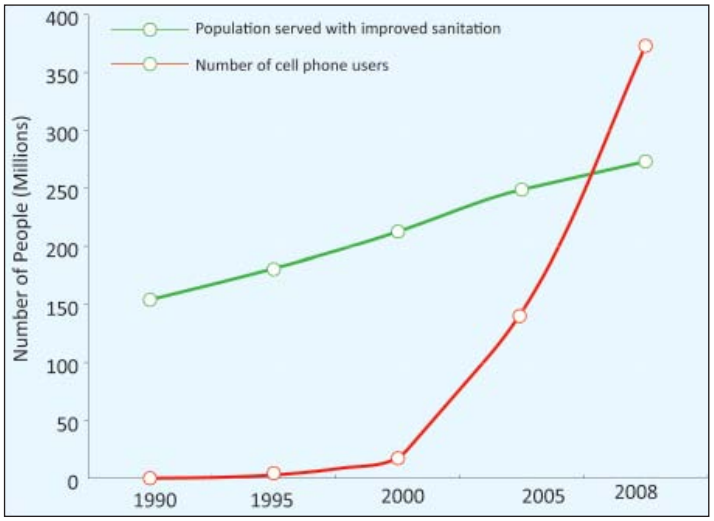


Figure 16: Growth in Africa's number of cellphone users compared to growth of population served by improved sanitation.

Such opportunities contribute ideas to efforts being made to implement the water-related MDGs, to which African countries became re-committed in several recent pronouncements. At the 2008 Ministerial Conference on Sanitation at eThekwini, for example, ministers pledged to adopt national sanitation and hygiene policies within 12 months and to ensure these are on track to meet national sanitation goals and the MDGs by 2015. Similarly, African heads of state and government demonstrated firm political leadership by adopting the Sharm el-Sheikh Commitments on Water and Sanitation at the 2008 African Union (AU) Summit. They also reaffirmed their commitment to the Africa Water Vision 2025 and to the achievement of the MDGs, specifically those related to water, at the Ministerial Meeting on Water for Agriculture and Energy at Sirte in 2008. Later, in September 2010, world leaders at the MDG Summit committed themselves to accelerating progress to achieve Millennium Development Goal 7, including by "continuing to increase sustainable access to safe drinking water and basic sanitation through prioritizing integrated water and sanitation strategies" and especially by "redoubling efforts to close the sanitation gap through scaled-up ground-level action, supported by strong political will and increased community participation, in accordance with national development strategies".

The challenges re-iterate those noted in the Africa Water Vision 2025, which states that "Unsustainable financing of investments in water supply and sanitation is a human threat to the sustainability of water resources" while the opportunities support the Africa Water Vision of a future in which "There is sustainable access to safe and adequate water supply and sanitation to meet the basic needs of all".

Challenge 3: Foster cooperation in transboundary water basins

The Challenge: *Reduce potential conflicts over water resources by enhancing cooperation in transboundary water basins.*

The Situation: *Africa has 63 shared water basins. There is a potential for conflict over shared water resources; but there are already at least 94 international water agreements in Africa to cooperatively manage them.*

The Constraints: *Population growth is diminishing shared water supplies; climate change threatens to stress shared waters; water is declining in shared aquifers; there are seasonal differences in water supplies, and inadequate joint management laws and conflicting national interests stress joint management capacities.*

The Opportunities: *Recognize and build on water as a binding factor between otherwise hostile states; and learn from successful transboundary cooperation efforts and agreements among African states.*

Africa has 63 shared water basins, so it is a challenge to address potential conflicts over transboundary water resources. The Africa Water Vision 2025 notes that human threats to transboundary cooperation include inappropriate governance and institutional arrangements in managing national and transnational water basins. It calls for a future in which a new form of regional cooperation includes partnerships and solidarity between countries that share common water basins and an effective and financially sustainable system for data collection, assessment and dissemination for national and transboundary water basins. Similarly, the declaration of the 2008 Ministerial Meeting on Water for Agriculture and Energy in Sirte encourages bilateral and regional agreements on shared water resources and the strengthening of existing water-basin organizations to

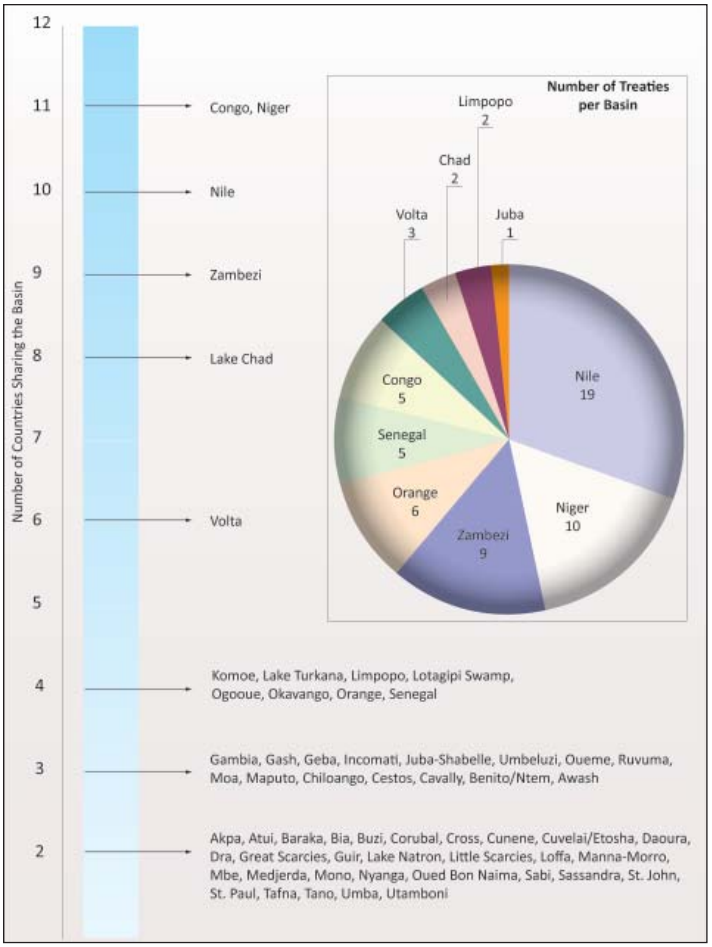


Figure 17: Number of countries in top-most shared basins and number of treaties for each of the major basins

