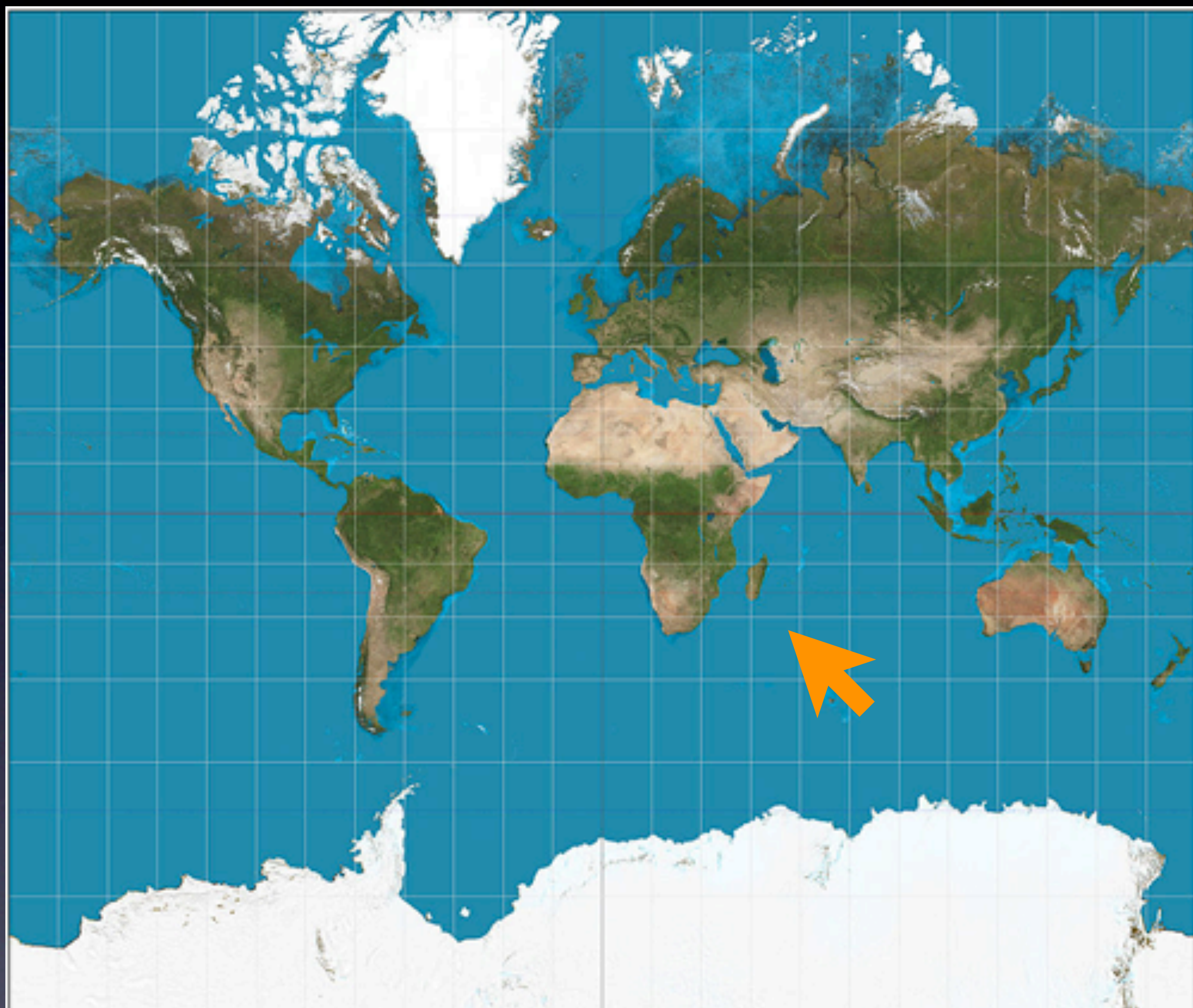
Africa Water Atlas

Arne Johannessen

Mercator-Projektion (winkeltreuer Schnittzylinder @ 45°)



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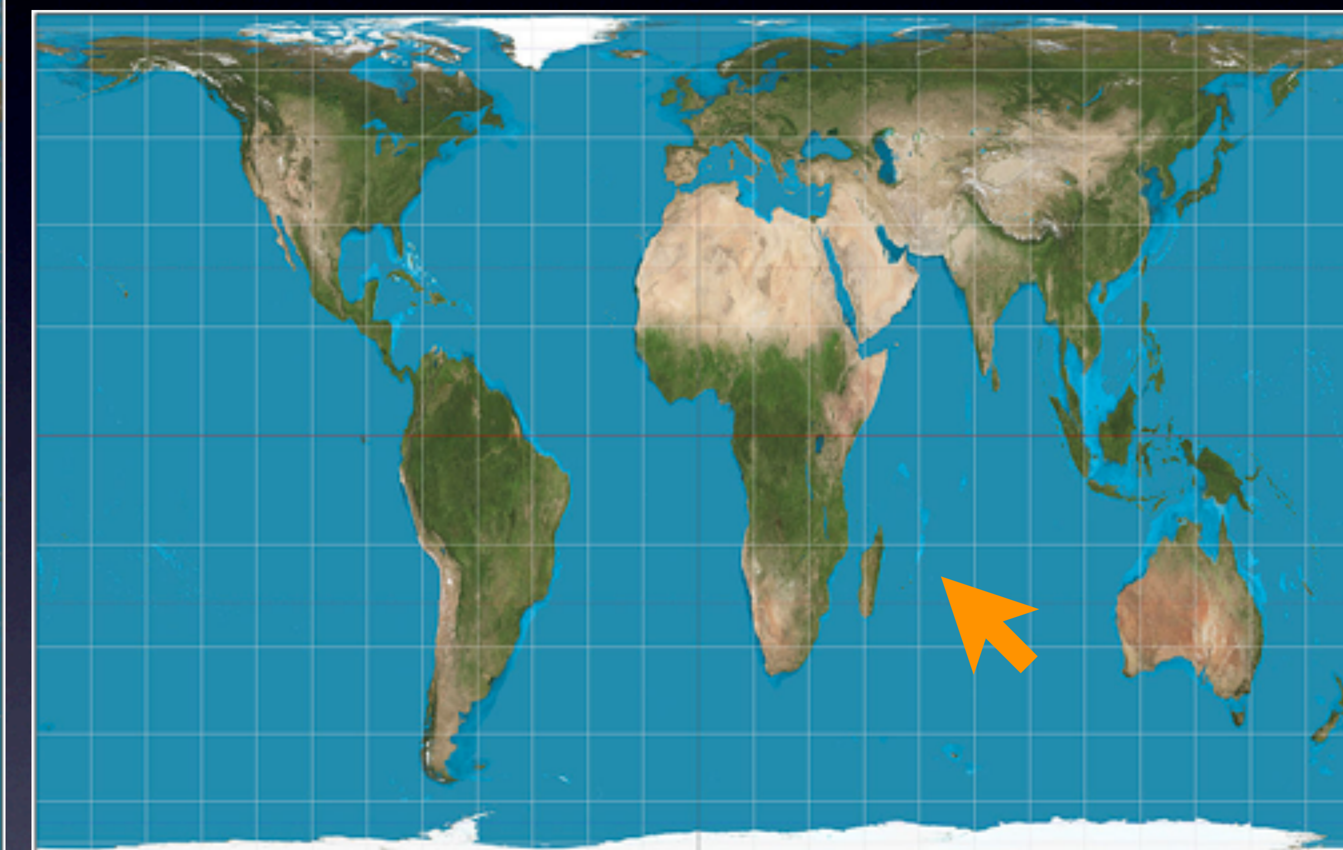

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AFRICA WATER ATLAS

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Masse: 2,3 kg

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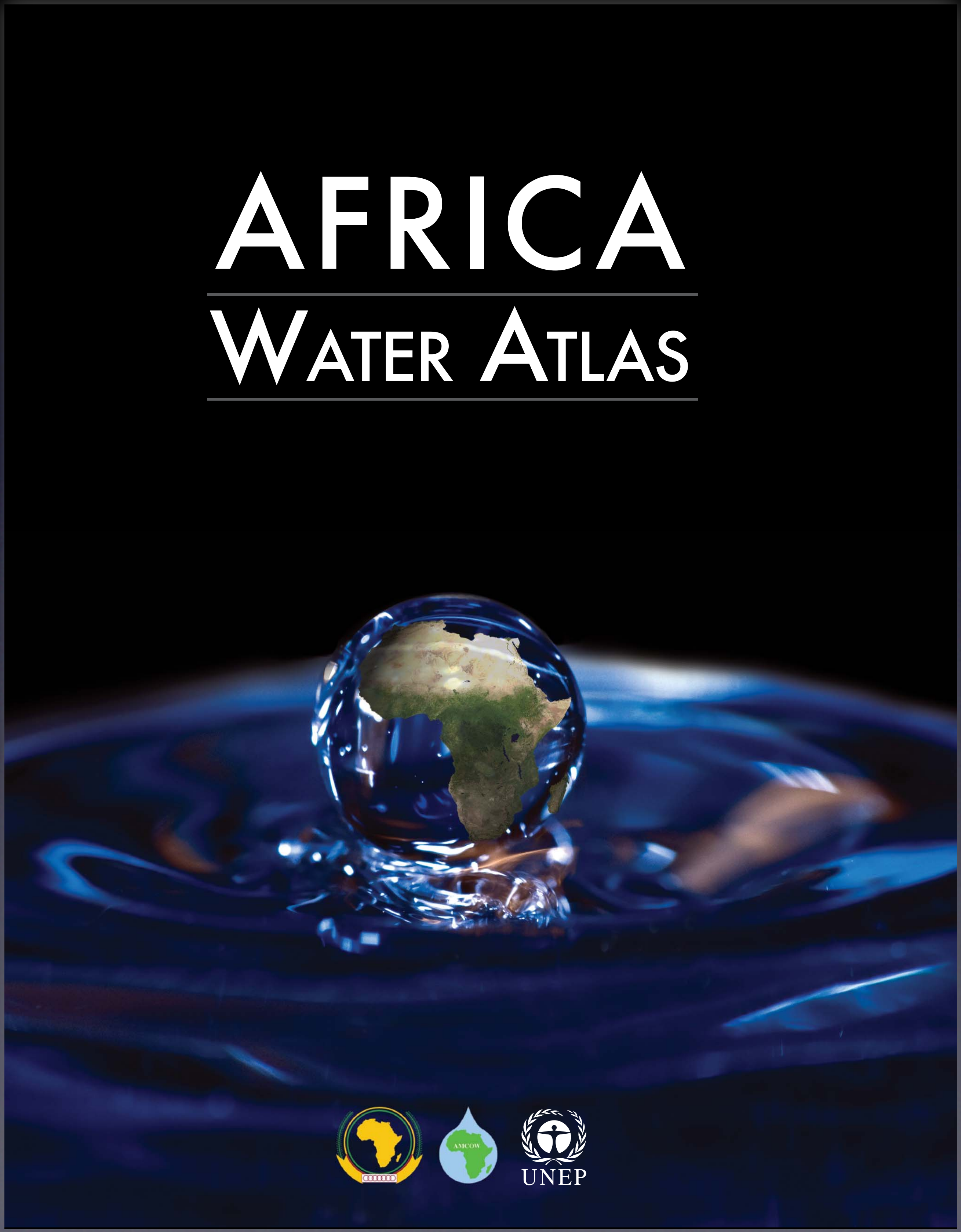
rund 100 Satelliten-Bilder
„hunderte“ Fotos und Infografiken

Engl. und Franz. Ausgaben



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United Nations
Environment Programme

2010

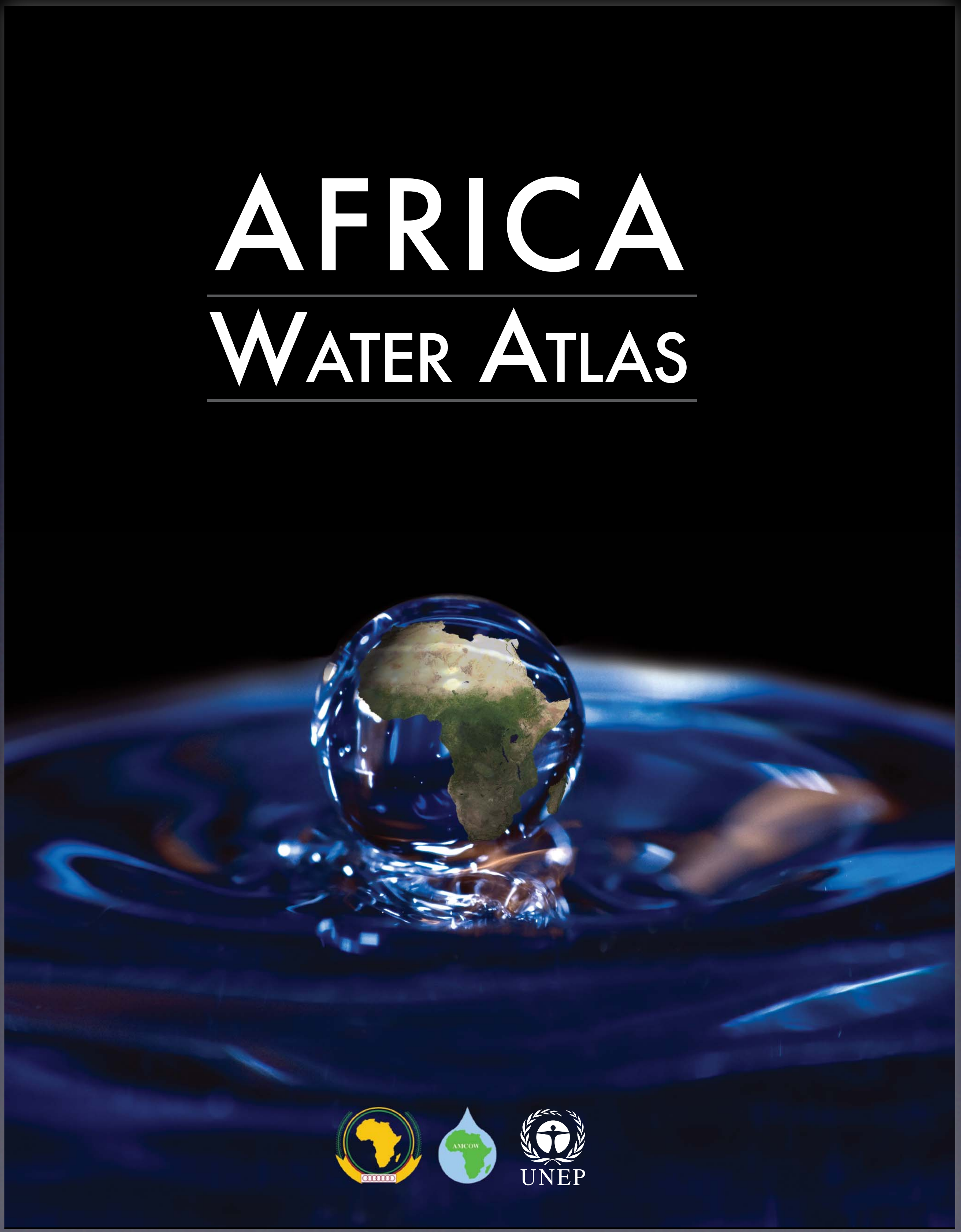

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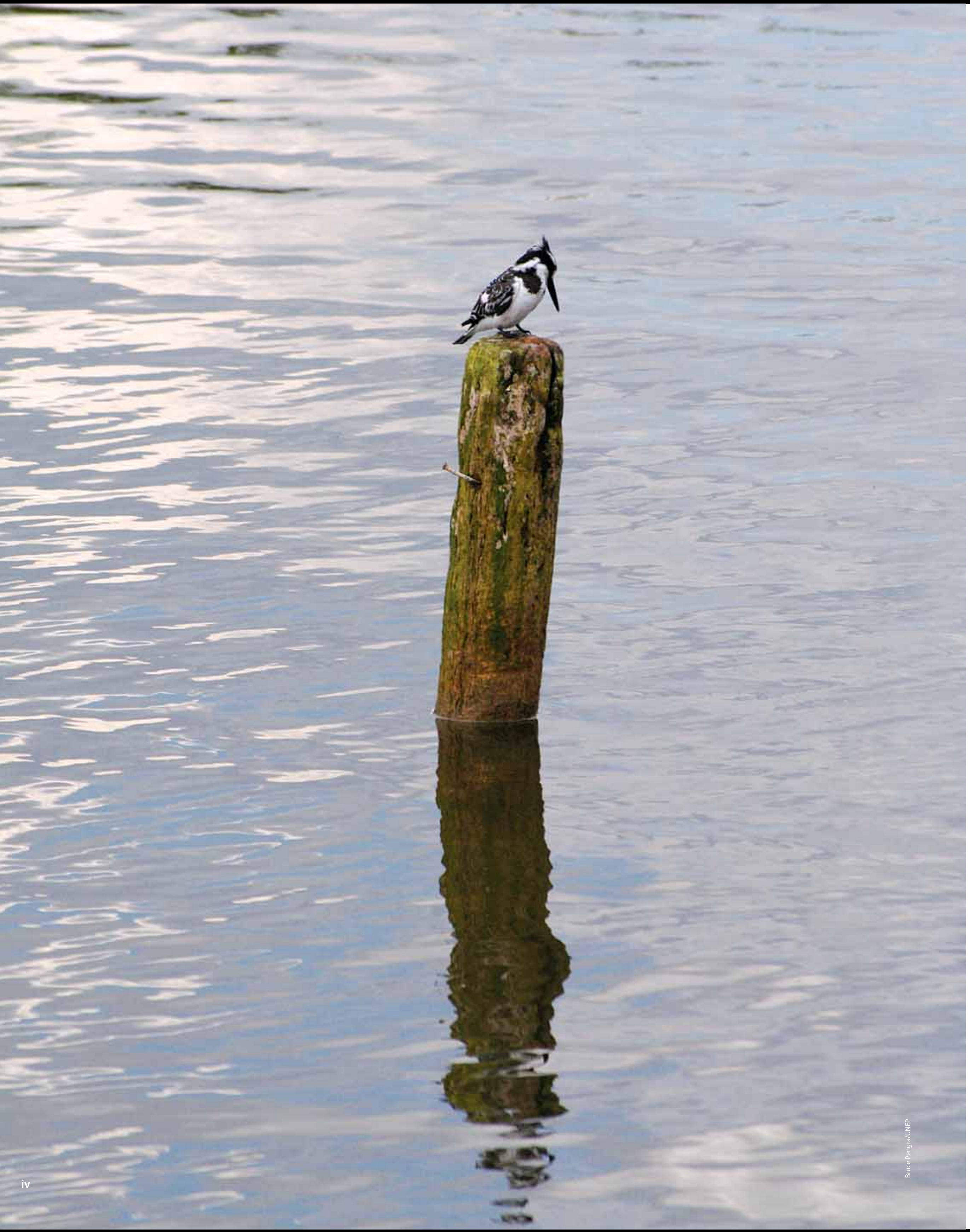
Table of Contents



Foreword

The Millennium Declaration was our boldest political commitment as heads of state and governments to provide focused leadership and champion good governance to eliminate illiteracy, poverty, disease and environmental degradation by 2015. The Declaration was a pro-poor statement that was subsequently encapsulated into eight Millennium Development Goals (MDGs), setting specific targets negotiated at high-level meetings.

It has been ten years since the Millennium Declaration and as this Atlas makes evident, significant progress has been made in the water sector in Africa, but a lot more remains to be done. It also shows that although there has been important cross-border and sub-regional dialogue and cooperation, a dearth of scientific data and information impedes efforts to manage water issues better. Therefore, this Africa Water Atlas has been wisely and skilfully packaged to trigger continuous debate and dialogue to define an agenda for discussions and strategy planning among ordinary citizens and between water experts within countries and across national borders.

My own country, Liberia, is not dissimilar to many African countries that continue to face challenges in meeting the MDG targets on water and sanitation. At the 64th Session of the UN General Assembly, the Secretary General Ban Ki-Moon noted that "It is clear that improvements in the lives of the poor have been unacceptably slow, and some hard-won gains are being eroded by the climate, food and economic crises." Whereas, on average, the world will meet the MDG water targets by 2015, Africa will not, and the effects of climate change exacerbate the situation of water scarcity.

Only 26 countries in Africa are expected to halve the proportion of their citizens without access to improved water by the targeted deadline. It is reliably estimated that in view of increasing population growth and the spiralling cycle of poverty, new models must be developed if the MDG targets on water are to be met by 2015. These estimates show that continental coverage needs to increase from 64 per cent in 2006 to 78 per cent by that date.

The sanitation situation is yet another challenge that needs our special focus as political leaders: only nine countries in Africa will meet the MDG sanitation target. It is heartbreaking and unacceptable that only half of Africa's population use improved sanitation facilities and that one in four has no such recourse. Because of such unsanitary conditions, globally more children under the age of five die of diarrhoea than of AIDS, measles and malaria combined. Investing in safe toilet facilities, clean drinking water supplies and raising awareness of hygiene practices could protect vulnerable populations from these deaths.

The commitment of some African nations to allocating 0.5 per cent of their GDP to sanitation under the e-Thekwini Declaration is an encouraging step forward. In Liberia, just 17 per cent of the population has access to proper sanitation, but increased budgetary allocation by governments to the water and sanitation sector last year alone has reduced child mortality. To meet the MDG sanitation target of halving the proportion of people without sustainable access to basic sanitation, coverage in Africa needs to increase from 38 per cent in 2006 to 67 per cent in 2015.

This Africa Water Atlas vividly illustrates the importance of Africa's water resources in supplying millions of people with life-giving water and in supporting activities that are crucial to our ecosystems and economies. I encourage every leader and policy maker in Africa to open these pages, and not only marvel at the images, but take stock of important messages it has to offer that will help Africa move faster towards the MDG water targets and secure a better future for our children and generations to come.

H.E. President Ellen Johnson Sirleaf
Republic of Liberia

SPECIAL FEATURE

WATER "HOTSPOTS" TO "HOPESPOTS", AND WATER TOWERS OF AFRICA

The title of this special section highlights the often two-sided nature of water issues in Africa: positive and negative, scarcity and surplus, over-exploited and under-developed, challenges and opportunities. It looks at the challenges and opportunities inherent in two quintessential African water issues—uneven spatial distribution of resources and temporal rainfall variability. The two vignettes present both the troublesome and hopeful sides of these two issues.

Hotspots to Hopespots

Over 64 per cent of Africa's population is rural (World Bank 2008), with much of that number living on small subsistence farms. Ninety-five per cent of sub-Saharan Africa's farmland relies on rain-fed agriculture (Wani and others 2009), making most people heavily dependent upon each year's rainfall pattern. For smallholder farms, timely and adequate rains are vital for livelihoods and food security. In some areas, such as West Africa where 80 per cent of employment is in the agriculture sector (Barry and others 2008), timely rainfall is central to the entire economy. However, Africa experiences remarkable variability in rainfall at inter-annual, decadal and longer time scales (Nicholson 1998, Nicholson 2000, Peel and others 2001). This is of particular concern in arid and semi-arid zones where rain-fed agriculture is marginal.

Hotspots

Researchers have consequently identified Africa as one of three global "hotspots" for water-constrained, rain-fed agriculture. They find that people living in these "hotspot" environments are disproportionately undernourished and they link it to climate-driven food insecurity. Most of the 100 million people in Africa living in these areas of water-constrained, rain-fed agriculture are found in a band running through Senegal, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Ethiopia, Somalia, Kenya, Tanzania, Zambia, Malawi, Mozambique, Zimbabwe and South Africa (Rockström and Karlberg 2009). The red hatching on Figure i shows the areas within Africa's arid and semi-arid regions (Trabucco and others 2009) with populations of 20 persons per km^2 or more (ORNL 2008). These are generally the areas in which food security is most tenuous in Africa.

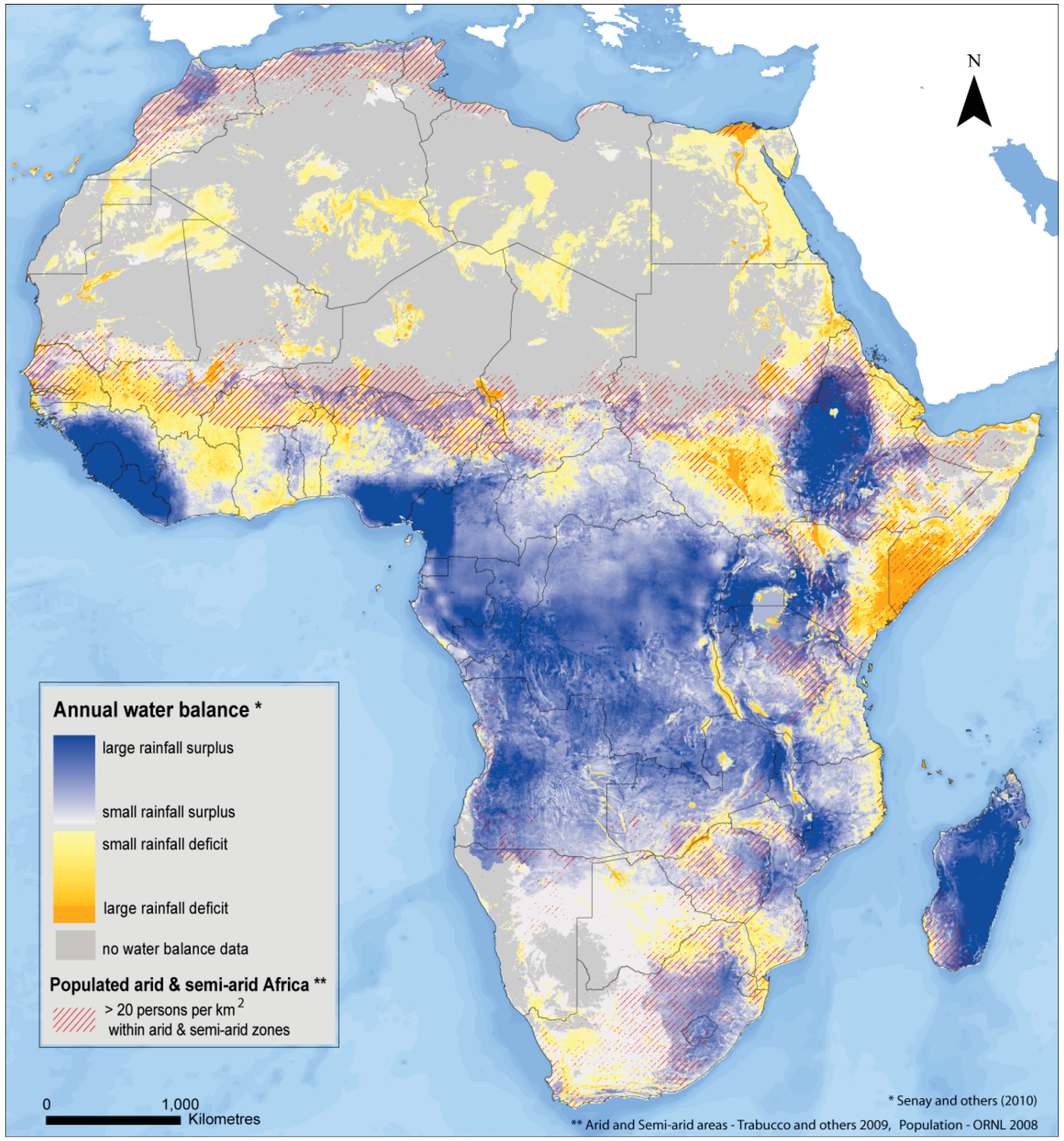
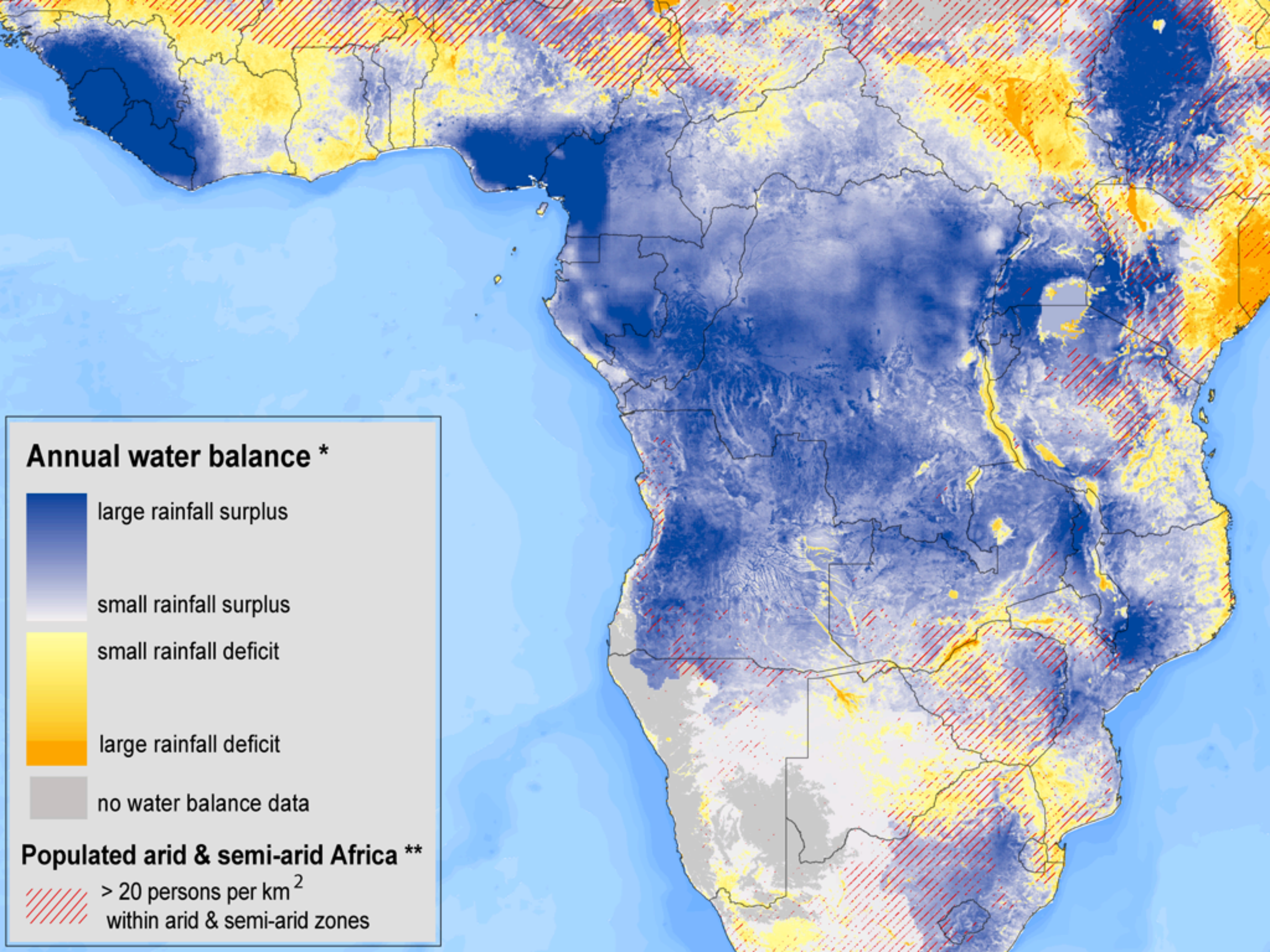
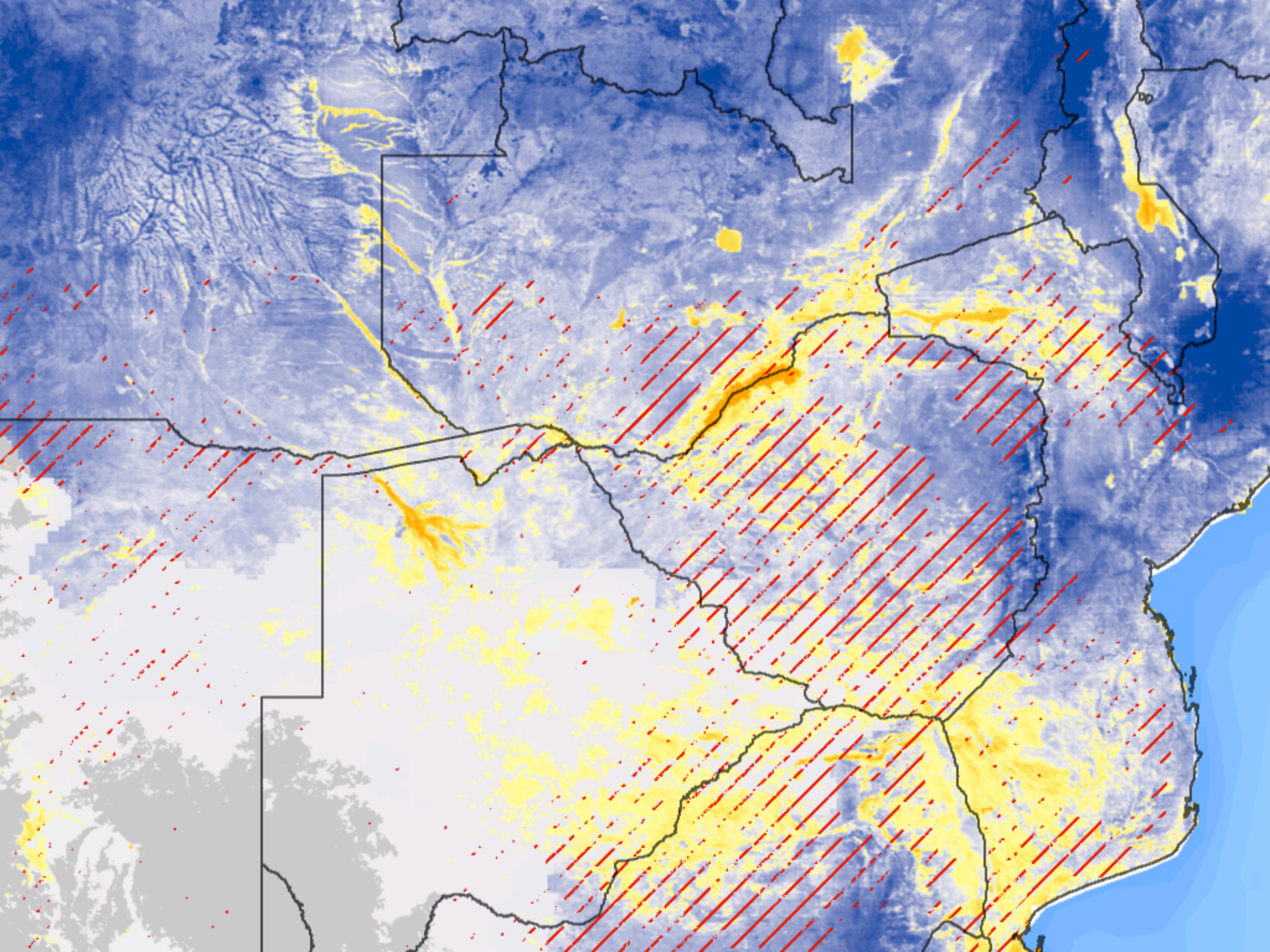


Figure i: Annual water balance is an estimate of the available runoff after evapotranspiration—water that is potentially available for water harvesting. The red hatching overlaying the water balance map shows where population density of greater than 20 persons per km^2 coincides with areas defined as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

Water Balance

Hydrologists model Africa's surface water systems using data sets describing precipitation, temperature, evapotranspiration, topography, soils and human-made diversions and impoundments. Recent research has used satellite data to more accurately quantify land-surface processes across the African continent, and in turn, to better estimate vegetation water use. Combined with climate data, this produces a map of "evapotranspiration"—an estimate of the sum of surface evaporation and plant transpiration. This data layer has been used to more accurately generate a water balance map (rainfall minus the water lost to evapotranspiration) as shown in Figure i. This water-balance data is used to model surface water and groundwater behaviour, including stream flow and the potential for dams and other forms of water harvesting.


