

# Irrigation in Africa in figures

AQUASTAT Survey – 2005



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AQUASTAT Survey – 2005

FAO  
WATER  
REPORTS

29

Edited by

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FAO Land and Water Development Division

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# Country profiles (available on the attached CD-ROM)

The country profiles were prepared in the FAO official language of each country, either English (E) or French (F) (except Equatorial Guinea where FAO's official language is Spanish, but which was prepared in French), and they are presented in this language, as are the related tables and figures

Algeria (F)	Libyan Arab Jamahiriya (E)
Angola (F)	Madagascar (F)
Benin (F)	Malawi (E)
Botswana (E)	Mali (F)
Burkina Faso (F)	Mauritania (F)
Burundi (F)	Mauritius (E)
Cameroon (F)	Morocco (F)
Cape Verde (F)	Mozambique (E)
Central African Republic (F)	Namibia (E)
Chad (F)	Niger (F)
Comoros (F)	Nigeria (E)
Congo (F)	Rwanda (F)
Côte d'Ivoire (F)	Sao Tome and Principe (F)
Democratic Republic of the Congo (F)	Senegal (F)
Djibouti (F)	Seychelles (E)
Egypt (E)	Sierra Leone (E)
Equatorial Guinea (F)	Somalia (E)
Eritrea (E)	South Africa (E)
Ethiopia (E)	Sudan (E)
Gabon (F)	Swaziland (E)
Gambia (E)	Togo (F)
Ghana (E)	Tunisia (F)
Guinea (F)	Uganda (E)
Guinea-Bissau (F)	United Republic of Tanzania (E)
Kenya (E)	Zambia (E)
Lesotho (E)	Zimbabwe (E)
Liberia (E)	

## System requirements to use the CD-ROM:

- PC with Intel Pentium® processor and Microsoft® Windows 95/98/2000/Me/NT/XP
- 64 MB of RAM
- 50 MB of available hard-disk space
- Adobe Acrobat® Reader (included on the CD-ROM)



# Units

## Length

1 km = 1 000 m =  $1 \times 10^3$  m

1 mile = 1.56 km = 1 560 m

## Area

1 acre = 4 047 m<sup>2</sup> = 0.4047 ha =  $4.047 \times 10^{-4} \times 1\,000$  ha

1 are = 100 m<sup>2</sup> = 0.01 ha =  $1 \times 10^{-5} \times 1\,000$  ha

1 feddan = 4 200 m<sup>2</sup> = 0.42 ha =  $4.2 \times 10^{-4} \times 1\,000$  ha

1 ha = 10 000 m<sup>2</sup>

1 km<sup>2</sup> = 1 000 000 m<sup>2</sup> = 100 ha =  $1 \times 10^{-1} \times 1\,000$  ha

1 m<sup>2</sup> = 0.0001 ha =  $1 \times 10^{-7} \times 1\,000$  ha

## Volume

1 dm<sup>3</sup> = 1 litre = 0.001 m<sup>3</sup> =  $1 \times 10^{-12}$  km<sup>3</sup>

1 hm<sup>3</sup> = 1 million m<sup>3</sup> = 1 000 000 m<sup>3</sup> =  $1 \times 10^{-3}$  km<sup>3</sup>

1 km<sup>3</sup> = 1 billion m<sup>3</sup> =  $10^9$  m<sup>3</sup>

1 m<sup>3</sup> =  $10^{-9}$  km<sup>3</sup>

1 UK gallon = 4.546 dm<sup>3</sup> = 0.004546 m<sup>3</sup> =  $4.546 \times 10^{-12}$  km<sup>3</sup>

1 US gallon = 3.785 dm<sup>3</sup> = 0.003785 m<sup>3</sup> =  $3.785 \times 10^{-12}$  km<sup>3</sup>

## Power-energy

1 GW =  $1 \times 10^3$  MW =  $1 \times 10^6$  kW =  $1 \times 10^9$  W

1 GWh =  $1 \times 10^3$  MWh =  $1 \times 10^6$  kWh

US\$1 = 1 United States Dollar

1 °C = 1 degree centigrade

The information presented in this publication is collected from a variety of sources. It reflects FAO's best estimates, based on the most accurate and up-to-date information available at the date of printing.

# Foreword

Sustainable social and economic development in Africa is linked intimately to the development of its agriculture sector, on which more than 60 percent of its population and 80 percent of its poor depend. However, Africa continues to show a low level of investments in basic infrastructure, including irrigation. Public investment in agricultural water development in sub-Saharan Africa has even declined in the past two decades. While there may be several reasons for this decline, it is thought to be mainly the consequence of concerns over the disappointing performance of past investments in terms of returns and sustainability.

In recent years, substantial changes have taken place in the region, and the need has emerged for renewed attention to agriculture and the rural sector. The New Partnership for Africa's Development (NEPAD) has identified water control as the first pillar to sustain development in the context of the Comprehensive Africa Agriculture Development Programme (CAADP). Recent initiatives, including the Commission for Africa and the Water Facilities of the African Development Bank and the European Union, call for increased investment in rural water management. The World Bank rural development strategy also calls for re-engaging in water management in rural areas, including irrigation and drainage.

All these initiatives require a good understanding of the state, trends and challenges facing water management for agriculture in the countries of Africa. In 1993, FAO initiated the AQUASTAT Programme, its global information system on water and agriculture. It collects, analyses and disseminates data and information by country in order to provide readers with the most accurate, reliable, consistent and up-to-date information available on water resources and agricultural water management.

This report presents the most recent information available on water availability and its use on the African continent, with an emphasis on agricultural water use and management. It analyses the changes that have occurred since the first survey in 1995. The CD-ROM accompanying this report contains detailed profiles on the situation in each of the 53 countries of the African continent.

We hope that this publication will contribute to a better understanding of the conditions of irrigation in Africa and to well-informed decision-making in the field of water for agriculture.



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## List of abbreviations

AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ARWR	Actual renewable water resources
CAAPD	Comprehensive Africa Agriculture Development Programme
CEPGL	Economic Community of the Great Lakes Countries
CILSS	Comité permanent inter états de lutte contre la sécheresse dans le Sahel
EC	European Commission
ERWR	External renewable water resources
ETP	Evapotranspiration
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GNI	Gross National Income
GWP	Global Water Partnership
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
ICLD	International Commission on Large Dams
IFAD	International Fund for Agricultural Development
IRWR	Internal renewable water resources
IUCN	International Union for the Conservation of Nature
IVB	Inland valley bottom
IWRM	Integrated water resources management
JMP	Joint Monitoring Programme
KBO	Organization for the management and development of the Kagera River Basin (Kagera Basin Organization)
LBPTC	Limpopo Basin Permanent Technical Commission
LCBC	Lake Chad Basin Commission
LDC	Least developed countries
LHWP	Lesotho Highlands Water Project
LIMCOM	Limpopo Basin Commission
NBA	Niger Basin Authority
NBI	Nile Basin Initiative
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
Nile COM	Council of Ministers of Water Affairs of the Nile Basin States
O & M	Operation and maintenance
OKACOM	Okavango River Basin Water Commission
OMVS	Organization for the Development of the Senegal River

ORASECOM	Orange-Senqu River Commission
PIM	Participatory irrigation management
PRSP	Poverty Reduction Strategy Paper
SADC	Southern African Development Community
SOGREAH	Société grenobloise d'études et d'applications hydrauliques
SPFS	Special Programme for Food Security of FAO
SSA	Sub-Saharan Africa
TRWR	Total renewable water resources
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
VBTC	Volta Basin Technical Committee
WDI	World development indicator
WFP	World Food Programme
WHO	World Health Organization
WUA	Water users' association
ZAMCOM	Zambezi Watercourse Commission
ZRA	Zambezi River Authority

# Presentation of the study

In 1993, FAO launched a programme known as AQUASTAT, its global information system on water and agriculture (<http://www.fao.org/ag/aquastat>). AQUASTAT supports the sustainable use of water in agriculture and rural development by: (i) developing systematic descriptions on water resources and agricultural water management by country and by region; (ii) providing the most up-to-date and reliable data available by country; (iii) predicting future agricultural water use and irrigation developments; (iv) providing deeper insight on specific issues through thematic studies; (v) developing methodologies for country water resource calculations and definitions; (vi) collaborating with other development organizations and institutes; (vii) answering requests from governments, research institutes, universities, individuals, etc.

One of the main missions of AQUASTAT is to collect information on a national and provincial scale and to disseminate it in a standardized format to readers interested in acquiring a global, regional or national perspective on water resources and agriculture. At the time of its launch, priority was given to Africa, which initiated the AQUASTAT publication series (FAO, 1995). The survey continued with the Near East (FAO, 1997a), the countries of the former Soviet Union (FAO, 1997b), South and East Asia (FAO, 1999), and, finally, Latin America and the Caribbean (FAO, 2000).

Ten years after the first publication on Africa, it appeared necessary to update the data and to identify the main changes in water use and irrigation that had occurred on the African continent. To the two objectives of the previous publications a third was added in this new survey of the 53 countries in Africa:

- to provide for every country the most accurate status of rural water resources management, with a special focus on irrigation, by featuring major characteristics, trends, constraints and prospective changes on irrigation and on water resources;
- to support continental and regional analyses by providing systematic, up-to-date and reliable information on the status of water resources and of agricultural water management that can serve as a tool for regional planning and predictive studies;
- to prepare a series of chronological data in order to highlight the major changes that have occurred in the last decade on national, regional and continental scales.

To obtain the most reliable information possible, the survey was organized as follows:

1. Overview of the bibliography and of the existing information at country level.
2. Collection of information by country using a detailed questionnaire filled in by national consultants, international consultants, or the AQUASTAT team at FAO.
3. Compilation and critical analysis of the information collected using data-processing software developed for this specific survey, and selection of the most reliable information.
4. Preparation of country profiles and submission to national authorities responsible for water resources or water management for verification, correction and approval.
5. Preparation of the final profile, the tables and the figures presenting the information by country.

6. Updating the on-line database.
7. Preparation of the general regional analysis, the figures and the regional tables.

Where possible, AQUASTAT made use of national capacity and competence. While collecting the information by country, preference was given to national consultants as they have a better knowledge of their own country and easier access to national documents. The choice of the countries for which a national consultant was recruited depended on several factors, namely: the importance of irrigation in the country; the availability of an expert; the scarcity of data observed during the previous survey; and the funds available. For about half of the countries concerned, a national consultant assisted the AQUASTAT team.

### COUNTRY PROFILES

Country profiles were prepared in the FAO official language of each country (except Equatorial Guinea, which was prepared in French), and they are presented in this language, as are the related tables and figures. Only the regional general summary and its illustrations (figures and summary tables) are presented in both English and French.

The country profiles are available on the CD-ROM that accompanies this report. They describe the state of water resources and water use in the respective country, as well as the state of agricultural water management. The aims are to describe the particularities of each country and the problems met in the development of the water resources and, in particular, irrigation. They summarize the irrigation trends in the country and the perspectives for water management in agriculture as described in the literature. The country profiles have been standardized and organized in sections according to the following model:

- geography, climate and population;
- economy, agriculture and food security;
- water resources and water use;
- irrigation and drainage development;
- water management, policies and legislation related to water use in agriculture;
- environment and health;
- perspectives for agricultural water management;
- references and additional information.

Standardized tables were used for each country. A hyphen (-) indicates that no information was available. As most information is available only for a limited number of years, the tables present the most recent reliable information and indicate the year to which it refers.

### DATA COLLECTION, PROCESSING AND RELIABILITY

The main sources of information were:

- national policies, and water resources and irrigation master plans;
- national reports, yearbooks and statistics;
- reports from FAO and other projects;
- international surveys;
- results and publications from national and international research centres;
- the Internet.

Furthermore, the following sources systematically provide certain data:

- FAOSTAT (<http://faostat.external.fao.org/>). This was the only source used for variables of area (total, arable and permanent crops) and population (total, rural, urban, female, male, and economically active). FAOSTAT data are provided every year by the countries through the FAO representations.
- World Development Indicators (<http://www.worldbank.org/data/>). This database is the World Bank's premier annual compilation of data on

development. This source provided the data on gross domestic product (GDP) and per-capita GDP.

- The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) (<http://www.unicef.org/statis/index.html>). These organizations provided data on access to improved water sources under their Joint Monitoring Programme (JMP).
- The United Nations Development Programme (UNDP) (<http://hdr.undp.org/statistics/data/>). The UNDP provided the Human Development Index (HDI).

In total, more than 50 variables were selected and these are presented in the national tables attached to the country profiles. They are ordered in categories corresponding to the various sections of the country profiles: characteristics of the country and population; water: resources and use; and irrigation and drainage. A detailed description of each variable is given below. Additional tables were added to the country profiles where information was available, especially in order to specify regional or river basin data.

In most cases, a critical analysis of the information was required in order to ensure the general coherence of information collected for a given country. Where several sources resulted in divergent or contradictory information, preference was given to information collected at the country or provincial levels rather than at regional or world levels. Moreover, except in the case of evident errors, official sources were privileged. As regards shared water resources, the comparison of information between countries made it possible to verify and complete the data concerning the flows of transboundary rivers and to ensure coherence at a river basin level.

In spite of these precautions, the accuracy, reliability and frequency with which information is collected vary considerably according to the region, the country and the category of information. These considerations are discussed in the country profiles.

On a continental scale, data for certain variables (cultivable area, irrigation techniques, origin of water for irrigation, and irrigated crops) were too incomplete to allow a regional analysis. Indeed, for several countries, it was difficult, even impossible, to obtain new data. At the end of the 1980s and at the beginning of the 1990s, many African countries had prepared water resources and irrigation master plans, which facilitated data gathering during the previous survey. However, few of these countries have updated their data since then. Estimations based on the field knowledge of the AQUASTAT team and the Land and Water Development Division of FAO were then used to complete the regional analysis, especially those sections concerning cultivable area, irrigation techniques and origin of water. Thus, it is not always possible to explain the differences between the two AQUASTAT surveys.

Data concerning areas under water management may have undergone significant changes in the last ten years because of re-adjustments to equipped or non-equipped areas that are no longer cultivated. Indeed, available information about irrigated areas and areas under water management is more reliable than in the previous survey. This is because of the availability of the previous reference, which allowed comparison with new data. Thus, conclusions about the evolution of irrigation methods can reflect current trends on the ground and/or better knowledge of the variables involved.

The regional analysis tables show the period 1994–2004 as the period between the two surveys. The AQUASTAT team justifies this choice by virtue of the slow evolution of data for different years for each country. However, should more precision be required, the summary tables and the on-line database specify the exact year for the items of national data.

## **CONTENT OF THIS DOCUMENT AND OF THE CD-ROM**

The information in the country profiles is much more detailed than that in the first AQUASTAT survey. In order to establish a more complete picture of the agricultural



water sector in each country, it addresses issues related to water and to irrigation that were not previously included. Some issues have been added in response to user demand. Because of the considerable volume of information now available, the present printed document consists of only the presentation of the study and the regional general summary for Africa, illustrated with summary tables and continental figures. The CD-ROM contains the whole document and the profiles of the 53 African countries, matched with summary tables. Finally, the document is also available on the Web site of the Land and Water Development Division (AGL) of FAO (<http://www.fao.org/landandwater>) and that of AQUASTAT (<http://www.fao.org/ag/aquastat>). The latter site also allows access to the AQUASTAT database.

### **GLOSSARY OF TERMS USED IN THIS STUDY**

The following definitions have been used for the variables presented in the country profiles, the tables and the database.

#### *Access to improved drinking water sources (%)*

Figures provided by WHO/UNICEF. According to their definition, it refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source such as a household connection, public stand-pipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 litres/person per day from a source within one kilometre of the dwelling.

#### *Actually irrigated area as % of the total area equipped (%)*

That part of the area equipped for irrigation, which is actually irrigated, in a given year. Often, part of the equipped area is not irrigated for various reasons such as lack of water, absence of farmers, land degradation, damage and organizational problems. It only refers to physical areas. Irrigated land that is cultivated twice a year is counted once.

#### *Agricultural drainage water (km<sup>3</sup>/year)*

This is water withdrawn for agriculture but not consumed and returned. It does not go through special treatment and therefore should be distinguished from reused wastewater.

#### *Annual crops (ha)*

Area of land under temporary (annual) crops, which are crops with a growing season lasting between several months and about one year and which need to be re-sown or replanted after each harvest, such as cereals and vegetables.

#### *Arable land (ha)*

The official FAO definition of arable land is “land under temporary crops (double-cropped areas are counted only once) + temporary meadows for mowing or pasture + land under market and kitchen gardens + land temporarily fallow (less than five years).” The abandoned land resulting from shifting cultivation is not included in this category. Data for “arable land” are not meant to indicate the amount of land that is potentially cultivable.

#### *Area of the country (ha)*

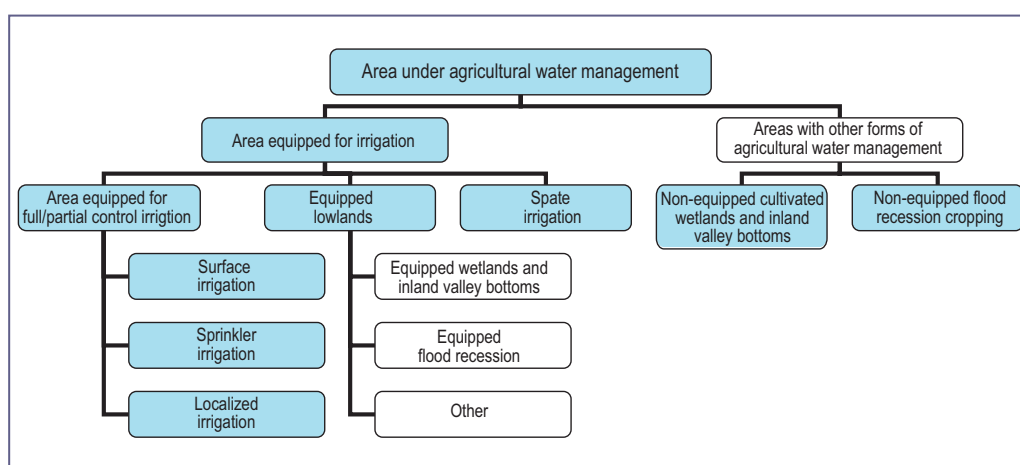
Total area of the country, including inland water. It is thus greater than or equal to the total land area of the country.

### *Area equipped for irrigation: total (ha)*

Area equipped to provide water to crops. It includes areas equipped for full control irrigation, equipped lowland areas, and areas equipped for spate irrigation. It does not include non-equipped cultivated wetlands and inland valley bottoms or non-equipped flood recession cropping areas. In the text the expression “area equipped for irrigation” is used sometimes and the expression “irrigated area” is also sometimes used.

### *Area under agricultural water management (ha)*

This is the sum of the total area equipped for irrigation and areas with other forms of agricultural water management (non-equipped). The classification adopted by AQUASTAT is presented in the following diagram and an explanation of each of the variables is given below.



### *Average annual increase of the area equipped for irrigation (%)*

This increase is calculated with the following formula:  $\text{new area} = (1+i)^n \times \text{old area}$ , where “n” is the number of years in the period considered between the two AQUASTAT surveys and “i” the average annual increase. The percentage is equal to  $(100 \times i)$ .

### *Cropping intensity: irrigated area (%)*

The number of times the same area is cropped in one year (referring to area equipped for full/partial control irrigation). If available, the area effectively irrigated is used for the calculation of cropping intensity. If not available, the equipped area is used. The calculation only refers to irrigated crops. This means that in a country with one or two wet seasons only the crops grown under irrigation are taken into consideration. The crops grown on the full/partial control equipped area during the wet season without irrigation (but using the residual soil humidity) are not included in the irrigated crop area when calculating cropping intensity.

### *Cultivable area (ha)*

Area of land potentially fit for cultivation. This term may or may not include part or all of the forests and rangeland. Assumptions made in assessing cultivable land vary from country to country. In this survey, national figures have been used whenever available, despite possible large discrepancies in computation methods.

### *Cultivated area (ha)*

Area under temporary (annual) and permanent crops. This refers to the physical area actually cultivated and does not include land which is temporarily fallow.

***Dam capacity (km<sup>3</sup>)***

Total cumulative capacity of large dams expressed in km<sup>3</sup> (10<sup>9</sup> m<sup>3</sup>) The capacity of the dams indicated here is the theoretical initial capacity; it does not change with time. The current dam capacity is the state of the dams at a given time that can be reduced by silting. A dam is a barrier constructed across a valley for impounding water or creating a reservoir. Dams are characterized by their purposes and the construction materials used. The International Commission on Large Dams classifies the dams according to the height (above 15 m) and the water volume stored. Every country, however, has its own definition of large dams.

***Dependency ratio (%)***

That part of the total renewable water resources originating outside the country. It is equal to 100x(ERWR/TRWR).

***Depletion of renewable groundwater resources: rate (km<sup>3</sup>/year)***

Annual amount of water withdrawn from renewable aquifers which is not replenished (average overexploitation of aquifers). When the action is continuous, it is a form of overdraft of rechargeable aquifers. Over a long period of time, there is a risk of depleting the aquifer when the abstraction exceeds the recharge.

***Desalinated water produced (million m<sup>3</sup>/year)***

Production of fresh water by desalination of brackish or salt water (estimated annually on the basis of the total capacity of water desalination installations).

***Drained area in area equipped for irrigation (ha)***

That part of the area equipped for irrigation where drainage is used as an instrument to control salinity, ponding and waterlogging. This refers mainly to the area equipped for surface irrigation and to equipped wetlands and inland valley bottoms.

***Drained area in non-irrigated area (ha)***

Area cultivated and not irrigated, where drainage is used to remove excess water from the land surface and/or the upper soil layer to make humid/wet land more productive.

***Drained area: total (ha)***

This is the sum of the area drained and equipped for irrigation and the non-irrigated area.

***Exploitable water resources: regular renewable surface water/groundwater (km<sup>3</sup>/year)***

Regular or permanent resources refer to the surface water or groundwater that is available for 90 percent of the time. In practice, it is equivalent to the low water flow of a river and the flow of groundwater that are often mixed. It includes the flow of groundwater not collected by watercourses flowing into the sea, enclosed lakes and areas of evaporation. It is the resource that is offered to withdrawal, diversion or groundwater extraction with a regular flow.

***Exploitable water resources: irregular renewable surface water (km<sup>3</sup>/year)***

Irregular resources are equivalent to the variable component of water resources (such as floods) and exceptional groundwater levels (flooding of karstic aquifers). It includes seasonal and inter-annual variations i.e. seasonal flow and/or flow during wet years. It is the flow that needs to be regulated (by dams for example).

***Exploitable water resources: total (km<sup>3</sup>/year)***

That part of the water resources considered to be available for development under specific technical, economic and environmental conditions. This figure considers factors such as the dependability of the flow, extractable groundwater, minimum flow required for environmental, social and non-consumptive use. It is also called manageable water resources or water development potential.

***Flood protection area (ha)***

Area of land protected by flood control structures.

***Flood recession cropping area: non-equipped but cultivated (ha)***

Areas along rivers where cultivation occurs in the areas exposed as floods recede and where nothing is done to retain the receding water. The special case of floating rice is included in this category.

***Fossil groundwater: abstraction (km<sup>3</sup>/year for a given period)***

Annual amount abstracted from deep aquifers with a very low rate of renewal (less than 1% per year) and so considered as non-renewable or “fossil”. Non-renewable resources are expressed normally as a volume of water (km<sup>3</sup>) since they are considered a primary mineral deposit, but they can exceptionally be referred to in terms of average flow over a set period of time, which depends on the programme of exploitation rather than the natural conditions.

***Full/partial control irrigation: area equipped for localized irrigation (ha)***

Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or adjacent to it. There are three main categories: drip irrigation (where drip emitters are used to apply water slowly to the soil surface), spray or micro-sprinkler irrigation (where water is sprayed onto the soil near individual plants or trees) and bubbler irrigation (where a small stream of water is applied to flood small basins or the soil adjacent to individual trees). To refer to localized irrigation, the following terms are also sometimes used: micro-irrigation, trickle irrigation, daily flow irrigation, drop-irrigation, sip irrigation and diurnal irrigation.

***Full/partial control irrigation: area equipped for sprinkler irrigation (ha)***

A sprinkler irrigation system consists of a pipe network through which water moves under pressure before being delivered to the crop via sprinkler nozzles. The system basically simulates rainfall in that water is applied through overhead spraying. Therefore, these systems are also known as overhead irrigation systems.

***Full/partial control irrigation: area equipped for surface irrigation (ha)***

Surface irrigation systems are based on the principle of moving water over the land by simple gravity in order to wet it, either partially or completely, before infiltration. They can be subdivided into furrow, borderstrip and basin irrigation (including submersion irrigation of rice). Surface irrigation does not refer to the method of transporting water from the source up to the field, which may be done by gravity or by pumping. Manual irrigation using buckets or watering cans should also be put here.

***Full/partial control irrigation: total area equipped (ha)***

This is the sum of surface irrigation, sprinkler irrigation and localized irrigation. The text uses indifferently the expressions “full control” and “full/partial control”.

***Full/partial control irrigation: area equipped irrigated by groundwater (ha)***

That part of the area equipped for full control irrigation, irrigated from wells (shallow wells and deep tube wells) or springs.

***Full/partial control irrigation: area equipped irrigated by surface water (ha)***

That part of the area equipped for full control irrigation, irrigated from rivers or lakes (reservoirs, pumping or diversion).

***Full/partial control irrigation: area equipped irrigated by mixed and other sources of water (ha)***

That part of the area irrigated from mixed surface water and groundwater or non-conventional sources of water such as drainage water, treated wastewater or desalinated water (however very rare in agriculture).

***Full/partial control irrigation: schemes (ha)***

Areas of irrigation schemes, usually classified as large, medium, and small schemes. Criteria used in this classification are given in the tables.

***Gross Domestic Product (GDP)***

Figures provided by the World Development Indicators (WDI), the World Bank's premier annual compilation of data about development (<http://www.worldbank.org/data/>). GDP is there defined as the sum of the value added in the agriculture, industry and services sectors. If the value added of these sectors is calculated at purchaser values, total value added is derived by subtracting net product taxes from GDP. Data are in constant 1995 US\$.

***Harvested irrigated crop area (ha)***

Total harvested irrigated area for the crop in the given year. It refers to crops cultivated under full control irrigation. Areas under double cropping should be counted twice. Total is indicated only if all irrigated crops have been taken into account and written previously.

***Households in irrigation***

Total number of households living directly on earnings from full or partial control irrigation.

***Human Development Index (HDI)***

Figures provided by UNDP (<http://hdr.undp.org/statistics/data/>). The HDI combines indicators for three dimensions of human development into one summary measure: (i) a long and healthy life measured by life expectancy at birth; (ii) knowledge, measured by the adult literacy rate and the combined gross enrolment ratio for primary, secondary and tertiary schools; and (iii) a decent standard of living measured by per capita GDP.

***Irrigated grain production: total (t)***

The total quantity of cereals harvested annually in the irrigated area. Several harvests per year on the same area are counted several times.

***Irrigation: total area (ha):***

See: Area equipped for irrigation: total (ha).

***Irrigation potential (ha)***

Area of land which is potentially irrigable. Country/regional studies assess this value according to different methods, for example some consider only land resources suitable

for irrigation, others consider land resources plus water availability, others include in their assessment economic aspects (such as distance and/or difference in elevation between the suitable land and the available water) or environmental aspects, etc. Whatever the case, it includes the area already under agricultural water management.