promote sustainable water resources development and management in accordance with international law, including the agreements concluded among riparian States.

There are already at least 94 international water agreements in Africa to cooperatively manage shared waters (Figure 17). There is thus an opportunity to learn from their successes and to build on water as a binding factor. The African Network of Basin Organizations (ANBO) in its Johannesburg Declaration of 2007 recognizes the need to enhance the value of regional institutions as agents of cooperation, foster the harmonization of water policies and laws and implement action plans in the water sector.

Challenge 4: Provide water for food security

The Challenge: *Provide African agriculture with enough water to ensure long-term food security.*

The Situation: *Agricultural growth is the mainstay of most African economies; agriculture is the greatest user of water in Africa; there is inadequate water use for sustainable food production; Africa suffers from food insecurity and 30 per cent of the population lives with chronic hunger.*

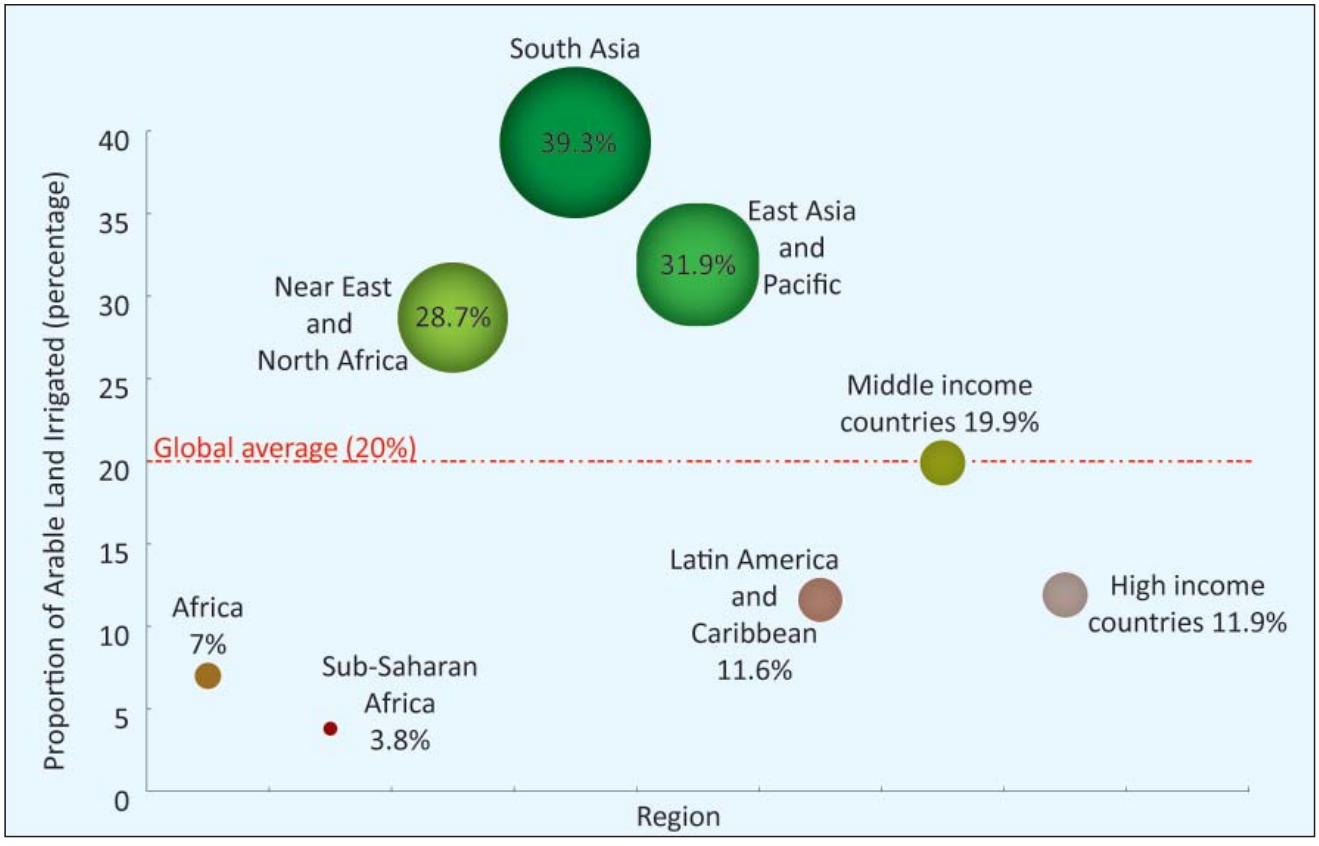
The Constraints: *Per capita food intake is rising; food production is not increasing; green water efficiency is very low; and irrigation capacity is underdeveloped.*

The Opportunities: *Learn from the 1960-1990 Green Revolution; promote a greener, Green Revolution in Africa; increase irrigation to increase food security; avoid the pitfalls of over-irrigation; invest in simple and inexpensive irrigation technologies; tie irrigation development to issues of social equity and environmental sustainability; secure sustainable investment for the Green Revolution; invest in targeted breeding of drought tolerant varieties.*

Water scarcity challenges Africa's ability to ensure food security for its population. Agriculture uses the most water in Africa and the estimated rate of agricultural output increase needed to achieve food security is 3.3 per cent per year. The potential for meeting this estimate exists, however, since two-thirds of African countries have developed less than 20 per cent of their agricultural production and less than 5 per cent of cultivated area is under irrigation in all but four countries. In sub-Saharan Africa, the proportion was only 3.8 per cent of arable land (Figure 18).