Annual water balance *
large rainfall surplus
small rainfall surplus
small rainfall deficit
large rainfall deficit
no water balance data
Populated arid & semi-arid Africa **
> 20 persons per km 2
within arid & semi-arid zones



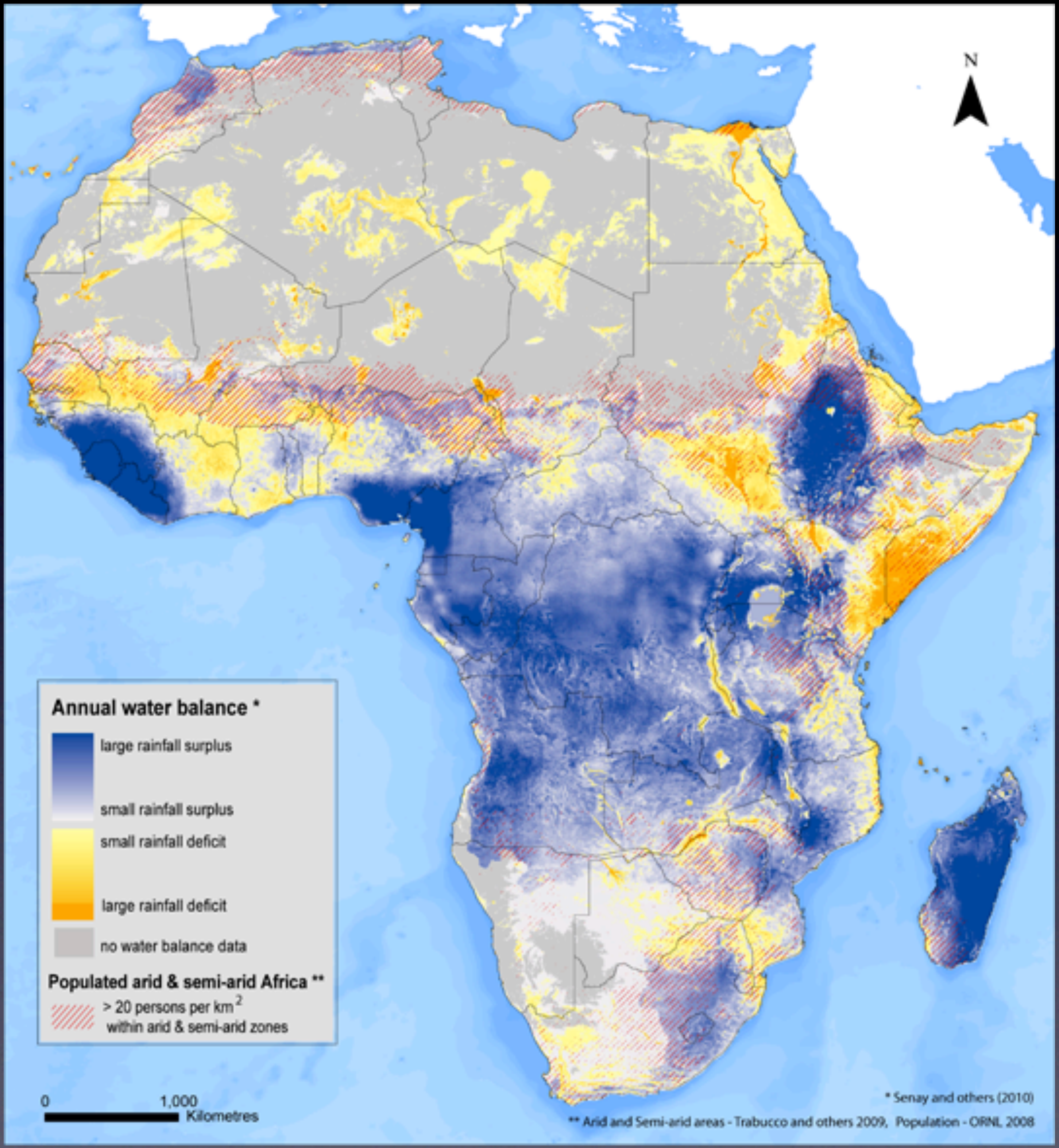
Basis: Grenzen

mehrschichtig
synthetisch
komplex (heterogen)

(1) „Pixelkartogramm“
ordinal
ohne Klassenbildung
Helligkeit, Farbe

(2) Arealmethode
Einzelmerkmal

Schicht-Unterscheidung:
Farbe, Muster



1 WATER RESOURCES

William Warby/Flickr.com

In Africa, the world's second-driest continent, the availability and access to water is more crucial to existence than it is almost anywhere else on Earth. Poverty is widespread and although it is rapidly urbanizing, the majority of its population is still rural-based and dependent on agriculture. In sub-Saharan Africa, 69 per cent of the population has no proper sanitation facilities, while 40 per cent has no reliable access to safe water (WHO/UNICEF 2008). Thus, a large number of countries on the continent still face huge challenges in attempting to achieve the United Nations (UN) water-related Millennium Development Goals. Water plays a central role in development, covering a broad cross-section of socio-economic aspects that include meeting people's basic needs, such as drinking and sanitation, demands from various economic sectors, food security, poverty, health, gender issues, governance issues, energy and transport. Water is indeed everyone's business, an essential resource to all aspects of society. In short, water is life.

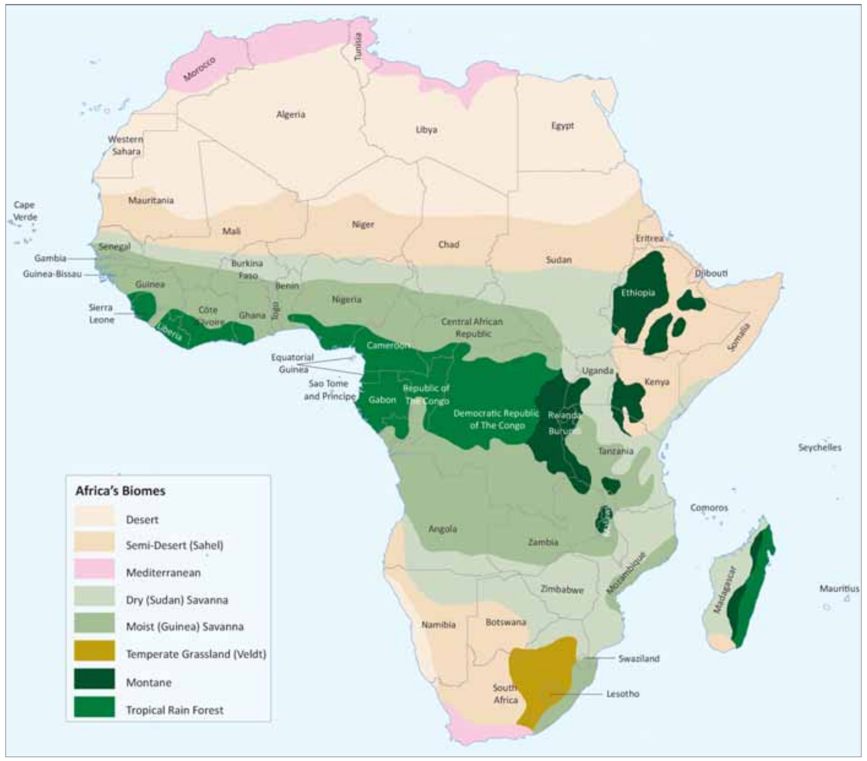


Figure 1.7: Africa's Biomes (Source: Chi-Bonnardel 1973)

Sahel, Southern and Eastern Africa, experiencing pronounced seasonal wet and dry periods (Hulme and others 2001) (Figure 1.6). Topographical features and differences in sea-surface temperatures influence climatic differences between the eastern and western parts of the continent.

The highest rainfall is observed in the Indian Ocean Islands and Central African states, while Northern African states receive the lowest. Overall, annual rainfall reliability is low, and in most sub-regions except Central Africa, it is less than potential evapotranspiration, with a highly variable picture across Indian Ocean Island States (UNEP and WRC 2008). Historical records show that during the 20th century, rainfall has been decreasing over large portions of the Sahel, while rainfall has increased in East Central Africa (Nicholson 2005).

Major influences on the climate come from prevailing wind movements, which are found in the equator region, the two tropics and the two largest deserts: the Sahara in the north, and the Kalahari in the south-western part. Circulation of these air masses brings rainfall to different parts of the continent, and seasonal, inter-annual and long-term circulation dynamics are instrumental to changes in local climate zones (Dinar and others 2008).

Christian Lambrechts/UNEP

Key Facts

Arid lands cover about 60 per cent of Africa

Precipitation, primary productivity and biodiversity are correlated

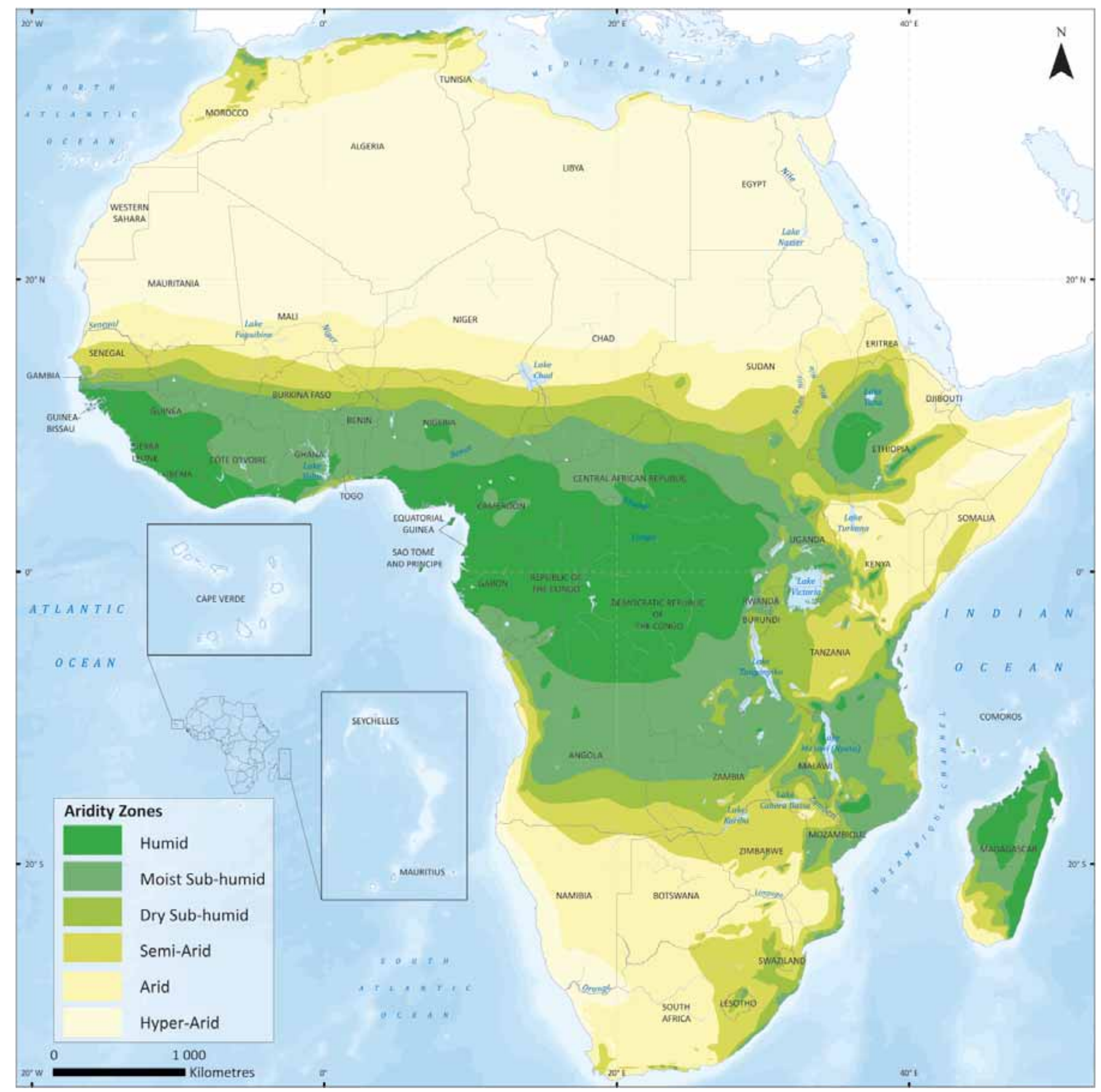
More than 40 per cent of Africa's population lives in arid, semi-arid and dry sub-humid areas

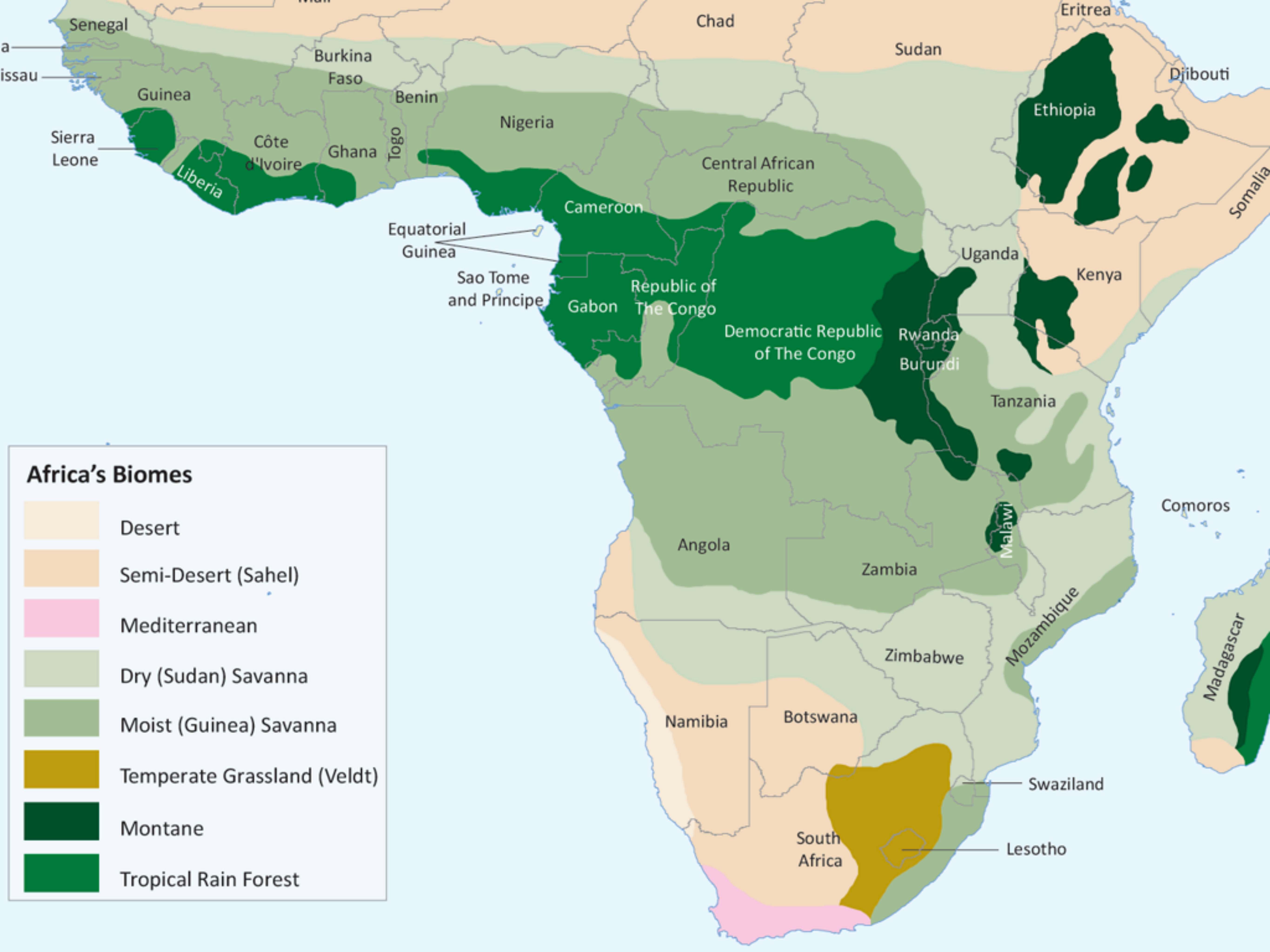
Africa's Biomes

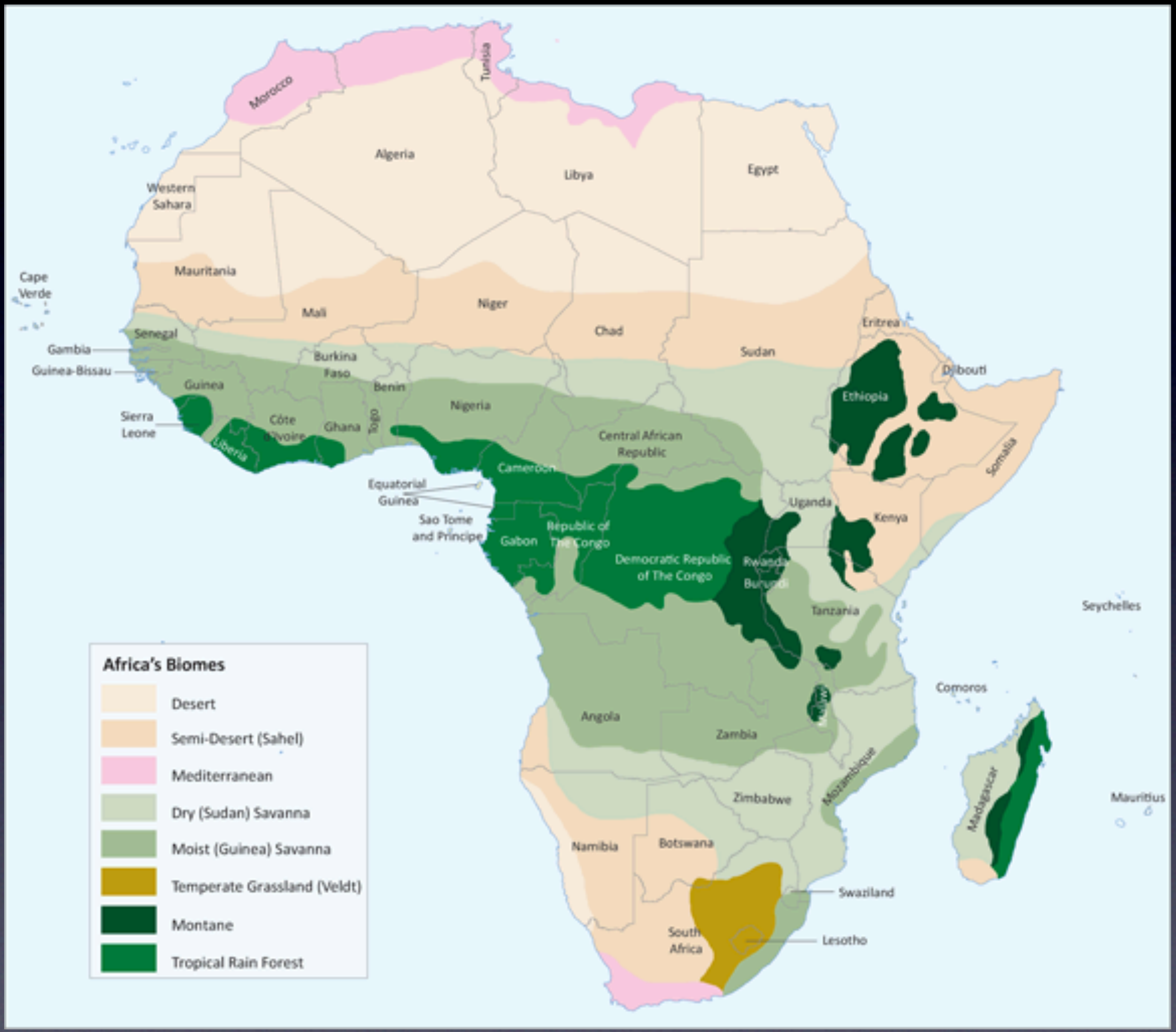
Generally, the pattern of vegetation in Africa largely mirrors its climatic zones, with areas of high rainfall producing the greatest volume of biomass, or primary productivity. On a broad scale, UNEP (2008) has defined the vegetation of Africa in terms of eight major biomes—large areas with similar patterns of vegetation, soils, fauna and climate (Figure 1.7).

Approximately 66 per cent of Africa is classified as arid or semi-arid (Figure 1.8), with extreme variability in rainfall (UNEP 2002). There are three main deserts: the Sahara in the north, and the Kalahari and the Namib deserts in southern Africa. They are situated around the Tropic of Cancer in North Africa and the Tropic of Capricorn in the south. Other arid to semi-arid areas include the belt along

Figure 1.8: Aridity zones (Source: UNEP 2004)




Senegal
Guinea
Sierra Leone
Liberia
Côte d'Ivoire
Ghana
Togo
Burkina Faso
Benin
Nigeria
Chad
Sudan
Eritrea
Djibouti
Ethiopia
Somalia
Central African Republic
Cameroon
Equatorial Guinea
Sao Tome and Principe
Gabon
Republic of The Congo
Democratic Republic of The Congo
Uganda
Kenya
Rwanda
Burundi
Tanzania
Comoros
Malawi
Angola
Zambia
Mozambique
Madagascar
Zimbabwe
Namibia
Botswana
Swaziland
South Africa
Lesotho
Africa's Biomes
Desert
Semi-Desert (Sahel)
Mediterranean
Dry (Sudan) Savanna
Moist (Guinea) Savanna
Temperate Grassland (Veldt)
Montane
Tropical Rain Forest



Basis: Grenzen

einschichtig
synthetisch

- Flächenmittelwerte
  nominal
  Farbe, Helligkeit

2 TRANSBOUNDARY WATER RESOURCES

Lawrence Murray/Flickr.com

Water systems occur at many scales from local to global and ultimately are all interlinked. While it is important to understand these linkages at all scales it is often most useful to view surface water at the level of the basin. Hydrological basins are an important unit of management for most of the ecosystem services upon which humans and natural systems depend. Surface water flows across basins and sub-basins unite areas by providing common water sources, aquatic habitats, transportation networks, quality water, hydropower potential and other shared goods and services. This is borne out by the formation of numerous multi-national basin management organizations worldwide, with several notable examples in Africa. The continent also has many transboundary aquifer systems, about which much less is known. While their connections are less obvious than are those of river and lake basins, their management is also well served by basin-scale management, and like surface water basins, the emerging formation of multi-national groundwater basin management organizations is testimony to this reality.

Most people in Africa live in rural areas and are still heavily dependent on agriculture for their livelihoods. This makes water an especially vital economic and social commodity. Along with a growing population, the extreme variability of rainfall on Africa's landscapes—from arid northern and southern regions to the continent's belt of tropical forests—poses many challenges to providing safe drinking water and sanitation for millions of people. Consequently, transboundary water resource management requires an enabling environment that encourages cooperation on numerous fronts.

An important part of this enabling environment is the availability of adequate information about surface and groundwater upon which policy makers can make informed management decisions. Data for Africa's water resources remain incomplete and inconsistent, particularly for groundwater resources. Building on a foundation of detailed, consistent, accurate and available data is one of the central challenges for Africa's water future. The emergence of transboundary basin organizations for many of Africa's large basins may provide a powerful opportunity to build part of this foundation.

Transboundary Surface Water Basins

Worldwide, there are 263 transboundary river basins, which can be defined as basins shared by two or more riparian states. Approximately 60 per cent of the world's population depends on these international water systems (UNU 2006). Transboundary river basins are also important because of the complex natural ecosystems they support. The potential increase in conflicts over shared water resources as well as the effects of climate change represent significant social, economic and environmental threats. In addition, there is a growing danger to human health from inadequate or unsafe water supplies (UNEP 2006a).

Africa's 63 international transboundary river basins cover about 64 per cent of the continent's land area and contain 93 per cent of its total surface water resources (Figure 2.1). They are also home to some 77

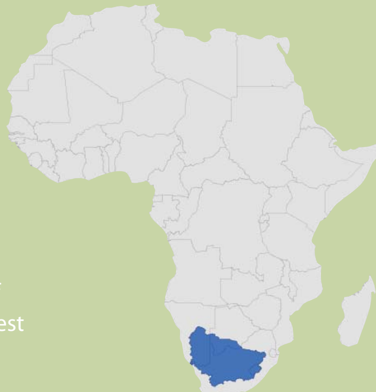
Figure 2.1: Africa's major transboundary river basins

per cent of Africa's population. The Nile River Basin is the most highly populated in all of Africa with over 220 million people—nearly a quarter of Africa's total population (SEDAC 2010). Fifteen principal lakes and 24 main watersheds also cross the political boundaries of two or more countries in Africa (UNEP 2006b). The catchment areas of the 17 largest river and lake basins on the continent exceed 100 000 km^2 in size and are therefore classified as large basins (UNU 2006).

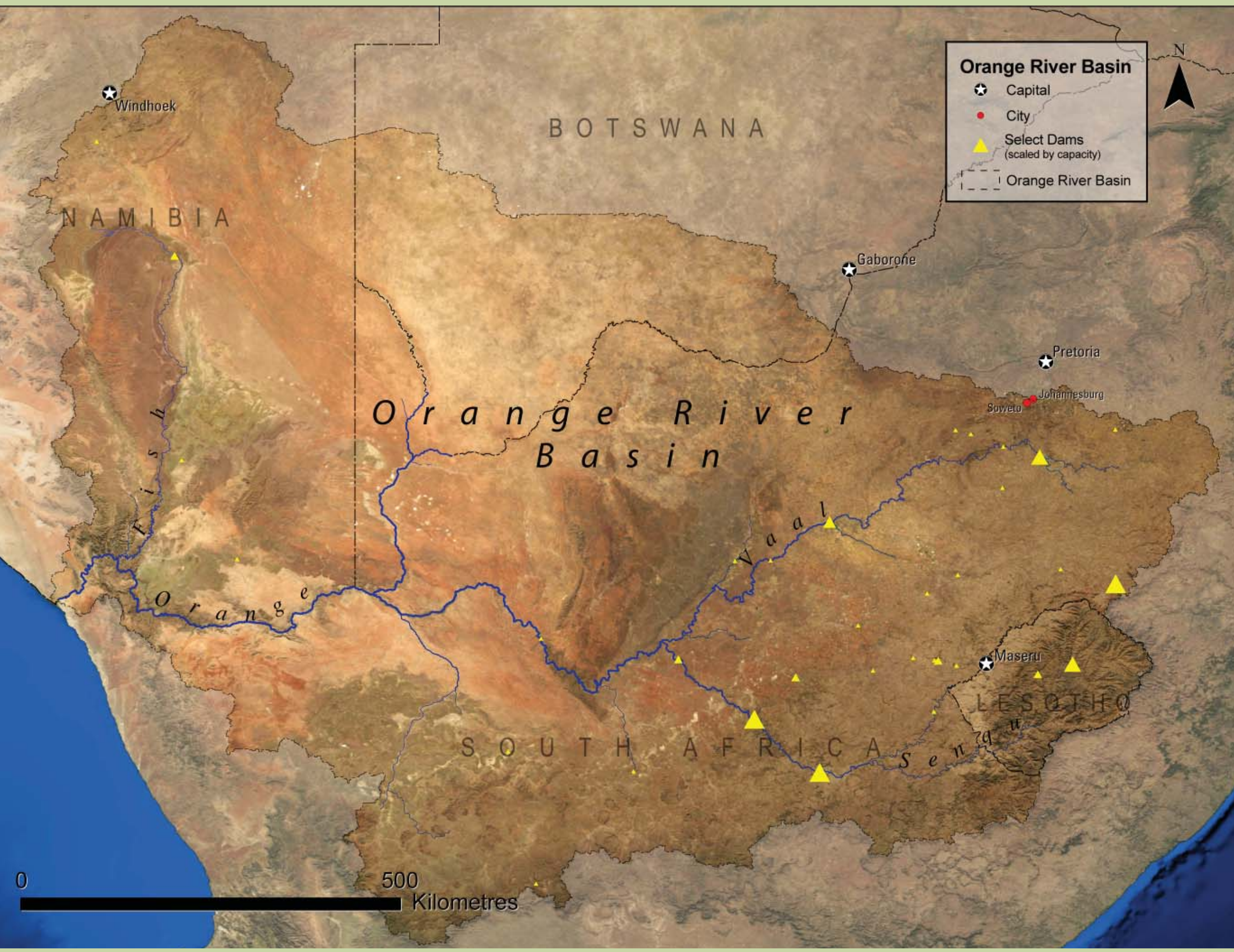
The complexity of the physical, political and human interactions within transboundary river basins can make equitable management of their risks, costs and benefits especially challenging. Quite often the resources are not evenly distributed by area or population. This often puts upstream areas or nations in a position of advantage over their downstream neighbours. Examples of this can be seen in the Niger Basin, Juba-Shabelle Basin, Okavango Basin and others. The degree and type of dependence on the common resources might also vary greatly within a basin. For example, on the Nile, Uganda is highly dependant upon the river for hydropower and manages it accordingly, however downstream it is water for agriculture that Egypt counts on most from the Nile.

The major transboundary basins of Africa present a variety of challenges and opportunities to the people and countries who share them. Each basin differs in many ways from the others but all share common attributes as well. The basin-scale profiles that follow present some of that diversity and commonality through common measures such as population and precipitation, and bring to life some of the management challenges and opportunities with specific cases within the basins.

Orange River Basin



The Orange River originates in Lesotho where its tributary, the Senqu, begins high in the Drakensberg Mountains. While only three per cent of the basin lies in Lesotho the country's highlands have some of the highest mean annual rainfall in the basin and Lesotho contributes nearly 17 per cent of the Orange River's water budget (Senay and others 2010).



While only three per cent of the basin lies in Lesotho, the country's highlands contribute nearly 17 per cent of the water budget

The Vaal River drains the wetter eastern portion of South Africa, which occupies 60 per cent of the basin and contributes most of South Africa's 76 per cent share of the basin's water. Namibia (25 per cent) and Botswana (13 per cent) each make up significant shares of the basin's area but because of high evapotranspiration of limited rainfall, make only minor contributions to the river's flow.

Precipitation in the basin declines from east-to-west with some areas of Lesotho and South Africa receiving over 1 000 mm of rain annually while western areas of South Africa and Namibia receive less than 200 mm (Figure 2.11.1, Figure 2.11.2)

Population

Population also follows an east-to-west gradient with the majority of people living in the eastern third of the basin. Nearly 12 million South Africans live within the Orange Basin, most of them in and around the cities of Gauteng Province. Lesotho's average population density of around 67 persons per km^2 is the highest in the basin. Populations in the Namibia and Botswana portions of the basin are quite sparse with densities near one person per km^2 (Figure 2.11.3).

Dams, Irrigation and Development

The Orange River Basin is highly developed, with many dams and transfer schemes, particularly in the South African share of the basin. The largest-capacity dams are the Gariep and Vanderkloof on the Orange River, the Sterkfont Dam on the Nuvejaars River, and the Vaal Dam on the Vaal River. The Katse Dam and Mohale are the largest dams outside of South Africa. Both are in Lesotho and are a part of the world's largest inter-basin water transfer scheme, the Lesotho Highlands Water Project, which transfers water north to Gauteng Province to help meet the Johannesburg area's rapidly growing water needs (Earle and others 2005). Irrigation developments line the river banks. In the Vaal River catchment's heavily populated upper reaches, large volumes of water are utilized for domestic, industrial, and mining purposes. In the western regions where population is sparse, water schemes draw on the river to provide water for livestock, irrigation, and mining (SADC-GTZ 2007).