***Lowland areas: area equipped for irrigation (ha)***

These include:

- Cultivated wetlands and inland valley bottoms (IVB), which have been equipped with water control structures for irrigation and drainage (intake, canals, etc.).
- Areas along rivers, where cultivation occurs making use of water from receding floods and where structures have been built to retain the receding water.
- Developed mangroves for agriculture.

***Permanent crops (ha)***

Land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber; this category includes land under flowering shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber.

***Precipitation: average (mm/year and km<sup>3</sup>/year)***

Average over space and time of water falling on the country in a year (in height and in volume).

***Population: economically active population (inhabitants)***

This refers to the number of all employed and unemployed persons and includes those seeking work for the first time. It covers employers, self-employed workers, salaried employees, wage earners, unpaid workers assisting in a family farm or business operation, members of producers' cooperatives and members of the armed forces. The economically active population is also called the labour force.

***Population: economically active population in agriculture (inhabitants)***

That part of the economically active population engaged in or seeking work in agriculture, hunting, fishing or forestry.

***Population: total, urban, rural (inhabitants)***

According to the FAO definition, the total population usually refers to the present-in-area (de facto) population which includes all persons physically present within the present geographical boundaries of countries at the mid-point of the reference period.

***Population: urban, rural (inhabitants)***

Usually the urban area is defined and the remainder of the total population is defined as rural. In practice, the criteria adopted for distinguishing between urban and rural areas vary from country to country. However, these criteria can be roughly divided into three major groups: classification of localities of a certain size as urban; classification of administrative centres of minor civil divisions as urban; and classification of centres of minor civil divisions on a chosen criterion which may include type of local government, number of inhabitants or proportion of population engaged in agriculture. Thus, the urban and rural population estimates in this domain are based on the varying national definitions of urban areas.

***Population affected by water related diseases (inhabitants)***

That part of the total population suffering from water-related diseases. Water-borne diseases are those diseases arising from infected water and are transmitted when the

water is used for drinking or cooking (for example cholera, typhoid). It is to be distinguished from water-based and water-related insect vector diseases. Water-based diseases are those in which water provides the habitat for host organisms of parasites ingested (for example shistosomiasis or bilharzia). Water-related insect vector diseases are those in which insect vectors rely on water as habitat but transmission is not through direct contact with water (for example malaria, onchocerciasis or river blindness and elephantiasis).

***Power irrigated area as percentage of total area irrigated (%): (Lift irrigated areas)***

That part of the area equipped for irrigation, where pumps are used for water supply from the source to the scheme. It includes areas where water is drained out with human- or animal-driven water lifting devices.

***Renewable water resources: internal (km<sup>3</sup>/year)***

The internal renewable water resources (IRWR), is the average annual flow of rivers and recharge of aquifers generated from endogenous precipitation (resources produced in the territory). It is the sum of the internal surface water resources and internal groundwater resources minus the so-called “overlap”, which is the part common to both surface water and groundwater. A critical analysis of the data is necessary in order to avoid double counting of this base flow. The methodology used has been explained in Water Reports n° 23 “Review of world water resources by country”.

***Renewable water resources: external (km<sup>3</sup>/year)***

The external renewable water resources (ERWR), is that part of the country’s renewable water resources which is not generated within the country. It includes inflows from upstream countries (groundwater and surface water), and part of the water of border lakes or rivers.

***Renewable water resources: total (km<sup>3</sup>/year)***

The total renewable water resources (TRWR) is the sum of internal and external renewable water resources.

***Renewable water resources: total actual (km<sup>3</sup>)***

The total actual renewable water resources (TARWR) is the sum of internal and external renewable water resources, taking into consideration the quantity of flow reserved for upstream and downstream countries through formal or informal agreements or treaties and reduction of flow due to upstream consumption. Their computation refers to a given period and not to an inter-annual average.

***Return flow***

That part of the water used for agricultural, domestic or industrial purposes which is returned to rivers or aquifers after use.

***Safe yield (million m<sup>3</sup>)***

Amount of water (in general, the long-term average amount) which can be sustainably withdrawn from a groundwater basin or surface water system without causing undesirable results.

***Salinized area due to irrigation (ha)***

Total irrigated area affected by salinization. This does not include naturally saline areas. In general, each country has its own definition of a salinized area.

### *Soil and water conservation*

Soil and water conservation practices refer to measures that aim to control or prevent soil erosion or maintain its fertility.

### *Spate irrigation: area equipped for irrigation (ha)*

Spate irrigation can also be referred to as floodwater harvesting. It is a method of random irrigation using the floodwaters of a normally dry watercourse or riverbed (wadi). These systems are in general characterized by a very large catchment upstream (200 ha - 50 km<sup>2</sup>) with a “catchment area: cultivated area” ratio of 100:1 to 10 000:1. There are two types of floodwater harvesting or spate irrigation: 1) floodwater harvesting within streambeds, where turbulent channel flow is collected and spread through the wadi in which the crops are planted; cross-wadi dams are constructed with stones, earth, or both, often reinforced with gabions; 2) floodwater diversion, where the floods - or spates - from the seasonal rivers are diverted into adjacent embanked fields for direct application. A stone or concrete structure raises the water level within the wadi to be diverted to the nearby cropping areas.

### *Wastewater: produced volume (km<sup>3</sup>/year)*

Annual quantity of wastewater produced in the country. The origin can be domestic use (used water from bathing, toilets, cooking etc.) or industrial use. It does not include agricultural wastewater.

### *Wastewater: treated volume (km<sup>3</sup>/year)*

Quantity of produced wastewater that is treated in a given year and discharged from a treatment plant (effluent). Wastewater treatment is the process that renders wastewater fit to meet applicable environmental standards or other quality norms for recycling or reuse. Three broad types of treatment can be distinguished: primary, secondary and tertiary. Wastewater treatment does not include collection of sewage or storm waters, even when no treatment will be possible without collection.

### *Wastewater: treated and reused (km<sup>3</sup>/year)*

Annual quantity of treated wastewater, which is reused in a given year. This water can be reused either for domestic consumption or for irrigation.

### *Water harvesting area (ha)*

Areas where regular rainwater is collected and either directly applied to the cropped area and stored in the soil profile for immediate uptake by the crop (for example runoff farming) or stored in a water reservoir for future productive use (for example to be used for supplementary irrigation). Only roof water harvesting and runoff water harvesting (micro-catchment and macro-catchment) are considered in this section:

- Roof water harvesting is mainly used for domestic purposes and sometimes used as a water supply for family gardens.
- Micro-catchment water harvesting is characterized by a relatively small catchment area  $C$  ( $< 1\,000\text{ m}^2$ ) and cropping area  $CA$  ( $< 100\text{ m}^2$ ) with ratio  $C:CA = 1:1$  to  $10:1$ . The farmer usually has control over both the catchment area and the target area. These systems are used to irrigate single trees, fodder shrubs or annual crops. The construction is mainly manual. Examples are pits, semi-circular bunds, Negarim micro-catchment, eyebrow terrace, contour bench terrace, etc.
- Macro-catchment water harvesting collects water that flows over the ground as turbulent runoff and channel flow. These systems are characterized by a



large catchment area C ('external' catchment area of 1 000 m<sup>2</sup> – 200 ha), located outside the cultivated area CA, with a ratio C:CA = 10:1 to 100:1. The systems are mainly implemented for the production of annual crops. The construction is manual or mechanized. Examples are trapezoidal bunds, large semi-circular bunds, stone bunds, etc.

***Water managed area (ha)***

See: Area under agricultural water management

***Water withdrawal for agriculture (million m<sup>3</sup>/year)***

Annual quantity of water withdrawn for agricultural purposes. It includes irrigation and livestock watering. Methods for computing agricultural water withdrawal vary from country to country. Like domestic and industrial water withdrawals, it includes conveyance losses, consumptive use and return flow. It does not include water to be reserved for uses with a low consumption rate, such as navigation, recreation, mining, cooling of power plants, etc.

***Water withdrawal for livestock (million m<sup>3</sup>/year)***

Some countries include this in domestic water withdrawal, others in agricultural water withdrawal.

***Water withdrawal for domestic/municipal use (million m<sup>3</sup>/year)***

Annual quantity of water withdrawn for domestic/municipal purposes. It is usually computed as the total amount of water withdrawn by the public distribution network. It can include withdrawal by any industries connected to the network.

***Water withdrawal for industry (million m<sup>3</sup>/year)***

Usually, this sector refers to self-supplied industries not connected to any distribution network.

***Water withdrawal: total (million m<sup>3</sup>/year)***

Annual quantity of water withdrawn for agricultural, industrial and domestic purposes. It does not include other categories of water use, such as for cooling power plants, mining, recreation, navigation, fisheries, etc., which are sectors that are characterized by a very low net consumption rate.

***Waterlogged area due to irrigation (ha)***

That part of the land that is waterlogged because of irrigation. Irrigation contributes to the raising of the level of the aquifers. The non-saturated area of soils becomes too small and the soils are oversaturated with water. If recharge to groundwater is greater than natural drainage, additional drainage is necessary to avoid waterlogging.

***Waterlogged area not irrigated (ha)***

That part of the land in non-irrigated areas that is waterlogged.

***Wetlands and inland valley bottoms: non-equipped but cultivated (ha)***

Wetlands and inland valley bottoms (IVB) which have not been equipped with water control structures but are used for cropping when covered with water. They are often found in Africa. They will have limited (mostly traditional) arrangements to regulate water and control drainage.

## General summary

The 53 African countries have been grouped into seven regions based on geographical and climatic homogeneity, which has a direct influence on irrigation. These regions (Figure 5) and the countries they include are:

- Northern: Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, Tunisia;
- Sudano-Sahelian: Burkina Faso, Cape Verde, Chad, Djibouti, Eritrea, Gambia, Mali, Mauritania, Niger, Senegal, Somalia, Sudan;
- Gulf of Guinea: Benin, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone, Togo;
- Central: Angola, Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe;
- Eastern: Burundi, Ethiopia, Kenya, Rwanda, Uganda, United Republic of Tanzania;
- Southern: Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe;
- Indian Ocean Islands: Comoros, Madagascar, Mauritius, Seychelles.

They are identical to the regions in the previous report "Irrigation in Africa in figures" (FAO, 1995), which allows for comparison with the earlier data. This general summary presents distinguishing features arising from the new data collected on a national scale for issues addressed in the country profiles. The interest of this new survey lies both in the updating of data and in the trends in the last ten years.

### GEOGRAPHY, CLIMATE AND POPULATION

The total area of Africa is 30 million km<sup>2</sup>, or 22 percent of the world's emerged landmass. The five largest countries (Sudan, Algeria, Democratic Republic of the Congo, Libyan Arab Jamahiriya, and Chad in decreasing order) represent 34 percent of this territory, while the smallest five countries (all islands: Cape Verde, Comoros, Mauritius, Sao Tome and Principe, and Seychelles) constitute little more than 3 percent (Tables 1 and 22). The cultivated area is estimated at 211 million ha, or 27 percent of the cultivable land on the continent. The Sudano-Sahelian Region is the region with the greatest potential in terms of cultivable land, but only 19 percent of this is exploited compared with more than 40 percent in the Northern, Gulf of Guinea and Indian Ocean Islands Regions (Table 1).

The climate in Africa is influenced by the equator, by the two tropics, and by the two large deserts (the Sahara in the Northern Hemisphere, and the Kalahari in the

TABLE 1  
Regional distribution of cultivable and cultivated areas

Region	Cultivable areas (ha)	Cultivated areas in 2002	
		Area (ha)	In % of cultivable areas (%)
Northern	65 320 000	28 028 178	43
Sudano-Sahelian	208 256 000	38 764 012	19
Gulf of Guinea	119 860 000	54 964 000	46
Central	173 060 000	21 303 000	12
Eastern	82 853 400	30 869 000	37
Southern	113 678 650	32 950 000	29
Indian Ocean Islands	8 307 000	3 795 000	46
<b>Africa</b>	<b>771 335 050</b>	<b>210 673 190</b>	<b>27</b>

TABLE 2  
Regional distribution of area and of population

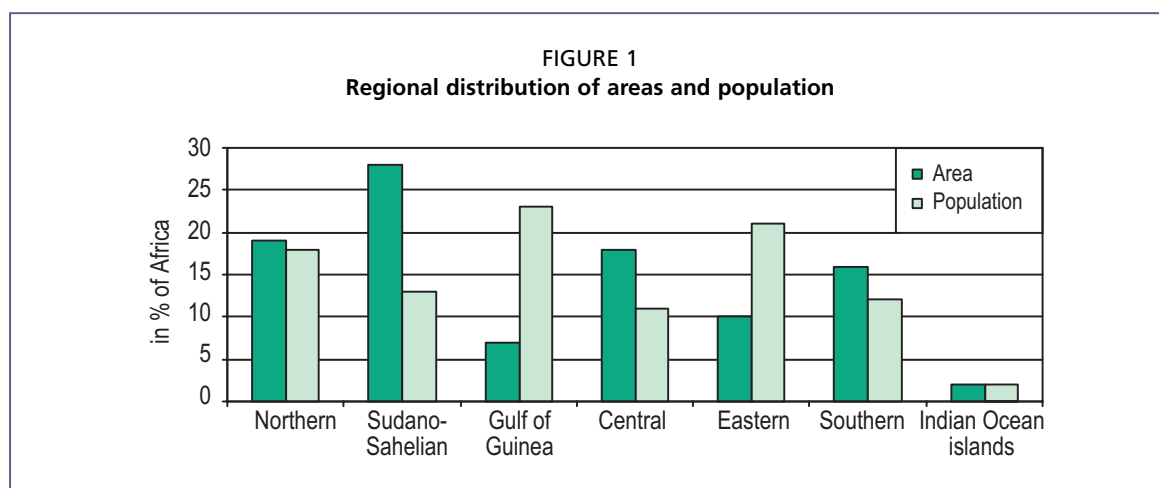
Region	Area		Population 2004				
	km <sup>2</sup>	% of Africa	Population (million)	% of Africa	% living in rural areas	density (inhab./km <sup>2</sup> )	% of economically active population in agriculture
Northern	5 752 890	19	152.4	18	48	26	28
Sudano-Sahelian	8 587 030	28	113.0	13	66	13	72
Gulf of Guinea	2 119 270	7	196.1	23	54	93	40
Central	5 328 660	18	94.5	11	62	18	62
Eastern	2 924 970	10	184.8	21	76	63	79
Southern	4 736 260	16	107.3	12	57	23	46
Indian Ocean Islands	591 760	2	20.0	2	72	34	69
<b>Africa</b>	<b>30 040 840</b>	<b>100</b>	<b>868.1</b>	<b>100</b>	<b>61</b>	<b>29</b>	<b>55</b>

Southern Hemisphere). Very different climates are in juxtaposition, ranging from very dry to wet equatorial by way of more moderate climate (Figure 6).

Africa's population was estimated at 868 million inhabitants in 2004, representing about 14 percent of the world's population (Tables 2 and 32). Nigeria, situated in the Gulf of Guinea, is the most populous country with 15 percent of the African population (Table 23 and Figure 1). The average proportion of the population living in rural areas (61 percent) exceeds the world average (51 percent). However, this average lies between the extremes of the Northern Region (48 percent) and the Eastern Region (76 percent). The average population density of 29 inhabitants/km<sup>2</sup> also hides wide diversity at the national and regional levels (Figure 7). The five most densely populated countries are Mauritius, Comoros, Rwanda, Burundi and Seychelles, with 604, 354, 322, 254 and 182 inhabitants/km<sup>2</sup>, respectively (Table 23). On a continental scale, the Gulf of Guinea Region has the highest population density (93 inhabitants/km<sup>2</sup>), while the Sudano-Sahelian Region is on the whole not very densely populated (13 inhabitants/km<sup>2</sup>). In 2000, 300 million Africans, or more than one-quarter of the total population, had no access to drinking-water. In the same year, average life expectancy was 41 years.

### Northern Region

The Northern Region, consisting of Algeria, Egypt, Libyan Arab Jamahiriya, Morocco and Tunisia, covers an area of about 6 million km<sup>2</sup>, or 19 percent of the continent (Table 1). Algeria covers 40 percent of the area of this region (Table 22). Each of the countries in this region has access to the Mediterranean Sea. Out of a total cultivable area of 65 million ha, only 28 million ha are cultivated, or 43 percent of the potential.



This region is bordered in the north by the Mediterranean Sea and in the south by the Sahara, both of which have a strong influence on the climate (more moderate in the north and very dry in the south). Annual average precipitation in the region reaches only 96 mm (western Sahara excluded), ranging from 750 mm in the extreme northwest of Morocco to close to 0 mm in the south of Egypt.

In 2004, the Northern Region had 153 million inhabitants, with 48 percent of the population living in rural areas (Table 2). Half of this population lives in Egypt (Table 23). The average regional density of 26 inhabitants/km<sup>2</sup> is equal to the average density of the continent, but the population is concentrated mainly on the Mediterranean Sea coasts and in the Nile Delta and Nile Valley, where density can reach 1 165 inhabitants/km<sup>2</sup>, while the desert is practically uninhabited. The overall annual population growth of 1.9 percent in the period 1994–2004 was relatively low, ranging from 1.2 percent in Tunisia to 2.2 percent in the Libyan Arab Jamahiriya, and it has decreased compared with the previous decade (2.5 percent between 1984 and 1994).

### **Sudano-Sahelian Region**

This region covers 12 countries: Burkina Faso, Cape Verde, Chad, Djibouti, Eritrea, Gambia, Mali, Mauritania, Niger, Senegal, Somalia and Sudan. It has a total area of 8.6 million km<sup>2</sup>, or 28 percent of the continent (Table 1). The Sudan, the largest country on the continent, represents 29 percent of this territory (Table 22). Four of the countries are landlocked: Burkina Faso, Chad, Mali and Niger. In 2000, the cultivable area was 208 million ha (50 percent of which were in Sudan) and crops were cultivated on about 39 million ha, or almost 19 percent of the cultivable area.

This region extends to the north of the Sahara and is bordered in the south by the Gulf of Guinea Region, which is more humid. The climate is generally dry, of Sahelian or Sudano-Sahelian type, and characterized by two seasons. The annual average precipitation is 311 mm, ranging from 25 mm in the north of the Sudan to more than 1 600 mm in the south of this country. The average evapotranspiration is about 2 000 mm/year, but it can reach 8 000 mm/year in the Gash-Barka Basin in Eritrea.

About 113 million people lived in the region in 2004, which is equal to a density of 13 inhabitants/km<sup>2</sup>, the lowest on the continent (Table 2). However, national average densities range from 3 inhabitants/km<sup>2</sup> in Mauritania to 129 inhabitants/km<sup>2</sup> in the Gambia (Table 23). About 66 percent of this population is rural. However, 84 percent of the population of Djibouti is concentrated in urban areas, in particular in the capital. The regional annual population growth of 3.2 percent in the period 1994–2004 was the highest on the continent and approximately the same as in the period 1984–1994 (almost 3.3 percent/year).

### **Gulf of Guinea Region**

Nine countries form this region: Benin, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone and Togo. They cover a total area of 2.1 million km<sup>2</sup>, or 7 percent of the continent, with Nigeria accounting for 44 percent of this area (Tables 1 and 22). Of the total cultivable area of 120 million ha, about 55 million ha were cultivated in 2002 (46 percent of the potential).

The region is bordered in the north by the Sudano-Sahelian Region and in the south by the Atlantic Ocean. The climate is Sudanese in the north and wet tropical in the south. The annual average precipitation of the region is 1 356 mm, with large variations between countries: from 1 039 mm/year in Benin to 2 526 mm/year in Sierra Leone. Evapotranspiration increases from 1 500 mm/year in the south of Togo to 5 200 mm/year in the north of Nigeria.

The population was 196 million inhabitants in 2004, of whom 65 percent lived in Nigeria (Table 2). The average density of 93 inhabitants/km<sup>2</sup> is the highest on the continent. However, variations both between and within countries can be very

important, ranging from 31 inhabitants/km<sup>2</sup> in Liberia to 138 inhabitants/km<sup>2</sup> in Nigeria, and from 16 inhabitants/km<sup>2</sup> in Beyla in the province of Guinea Forestiere in Guinea to 2 429 inhabitants/km<sup>2</sup> in its capital, Conakry (Table 23). In this region, about 54 percent of the population is rural. Annual population growth ranges from barely 1.7 percent in Ghana to 2.9 percent in Guinea-Bissau, with a regional average of 2.8 percent in the period 1994–2004, compared with 3.4 percent between 1984 and 1994.

### Central Region

This region comprises eight countries: Angola, Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, and Sao Tome and Principe. Its total area is 5.3 million km<sup>2</sup>, or 18 percent of the continent (Table 1). The estimated cultivated area in 2002 was about 21 million ha, or 12 percent of the 173 million ha of cultivable land (Table 22).

The Central African Republic is the only landlocked country in the region. The climate varies from tropical dry or wet to equatorial, depending on countries. Average precipitation (1 425 mm/year) reaches both extremes in Sao Tome and Principe, ranging from 900 mm/year in the northeast to 6 000 mm/year in the southwest. On a regional scale, the averages range from 1 010 mm/year in Angola to 3 200 mm/year in Sao Tome and Principe. Evapotranspiration in this region varies from 1 200 mm/year to 2 200 mm/year.

The Central Region has an estimated population of 94.5 million inhabitants (11 percent of the African population). Some 56 percent of them live in the Democratic Republic of the Congo, which is also the largest country (44 percent of the area of the region). The low average population density of 18 inhabitants/km<sup>2</sup> ranges from 5 inhabitants/km<sup>2</sup> in Gabon to 172 inhabitants/km<sup>2</sup> in Sao Tome and Principe (Tables 2 and 23). Annual population growth ranges from 1.5 percent in the Central African Republic to 3.3 percent in the Democratic Republic of the Congo, for a regional average of 2.7 percent between 1994 and 2004, significantly lower than in the previous period (3.6 percent).

### Eastern Region

The Eastern Region comprises six countries: Burundi, Ethiopia, Kenya, Rwanda, Uganda, and United Republic of Tanzania. Its total area is about 3 million km<sup>2</sup>, or 10 percent of Africa (Table 1). Ethiopia and the United Republic of Tanzania constitute 70 percent of the territory of this region (Table 22). Burundi, Ethiopia, Rwanda and Uganda are landlocked. The cultivated area is 37 percent of the total cultivable area of 83 million ha.

The Eastern Region is bordered in the northwest, north and northeast by the Sudano-Sahelian Region, in the east by the Indian Ocean, in the south by the Southern Region, and in the west by the Central Region. Thus, the climate is diversified. It is dry in parts of Ethiopia and Kenya, equatorial in Uganda, tropical in the west of Burundi in the Imbo Plain near Lake Tanganyika, and moderate tropical in the highlands of Rwanda and the United Republic of Tanzania. Distributed over one or two periods, the average annual precipitation is 920 mm, ranging from less than 100 mm in the northeast of Ethiopia to 3 000 mm in some areas of the United Republic of Tanzania.

The population of the region is 185 million inhabitants, or 21 percent of the African population (Table 2). The average population density is 63 inhabitants/km<sup>2</sup>, ranging from 40 inhabitants/km<sup>2</sup> in the United Republic of Tanzania to 322 inhabitants/km<sup>2</sup> in Rwanda (Table 23). The annual population growth of this region was 2.9 percent in the period 1994–2004, but, depending on countries, it has varied between 1.8 and 3 percent/year in the last few years.

### Southern Region

The Southern Region comprises nine countries: Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. The region has a total area of 4.7 million km<sup>2</sup>, or 16 percent of the continent (Table 1). South Africa, Namibia and Mozambique together represent more than 60 percent of the total area (Table 22). The cropped area is about 33 million ha, or 29 percent of the total cultivable area of 114 million ha.

The region is bordered in the northwest by the Central Region, in the northeast by the Eastern Region, and in the west, south and east by the Atlantic and Indian Oceans, which meet at the Cape of Good Hope. Mozambique, Namibia, and South Africa have access to the sea, the other countries are landlocked. The main landscapes of the region are: the fringing plains; the Kalahari scrub-desert with a total surface area of about 500 000 km<sup>2</sup> (covering a wide part of Botswana and extending towards Namibia and South Africa); and Africa's Great Rift. The climate is dry in the deserts, moderate at higher altitudes (Lesotho), and tropical to subtropical in the rest of the region. Rains fall mainly in the summer (October–April), except near the Cape of Good Hope in South Africa, where the climate is Mediterranean and rain falls in winter. The annual average precipitation in the region is 659 mm, ranging from less than 100 mm in the desert to more than 2 000 mm in the north of Mozambique. The most humid country is Malawi (with an average precipitation of 1 181 mm/year), and the least humid is Namibia (285 mm/year). Evapotranspiration can exceed 3 700 mm/year in certain zones of Namibia.

The region has a total population of 107 million inhabitants, of whom 57 percent live in rural areas (Table 2). The average population density is rather low (23 inhabitants/km<sup>2</sup>), ranging from 2.4 inhabitants/km<sup>2</sup> in Namibia to 104 inhabitants/km<sup>2</sup> in Malawi (Table 23). Population growth is also limited at no more than 2 percent/year in all the countries. In the last two decades, population growth has declined from 2.8 percent/year in the period 1984–1994 to 1.7 percent/year in the period 1994–2004. This decline is a consequence of the very high incidence of HIV/AIDS (infection rates ranged from 12.2 percent in Mozambique to 38.8 percent in Swaziland at the end of 2003 among all people aged 15–49 years), which has also caused a severe reduction in the average life expectancy in the region, from 48 years in 1970 to 38 years in 2003 (Table 23).

### Indian Ocean Islands Region

Madagascar represents more than 99 percent of the 591 760 km<sup>2</sup> of this region, which also includes Comoros, Mauritius and Seychelles (Tables 1 and 22). The cultivated area of 3.8 million ha, a very significant proportion of which is in Madagascar, covers 46 percent of the cultivable area (8.3 million ha).

In Madagascar, the climate varies from semi-arid to tropical humid, while it is generally tropical humid in Seychelles and the Comoros, and subtropical to temperate maritime in Mauritius. The mean annual rainfall is 1 510 mm, ranging from 900 mm in the Comoros to 2 040 mm in Mauritius.

The total population of the four countries amounts to 20 million inhabitants, with 90 percent in Madagascar (Tables 2 and 23). The average population density is rather low (34 inhabitants/km<sup>2</sup>), but there are wide difference between Madagascar (30 inhabitants/km<sup>2</sup>) and the other three countries (446 inhabitants/km<sup>2</sup> on average). The population growth of the region declined from 3.2 percent/year in the period 1984–1994 to 3 percent/year in the period 1994–2004. However, there are considerable differences between the countries as Seychelles has the lowest national population growth rate of the whole continent (1 percent/year) and the Comoros one of the highest (2.9 percent/year).

## ECONOMY, AGRICULTURE AND FOOD SECURITY

Poverty is common and sometimes extreme in Africa. Thirty-four of the 49 least developed countries (LDCs) are African and 315 million people, or 36 percent of the total population, survive on less than US\$1/day. The sum of national GDPs in 2003 amounted to US\$641 000 million, or barely 5 percent of the GDP of the United States of America. It corresponds on average to a GDP of US\$738/inhabitant, ranging from US\$91/inhabitant in Ethiopia to US\$8 890/inhabitant in Seychelles. The HDI (range = 0–1) varies from 0.273 in Sierra Leone to 0.853 in Seychelles (35th out of a total of 177 countries), while the 19 countries with the lowest HDI are African. The HDI for Liberia and Somalia is not known.