The Africa Water Vision notes that there is sufficient water for food security. There is also the opportunity to promote a greener more sustainable version of the Green Revolution, including investments in simple and inexpensive irrigation technologies and breeding drought-tolerant crop varieties. In 2008, the Declaration of the Ministerial Conference on Water for Agriculture and Energy in Africa held at Sirte noted the need to accelerate investments in agricultural water development to ensure agricultural growth and help eradicate hunger and poverty.

Figure 18: Proportion of arable land irrigated—regional and global



Challenge 5: Develop hydropower to enhance energy security

The Challenge: *Develop Africa's water resources for hydroelectricity to boost energy security.*

The Situation: *Hydroelectricity supplies 32 per cent of Africa's energy; electricity consumption in Africa is the lowest in the world; access to electricity is uneven; electricity supply is often unreliable; wars have destroyed existing electricity service in some areas; and Africa's hydro potential is underdeveloped.*

The Constraints: *The capacity to generate hydropower is unequal across the continent; climate change will exacerbate rainfall variability and hinder hydro potential; and hydro dams will need to avoid the environmental and social impacts historically characteristic of large dam developments.*

The Opportunities: *Recognize that Africa has enormous hydroelectricity potential; develop hydropower because it will boost the economy and human well-being; invest in hydroelectricity rather than fossil fuels, which makes sense in an era of climate change; learn from the many African countries that have developed hydropower successfully; learn from and copy successful regional power pools; and develop small-scale hydropower projects to avoid the environmental and human costs associated with large dams.*

Hydroelectricity supplies 32 per cent of Africa's energy, but electricity use on the continent is the lowest in the world. Africa's hydropower potential is underdeveloped (Figure 19), with only three per cent of its renewable water resources exploited for hydroelectricity even though hydropower development potential is greater than the entire continent's electricity needs. The Africa Water Vision also notes that the continent has a high potential for the development of hydroelectric power. There are opportunities to develop this untapped resource, but it should be done in ways that avoid the environmental and human costs associated with large dams.

In 2008, at the Ministerial Meeting on Water for Agriculture and Energy, the declaration included the commitment to adopt sound policies and associated institutional reforms for water development at the national, sub-regional, regional and continental levels to fully exploit the potential of both the agriculture and energy sectors. It also encouraged accelerating the integration of the continent's power network, developing waterfalls to provide electric power and small hydropower generation to speed up rural electrification. It also called upon AMCOW to promote an integrated water resource management approach in preparing water resources policies and plans.

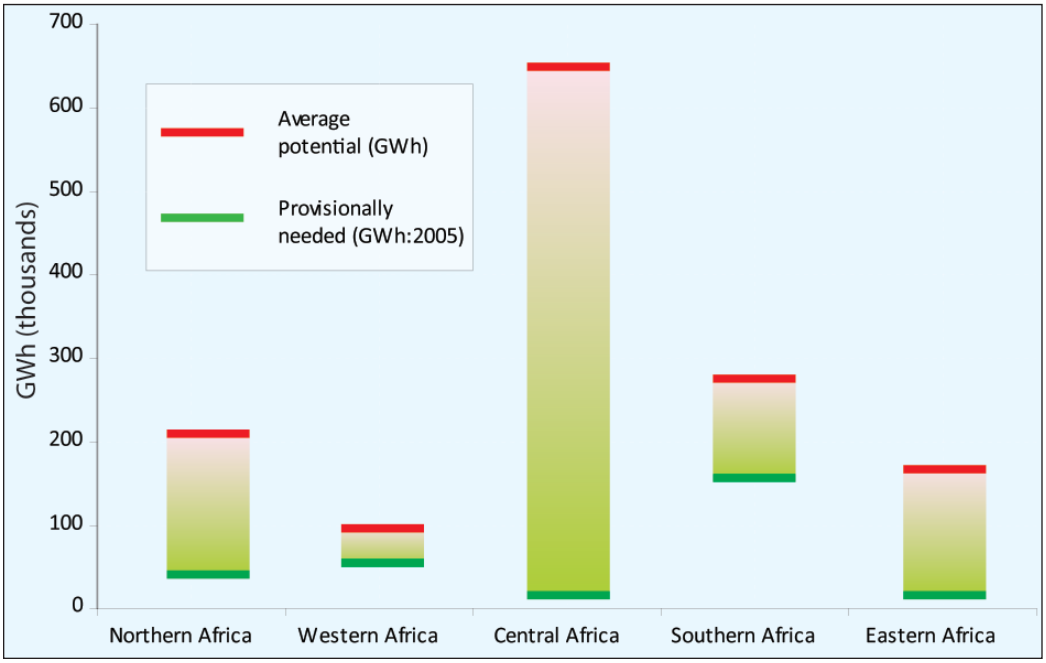


Figure 19: Regional development of economically feasible hydropower potential



Challenge 6: Meet the growing water demand

The Challenge: *Meet Africa's growing demand for water in a time of ever-scarcer water resources.*