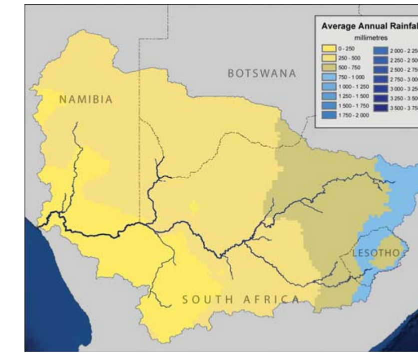


Figure 2.11.1: Orange River Basin average annual rainfall

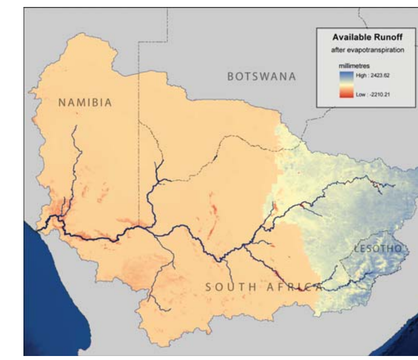


Figure 2.11.2: Orange River Basin modeled available runoff

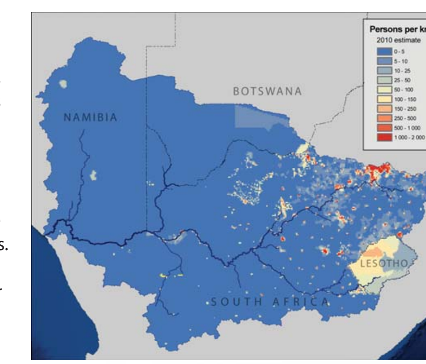
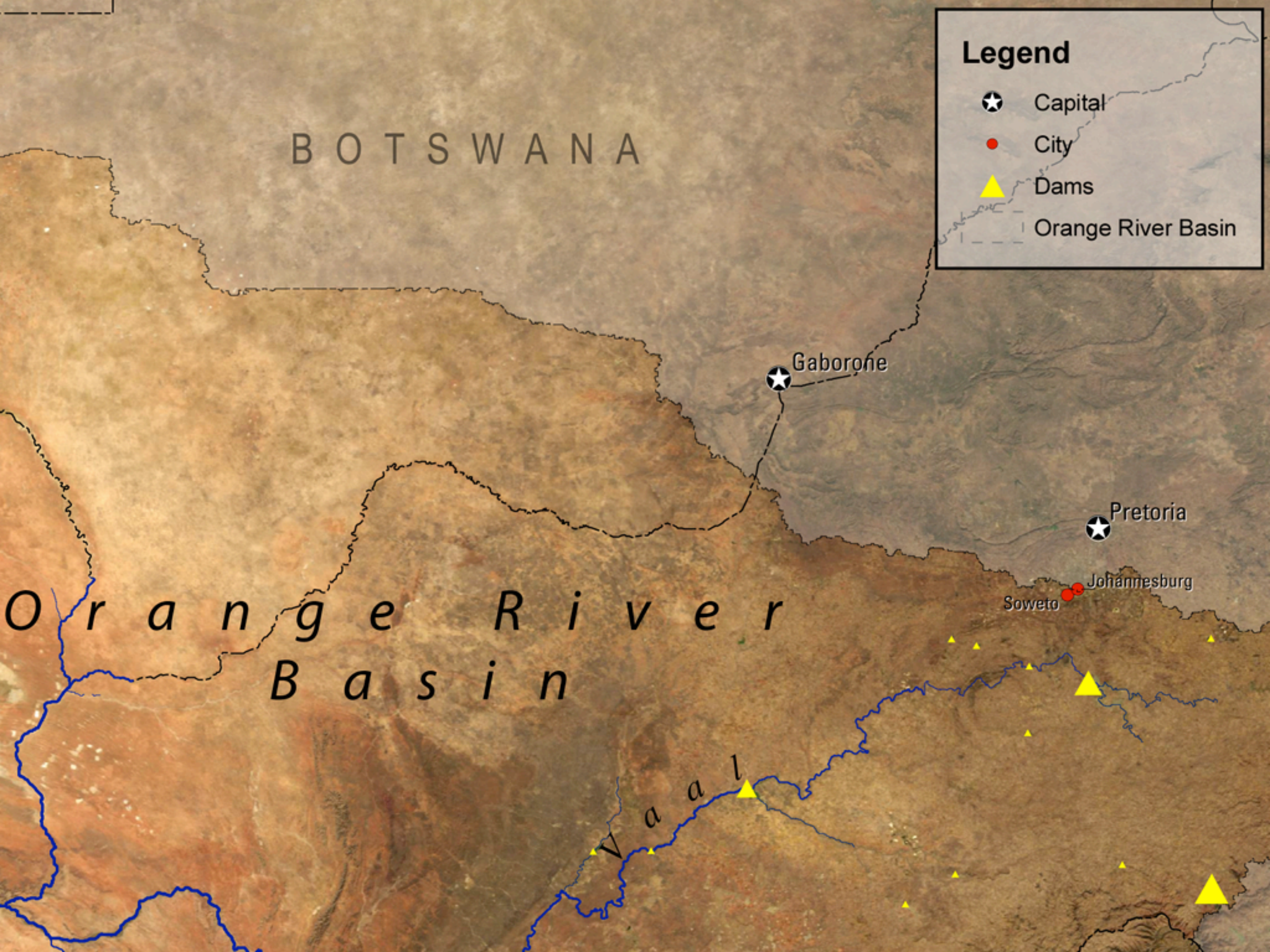


Figure 2.11.3: Orange River Basin population density

Henri Bergius/Flickr.com


Legend
Capital
City
Dams
Orange River Basin
BOTSWANA
Gaborone
Pretoria
Johannesburg
Soweto
Orange River
Basin
Vaal

Basis: Sat-Bild, Grenzen, Flüsse, Städte

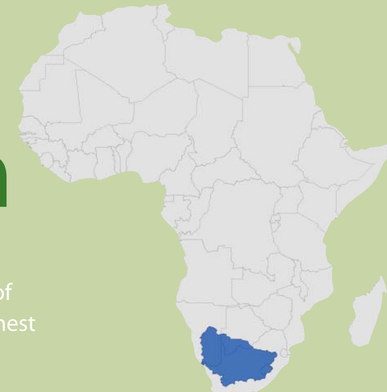
mehrschichtig
komplex (homogen)
analytisch

(1) Positionsdiagramme
ordinal – Größe

(2) Arealmethode
Einzelmerkmal

Schicht-Unterscheidung: Helligkeit, Farbe, Form

Orange
River Basin



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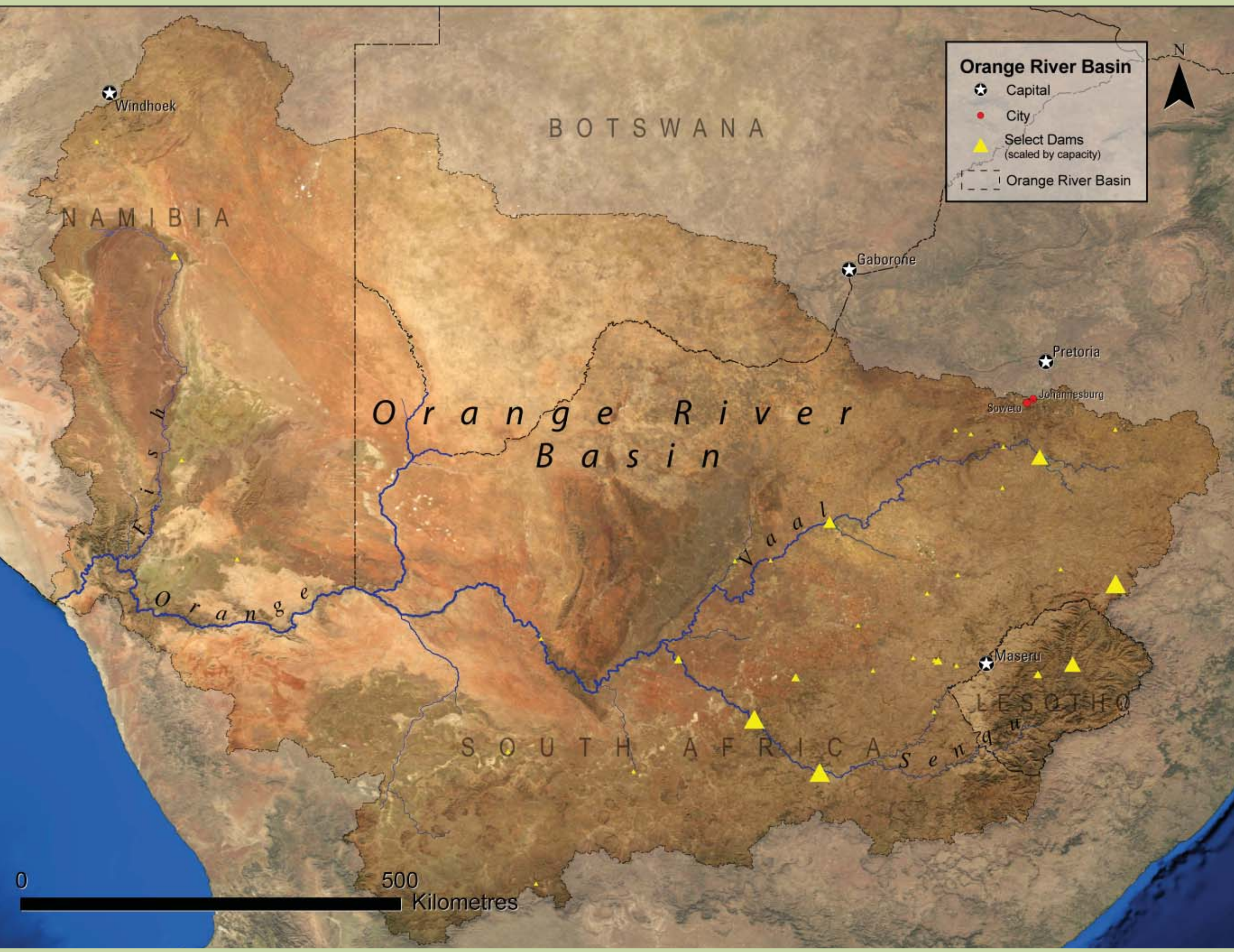

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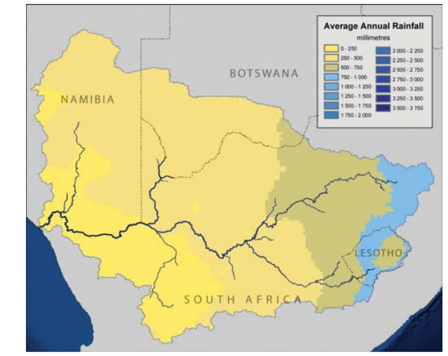

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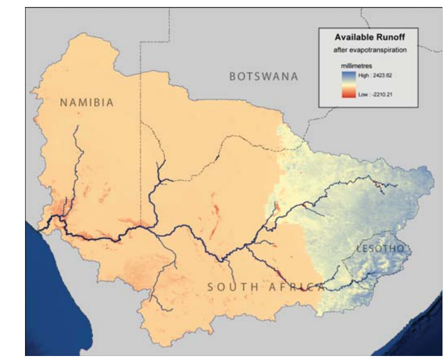


Figure 2.11.2: Orange River Basin modeled available runoff

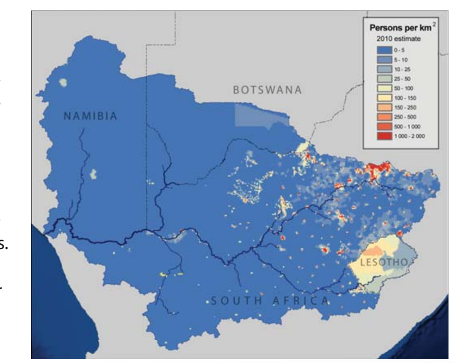
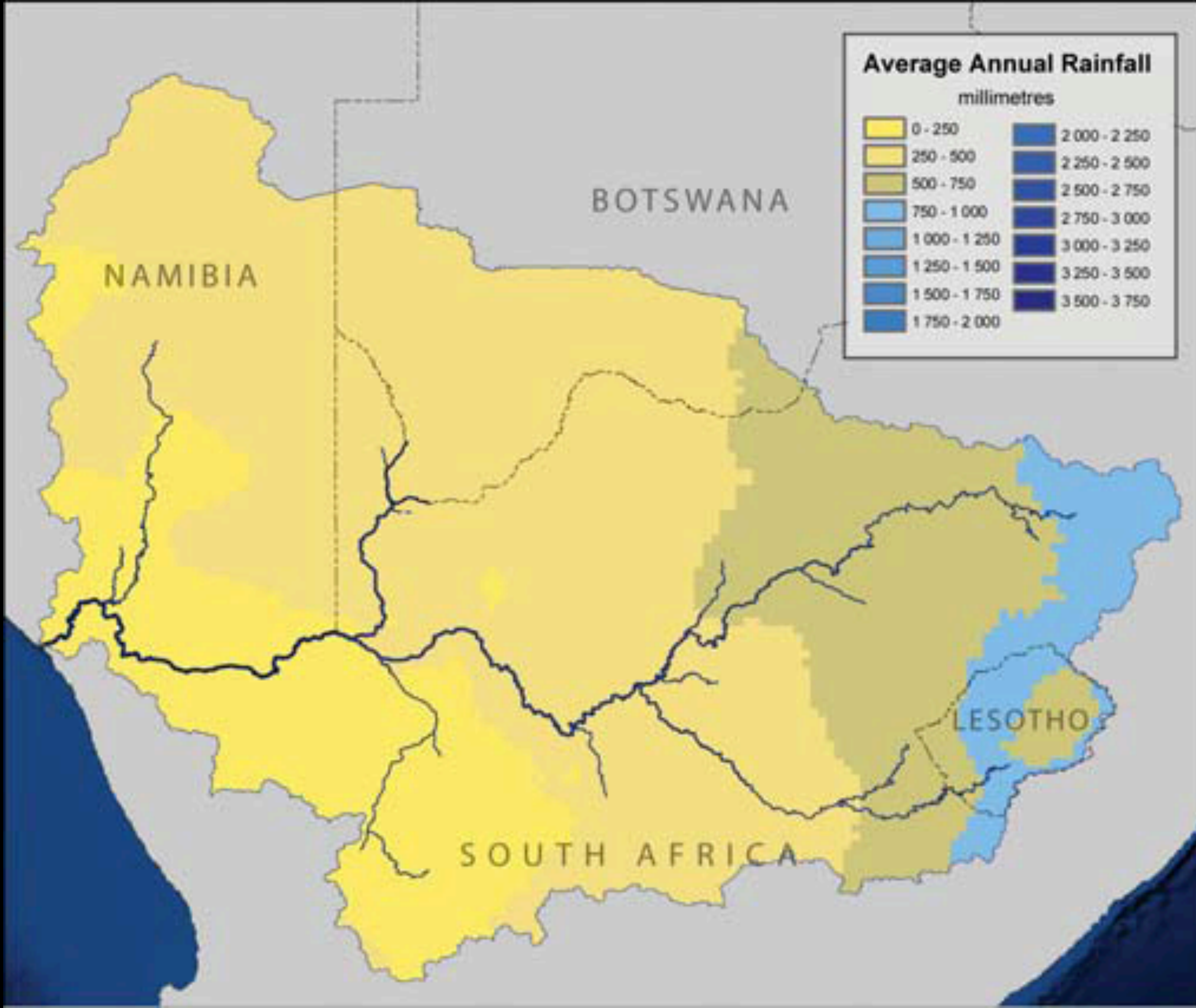


Figure 2.11.3: Orange River Basin population density

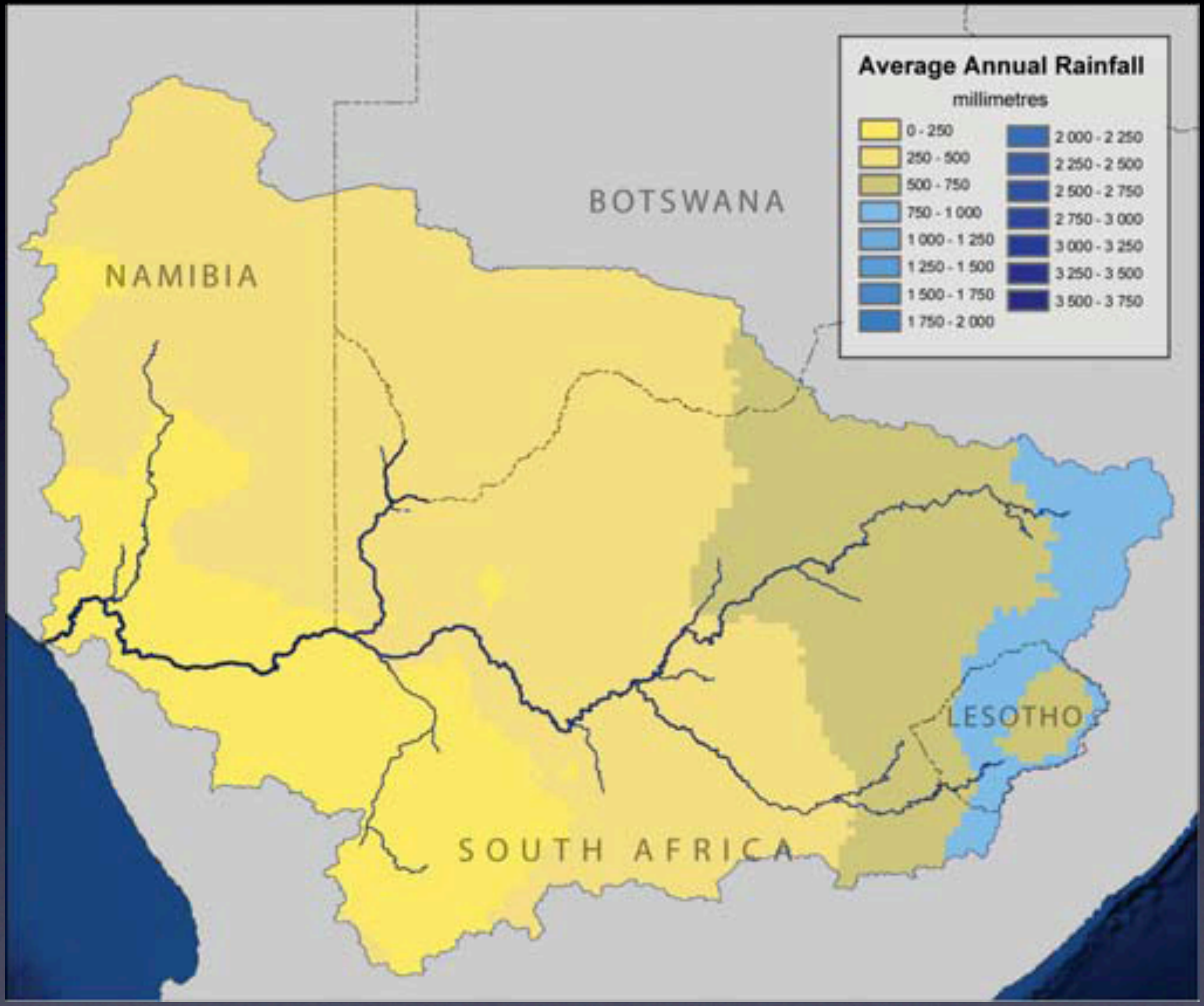


Average Annual Rainfall
millimetres
0 - 250
250 - 500
500 - 750
750 - 1 000
1 000 - 1 250
1 250 - 1 500
1 500 - 1 750
1 750 - 2 000
2 000 - 2 250
2 250 - 2 500
2 500 - 2 750
2 750 - 3 000
3 000 - 3 250
3 250 - 3 500
3 500 - 3 750
BOTSWANA
NAMIBIA
LESOTHO
SOUTH AFRICA

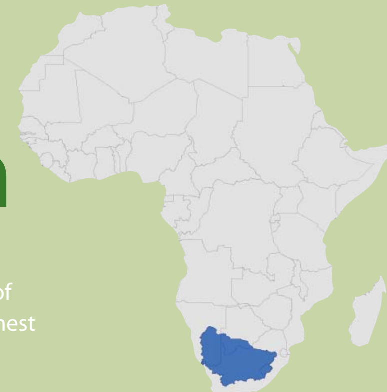
Basis: Grenzen, Flüsse

einschichtig
elementar
analytisch

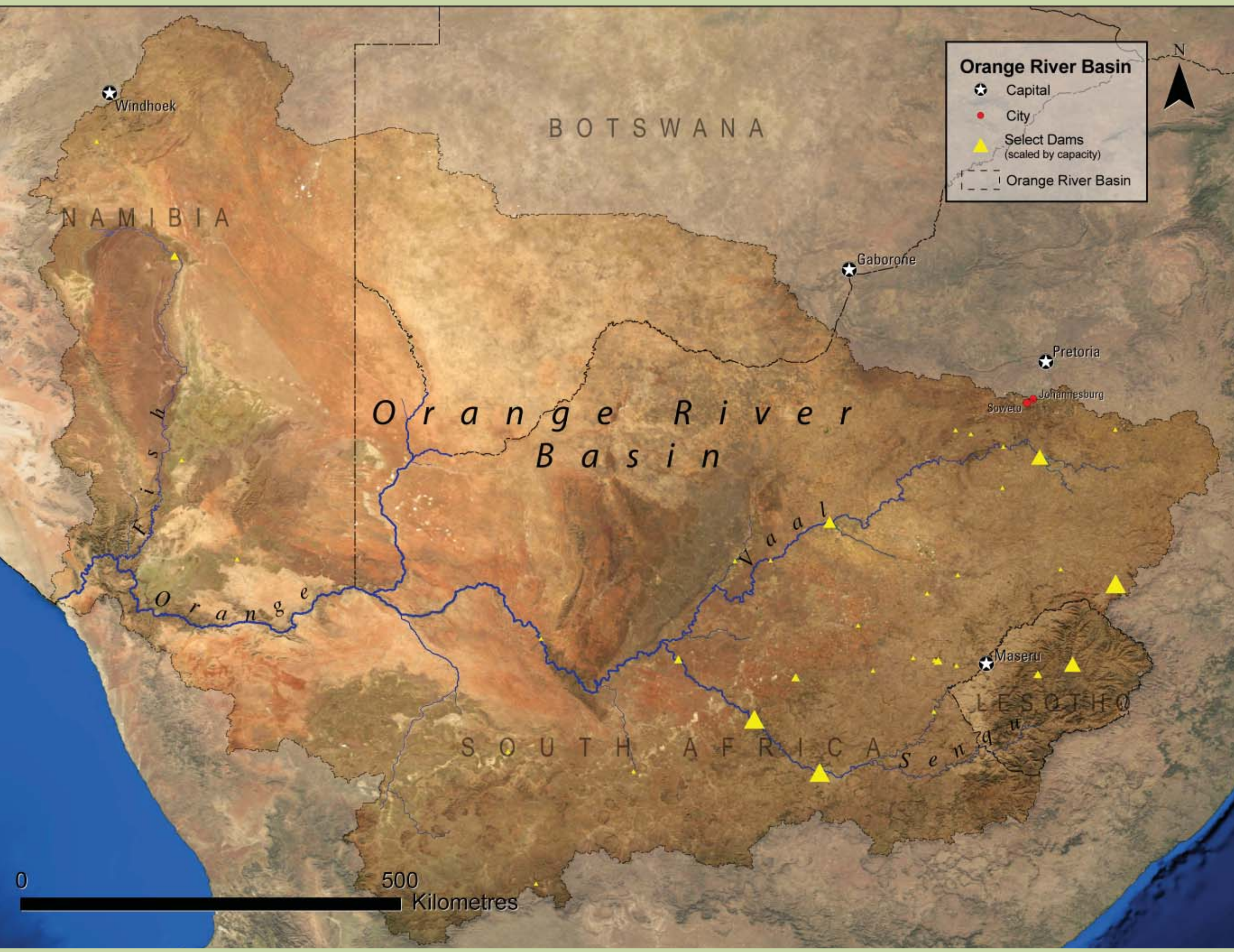
- Felderkartogramm (?)
  ratio
  Farbe, Helligkeit



Orange River Basin



The Orange River originates in Lesotho where its tributary, the Senqu, begins high in the Drakensberg Mountains. While only three per cent of the basin lies in Lesotho the country's highlands have some of the highest mean annual rainfall in the basin and Lesotho contributes nearly 17 per cent of the Orange River's water budget (Senay and others 2010).



While only three per cent of the basin lies in Lesotho, the country's highlands contribute nearly 17 per cent of the water budget

The Vaal River drains the wetter eastern portion of South Africa, which occupies 60 per cent of the basin and contributes most of South Africa's 76 per cent share of the basin's water. Namibia (25 per cent) and Botswana (13 per cent) each make up significant shares of the basin's area but because of high evapotranspiration of limited rainfall, make only minor contributions to the river's flow.

Precipitation in the basin declines from east-to-west with some areas of Lesotho and South Africa receiving over 1 000 mm of rain annually while western areas of South Africa and Namibia receive less than 200 mm (Figure 2.11.1, Figure 2.11.2)

Population

Population also follows an east-to-west gradient with the majority of people living in the eastern third of the basin. Nearly 12 million South Africans live within the Orange Basin, most of them in and around the cities of Gauteng Province. Lesotho's average population density of around 67 persons per km^2 is the highest in the basin. Populations in the Namibia and Botswana portions of the basin are quite sparse with densities near one person per km^2 (Figure 2.11.3).

Dams, Irrigation and Development

The Orange River Basin is highly developed, with many dams and transfer schemes, particularly in the South African share of the basin. The largest-capacity dams are the Gariep and Vanderkloof on the Orange River, the Sterkfont Dam on the Nuvejaars River, and the Vaal Dam on the Vaal River. The Katse Dam and Mohale are the largest dams outside of South Africa. Both are in Lesotho and are a part of the world's largest inter-basin water transfer scheme, the Lesotho Highlands Water Project, which transfers water north to Gauteng Province to help meet the Johannesburg area's rapidly growing water needs (Earle and others 2005). Irrigation developments line the river banks. In the Vaal River catchment's heavily populated upper reaches, large volumes of water are utilized for domestic, industrial, and mining purposes. In the western regions where population is sparse, water schemes draw on the river to provide water for livestock, irrigation, and mining (SADC-GTZ 2007).

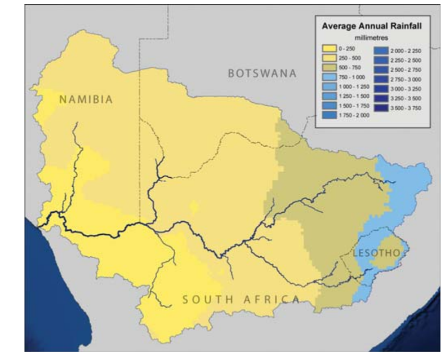


Figure 2.11.1: Orange River Basin average annual rainfall

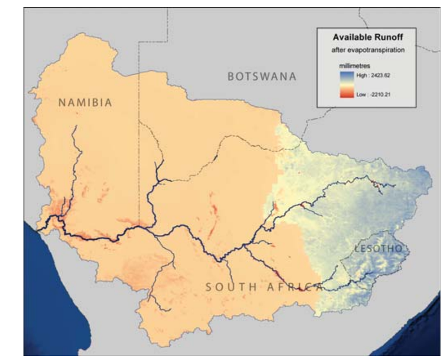


Figure 2.11.2: Orange River Basin modeled available runoff

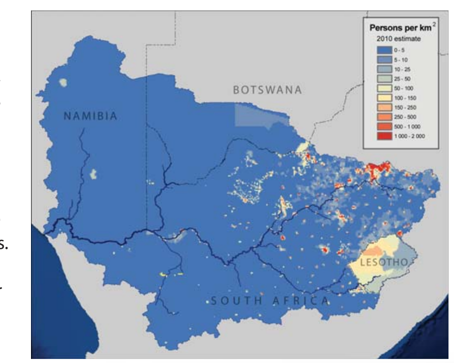


Figure 2.11.3: Orange River Basin population density

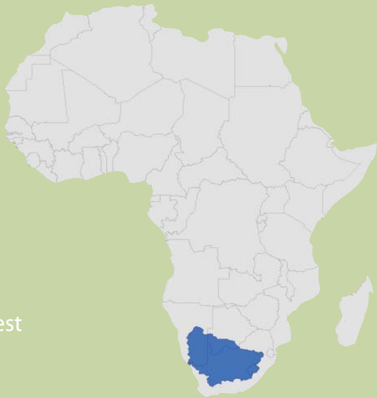
Available Runoff
after evapotranspiration
millimetres
High : 2423.62
Low : -2210.21
BOTSWANA
NAMIBIA
LESOTHO
SOUTH AFRICA

Basis: Grenzen, Flüsse

einschichtig
elementar
analytisch

- Pixelkartogramm
  intervall
  ohne Klassenbildung
  Farbe, Helligkeit

Orange River Basin



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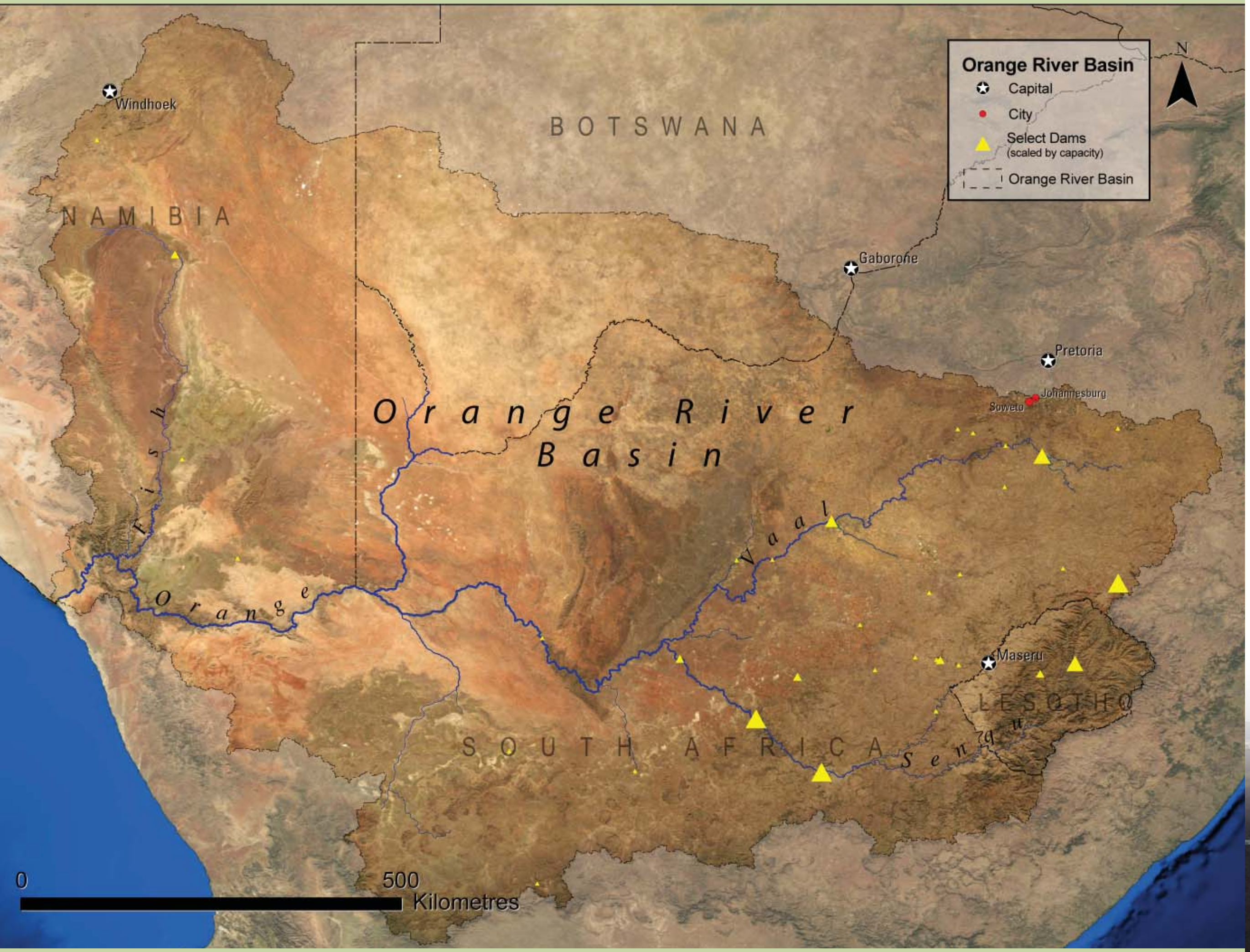

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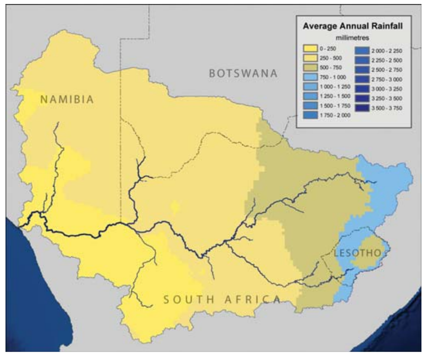


Figure 2.11.1: Orange River Basin average annual rainfall

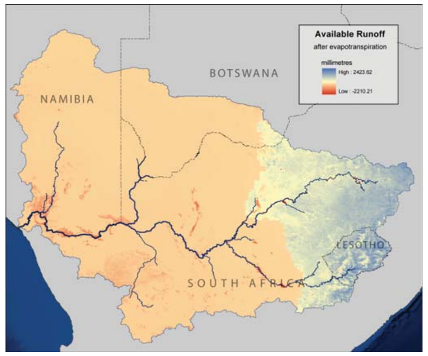


Figure 2.11.2: Orange River Basin modeled available runoff

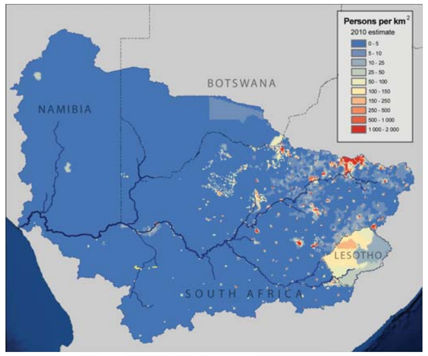
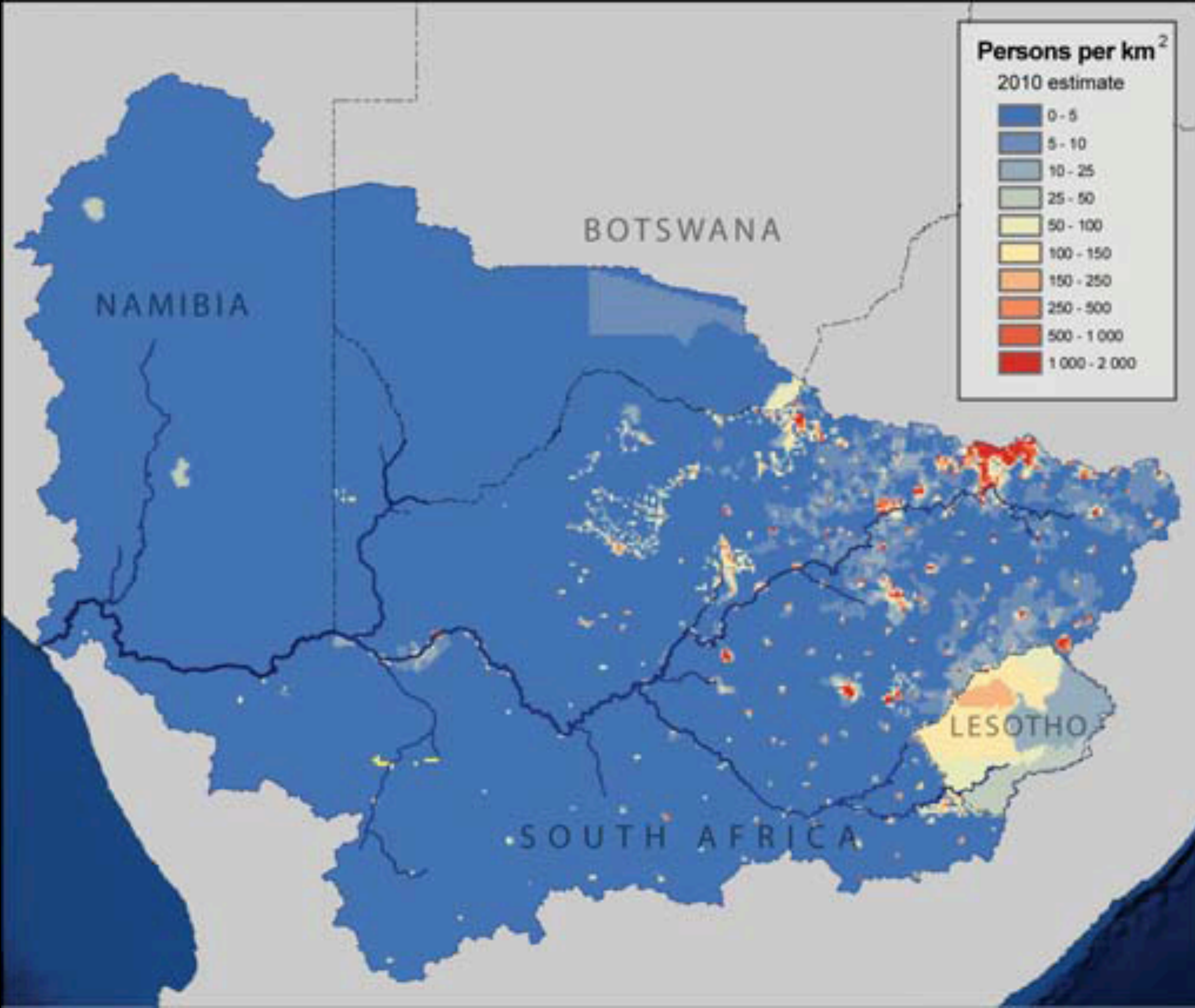


Figure 2.11.3: Orange River Basin population density

Henri Bergius/Flickr.com

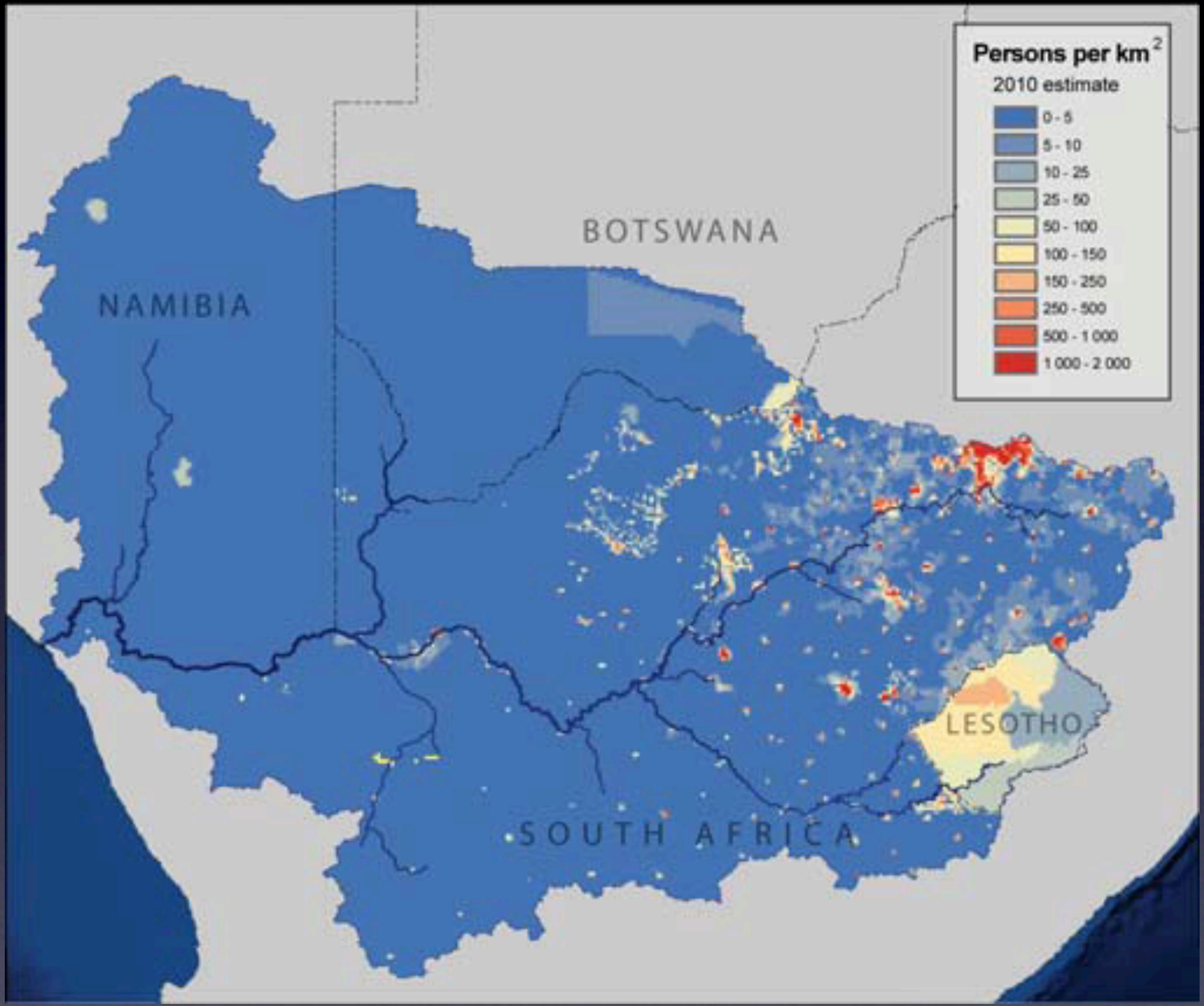


Persons per km 2
2010 estimate
0 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 150
150 - 250
250 - 500
500 - 1 000
1 000 - 2 000
BOTSWANA
NAMIBIA
LESOTHO
SOUTH AFRICA

