Contemporary International Issues

2nd Term 2017/2018

Dr. Abbas M. Sharaky
0100 361 9699
sharaky@geologist.com
sharaky@yahoo.com

Grading

Mid Term Exam (April 4, 2018) ……….……. ….	15%
Term paper and class activity………………………	15%
Oral Exam (May 2, 2018)…………………..…….	10%
Final Exam …………………....................................	60%

Course Description:

This course examines the global challenges affecting food production, focusing on current issues (Food Security) that illustrate these challenges. Students will investigate a range of topics including water, energy, and environmental aspects, regional disparities in the ability to meet basic human needs, and protection of the natural environment in an attempt to help students to appreciate the natural resources, to provide them with some historical perspective on the present status of the planetary environment; to give students opportunities to analyze specific environmental quality issues and to familiarize them with the ideas and practices of managing resources and environments according to the principles of sustainable development.

<u>Course Content</u>:

1. Water Issues:

1.1 Water Security

- 1.1.1 Water cycle and global water balance
- 1.1.2 Water resources in Africa
- 1.1.3 Water resources in the Arab World
- 1.1.4 Water resources in Egypt
- 1.1.5 Water quality (pollution)

1.2 Transboundary Rivers (Nile River)

- 1.2.1 Ethiopian water sources
- 1.2.2 Equatorial water sources
- 1.2.3 Southern Sudan

1.3 Ethiopian Renaissance Dam

1.3 Water Agreements

2. Energy Resources issues:

2.1 Non-renewable energy resources (fossil oil, natural gas, coal, uranium).

2.2 Renewable energy resources (solar, wind, geothermal, hydroelectricity, biomass, biofuels, nuclear power).

3. Global warming issues:

4. Desertification issues:

4.1 Drought, Potential Evapotranspiration, deforestation, overgrazing, urbanization.

4.2 Sand dune encroachment.

Introduction:

More than at any other time in history, the future of humankind is being shaped by issues that are beyond any one nation's ability to solve. Climate change, avian flu, financial instability, terrorism, waves of migrants and refugees, water scarcities, disappearing fisheries, stark and seemingly intractable poverty—all of these are examples of global issues whose solution requires cooperation among nations. Each issue seems at first to be connected to the next. Some common features soon become apparent (Bhargava, 2006):

- Each issue affects a large number of people on different sides of national boundaries.
- Each issue is one of significant concern, directly or indirectly, to all or most of the countries of the world, often as evidenced by a major U.N. declaration or the holding of a global conference on the issue.
- Each issue has implications that require a global regulatory approach; no one government has the power or the authority to impose a solution, and market forces alone will not solve the problem.
- Global environmental issues: Harmful aspects of human activity on the biophysical environment. As such, they relate to the anthropogenic effects on the natural environment, which are loosely divided into causes, effects and mitigation.

The 10 Most Significant Environmental Issues:

1. Water Scarcity

Causes: Destruction of water resources, Global warming, Deforestation, Decrease in rain water.

2. Energy Scarcity

Causes: Great dependence on traditional energy sources, slow growth for renewable energy technology, over use of energy sources (exploitation).

3. Pollution

Air pollution

Light pollution, Visual pollution, Noise pollution, Ozone depletion.

Soil pollution

Soil erosion, Soil contamination, Soil salination

Water pollution

Acid rain, Agricultural runoff, Groundwater contamination, Marine pollution

Oil spills, Wastewater.

4. Global Warming

As a result of over deforestation and emission of excess amount of oxides of carbon from power plants and vehicles there has been formed a green house effect around the Earth. Global warming would leads to water scarcity and extinction of several living organisms.

5. Desertification

Root causes of desertification have been identified as population growth and climate change which contribute to the nature and extent of environmental stress.

6. Climate Change, Sea level Rise, Flood, Drought

Causes: global warning, over exploitation of minerals and resources, pollution of water bodies. Deforestation, reduction in water absorption capacity of soil, heavy rainfall.

7. Food Scarcity

Causes: population explosion, conversion of green farm areas to concrete farms, diet style. About 800 million people do not get enough food to eat. Eliminating hunger is thus one of the most fundamental challenges facing humanity.

8. Earthquakes

Causes: Dams, uncontrolled stone mining, nuclear experiments.

9. Infectious Diseases and Carcinogens and mutation

Causes: Radiation, ozone layer depletion, nuclear reactor explosions, mobile towers.

10. Human overpopulation

The hydrologic (water) cycle

There is water in the atmosphere, rivers, & lakes. It moves around and around the water cycle. Water changes state between liquid, gas and solid. The water cycle is how water travels around the world. The water cycle on earth will never run out.

It is a conceptual model that describes the storage and movement of water between the biosphere, atmosphere, lithosphere, and the hydrosphere. Water on this planet can be stored in any one of the following reservoirs: The hydrological cycle consists of a collection of reservoirs (each having a particular mass of water substance) and movement (fluxes, measured in units of mass or volume per unit time) of water substance between these reservoirs.