The Situation: *More than 40 per cent of Africa's population lives in the arid, semi-arid and dry sub-humid areas; the amount of water available per person in Africa is far below the global average and is declining; groundwater is falling; and rainfall is also declining in some regions.*

The Constraints: *Demand for water is increasing with population growth and economic development; development of water resources is inadequate; prices to access water are generally distorted; and water provision is highly inefficient.*

The Opportunities: *Further develop and manage water resources sustainably; improve water use productivity; improve urban planning for better water provision; rationalize water prices; and protect Africa's water towers.*

More than 40 per cent of Africa's population lives in arid, semi-arid, and dry sub-humid areas where annual rainfall reliability is low. Rainfall in some areas is declining and aquifers are being overdrawn at the same time as demand is rising. It has been predicted that the proportion of the African population at risk of water stress and scarcity will increase from 47 per cent in 2000 to 65 per cent in 2025, affecting 18 countries. The uncertainty of water supplies has implications for Africa's people in terms of food security and public health, seasonal and permanent rural-to-urban migrations and political instability and conflicts over scarce water resources.

Africa faces the challenge of providing enough water for its people in a time of growing demand and increased scarcity. But Africa is endowed with large and often under-utilized aquifer resources that contain excellent water and could provide water security in times of drought. For example, less than 25 per cent of Africa's average annual river runoff is being used for human developmental activities. The Africa Water Vision 2025 notes that "Africa appears to have abundant water resources. It has large rivers, big lakes; vast water lands and limited, but widespread ground water resources". There is also the opportunity to address distorted water prices and to increase water-use productivity and efficiency rather than develop new sources.

Challenge 7: Prevent land degradation and water pollution

The Challenge: *Prevent water pollution, and address land degradation related to rainfall variability and the impacts of such degradation on water resources.*

The Situation: *The Sahel has been subject to enormous rainfall fluctuations. Over the last three decades, the Sahel has suffered from land degradation; groundwaters are being polluted by saltwater intrusion, and Africa's scarce water supplies are being polluted by point sources.*

The Constraints: *Lack of valuing of ecosystem services; political instability and conflict within and between countries; poor agricultural practices and farming on marginal lands that affect water use or water resources; and lack of structured water monitoring and governance.*

The Opportunities: *Maintain vital ecosystem functions; foster the greening of the Sahel by encouraging adaptation to drought; and support scientific assessments of both land degradation and water quality.*

The impacts of both rainfall variability and human uses in the Sahel have led to spatial and temporal changes and variability in landscape features such as tree-crop patterns and forest cover and to the severe degradation of soils and fragile ecosystems (Figure 20). There are 500 million ha of moderately or severely degraded land in Africa, which represents 27 per cent of global land degradation. In some areas, land is becoming saline due to inappropriate irrigation. In addition, the discharge of industrial effluent, untreated sewage and other wastes are polluting water bodies.

The Africa Water Vision 2025 also notes that human threats include depletion of water resources through pollution, environmental degradation and deforestation. Indeed, land degradation and water pollution reduce water quality and availability. These challenges could be addressed by efforts to maintain vital ecosystem functions and by fostering the greening of the Sahel by encouraging adaptive water management strategies.