Basis: Grenzen, Flüsse

einschichtig
elementar
analytisch

- Pixelkartogramm
  ratio
  Farbe, Helligkeit



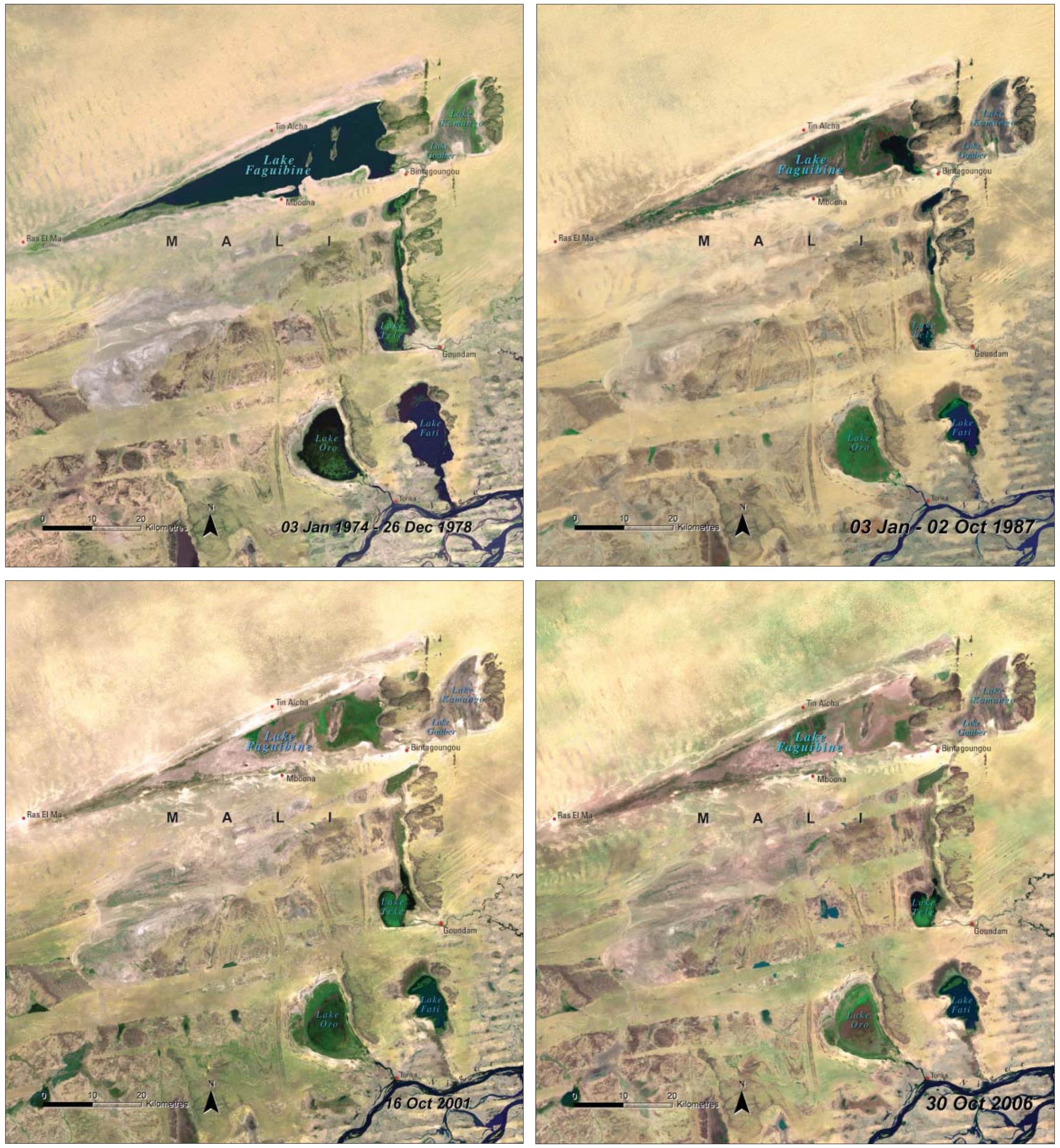
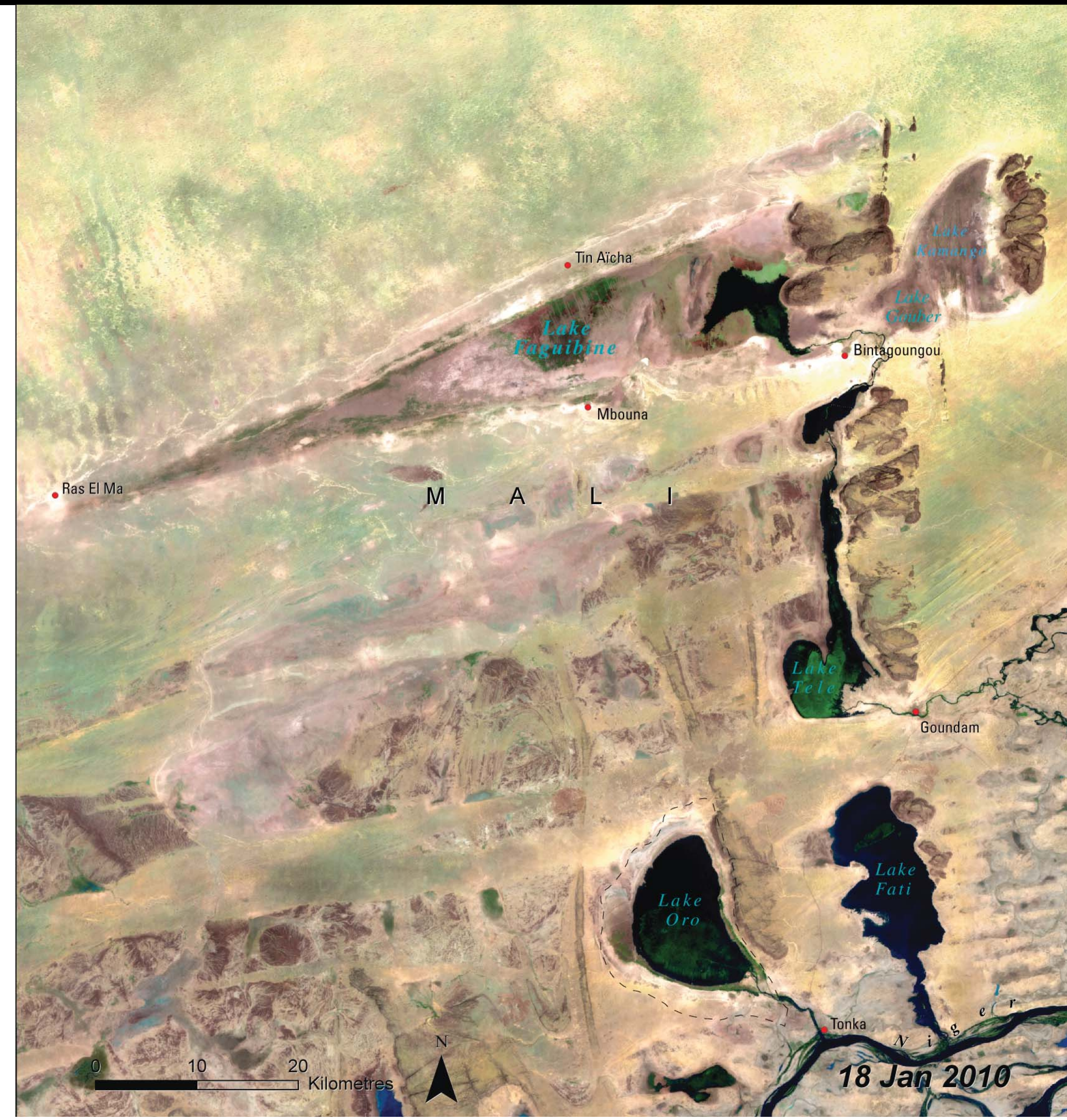


Figure 2.7.5 After drying up in the 1990s Lake Faguibine has not refilled significantly, however some pooling has occurred during wet years. Work is underway to clear debris from channels that feed the lake

Lake Faguibine

Lake Faguibine is located in the Sahelian sub-desert zone to the west of Timbuktu in northern Mali. Annual precipitation in the Faguibine area is in the range of 250 mm/yr, with the rainy season beginning in mid-June and lasting three to four months. When Lake Faguibine is full, as it was in the 1970s satellite image (Figure 2.7.5), it is among the largest lakes in West Africa, covering approximately 590 km² (Duvail and Hamerlynck 2009). During the great droughts of the 1970s and 1980s, Faguibine began declining and in the 1990s it dried up completely. With the lake all but gone, many local livelihoods also dried up including agriculture, fishing, and dry-season grazing (Duvail and Hamerlynck 2009).

The sparse rainfall is not enough to support rain-fed agriculture and cannot fill the lake without inflow from distant parts of the Niger Basin where the rainfall is heavier. The lake receives most of its water through two channels that carry water from the Niger River when its levels are high enough (CNEARC 2004). Despite some better rainfall years since the great droughts (Descroix and others 2009), Lake Faguibine has not significantly refilled, only forming a small pond for a few years during the wet seasons since the 1990s. The 2010 wet season satellite image shows a pool of about 35 km² (six per cent of the 1974 surface area).



During the extended droughts of the 1970s and 1980s, the channels that carry water between the Niger and Lake Faguibine had become clogged with sand and vegetation (UNEP n.d., BBC 2009). The government of Mali has been working to clear the channels and recently received a commitment of US$15 million from the United Nations Environment Programme to help support that work. A government official working with the project says that conditions are already improving with a dramatic increase in farming around the lake between 2006 and 2010 (BBC 2009).

Basis: Sat-Bild, Städte

kein thematischer Inhalt

Zeitreihe

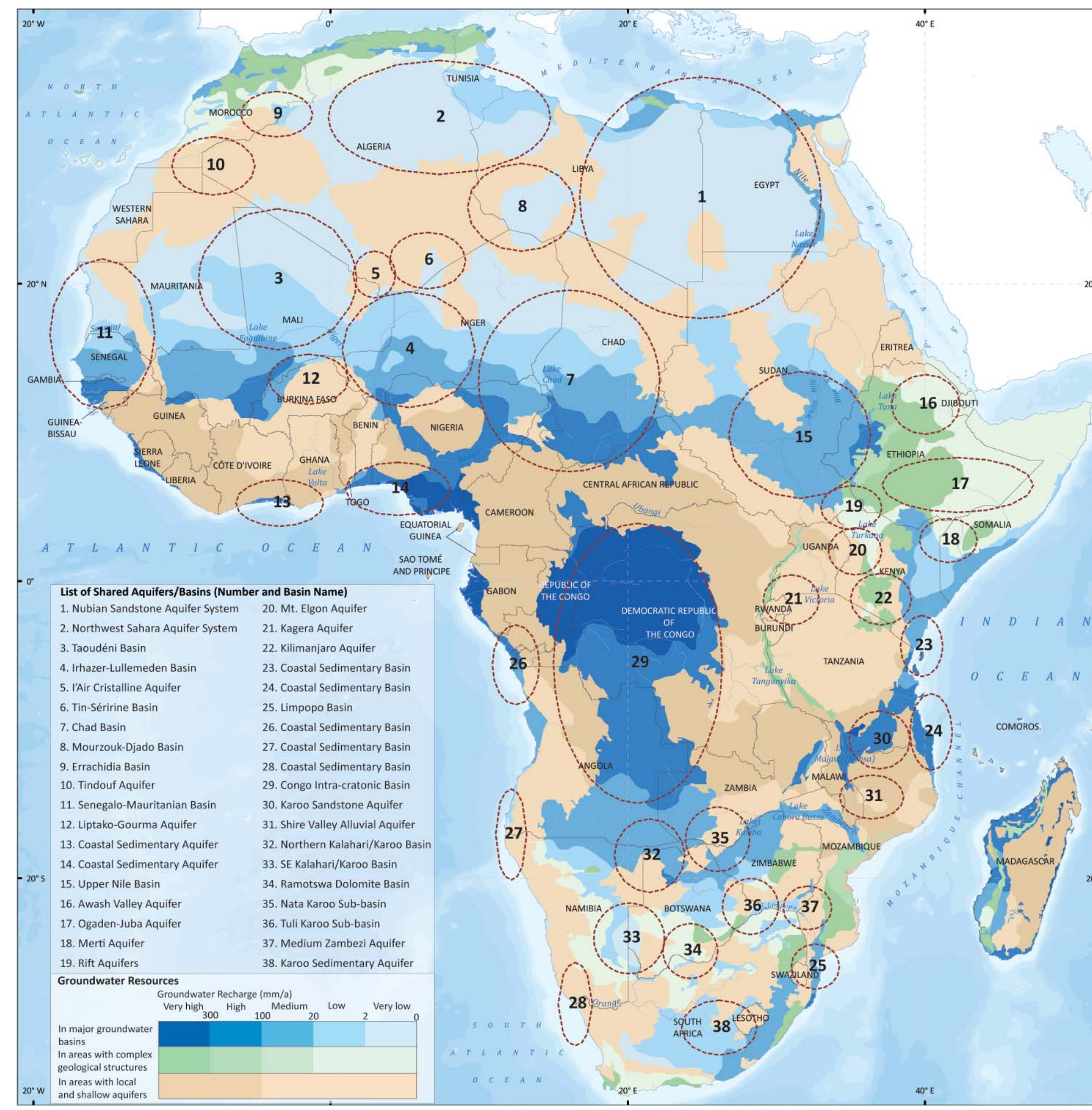
Transboundary Aquifers

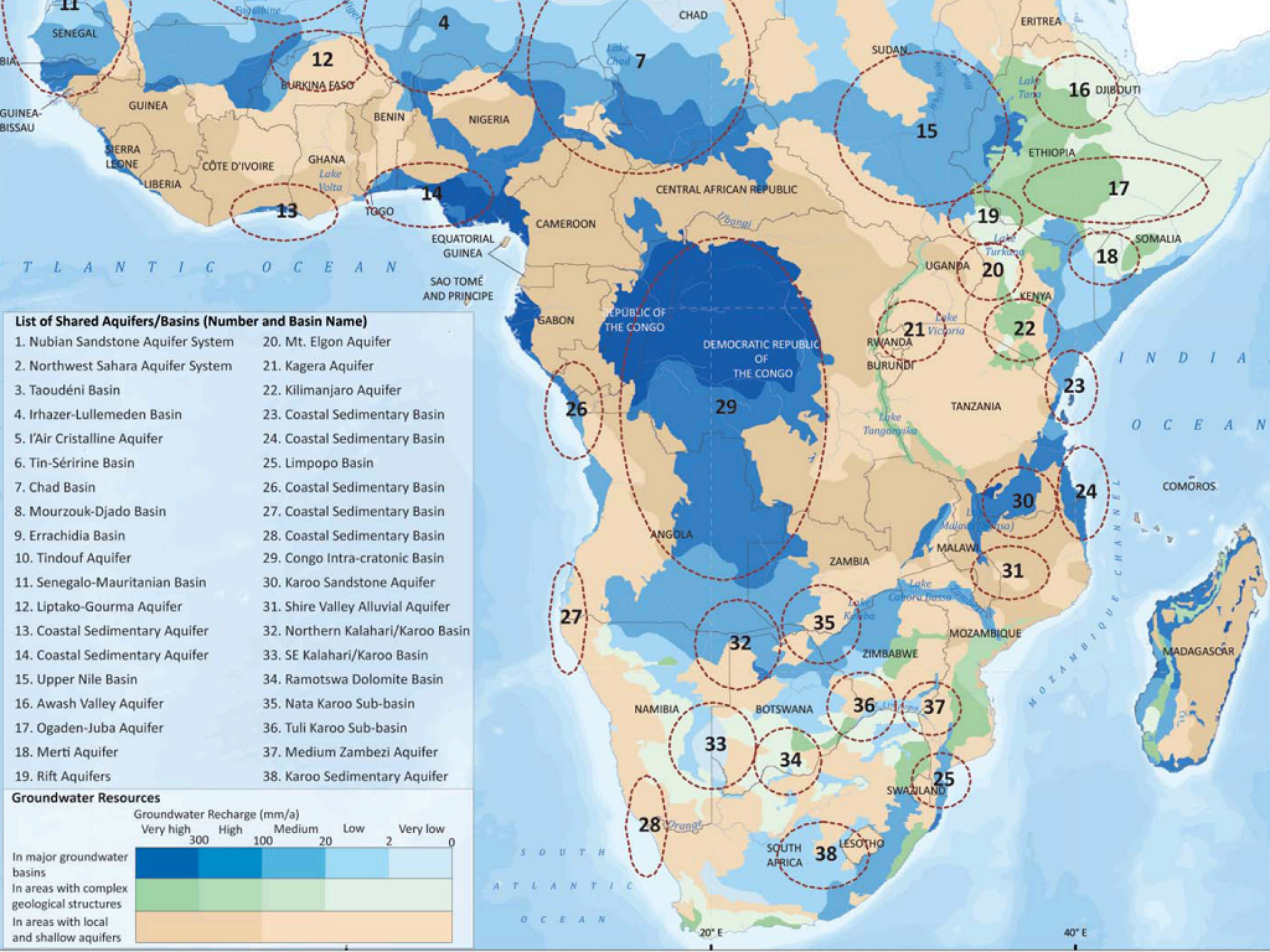
Just as there are internationally shared river basins, there are also internationally shared, or transboundary, water resources and aquifers hidden underground. Some of the world's transboundary aquifers contain huge freshwater resources, enough to provide safe and good-quality drinking water for the needs of all humanity for decades (UNESCO 2001) (Figure 2.15.1). Generally, aquifer systems contain excellent quality water, due in part to their relative isolation from surface impacts. The hidden nature of transboundary groundwater and lack of legal frameworks to manage them, however, also invite misunderstanding by many policy makers. Not surprisingly therefore, transboundary aquifer management is still in its infancy, since groundwaters are difficult to evaluate and there is a lack of institutional will and finances to collect the necessary information. Although there are fairly reliable, detailed estimates of the water resources in rivers shared by two or more countries, no equivalent estimates exist for transboundary aquifers (Salman 1999).

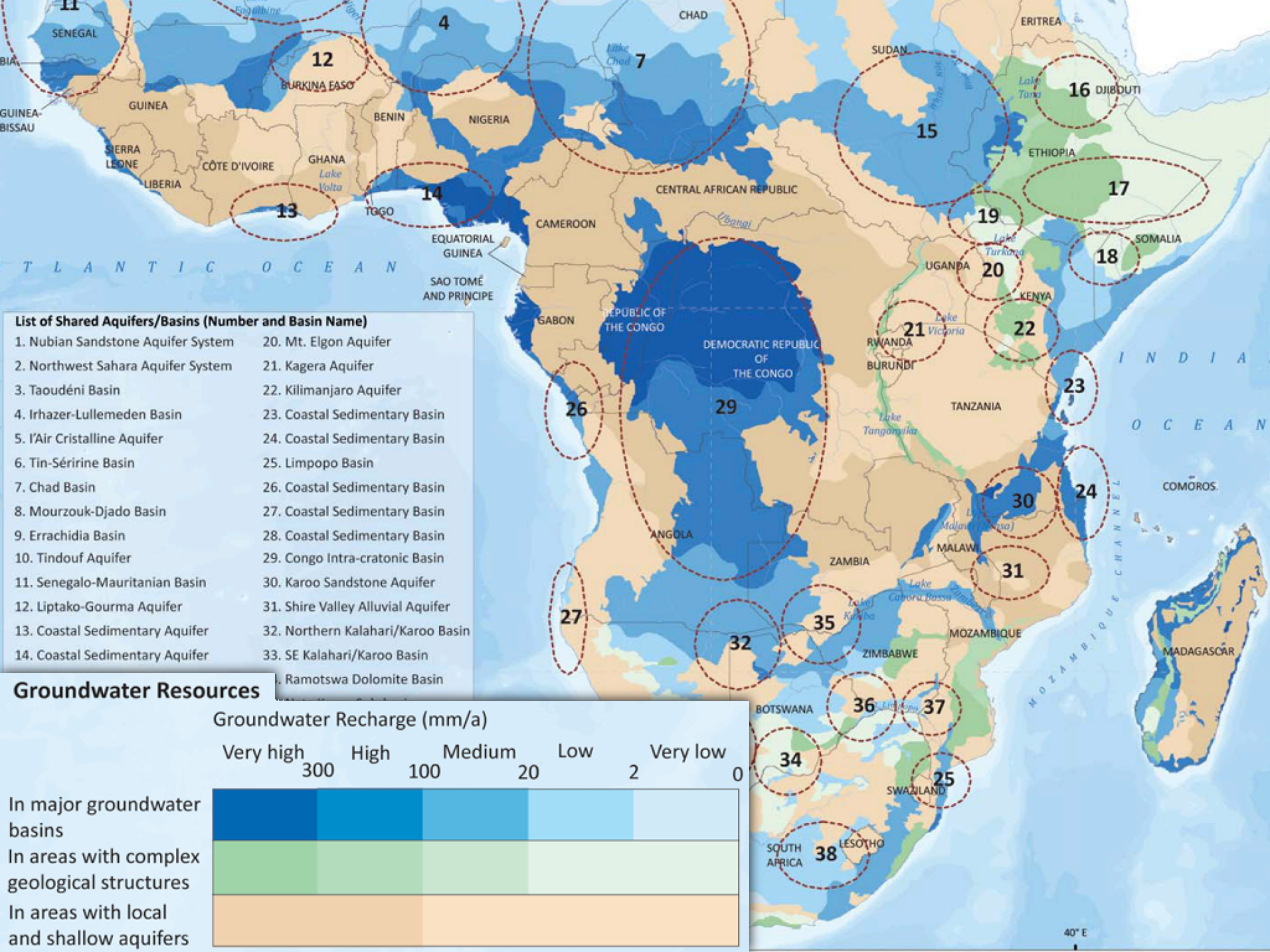
In Africa, groundwater is an important source of freshwater and it is essential to supplement the surface water resources in a region that is increasingly affected by recurrent drought. Africa is endowed with large and often under-utilized aquifer resources, predominantly in the large shared subregional sedimentary systems of the Sahara and Central and Southern Africa. There are also significant shared coastal aquifer resources that supply the large urban populations concentrated in rapidly growing coastal areas (Figure 2.15.2).

Large shared aquifer resources often represent the only source of drought security and life sustenance for large populations in semi-arid areas. While the linkages between surface water and groundwater are critical to aquifer recharge, the watersheds in many aquifer recharge zones are threatened by accelerated land degradation and

Figure 2.15.1: Transboundary aquifers (Source: adapted from UNESCO-IHP/ISARM 2004)




List of Shared Aquifers/Basins (Number and Basin Name)
1. Nubian Sandstone Aquifer System
2. Northwest Sahara Aquifer System
3. Taoudéni Basin
4. Irhazer-Lullemeden Basin
5. l'Air Cristalline Aquifer
6. Tin-Séririne Basin
7. Chad Basin
8. Mourzouk-Djado Basin
9. Errachidia Basin
10. Tindouf Aquifer
11. Senegalo-Mauritanian Basin
12. Liptako-Gourma Aquifer
13. Coastal Sedimentary Aquifer
14. Coastal Sedimentary Aquifer
15. Upper Nile Basin
16. Awash Valley Aquifer
17. Ogaden-Juba Aquifer
18. Merti Aquifer
19. Rift Aquifers
20. Mt. Elgon Aquifer
21. Kagera Aquifer
22. Kilimanjaro Aquifer
23. Coastal Sedimentary Basin
24. Coastal Sedimentary Basin
25. Limpopo Basin
26. Coastal Sedimentary Basin
27. Coastal Sedimentary Basin
28. Coastal Sedimentary Basin
29. Congo Intra-cratonic Basin
30. Karoo Sandstone Aquifer
31. Shire Valley Alluvial Aquifer
32. Northern Kalahari/Karoo Basin
33. SE Kalahari/Karoo Basin
34. Ramotswa Dolomite Basin
35. Nata Karoo Sub-basin
36. Tuli Karoo Sub-basin
37. Medium Zambezi Aquifer
38. Karoo Sedimentary Aquifer
Groundwater Resources
Groundwater Recharge (mm/a)
Very high
High
Medium
Low
Very low
300
100
20
2
0
In major groundwater basins
In areas with complex geological structures
In areas with local and shallow aquifers
SENEGAL
GUINEA
GUINEA-BISSAU
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
GHANA
Lake Volta
BURKINA FASO
BENIN
TOGO
NIGERIA
CHAD
Lake Chad
SUDAN
ERITREA
DJIBOUTI
ETHIOPIA
Lake Tana
SOMALIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
EQUATORIAL GUINEA
SAO TOMÉ AND PRINCIPE
GABON
REPUBLIC OF THE CONGO
DEMOCRATIC REPUBLIC OF THE CONGO
Ubangi
UGANDA
Lake Turkana
KENYA
Lake Victoria
RWANDA
BURUNDI
TANZANIA
Lake Tanganyika
ANGOLA
ZAMBIA
MALAWI
Lake Kariba
Lake Cabora Bassa
MOZAMBIQUE
ZIMBABWE
NAMIBIA
BOTSWANA
SWAZILAND
LESOTHO
SOUTH AFRICA
Orange
MADAGASCAR
COMOROS
MOZAMBIQUE CHANNEL
ATLANTIC OCEAN
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
20° E
40° E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Groundwater Recharge (mm/a)
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High
Medium
Low
Very low
300
100
20
2
0
In major groundwater basins
In areas with complex geological structures
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SENEGAL
GUINEA
GUINEA-BISSAU
SIERRA LEONE
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DJIBOUTI
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INDIAN OCEAN
MOZAMBIQUE CHANNEL
Lake Chad
Lake Tana
Lake Turkana
Lake Victoria
Lake Tanganyika
Lake Volta
Lake Kariba
Lake Cahora Bassa
Ubangi
White Nile
Blue Nile
Zambezi
40° E

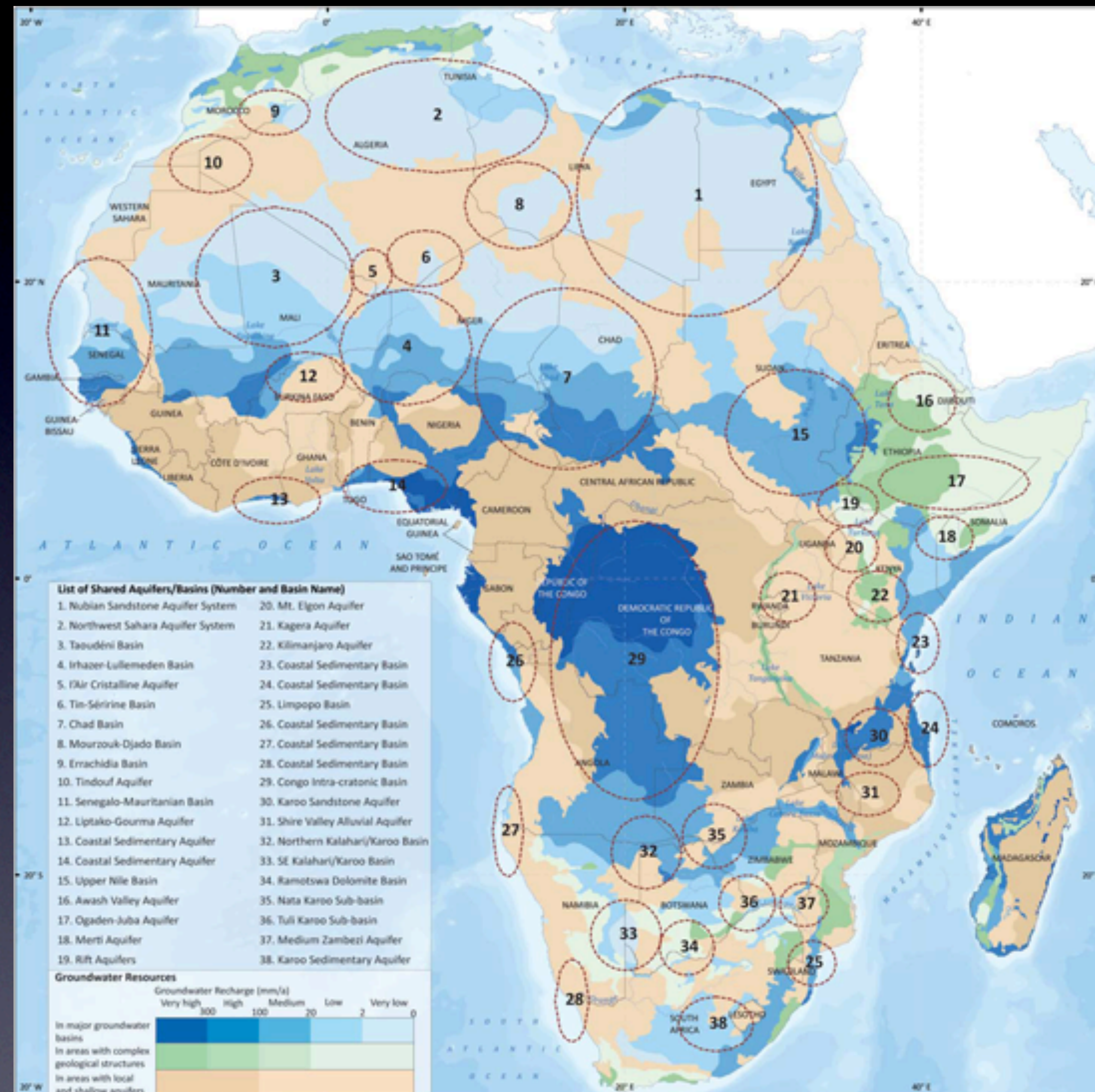
Basis: Grenzen, Flüsse, Netz

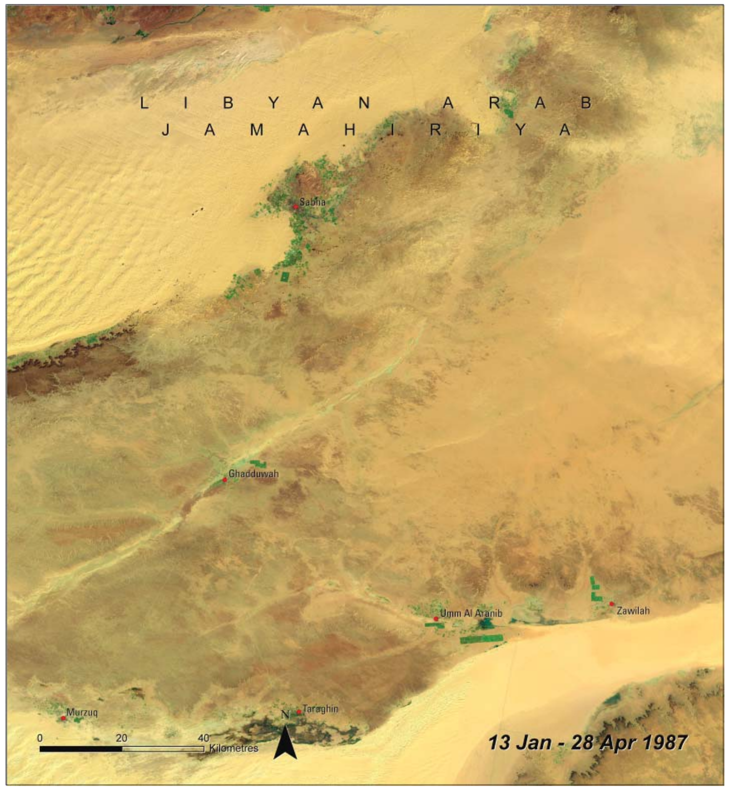
mehrschichtig
komplex (homogen)
synthetisch

(1) Flächenmittelwerte / Flächenkartogramm
nominal – Farbe
ratio – Helligkeit

(2) Arealmethode
nominal – Schrift

Schicht-Unterscheidung: Farbe, Muster





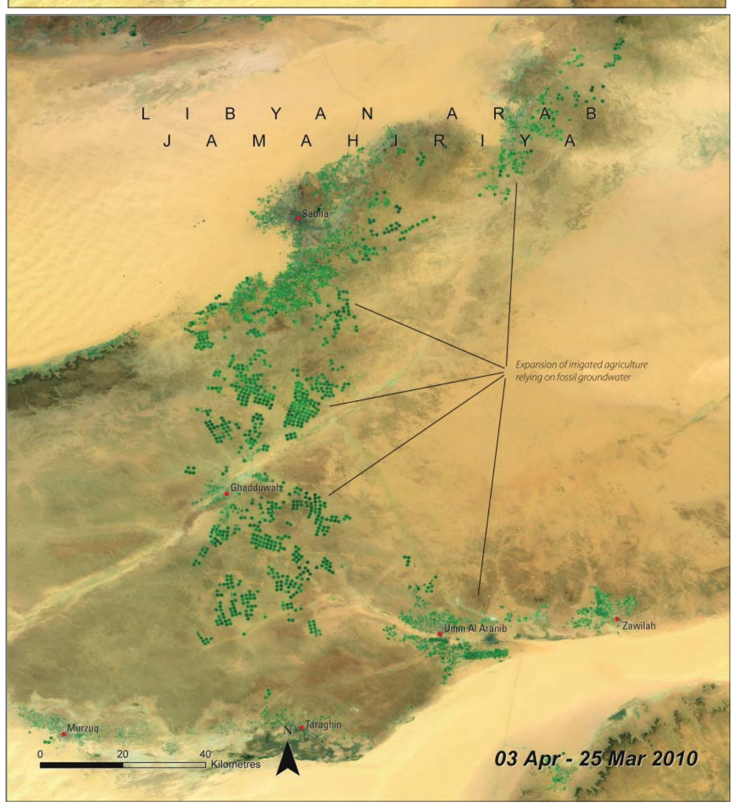


Figure 2.16.9: Expansion of irrigated agriculture relying on fossil groundwater

water is for industry, domestic use and to support irrigated farms that feed Libya's growing population. The system is among the largest civil engineering projects in the world.

The majority of the system's water comes from Libya's two largest groundwater resources—the Murzuq and Kufra groundwater basins (Alghariani 2007). Located in Libya's southern desert, they hold over two-thirds of Libya's groundwater reserves (Alghariani 2007). Neither aquifer system receives significant recharge; consequently any withdrawal of water reduces the total reserves. While the total volume of water in the two aquifers is enormous, drawdown of the water levels under heavy usage could eventually make extracting water prohibitively expensive (Shaki and Adeloye 2006, Alghariani 2003). The July 2010 image (Figure 2.16.7, previous page) shows some of the wells of the East and North East Jabal Hasaouna well fields, which abstract around two million m^3 of water daily from the Murzuq Basin Aquifer (Abdelrhem and others 2008).