In 2003, the added value of the primary sector (agriculture) contributed 2.5 percent to the GDP in Botswana and 60.8 percent in the Central African Republic, with an average for the whole of Africa of 17.7 percent. More than half of the economically active people are engaged in the farming sector (Table 2). The Northern (28 percent), Gulf of Guinea (40 percent) and Southern Regions (46 percent) are exceptions. The more developed Northern Region has less agriculture and more industries and services. Nigeria, a large oil-exporting country, has a large impact on the data of the Gulf of Guinea Region. Finally, South Africa (where development is very marked), Namibia and Botswana, three countries where apartheid was formerly practised, are responsible for this reduced percentage of active agricultural workers. At a country level, Burundi and Rwanda, where 90 percent of the total labour force is engaged in the primary sector, are the two countries with the most limited cultivable area per inhabitant on the continent (less than 0.2 ha/person). Conversely, Namibia and Gabon, with the largest cultivable area per person (12.4 and 11.2 ha/person, respectively), have less than 40 percent of their economically active people working in the primary sector. With 5 percent of the economically active people engaged in agriculture and cultivating about 23 ha per active agricultural worker, the Libyan Arab Jamahiriya is the country that allocates the lowest percentage of economically active people to this sector.

The HIV/AIDS pandemic (Table 23) has reached such a scale that it influences the economy of those countries most affected. About two-thirds (64 percent) of all the people infected by AIDS live in sub-Saharan Africa (SSA), as well as more than three-quarters (76 percent) of all the women who have acquired this disease. The incidence of the disease in the SSA region was almost 7.4 percent at the end of 2004. The Northern Region has an incidence of less than 0.3 percent for people aged 15–49 years, and Mozambique with an incidence of 12.2 percent is the least affected country in the Southern Region. Four countries in the Southern Region have an incidence rate of 20–30 percent: Namibia, South Africa, Zimbabwe and Lesotho, in increasing order. In Botswana and Swaziland, the incidence is even higher at 37.3 and 38.8 percent, respectively. The other regions fall between these two extremes: The national-level incidence ranges from 0.6 to 4.8 percent in the Sudano-Sahelian Region, from 1 to 7 percent in the Gulf of Guinea Region, from 4.1 to 8.8 percent in the Eastern Region, and from 3.9 to 13.5 percent in the Central Region. In the Indian Ocean Islands Region, only the incidence for Madagascar is known (1.7 percent).

This disease causes a significant increase in rural poverty and malnutrition, two plagues already widespread in Africa. It aggravates difficulties for rural women; the rates of infection can be 3–5 times higher for women than for men. Finally, the disease exerts a negative impact on household food security as well as on the national food production because of the loss of agricultural workers, notably in countries where agriculture contributes considerably to GDP. Indeed, the largest number of infected people is in the 15–49-year age bracket, the most productive group in the population. Therefore, the population composition has been modified, leading to a situation where old and young people predominate. When a family member is affected, the family not only has to compensate for the loss in income but also has to take care of the patient.

In 2004, FAO estimated that in the 25 most affected countries in Africa, about 7 million agricultural workers had been victims of AIDS since 1985; another 16 million could become victims before 2020. The most affected African countries could lose up to 26 percent of their labour force in the next two decades. Average life expectancy in SSA is now 47 years, while it would have been 62 years without AIDS. In Botswana, life expectancy at birth has fallen to its 1950 level, but Zimbabwe has seen the most dramatic drop with life expectancy falling from 55 years in 1970 to 33 years in 2003.

## WATER RESOURCES

### Renewable water resources

Annual precipitation in Africa is estimated at about 20 360 km<sup>3</sup>, a continentwide average of 678 mm (Figure 6). Disparities between countries and regions are very important. The driest country is Egypt with 51 mm/year on average, followed closely by the Libyan Arab Jamahiriya (56 mm/year) and Algeria (89 mm/year), which suggests that Morocco (346 mm/year) and Tunisia (207 mm/year) are most advantaged countries in the Northern Region (Table 24). This region is the driest region on the continent with an average of 96 mm/year. The countries with precipitation exceeding 2 000 mm/year (Sao Tome and Principe with 3 200 mm/year, Sierra Leone 2 526 mm/year, Seychelles 2 330 mm/year, Liberia 2 390 mm/year, Equatorial Guinea 2 156 mm/year, Mauritius 2 041 mm/year) belong to the Gulf of Guinea, Central and Indian Ocean Islands Regions, which are the rainiest (Table 3). With more than 7 500 km<sup>3</sup>/year, the Central Region receives 37 percent of all precipitation in Africa in an area that accounts for less than 20 percent of the total. In contrast, the Northern Region, with an area similar to the Central Region, receives less than 3 percent of total precipitation.

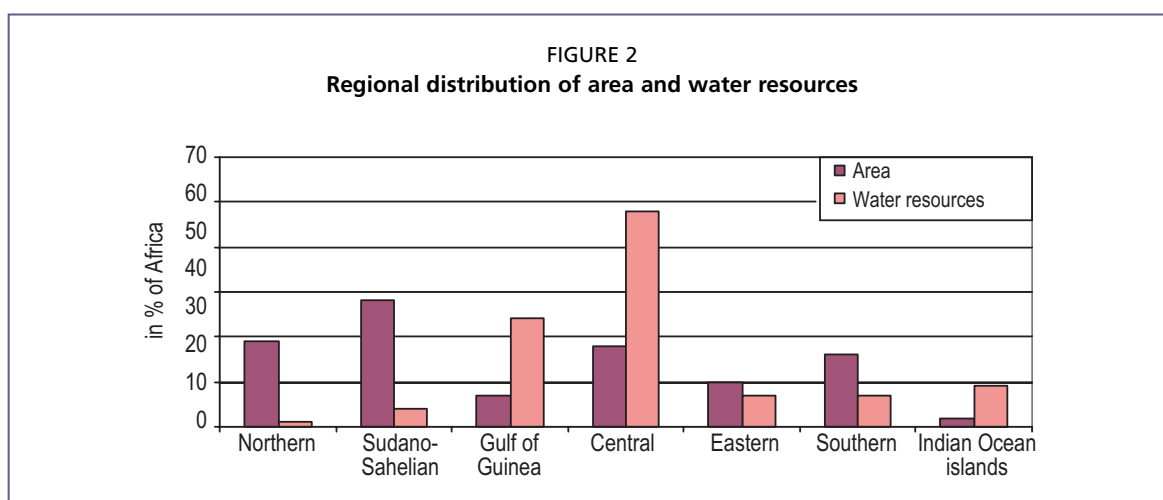
Renewable water resources for the whole of Africa amount to about 3 930 km<sup>3</sup>, or less than 9 percent of global renewable resources (Figure 8 and Table 32). The Central Region is the best endowed, with 48 percent of Africa's resources for only 18 percent of its area (Figure 2). With 24 percent of Africa's resources, the Gulf of Guinea Region is also well supplied with water. On the other hand, the Northern Region is the most disadvantaged with less than 1 percent of the renewable water resources for an area equivalent to 19 percent of Africa. The Democratic Republic of the Congo has 900 km<sup>3</sup> of internal renewable water resources, 23 percent of the total for African, while the Libyan Arab Jamahiriya has only 0.01 percent of these resources.

There has been a decrease in internal renewable water resources per inhabitant since the previous AQUASTAT survey. In 2004, the average was 4 530 m<sup>3</sup>/inhabitant, ranging from 325 m<sup>3</sup>/inhabitant in the Northern Region to 19 845 m<sup>3</sup>/inhabitant in the Central Region. At country level, the values range from 25 m<sup>3</sup>/inhabitant for Egypt to 121 392 m<sup>3</sup>/inhabitant for Gabon (Table 24). However, the distribution of total renewable water resources is different because of international and interregional river basins, with values ranging from 106 m<sup>3</sup>/inhabitant in the Libyan Arab Jamahiriya to

TABLE 3  
Regional distribution of the water resources

Region	Annual precipitation		Annual internal renewable water resources		
	Height (mm)	Volume (million m <sup>3</sup> )	Volume (million m <sup>3</sup> )	In % of Africa (%)	Per inhabitant (2004) (m <sup>3</sup> )
Northern	96	549 959	49 495	1	325
Sudano-Sahelian	311	2 671 364	160 200	4	1 418
Gulf of Guinea	1 356	2 873 971	951 940	24	4 853
Central	1 425	7 592 517	1 876 180	48	19 845
Eastern	920	2 665 720	280 960	7	1 521
Southern	659	3 110 159	270 130	7	2 518
Indian Ocean Islands	1 510	895 250	340 951	9	17 042
<b>Africa</b>	<b>678</b>	<b>20 358 940</b>	<b>3 929 856</b>	<b>100</b>	<b>4 527</b>





217 915 m<sup>3</sup>/inhabitant in Congo. Indeed, because of an agreement with the Sudan, Egypt benefits from very important outside contributions (of the Nile River). Congo also benefits from water resources from the Congo River from countries situated upstream, unlike the Libyan Arab Jamahiriya and Gabon, which do not have any external resources. Therefore, the dependency ratio, which enables the proportion of total renewable resources originating from outside a country to be quantified and, thereby, a country's dependence on external water resources, is negligible for these two countries (Table 24).

Table 4 presents total and internal renewable water resources for seven countries where resources per inhabitant are very limited. With respect to internal renewable water resources, seven countries have resources lower than the cutoff point of 500 m<sup>3</sup>/inhabitant a year, while Algeria and Djibouti exceeded this threshold slightly in 1994. Taking into consideration international rivers shared with countries upstream, Egypt, Mauritania and Niger (thanks to the Nile, Senegal and Niger rivers, respectively) are well above this threshold in terms of total renewable water resources. Only Algeria, Djibouti, Libyan Arab Jamahiriya and Tunisia remain below this threshold, not benefiting (dependency ratio of zero for Djibouti and Libyan Arab Jamahiriya) or benefiting only slightly (ratio lower than 10 percent for Algeria and Tunisia) from outside contributions. It is necessary to highlight the particular case of Egypt, which, thanks to the Nile River, saw its total resources rise to almost 800 m<sup>3</sup>/inhabitant in 2004 from 25 m<sup>3</sup>/inhabitant of internal resources. Therefore, its dependency ratio is very high (97 percent), but a large part of this contribution (55.5 km<sup>3</sup> or 98 percent) is secured by a treaty with the Sudan, located upstream on the Nile River.

**TABLE 4**  
**Countries with water resources of less than 500 m<sup>3</sup>/inhabitant/year**

Country	Internal renewable water resources/ inhabitant/year		Total renewable water resources/ inhabitant/year	
	1994	2004	1994	2004
	(m <sup>3</sup> )			
Algeria	411	348	427	361
Djibouti	537	421	537	421
Egypt	30	25	964	794
Libyan Arab Jamahiriya	129	106	129	106
Mauritania	178	134	5 087	3 826
Niger	401	282	3 852	2 710
Tunisia	476	422	521	462

TABLE 5  
The nine largest international basins

Basin	Area		Countries included
	km <sup>2</sup>	% of Africa	
Congo/Zaire	3 789 053	12.5	Angola, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Rwanda, United Republic of Tanzania, Zambia
Nile	3 112 369	10.3	Burundi, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Uganda, United Republic of Tanzania
Lake Chad	2 381 635	7.8	Algeria, Cameroon, Central African Republic, Chad, Niger, Nigeria, Sudan,
Niger	2 273 946	7.5	Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria
Zambezi	1 340 291	4.5	Angola, Botswana, Malawi, Mozambique, Namibia, United Republic of Tanzania, Zambia, Zimbabwe
Orange-Senqu	896 368	3.0	Botswana, Lesotho, Namibia, South Africa
Senegal	483 181	1.6	Guinea, Mali, Mauritania, Senegal
Limpopo	412 938	1.3	Botswana, Mozambique, South Africa, Zimbabwe
Volta	394 196	1.3	Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Togo
<b>Total</b>	<b>15 083 977</b>	<b>42.3</b>	

### International waters

The main international river basins are, in decreasing order of area: Congo (Zaire), Nile, Lake Chad, Niger, Zambezi, Orange, Senegal, Limpopo, and Volta. These nine basins cover nearly half of the total area of the continent (Table 5 and Figure 9).

The water in these river basins, shared between several countries, is managed through basin organizations that group together all or some of the countries included in one basin. Of the basins mentioned, only the Congo River Basin does not have this type of organization to coordinate actions related to the water resources of the nine states contained in this basin, although it is the largest African river basin. The organizations managing the other basins are:

- *The Nile Basin Initiative* (NBI), created in 1999 on the initiative of the Council of Ministers of water resources of the countries of the Nile Basin (Nile COM), furthers a first agreement in 1959 between Egypt and Sudan on the water of the river, and also of the Committee of Technical Cooperation for the Promotion of the Development and the Environmental Protection of the Nile Basin (TECCONILE) in 1993. Among the ten countries included in the Nile Basin (Burundi, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Uganda and United Republic of Tanzania), only Eritrea is not a member of the NBI, but it is a “prospective member”. It participates in the Nile COM dialogue as an observer. The initiative tries to realize sustainable socio-economic development through the use of water resources in the Nile Basin and equitable benefit sharing. Therefore, the main objectives are: (i) to develop the Nile River water resources in an equitable and sustainable manner in order to ensure prosperity, security and peace for the inhabitants; (ii) to guarantee effective water management and optimal resource use; (iii) to promote cooperation and combined action between member countries; and (iv) to combat poverty and promote economic integration.
- *The Lake Chad Basin Commission* (LCBC) was created in May 1964 by the leaders of the states that share Lake Chad (Cameroon, Chad, Niger and Nigeria). The Central African Republic became the fifth member in 1994. Algeria and Sudan, also included in the lake basin, are not part of the “conventional basin”. The main objectives of the LCBC are: (i) to conserve the limited water resources; (ii) to restore the water level in Lake Chad, which is one of the largest wet zones in Africa; (iii) to combat desertification through dune fixation; (iv) to combat erosion and to lead programmes of plant regeneration; and (v) to collect data on the resources for an effective management of the river basin.

- *The Niger Basin Authority* (NBA), created in 1980, is the successor to the Niger River Commission, created in 1964. Of the ten countries included in the basin (Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d’Ivoire, Guinea, Mali, Niger and Nigeria), only Algeria is not part of the NBA. The objective of the NBA is: “to promote cooperation between member countries and to ensure an integrated development of the resources of the river basin, notably in energy, water, agriculture, livestock, fishing, aquaculture, forestry, wood, transport and communication, and industry”. To achieve this, it is necessary to accomplish the following three objectives: (i) harmonize and coordinate the national policies on the development of the resources in the basin; (ii) plan river basin development by developing and implementing an “integrated river basin development plan”; and (iii) conceive, develop, undertake and maintain common works and projects.
- *The Zambezi Watercourse Commission* (ZAMCOM) was created in 2004 by the eight countries of the Zambezi Basin: Angola, Botswana, Malawi, Mozambique, Namibia, United Republic of Tanzania, Zambia and Zimbabwe. Negotiations for the creation of this basin organization started in the 1980s, but were interrupted at the beginning of the 1990s to allow discussions on the Protocol on Shared Watercourse Systems of the Southern African Development Community (SADC), signed in 1995. The objective of ZAMCOM is to promote the fair and reasonable use of the Zambezi water resources, as well as their effective management and sustainable development. The governments of Zambia and Zimbabwe work together in the Zambezi River Authority (ZRA) to co-manage the river, concentrating in particular on managing the Kariba Dam, located on the Zambezi River and forming the border between the two countries.
- *The Orange Commission - Senqu River* (ORASECOM) was created in 2000 by the four states that share the basin: Botswana, Lesotho, Namibia and South Africa. It is responsible for studying the potential of the basin’s resources. At the same time, it is necessary to strengthen human and institutional capacities in order to facilitate the integrated and effective management of the water resources, thereby enabling the sustainable development of all of the basin countries.
- *The Organization for the Development of the Senegal River* (OMVS), created in 1972, comprises Mali, Mauritania and Senegal. Although Guinea shares the basin’s waters, it is not a member of the OMVS, having withdrawn from the previous organization (Organisation des États riverains du Sénégal in 1968). The OMVS has taken over from previous organizations, namely: Mission d’études et d’aménagement du fleuve Sénégal, created in 1934; Mission d’aménagement du fleuve Sénégal, created in 1938 and which became a common body of water resources development for the three autonomous states in 1959; Inter-State Committee, created in 1963 and which also included Guinea; and Organisation des États riverains du Sénégal, created in 1968. The mission of the OMVS is: (i) to achieve food self-sufficiency for the population of the basin and of the subregion; (ii) to secure and improve incomes for population in the river valley; (iii) to preserve the balance of the ecosystems in the subregion and in particular in the basin; (iv) to reduce the vulnerability of the economies of the member states to climate hazards and negative external factors; and (v) to accelerate the economic development of the member states.
- In 2002, the four countries located in the Limpopo River Basin (Botswana, Mozambique, South Africa and Zimbabwe) set up the *Limpopo Basin Commission* (LIMCOM), which replaced the Limpopo Basin Permanent Technical Committee (LBPTC).

- An agency does not yet exist for the Volta River Basin, but its creation seems imminent. Among the six countries of the basin (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo), Ghana and Burkina Faso have already strengthened their dialogue for the management of their shared water resources related to the Project for Improving Water Governance in the Volta River Basin, launched in July 2004. The *Volta Basin Technical Committee* (VBTC) brings together experts from ministries in charge of water for the six countries that share the Volta River Basin. It held its first session in March 2005, enabling the adoption of internal regulations and the election of the VBTC officials whose mission is to work on the establishment of a Volta River Basin agency.

## Dams

The total dam capacity in Africa is 798 km<sup>3</sup>, of which 726 km<sup>3</sup> relates to the capacity of 53 large dams built in 22 river basins (Table 25). On the nine international river basins indicated in Table 5, 31 large dams have been built with a total capacity of 643 km<sup>3</sup>. The Southern Region contains more than one-third of the total dam capacity on the continent (39 percent), followed by the Gulf of Guinea Region (29 percent) and the Northern Region (24 percent), while the Central Region and the Indian Ocean Islands Region, the most humid on the continent, have a small dam capacity (Table 6). Five main dams (situated in the three regions with the highest capacity on the continent) total 565 km<sup>3</sup> of capacity, or 71 percent of the total capacity in Africa (Table 7). The dam with the largest capacity is the Kariba Dam (188 km<sup>3</sup>). More than half of the dams are in the Southern Region. This probably reflects the fact that the inventory of dams in South Africa is very exact because it includes even small-capacity dams.

## Non-conventional sources of water

Data on non-conventional sources of water are only available for 15 countries. These countries are in particular those whose renewable resources are limited and who already use a very considerable portion of their water. Table 8 shows that they belong mainly to the Northern Region and, at a much lower level of use, to the Southern Region. The reuse of treated wastewater and water desalination take place mainly in dry countries seeking to increase their limited resources. The main countries practising desalination are: Egypt, South Africa, Libyan Arab Jamahiriya, Algeria, Tunisia, Morocco, Mauritania, Cape Verde, Seychelles, Sudan and Djibouti, in decreasing order of production. Some countries have also introduced irrigation projects that use treated wastewater, mainly in urban and peri-urban agriculture.

The absence of data on the quantity of wastewater produced and/or treated in the Gulf of Guinea, Central and Eastern Regions

TABLE 6  
Regional distribution of dams

Region	Dam capacity		Number of dams
	km <sup>3</sup>	% of Africa	
Northern	194.03	24.3	230
Sudano-Sahelian	30.13	3.8	90
Gulf of Guinea	234.62	29.4	126
Central	4.74	0.6	45
Eastern	27.06	3.4	33
Southern	306.51	38.4	723
Indian Ocean Islands	0.59	0.1	24
<b>Africa</b>	<b>797.68</b>	<b>100.0</b>	<b>1 271</b>

TABLE 7  
The five largest dams in Africa

Dam	River	Capacity (km <sup>3</sup> )	Main uses	Country
Kariba	Zambezi	188	Hydroelectricity	Zambia and Zimbabwe
Aswan	Nile	162	Irrigation, hydroelectricity and flood control	Egypt
Akosombo	Volta	148	Hydroelectricity	Ghana
Chahora Bassa	Zambezi	39	Irrigation, hydroelectricity and flood control	Mozambique
Koussou	Bandama	28	Hydroelectricity	Côte d'Ivoire

TABLE 8  
Regional distribution of non-conventional sources of water and their uses

Region	Wastewater produced	Treated wastewater	Reused treated wastewater	Desalinated water
	(million m <sup>3</sup> )			
Northern	5 963.0	3 199.0	3 032.00	155.2
Sudano-Sahelian	24.0	1.8	0.70	3.6
Gulf of Guinea	-	-	-	-
Central	-	-	-	-
Eastern	-	-	-	-
Southern	3 255.0	3 217.0	-	18.0
Indian Ocean Islands	8.8	21.6	0.01	1.0
<b>Total</b>	<b>9 250.8</b>	<b>6 439.4</b>	<b>3 032.71</b>	<b>177.8</b>

reflects a lack of sanitation and wastewater treatment systems or their inefficiency in many countries in these regions.

### WATER WITHDRAWAL

The data on water withdrawal refer to the gross quantity of water withdrawn annually for a given use. Table 9 presents the distribution of water withdrawal by region for the three large water-consuming sectors: agriculture (irrigation and livestock watering), water supply (domestic/municipal use), and industry. Although able to mobilize a significant portion of water, requirements for energy purposes (hydroelectricity), navigation, fishing, mining, environment and leisure activities have a low rate of net water consumption. For this reason, they are not included in the calculation of the regional withdrawals but they do appear in the country profiles where information is available.

For most countries, the methods used for the calculation or the measurements for obtaining the values of the withdrawals are not specified. For the countries for which recent data were not available or were not reliable, the withdrawal estimations calculated by AQUASTAT for 2000 have been used.

The annual total water withdrawal for Africa is 215 km<sup>3</sup>, or barely 5.5 percent of the renewable water resources on the continent (Table 9) and less than 6 percent of world withdrawals (Table 32). On a continental scale, 86 percent of inventoried withdrawals are used for agriculture, a value higher than the global agricultural water withdrawal (70 percent). However, this figure varies substantially at regional level. The Sudano-Sahelian and the Indian Ocean Islands Regions have the highest levels of agricultural withdrawals (95 and 94 percent, respectively, of the total regional water withdrawal),

TABLE 9  
Regional distribution of water withdrawals

Region	Annual withdrawals by sector										
	Agriculture		Municipalities			Industry		Total			
	million m <sup>3</sup>	% of total	million m <sup>3</sup>	% of total	m <sup>3</sup> per inhabitant. (2004)	million m <sup>3</sup>	% of total	million m <sup>3</sup>	% of Africa	m <sup>3</sup> per inhabitant (2004)	% of internal resources
Northern	79 657	85	8 837	9	58	5 395	6	93 889	43.7	616	189.0
Sudano-Sahelian	52 369	95	2 133	4	19	445	1	54 948	25.7	486	35.0
Gulf of Guinea	8 821	71	2 459	20	13	1 115	9	12 395	5.8	63	1.3
Central	1 114	56	640	32	7	239	12	1 993	0.9	21	0.1
Eastern	12 445	88	1 549	11	8	221	1	14 215	6.6	77	5.0
Southern	15 134	70	5 194	24	48	1 330	6	21 657	10.0	202	8.0
Indian Ocean Islands	14 809	94	650	4	32	258	2	15 717	7.3	786	4.6
<b>Africa</b>	<b>184 349</b>	<b>86</b>	<b>21 462</b>	<b>10</b>	<b>25</b>	<b>9 003</b>	<b>4</b>	<b>214 814</b>	<b>100.0</b>	<b>247</b>	<b>5.5</b>

while the Central Region uses only 56 percent of its withdrawals for agriculture. The annual precipitation in this region allows rainfed agriculture, which is not feasible in the dry countries. Generally speaking, as in 1995, these are the countries that withdraw the highest volumes of water. Indeed, about 70 percent of Africa's total water withdrawal is concentrated in the Northern and the Sudano-Sahelian Regions. These two regions cover nearly half of the continent (48 percent) and account for two-thirds of the irrigated areas (67 percent).

The regional-level values are influenced strongly by some countries: Egypt accounts for 73 percent of the withdrawals in the Northern Region; Sudan accounts for 67 percent in the Sudano-Sahelian Region; Cameroon accounts for 49 percent in the Central Region; Ethiopia and United Republic of Tanzania account equally for 76 percent in the Eastern Region; Nigeria accounts for 65 percent in the Gulf of Guinea Region; and South Africa accounts for 58 percent in the Southern Region (Table 26). Although they cover only 27 percent of the continent, these seven countries account for 64 percent of African water withdrawals. However, they are also home to 47 percent of its population and 67 percent of its irrigated areas.

Water withdrawals per inhabitant are 247 m<sup>3</sup>/year, but this average conceals significant variations both between and within regions. They range from 21 m<sup>3</sup>/inhabitant/year in the Central Region (with 6 m<sup>3</sup>/inhabitant/year in the Central African Republic and 7 m<sup>3</sup>/inhabitant/year in the Democratic Republic of the Congo) to 786 m<sup>3</sup>/inhabitant/year in the Indian Ocean Islands Region (Figure 10). The region whose rate of water withdrawal (as a function of internal renewable water resources) is the lowest is the Central Region (0.1 percent), while the region with the highest rate of water withdrawal is the Northern Region (200 percent) (Figure 11). This latter rate is induced by the contribution and the use of water resources from outside the region (water from the Nile River in Egypt), and to a lesser extent by the use of non-renewable water resources (in Algeria and Libyan Arab Jamahiriya).

Domestic water withdrawal per inhabitant is low at 25 m<sup>3</sup>/year for the continent as a whole, with rather small regional and national variations compared with agricultural water withdrawals (from 7 m<sup>3</sup>/inhabitant/year in the Central Region to 58 m<sup>3</sup>/inhabitant/year in the Northern Region). Somalians use the least water for domestic purposes (less than 1.5 m<sup>3</sup>/inhabitant/year), while annual domestic consumption in Mauritius exceeds 173 m<sup>3</sup>/inhabitant (reflecting the impact of the tourism industry).

## IRRIGATION POTENTIAL

Table 10 presents the irrigation potential by river basin. Because of this distribution by basin, water resources shared by several countries, notably international rivers, are counted only once. The irrigation potential generally takes into account at the same time the land suitable for irrigation and the renewable water resources. However, estimation methods vary and different estimations are sometimes available for the same country depending on the factors considered (resources, techniques, economic criteria, the environment, etc.).

The irrigation potential of the continent is estimated at more than 42.5 million ha, considering irrigation potential by basin and renewable water resources (Figure 12). One-third of this potential is concentrated in two very humid countries: Angola and the Democratic Republic of the Congo. For two countries, the irrigation potential is less than the area under water management (see below). In Algeria, the area managed is 112 percent of the potential while in the Libyan Arab Jamahiriya it is 1 175 percent of the irrigation potential (Table 28). These countries also use non-renewable fossil groundwater for irrigation, whereas Figure 12 considers only renewable water resources. They are also among the countries that have developed non-conventional sources of water.