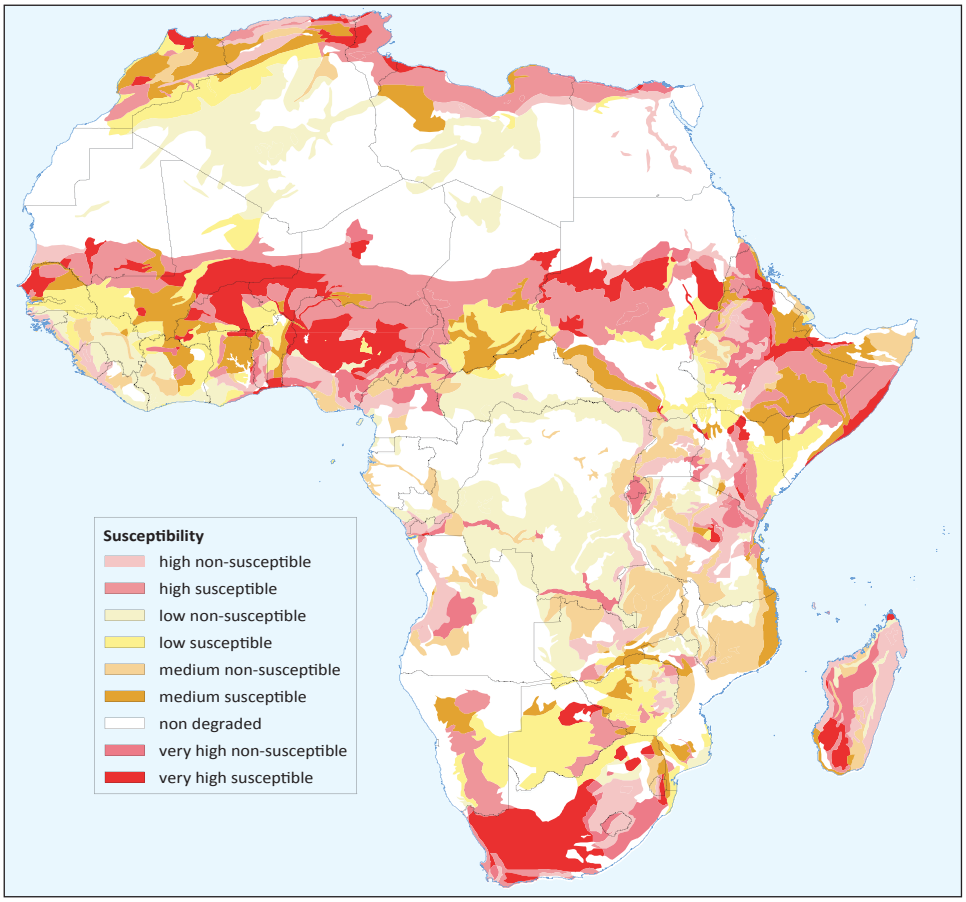


Figure 20: Land degradation and susceptibility in Africa



Challenge 8: Manage water under global climate change

The Challenge: *Manage Africa's water under the impacts of global climate change.*

The Situation: *Global warming and its human cause are undeniable; warming patterns in Africa are consistent with global ones; Africa is already subject to important spatial and temporal rainfall variability; drought in Africa is common and some regions are becoming drier; Africa's repeated drought cycles kill thousands of people each event; and floods also occur regularly with severe impacts on people's livelihoods.*

The Constraints: *Africa is one of the most vulnerable continents to climate change and climate variability; the convergence of multiple stressors limits Africa's capability to address climate change impacts; increased rainfall variability contributes to Africa's economic limitations in adapting to climate change impacts; population growth in peri-urban areas will exacerbate flooding events; climate change will likely increase aridity, with important impacts on food production; climate change will increase water stress in Africa; climate variability and change could result in low-lying lands being inundated; climate change impacts in productive aquatic ecosystems will be costly economically and in terms of food supplies; and it is likely that climate change will affect disease vectors.*

The Opportunities: *Reinforce traditional adaptation mechanisms; provide early warning; introduce adaptation measures informed by a more reliable system of seasonal predictions; support public-private partnerships that develop innovative adaptation measures; and improve physical infrastructure.*

Africa is one of the most vulnerable continents to climate change and climate variability. Given the inherent inter-annual rainfall variability, people in arid and semi-arid lands have a long history of traditional adaptation mechanisms that could be reinforced and adjusted to new circumstances. The Africa Water Vision 2025 supports this claim: "There are effective and sustainable strategies for addressing natural and man-made water-resources problems, including climate variability and change." In addition, there is the opportunity to provide more and better early warning mechanisms, as suggested in the 2008 Ministerial Meeting on Water for Agriculture and Energy: The Challenges of Climate Change, at Sirte. The meeting's declaration includes commitments to foster and strengthen cooperation between meteorological and hydrological institutions on matters of climate variability and climate change to develop aid decision tools; to establish or enhance national and regional Early Warning Systems and their continental coordination to minimize the negative impact of drought, desertification, floods and pests; and to foster research and development in renewable energy and agriculture in Africa to increase resilience and adaptation to climate change.

Challenge 9: Enhance capacity to address water challenges

The Challenge: *Enhance Africa's capacity to address its water challenges.*

The Situation: *Africa faces a situation of economic water scarcity; and current institutional, financial and human capacities for managing water are lacking.*

The Constraints: *Inadequate and unsustainable funding arrangements for water resources management; insufficient knowledge base; lack of an effective research and technology base; and weak institutional arrangements and legal frameworks for the ownership, allocation and management of water resources.*

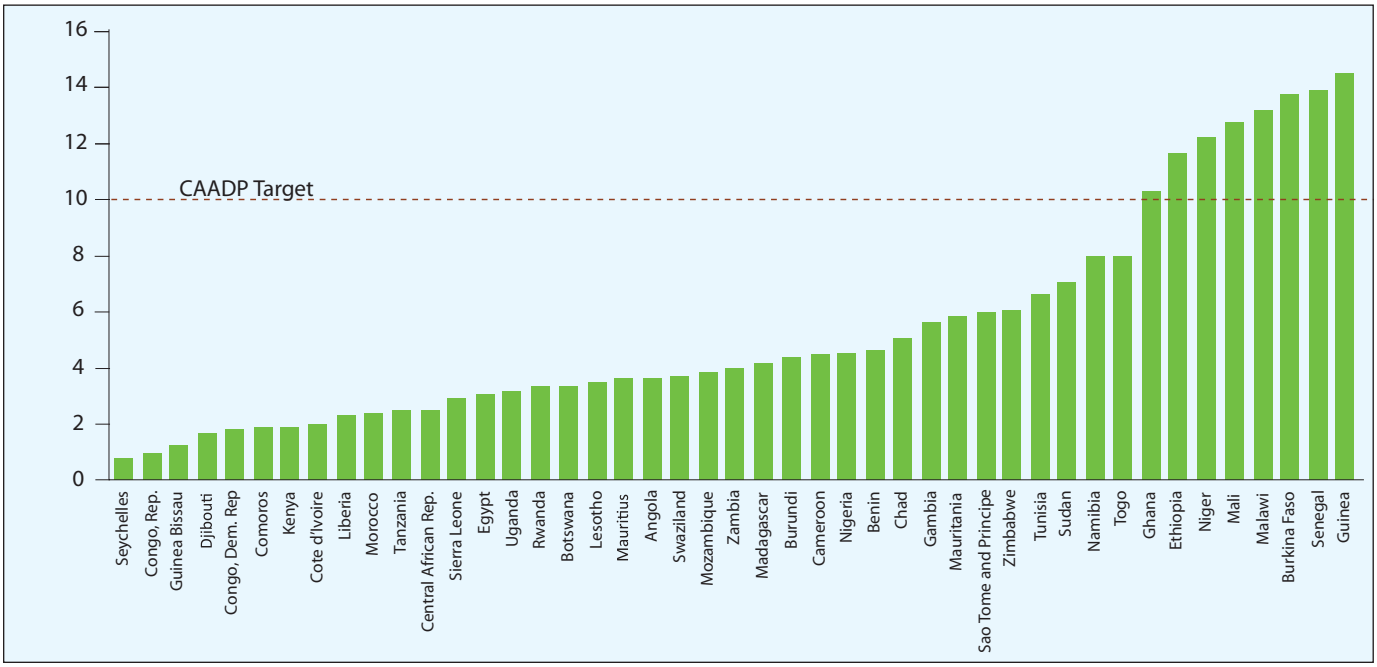
The Opportunities: *Reform water institutions; improve public-private partnerships; and improve the knowledge base through human capacity building.*