The satellite image pairs (Figure 2.16.9) show the large increase in centre pivot irrigation at two locations —one drawing from the Kufra Basin in the southeast and the other from the Murzuq Basin in the southwest. The majority of Libya's groundwater, as much as 80 per cent (Alghariani 2003), is used for agriculture including wheat, alfalfa, vegetables and fruits. Water and agricultural demands are driven by Libya's population, which was growing at just over two per cent per year in 2008, down from five per cent per year in the early eighties (World Bank 2010). Since the project's initiation in 1983 the cost of alternative sources of water, particularly by desalinization, has become competitive with water delivered by the Great Man-Made River transfer scheme (Alghariani 2003) and will likely become less expensive in the foreseeable future.

The project is being built in several stages. Phase One provides two million cubic metres per day from wells at Sarir and Tazerbo to the Northern Cities of Benghazi and Sirte. The second phase delivers water to the Jeffara Plain and to Tripoli. The third phase of the project has begun construction, although some parts of that phase have been cancelled (WaterTechnologyNet n.d.).

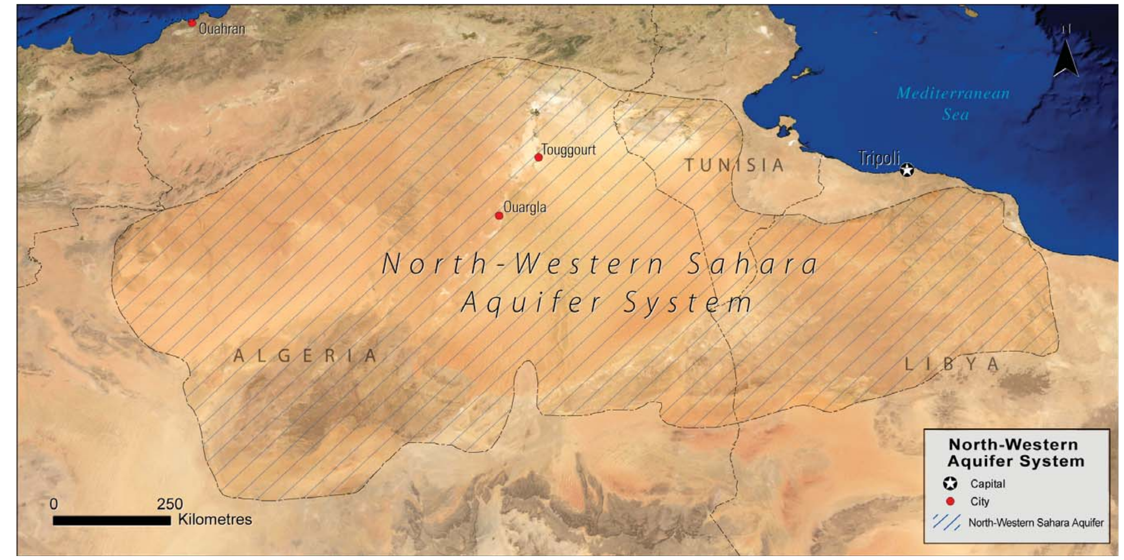
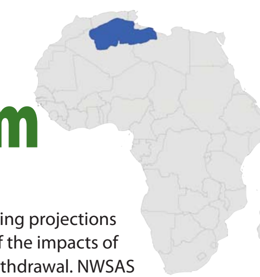
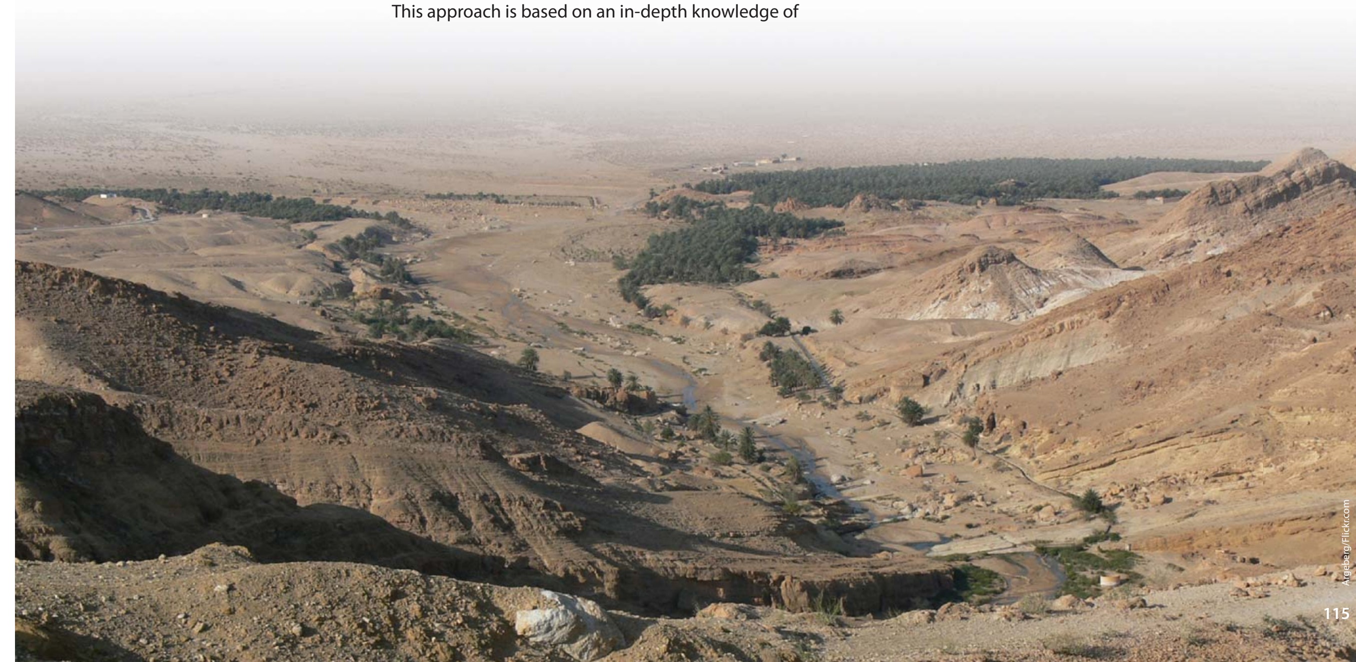


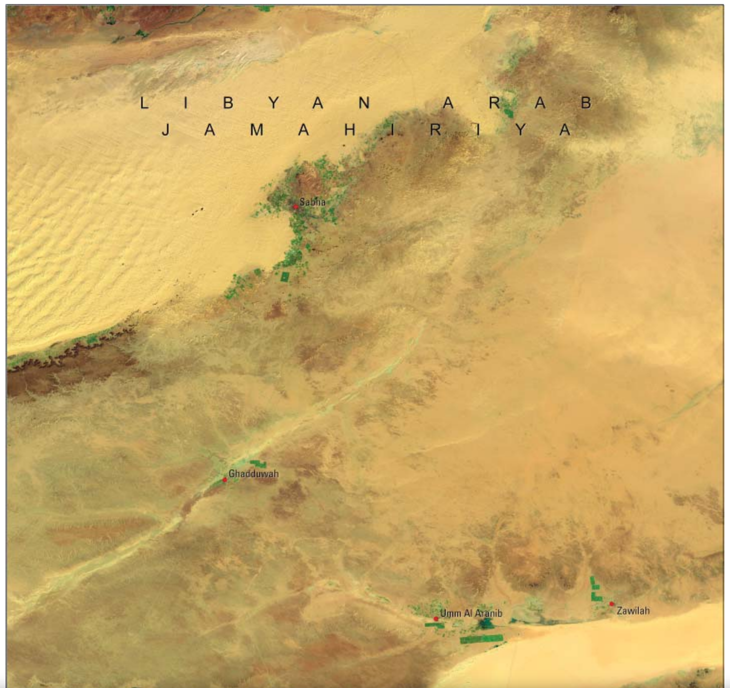
Figure 2.17.1: North-Western Sahara Aquifer System

North-Western Sahara Aquifer System



The North-Western Sahara Aquifer System (NWSAS) covers a total area of over one million km^2: 700 000 km^2 in Algeria, 80 000 km^2 in Tunisia and 250 000 km^2 in Libya (Figure 2.17.1). It contains sedimentary deposits that have two main levels of aquifers, the Intercalary Continental (IC) and the Terminal Complex (TC). The three NWSAS countries have embraced an approach of joint management. This approach is based on an in-depth knowledge of the aquifer, including projections and simulations of the impacts of intensive water withdrawal. NWSAS is crucial to development in the north-western part of the Sahara desert, especially to secure food for a growing population close to, and even far beyond its borders, and to meet the demands of agriculture, industry, and construction.





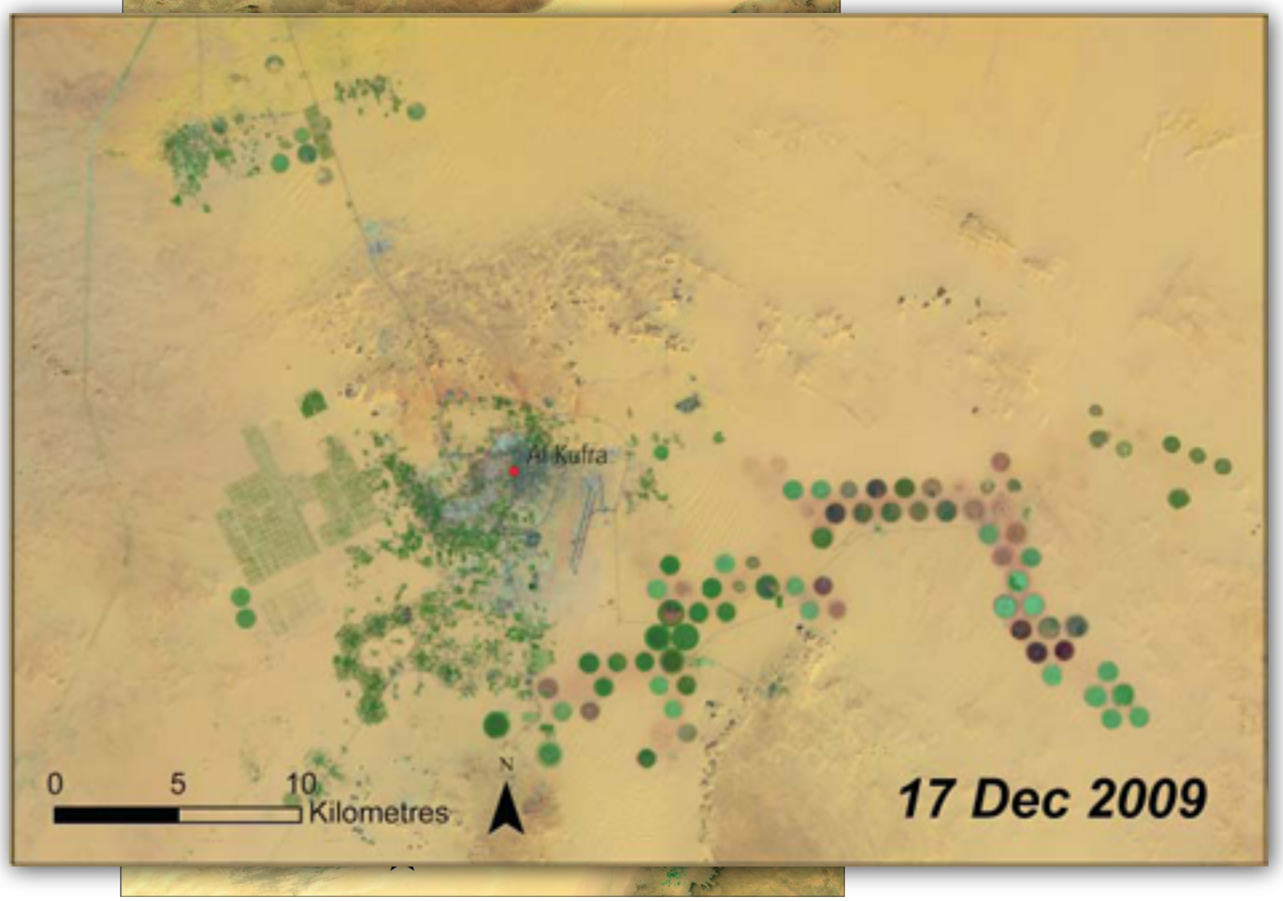


Figure 2.16.9: Expansion of irrigated agriculture relying on fossil groundwater

water is for industry, domestic use and to support irrigated farms that feed Libya's growing population. The system is among the largest civil engineering projects in the world.

The majority of the system's water comes from Libya's two largest groundwater resources—the Murzuq and Kufra groundwater basins (Alghariani 2007). Located in Libya's southern desert, they hold over two-thirds of Libya's groundwater reserves (Alghariani 2007). Neither aquifer system receives significant recharge; consequently any withdrawal of water reduces the total reserves. While the total volume of water in the two aquifers is enormous, drawdown of the water levels under heavy usage could eventually make extracting water prohibitively expensive (Shaki and Adeloye 2006, Alghariani 2003). The July 2010 image (Figure 2.16.7, previous page) shows some of the wells of the East and North East Jabal Hasaouna well fields, which abstract around two million m^3 of water daily from the Murzuq Basin Aquifer (Abdelrhem and others 2008).

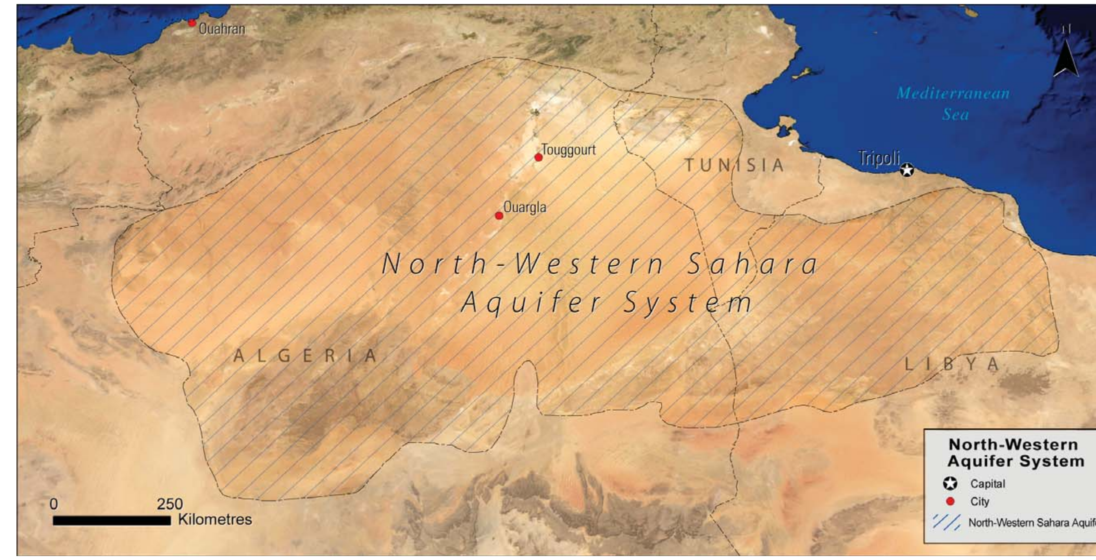
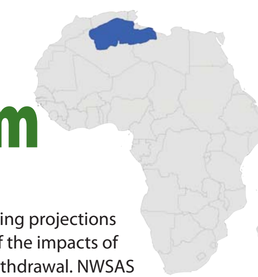
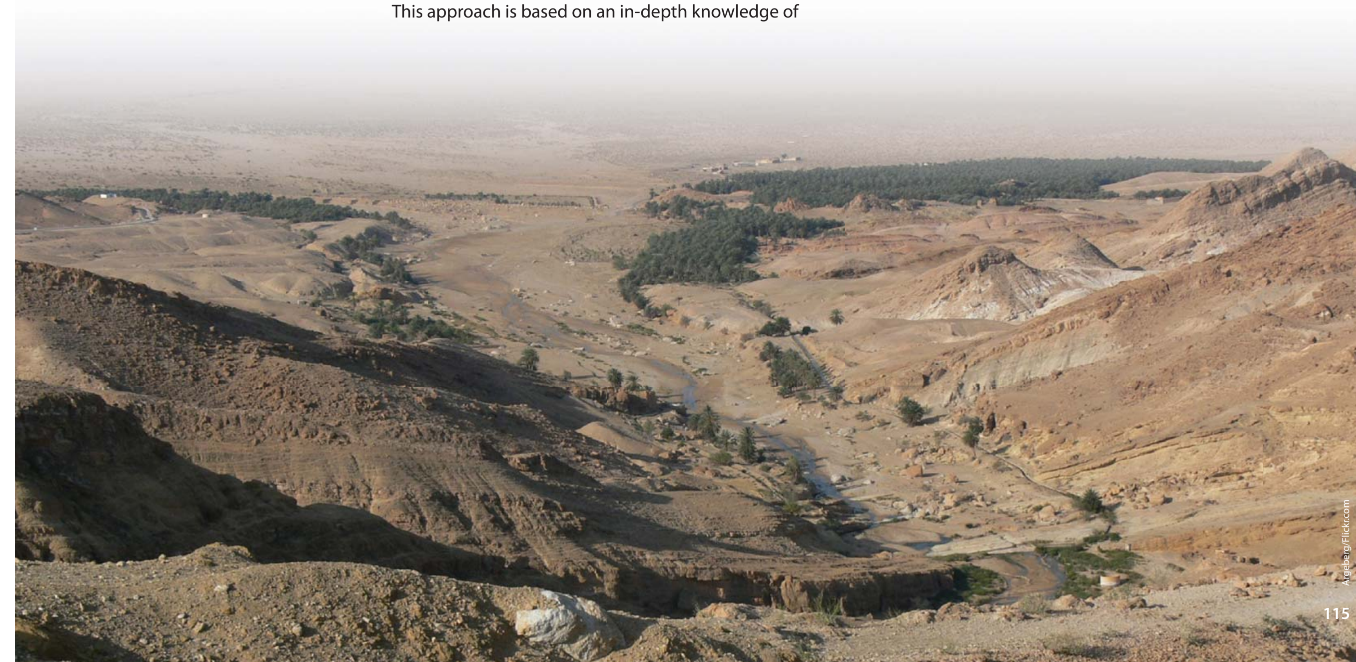


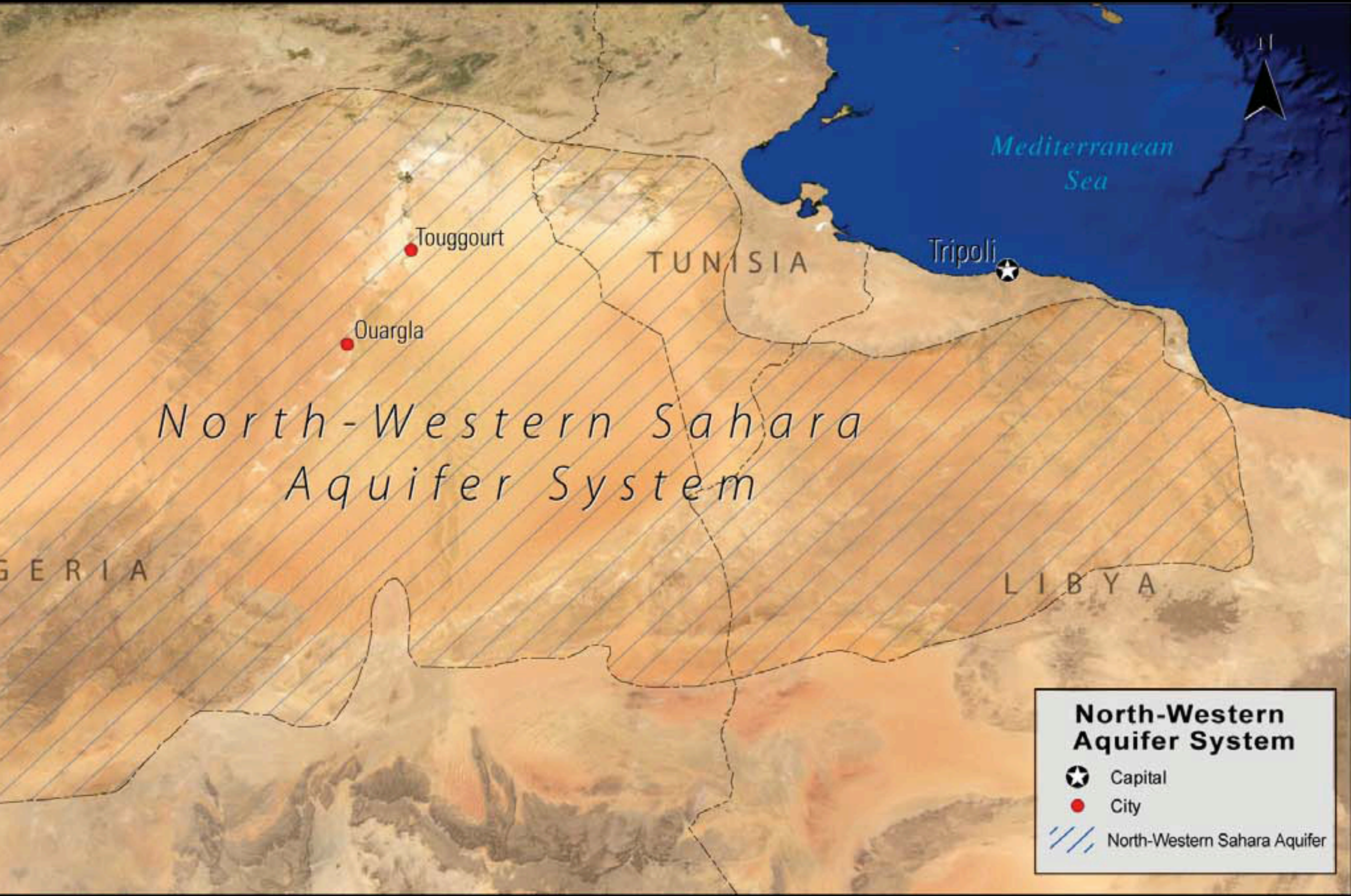
Figure 2.17.1: North-Western Sahara Aquifer System

North-Western Sahara Aquifer System



The North-Western Sahara Aquifer System (NWSAS) covers a total area of over one million km^2: 700 000 km^2 in Algeria, 80 000 km^2 in Tunisia and 250 000 km^2 in Libya (Figure 2.17.1). It contains sedimentary deposits that have two main levels of aquifers, the Intercalary Continental (IC) and the Terminal Complex (TC). The three NWSAS countries have embraced an approach of joint management. This approach is based on an in-depth knowledge of the aquifer, including projections and simulations of the impacts of intensive water withdrawal. NWSAS is crucial to development in the north-western part of the Sahara desert, especially to secure food for a growing population close to, and even far beyond its borders, and to meet the demands of agriculture, industry, and construction.




Mediterranean Sea
Touggourt
Ouargla
TUNISIA
Tripoli
North-Western Sahara Aquifer System
GERIA
LIBYA
North-Western Aquifer System
Capital
City
North-Western Sahara Aquifer

Basis: Sat-Bild, Grenzen, Städte

einschichtig
elementar
analytisch

- Arealmethode
  Einzelmerkmal

3 CHALLENGES & OPPORTUNITIES

Curt Carnemark / World Bank

Improving the Quantity, Quality and Use of Africa's Water

Africa faces mounting challenges in providing enough safe water for its growing population, especially for the huge numbers of people migrating to peri-urban areas, where municipal water services are often non-existent. Many African nations will fail to achieve the Millennium Development Goal's safe water target to reduce by half the proportion of the population without sustainable access to safe drinking water by 2015, and many more will miss the sanitation target that stipulates that by that date, they reduce by half the proportion of the population without sustainable access to basic sanitation. Other challenges include avoiding potential conflicts over water in the 63 water basins on the continent shared by two or more countries; adapting to the impacts of climate change on water resources, which will be greater than most other regions because Africa already suffers from extreme rainfall variability; and developing water resources that are adequate for local needs but that are unavailable due to political and economic constraints.

Box 3.4.1: Small-scale irrigation projects bring multiple benefits

A recent study of selected small-scale irrigation projects in Burkina Faso, Mali and the United Republic of Tanzania shows the potential for these initiatives to increase farm productivity. Small dams, wells and canals built in the villages increased agricultural productivity and generated income that allowed people to cope better with "hungry periods" of the year. The projects included nonagricultural activities such as nutrition education. The benefits extended beyond increased agricultural productivity, giving women time to start market gardens and helping families reduce debt, increase school attendance, limit seasonal migration for work and earn cash to pay for health care.

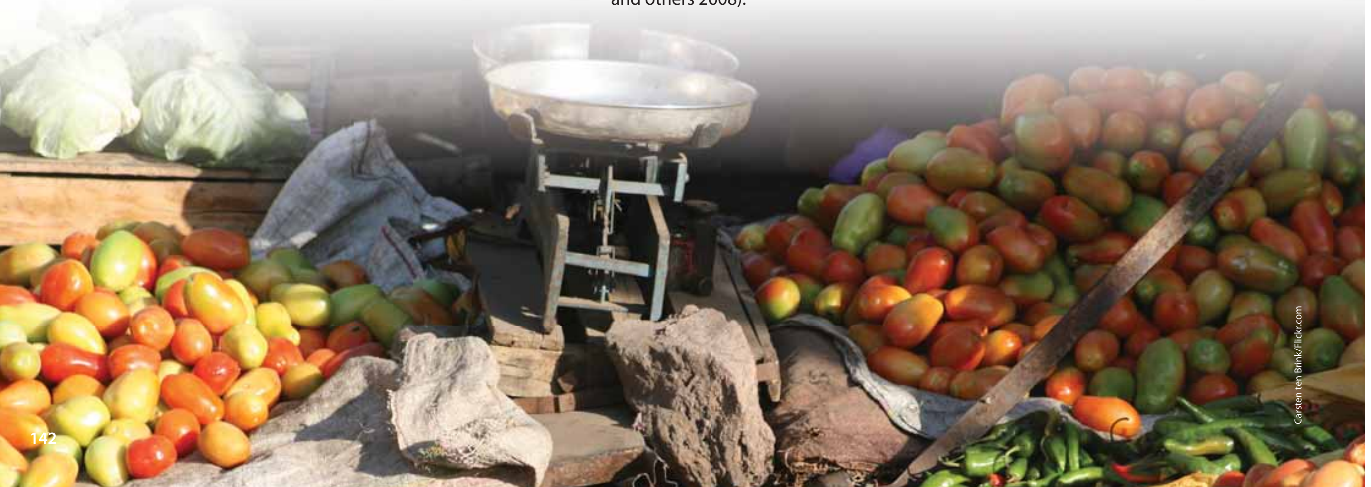
Source: FAO 2002

- *Tie irrigation development to issues of social equity and environmental sustainability:* The large-scale irrigation schemes of the past have lost favour because of their social, environmental and financial costs. Now, project planners are seeking the participation of farmers in designing and managing irrigation plans. In implementing small-scale irrigation projects, there are opportunities to extend benefits to enhance social and environmental sustainability (Box 3.4.1). One of these benefits should be providing opportunities for rural women; given their central role not only as mothers and caregivers, but also as farmers, they hold the key to food security (Nwanze 2010).

- *Secure sustainable investment for the green, Green Revolution:* Technologies such as the development of underutilized irrigation potential, and the development of high yielding and more drought tolerant varieties can work for Africa if there is good investment (World Bank 2008). African farmers can reduce reliance on food imports and protect against the import of low-price grains. Governments in Africa are taking ownership of their own agricultural policies through initiatives such as the Comprehensive Africa Agriculture Development Programme (CAADP), which provides the framework for supporting the design and implementation of national agriculture and food security strategies (MDG Africa Steering Group 2008). This initiative presents an opportunity for development partners and the private sector to support national governments, and to reduce donor fragmentation so that financing can be channeled to effectively support the implementation of national-scale agriculture strategies within the framework.

- *Invest in targeted breeding of drought-tolerant varieties:* For example, the AfDB funded and African Rice Initiative coordinated project contributed to a six per cent increase in the continent's rice output during 2007 (World Bank 2008). Such targeted breeding can produce crop varieties that are higher yielding, more drought tolerant, utilize fertilizers more efficiently, and are more resistant to pests. It is important to note that genetically modified organisms (including crops) are still considered an emerging issue in Africa since they present the following concerns and uncertainties in light of increasing cooperation and trade:

- The issues of bio-safety;
- The impact of GMOs on the environment;
- Trade with non-GMO partners;
- Ethics issues;
- Intellectual property rights; and,
- Access to seeds by small-scale farmers (SADC and others 2008).



CHALLENGE 5

DEVELOP HYDROPOWER TO ENHANCE ENERGY SECURITY

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

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

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

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

The Challenge

Africa has plentiful water resources for hydroelectricity and can boost energy security by increasing hydro development.

The Situation

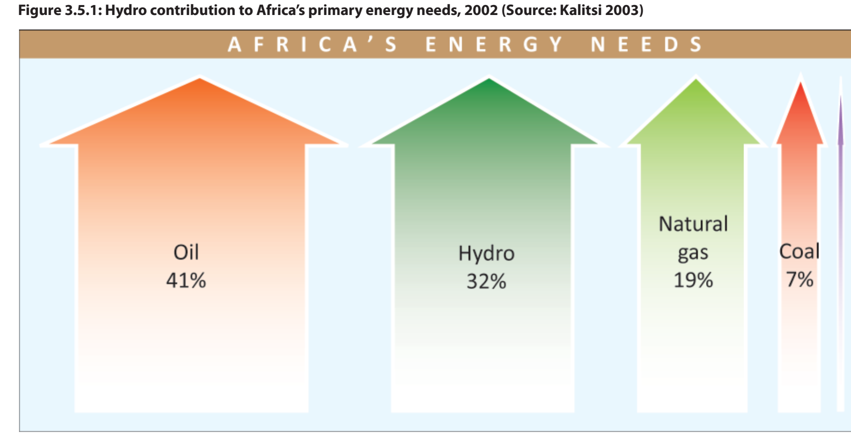
- *Hydroelectricity supplies 32 per cent of Africa's energy* (Figure 3.5.1);

- *Electricity consumption in Africa is the lowest in the world:* Although Africa has the second-largest population after Asia, it has the lowest energy consumption per capita of any continent (Figure 3.5.2, next page). Many African nations have a per capita electricity consumption of less than 80 kWh/yr (Figure 3.5.3, next page), compared to 26 280 kWh/yr in Norway, 17 655 kWh/yr in Canada, and 13 800 kWh/yr in the United States (Bartle 2002).

- *Access to electricity is low and uneven:* More than 90 per cent of the rural population relies on biomass energy sources that include wood, crop waste, charcoal and manure for cooking and heating, and candles and kerosene for lighting (Bartle 2002, Tshombe and others 2007). Only one in four people in Africa has access to electricity, and this figure is barely 10 per cent in rural areas (MDG Africa Steering Group 2008). There are major disparities in levels of electrification between North Africa (93.6 per cent) and sub-Saharan Africa (23.6 per cent) (Kauffman 2005).

- *Electricity supply is often unreliable:* Even where access to electricity is available, it does not necessarily mean that electricity is available on demand. People frequently have to cope with unreliable supply and this disrupts economic activity at all levels and hampers progress. There are many reasons for the frequent and extended

Figure 3.5.1: Hydro contribution to Africa's primary energy needs, 2002 (Source: Kalitsi 2003)



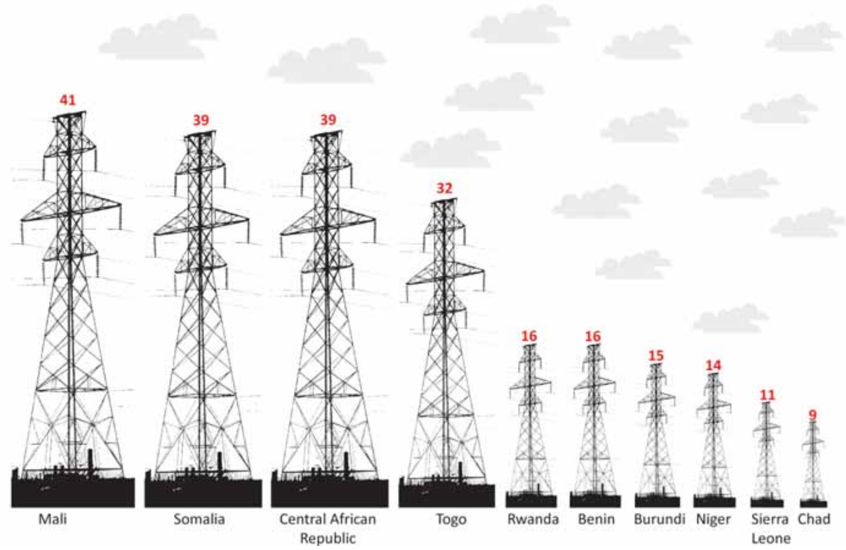


Figure 3.5.3. African countries with less than 80 kWh per capita electricity consumption (Source: Adopted from Bartle 2002)

interruptions, including conflicts that have damaged infrastructure, lack of government funds or treating hydro as a low priority, and aging equipment. Nigeria, for example, operates at about one-third of its installed capacity due to aging facilities. In addition, unpredictable and variable climatic conditions affect the constancy of electricity supply. The 1999-2000 East African drought had a serious impact on hydroelectric facilities, especially in Kenya and Ghana (MBendi n.d.). Rising demand is another reason. In 2007, frequent and extended electricity interruptions affected nearly two-thirds of the countries in sub-Saharan Africa, and although conflict and drought were to blame in several instances, electricity supplies failing to keep pace with growing demand was the cause in most cases (IMF 2008).

- *Wars have destroyed existing electricity service in some areas*: Infrastructure for electricity distribution and transmission has been

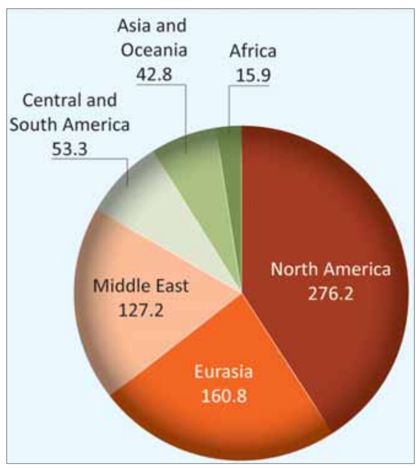


Figure 3.5.4: World per capita total primary energy consumption, 2006 (Million Btu) (Source: IEA 2008)

Africa is the "underdammed" continent. Only three per cent of its renewable water is used, against 52 per cent in Asia. So there is plenty of scope for an African dam-building boom.

—The Economist 2010

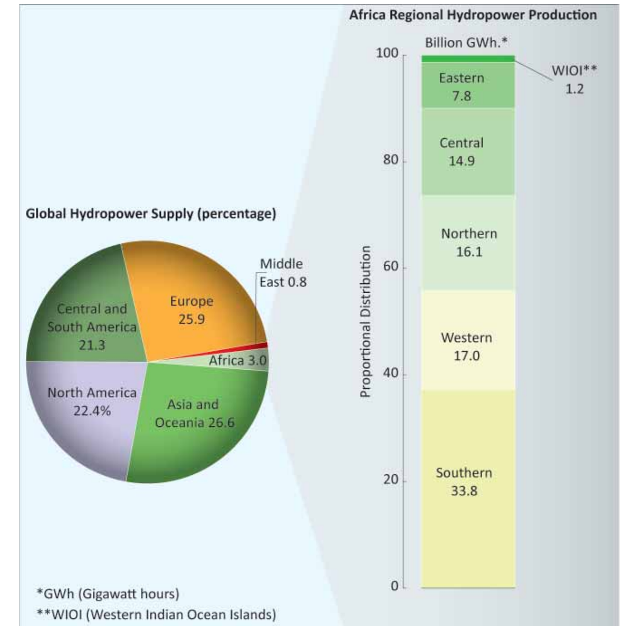


Figure 3.5.4: Regional shares in hydropower supply, 2004 (Data source: IEA 2007)

destroyed by war in countries such as Angola, Congo, Côte d'Ivoire, Chad and Sudan. According to the IEA (2008), it is more costly to restore service than the average cost of serving new customers in a stable environment.