TABLE 10  
Distribution of irrigation potential by river basin

Basin	Irrigation potential	% of Africa's potential	Regions
Congo/Zaire	9 800 000	23	Central, Eastern, Southern
Nile	8 000 000	19	Northern, Sudano-Sahelian, Central, Eastern
Niger	2 816 510	7	Northern, Gulf of Guinea, Central, Sudano-Sahelian
Zambezi	3 160 380	7	Central, Southern, Eastern
Lake Chad	1 163 200	3	Northern, Central, Sudano-Sahelian, Gulf of Guinea
Rift Valley	844 010	2	Sudano-Sahelian, Eastern
Senegal	420 000	1	Gulf of Guinea, Sudano-Sahelian
Volta	1 487 000	3	Gulf of Guinea, Sudano-Sahelian
Orange-Senqu	390 000	1	Southern
Shebelle-Juba	351 460	1	Sudano-Sahelian, Eastern
Limpopo	295 400	0.5	Southern
Okavango	208 060	0.5	Central, Southern
South Interior	54 000	0	Central, Southern
North Coast	2 199 050	5	Northern, Sudano-Sahelian, Eastern
West Coast	6 268 650	15	Sudano-Sahelian, gulf of Guinea, Central, Southern
South Coast	1 584 200	4	Southern
Central East Coast	1 927 460	4.5	Sudano-Sahelian, Eastern, Southern
Madagascar and Islands	1 534 990	3.5	Indian Ocean Islands
<b>Africa</b>	<b>42 504 370</b>	<b>100.0</b>	

## IRRIGATION AND WATER MANAGED AREAS

### Typology of irrigation and water managed areas

Initially, irrigation in Africa was associated with irrigation plains of large perennial rivers, such as the Niger, Senegal, Nile, Volta, Zambezi, etc. where governments developed the first large irrigation schemes. Since the end of the 1980s, the irrigation sector has undergone important changes, such as liberalization of the production chain, the transfer of scheme management to users, and the emergence of environmental concerns. Furthermore, donor interest in this sector has waned for a number of reasons, such as the decline in world food prices, the high per-hectare development cost (which moreover increases because the easiest areas to develop for irrigation have already been developed), investments necessary for rehabilitation, and environmental standards (which discourage the construction of dams). There is a tendency to promote small irrigation projects (sometimes with private-sector investment) and user participation on the basis of the better results obtained. At the same time, the use of pumps (powered by animals, humans or motors) has enabled groundwater use to become more widespread. This has given rise to a new environmental problem: the overexploitation of aquifers and its numerous consequences (seawater intrusion, sustainability, etc.).

Depending on the regions, irrigation is seen as a necessary technique without which agricultural production would be practically impossible in dry countries, or as a means to increase productivity and cropping intensity, and to favour crop diversity in the most humid countries; hence, the large variety of techniques developed for water management.

Table 11 presents the regional distribution of the areas under water management, making a distinction between areas under irrigation (the sum of full/partial control irrigation areas, spate irrigation areas, and equipped lowlands) and the other cultivated lowland areas that are non-equipped (wetlands, inland valley bottoms, and flood recession cropping areas). The total area where water other than direct rainfall is used for agricultural production has been named “area under water management” or “water managed area”. The term “irrigation” refers to areas equipped to supply water to crops (Tables 27 and 28). The distinction between irrigation and water management is sometimes difficult; in particular, the demarcation between equipped and non-equipped

TABLE 11  
Regional distribution of areas under water management

Region	Irrigation		Non-equipped cultivated wetlands and inland valley bottoms		Non-equipped flood recession cropping area		Total area under water management	
	ha	% of total	ha	% of total	ha	% of total	ha	% of Africa
Northern	6 339 756	100	-	-	-	-	6 339 756	41
Sudano-Sahelian	2 619 950	89	67 356	2	257 984	9	2 945 290	19
Gulf of Guinea	565 257	39	196 606	14	681 914	47	1 443 777	9
Central	132 439	29	322 500	71	1 000	0	455 939	3
Eastern	616 143	73	233 195	27	-	-	849 338	6
Southern	2 063 427	91	181 900	8	8 510	1	2 253 837	15
Indian Ocean Islands	1 107 903	99	-	-	9 750	1	1 117 653	7
<b>Total</b>	<b>13 444 875</b>	<b>87</b>	<b>1 001 557</b>	<b>7</b>	<b>959 158</b>	<b>6</b>	<b>15 405 590</b>	<b>100</b>

areas is often vague, given that equipment in Africa often consists of small devices for holding water, but which do not always allow full water management.

The areas under water management cover more than 15.4 million ha in Africa, but their geographical distribution is very uneven both from region to region and from country to country (Figure 13). More than 40 percent of the water managed area is concentrated in the Northern Region and the percentage increases further when considering only those areas under irrigation. Egypt accounts for 54 percent of the irrigated area in the Northern Region. The Sudano-Sahelian Region ranks second with 19 percent of the water managed area and 20 percent of the irrigated area. However, these figures reflect the area equipped for irrigation in the Sudan (71 percent of the area equipped for irrigation in the region and 63 percent of the area under water management). Finally, the Southern Region contains 15 percent of the area equipped for irrigation and the water managed area on the continent. South Africa has a strong effect on the figures for this region as it accounts for 73 percent of its irrigation.

Spate irrigation is specific to dry countries. It is used mainly in the Northern Region (Tunisia, Morocco and Algeria) and in the Sudano-Sahelian Region (Somalia and Sudan, and, to a lesser extent, Eritrea) (Table 12). In the Central Region, only Cameroon has developed it, but on a small area (Table 27). On the other hand, equipped lowlands are frequent in countries with greater water resources, that is, in all regions except the Northern and Indian Ocean Islands Regions, as are cultivated non-equipped wetlands and inland valley bottoms. Finally, water use during flood recession is practised mainly in the Gulf of Guinea Region, to a lesser extent in the Sudano-Sahelian Region, and to a much lesser extent in the Indian Ocean Islands, Southern and Central Regions (Table 28).

TABLE 12  
Regional distribution of areas under irrigation

Region	Full/partial control irrigation	Spate irrigation	Equipped lowlands	Total irrigation		
				Area	% of Africa	% of cultivated area
				(ha)	(%)	(%)
Northern	6 230 706	109 050	-	6 339 756	47	22.6
Sudano-Sahelian	2 098 238	299 520	222 192	2 619 950	20	6.8
Gulf of Guinea	360 088	-	205 169	565 257	4	1.0
Central	125 652	2 800	3 987	132 439	1	0.6
Eastern	593 103	-	23 040	616 143	5	2.0
Southern	1 962 902	-	100 525	2 063 427	15	6.3
Indian Ocean Islands	1 107 903	-	-	1 107 903	8	29.2
<b>Total</b>	<b>12 478 592</b>	<b>411 370</b>	<b>554 913</b>	<b>13 444 875</b>	<b>100</b>	<b>6.4</b>
<b>%</b>	<b>93</b>	<b>3</b>	<b>4</b>	<b>100</b>		



Irrigation, which covers 13.4 million ha, is by far the most widespread form of water management in Africa (Figures 14–16). It accounts for 87 percent of the area under water management, of which almost half is concentrated in Northern Africa. Furthermore, 9.3 million ha, or about 70 percent, of the total area under irrigation are in five countries (South Africa, Egypt, Madagascar, Morocco and Sudan). The areas under spate irrigation (3 percent) and equipped lowlands (4 percent) are greatly exceeded by areas under full/partial control irrigation, representing 93 percent of the area under irrigation (Table 12). At regional level, the proportion of irrigation in the areas under water management ranges from 100 percent in the Northern Region to 30 percent in the Central Region. However, the latter region accounts for more than 70 percent of the non-equipped cultivated wetlands and inland valley bottoms on the continent (Table 11). Its wetter climate ensures the presence of numerous humid lowlands (in the Democratic Republic of the Congo, Angola, Congo, Equatorial Guinea, Cameroon, Central African Republic, etc.).

Irrigation is practised on 6 percent of the total cultivated area of the continent (Tables 12 and 27). This percentage is much lower than that for other regions: 38 percent in Asia, 27 percent in the Caribbean, and 12 percent in Latin America. However, this overall average value, linked directly to the amount of precipitation, ranges from practically zero in the Central African Republic to 100 percent in Egypt, where farming would be impossible without irrigation (Table 27).

#### Full/partial control irrigation techniques

Table 13 presents the regional distribution of irrigation techniques used on areas under full/partial control irrigation. For countries where techniques were described in the previous publication and where no new data are available, this analysis uses the earlier values (Table 29). The Sudano-Sahelian and Central Regions are those whose data are the most deficient. Indeed, data on the type of techniques used in full/partial control irrigation are available for only one-eighth and one-quarter of their respective areas. According to the field knowledge of the AQUASTAT team, countries where data are missing practise mainly surface irrigation. Therefore, the totality of their area under full/partial control irrigation is included under the “surface irrigation” technique of the regional analysis (this estimation is not mentioned in the country profiles). Surface irrigation greatly exceeds pressurized irrigation techniques (sprinkler and localized irrigation).

Pressurized irrigation techniques are concentrated mainly in the Northern and Southern Regions. In percentage terms, sprinkler irrigation is the most widespread technique in the Southern Region. In the Northern Region, it is practised on a similar area, but it represents a lesser proportion because surface irrigation covers an area nearly five times as large. In the Gulf of Guinea, Eastern and Central Regions, the area under sprinkler irrigation is much more limited. The Sudano-Sahelian and Indian Ocean Islands Regions only have a very small percentage of their area under sprinkler

TABLE 13  
Regional distribution of full/partial control irrigation techniques

Region	Surface irrigation		Sprinkler irrigation		Localized irrigation		Total (ha)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	
Northern	4 925 733	79.1	923 583	14.8	381 390	6.1	6 230 706
Sudano-Sahelian	2 090 384	99.6	7 654	0.4	200	0.0	2 098 238
Gulf of Guinea	311 348	86.5	47 220	13.1	1 520	0.4	360 088
Central	120 221	95.7	5 430	4.3	1	0.0	125 652
Eastern	522 520	88.1	68 571	11.6	2 012	0.3	593 103
Southern	732 710	37.3	1 022 358	52.1	207 834	10.6	1 962 902
Indian Ocean Islands	1 086 413	98.1	19 468	1.8	2 022	0.2	1 107 903
<b>Total</b>	<b>9 789 329</b>	<b>78.4</b>	<b>2 094 284</b>	<b>16.8</b>	<b>594 979</b>	<b>4.8</b>	<b>12 478 592</b>

irrigation. Finally, localized irrigation has only really developed (except in pilot areas) in the Northern and Southern Regions. These regions are dry but also contain some of the most developed countries of the continent.

### Origin of water in full/partial control irrigation

Table 14 presents available data concerning the origin of irrigation water in the areas under full/partial control irrigation: surface water, groundwater or other (mix of groundwater and surface water, or non-conventional water). Data are available for all the countries of the Northern Region, water resources management in dry climates being a primary element for the sustainability of irrigation systems. Conversely, it is little known in the countries of the Eastern, Sudano-Sahelian and Central Regions.

For countries that did not supply new data, this analysis has used those from the previous AQUASTAT survey (Table 30). Most of the countries for which few or no data are available withdraw mainly surface water to feed their irrigation systems. An estimate (100 percent surface water, 50 percent surface water – 50 percent groundwater, or 100 percent groundwater) has been made for these countries in order to enable a more complete analysis. Finally, for the earlier data, the percentages for each of the sources were retained and applied to areas under full/partial control at present. Therefore, these values are in order of magnitude only and are not an exact reflection of the real situation (like those in Table 13). However, it seemed worth attempting to complete the data based on the field knowledge of the AQUASTAT team in order to form a more precise picture of the sources of water used for irrigation in Africa.

With respect to “other sources”, Algeria, Botswana and Guinea-Bissau use a mix of surface water and groundwater, while Egypt, Libyan Arab Jamahiriya, and Tunisia have started using treated wastewater to increase their water resources (Tables 14 and 30).

Surface water is the main source of the water for irrigation systems on the continent level (78 percent). Only Algeria, Eritrea, Libyan Arab Jamahiriya, and Tunisia (four countries with a dry climate in the Northern and Sudano-Sahelian Regions) feed their irrigation systems mainly with groundwater. Except for Eritrea, areas under irrigation in the other three countries are close to the irrigation potential calculated on the basis of renewable water, or exceed it (70-1 175 percent of the potential). Algeria and Libyan Arab Jamahiriya withdraw non-renewable fossil groundwater to meet their agricultural water requirements.

### Scheme sizes

The definition of large schemes varies from one country to another. While certain countries consider a scheme of 25 ha as large, many countries use a minimum area of 500 ha. Schemes of more than 1 000 ha exist in about two-thirds of the 53 countries. Those of more than 10 000 ha exist in nearly one-quarter of the countries, representing

TABLE 14  
Regional distribution of the origin of water used in full/partial control irrigation

Region	Surface water		Groundwater		Other sources				Total Area (ha)
	Area	% of total	Area	% of total	Mix of surface water and groundwater		Treated wastewater		
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	
Northern	4 138 685	66.4	1 839 494	29.5	25 000	0.4	227 527	3.7	6 230 706
Sudano-Sahelian	1 986 450	94.7	111 788	5.3	0	0.0	0	0.0	2 098 238
Gulf of Guinea	230 432	64.0	122 285	34.0	7 371	2.0	0	0.0	360 088
Central	125 652	100.0	0	0.0	0	0.0	0	0.0	125 652
Eastern	446 920	75.4	146 183	24.6	0	0.0	0	0.0	593 103
Southern	1 715 995	87.4	246 849	12.6	58	0.0	0	0.0	1 962 902
Indian Ocean Islands	1 102 528	99.5	5 375	0.5	0	0.0	0	0.0	1 107 903
<b>Total</b>	<b>9 746 662</b>	<b>78.1</b>	<b>2 471 974</b>	<b>19.8</b>	<b>32 429</b>	<b>0.3</b>	<b>227 527</b>	<b>1.8</b>	<b>12 478 592</b>

TABLE 15  
Regional distribution of irrigated crops under full/partial control irrigation

Region	Rice	Other cereals	Vegetables	Root and tuber crops	Fodder	Sugar cane	Other industrial crops	Fruit trees	Other annual crops	Other permanent crops	Total
	(1 000 ha)										
Northern	658.23 (8%)	2 821.58 (33%)	1 073.27 (12%)	305.87 (4%)	1 471.40 (17%)	159.21 (2%)	873.65 (10%)	457.02 (5%)	292.40 (3%)	513.67 (6%)	8 626.30 (100%)
Sudano-Sahelian	242.19 (14%)	720.94 (43%)	138.76 (8%)	41.77 (2.5%)	141.90 (8%)	103.45 (6%)	293.42 (17.5%)	4.80 (0.5%)	5.08 (0.5%)	0.06 (0%)	1 692.37 (100%)
Gulf of Guinea	27.50 (12.5%)	38.00 (17%)	68.64 (31%)	4.21 (2%)	-	39.05 (18%)	10.96 (5%)	-	24.50 (11%)	7.37 (3.5%)	220.23 (100%)
Central	27.14 (26%)	7.55 (7%)	10.22 (10%)	-	-	23.70 (23%)	31.73 (30%)	3.50 (3%)	1.38 (1%)	--	105.22 (100%)
Eastern	108.09 (16%)	193.08 (28%)	117.17 (17%)	52.23 (7.5%)	-	29.10 (4%)	93.94 (14%)	5.85 (1%)	81.00 (12%)	3.88 (0.5%)	684.34 (100%)
Southern	20.56 (1%)	460.00 (22%)	293.39 (14%)	51.07 (2.5%)	417.90 (20%)	229.18 (11%)	280.87 (14%)	77.16 (4%)	2.23 (0%)	234.23 (11.5%)	2 066.59 (100%)
Indian Ocean Islands	1 062.40 (96.4%)	0.04 (0.01%)	0.97 (0.08%)	-	-	36.54 (3.3%)	1.85 (0.2%)	0.04 (0.01%)	-	-	1 101.84 (100%)
<b>Total</b>	<b>2 146.11 (15%)</b>	<b>4 241.19 (29%)</b>	<b>1 702.42 (12%)</b>	<b>455.15 (3%)</b>	<b>2 031.20 (14%)</b>	<b>620.23 (4%)</b>	<b>1 586.42 (11%)</b>	<b>548.37 (4%)</b>	<b>406.59 (3%)</b>	<b>759.21 (5%)</b>	<b>14 496.89 (100%)</b>

almost half of the total area under irrigation. The only truly large scheme in Africa is the Gezira-Managil scheme in the Sudan with an area of about 870 000 ha, which is irrigated with water from the Blue Nile River thanks to the Sennar Dam. There are several schemes of more than 100 000 ha in Egypt, Morocco and Sudan. Schemes of more than 50 000 ha are also found in these three countries and in Algeria, Mali and Tunisia. Generally speaking, the schemes are smaller than in Asia.

Rather than by its size, a scheme is often described by its type of management: small private farms, commercial farms, communal schemes or public schemes. A distinction is also often made between “small-scale and medium-scale irrigation schemes” and “large-scale irrigation schemes”, the latter being implemented by governments.

Only five countries (South Africa, Egypt, Madagascar, Morocco and Sudan) in Africa have a total area under water management of more than 1 million ha, compared with 20 countries in Asia.

### IRRIGATED CROPS IN FULL/PARTIAL CONTROL SCHEMES

Table 15 shows the regional distribution of irrigated crops for countries that have provided such information. The equipped areas with several crop cycles a year are counted several times, which explains why the total is superior to the physically equipped areas given in Table 12. This also gives an idea of the cropping intensity under irrigation (see below). Finally, the values from the previous AQUASTAT survey were used for countries with no new data in order to obtain a more complete picture of irrigated crops in Africa. Only six countries do not have any values. The Northern and the Southern Regions are the only ones for which all the countries have data, and the values for these regions are closer to the real situation. However, in all the regions, the country-level data are not necessarily complete and, therefore, precision is lacking. Therefore, the analysis that follows should be considered with caution.

Cereals (including rice) represent about 45 percent of the harvested irrigated crop area. Industrial crops follow with 15 percent, of which sugar cane constitutes about one-quarter (4 percent). Irrigated fodder is the third most widespread crop, representing 14 percent. Vegetables (high-value crops) follow with 12 percent. Tree crops represent only 4 percent and roots and tubers only 3 percent of the harvested irrigated crop area. Cereals are the dominant crops in all the regions except the Gulf of Guinea Region, where vegetables (31 percent) are the most important irrigated crop in terms of area.

Irrigated fodder is cultivated mainly in the Northern Region, and more precisely in Egypt (which possesses about two-thirds of irrigated fodder in Africa, notably the Alexandria clover or *Trifolium/Bersim*). It is also cultivated also in the Southern Region in a much lower proportion and in the Sudano-Sahelian Region, where its cultivation is concentrated in the Sudan, whose northern part could be assimilated with the Northern Region because of its similar geographical and climate characteristics (Table 31). Madagascar accounts for half of the area under rice in Africa, and the Northern Region for almost one-third. However, this crop is cultivated in all the regions. Root and tuber crops (mainly potatoes, sweet potatoes, and sugar beets) are most significant in the Northern Region, although they are also cultivated in the Southern, Eastern and Sudano-Sahelian Regions. Cotton is the main industrial crop and covers an area larger than that under sugar cane. Cotton cultivation is concentrated in some countries: Egypt in the Northern Region, Sudan in the Sudano-Sahelian Region, South Africa and Zimbabwe in the Southern Region, and Ethiopia in the Eastern Region. Other industrial crops are: olives (mainly in Morocco in the Northern Region), peanuts (the Northern, Sudano-Sahelian and Southern Regions), sunflowers, bananas, tobacco, tea, coffee, and soybeans. Fruit trees, dominated by citrus fruits (61 percent), are found mainly in the Northern Region while in the Southern Region they are in much smaller numbers; other regions do not cultivate them (Indian Ocean Islands and Gulf of

Guinea Regions) or their cultivation is minor (Central and Eastern Regions). Finally, the irrigated cultivation of vegetables has developed considerably in recent years, accounting for almost the entire increase in irrigated area.

The Northern Region accounts for about 60 percent of the harvested irrigated crop area but only 47 percent of the physical irrigation area. This implies a higher cropping intensity than for the whole of Africa. With 14 percent of the harvested irrigated crop area, the Southern Region ranks second in terms of irrigated crop production. With a similar percentage of equipped area on the continent (15 percent), the cropping intensity is therefore lower. Incomplete data for the other regions prevent the determining of their cropping intensity. The following section provides data on cropping intensity for those countries where information was available.

### LEVEL OF USE OF AREAS EQUIPPED FOR IRRIGATION

On the continental level, it is difficult to calculate the area of the equipped areas actually irrigated because information is missing for about ten countries in both AQUASTAT surveys. Where a country did not have new data, those of the previous survey were used. Finally, this analysis used an estimation of 80 percent of equipped area for countries without any data in order to obtain a more complete picture. This figure corresponds to the average percentage of use for the whole of Africa when only available data (recent and older) are considered.

Use rates vary considerably among those the countries that supplied such data. They range from 2.5 percent for Lesotho (only 67 ha of the equipped 2 637 ha were actually irrigated in 1999, the remaining area corresponding to schemes where the equipment for sprinkler irrigation received during the apartheid period has never really functioned) to 100 percent for Egypt, Guinea, Guinea-Bissau, South Africa and Zambia, while Madagascar, Mauritius, Morocco, and Tunisia also have rates exceeding 98 percent. Eight countries (Angola, Benin, Congo, Djibouti, Lesotho, Mozambique, Somalia, and Sudan) have use rates lower than 50 percent (Table 27). In numerous cases, low rates are explained by a deterioration in the infrastructure owing to a lack of maintenance (caused by a lack of experience or the use of non-adapted techniques) or political and economic reasons. However, other causes are: inadequate management of technical means of production under irrigation, soil impoverishment, local instability and insecurity, and the reduction of public funds allocated to irrigation.

On the regional level, the Indian Ocean Islands Region, especially influenced by Madagascar, uses practically all its areas equipped for irrigation (Table 16). The Northern and Southern Regions, with more than 90 percent of their equipped areas actually irrigated, also make good use of their equipment. However, use rates are low in the Sudano-Sahelian Region, mainly because of the Sudan. The equipped areas in the Sudan that are not actually irrigated represent 41 percent of the equipped area in

TABLE 16  
Regional distribution of actually irrigated areas

Region	Equipped areas (ha)	Actually irrigated	
		Area (ha)	% of equipped areas (%)
Northern	6 339 756	6 032 510	95
Sudano-Sahelian	2 619 950	1 266 546	48
Gulf of Guinea	565 257	465 348	82
Central	132 439	74 429	56
Eastern	616 143	506 135	82
Southern	2 063 427	1 925 625	93
Indian Ocean Islands	1 107 903	1 102 085	99
<b>Total</b>	<b>13 444 875</b>	<b>11 372 678</b>	<b>85</b>

TABLE 17  
Cropping intensity in some countries

Country	Area equipped for full/ partial control irrigation	Area actually irrigated in full/partial control irrigation	Harvested irrigated crop areas	Cropping intensity
	(ha)	(ha)	(ha)	(%)
	(1)	(2)	(3)	= 100 × (3)/(2)
Egypt	3 422 178	3 422 178	6 027 115	176
Ethiopia	289 530	289 530	410 557	142
Guinea	20 386	20 386	20 386	100
Guinea-Bissau	8 562	8 562	8 562	100
Libyan Arab Jamahiriya	470 000	316 000	441 000	140
Madagascar	1 086 291	1 080 691	1 080 691	100
Mali	97 499	97 499	171 581	176
Mauritania	45 012	22 840	22 840	100
Mauritius	21 222	20 800	20 919	101
Morocco	1 458 160	1 406 560	1 520 200	108
Sao Tome and Principe	9 700	9 700	9 700	100
Senegal	102 180	69 000	74 239	108
South Africa	1 498 000	1 498 000	1 664 300	111
Swaziland	49 843	44 840	45 482	101
Togo	2 300	1 247	1 247	100
Tunisia	367 000	367 000	367 000	100
United Republic of Tanzania	184 330	184 330	227 000	123
Zambia	55 387	55 387	55 387	100
Zimbabwe	173 513	123 900	202 430	163

the region. Countries responsible for the low use rate in the Central Region are mainly Angola, followed by the Central African Republic and Congo, their actually irrigated area being 44, 51 and 11 percent, respectively (Table 27).

Cropping intensity, another indicator of the use of equipped areas, was only calculated for 19 countries owing to the lack of data (Table 17).

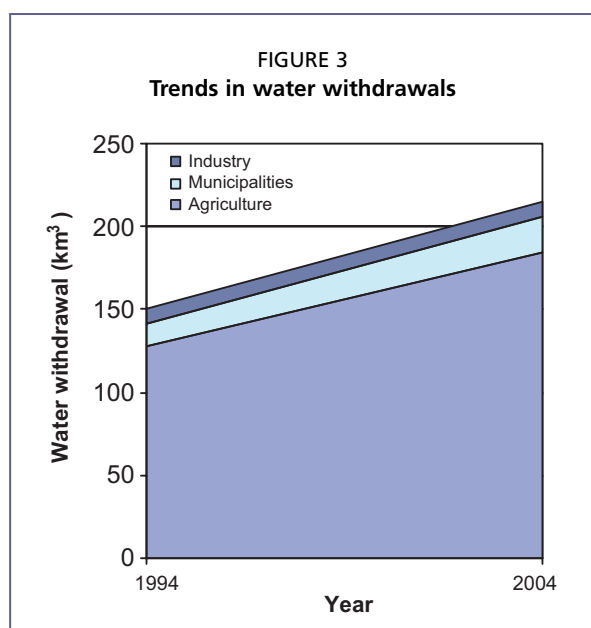
The calculation of cropping intensity is simple for dry countries because irrigation is indispensable for crops in all seasons. However, the calculation is more problematic for countries with one or more wet seasons. For two crop cycles a year, only one is irrigated (during the dry season), the second uses soil moisture provided by the precipitation. Therefore, the cropping intensity (irrigated crops only) is 100 percent on the area considered, while the harvested area is double.

### TRENDS IN THE LAST TEN YEARS

In 1994, the population of Africa was 689 million people, slightly more than 12 percent of the world's population. In 2004, it was 868 million people, or about 14 percent of the world's population. In 1994, about 66 percent of the African population lived in a rural environment compared with 61 percent in 2004 (Tables 1 and 23). This indicates that the rural exodus towards cities has not stopped but, on the contrary, it has continued. The rate of population growth in the period 1994–2004 was 2.6 percent/year, a sharp decrease compared with the 3.1 percent/year for 1984–1994. Finally, in 1994, the population density for the continent as a whole was 23 inhabitants/km<sup>2</sup> compared with 29 inhabitants/km<sup>2</sup> in 2004. This increase of 6 inhabitants/km<sup>2</sup> in the period 1994–2004 was the same as that in the period 1984–1994.

### Water withdrawals

On a sectoral basis, the proportions of water withdrawals have remained almost unchanged with agriculture remaining the main water consumer (Figure 3). However, total withdrawals have grown by 43 percent. Between the two survey dates, withdrawals



per inhabitant also increased (by 35 m<sup>3</sup>). This growth, which is much larger in SSA than in the Northern Region, reflects both the increase in the population and an increase in per-capita consumption. Finally, the Northern Region which accounted for 51 percent concentrated of total water withdrawals in Africa in the previous AQUASTAT survey, has seen its portion fall with SSA now accounting for 56 percent of total withdrawals (Table 18).