Faced with economic water scarcity, current institutional, financial and human capacities for managing water in Africa are lacking. For example, there has been inadequate implementation of the 2003 Comprehensive Africa Agriculture Development Programme (CAADP), the Africa-owned and Africa-led initiative to boost agricultural production through irrigation and water management, among other measures. In 2003, member countries made a commitment to spend ten per cent of their total national expenditures on agriculture, but by 2008, only a handful of countries had implemented their promises (Figure 21).

There is generally a lack of data, which is related to financing but is also due to the underdeveloped human capacity for research, collection, assessment and dissemination of water resources data, and a lack of motivation and retention of skilled staff. This is especially evident in the deficiency of climate change data on Africa, as identified in the G8 Gleneagles plan of action (2005), which is still relevant.

The matter of data and information deficiency is also highlighted in the Africa Water Vision 2025, which remarks on the failure to invest adequately in resource assessment, protection and development. The opportunities for addressing this challenge include reforming water institutions, improving public-private partnerships and expanding the knowledge base through human capacity building. These will help to attain the Vision for 2025 in which water is financed and priced to promote equity, efficiency and sustainability. These and other actions were highlighted in the AMCOW Ministerial Declaration on "Accelerating Water Security

Figure 21: Agricultural expenditures as percentage of total expenditures by CAADP member country, 2008



for Africa's Socio-Economic Development" in Tunis in 2008 and in the 2008 Ministerial Meeting on Water for Agriculture and Energy at Sirte.

The countries of Africa recognize the need to implement Integrated Water Resources Management to strengthen water security. For example, the 2008 AMCOW declaration calls upon the African Regional Economic Communities to develop and strengthen appropriate regional instruments on integrated water resources management and to strengthen regional Centres of Excellence and networks for agriculture, hydropower generation, water management, climate change, desertification, drought, floods and environmental management. ANBO also supports IWRM and its Johannesburg Declaration of 2007 commits to engaging governments, basin organizations and development partners in Africa to support the IWRM process in each country and their respective water basins.

Synthesis

Although these nine challenges and opportunities are presented as discrete issues, there is a multitude of links among them. For example, actions to address the water-related MDGs in Challenges 1 and 2 by better managing municipal water for potable water supplies and sanitation will help to address point-source pollution and land degradation, topics covered in Challenge 7 and to prepare for a potential rise in flooding events due to climate change, highlighted in Challenge 8. As well, the constraints facing many issues are the same. They are the main drivers of poor performance in the water sector and include rapid peri-urban growth, increased demand for water, declining aquifers, distorted water pricing, conflict among different sectors and users, poverty and weak water-services management, among others. The water profiles of each of Africa's 53 countries underscore these constraints at the national level.



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Country water profiles

Although Africa as a whole faces distinct water challenges and there are specific regional and transboundary water issues, each country is unique in terms of water availability, use and human access (Table 1). The country water profiles identify and discuss two of the most important water issues in each nation and summarize progress toward the MDG water targets. The MDG summaries frequently highlight the difference between water and sanitation provision in urban versus rural areas. Generally, the greatest challenges in attaining the targets are not environmentally deterministic; rather, they have to do with political unrest and conflicts that have damaged water and sanitation resources or prevented their development; the influx of people to burgeoning cities and slums; and a lack of resources to support water-management capacity or simply weak management. The following table, organized by region, provides a snapshot of each country's most salient water issue, the proportion of the population using improved water and sanitation facilities as well as data on per capita renewable water. Note the difference between the international water scarcity threshold of 1 000 m^3/inhab/yr and the values for each country. Those that fall below this threshold include Algeria, Egypt, Libya, Morocco, Tunisia, Djibouti, Kenya, Rwanda, Burkina Faso and Cap Verde.

The countries where less than half of the population uses improved drinking water sources include Ethiopia, Democratic Republic of the Congo, Equatorial Guinea, Niger, Sierra Leone, Mozambique and Madagascar. Finally, in 35 of the 53 countries, less than half the population has access to improved sanitation; in 17 countries, less than a quarter of people have such access; and the proportion in Chad and Niger is below 10 per cent.