- *Africa's hydro potential is underdeveloped:* Only three per cent of its renewable water resources are exploited for hydroelectricity, compared to an average of 45 per cent in OECD countries and 21 per cent in Latin America (Figures 3.5.4 and 3.5.5, and Box 3.5.1).

Box 3.5.1: How much hydro potential has Africa developed?

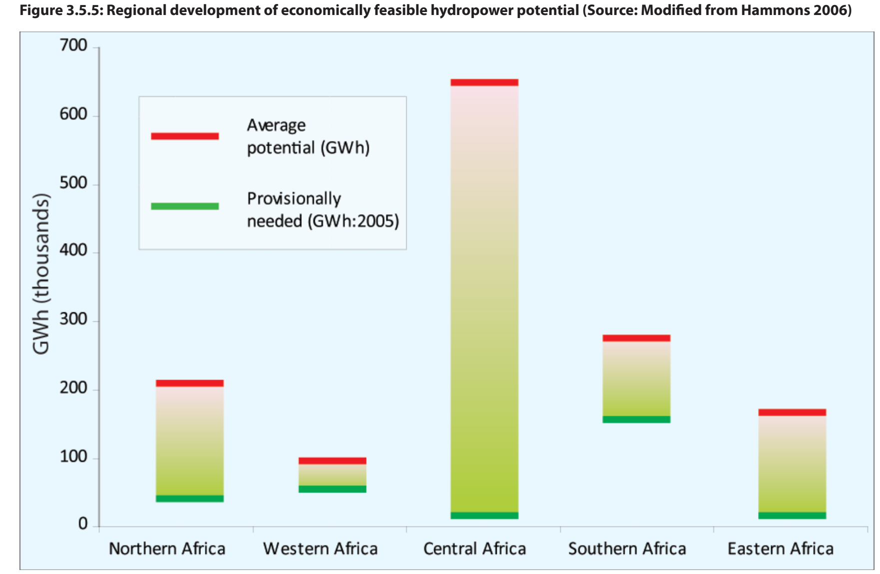
Various estimates regarding the extent of hydropower development in Africa have been given by different sources in the last decade. Despite these variations, as shown in this box, one underlying message is clear: Africa's vast hydropower potential is yet to be tapped.

Capacity Developed	Source
4 per cent	Bartle (2002); Blyden and Akiwumi (2008)
8 per cent	World Bank (2010a)
Less than 8 per cent	AfDB (2006)
4 per cent**	World Water Assessment Programme (2009)
7 per cent	AfDB (2006)

*Figure provided as "renewable water use", which covers other sectors in addition to hydropower.

**Figure covers annual renewable flows for irrigation, food production and hydroelectricity for sub-Saharan Africa only.

Figure 3.5.5: Regional development of economically feasible hydropower potential (Source: Modified from Hammons 2006)



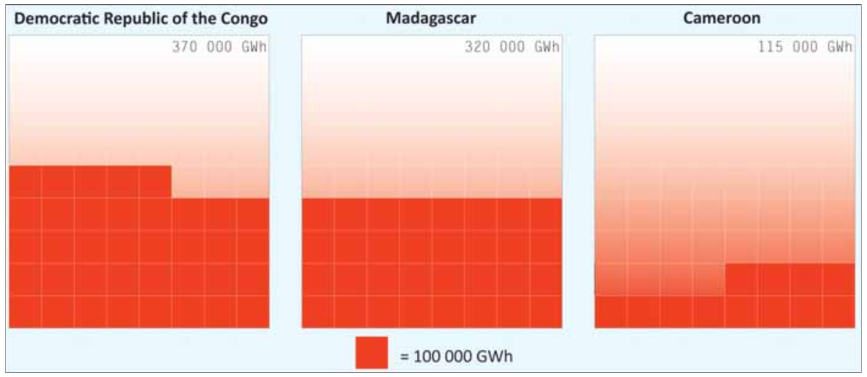


Figure 3.5.7: Top three potential electricity generating nations (Source: Tshombe and others 2007)

to energy will improve food security and health through refrigeration, while electric lighting promotes educational development and lengthens working hours. Improved access to energy also increases economic development through industrialization and communications technologies, among other benefits. The advent of electricity in rural homes reduces the human costs of fetching wood for fuel, freeing women's and girl's time for more productive and educational pursuits (Kauffman 2005).

- *Invest in hydroelectricity rather than fossil fuels, which makes sense in an era of climate change:* Fuel shares of world total primary energy supply were 10 345 Mtoe (Million tonnes of oil equivalent) in 2004. The global energy market is currently dominated by fossil fuel consumption. Concern about global warming is one of the major drivers behind recent interests in renewable and clean sources such as hydropower and biofuels (Ringler and others 2010). According to the World Bank (2010), regional hydropower trade could offer Africa the least-cost energy supply with zero carbon emissions.
- *Learn from the many African countries that have developed hydropower successfully:* Despite the low level of exploitation of technically feasible hydro potential, many African countries have shown that it is possible to develop that potential: hydroelectricity contribution is more than 50 per cent in 25 countries, and greater than 80 per cent in Angola, Benin, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Ethiopia, Guinea, Lesotho, Malawi, Mozambique, Namibia, Rwanda, Tanzania, Uganda and Zambia (Bartle 2002) (Figure 3.5.7).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Box 3.5.2. Regional power pools and the Grand Inga Project

A regional power pool is a "framework for pooling energy resources and power exchanges between utilities in a given geographic area base in an integrated master plan and pre-established rules." Such pools are meant to allow countries to secure their own power supply while they reduce costs, foster mutual help when power systems fail, bring social and environmental benefits, and strengthen relationships among nations (Hamad 2010). Africa's regional power pools are at very different stages of development, both technically and institutionally. The South African Power Pool (SAPP) was the first operational power pool in Africa, sponsored under the authority of the Southern African Development Community (SADC). The political process is also well advanced in the West African Power Pool (WAPP), supported by political agreements at the head of state level through the Economic Community of West African States (ECOWAS). The pools, particularly the SAPP and WAPP, have facilitated significant cross-border power exchanges.

Inga Hydroelectric Plants (Source: Tshombe and others 2007)

Element of Hydropower	Inga 1	Inga 2	Inga 3 Planned	Grand Inga Planned
Number of unit	6	8	7	5
Total installed capacity	351 MWh	1 424 MWh	1 344 MWh	244 000 MWh
Height of water head	50 metres	58 metres	60 metres	150 metres
Gross energy capacity	2 400 GWh	10 400 GWh	9 900 GWh	324 900 GWh

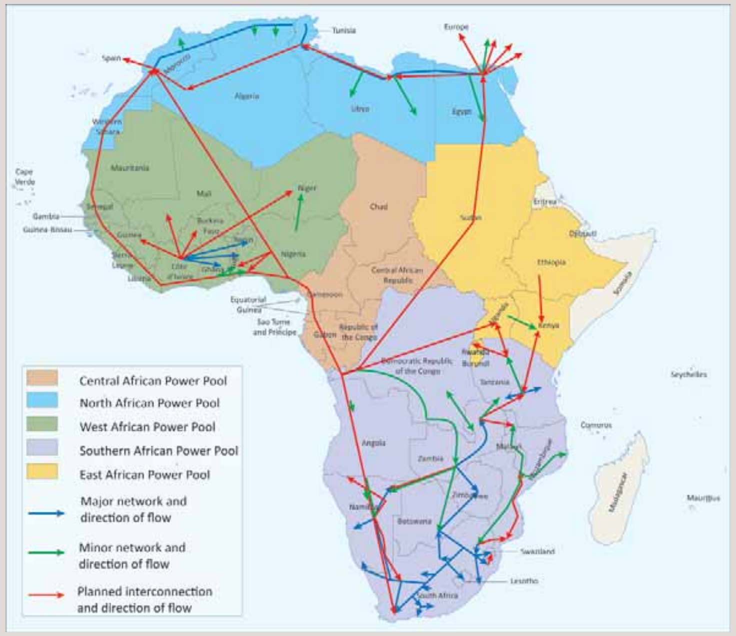
Regional power pools are able to reduce costs and improve conditions on the supply side. Operational costs are lower, due to investment in least-cost power generation plants on a regional basis. Benefits on the supply side, all contributing to increased reliability, include reduced coincident peak loads on the regional power pool, compared with the sum of the individual peak loads for each national power grid; shared power generation reserves for the interconnected power grids; and increased robustness to deal with local droughts or other unexpected events.

The Grand Inga dam in the Democratic Republic of Congo (DRC) is one of the key projects that will support regional pools. The project is estimated to cost US$80 billion and to have a total installed capacity of 44 000 MWh. Difficulties associated with the project include an absence of political consensus and legal harmonization. Nigeria is expected to be the largest consumer. The carbon-emission reduction potential is expected to help attract necessary investment.

Most of the power will be used for industry or for export. Inga 1 and Inga 2 were commissioned in 1972 and 1982, as part of an industrial development scheme in the DRC. The two dams currently operate at only 40 per cent capacity because they have never received maintenance. The World Bank is partially financing a project to rehabilitate these dams. When Inga 2 was built, a 1 800-km transmission line was also built to transport the power to state-owned copper mines in the Katanga province, bypassing nearly every city and village underneath. A component of the Grand Inga project could be expanded for household electricity access, particularly in the DRC, where access is estimated to be 13 per cent in urban areas and only three per cent in rural areas.

Sources: Tshombe and other 2007, IEA 2008

Africa's Regional Power Pools: CAPP, EAPP, SAPP and WAPP (Source: SAPP n.d.)



4
WATER PROFILE OF COUNTRIES

Julien Harneis/Flickr.com

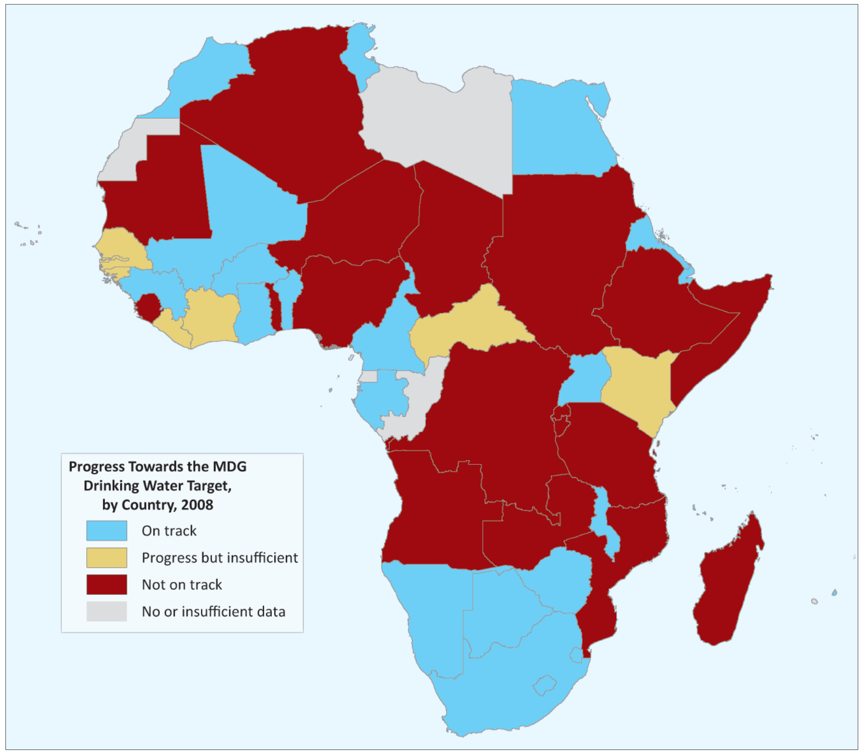
Tracking Progress Towards Environmental Sustainability

In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at the United Nations Headquarters in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets—with a deadline of 2015—that have become known as the Millennium Development Goals (MDGs).

The eight MDGs, which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015, form a blueprint agreed to by all the countries and all the world's leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest. In September 2010, with only five years left until the 2015 deadline, world leaders met at a summit in New York to accelerate progress towards the MDGs.

Note: Material for this section has been drawn directly from WHO/UNICEF 2008 and WHO/UNICEF 2010 and may differ from country profiles drawn from UN Statistical Division data.

Apparent discontinuities between these two datasets may result from differences in date of collection, differences in data made available to WHO/UNICEF and UNSD as well as differences in metrics used to derive these two data sets.



Progress Towards the MDG Improved Drinking Water Target by Country, 2008 (Source: WHO/UNICEF 2010)

Globally, the world is expected to reach the drinking water target

- At the current rate of progress, the world is expected to exceed the MDG target of halving the proportion of the population without sustainable access to safe drinking water.
- Even so, 672 million people will still lack access to improved drinking water sources in 2015.

Africa, however, is not expected to meet the drinking water target

- The rate at which people of Africa have gained access to improved drinking water sources—245 million people since 1990—falls short of that required to meet the 2015 MDG drinking water target.
- To meet the MDG drinking water target, coverage needs to increase from 64 per cent in 2006 to 78 per cent in 2015.
- Only 26 countries in Africa are on track to meet the MDG water target.
- To meet the target almost 300 million people need to gain access to an improved drinking water source. That is half as many as the current population with access in Africa.
- On average 33 million people of Africa need to gain access to an improved drinking water source every year until 2015.
- Even when the MDG drinking water target is met, 253 million people in Africa will still be without access to an improved drinking water source.

Access to Improved Sanitation

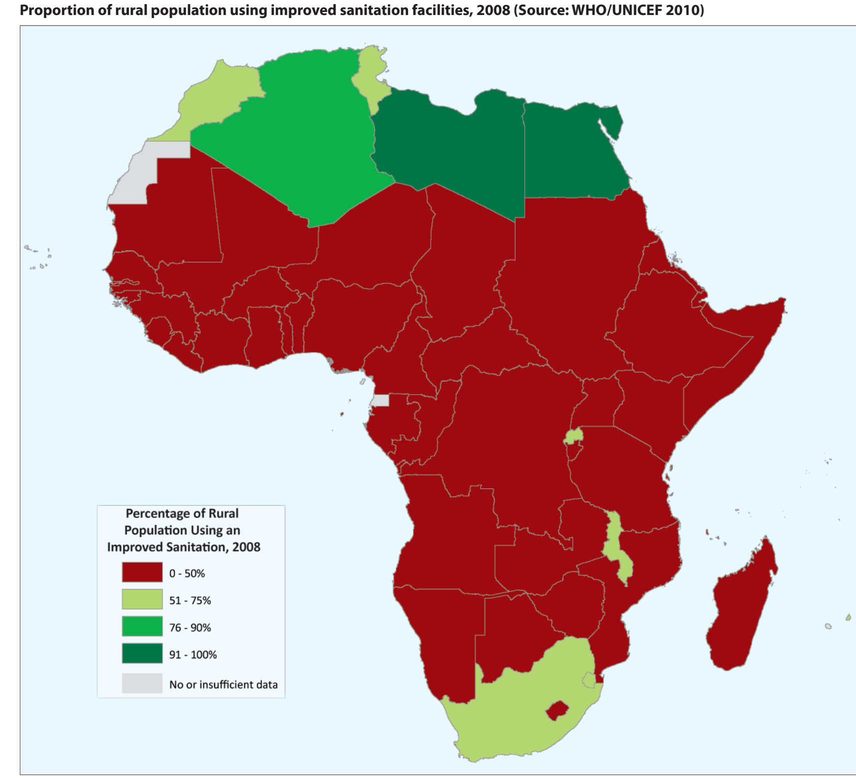
Globally, 2.6 billion people still do not use improved sanitation

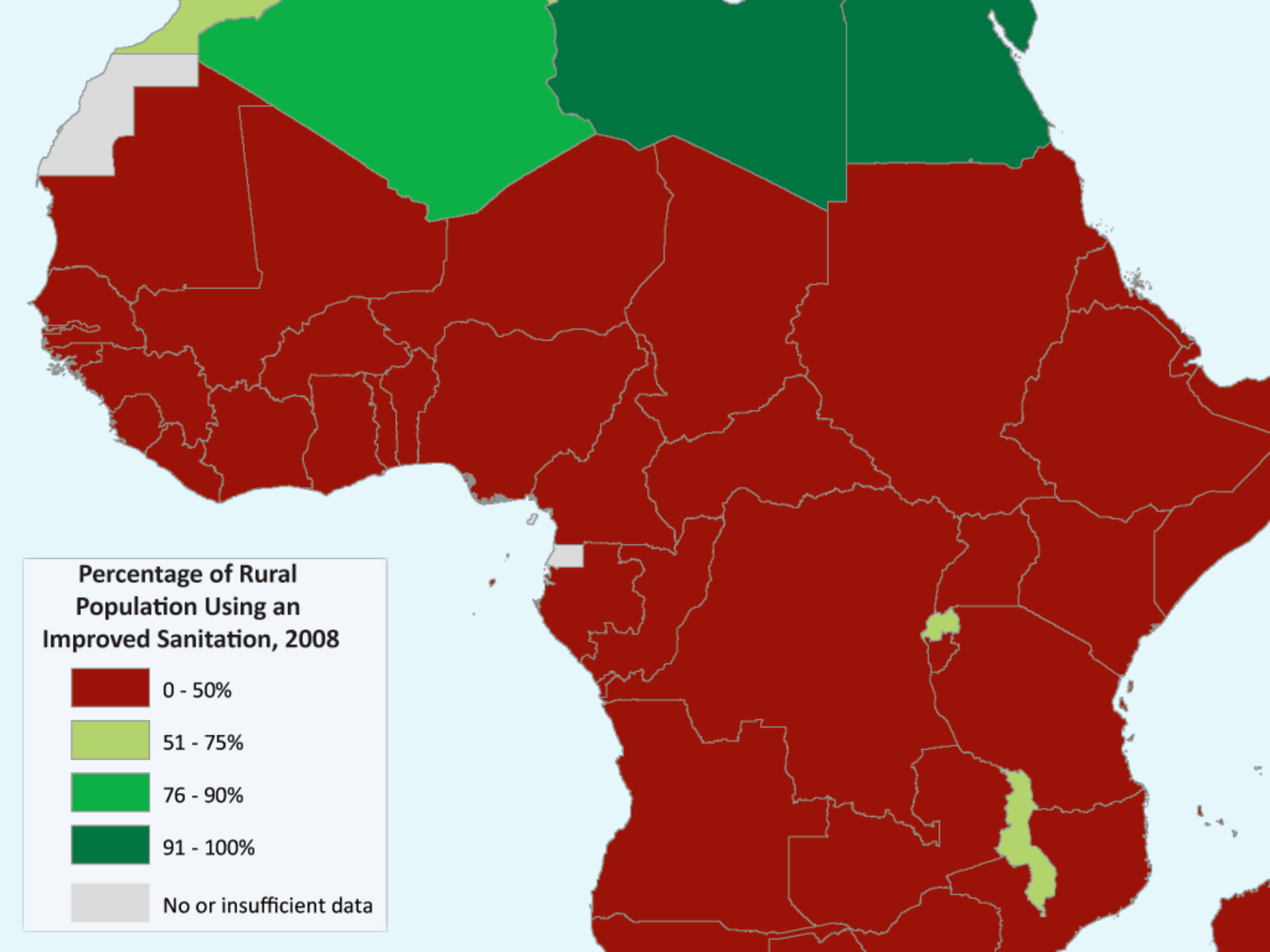
- Less than two thirds of the world's population uses improved sanitation facilities.
- In developing regions only around half the population uses improved sanitation.

In Africa, half the population uses an improved or shared sanitation facility; but one in four practices open defecation

- Three hundred and fifty four million people of Africa had access to improved sanitation facilities in 2006. Coverage increased from 33 per cent in 1990 to 38 per cent in 2006.
- The African population without access to sanitation increased by 153 million—from 430 million in 1990 to 583 million in 2006. Increases in coverage are not keeping pace with population growth.
- In 38 countries in Africa sanitation coverage is less than 50 per cent.
- Open defecation in Africa has dropped from 33 per cent in 1990 to 24 per cent in 2006, although the absolute number of people practicing open defecation has increased by 20 million.
- Fifteen per cent of the African population (143 million) shares an otherwise adequate type of sanitation facility, while 23 per cent (212 million) uses an unimproved facility that does not meet minimal hygiene standards.
- Use of shared sanitation facilities is most common in Southern Africa.
- Sanitation coverage is highest in Northern Africa and lowest in Western Africa.

Proportion of rural population using improved sanitation facilities, 2008 (Source: WHO/UNICEF 2010)

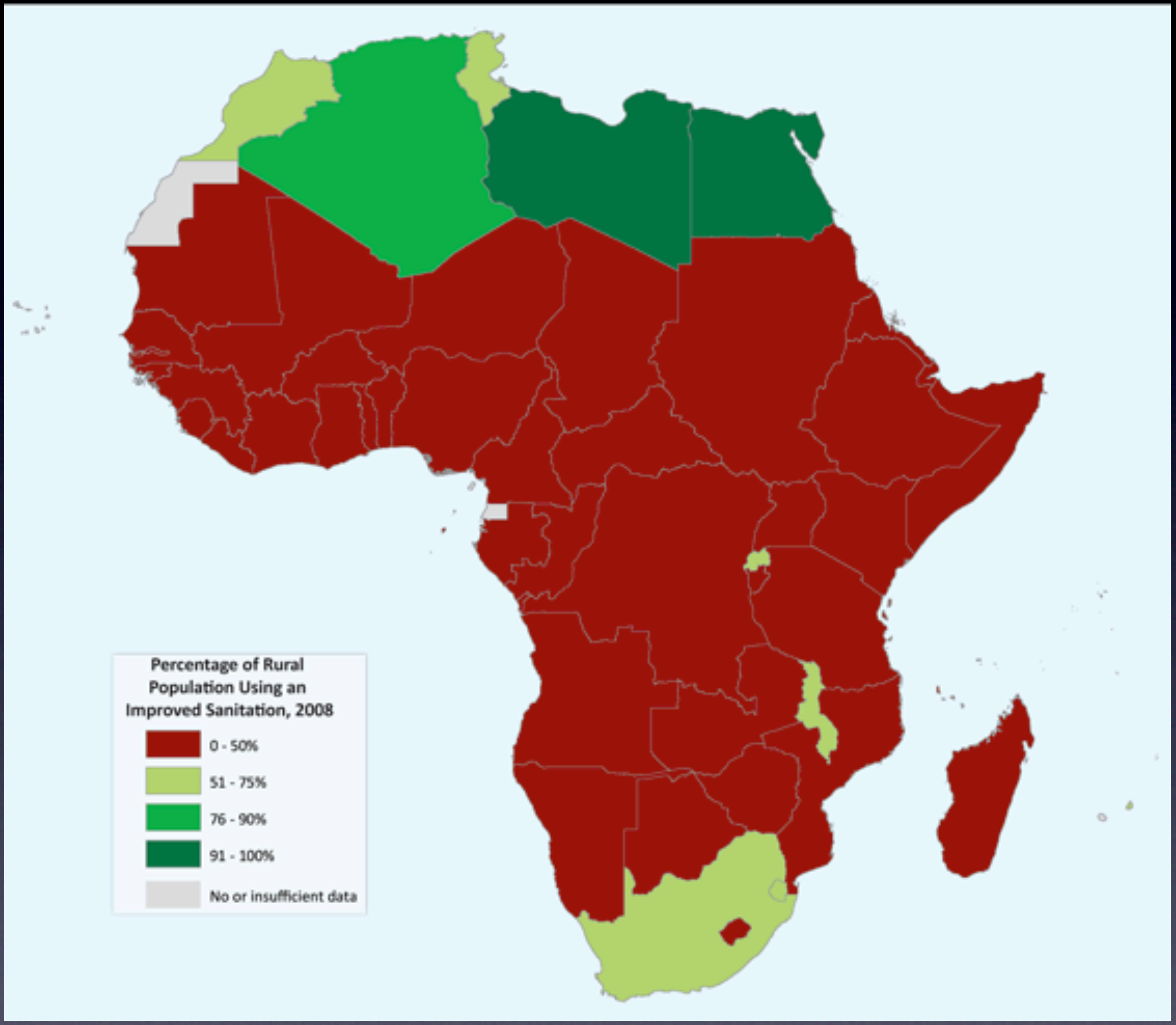



Percentage of Rural Population Using an Improved Sanitation, 2008
0 - 50%
51 - 75%
76 - 90%
91 - 100%
No or insufficient data

Basis: Grenzen

einschichtig
elementar
analytisch

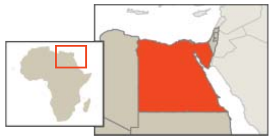
- Flächenkartogramm
  ratio
  Farbe, Helligkeit



Flickr.com

Northern Africa

Algeria
Egypt
Libyan Arab Jamahiriya
Morocco
Sudan
Tunisia

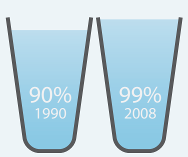


Arab Republic of
Egypt

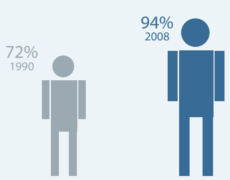
Total Surface Area: 1 001 449 km²
Estimated Population in 2009: 82 999 000

Progress Towards MDG Goal 7

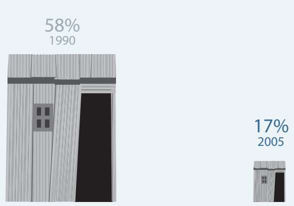
By 2008, almost all Egyptians were using improved drinking water. Remarkable progress was made in providing access to improved sanitation, with rates up from 72 per cent to 94 per cent of the population from 1990 to 2008. Progress was made from 1990 to 2008 in both urban and rural areas with an increase from 91 to 97 per cent in the former and from 57 to 92 per cent in the latter. Egypt has already the sanitation target, which requires that it provides sanitation to 77 per cent of its people by 2015.



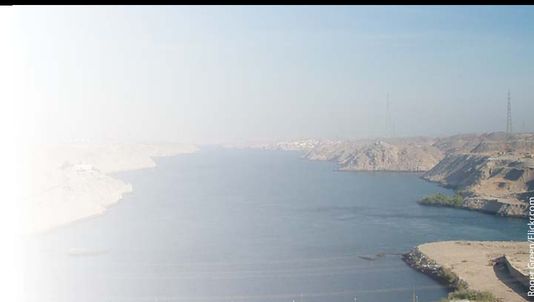
Proportion of total population using improved drinking water sources, percentage



Proportion of total population using sanitation facilities, percentage



Slum population as percentage of urban



Water Profile

Water Availability

	Year	Value
Average precipitation in depth (mm/yr)	2008	51
Total renewable water (actual) (10^9 m³/yr)	2008	57.3
Total renewable per capita (actual) (m³/inhab/yr)	2008	702.8
Surface water: total renewable (actual) (10^9 m³/yr)	2008	56
Groundwater: total renewable (actual) (10^9 m³/yr)	2008	1.3
Dependency ratio (%)	2008	96.9

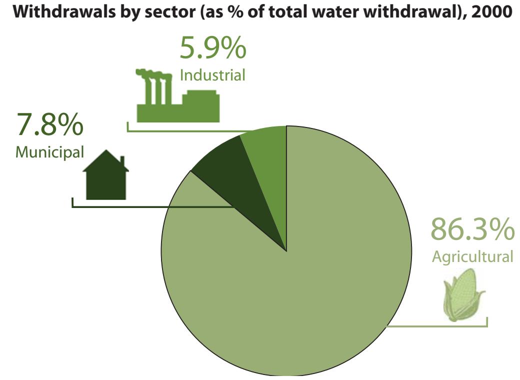
Withdrawals

	Year	Value
Total freshwater withdrawal (surface water + groundwater) (10^9 m³/yr)	2000	54.3
Surface water withdrawal (10^9 m³/yr)	...	...
Groundwater withdrawal (10^9 m³/yr)	...	...
Total water withdrawal per capita (m³/inhab/yr)	2002	937
Freshwater withdrawal as % of total renewable water resources (actual) (%)	2002	94.7

Irrigation

	Year	Value
Irrigated grain production as % of total grain production (%)	1993	100
Area salinized by irrigation (1000 ha)	2005	250

Withdrawals by sector (as % of total water withdrawal), 2000



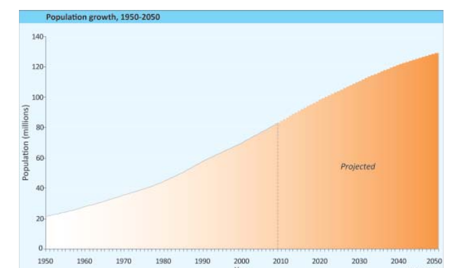
Vulnerability of the Nile Delta to Sea Level Rise

The Nile Delta is one of world's oldest intensely cultivated regions. It accounts for 24 900 km² of Egypt's one million km² area and has a high population density of up to 1 600 inhabitants per km². Despite its comparatively small area, 65 per cent of Egypt's agricultural land is found in the Nile Delta, land that is currently at risk because of climate-change related sea-level rise. River deltas are particularly vulnerable due to their low-lying nature and increases in sea level are often compounded by land subsidence and human interference such as sediment trapping by dams (AFED 2009) (see page 85).

With a one-metre rise in sea level, it is estimated that 34 per cent of the Nile Delta would be inundated, putting more than 12 per cent of Egypt's best agricultural land at risk. The coastal cities of Alexandria, Idku, Damietta and Port-Said would be directly affected, displacing roughly seven million Egyptian's or 8.5 per cent of the population. In the extreme case of a five metre sea-level rise, more than half (58 per cent) of the Delta would flood, devastating 35 per cent of Egypt's agricultural land and displacing roughly 11.5 million people from over 10 major cities. Along with the direct effect on people's livelihoods, Egypt's economic growth will also feel the repercussions. A one-metre rise would incur a six per cent drop in GDP while a three-metre rise would result in a 12 per cent drop (AFED 2009).

Water Pollution

Egypt's population is increasing rapidly, growing from an estimated 21.5 million in 1950 to 84.5 million in 2010 and is projected to reach almost 130 million by 2050 (United Nations 2008). The vast majority (99 per cent) is concentrated along the Nile Valley and Delta, which accounts for just four per cent of Egypt's total land mass (EEAA 2008). The water quality in the Nile is generally assessed to be good until the river reaches Cairo where it divides into the Damietta and Rosetta branches. At this point the quality deteriorates as a result of municipal and industrial effluents and agricultural drainage (World Bank 2006).



In Egypt, only 53.6 per cent of households were connected to main sewage in 2004, with less than half the wastewater being collected and treated (EEAA 2008). This figure falls even further, to 11 per cent, in rural areas (EEAA 2008). Between the Damietta and Rosetta branches, fecal coliform bacteria concentration from human or animal feces, are 3-5 times higher than the permissible national standard (World Bank 2006).

Of the 129 industrial facilities located on the Nile, 102 of them discharge roughly 4.05 billion m³ /yr of water containing heavy metals, organic and inorganic components directly or indirectly into the river (EEAA 2008). An intensive use of pesticides and fertilizers in agriculture adds to Egypt's water pollution concerns.