The countries with data on non-conventional resources are practically the same as in the previous publication. The volume of wastewater produced has increased by nearly 60 percent, while the volume of treated wastewater increased by a factor of more than seven and the volume of reused treated wastewater rose by a factor of nine. However, available data indicate that the volume of desalinated water remained practically

unchanged. However, these results may reflect not only real increases but also data adjustments. As a final point, it should be noted that the search for new water resources under all forms is very intense in about 15 countries, notably in the drier areas of the Northern, Sudano-Sahelian and Southern Regions.

### Irrigation and water managed areas

Table 19 presents the trends in these areas since the previous AQUASTAT report on Africa in 1995.

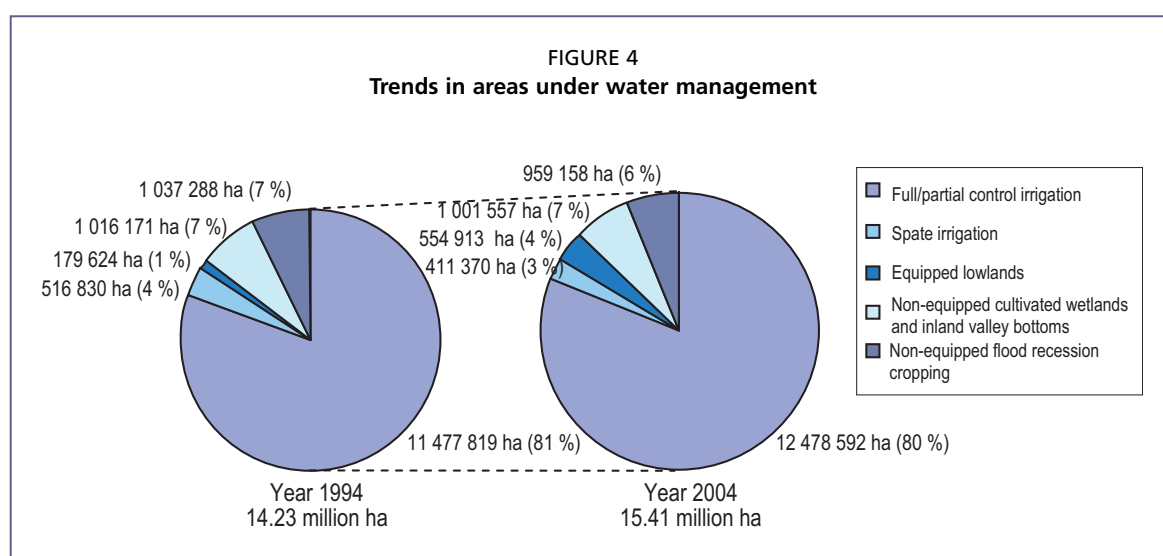
In Africa, the area under water management has increased by 1.18 million ha (8 percent) in the last ten years. This expansion is mainly the result of an increase in equipped areas (10 percent) at the expense of non-equipped areas, i.e. non-equipped cultivated wetlands and inland valley bottoms and non-equipped flood recession cropping (Figure 4). These latter types of water management contracted at an annual rate of 4.5 percent in this period. The most marked change relates to equipped lowlands. This development is explained by the development of small irrigation schemes that use techniques that do not allow full water management, but which are less expensive. It is also probable that some non-equipped cultivated wetlands and inland valley bottoms and non-equipped flood recession cropping areas have been equipped. Therefore, these are added to the “equipped lowlands” or “partial/full control irrigation” categories, which translates into a trend of increasing equipped areas.

TABLE 18  
Trends in water withdrawals

Region		Annual water withdrawal by sector									
		Agriculture		Domestic		Industry		Total			
		km <sup>3</sup>	% of total	km <sup>3</sup>	% of total	km <sup>3</sup>	% of total	km <sup>3</sup>	% of Africa	km <sup>3</sup> /inhabitant	% of internal renewable water resources
Northern	1994	65.0	85	5.5	7	5.8	8	76.3	51	590	163
	2004	79.7	85	8.8	9	5.4	6	93.9	44	616	200
Sub-Saharan Africa	1994	62.9	86	7.5	10	3.2	4	73.6	49	127	2
	2004	104.7	87	12.6	10	3.6	3	120.9	56	169	3
Total	1994	127.9	85	13.0	9	9.0	6	149.9	100	212	3.8
	2004	184.4	86	21.4	10	9.0	4	214.8	100	247	5.5

TABLE 19  
Regional trends in the areas under irrigation and water management

Region		Irrigation (ha)			Total irrigation (4) = (1) + (2) + (3)	Non-equipped cultivated wetlands and inland valley bottoms (5)	Non-equipped flood recession cropping (6)	Water management (7) = (4) + (5) + (6)
		Full/partial control irrigation	Spate irrigation	Equipped lowlands				
		(1)	(2)	(3)				
Northern	1994	5 609 700	305 000	-	5 914 700	-	-	5 914 700
	2004	6 230 706	109 050	-	6 339 756	-	-	6 339 756
Sudano-Sahelian	1994	2 258 579	211 830	8 900	2 479 309	96 796	296 023	2 872 128
	2004	2 098 238	299 520	222 192	2 619 950	67 356	257 984	2 945 290
Gulf of Guinea	1994	307 290	-	163 354	470 644	192 560	729 982	1 393 186
	2004	360 088	-	205 169	565 257	196 606	681 914	1 443 777
Central	1994	124 172	-	1 800	125 972	322 500	2 783	451 255
	2004	125 652	2 800	3 987	132 439	322 500	1 000	455 939
Eastern	1994	428 116	-	5 570	433 686	222 415	-	656 101
	2004	593 103	-	23 040	616 143	233 195	-	849 338
Southern	1994	1 645 332	-	-	1 645 332	181 900	8 500	1 835 732
	2004	1 962 902	-	100 525	2 063 427	181 900	8 510	2 253 837
Indian Ocean Islands	1994	1 104 630	-	-	1 104 630	-	-	1 104 630
	2004	1 107 903	-	-	1 107 903	-	9 750	1 117 653
Total	1994	11 477 819	516 830	179 624	12 174 273	1 016 171	1 037 288	14 227 732
	2004	12 478 592	411 370	554 913	13 444 875	1 001 557	959 158	15 405 590
<b>Change</b>		<b>+1 000 773</b>	<b>-105 460</b>	<b>+ 375 289</b>	<b>+1 270 602</b>	<b>- 14 614</b>	<b>- 78 130</b>	<b>+1 177 858</b>



For the whole continent, the increase in the equipped area is 10 percent, an annual rate of 0.88 percent in the 1992–2000 weighted year index (Table 20). The weighted year index is calculated by allocating to the year for each country a weighting coefficient proportional to its area (equipped for irrigation or under water management), therefore giving more importance to countries with the largest areas under irrigation and water management. On a national scale, the expansion in equipped areas has been concentrated in a few countries, with four countries (South

TABLE 20  
Annual increase in areas under irrigation and water management, weighted year index, 1992–2000

Region	Rate of annual increase	
	Areas under irrigation	Areas under water management
	(%)	
Northern	0.67	0.67
Sub-Saharan Africa	1.17	0.80
<b>Africa</b>	<b>0.88</b>	<b>0.73</b>



Africa, Morocco, Egypt and Zambia) accounting for nearly 60 percent of the total increase. Although the increases in equipped areas may not be as important, other countries have also shown considerable rates of increase (Table 27). However, the rate of annual increase in Ghana, the highest in Africa (30 percent), is distorted by informal irrigation that, although probably already existing, was not included in the data in the previous survey. Moreover, the area under traditional irrigation was underestimated for Ethiopia. The increase in irrigated areas in Mali (20.1 percent) is explained by the reclassification of areas previously indicated as non-equipped, which were this time accounted for as equipped areas because of better knowledge of the field situation. The increase in equipped areas in Zambia (12.9 percent) is accounted for by the equipping of areas that were non-equipped in 1992 during the first survey; indeed, the total area under water management has increased only slightly (5.7 percent). The same holds for Rwanda (11.4 percent), even though its total area under water management fell between 1993 and 2000, and again for Senegal (6.7 percent and 0.7 percent, respectively). The annual rate of increase in areas under water management is 0.73 percent, slightly lower than that of the areas equipped for irrigation (0.88 percent). For Guinea-Bissau, a more detailed inventory (1994–96) enabled a more accurate assessment of the irrigated areas, but it is not possible to speak of a real increase. Finally, the Sudan shows a drop in its areas equipped for irrigation. This is the consequence of some of its equipment being so severely degraded that it has become unusable and even beyond rehabilitation.

### **Irrigation techniques**

Available data on irrigation techniques in 1995 covered only half of the areas under full/partial control irrigation. In the present update, they concern 77 percent of these areas. Therefore, it is difficult to analyse the trends in the different irrigation techniques. A careful estimate would show that the proportion of area under surface irrigation has decreased in favour of techniques requiring less water, such as sprinkler irrigation and in particular localized irrigation (whose area has increased by a factor of almost six). The area covered by sprinkler irrigation has more than doubled, almost all of the increases being in the Southern Region, while localized irrigation is well developed in both the Northern and Southern Regions. Although these regions include the driest countries on the continent, these countries are also among the most developed, two factors favouring the adoption of these techniques.

### **Irrigated crops**

The main change in the last ten years has been a decrease in rice-growing areas and their proportion in the whole area under full/partial control irrigation. This reduction has occurred mainly because of the increase in the area under vegetables. This increase has been particularly marked in the Southern Region. The area under industrial crops has also increased, indicating that a higher percentage of irrigated area is dedicated to these crops, while the proportion of areas under sugar cane only has remained unchanged. The area under root and tuber crops has also increased, especially in the Northern Region. Areas allocated to arboriculture and to fodder crops have increased, but their respective proportion of irrigated areas has remained the same. Finally, the decline in irrigated crop areas in the Gulf of Guinea Region and in rice growing in general is reflected by the removal of the Nigerian “fadamas” from the category of harvested irrigated crop areas. In this new survey, this category includes only areas under full/partial control irrigation.

### **Use rate of areas equipped for irrigation**

Among the countries for which information is available, four have seen their rate of use for equipped areas improve in the last ten years. Areas actually irrigated in Algeria

increased from 66 percent of equipped areas in 1992 to 80 percent in 2001 (while there was also a small growth in equipped areas). The same holds for the Libyan Arab Jamahiriya (from 51 percent in 1990 to 67 percent in 2000, for identical equipped areas), Madagascar (from 82 percent to 99.5 percent between 1992 and 2000, for practically the same equipped areas) and Tunisia (from 84 percent in 1991 to 99.7 percent to 2000, for increased equipped areas). Conversely, three countries have experienced a reduction in the use of their irrigation systems. In Lesotho, the area actually irrigated declined from 7 percent of equipped areas in 1994 to 3 percent between in 1999, for the same equipped areas. In Mozambique the use rate fell from 42 percent to 34 percent between 1995 and 2001, for a slight increase in equipped area. While a more extensive use of equipped areas in the first group of countries can be explained by the rehabilitation of degraded schemes, it is often the degradation of equipment that justifies the abandonment of equipped areas in the latter group of countries. Finally, among those countries with a current use rate of less than 50 percent, the Sudan has experienced considerable degradation, with the area actually irrigated declining from 63 percent in 1995 to 43 percent in 2000.

### **WATER MANAGEMENT**

Water management in African countries is generally based on a water code. Thirty-seven countries have such a code for governing in a global way the management of water resources present on their territory. Three other countries (Gabon, Seychelles and Sudan) have included water in their legislation on the environment or on natural resources although they have no specific water law. In six other countries (Central African Republic, Democratic Republic of the Congo, Libyan Arab Jamahiriya, Rwanda, Sao Tome and Principe, and Swaziland), certain aspects of water management such as pollution, drilling or water rights are regulated, but these specific arrangements are not grouped in a water code. Five countries (Gambia, Ghana, Liberia, Sierra Leone, and Somalia) have institutions responsible for water supply or water management, but without clear definitions as to the direction that this water management should take. Finally, no information was available for two humid countries, the Comoros and Equatorial Guinea. Somaliland, in the north of Somalia, has formulated its own water policy and is working on the constitution of a water code. Of the 37 countries with a comprehensive legal framework, 25 have drafted, amended or applied it since 1995, which indicates the topicality of the subject. However, Eritrea has not yet approved its water law drafted in 1996. Finally, legislation focusing more specifically on irrigation management is rare. Only Mauritius, Kenya and Malawi have enacted an irrigation law, in 1979, 1996 and 2001, respectively. FAO has ongoing projects to assist governments in setting up a strategy for the irrigation sector and to formulate an irrigation policy in the following countries: Botswana, Eritrea, Ghana, Nigeria, Swaziland, United Republic of Tanzania, and Zambia.

The national-level institutions responsible for the management and planning of irrigation development are, for a large majority of African countries (41 out of 53), departments or divisions within the Ministry of Agriculture (37) or within the Ministry of Agriculture and Irrigation or Water Resources (4). However, the management and conservation of water resources are generally the responsibility of another ministry (of environment, natural resources, energy or water resources), and coordination between these national institutions is almost non-existent. Only Burundi, Guinea-Bissau, Mozambique and Senegal have created an interministerial committee for actions to be undertaken in synergy. Six countries have only entrusted part of their irrigation to the Ministry of Agriculture, distributing the management of the sector between several ministries (Benin, Libyan Arab Jamahiriya, Morocco, Mauritania, Sudan and Zimbabwe). Finally, only four countries have a Ministry of Water Resources that includes irrigation management: Algeria, Egypt, Kenya and Nigeria, which account for 43 percent of

the area under water management in Africa. In Congo and Guinea, irrigation is the responsibility of the Ministry of Water Resources, Minerals and Energy.

The management of the irrigation systems is generally ensured jointly by the State, as regards the primary infrastructure or public systems, and by users associations for the secondary and tertiary infrastructure or private systems. The disengagement of the State from the irrigation sector since the 1980s, and the subsequent creation of users associations that are already in place or planned (South Africa, Burundi, Côte d'Ivoire, Ghana, Madagascar, Mali, Morocco, Mauritius, Niger, Nigeria, Senegal, Sudan, Swaziland, Tunisia and Zimbabwe), as well as the more recent promotion of participatory approaches (Burkina Faso, Mauritania and Chad) concerns about 20 African countries. The example of Kenya illustrates well the choice of management transfer; indeed, all the new schemes created between 1992 and 2003 are private, while certain former public schemes are still partially administered by the State. In Egypt, rather than a transfer to the users, the government has chosen to promote their participation by replacing its formerly very centralized management with a form of joint management.

Informal irrigation, notably in the urban and peri-urban zones of large African cities, has become increasingly important. This irrigation is generally not included in official statistics or in the integrated management of resources. It is probably not included in AQUASTAT statistics (or is only partially included) for most countries because of the difficulty in obtaining data. Its growth and development are explained by the disengagement of the State in the irrigation sector and the development of private irrigation. It is generally carried out on a small scale, but represents a significant added value for each of the farmers in terms of income. It is difficult to estimate this type of irrigation on a continental scale.

Water tariffication is used in only 27 countries, 23 of which envisage charges, mainly based on irrigated area. In nine countries, it is supposed that water charges are heavily subsidized (Chad and Namibia), applied only to large schemes (Morocco), applied rarely in spite of the law (Togo and Côte d'Ivoire), or cover only the costs of operation and maintenance (Madagascar). Water and irrigation services are free in Botswana, Ethiopia, Libyan Arab Jamahiriya and Somalia.

## ENVIRONMENT AND HEALTH

Of the 29 countries for which information concerning water quality is available, 12 (Benin, Burkina Faso, Cameroon, Chad, Congo, Ghana, Guinea, Libyan Arab Jamahiriya, Malawi, Mozambique, Senegal and Zimbabwe) assert that their water is of a quality relatively suitable for irrigation and that pollution is site specific and limited mainly to human settlements without sanitation infrastructure (urban area) and to agriculture where it is mainly the result of concentrations of livestock. For the other 17 countries, agriculture is mentioned as the main source of pollution, e.g.: Algeria, Mali (in the zone of the Office of Niger), Mauritius (mainly because of sugar cane), Sudan, Swaziland (because of animals that contaminate sources), Togo (where agricultural pollution only affects surface water), and Tunisia. Among other sources of pollution, a combination of agriculture, industry and domestic waste are mentioned (Democratic Republic of the Congo, Sao Tome and Principe, Somalia, and South Africa) and, to a lesser extent, the mining industry (petroleum in the Niger Delta in Nigeria, and diamonds in Botswana and Lesotho). In the Comoros, Eritrea and Rwanda, it is population density and domestic waste that degrade water quality.

The overexploitation of aquifers (when water withdrawal exceeds water recharge) and the subsequent lowering in their levels is a problem in seven countries: Algeria, Cape Verde, Djibouti, Morocco, Nigeria, Senegal and Tunisia; a problem that can also be found in the coastal aquifers of the Comoros and the Libyan Arab Jamahiriya. This overexploitation is at the origin of seawater intrusion in Algeria and Cape Verde.

Eritrea and Mauritius (in the north and east) are also affected. Finally, the use of fossil water, that is, water from aquifers whose rate of renewal is very low and that are therefore considered as non-renewable (notably in the Libyan Arab Jamahiriya and to a lesser extent in Algeria), will cause depletion of the aquifers in the long term.

Soil salinization is a problem in 14 countries in Africa. The situation is of particular concern in Morocco, Nigeria and Sudan, where the area salinized by irrigation exceeds 100 000 ha (Table 21) although less so in Kenya, Tunisia and United Republic of Tanzania. Salinization also requires monitoring in: Djibouti, Gambia and Mozambique, where soils are naturally saline; Namibia; Niger, where 350 ha have been abandoned and others risk being so shortly; Somalia; and Zimbabwe. Finally, Egypt has controlled its salinization since the 1970s on a large part of its irrigation schemes through the installation of drainage systems (Box 1).

Other major environmental problems related to irrigation in Africa are: (i) erosion and its consequences and silting up or sedimentation of water bodies, dams and canals (ten countries); (ii) proliferation of aquatic vegetation (six countries); and (iii) the drying up or the risk of drying up of wetlands (four countries) (Box 2).

An estimated 70–90 percent of all cases of malaria in the world occur in Africa. Africa remains by far the worst affected continent, with 365 million cases of malaria in 2002. The WHO (2005) report on malaria in Africa indicates that malaria is the cause of at least one death in five among very young children. More than 80 percent of deaths caused by this pathology occur in Africa, where it threatens an estimated 66 percent of the population. According to the WHO, the only African countries where the disease is not endemic are Lesotho, Libyan Arab Jamahiriya, Seychelles and Tunisia.

## PERSPECTIVES FOR WATER MANAGEMENT IN AFRICA

Numerous countries in Africa consider water and irrigation management as a key factor to improving their food security and to ensuring access to drinking-water for their populations.

Although they already exist, water transfers are still rare. They take place either within the same country such as in Morocco (for a volume of 2.7 km<sup>3</sup> between river basins) and in the Libyan Arab Jamahiriya (transfer of fossil groundwater resources between the south and the north through the “Great Manmade River Project”) or between countries, the only example currently known being the transfer of 2.2 km<sup>3</sup>/year from the Malibamatso River in Lesotho to the Vaal River in South Africa (both in the Orange basin) within the framework of the “Lesotho Highlands Water Project”. In compensation, Lesotho receives assistance in the production of its own electricity (Table 25). Many projects to develop such transfers are being studied: in Algeria, from the south to the north; in Kenya, from Lake Victoria towards drier zones such as the Kerio in the Rift Valley, or towards the Vembere plateau (a project dating back to the German colonial period); in Botswana, between the Shashe and the Notwane rivers, both in the Limpopo basin; and water flowing towards Lake Chad to compensate for the decrease in water levels (from the Niger Basin in Nigeria, or from the Congo Basin) (Box 2).

According to available information, the current use of non-conventional sources of water (desalination, and reuse of treated wastewater) concerns less than one-third of

TABLE 21  
Salinization in certain countries

Country	Salinization		
	Year	ha	% of equipped area
Egypt	2005	250 000	7
Kenya	1999	30 000	29
Libyan Arab Jamahiriya	1998	190 000	40
Morocco	2000	150 000	10
Mozambique	1993	2 000	2
Namibia	1992	1 300	17
Niger	2000	350	0.5
Nigeria	1999	100 000	34
Sudan	1999	500 000	27
Tunisia	2000	86 000	22
United Republic of Tanzania	1999	50 000	27

## BOX 1

**Salinization and drainage in the Nile Delta**

The Nile Delta is located in Egypt north of Cairo, where the Nile River splits into the Damietta and Rosetta branches. It is bounded by the Eastern Desert and the Suez Canal in the east and by the Western Desert in the west. Some lakes are adjacent to the Mediterranean Sea (Mariut, Idku, Burullus and Manzala). The delta is about 160 km long and 250 km broad at its widest part. About 2 million ha are irrigated in the delta, which is a densely populated area. Agricultural production is intensive, the main crops being rice, cotton and maize in summer, and berseem, wheat and field beans in winter. The lakes support important fishery activities.

The climate is characterized by its aridity, average annual rainfall (from October to May) ranges from 190 mm along the Mediterranean coast to 20–50 mm in the south, annual potential evapotranspiration being about 1 400 mm in the coastal zones and increasing towards the south.

One of the problems of the Nile Delta was salinity affecting its clay-textured alluvial soils. However, after installing subsurface drainage systems on 90 percent of irrigated lands to control the saline groundwater, most of the soils of the delta now are non-saline. However, approaching the coast and lakes, soil salinity increases because of the effect of the shallow saline groundwater and seepage of brackish water from the sea and lakes through more permeable soils.

Currently, the most challenging issue in the Nile Delta is the availability of water resources both in terms of quantity and quality. Good-quality surface water is supplied by the Nile River and shallow and deep groundwater is also available.

Irrigation expansion in the Nile Valley and adjacent desert areas has limited the conventional water available to cover water demand in the Nile Delta. As irrigation requires huge amounts of water, increasing water-use efficiency is essential. This is one of the objectives of the Irrigation Improvement Project of the Ministry of Water Resources and Irrigation (MWRI).

Reuse of drainage water is another alternative considered by the MWRI through the Drainage Water Irrigation Project, started in 1998. Planned reuse is carried out by pumping water from the main drains into the main irrigation canals. In 1996–97, the amount of water pumped at the pumping station amounted to 4 400 million m<sup>3</sup> with an average salinity of 1.8 dS/m. The volume of drainage water officially reused for irrigation is expected to increase to 8 000 million m<sup>3</sup>/year in the near future. The reuse of drainage water has not generally caused major increases in soil salinity. This is because reused drainage water, after mixing with freshwater, has a low salinity content. However, pollution of drainage water by the discharge of untreated wastewater into the agricultural drainage systems has increased the deterioration of water quality in the main drains, and, therefore, it is a major threat to reuse. Farmers also use drainage water directly by pumping it from drains close to their field.

As the salinity content of water increases from the south to the north in the main drains, which is the general flow direction, and as water pollution is also increasing, one option currently being considered is to intercept drainage water with a favourable salinity content water from intermediate branch drains and to pump it into the branch canals at their intersections, while disposing of drainage water with a high salinity content in the coastal lakes in order to maintain the levels of salinity required for aquaculture.

Tests of the drainage water reuse strategies have yielded reasonable results in terms of soil salinity and crop yields. However, as local soil salinity levels might be high, especially in tail end areas where irrigation water is inadequate and groundwater salinity is high, monitoring of soil and water salinity is required. A central issue is how much of the annual drainage discharge released into the Mediterranean Sea and the coastal lakes can be reused.

the countries. This should develop considerably in the future in order to mitigate the lack of available resources in numerous dry countries.

The two trends confirming a net progress in water management in African countries are integrated water resources management (IWRM) and the development of small-

## BOX 2

**Lake Chad: reduction of its area by more than 90 percent in 40 years**

Lake Chad was formerly the largest freshwater lake in Africa but its surface area decreased from 25 000 km<sup>2</sup> in 1964 to 1 900 km<sup>2</sup> in 2003, with a variation of its level of more than 8 m and a downward trend in volume from 100 to 20 km<sup>3</sup>. The Chari-Logone rivers contribute about 95 percent of the total inflow into the lake (38.5 km<sup>3</sup>/year). The total inflow in recent times has varied between 54 km<sup>3</sup>/year in 1955/56 and 7 km<sup>3</sup>/year in 1984/85.

The extensive Lake Chad Basin is experiencing progressive degradation as climate variability and the induced environmental changes are accelerated by human demands for the natural resources in the basin (mainly land and water). The basin, with an area of almost 2.4 million km<sup>2</sup>, is home to about 42.5 million people. For the immediate region of Lake Chad, the lowering of the level of the lake and the reduction in its area have resulted in a decline in fish production, a reduction in the zone where flood recession agriculture is practised, and increased cross-border movement of local populations as they attempt to adapt to changed environmental circumstances. One major irrigation scheme in Nigeria, the Southern Lake Chad Irrigation Project, has had its intake compromised by the retreat of the lake shoreline.

The areas under irrigation in the basin are small, amounting to only 1.5 km<sup>3</sup> of water withdrawn, some 4 percent of the mean annual inflows to Lake Chad. Agricultural productivity in the immediate area around Lake Chad has declined as population pressures have increased, resulting in deforestation, bush-burning and poorly adapted agricultural practices. As a result, a vicious spiral of poverty and environmental degradation characterizes this region, particularly in the more arid Sahelian zones on the northern margins of the basin. Elsewhere in the basin, the impacts of civil strife in the Central African Republic and Sudan combined with intense natural resource competition in the Komadugu-Yobe sub-basin in Nigeria, have all been exacerbated by the impacts of prolonged regional drought as mean annual rainfall isohyets have migrated south. Further environmental impacts across the basin are anticipated as pollution from sources such as oil drilling and production, mining, and increasing fertilizer and pesticide use show upward trends. Fish capture in the upper catchments of the basin in the Chari-Logone sub-basin is particularly at risk.

Despite a number of initiatives, there is insufficient knowledge of water resources generally and of the functioning of aquatic systems specifically within the basin. There is no effective system for monitoring the quantity and quality of freshwater resources, nor are there effective water-quality protection programmes. There is ineffective management of water demand and little attention paid to adapting production methods to natural resource limitations. Last, little value is accorded to water and the environment in economic policies, and there is an absence of economic instruments and incentive measures, and of specific programmes to promote and support local initiatives. These problems overlap with the problem of short-term policy focus. However, costly environmental monitoring programmes cannot be high on the priority list of governments struggling to cope with high levels of malnutrition and poverty.

To date, there has been limited progress towards harmonizing legal frameworks at the regional level in order to protect shared water resources and make their use sustainable. If regional cooperation does not succeed in reversing the trends, further deterioration of the Lake Chad Basin natural environment will occur. FAO has offered technical and legal advice to the LCBC, particularly concerning a proposed water transfer from the Ubangui (Congo Basin) into the headwaters of the Chari-Logone sub-basin in the Central African Republic. The economic viability and environmental implications of the proposed transfer will need to be analysed with care, particularly in relation to invasive aquatic species. In addition, consent will need to be obtained from downstream riparians in the Congo Basin who are not members of the LCBC.

scale irrigation. The former appears in different policies or legislative proposals, and accompanies the protection of water resources to guarantee their long-term

sustainability. Eight countries have incorporated IWRM into their policies or have proposed doing so. As for small-scale irrigation, it is the main type of construction retained by countries still trying to develop their irrigated area. It envisages management by the users and their more active participation, and it often goes hand in hand with the introduction of lower-cost technologies (treadle pumps, “drip kits”, etc). Countries that have already developed their irrigation potential, such as South Africa or Libyan Arab Jamahiriya, no longer carry out construction work, rather, they have undertaken the development of more efficient techniques for water use (sprinkler and drip irrigation) with the aim of reducing the water volume used for crops.