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Table 1: Summary of country water profiles

Country	Per capita total renewable water, actual: m^3/inhab/yr, latest data available (Note: International water scarcity threshold is 1 000 m^3/inhab/yr)	Proportion of total population using improved drinking water sources, percentage, (2008 or latest available data)	Proportion of total population using improved sanitation facilities, percentage, (2008 or latest available data)	Major water issues
Northern Africa				
Algeria	339.5	83	95	• Industrial water pollution • Water scarcity
Egypt	702.8	99	94	• Vulnerability of the Nile Delta to sea-level rise • Water pollution
Libya	95.3	54	97	• Water scarcity and virtual water • Urbanization and water pollution
Morocco	917.5	81	69	• Urban wastewater • Salinity of water resources
Sudan	1 560	57	34	• Water-related disease • Groundwater contamination from sewage
Tunisia	451.9	94	85	• Unsustainable exploitation of aquifers • Coastal water pollution
Eastern Africa				
Burundi	1 553	72	46	• Degradation of wetland ecosystems • Industrial water pollution
Djibouti	353.4	92	56	• Climate-change impacts on water availability • Drought and food security
Eritrea	1 279	61	14	• Water stress and food security • Use of improved sanitation facilities
Ethiopia	1 512	38	12	• Rural water and sanitation infrastructure • Drought and food security
Kenya	792	59	31	• Endemic droughts and water scarcity • Waste management issues and implications for water quality
Rwanda	977.3	65	54	• Water pollution • Wetland degradation
Somalia	1 647	30	23	• Civil unrest and water access • Impacts of extreme climate on water supply
Uganda	2 085	67	48	• Drought • Sanitation access in Kampala
Central Africa				
Cameroon	14 957	74	47	• Hydropower capacity and drought vulnerability • Rural water access
Central African Republic	33 280	67	34	• Civil unrest affecting water access • Riverine ecosystem degradation from mining activities

Chad	3 940	50	9	• Drought and food security • Water related diseases
Republic of the Congo	230 152	71	30	• Population and civil unrest strain the water supply • Impacts of stagnant water and polluted rivers on health
Democratic Republic of the Congo	19 967	46	23	• Displacement and potable water access in Eastern DRC • Water transportation
Equatorial Guinea	39 454	43	51	• Water access • Water pollution from oil production
Gabon	113 260	87	33	• Urban water access and pollution • Water Contamination from logging activities
São Tomé and Príncipe	13 625	89	26	• Water pollution • Access to sanitation
Western Africa				
Benin	3 047	75	12	• Sand mining • Flood risk
Burkina Faso	820.5	76	11	• Climate variability and water scarcity • Public health concerns due to extensive dam construction
Cape Verde	601.2	84	54	• Unsustainable exploitation of aquifers • Water scarcity and rainwater harvesting
Côte d'Ivoire	3 941	80	23	• Threats to aquaculture production from sea-level rise • Water shortages in Abidjan
Gambia	4 819	92	67	• Wetland degradation • Salt-water intrusion
Ghana	2 278	82	13	• Degradation of the Lake Volta ecosystem • Access to sanitation
Guinea	22 984	71	19	• Taking advantage of hydropower potential • PCB contamination in Conakry
Guinea-Bissau	19 683	61	21	• Contaminated water supplies in Bissau • Saltwater intrusion
Liberia	61 165	68	17	• Slums and access to sanitation facilities in Monrovia • Water pollution from rubber plantations
Mali	7 870	56	36	• Drought, desertifi cation and the restoration of Lake Faguibine • Water-related disease
Mauritania	3 546	49	26	• Water pollution • Mining impacts on the Senegal River
Niger	2 288	48	9	• Access to water and sanitation • Water scarcity and food security
Nigeria	1 893	58	32	• Degradation of the Hadejia-Nguru Wetlands • Oil pollution in the Niger Delta

Senegal	3 177	69	51	• Public health impacts of dams along the Senegal River • Industrial pollution of Hann Bay
Sierra Leone	28 777	49	13	• Hydroelectric power potential • Rural water and sanitation access
Togo	2 276	60	12	• Threats from sea-level rise • Low access to sanitation facilities
Southern Africa				
Angola	8 213	50	57	• Under-developed irrigation potential • Water pollution from unplanned settlements
Botswana	6 372	95	60	• Water availability in the Okavango Delta • Desertification from drought and overgrazing
Lesotho	1 475	85	29	• Water scarcity • Industrial water pollution
Malawi	1 164	80	56	• Water-related constraints on agricultural production • Fisheries management
Mozambique	9 699	47	31	• Urban and rural water and sanitation challenges • Food shortages from drought and flood events
Namibia	8 319	92	33	• Water scarcity • Access to improved sanitation
South Africa	1 007	91	77	• Water supply shortage • Distribution of water rights
Swaziland	3 861	69	55	• Responding to natural disasters • Water rationing
Tanzania	2 266	54	24	• Lack of water and sanitation infrastructure in unplanned settlements • Wetland loss
Zambia	8 336	60	49	• Altered flood regime in the Kafue River • Water quality implications of copper mining
Zimbabwe	2 558	82	44	• Water-related diseases • Water scarcity affects agricultural water use
Western Indian Ocean Islands				
Comoros	1 412	95	36	• Water contamination from volcanic eruptions • Climate-change impacts on water resources
Madagascar	17 634	41	11	• Drought in southern Madagascar • Water and sanitation access
Mauritius	2 149	99	91	• Water pollution • Drought
Seychelles	No data	100	97	• Water availability and storage • Climate-change impacts