30° N
Cairo
Giza
AS SUWAYS
MARSA MATRUH
AL FAYYUM
Gulf of Suez
JANUB SINA'
AL JIZAH
BANI SUWAYF
Minya
AL MINYA
Asyut
Red
Sea
LIBYA
EGYPT
Qena
Luxor
AL BAHR AL AHMAR
25° N
Al Kharijah
AL WADI AL JADID
Aswan
Lake
Nasser
SUDAN
Capital City
Town/City
Dam
River
Lake/Reservoir
Saline Systems
Tidal/Coastal Systems
Freshwater Marshes
and Floodplains

Basis: Grenzen, Städte, Netz

mehrschichtig
komplex (homogen)
analytisch

(1) Positionssignaturen
Einzelmerkmal

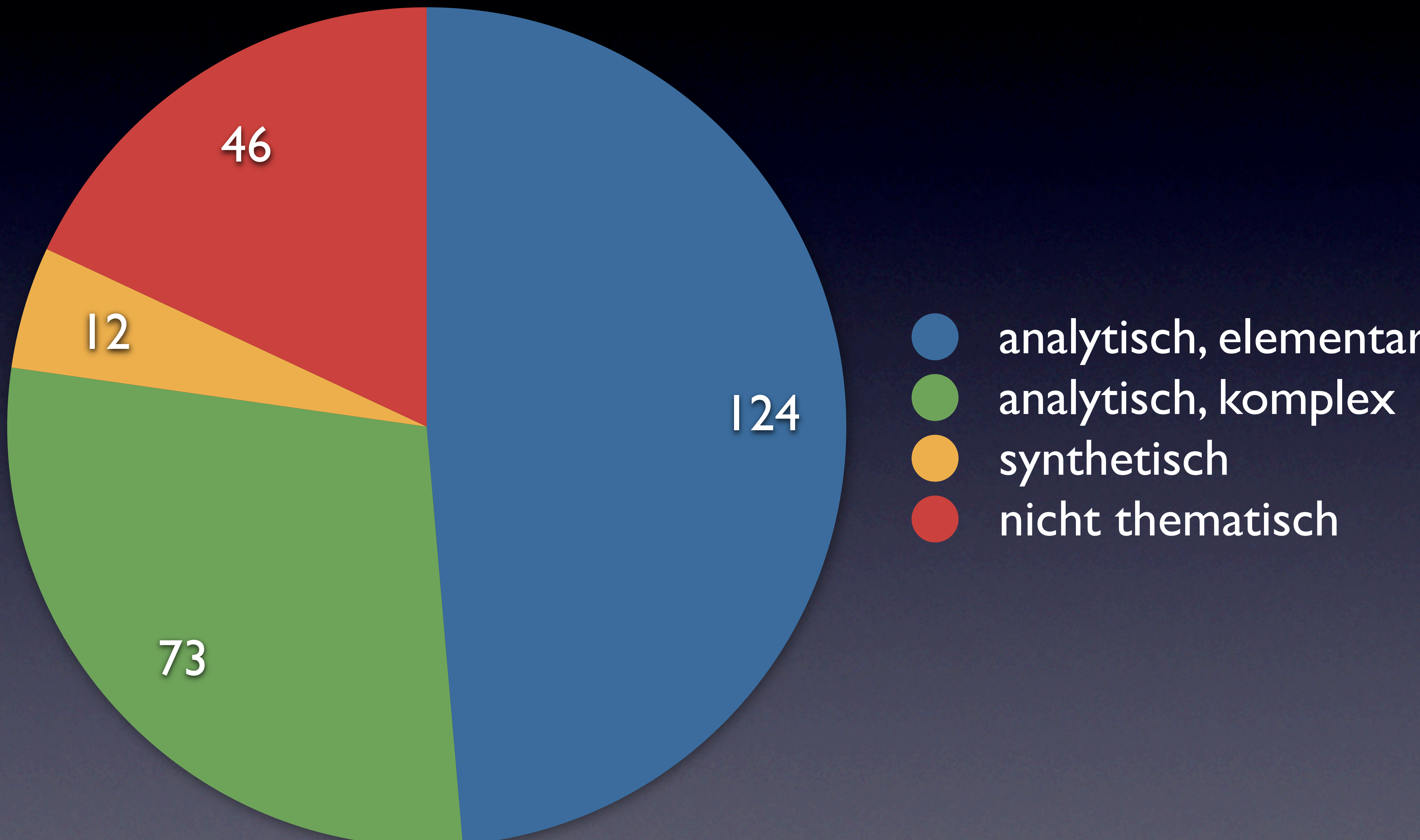
(2) Linearsignaturen
Einzelmerkmal

(3) Arealmethode
nominal – Farbe

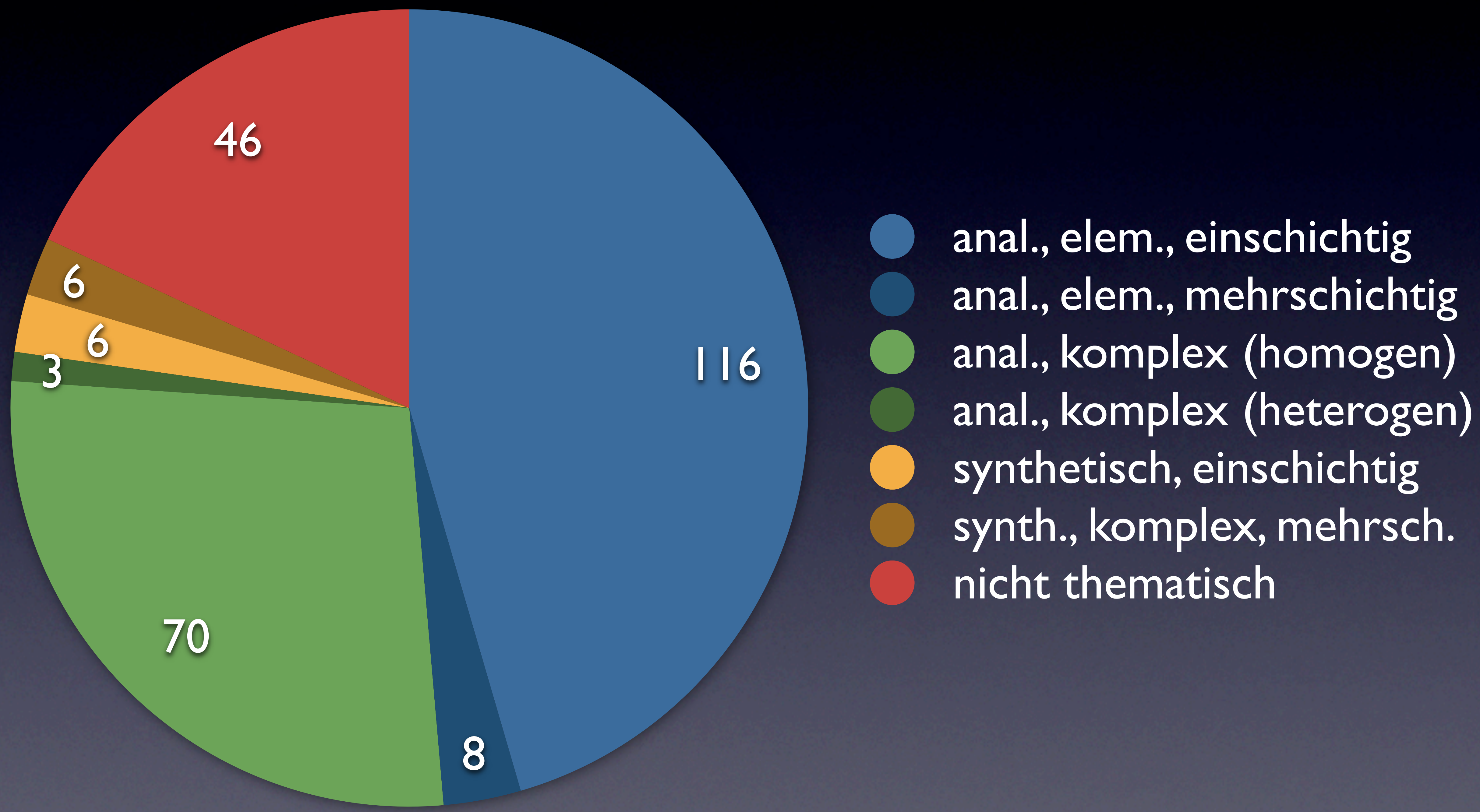
Schicht-Unterscheidung:
Farbe, Form, Muster

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

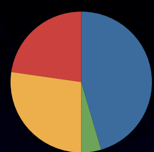
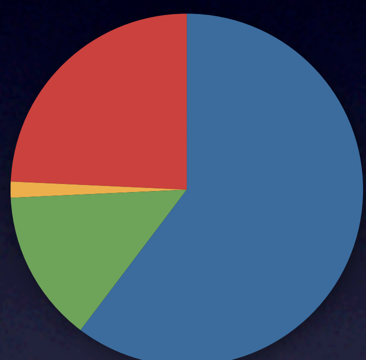
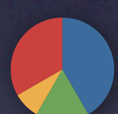
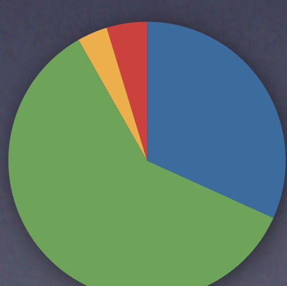
Kartentypen



Kartentypen

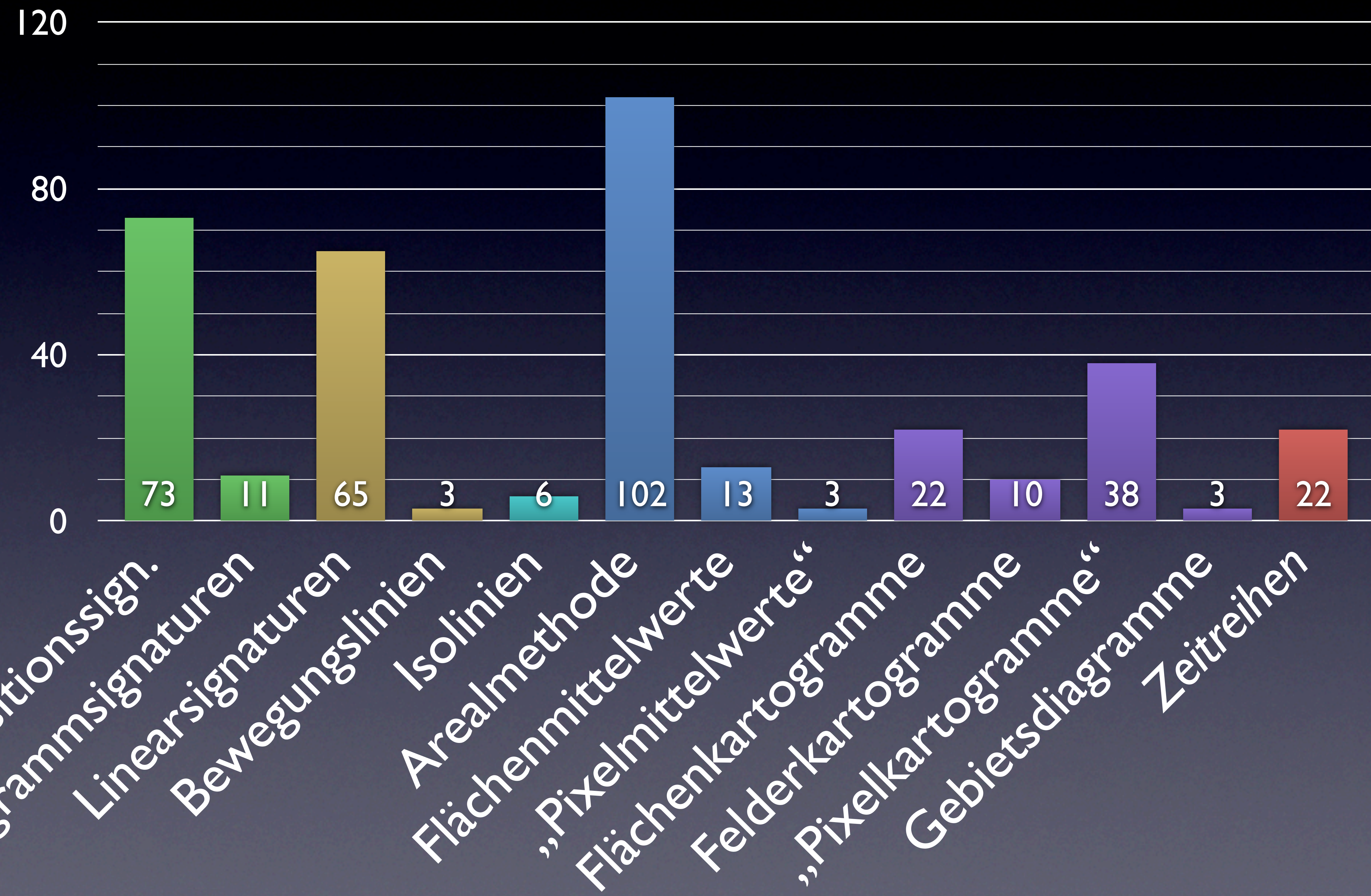


Karten nach Kapiteln

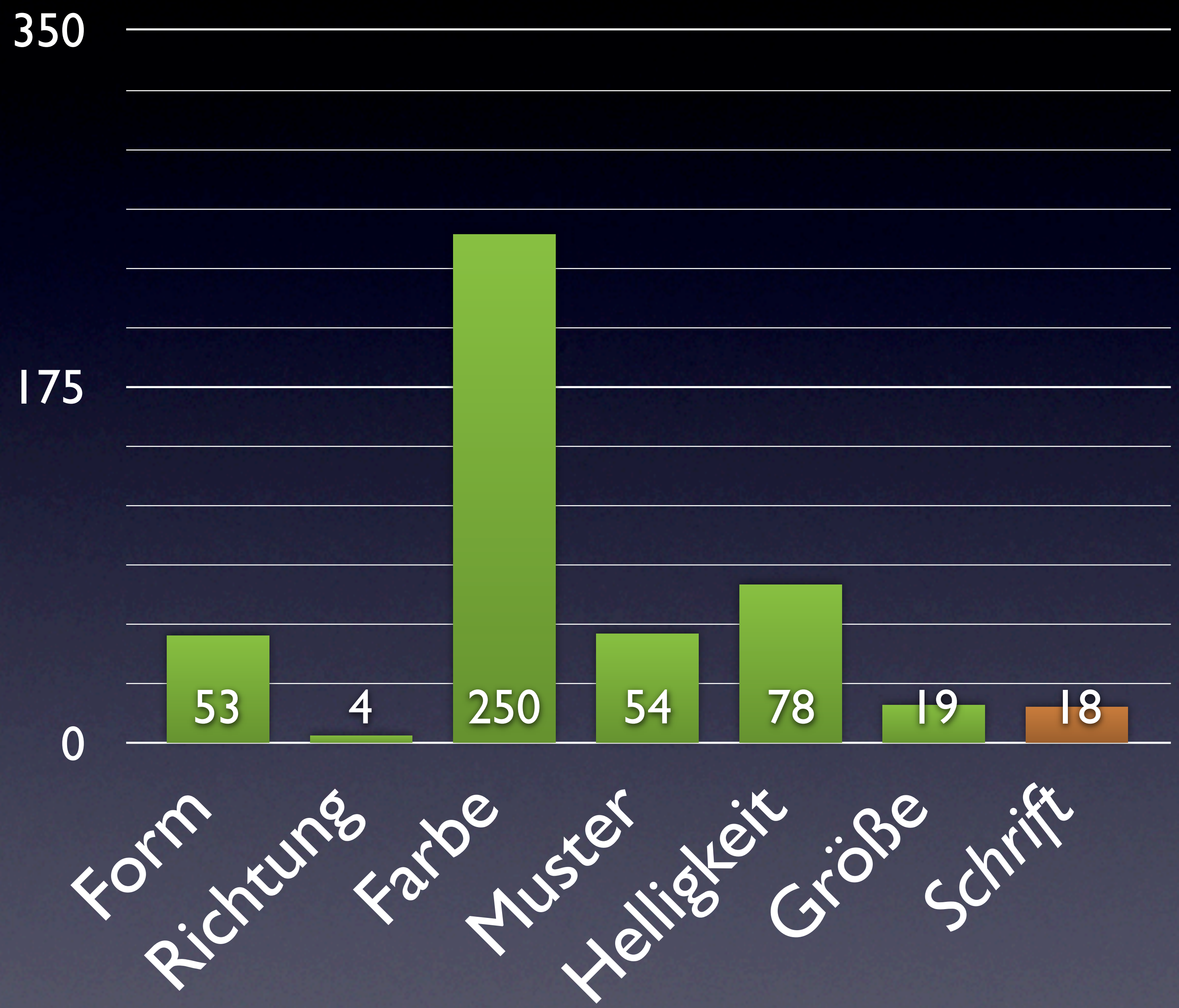
	22		Water Resources
	136		Transboundary Water Resources
	12		Challenges & Opportunities
	85		Water Profiles of Countries

- analytisch, elementar
- analytisch, komplex
- synthetisch
- nicht thematisch

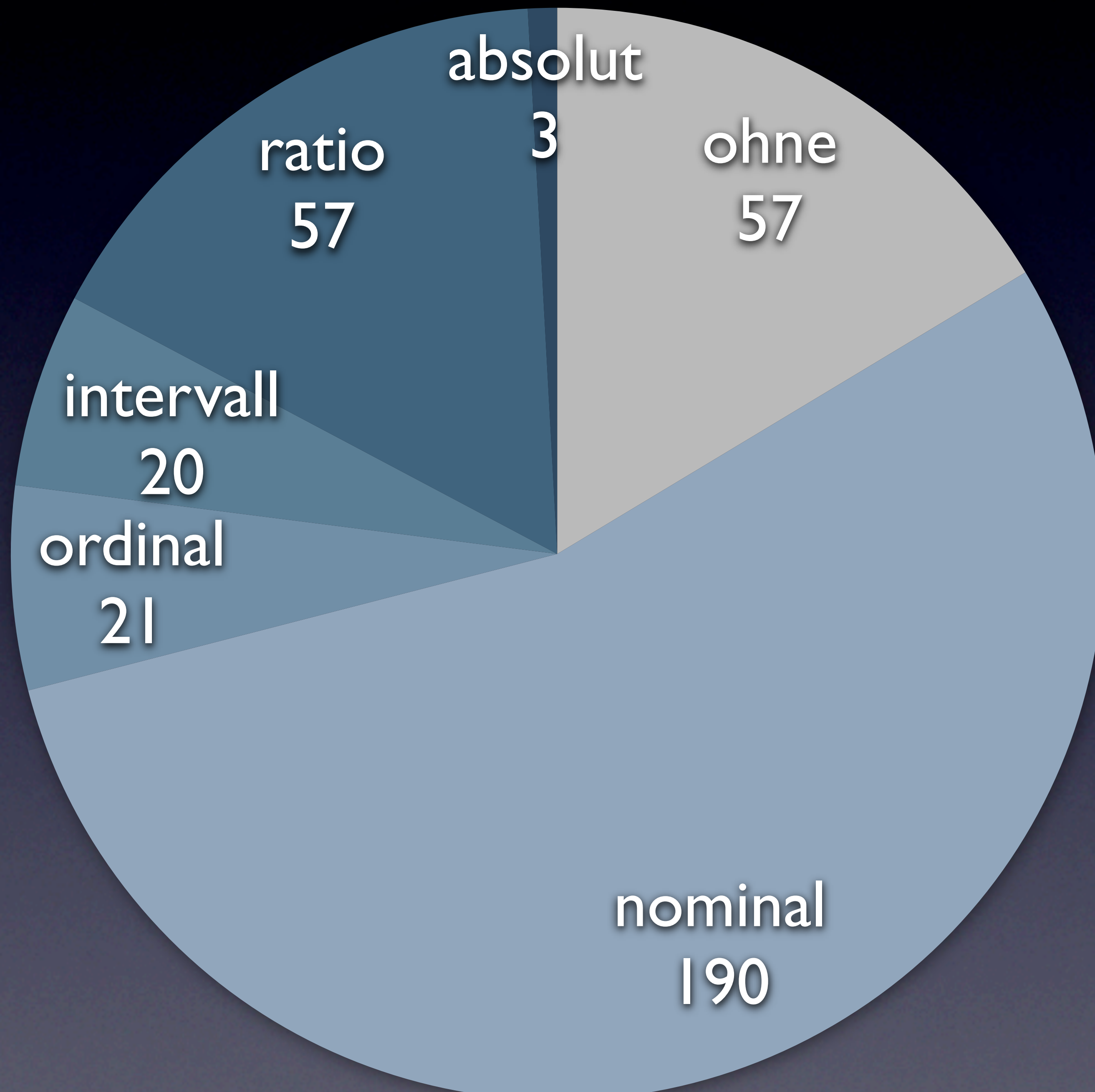
Darstellungsmethoden



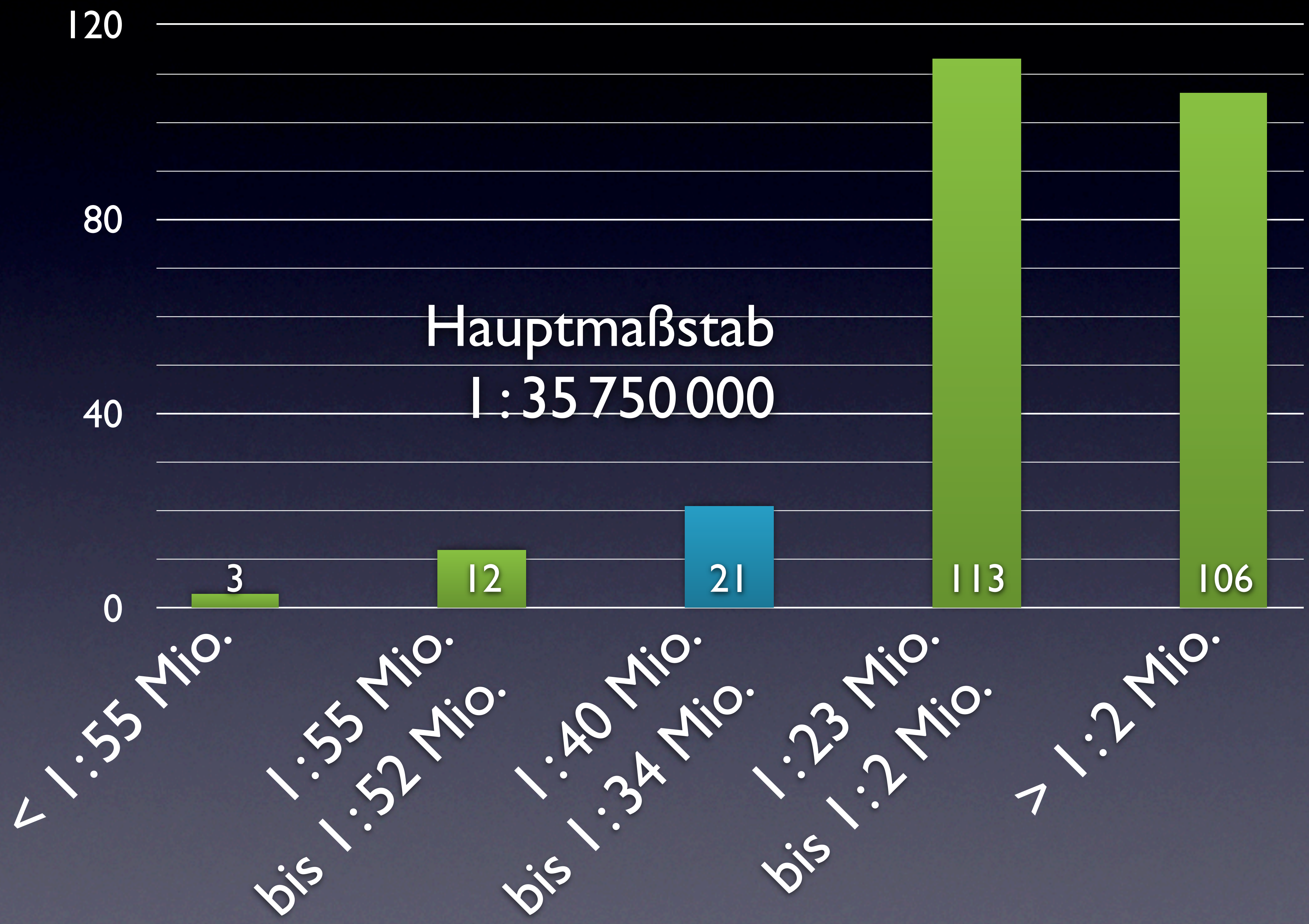
Graphische Variablen



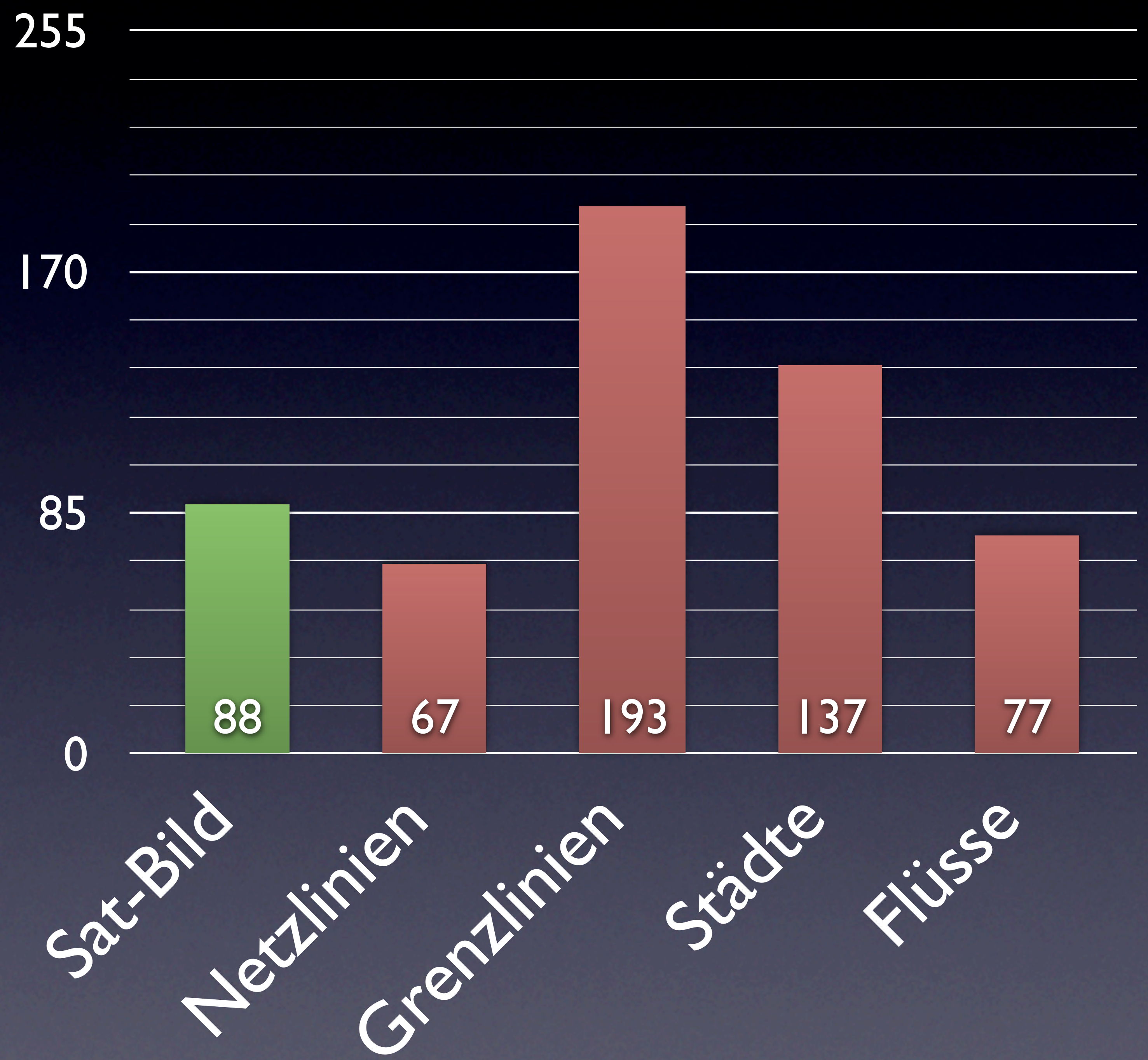
Skalierungsniveaus



Maßstäbe


120
80
40
0
Hauptmaßstab
1 : 35 750 000
3
12
21
113
106
< 1:55 Mio.
1:55 Mio. bis 1:52 Mio.
1:40 Mio. bis 1:34 Mio.
1:23 Mio. bis 1:2 Mio.
> 1:2 Mio.

Kartenhintergründe



Water and Poverty

Africa is widely acknowledged as the poorest and least developed continent in the context of the following selected issues:

- Nearly half of the entire population of Africa lives on less than one dollar a day per person (AfDB 2009);
- Malaria remains the leading cause of child mortality and anaemia in pregnant women in Africa, and is endemic in 46 countries (AfDB 2009);
- The prevalence of undernourishment in the total population was 25.5 per cent for the period of 2000-2007 (AfDB 2009), and 30 per cent of Africa's children less than five years of age suffer from moderate to severe malnutrition (Kolo 2009).

Key Facts

Africa is widely acknowledged as the world's poorest and least developed continent

There are significant linkages between water, the environment and poverty

Many of these issues can be linked to Africa's water-related problems, which are compounded to include food shortages, diseases spread by water and other vectors, and flood damage, among other risks (Van Koppen and Schreiner 2003). Chapter 3 discusses water stress, vulnerability, physical and economic water scarcity and the lack of water for food security in greater depth.

Figure 1.11: Linkages between poverty, water, and the environment (Data Source: Hirji and others 2002)

Poverty is a large part of the reason for low levels of access to safe water and sanitation, as well as for lack of other water-related needs such as irrigation. Poverty is widespread in Africa and although it is rapidly urbanizing, the majority of its population is still rural-based and dependent on mostly rain-fed agriculture (as explained in the next section). Poverty is a cross-sectoral issue that is normally defined in different contexts. However, it is widely acknowledged that there are linkages between water, the environment and poverty (Faurès and others 2008, Chowdhury and Ahmed 2010) (Figure 1.11).

While poverty is a contributing factor in the widespread lack of access to improved water sources, wealth is often linked to the

overconsumption of water resources. For example, a family of eight living in a squatter camp in the Cape Town area of South Africa uses about 120 litres of water a day collected from a tap a few hundred metres away. In contrast, a couple in a nearby rich neighbourhood who have a big garden to water, can use 2 000 litres per day (Pallett 1997). Figure 1.11 shows an example of a framework for summarizing linkages between poverty, water and environment, where the cross-sectoral nature of poverty is shown to cover aspects well beyond income and consumption. The different dimensions of poverty are shown in the triangles, and examples of water and environmental linkages are shown in the semi circles.

Water and Gender

Economically and socially vulnerable groups such as women, the elderly and children often experience considerable negative effects related to the natural environment, such as droughts and floods, and demographic-related factors that include high population densities and land degradation (Saleth and others 2007). The issue most directly related to gender and water is the fact that traditionally, women and young children, especially girls, are instrumental in providing water for their families, particularly in rural Africa. They are thus more adversely affected when there is limited access to water resources. They often fetch and carry water in containers from long distances, spending large amounts of time and energy that could otherwise be used for other productive tasks. Women often perform between 65 and 72 per cent of water collection duties (Black and King 2009, WHO/UNICEF 2008), and some African women spend as much as 40 per cent of their daily nutritional intake travelling to collect water (Chenje 2000) (Figure 1.12).

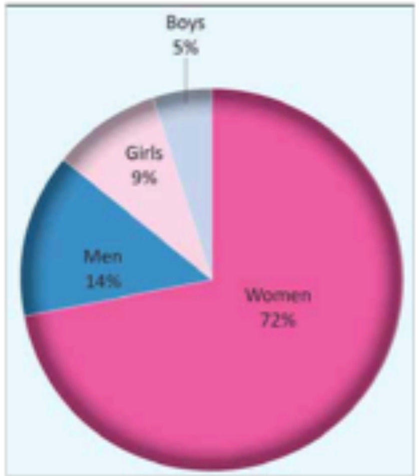


Figure 1.12: Average water collection responsibilities in Africa (Data Source: WHO/UNICEF 2008)

Key Facts

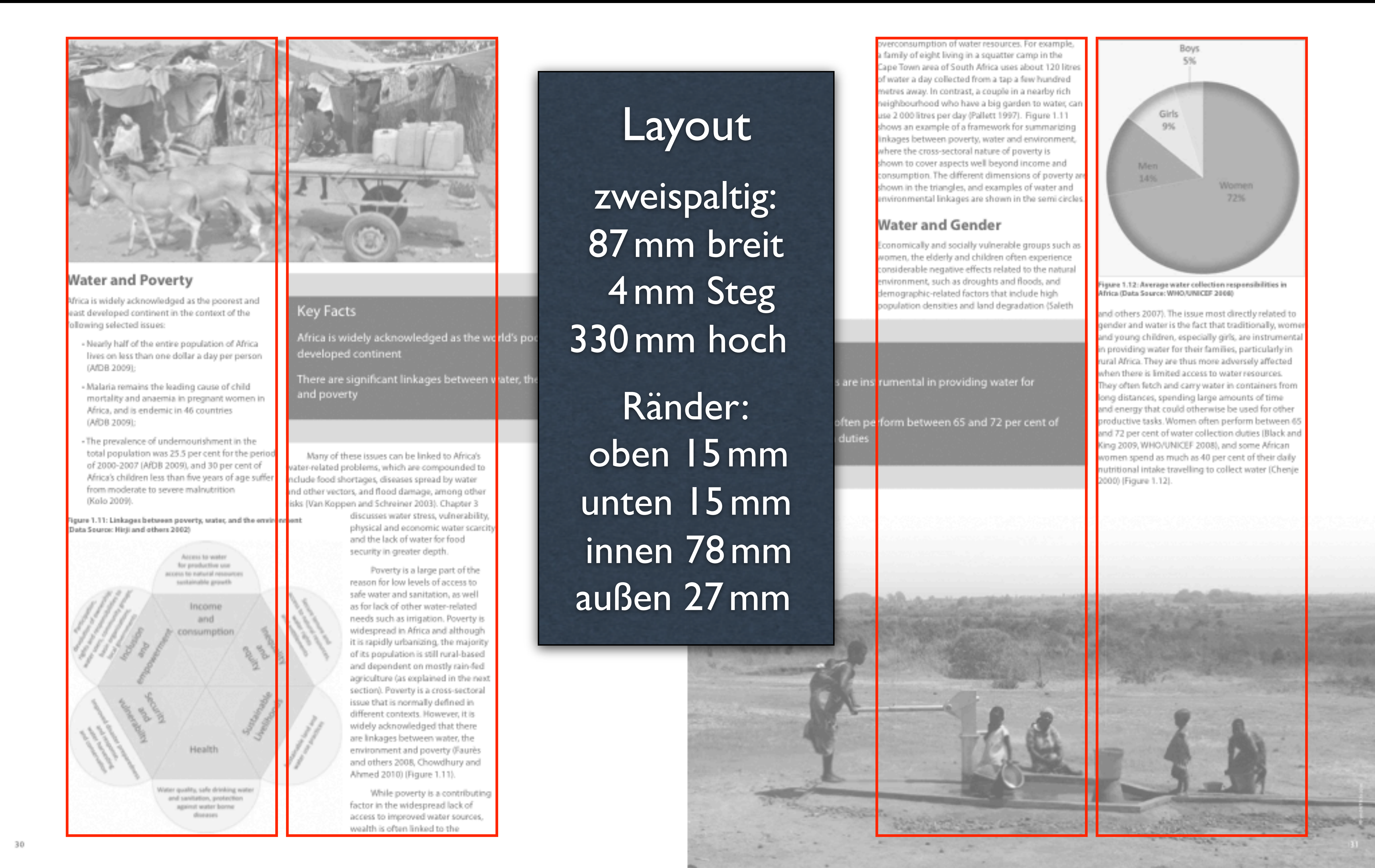
Women and girls are instrumental in providing water for their families

African women often perform between 65 and 72 per cent of water collection duties

Layout

zweispaltig:
87 mm breit
4 mm Steg
330 mm hoch

Ränder:
oben 15 mm
unten 15 mm
innen 78 mm
außen 27 mm



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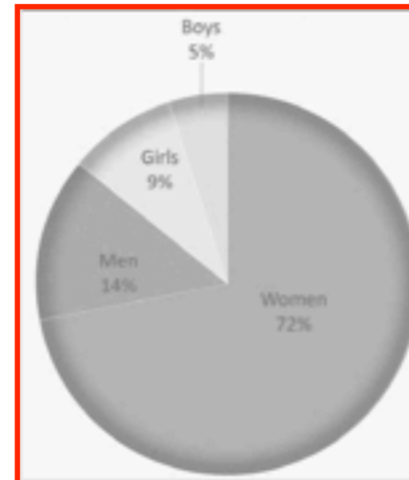

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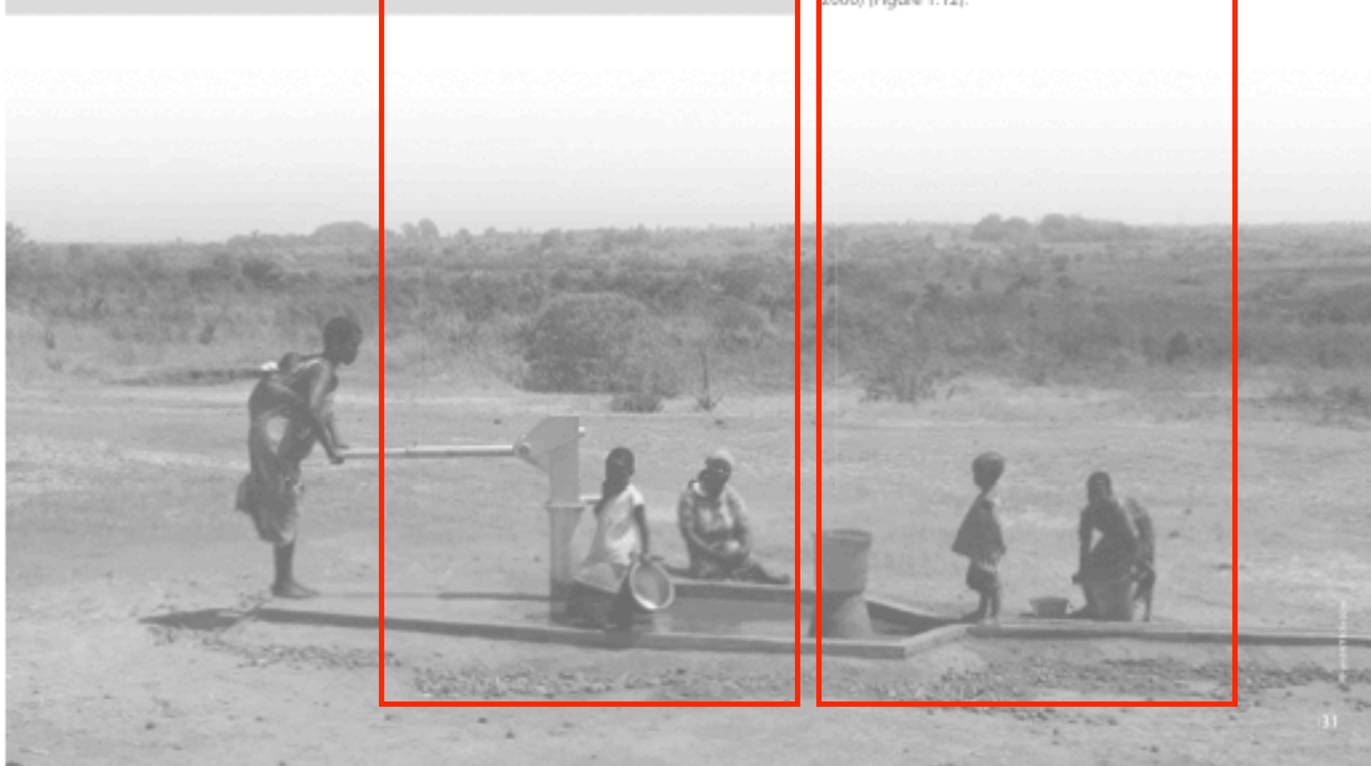