Finally, in the last ten years, one of the trends in irrigation has been to equip areas previously under surface water management, such as inland valley bottoms and flood recession areas. This approach has enabled development costs to be reduced and irrigation to be increased and, therefore, raised the productivity of agricultural land. This trend can be expected to continue in the next few years with the aim of intensifying irrigation on the most easily irrigable lands.

## Main sources of general information

Documents cited in this section were useful for the writing of the summary and are not specific to a country. Literature relative to the individual countries is listed in the section “Main sources of information” at the end of each country profile.

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## Summary tables



## Explanatory notes

### Table 22

The cultivated areas for Djibouti and Egypt do not correspond to the FAOSTAT data because these latter were lower than the areas equipped for full/partial control irrigation owing to rounding of the FAOSTAT values.

### Table 27

The percentages of effectively irrigated areas do not correspond to the year indicated in the first column for Angola (1996), Democratic Republic of the Congo (2000), Gambia (1991), Guinea (2000), Malawi (1992), Mauritius (2004), Niger (2005), and Swaziland (2002).

Ghana's high annual increase in the rate of irrigation (30.1 percent) is the result of including informal irrigation which, although already existing, was not included in the areas equipped for irrigation in the previous AQUASTAT survey.

An inventory in Guinea-Bissau between 1994 and 1996 has enabled better knowledge of the areas.

The sharp increase in areas equipped for irrigation in Mali (20.1 percent/year) is explained by the addition of areas previously declared as non-equipped. However, this reclassification is not the result of new investment in these areas, only the appreciation of the level of equipment has changed.

The rate for the Sudan is negative (-0.9 percent/year) because the degradation of certain schemes is such that they are no longer usable or beyond rehabilitation.

For Rwanda, Senegal and Zambia, the high rates of increase correspond to the equipping of areas that were previously not equipped, and so to a move of certain areas from the "non-equipped" to the "equipped" category. However, the total areas under water management have not undergone such an important increase.

### Table 28

The areas under water management exceed the irrigation potential in the Libyan Arab Jamahiriya and in Algeria because the irrigation potential takes into account only renewable water resources and these countries also use non-renewable resources, mainly fossil groundwater.

### Table 29

The data on irrigation techniques are not complete for all African countries.

The sum of areas with the various irrigation techniques in Botswana and Malawi is not equal to the area equipped for full/partial control irrigation because they do not refer to the same year.

### Table 30

Data on the origin of irrigation water are not complete for all countries.

### Table 31

The total area of irrigated crops (column 3) appears only for those countries for which the total of harvested irrigated crops is known (thus enabling calculation of the cropping intensity and the percentage of the main irrigated crop).

For Morocco, the physical actually irrigated area used for the calculation of cropping intensity (1 406 560 ha) refers to 2000, in order to correspond with the year of the areas of harvested irrigated crops. Therefore, it differs from the one indicated in the profile (the most recent value dating from 2004).

SUMMARY TABLE 22  
Land use and irrigation potential

Country	Total area		Cultivable area		Cultivated area (2002)		Irrigation potential	
	area	per inhabitant	area	per inhabitant	area	per inhabitant	area	in % of cultivable area
	ha	ha/inhab	ha	ha/inhab	ha	ha/inhab	ha	%
Unit	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=100x(7)/(3)
Algeria	238 174 000	7.36	40 000 000	1.24	8 265 000	0.26	510 300	1.3
Angola	124 670 000	8.86	32 000 000	2.27	3 300 000	0.23	3 700 000	11.6
Benin	11 262 000	1.63	7 000 000	1.01	2 815 000	0.41	322 000	4.6
Botswana	58 173 000	32.41	2 908 650	1.62	380 000	0.21	13 000	0.4
Burkina Faso	27 400 000	2.05	9 000 000	0.67	4 400 000	0.33	165 000	1.8
Burundi	2 783 000	0.39	1 400 000	0.20	1 351 000	0.19	215 000	15.4
Cameroon	47 544 000	2.92	-	-	7 160 000	0.44	290 000	1.9
Cape Verde	403 000	0.85	-	-	45 000	0.10	3 109	4.4
Central African Republic	62 298 000	15.92	15 000 000	3.83	2 024 000	0.52	1 900 000	12.7
Chad	128 400 000	14.50	19 000 000	2.15	3 630 000	0.41	335 000	1.8
Comoros	223 000	0.28	-	-	132 000	0.17	300	1.8
Congo	34 200 000	8.96	-	-	240 000	0.06	340 000	2.3
Côte d'Ivoire	32 246 000	1.91	21 000 000	1.24	6 900 000	0.41	475 000	2.3
Democratic Republic of the Congo	234 486 000	4.31	80 000 000	1.47	7 800 000	0.14	7 000 000	8.8
Djibouti	2 320 000	3.26	6 000	0.01	1 012	0.00	2 400	40
Egypt	100 145 000	1.36	4 420 000	0.06	3 422 178	0.05	4 420 000	100
Equatorial Guinea	2 805 000	5.53	850 000	1.68	230 000	0.45	30 000	3.5
Eritrea	11 760 000	2.74	1 600 000	0.37	503 000	0.12	187 500	11.7
Ethiopia	110 430 000	1.52	13 200 000	0.18	10 671 000	0.15	2 700 000	20.5
Gabon	26 767 000	19.81	15 155 000	11.22	495 000	0.37	440 000	2.9
Gambia	1 130 000	0.77	430 000	0.29	255 000	0.17	80 000	18.6
Ghana	23 854 000	1.12	10 000 000	0.47	6 331 000	0.30	1 900 000	19
Guinea	24 586 000	2.85	6 000 000	0.70	1 540 000	0.18	520 000	8.7
Guinea-Bissau	3 612 000	2.35	1 100 000	0.72	548 000	0.36	281 290	25.6
Kenya	58 037 000	1.79	9 942 000	0.31	5 162 000	0.16	353 060	3.6
Lesotho	3 035 000	1.69	-	-	334 000	0.19	12 500	1.3
Liberia	11 137 000	3.19	-	-	600 000	0.17	600 000	12.0
Libyan Arab Jamahiriya	175 954 000	31.09	2 200 000	0.39	2 150 000	0.38	40 000	1.8
Madagascar	58 704 000	3.28	8 000 000	0.45	3 550 000	0.20	1 516 819	19.0
Malawi	11 848 000	0.96	3 600 000	0.29	2 440 000	0.20	161 900	4.5
Mali	124 019 000	9.25	43 700 000	3.26	4 700 000	0.35	566 000	1.3
Mauritania	102 552 000	34.41	1 000 000	0.34	500 000	0.17	250 000	25.0
Mauritius	204 000	0.17	-	-	106 000	0.09	33 000	22.0
Morocco	44 655 000	1.44	10 000 000	0.32	9 283 000	0.30	1 664 000	16.6
Mozambique	80 159 000	4.18	36 000 000	1.88	4 435 000	0.23	3 072 000	8.5
Namibia	82 429 000	40.99	25 000 000	12.43	820 000	0.41	47 300	0.2
Niger	126 700 000	10.21	16 500 000	1.33	4 500 000	0.36	270 000	1.6
Nigeria	92 377 000	0.73	61 000 000	0.48	33 000 000	0.26	2 330 510	3.8
Rwanda	2 634 000	0.31	1 511 400	0.18	1 385 000	0.16	165 000	10.9
Sao Tome and Principe	96 000	0.58	55 000	0.33	54 000	0.33	10 700	19.5
Senegal	19 672 000	1.90	3 800 000	0.37	2 506 000	0.24	409 000	10.8
Seychelles	45 000	0.55	-	-	7 000	0.09	1 000	10.0
Sierra Leone	7 174 000	1.39	5 360 000	1.04	600 000	0.12	807 000	15.1
Somalia	63 766 000	6.18	8 150 000	0.79	1 071 000	0.10	240 000	2.9
South Africa	121 909 000	2.70	18 320 000	0.41	15 712 000	0.35	1 500 000	8.2
Sudan	250 581 000	7.30	105 000 000	3.06	16 653 000	0.49	2 784 000	2.7
Swaziland	1 736 000	1.60	-	-	190 000	0.18	93 220	18.6
Togo	5 679 000	1.13	3 400 000	0.68	2 630 000	0.52	180 000	5.3
Tunisia	16 361 000	1.65	8 700 000	0.88	4 908 000	0.49	560 000	6.4
Uganda	24 104 000	0.90	16 800 000	0.63	7 200 000	0.27	90 000	0.5
United Republic of Tanzania	94 509 000	2.51	40 000 000	1.06	5 100 000	0.14	2 132 221	5.3
Zambia	75 261 000	6.89	16 350 000	1.50	5 289 000	0.48	523 000	3.2
Zimbabwe	39 076 000	3.02	-	-	3 350 000	0.26	365 624	3.7
<b>Africa</b>	<b>3 004 084 000</b>	<b>3.46</b>	<b>-</b>	<b>-</b>	<b>210 673 190</b>	<b>0.24</b>	<b>-</b>	<b>-</b>

SUMMARY TABLE 23  
Population characteristics

Country	Population (2004)		Population density	Human Development Index (2002)	HIV/AIDS prevalence as % of population age 15-49 (end 2003)	Part of economically active population in agriculture
Unit	inhabitants	% rural	inhabitants per km <sup>2</sup>		%	%
Algeria	32 339 000	41	14	0.704	0.1	23
Angola	14 078 000	64	11	0.381	3.9	71
Benin	6 918 000	55	61	0.421	1.9	50
Botswana	1 795 000	48	3	0.589	37.3	44
Burkina Faso	13 393 000	82	49	0.302	4.2	92
Burundi	7 068 000	90	254	0.339	6	90
Cameroon	16 296 000	48	34	0.501	6.9	55
Cape Verde	473 000	43	117	0.717		20
Central African Republic	3 912 000	57	6	0.361	13.5	69
Chad	8 854 000	75	7	0.379	4.8	71
Comoros	790 000	64	354	0.530		72
Congo	3 818 000	46	11	0.494	4.9	37
Côte d'Ivoire	16 897 000	55	52	0.399	7	45
Democratic Republic of the Congo	54 417 000	68	23	0.365	4.2	61
Djibouti	712 000	16	31	0.454	2.9	77
Egypt	73 390 000	58	73	0.653	< 0.1	31
Equatorial Guinea	507 000	51	18	0.703		68
Eritrea	4 297 000	80	37	0.439	2.7	76
Ethiopia	72 420 000	84	66	0.359	4.4	81
Gabon	1 351 000	15	5	0.648	8.1	33
Gambia	1 462 000	74	129	0.452	1.2	78
Ghana	21 377 000	54	90	0.568	3.1	56
Guinea	8 620 000	64	35	0.425	3.2	82
Guinea-Bissau	1 538 000	65	43	0.350		82
Kenya	32 420 000	59	56	0.488	6.7	74
Lesotho	1 800 000	82	59	0.493	28.9	38
Liberia	3 487 000	52	31		5.9	65
Libyan Arab Jamahiriya	5 659 000	13	3	0.794	0.3	5
Madagascar	17 901 000	73	30	0.469	1.7	72
Malawi	12 337 000	83	104	0.388	14.2	81
Mali	13 409 000	67	11	0.326	1.9	79
Mauritania	2 980 000	37	3	0.465	0.6	52
Mauritius	1 233 000	56	604	0.785		10
Morocco	31 064 000	42	70	0.620	0.1	33
Mozambique	19 182 000	63	24	0.354	12.2	80
Namibia	2 011 000	67	2	0.607	21.3	38
Niger	12 415 000	77	10	0.292	1.2	87
Nigeria	127 117 000	52	138	0.466	5.4	30
Rwanda	8 481 000	80	322	0.431	5.1	90
Sao Tome and Principe	165 000	62	172	0.645		62
Senegal	10 339 000	50	53	0.437	0.8	72
Seychelles	82 000	50	182	0.853		77
Sierra Leone	5 168 000	61	72	0.273		60
Somalia	10 312 000	65	16			69
South Africa	45 214 000	42	37	0.666	21.5	8
Sudan	34 333 000	60	14	0.505	2.3	57
Swaziland	1 083 000	76	62	0.519	38.8	32
Togo	5 017 000	64	88	0.495	4.1	57
Tunisia	9 937 000	36	61	0.745	<0.1	23
Uganda	26 699 000	88	111	0.493	4.1	78
United Republic of Tanzania	37 671 000	63	40	0.407	8.8	79
Zambia	10 924 000	64	15	0.389	16.5	67
Zimbabwe	12 932 000	65	33	0.491	24.6	60
<b>Africa</b>	<b>868 094 000</b>	<b>61</b>	<b>29</b>	<b>-</b>	<b>-</b>	<b>55</b>

SUMMARY TABLE 24  
Renewable water resources

Country	Average annual precipitation		Annual renewable water resources				Dependency ratio
	height	volume	Internal (IRWR)		Total (TRWR)		
			volume	per inhabitant (2004)	volume	per inhabitant (2004)	
Unit	mm	million m <sup>3</sup>	million m <sup>3</sup>	m <sup>3</sup> /inhab	million m <sup>3</sup>	m <sup>3</sup> /inhab	%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=100×((5)-(3))/(5)
Algeria	89	211 499	11 247	348	11 667	361	2.9
Angola	1 010	1 258 790	148 000	10 513	148 000	10 513	0.0
Benin	1 039	117 046	10 300	1 489	26 393	3 815	61.0
Botswana	416	241 825	2 400	1 337	12 240	6819	80.4
Burkina Faso	748	204 925	12 500	933	12 500	933	0.0
Burundi	1 274	35 460	10 060	1 423	15 484	2 191	35.0
Cameroon	1 604	762 463	273 000	16 753	285 500	17 520	4.4
Cape Verde	228	919	300	634	300	634	0.0
Central African Republic	1 343	836 662	141 000	36 043	144 400	36 912	2.4
Chad	322	413 191	15 000	1 694	43 000	4 857	65.1
Comoros	900	2 007	1 200	1 519	1 200	1 519	0.0
Congo	1 646	562 932	222 000	58 146	832 000	217 915	73.3
Côte d'Ivoire	1 348	434 676	76 840	4 548	81 140	4 802	5.3
Democratic Republic of the Congo	1 543	3 618 120	900 000	16 539	1 283 000	23 577	29.8
Djibouti	220	5 116	300	421	300	421	0.0
Egypt	51	51 374	1 800	25	58 300	794.4	96.9
Equatorial Guinea	2 156	60 481	26 000	51 282	26 000	51 282	0.0
Eritrea	384	45 147	2 800	652	6 300	1466	55.6
Ethiopia	848	936 005	122 000	1 685	122 000	1 685	0.0
Gabon	1 831	489 997	164 000	121 392	164 000	121 392	0.0
Gambia	836	9 451	3 000	2 052	8 000	5 472	62.5
Ghana	1 187	283 195	30 300	1 417	53 200	2 489	43.1
Guinea	1 651	405 939	226 000	26 218	226 000	26 218	0.0
Guinea-Bissau	1 577	56 972	16 000	10 403	31 000	20 156	48.4
Kenya	630	365 633	20 700	638	30 700	947	32.6
Lesotho	788	23 928	5 230	2 906	3 022	1 679	0.0
Liberia	2 391	266 300	200 000	57 356	232 000	66 533	13.8
Libyan Arab Jamahiriya	56	98 534	600	106	600	106.0	0.0
Madagascar	1 513	888 192	337 000	18 826	337 000	18 826	0.0
Malawi	1 181	139 960	16 140	1 308	17 280	1 401	6.6
Mali	282	349 610	60 000	4 475	100 000	7 458	40.0
Mauritania	92	94 655	400	134	11 400	3 826	96.5
Mauritius	2 041	4 164	2 751	2 231	2 751	2 231	0.0
Morocco	346	154 685	29 000	934	29 000	934	0.0
Mozambique	1 032	827 161	100 300	5 229	217 100	11 318	53.8
Namibia	285	235 253	6 160	3 063	17 715	8 809	65.2
Niger	151	190 810	3 500	282	33 650	2 710	89.6
Nigeria	1 150	1 062 335	221 000	1 739	286 200	2 251	22.8
Rwanda	1212	31 932	9 500	1 120	9 500	1 120	0.0
Sao Tome and Principe	3 200	3 072	2 180	13 212	2 180	13 212	0.0
Senegal	686	135 048	25 800	2 495	38 800	3 753	33.0
Seychelles	2 330	887	-	-	-	-	-
Sierra Leone	2 526	181 215	160 000	30 960	160 000	30 960	0.0
Somalia	282	180 075	6 000	582	14 200	1 377	57.7
South Africa	495	603 926	44 800	991	50 000	1 106	10.4
Sudan	416	1 042 417	30 000	874	64 500	1 879	76.9
Swaziland	788	13 678	2 640	2 438	4 510	4 164	41.5
Togo	1 168	66 302	11 500	2 292	14 700	2 930	21.8
Tunisia	207	33 867	4 195	422	4 595	462	8.7
Uganda	1 180	284 427	39 000	1 461	66 000	2 472	40.9
United Republic of Tanzania	1 071	1 012 191	84 000	2 230	93 000	2 469	9.7
Zambia	1 020	767 700	80 200	7 342	105 200	9 630	23.8
Zimbabwe	657	256 729	12 260	948	20 000	1 547	38.7
<b>Africa</b>	<b>678</b>	<b>20 358 940</b>	<b>3 930 903</b>	<b>4 528</b>	<b>-</b>	<b>-</b>	<b>-</b>



SUMMARY TABLE 25  
Large dams by major river basin in Africa

River basin	Countries in basin	Number of existing large dams (> 1 km <sup>3</sup> )	Height of dams (m)	Reservoir capacity (km <sup>3</sup> )	Total reservoir capacity (km <sup>3</sup> )	Main purpose*
Senegal	Guinea, Mali, Mauritania, Senegal	1	70	11.3	11.3	I
Niger	Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria,	6	23 - 79	2.2 – 15.0	31.4	I, H
Lake Chad	Algeria, Cameroon, Central African Republic, Chad, Niger, Nigeria, Sudan	4	14 - 48	1.9 – 6.5	16.6	I
Volta	Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Togo	2	? - 134	1.4 – 148.0	149.4	H
Nile	Burundi, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Uganda, United Republic of Tanzania	6	22 - 111	0.9 – 162.0	174.9	I, H
Zambezi	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe	3	70 - 171	4.9 – 188.0	231.9	I, H
Orange	Botswana, Lesotho, Namibia, South Africa	5	? - 185	1.3 – 5.7	14.2	I, H
Limpopo	Botswana, Mozambique, South Africa, Zimbabwe	2	48 - 65	2.3 – 11.2	13.5	I, H
Congo	Angola, Burundi, Cameroon, Congo, Central African Republic, Democratic Republic of the Congo, Rwanda, United Republic of Tanzania, Zambia	2	50 - 58			H
Rift Valley	Djibouti, Eritrea, Ethiopia, Kenya, Sudan, Tanzania, Uganda	2	42 - 155	1.6 – 1.9	3.5	I, H
Save	Mozambique, Zimbabwe	1	67	1.4	1.4	I
Incomati	Mozambique, South Africa, Swaziland	1	46	1.3	1.3	I, H
Cunene	Angola, Namibia	1	58	2.6	2.6	I, H
Mono	Benin, Togo	1	44	1.7	1.7	I, H
Other basins:						
Bengo,	Angola	2	41	1.5	1.5	I
Djerem, Mape, Noun	Cameroon	3	17 - 34	1.8 – 3.2	7.6	H
Bandama, Sassandra	Côte d'Ivoire	2	37 - 58	8.3 – 27.7	36.0	
Tana	Kenya	1	70	1.6	1.6	H
El Abid, Inaouene, Ouergha, Oum R'Bia	Morocco	4	72 - 133	1.2 – 2.8	9.1	I, H
Lurio, Pungoé, Revué	Mozambique	3	40 - 75	1.2 – 2.5	5.3	H
Nuvejaarspruit, Pongola	South Africa	3	?	2.5 – 3.2	8.3	I
Great Ruaha/Rufiji	United Republic of Tanzania	1	45	3.2	3.2	H
<b>TOTAL</b>		<b>53</b>	<b>14 - 171</b>	<b>0.9 – 188.0</b>	<b>726.3</b>	
<b>Total Africa</b>					<b>798</b>	

\* I = Irrigation, H = Hydropower, 1 km<sup>3</sup> = 10<sup>9</sup> m<sup>3</sup> = 1 billion m<sup>3</sup> = 1 000 million m<sup>3</sup>

SUMMARY TABLE 26

## Water withdrawals

Country	Year	Annual water withdrawal									
		Agriculture		Municipalities		Industries		Total			
Unit		volume	% of total	volume	% of total	volume	% of total	volume	In % of IRWR	in % of TRWR	per inhabitant
		million m <sup>3</sup>	%	million m <sup>3</sup>	%	million m <sup>3</sup>	%	million m <sup>3</sup>	%	%	m <sup>3</sup> /inhab
		(1)	(2)= 100x(1)/(7)	(3)	(4)= 100x(3)/(7)	(5)	(6)= 100x(5)/(7)	(7)= (1)+(3)+(5)	(8)	(9)	(10)
Algeria	2000	3 938	65	1 335	22	801	13	6 074	54.0	52.1	201
Angola	2000	211	62	76	22	56	16	343	0.2	0.2	28
Benin	2001	59	45	41	32	30	23	130	1.3	0.5	20
Botswana	2000	80	41	79	41	35	18	194	8.1	1.6	112
Burkina Faso	2000	690	86	104	13	6	1	800	6.4	6.4	67
Burundi	2000	222	77	49	17	17	6	288	2.9	1.9	46
Cameroon	2000	728	74	178	18	79	8	985	0.4	0.3	65
Cape Verde	2000	20	91	1.6	7	0.4	2	22	7.3	7.3	50
Central African Republic	2000	1	5	17	77	4	18	22	0.0	0.0	6
Chad	2000	190	83	40	17	-	-	230	1.5	0.5	29
Comoros	1999	4.7	47	4.8	48	0.5	5	10	0.8	0.8	15
Congo	2002	4	9	32	70	10	21	46	0.0	0.0	13
Côte d'Ivoire	2000	604	65	217	23	110	12	931	1.2	1.1	59
Democratic Rep. of the Congo	2000	112	31	186	52	58	16	356	0.0	0.0	7
Djibouti	2000	3	16	16	84	-	-	19	6.3	6.3	29
Egypt	2000	59 000	86	5 300	8	4 000	6	68 300	3794.4	117.2	1 008
Equatorial Guinea	2000	1	1	88	83	17	17	106	0.4	0.4	232
Eritrea	2004	550	94.5	31	5.3	1	0.2	582	20.8	9.2	135
Ethiopia	2002	5 204	93.6	333	6	21	0.4	5 558	4.6	4.6	81
Gabon	2000	52	41	62	48	14	11	128	0.1	0.1	102
Gambia	2000	21.3	67	6.9	22	3.6	11	31.8	1.1	0.4	24
Ghana	2000	652	66	235	24	95	10	982	3.2	1.8	50
Guinea	2000	1 365	90	117	8	35	35	1 517	0.7	0.7	187
Guinea-Bissau	2000	144	82	23	13	8	8	175	1.1	0.6	128
Kenya	2003	2 165	79	470	17	100	100	2 735	13.2	8.9	87
Lesotho	2000	0.6	1.5	21	48	22	22	43.6	0.8	1.4	24
Liberia	2000	60	56	30.4	28.5	16.4	15.5	106.8	0.1	0.0	36
Libyan Arab Jamahiriya	2000	3 544	83	600	14	124	3	4 268	711.3	711.3	815
Madagascar	2000	14 313	96	423	2.5	234	1.5	14 970	4.4	4.4	937
Malawi	2000	810	80	148	15	47	5	1 005	6.2	5.8	88
Mali	2000	5 900	90	590	9	56	1	6 546	10.9	6.5	550
Mauritania	2000	1 500	88	150	9	48	3	1 698	424.5	14.9	642
Mauritius	2003	491	67	214	30	20	3	725	26.4	26.4	594
Morocco	2000	11 010	87	1 237	10	360	3	12 607	43.5	43.5	433
Mozambique	2000	550	87	70	11	15	2	635	0.6	0.3	36
Namibia	2000	213	71	73	24	14	5	300	4.9	1.7	158
Niger	2000	2 080	95	94	4	12	1	2 186	62.5	6.5	204
Nigeria	2000	5 507	69	1 687	21	810	10	8 004	3.6	2.8	70
Rwanda	2000	102	68	36	24	12	8	150	1.6	1.6	19
Sao Tome and Principe	1993	-	-	-	-	-	-	7	0.3	0.3	56
Senegal	2002	2 065	93	98	4	58	3	2 221	8.6	5.7	225
Seychelles	2003	0.9	7	8	65	3.4	28	12.3	-	-	152
Sierra Leone	2000	353.6	93	19.6	5	6.7	2	379.9	0.2	0.2	86
Somalia	2000	3 281	99.5	15	0.5	2	0	3 298	55.0	23.2	333
South Africa	2000	7 836	63	3 904	31	756	6	12 496	27.9	25.0	284
Sudan	2000	36 069	97	987	2.5	258	0.5	37 314	124.4	57.9	1 187
Swaziland	2000	1 006	97	24	2	12	1	1 042	39.5	23.1	998
Togo	2002	76	45	89	53	4	2	169	1.5	1.1	35
Tunisia	2000	2 165	82	365	14	110	4	2 640	62.9	57.5	277
Uganda	2002	120	40	134	45	46	15	300	0.8	0.5	12
United Republic of Tanzania	2002	4 632	89	527	10	25	1	5 184	6.2	5.6	143
Zambia	2000	1 320	76	286	16	131	8	1 737	2.2	1.7	162
Zimbabwe	2002	3 318	79	589	14	298	7	4 205	34.3	21.0	325
<b>Africa</b>	-	<b>184 349.1</b>	<b>86</b>	<b>21 462.3</b>	<b>10</b>	<b>9 003</b>	<b>4</b>	<b>214 814.4</b>	<b>5.5</b>	<b>-</b>	<b>247</b>