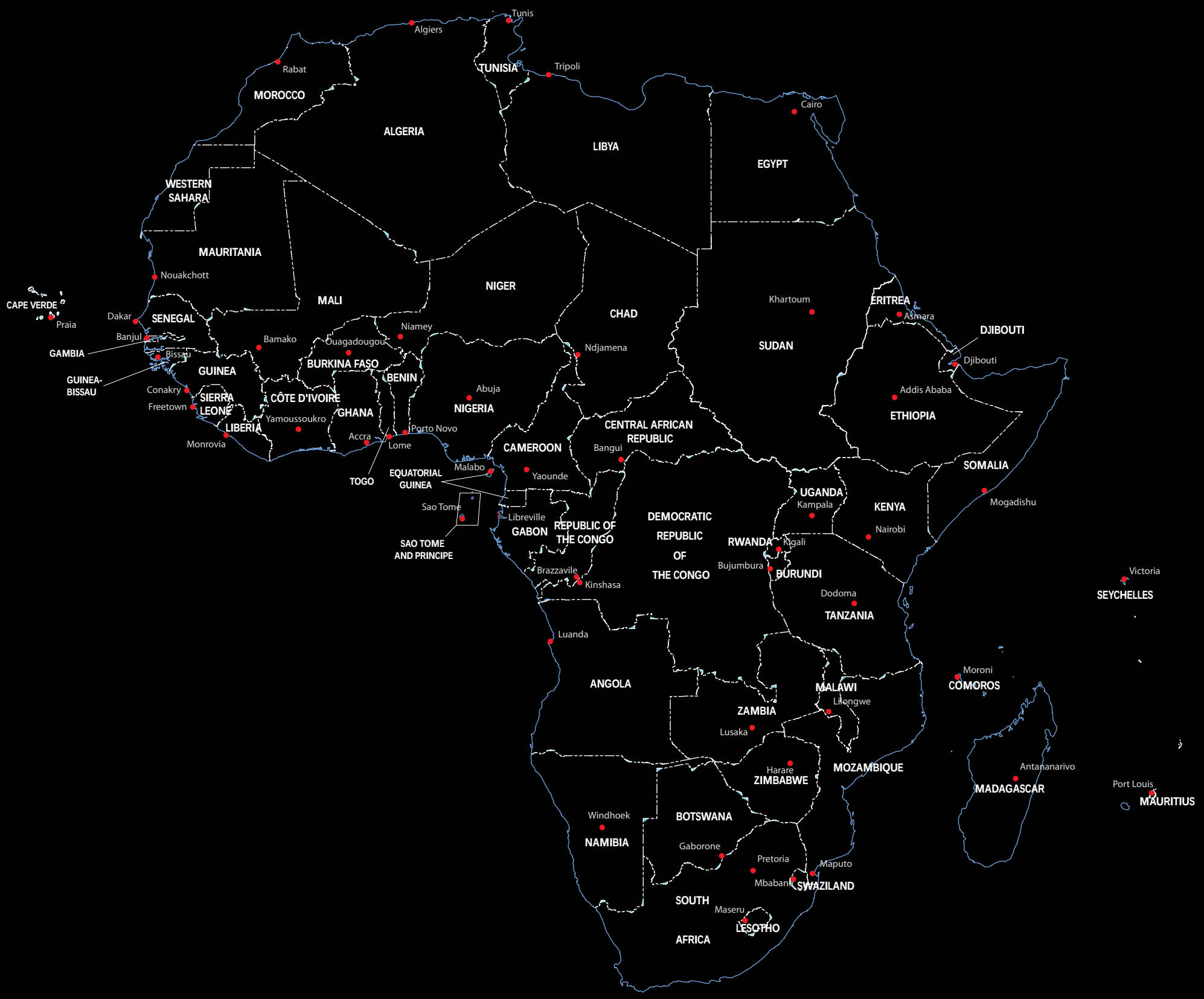
Opportunities for action

The *Africa Water Atlas* makes a major contribution to the state of knowledge about water in Africa by bringing together information about water issues in each country and summarizing the state of their progress towards the MDG water targets, synthesizing water issues by looking at them from the perspective of challenges and opportunities and providing distinctive profiles of transboundary water basins. It also provides a unique map of hotspots and hopespots. Importantly, it includes the first map of water balance in Africa.

This summary for decision makers links the challenges and opportunities highlighted in the Atlas to important declarations related to improving access to water made by governments and leaders in Africa, reinforcing the need for action. The following is a synthesis of the main opportunities for action that support those commitments:

- Improve urban planning, especially for water services, and target informal settlements;
- Encourage simple entrepreneurial technologies and solutions to safe water and sanitation provision, adaptation to climate change (including water harvesting) and more efficient irrigation;
- Build on water as a binding factor between potentially hostile users of common water resources;
- Increase irrigation and hydropower capacity in a sustainable fashion;
- Promote a "greener" version of the Green Revolution, especially through Integrated Water Resources Management and targeted breeding of drought-tolerant varieties;
- Reform water institutions, rationalize water pricing, improve monitoring and assessment and create and improve public-private partnerships;
- Protect Africa's water towers; and
- Expand the knowledge base about water issues through human capacity building and increased funding.


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SOMALIA
Malabo
TOGO
EQUATORIAL GUINEA
Yaounde
UGANDA
Kampala
Mogadishu
Sao Tome
KENYA
Libreville
Nairobi
GABON
REPUBLIC OF THE CONGO
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
Kigali
SAO TOME AND PRINCIPE
Bujumbura
Brazzavile
BURUNDI
Kinshasa
Victoria
SEYCHELLES
Dodoma
TANZANIA
Luanda
Moroni
COMOROS
ANGOLA
MALAWI
Lilongwe
ZAMBIA
Lusaka
Antananarivo
Harare
MOZAMBIQUE
MADAGASCAR
Port Louis
ZIMBABWE
MAURITIUS
Windhoek
BOTSWANA
NAMIBIA
Gaborone
Pretoria
Maputo
Mbabane
SWAZILAND
SOUTH
Maseru
LESOTHO
AFRICA