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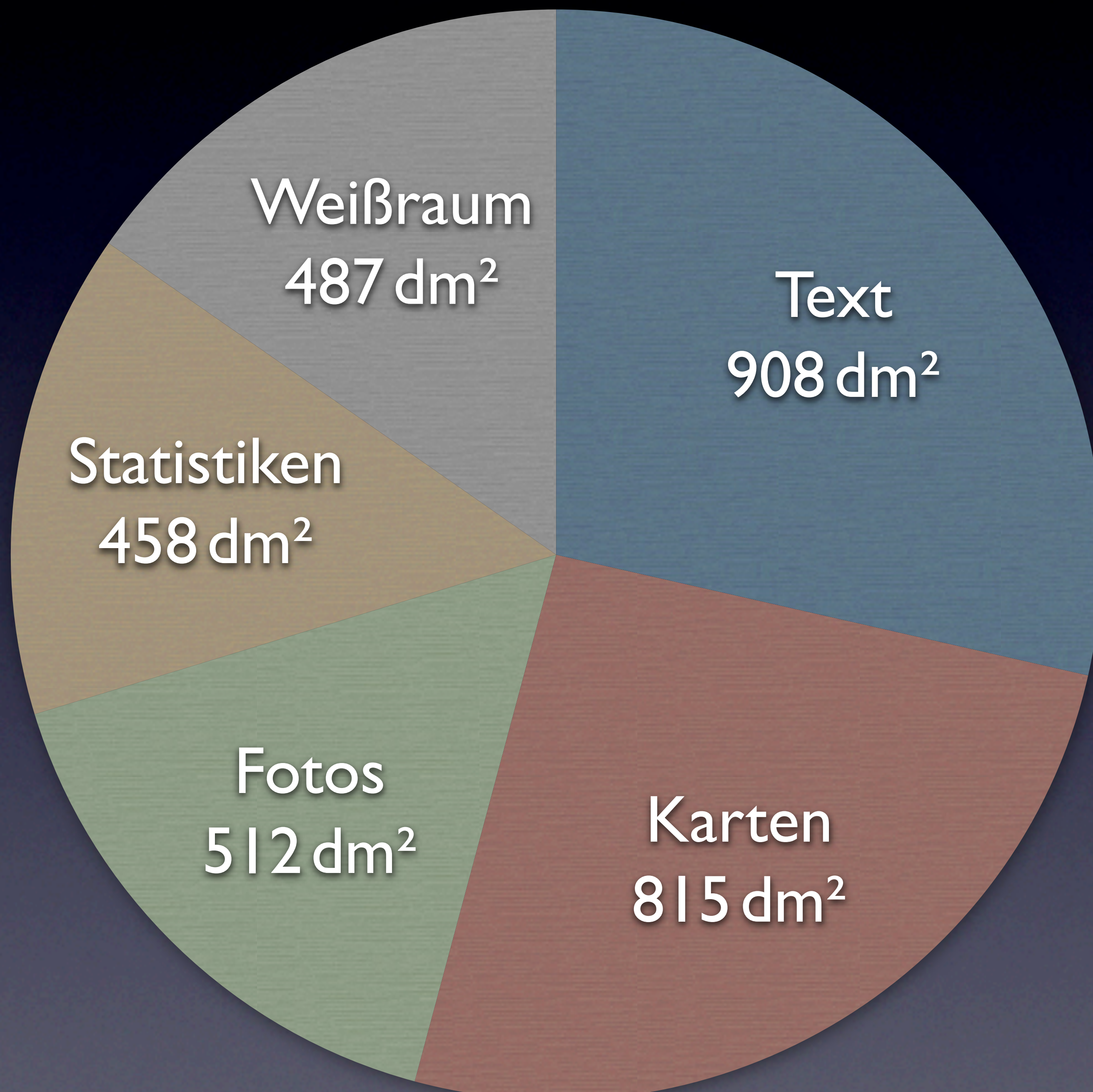

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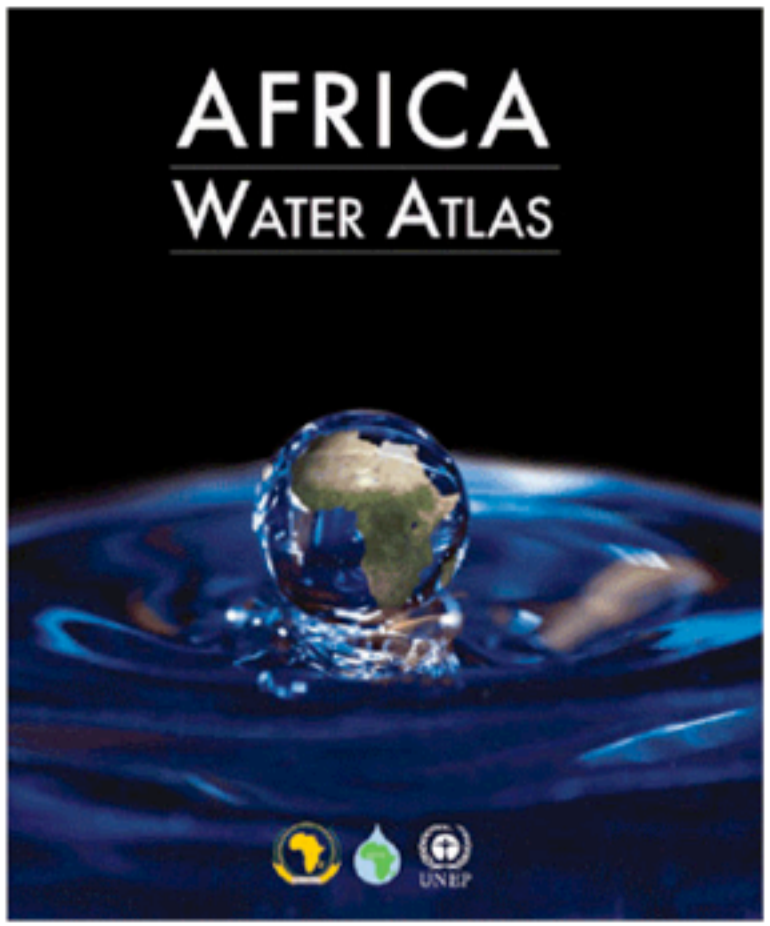

Africa Water Atlas

United Nations Environment Programme
Hardcover: 314 pages
ISBN: 9789280731101
Publication Date: 2010

Price: $150

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

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Average Rating:
369 Ratings

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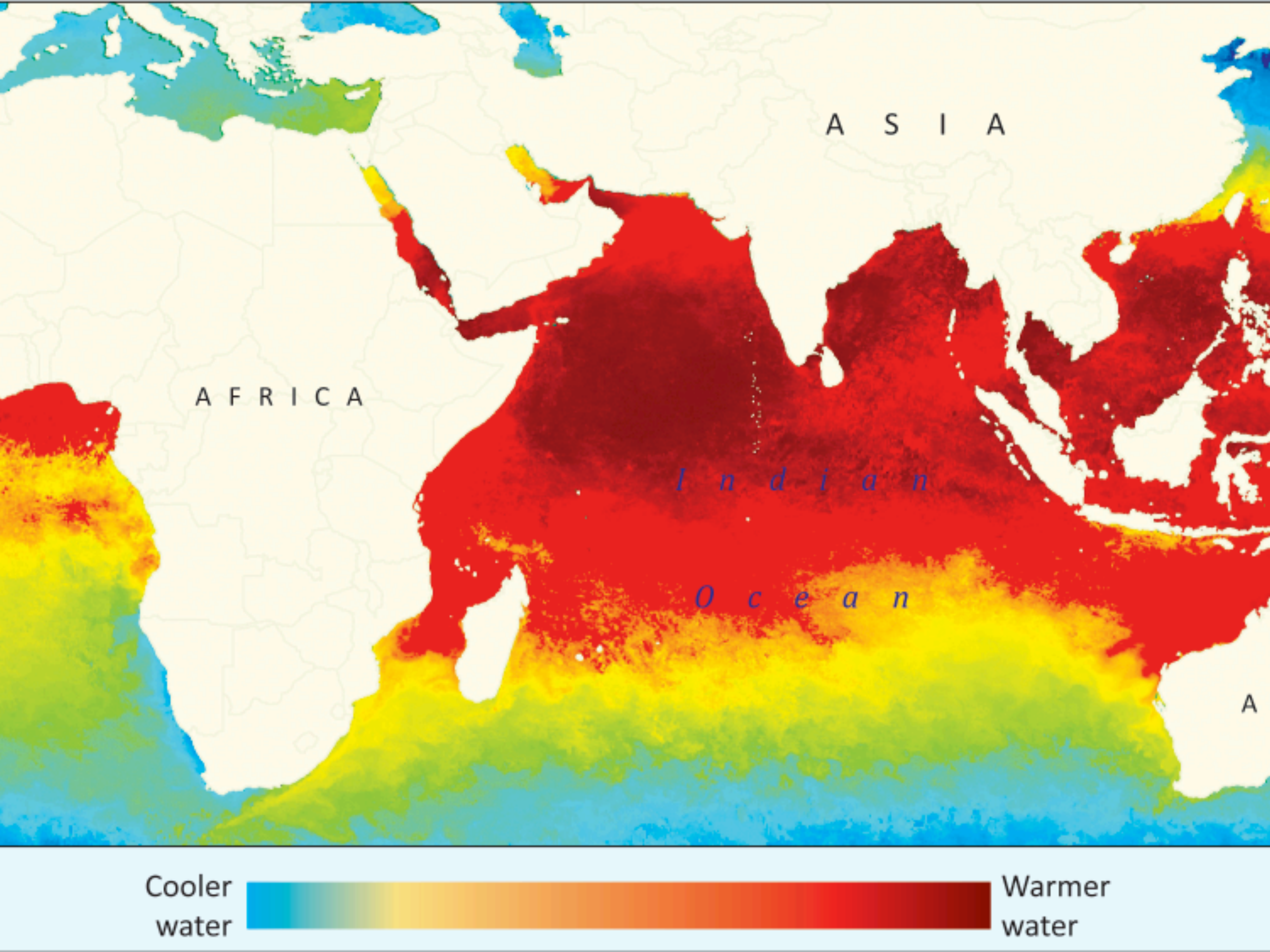
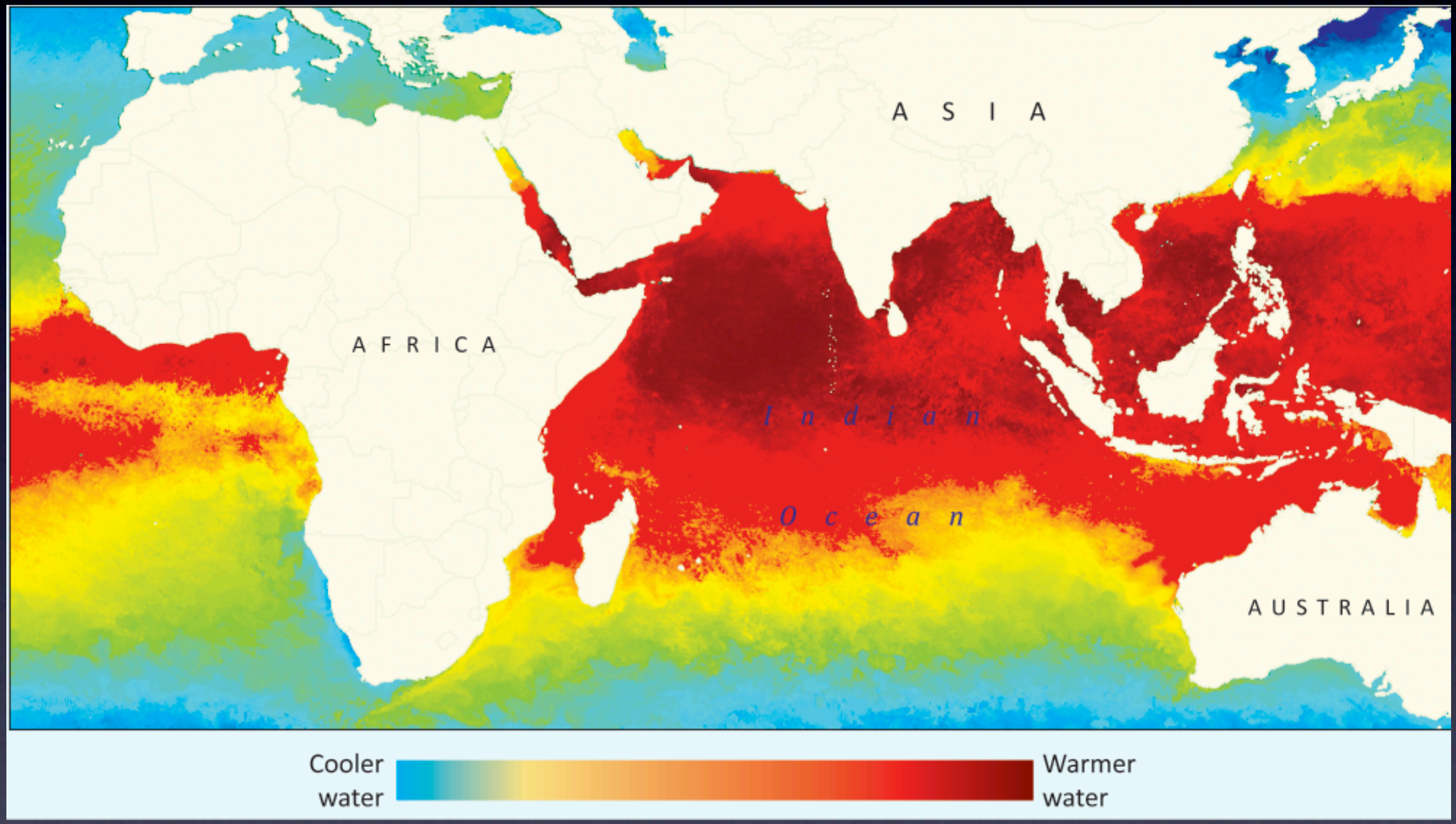
Demo


ASIA
AFRICA
Indian
Ocean
A
Cooler water
Warmer water

Basis: Grenzen

einschichtig
elementar
analytisch

- Flächenkartogramm
  ordinal
  ohne Klassenbildung
  Farbe, Helligkeit



Basis: Grenzen

einschichtig
elementar
analytisch

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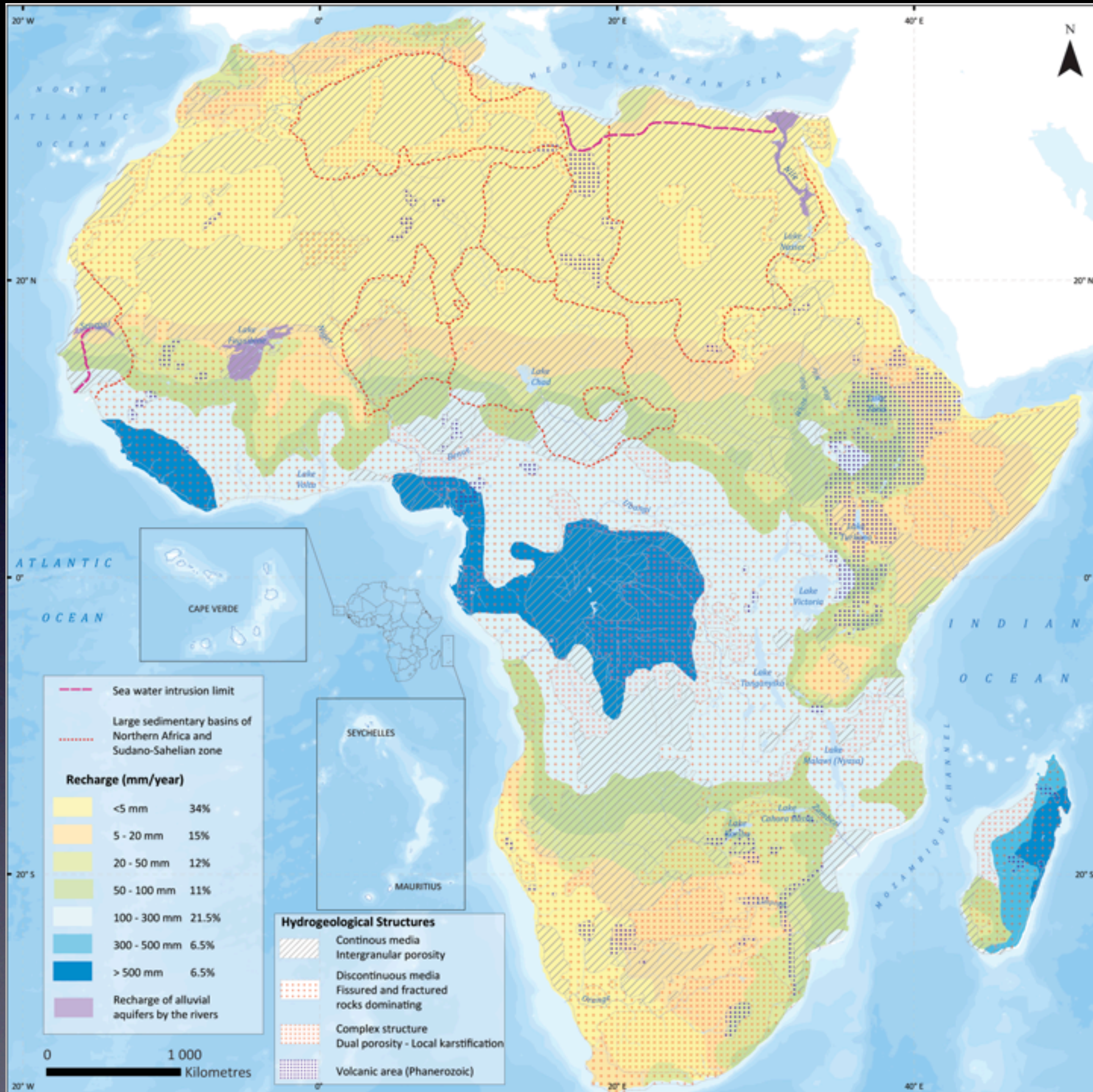
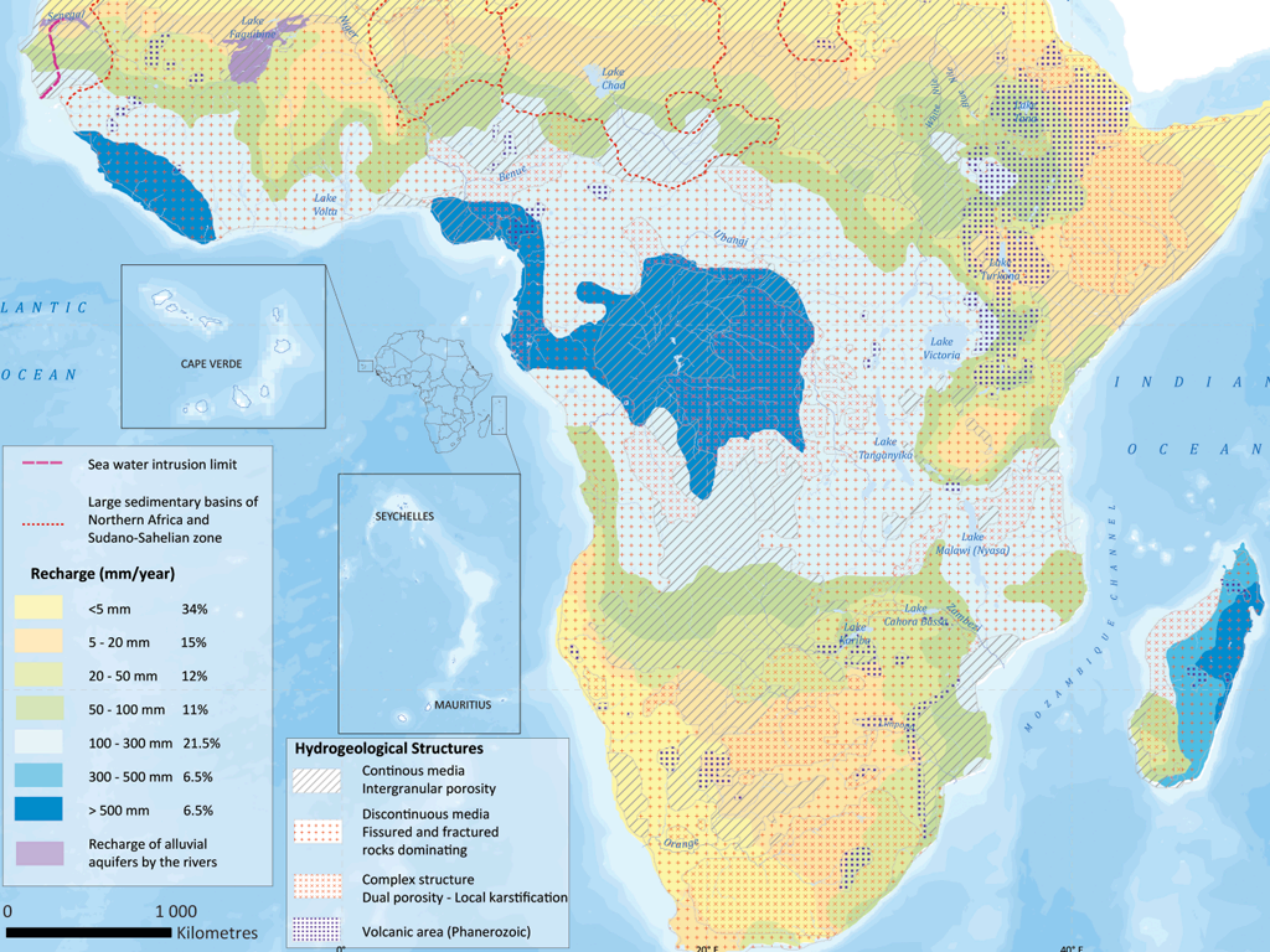
  Farbe, Helligkeit



N
20° W
0°
20° E
40° E
20° N
0°
20° S
NORTH ATLANTIC OCEAN
MEDITERRANEAN SEA
RED SEA
ATLANTIC OCEAN
INDIAN OCEAN
MOZAMBIQUE CHANNEL
Lake Chad
Lake Victoria
Lake Tanganyika
Lake Malawi (Nyasa)
CAPE VERDE
SEYCHELLES
MAURITIUS
Sea water intrusion limit
Large sedimentary basins of Northern Africa and Sudano-Sahelian zone
Recharge (mm/year)
<5 mm 34%
5 - 20 mm 15%
20 - 50 mm 12%
50 - 100 mm 11%
100 - 300 mm 21.5%
300 - 500 mm 6.5%
> 500 mm 6.5%
Recharge of alluvial aquifers by the rivers
Hydrogeological Structures
Continous media
Intergranular porosity
Discontinuous media
Fissured and fractured rocks dominating
Complex structure
Dual porosity - Local karstification
Volcanic area (Phanerozoic)
0
1 000
Kilometres



Senegal
Lake Faguibine
Niger
Lake Chad
White Nile
Blue Nile
Lake Tana
Benue
Lake Volta
Ubangi
Lake Turkana
LANTIC
OCEAN
CAPE VERDE
Lake Victoria
INDIAN
OCEAN
Lake Tanganyika
SEYCHELLES
MAURITIUS
Lake Malawi (Nyasa)
MOZAMBIQUE CHANNEL
Lake Cahora Bassa
Zambezi
Lake Kariba
Orange
Sea water intrusion limit
Large sedimentary basins of Northern Africa and Sudano-Sahelian zone
Recharge (mm/year)
<5 mm 34%
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20 - 50 mm 12%
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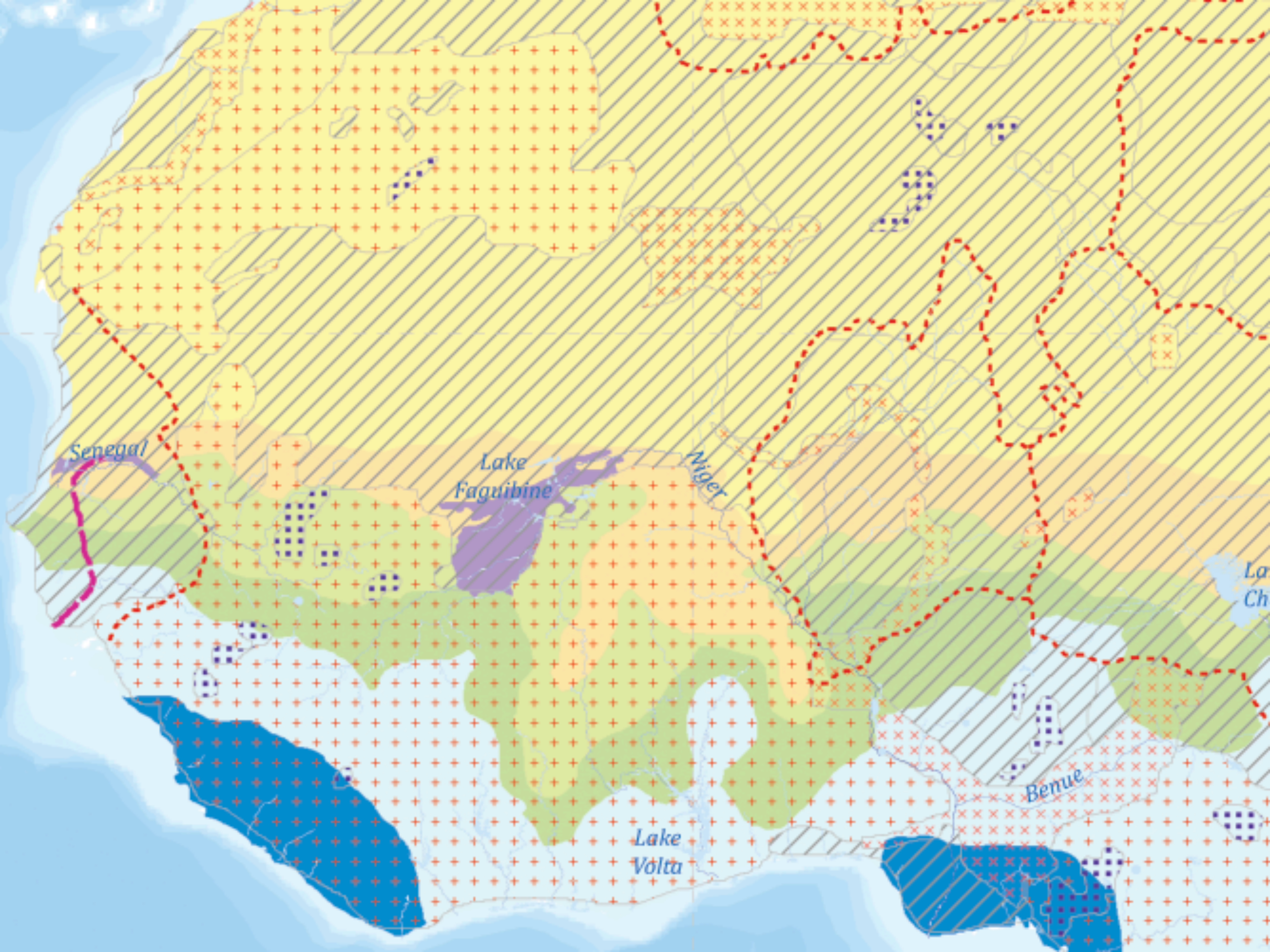
0
1 000
Kilometres


Senegal
Lake
Faguibine
Niger
Benue
Lake
Volta

Basis: Flüsse, Netz

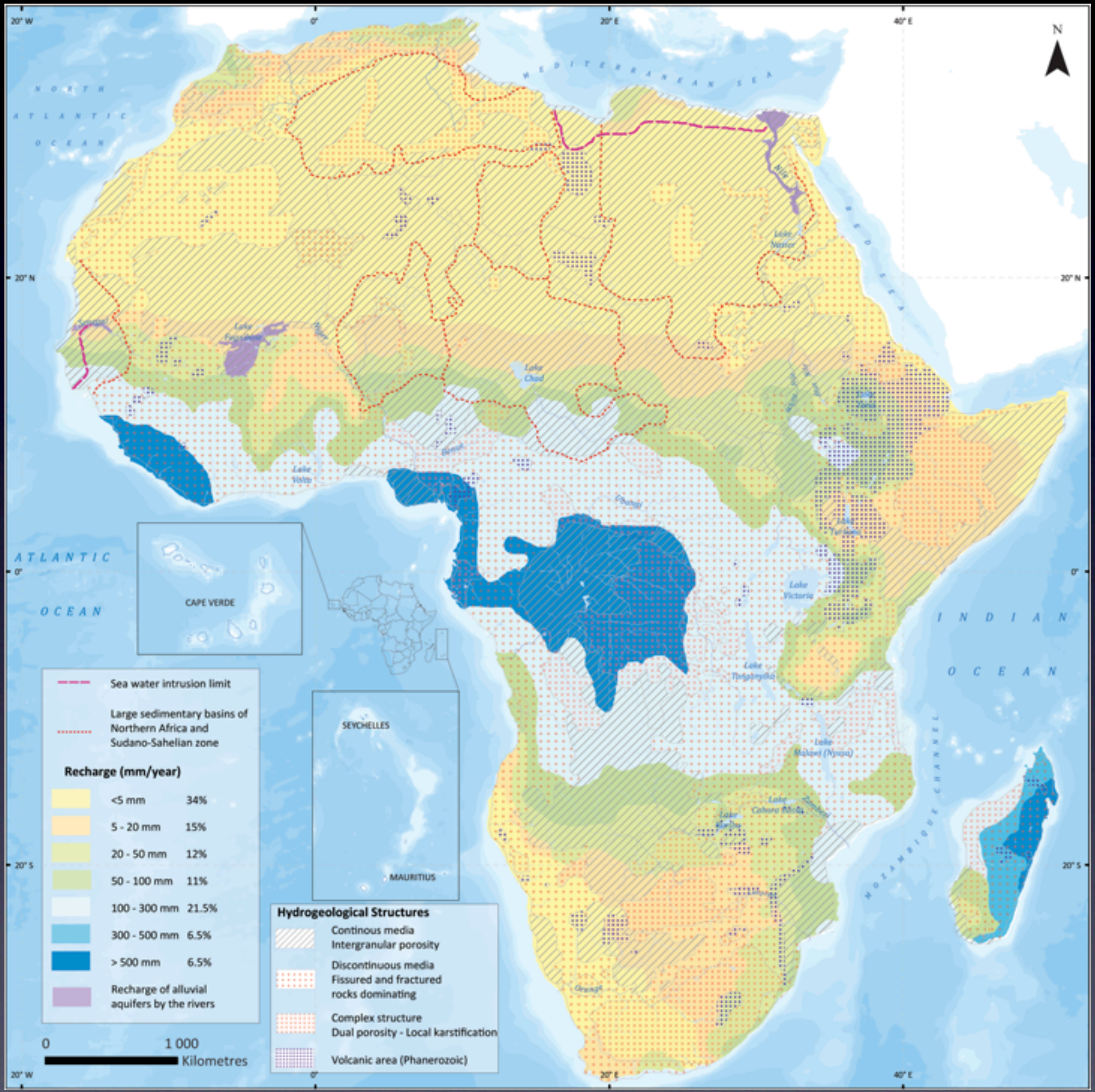
mehrschichtig
komplex
synthetisch

(1) Linearsignaturen
nominal – Form, Farbe

(2) Flächenkartogramm
ratio – Farbe, Helligkeit

(3) Flächenmittelwerte
nominal – Form

Schicht-Unterscheidung:
Farbe, Form, Muster



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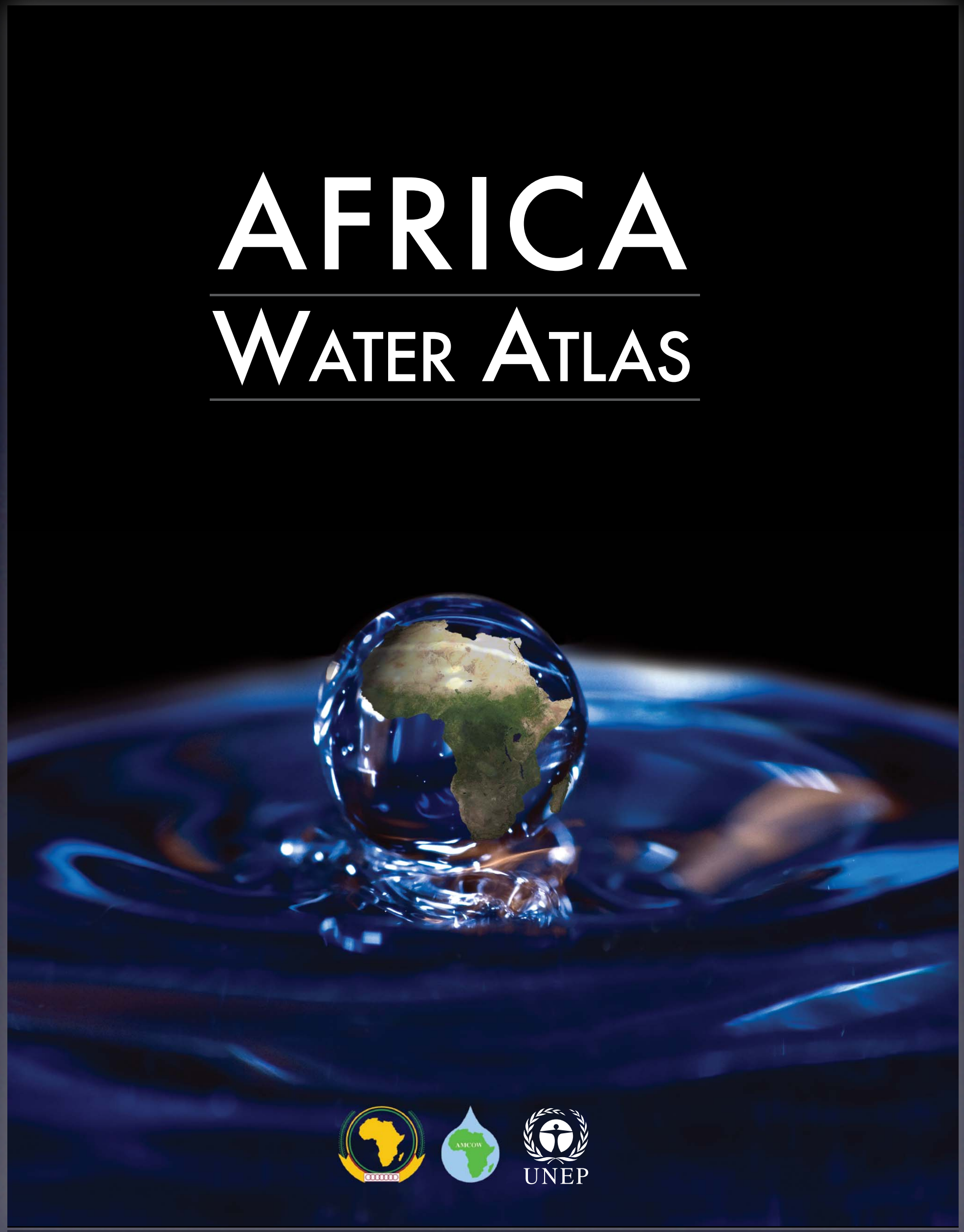
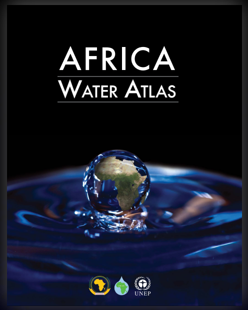
- kartographisch enttäuschend, „Bilderbuch“
- Datenquellen:
  viel Fernerkundung



Bildnachweis



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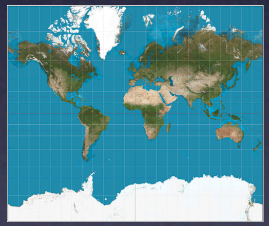

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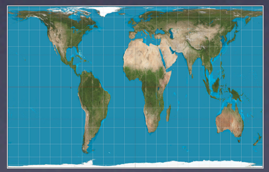

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