SUMMARY TABLE 27  
Area under irrigation

Country	Year	Full/partial control irrigation	Spate irrigation	Equipped lowlands	Total irrigation	% of cultivated area	Part of equipped area actually irrigated	Annual increase rate
Unit		ha	ha	ha	ha	%	%	%
		(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)	(7)
Algeria	2001	513 368	56 050	-	569 418	6.9	80	0.3
Angola	1975	80 000	-	-	80 000	2.4	44	-
Benin	2002	10 973	-	1 285	12 258	0.4	23	2.3
Botswana	2002	1 439	-	-	1 439	0.4	-	0.4
Burkina Faso	2001	18 600	-	6 400	25 000	0.6	100	0.3
Burundi	2000	6 960	-	14 470	21 430	1.6	-	2.7
Cameroon	2000	22 450	2 800	404	25 654	0.4	-	1.6
Cape Verde	1997	2 780	-	-	2 780	6.2	66	0.0
Central African Republic	1987	135	-	-	135	0.0	51	-
Chad	2002	30 273	-	-	30 273	0.8	87	5.7
Comoros	1987	130	-	-	130	0.1	65	-
Congo	1993	217	-	1 783	2 000	1	11	-
Côte d'Ivoire	1994	47 750	-	25 000	72 750	1.1	92	-
Democratic Republic of the Congo	1995	10 000	-	500	10 500	0.1	70	-
Djibouti	1999	1 012	-	-	1 012	100	38	4.1
Egypt	2002	3 422 178	-	-	3 422 178	100	100	0.6
Equatorial Guinea	-	-	-	-	-	0.0	-	-
Eritrea	1993	4 100	17 490	-	21 590	4.3	62	-
Ethiopia	2001	289 530	-	-	289 530	2.5	-	6.2
Gabon	1987	3 150	-	1 300	4 450	1	-	-
Gambia	1999	2 149	-	-	2 149	1	65	3.2
Ghana	2000	30 900	-	-	30 900	0.5	90	30.1
Guinea	2002	20 386	-	74 528	94 914	6.2	100	0.3
Guinea-Bissau	1996	8 562	-	13 996	22 558	5.1	100	14.8
Kenya	2003	103 203	-	-	103 203	2.0	94	4.1
Lesotho	1999	2 637	-	-	2 637	0.8	3	-
Liberia	1987	100	-	2 000	2 100	0.3	-	-
Libyan Arab Jamahiriya	2000	470 000	-	-	470 000	21.9	67	0.0
Madagascar	2000	1 086 291	-	-	1 086 291	31	100	0.0
Malawi	2002	56 390	-	-	56 390	2.3	96	7.3
Mali	2000	97 499	-	138 292	235 791	5.0	75	20.1
Mauritania	1994	45 012	-	-	45 012	9.4	51	-
Mauritius	2002	21 222	-	-	21 222	20.0	98	2.8
Morocco	2000	1 458 160	26 000	-	1 484 160	16	98	1.1
Mozambique	2001	118 120	-	-	118 120	2.8	34	1.3
Namibia	2002	7 573	-	-	7 573	0.9	100	2.1
Niger	2005	13 663	-	60 000	73 663	1.6	89	0.9
Nigeria	2004	238 117	-	55 000	293 117	0.9	75	1.8
Rwanda	2000	3 500	-	5 000	8 500	0.7	-	11.4
Sao Tome and Principe	1991	9 700	-	-	9 700	23.7	-	-
Senegal	2002	102 180	-	17 500	119 680	4.8	58	6.7
Seychelles	2003	260	-	-	260	3.7	77	-
Sierra Leone	1992	1 000	-	28 360	29 360	5.4	-	-
Somalia	2003	50 000	150 000	-	200 000	18.7	33	0.0
South Africa	2000	1 498 000	-	-	1 498 000	9.5	100	2.8
Sudan	2000	1 730 970	132 030	-	1 863 000	11.2	43	-0.9
Swaziland	2000	49 843	-	-	49 843	26.2	90	-
Togo	1996	2 300	-	5 000	7 300	0.3	86	0.7
Tunisia	2000	367 000	27 000	-	394 000	7.9	100	0.3
Uganda	1998	5 580	-	3 570	9 150	0.1	64	0.0
United Republic of Tanzania	2002	184 330	-	-	184 330	3.6	-	2.3
Zambia	2002	55 387	-	100 525	155 912	2.9	100	12.9
Zimbabwe	1999	173 513	-	-	173 513	5.2	71	6.9
<b>Africa</b>	-	<b>12 478 592</b>	<b>411 370</b>	<b>554 913</b>	<b>13 444 875</b>	<b>6.4</b>	<b>81</b>	<b>0.88</b>

SUMMARY TABLE 28  
Water managed area

Country	Year	Area equipped for irrigation (table 27)	Non-equipped cultivated wetlands & valley bottoms	Non-equipped flood recession cropping area	Total water managed area	% of irrigation potential	% of cultivated area
Unit		ha	ha	ha	ha	%	%
		(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)
Algeria	2001	569 418	-	-	569 418	112	6.9
Angola	1975	80 000	320 000	-	400 000	6	11.8
Benin	2002	12 258	6 988	-	19 246	6	0.7
Botswana	2002	1 439	-	6 500	7 939	61	2.1
Burkina Faso	2001	25 000	21 400	-	46 400	28	1.1
Burundi	2000	21 430	83 000	-	104 430	49	7.9
Cameroon	2000	25 654	-	-	25 654	9	0.4
Cape Verde	1997	2 780	-	-	2 780	89	6.2
Central African Republic	1987	135	500	-	635	0	0.0
Chad	2002	30 273	-	125 000	155 273	46	4.3
Comoros	1987	130	-	-	130	43	0.1
Congo	1993	2 000	-	-	2 000	1	1.0
Côte d'Ivoire	1994	72 750	16 250	-	89 000	19	1.4
Democratic Republic of the Congo	1995	10 500	2 000	1 000	13 500	0	0.2
Djibouti	1999	1 012	-	-	1 012	42	100.0
Egypt	2002	3 422 178	-	-	3 422 178	77	100.0
Equatorial Guinea	-	-	-	-	-	0	0.0
Eritrea	1993	21 590	-	-	21 590	12	4.3
Ethiopia	2001	289 530	-	-	289 530	11	2.5
Gabon	1987	4 450	-	-	4 450	1	1.0
Gambia	1999	2 149	13 170	-	15 319	19	6.8
Ghana	2000	30 900	-	-	30 900	2	0.5
Guinea	2002	94 914	-	-	94 914	18	6.2
Guinea-Bissau	1996	22 558	29 368	-	51 926	18	11.7
Kenya	2003	103 203	6 415	-	109 618	31	2.1
Lesotho	1999	2 637	-	-	2 637	21	0.8
Liberia	1987	2 100	18 000	-	20 100	3	3.3
Libyan Arab Jamahiriya	2000	470 000	-	-	470 000	1175	21.9
Madagascar	2000	1 086 291	-	9 750	1 096 041	72	31.3
Malawi	2002	56 390	61 900	-	118 290	73	4.8
Mali	2000	235 791	-	60 000	295 791	52	6.3
Mauritania	1994	45 012	32 786	30 984	108 782	44	22.7
Mauritius	2002	21 222	-	-	21 222	64	20.0
Morocco	2000	1 484 160	-	-	1 484 160	89	16.0
Mozambique	2001	118 120	-	-	118 120	4	2.8
Namibia	2002	7 573	-	2 000	9 573	20	1.2
Niger	2000	73 663	-	12 000	85 663	32	1.9
Nigeria	2004	293 117	-	681 914	975 031	42	3.0
Rwanda	2000	8 500	94 000	-	102 500	62	8.9
Sao Tome and Principe	1991	9 700	-	-	9 700	91	23.7
Senegal	2002	119 680	-	30 000	149 680	37	6.0
Seychelles	2003	260	-	-	260	26	3.7
Sierra Leone	1992	29 360	126 000	-	155 360	19	28.8
Somalia	2003	200 000	-	-	200 000	83	18.7
South Africa	2000	1 498 000	-	-	1 498 000	100	9.5
Sudan	2000	1 863 000	-	-	1 863 000	67	11.2
Swaziland	2000	49 843	-	-	49 843	53	26.2
United Republic of Tanzania	2002	184 330	-	-	184 330	9	3.6
Togo	1996	7 300	-	-	7 300	4	0.3
Tunisia	2000	394 000	-	-	394 000	70	7.9
Uganda	1998	9 150	49 780	-	58 930	65	0.8
Zambia	2002	155 912	100 000	10	255 922	49	4.8
Zimbabwe	1999	173 513	20 000	-	193 513	53	5.8
<b>Africa</b>	-	<b>13 444 875</b>	<b>1 001 557</b>	<b>959 158</b>	<b>15 405 590</b>		<b>7.3</b>

SUMMARY TABLE 29

## Full/partial control irrigation techniques

Country	Year	Full/partial control irrigation – equipped area		
		Surface irrigation	Sprinkler irrigation	Localized irrigation
Unit		ha	ha	ha
Algeria	2001	-	40 000	-
Angola	1975	-	-	-
Benin	2002	5 043	4 570	1 360
Botswana	1992	218	892	271
Burkina Faso	2001	14 700	3 900	-
Burundi	2000	6 960	-	-
Cameroon	2000	17 020	5 430	-
Cape Verde	1997	-	-	200
Central African Republic	1987	-	-	-
Chad	2002	26 519	3 754	-
Comoros	1987	-	-	-
Congo	1993	216	0	1
Côte d'Ivoire	1994	11 750	36 000	-
Democratic Republic of the Congo	1995	10 000	-	-
Djibouti	1999	-	-	-
Egypt	2000	3 028 853	171 910	221 415
Equatorial Guinea	-	-	-	-
Eritrea	1993	4 100	-	-
Ethiopia	2001	283 163	6 355	12
Gabon	1987	-	-	-
Gambia	1999	2 149	-	-
Ghana	2000	24 600	6 300	-
Guinea	2001	19 926	300	160
Guinea-Bissau	1996	8 562	-	-
Kenya	2003	39 217	61 986	2 000
Lesotho	1999	-	-	-
Liberia	1987	-	-	-
Libyan Arab Jamahiriya	2000	-	-	-
Madagascar	2000	1 083 891	2 400	0
Malawi	2000	6 357	43 193	5 450
Mali	2000	97 499	-	-
Mauritania	1994	-	-	-
Mauritius	2002	2 372	17 028	1 822
Morocco	2000	1 208 512	151 673	97 975
Mozambique	2001	-	-	-
Namibia	2002	2 950	3 276	1 347
Niger	2000	-	-	-
Nigeria	2004	238 067	50	-
Rwanda	2000	3 500	-	-
Sao Tome and Principe	1991	-	-	-
Senegal	2002	102 180	-	-
Seychelles	2003	20	40	200
Sierra Leone	1992	1 000	-	-
Somalia	2002	50 000	-	-
South Africa	2000	500 000	820 000	178 000
Sudan	2000	-	-	-
Swaziland	2000	25 887	20 905	3 051
Togo	1996	2 300	-	-
Tunisia	2000	215 000	90 000	62 000
Uganda	1998	5 350	230	-
United Republic of Tanzania	2002	-	-	-
Zambia	2002	32 189	17 570	5 628
Zimbabwe	2002	46 849	112 783	13 881



SUMMARY TABLE 31  
Harvested irrigated crops on full/partial control irrigation areas

Country	Year	Irrigated crops	Cropping intensity	Main irrigated crops		
				Name	Area	in % of total irrigated crops
					ha	%
Algeria	1986	-		Vegetable	95 000	-
Angola	1972	-		Sugar cane	12 500	-
Benin	1998	-		Vegetables	1 107	-
Botswana	2002	-		Fruit	321	-
Burkina Faso	2002	-		Rice	9 470	-
Burundi	2000	-		Rice	4 210	-
Cameroon	2000	-		Rice	20 388	-
Cape Verde	2004	-		Sugar cane	1 000	-
Central African Republic	-	-		-	-	-
Chad	2002	-		Rice	10 000	-
Comoros	-	-		-	-	-
Congo	1993	-		Vegetables	217	-
Côte d'Ivoire	1995	-		Sugar cane	18 118	-
Democratic Republic of the Congo	1995	-		Sugar cane	11 200	-
Djibouti	1989	-		Vegetables	-	-
Egypt	2002	6 027 115	176	Fodder	1 195 903	20
Equatorial Guinea	-	-		-	-	-
Eritrea	1993	-		-	-	-
Ethiopia	2002	410 557	142	Vegetables	107 126	26
Gabon	1987	-		Rice	4 450	-
Gambia	-	-		-	-	-
Ghana	2002	-		Rice	5 238	-
Guinea	2001	20 386	100	Rice	13 726	67
Guinea-Bissau	1996	8 562	100	-	-	-
Kenya	2003	-		Coffee	14 533	-
Lesotho	-	-		-	-	-
Liberia	-	-		-	-	-
Libyan Arab Jamahiriya	2000	441 000	140	Olive	110 000	25
Madagascar	2000	1 080 691	100	Rice	1 062 398	98
Malawi	2000	-		Sugar cane	21 685	-
Mali	2000	171 581	176	Rice	144 514	84
Mauritania	2004	22 840	100	Rice	16 874	74
Mauritius	2002	20 919	101	Sugar cane	19 490	93
Morocco	2000	1 520 200	108	Wheat	371 400	24
Mozambique	2001	-		Sugar cane	23 858	-
Namibia	1991	-		Maize	2 200	-
Niger	1997	-		Vegetables	22 500	-
Nigeria	1999	-		Vegetables	68 000	-
Rwanda	-	-		-	-	-
Sao Tome and Principe	1991	9 700	100	Cocoa	9 500	98
Senegal	1997	74 239	108	Rice	56 412	76
Seychelles	2003	-		Vegetables	211	-
Sierra Leone	1992	-		-	-	-
Somalia	1984	-		Maize	150 000	-
South Africa	2000	1 664 300	111	Fodder	407 900	25
Sudan	2000	-		Cotton	166 900	-
Swaziland	2002	45 482	101	Sugar cane	41 516	91
Togo	1996	1 247	100	Sugar cane	933	75
Tunisia	2000	367 000	100	Vegetables	93 400	25
Uganda	1998	-		Rice	1 650	-
United Republic of Tanzania	2002	227 000	123	Rice	89 000	39
Zambia	2002	55 387	100	Sugar cane	18 418	33
Zimbabwe	1999	202 430	163	Wheat	49 100	24

SUMMARY TABLE 32  
Africa compared to the world

Variable	Unit	Africa	World	Africa as % of the world
Total area	1 000 ha	3 004 084	13 442 788	22
Cultivated area 2002	1 000 ha	210 697	1 540 708	14
• in % of total area	%	7	11	
• per inhabitant	ha	0.24	0.24	
• per economic active person engaged in agriculture	ha	1.03	1.16	
Total population 2004	inhabitants	868 094 000	6 377 646 000	14
Population growth 2003-2004	%/year	2.2	1.2	
Population density	inhabitants/km <sup>2</sup>	29	47	
Rural population as % of total population	%	61	51	
Economically active population engaged in agriculture	%	56	21	
Precipitation	km <sup>3</sup> /year	20 359	110 000	18
	mm/year	678	818	
Renewable water resources	km <sup>3</sup> / year	3 931	43 744	9
• per inhabitant	m <sup>3</sup> /year	4 521	6 859	
Total water withdrawal	km <sup>3</sup> /year	215	3 818	6
- agricultural	km <sup>3</sup> /year	184	2 661	7
- in % of total water withdrawal	%	86	70	
- domestic	km <sup>3</sup> /year	22	380	6
- in % of total water withdrawal	%	10	10	
- industrial	km <sup>3</sup> /year	9	777	1
- in % of total water withdrawal	%	4	20	
• in % of renewable water resources	%	5.5	8.7	
• per inhabitant	m <sup>3</sup> / year	271	599	
Irrigation	ha	13 444 875	277 285 000	5
• in % of cultivated area	%	6	18	





## Continental figures



## Explanatory notes

### **Egypt**

The total water withdrawal for agricultural, domestic and industrial purposes is estimated at 63.8 km<sup>3</sup>, equal to 3 794 percent of the internal renewable water resources (1.8 km<sup>3</sup>). Most of the water is withdrawn from the transboundary Nile River, of which 55.5 km<sup>3</sup> is secured to Egypt by a treaty.

### **Libyan Arab Jamahiriya**

The total water withdrawal for agricultural, domestic and industrial purposes is estimated at 4.3 km<sup>3</sup>, equal to 711 percent of the internal renewable water resources (0.6 km<sup>3</sup>). A significant part of withdrawal comes from non-renewable groundwater resources, mainly from fossil aquifers in south of the country.

### **Mauritania**

The total water withdrawal for agricultural, domestic and industrial purposes is estimated at 1.7 km<sup>3</sup>, equal to 425 percent of the internal renewable water resources (0.4 km<sup>3</sup>). Most of the water is withdrawn from the transboundary Senegal River but no treaty guarantees its availability.

### **Sudan**

The total water withdrawal for agricultural, domestic and industrial purposes is estimated at 37.3 km<sup>3</sup>, equal to 124 percent of the internal renewable water resources (30 km<sup>3</sup>). Most of the water is withdrawn from the transboundary Nile River but no treaty guarantees its availability.

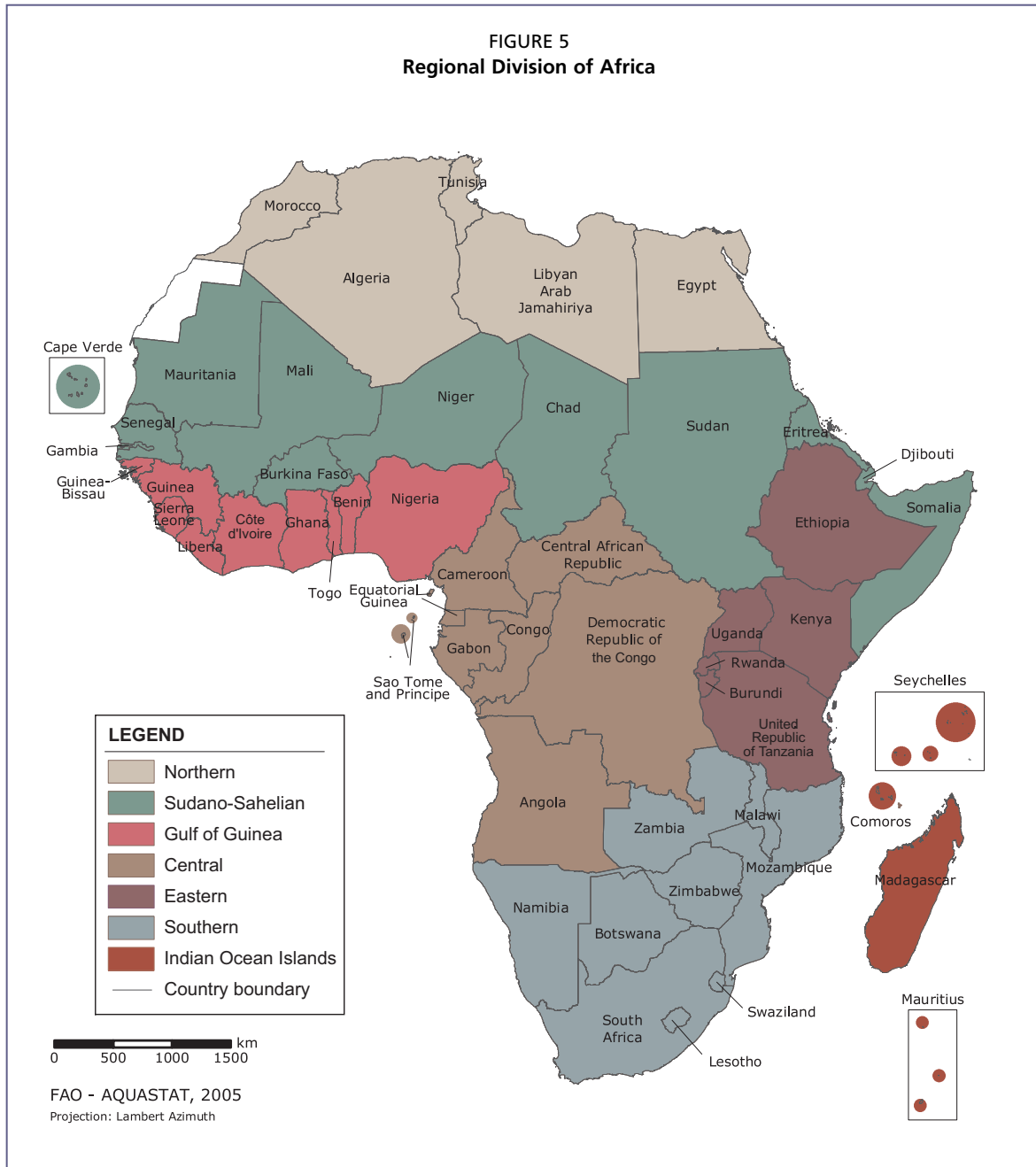
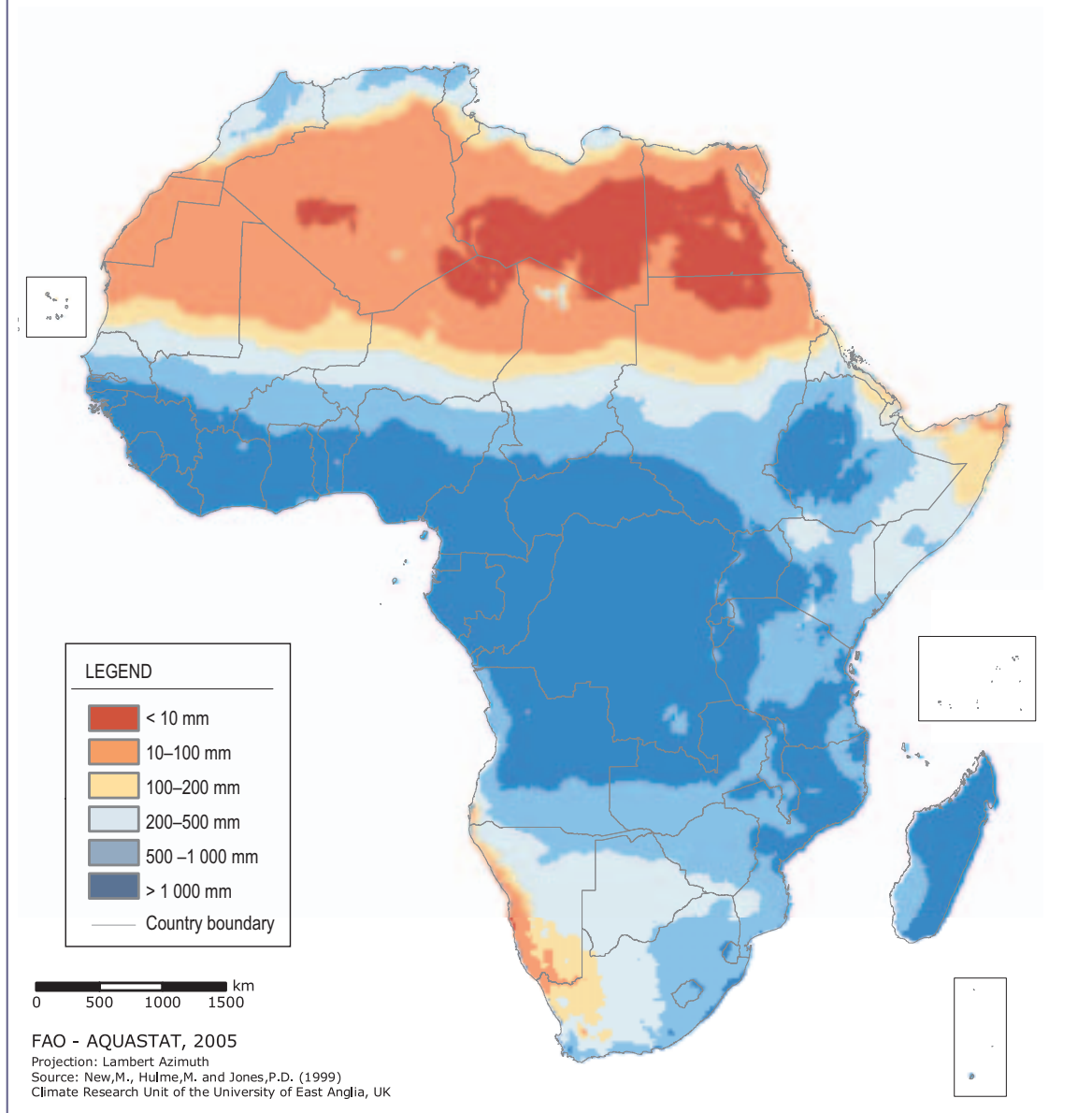
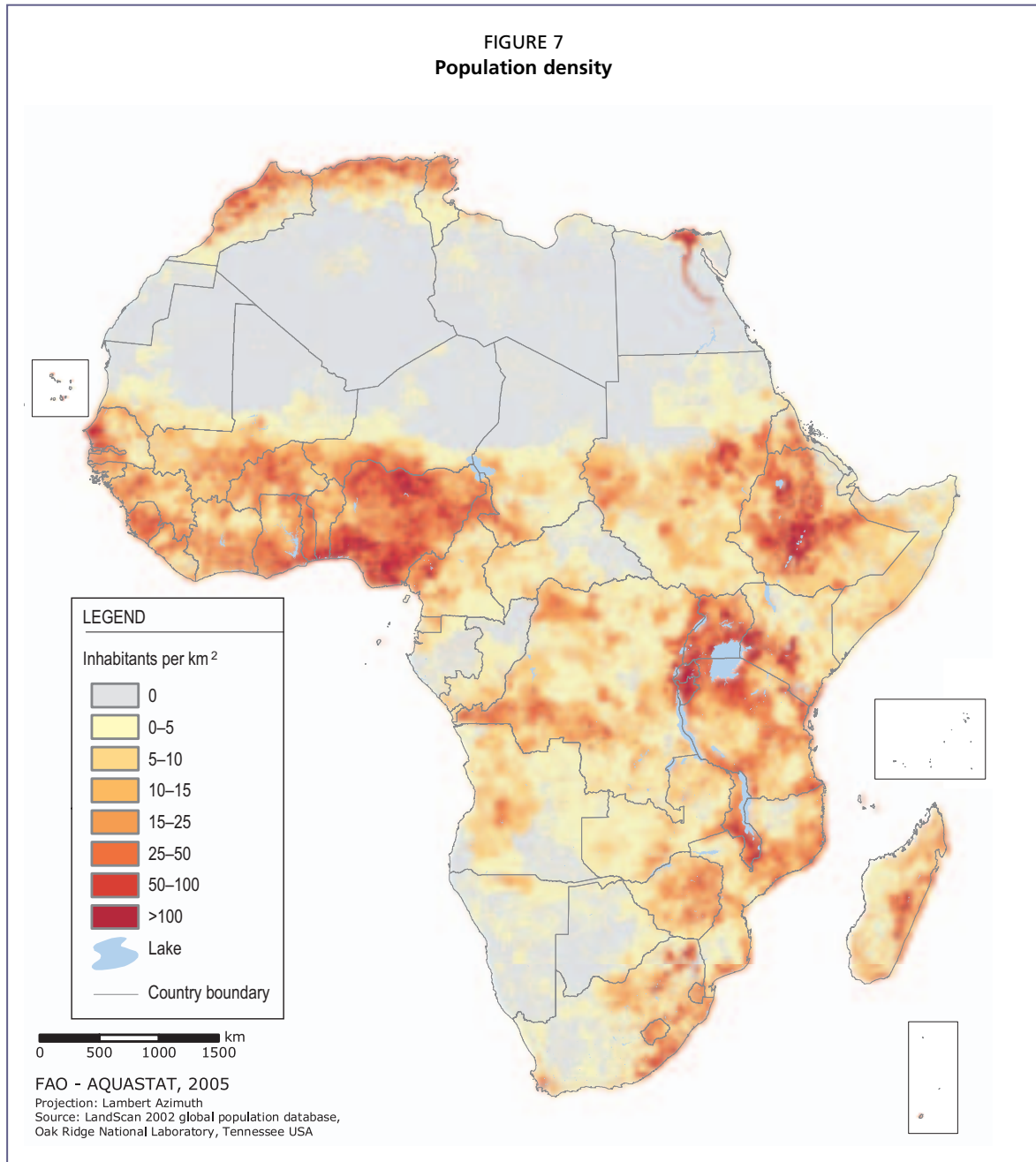
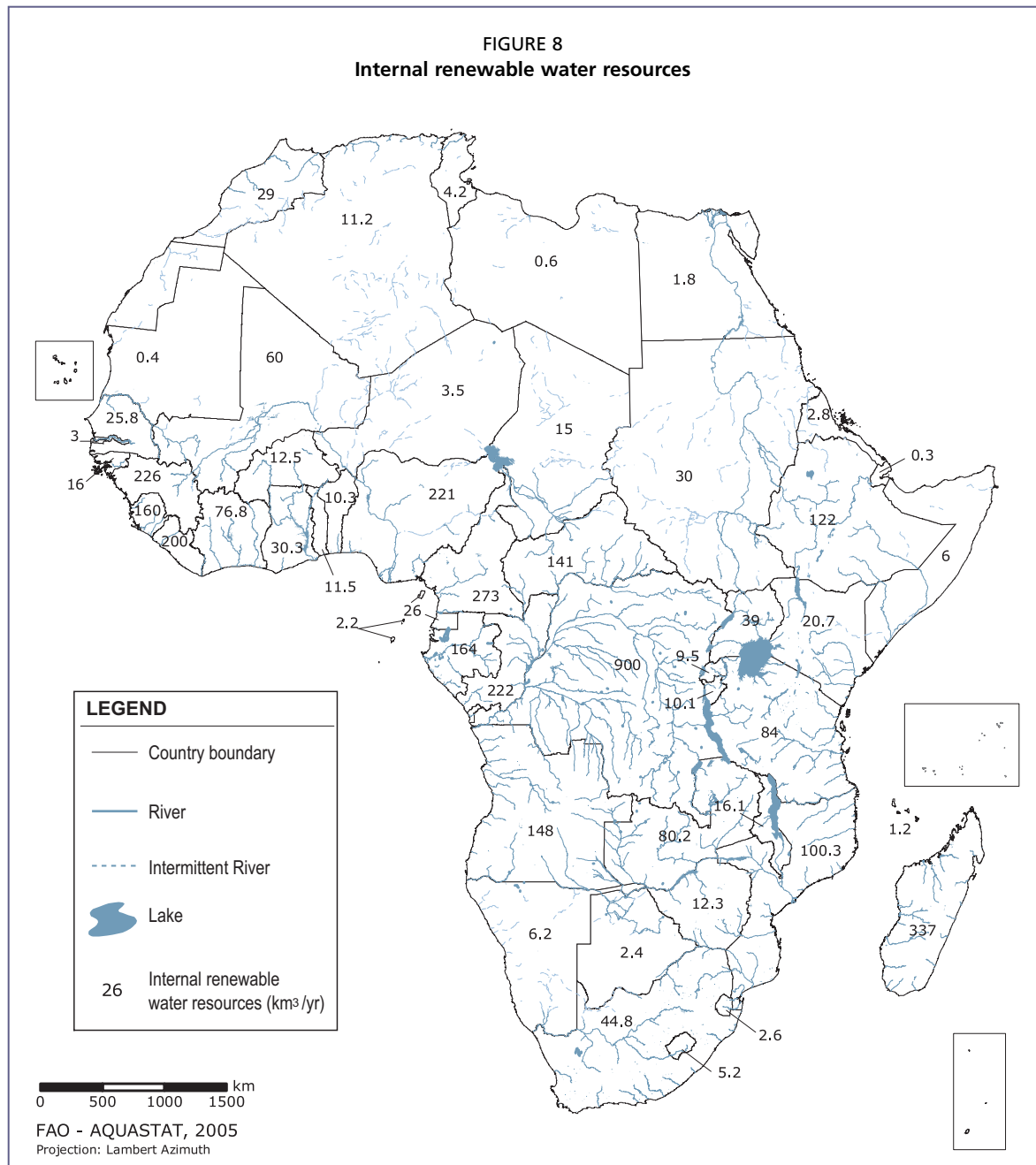


FIGURE 6  
Average annual rainfall



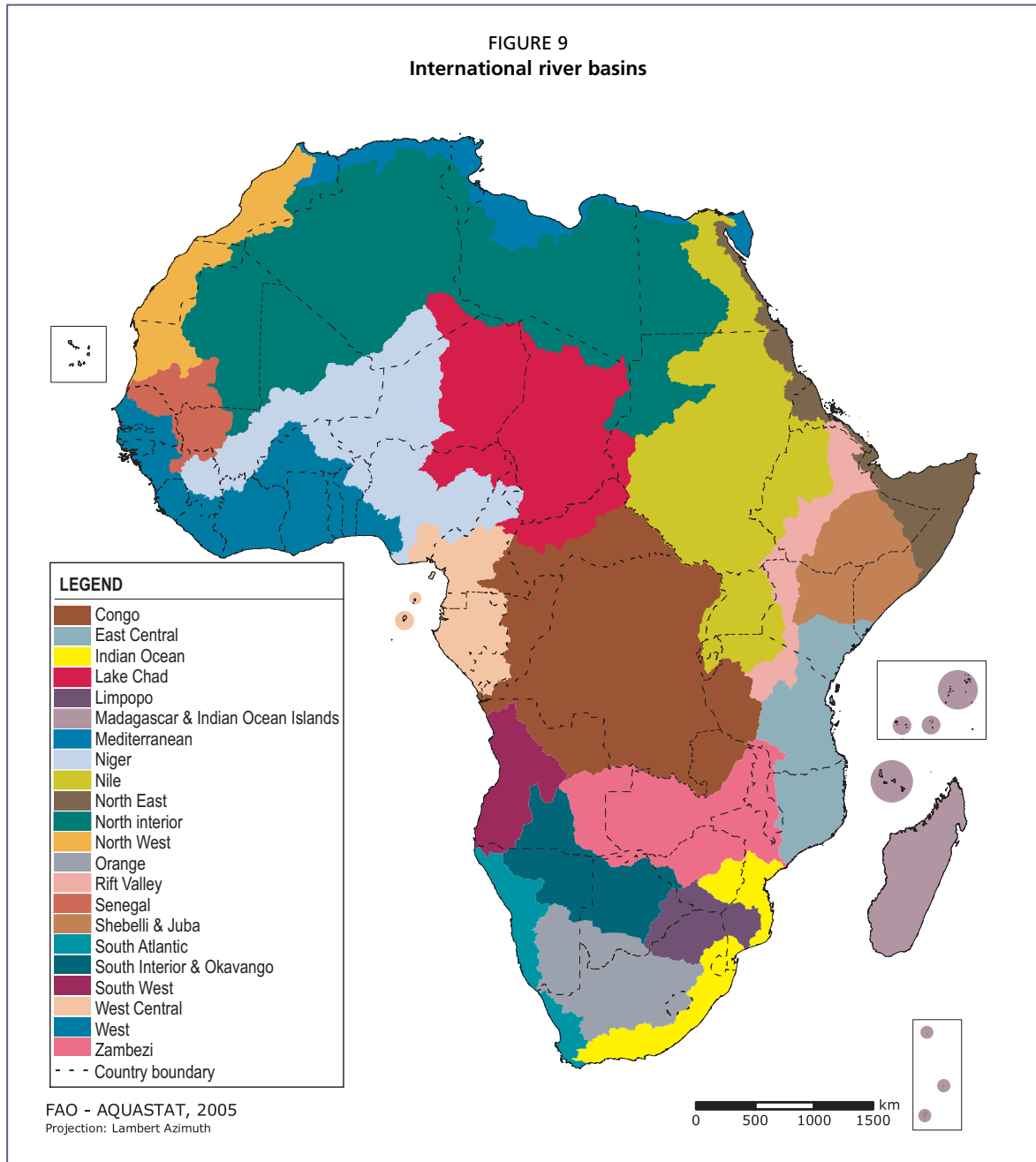
**FIGURE 7**  
**Population density**

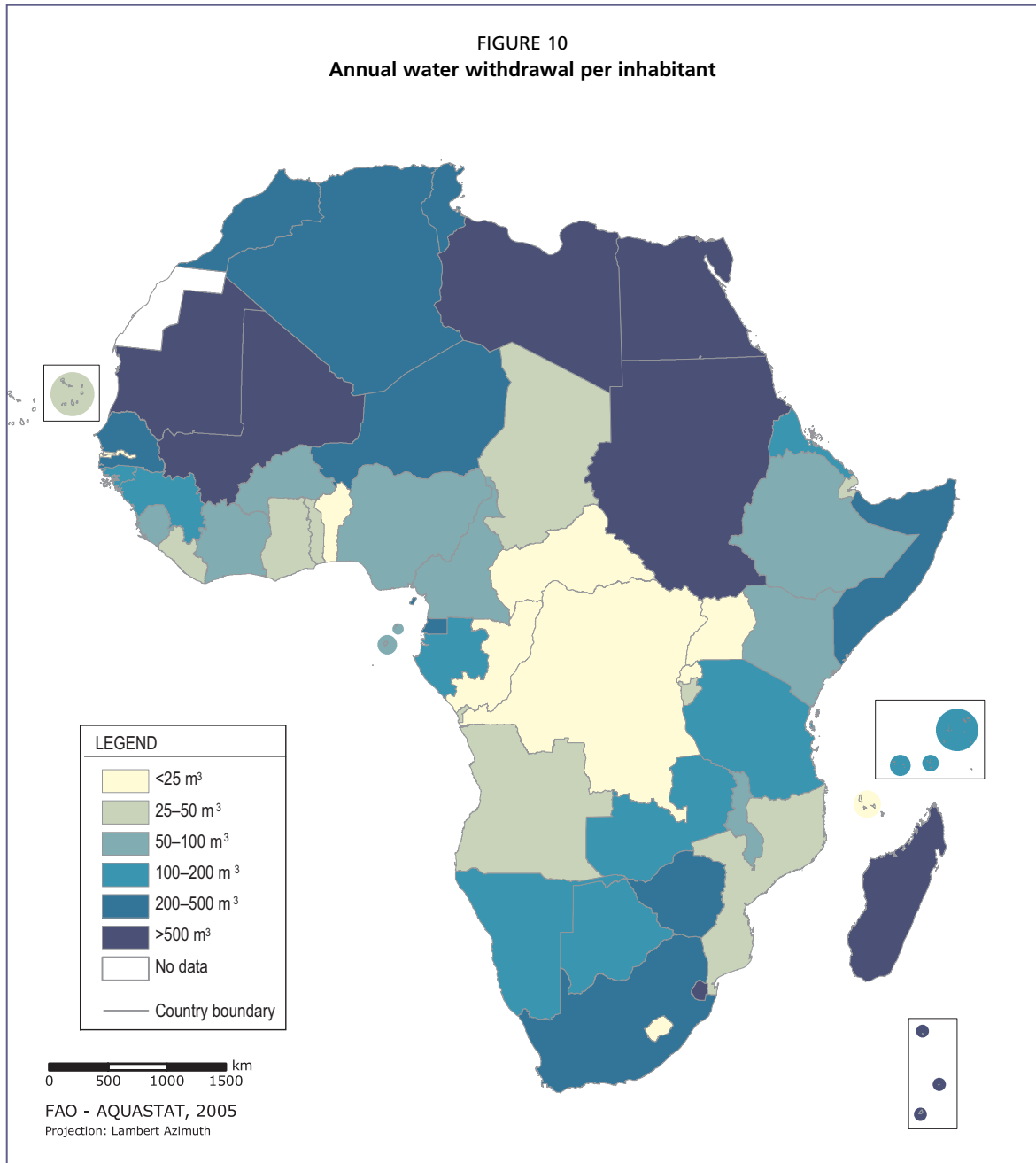


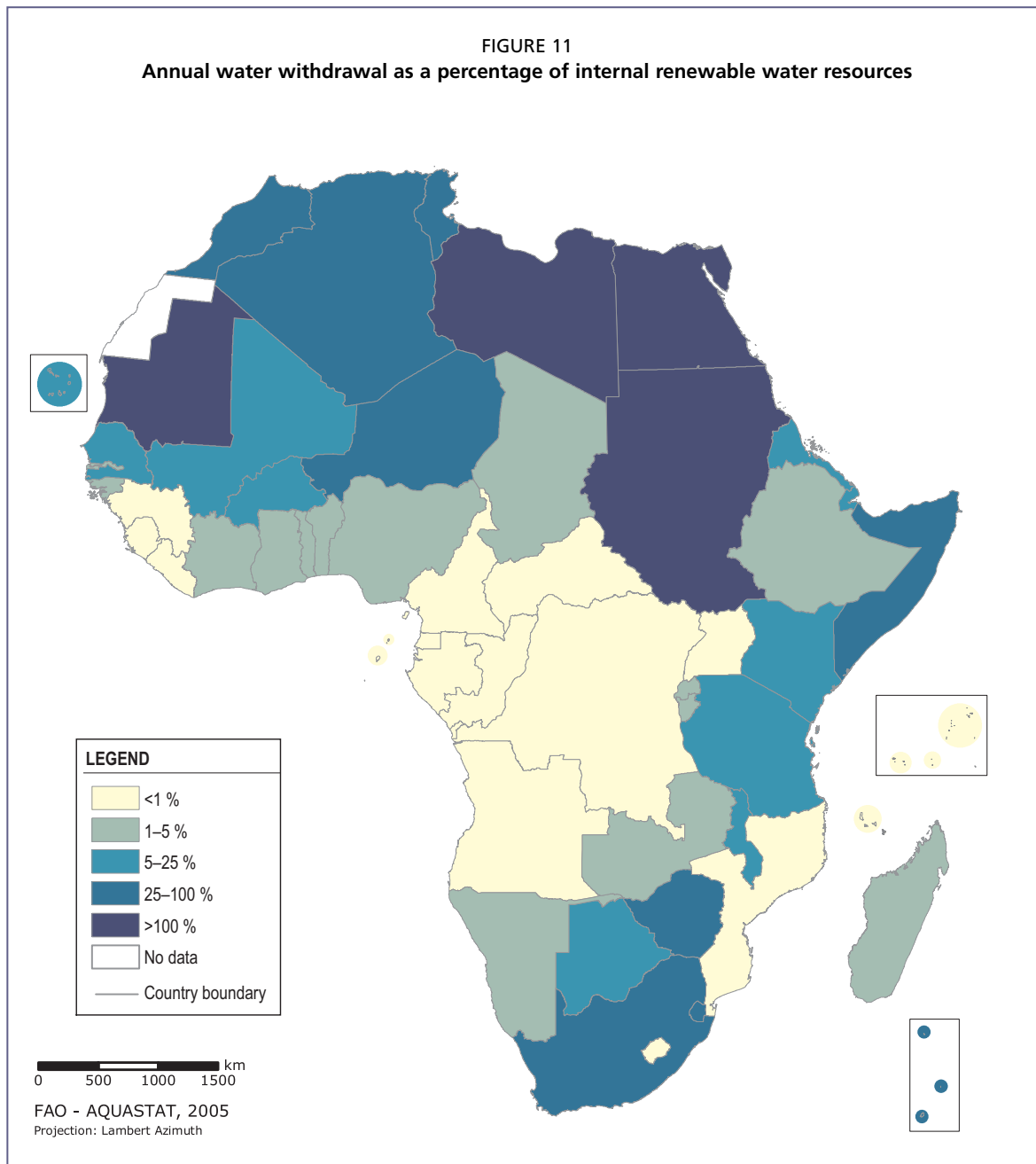




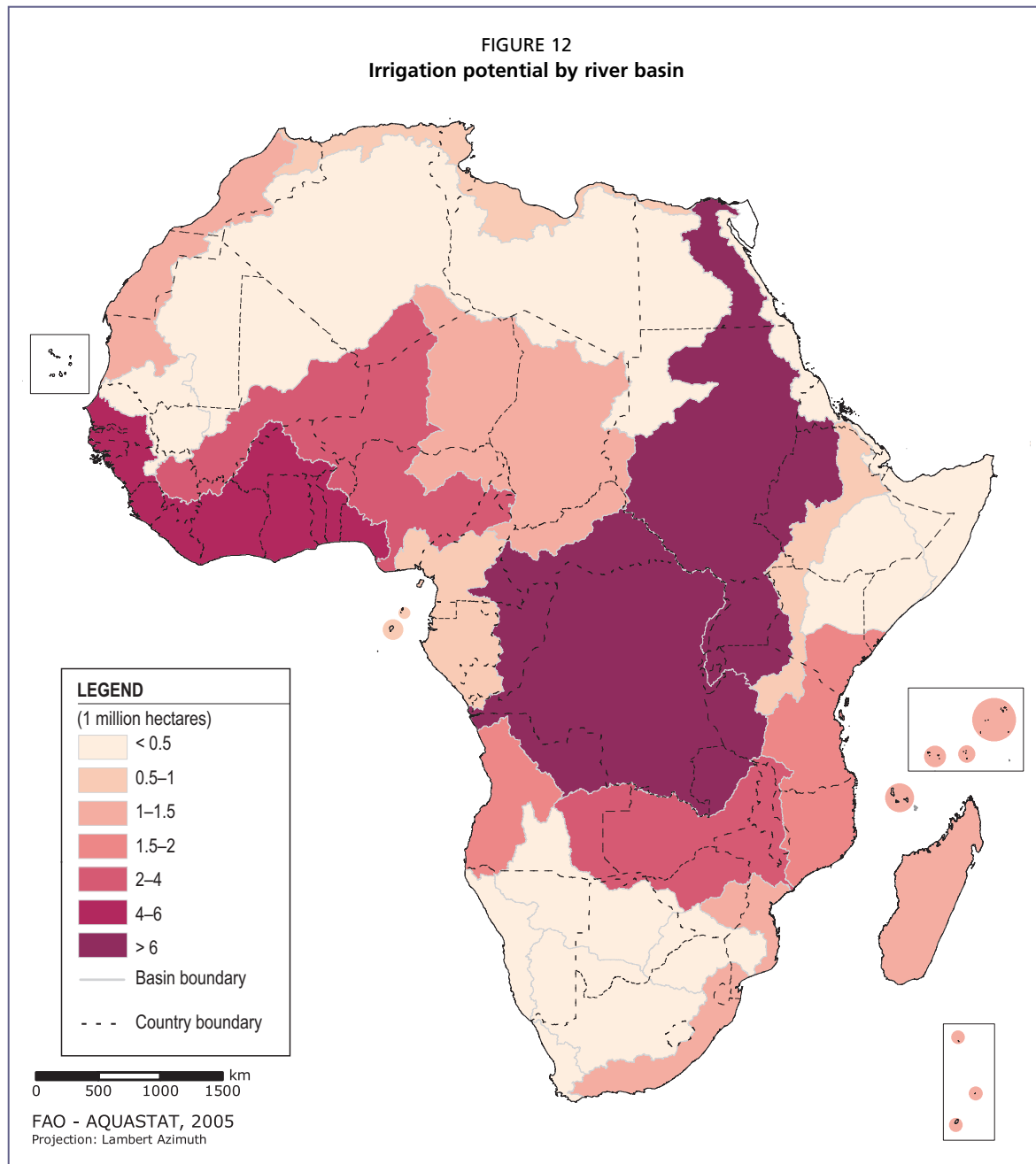
**FIGURE 9**  
**International river basins**



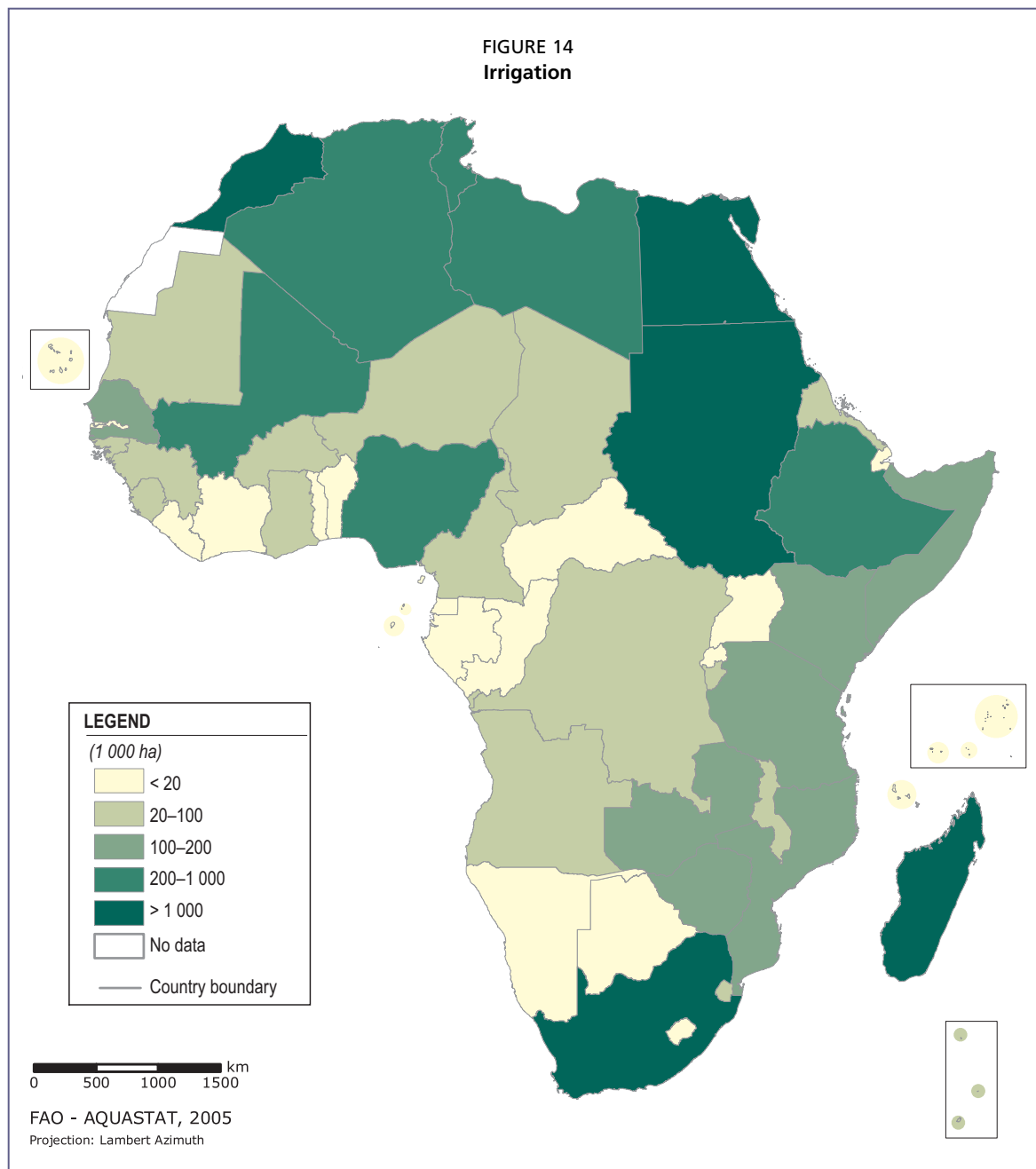


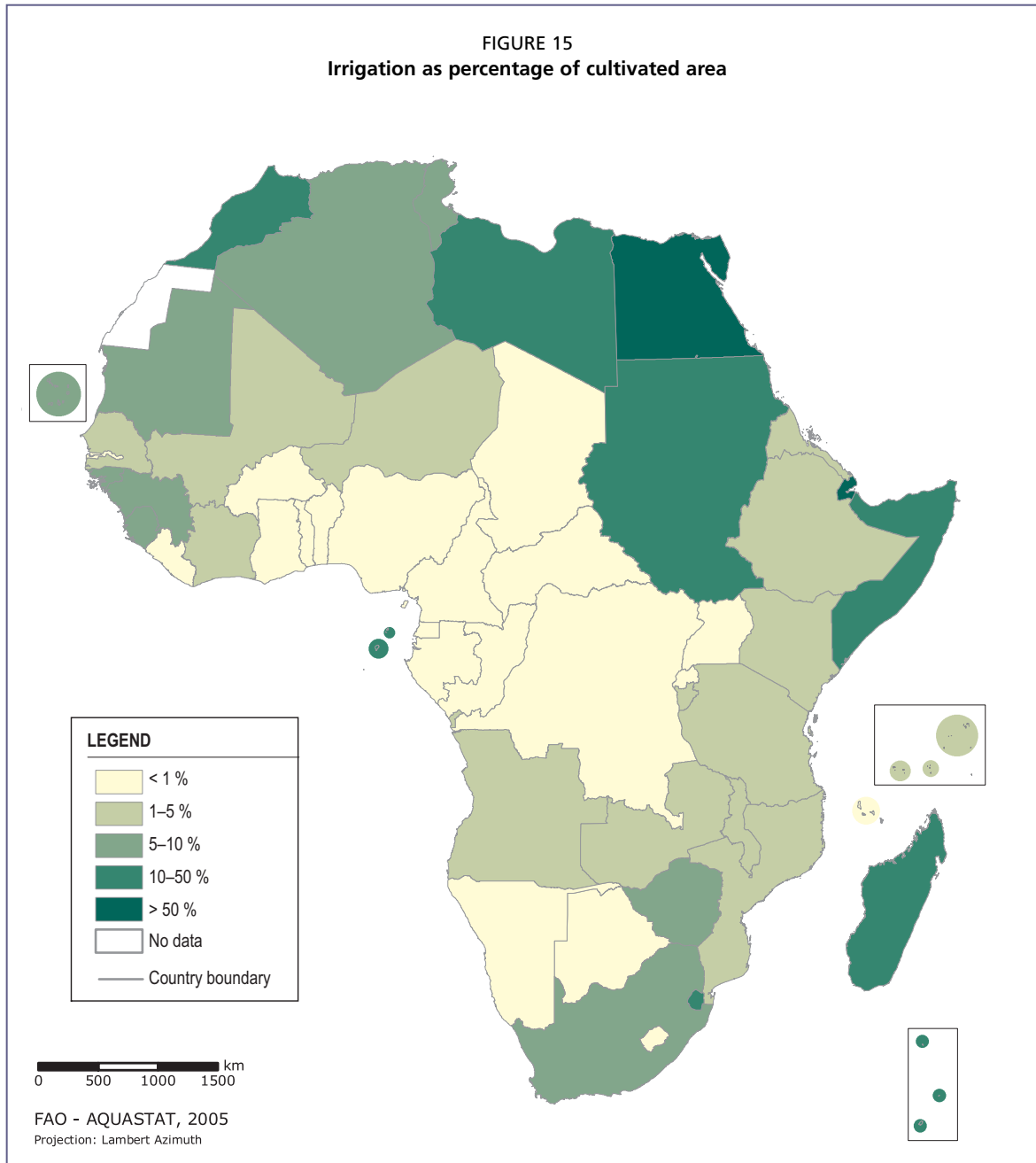


**FIGURE 12**  
**Irrigation potential by river basin**









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The AQUASTAT Programme was initiated with a view to presenting a comprehensive picture of water resources and irrigation in developing countries and providing systematic, up-to-date and reliable information on water for agriculture and rural development. This report presents the results of the most recent survey carried out in the 53 countries of Africa, and it analyses the changes that have occurred in the ten years since the first survey. Following the AQUASTAT methodology, the survey relied as much as possible on country-based statistics and information. A general summary presents a synopsis on water resources development, irrigation and drainage in the region. The CD-ROM accompanying this report contains detailed profiles on the situation in each country.