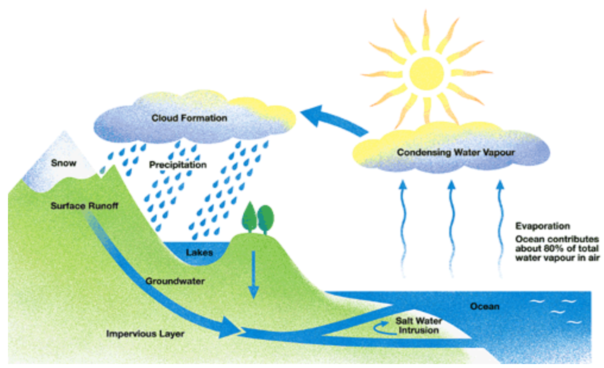
The following are reservoirs of the global hydrological cycle:

1. Global oceans
2. Ice masses
3. Antarctic ice sheet, Greenland ice sheet, Mountain glaciers, Arctic ice, Sea ice
4. Continental seasonal snow
5. Surface fresh water: Lakes, Rivers, Marshes and wetlands
6. Subsurface water: Soil moisture, Permafrost, Groundwater
7. Biospheric water
8. Atmospheric water vapor
9. Clouds: Liquid, Ice

Water moves from one reservoir to another by way of processes such as evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting and groundwater flow.

Precipitation:

All moisture from the atmosphere, rain, snow, hail and sleet come from clouds that move around the world. When clouds rise over mountain ranges, they cool, becoming so saturated with water that begins to fall as rain, snow or hail, depending on the temperature of the surrounding air.



Water Cycle

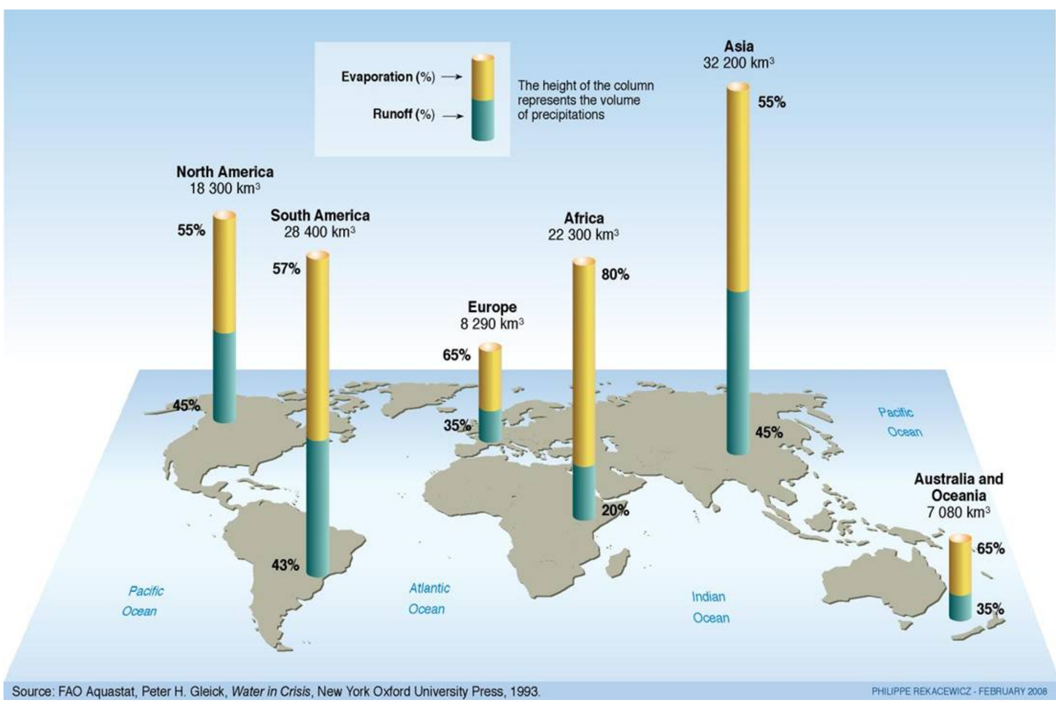
Evaporation:

Evaporation occurs when water goes from the liquid to the vapor state. As water is heated by the sun, the surface of it's molecule becomes sufficiently energized invisible vapor in the atmosphere. The oceans supply most of the evaporated water found in the atmosphere. Shiklomanov in Gleick (1993) estimates that each year about 502,800 km^3 of water evaporates over the oceans and seas, 90% of which (458,000 km^3) returns directly to the oceans through precipitation, while the remainder (44,800 km^3) falls over landmasses where climatological factors induce the formation of precipitation. The resulting imbalance between rates of evaporation and precipitation over land and ocean is corrected by runoff and groundwater flow to the oceans. The rate of evaporation depends mainly on: 1. the temperature of the air and the water body, 2. the absolute humidity of the air above the free surface of the water body, and 3. the wind speed: high winds keeps absolute humidity low, and stirs up the free surface. Africa receives considerable inputs of solar heat and radiation because it has large share of its area in the tropics. About 80% of the rainfall water is lost by evaporation.

Transpiration: All the water that could enter the air from plant leaves by a process called transpiration. The term ***evapotranspiration*** is used for the total water loss from a basin from evaporation and transpiration combined.

Condensation: Condensation is a process by which air masses are cooled. As water vapor rises, it cools and eventually condenses, usually on tiny particles of dust in the air. The normal lapse rate is about 0.7ºC /100 m of elevation change. When water condenses it becomes a liquid again or turns directly into a solid (ice, hail or snow). These water particles then collect and form clouds.

Runoff occurs when precipitation rate exceeds infiltration capacity at a given time. It is visible flow of water in rivers, creeks and lakes as the water stored in the basin drains out. Tropical regions exhibit greater river runoff volumes. The Amazon carries 15% of all the water returning to the world's oceans, while the Congo- carries 33% of the river flow in Africa.



World precipitation, runoff and evaporation.

Infiltration: Infiltration is a process by which water from precipitation or snow melt moves from the surface downwards into the soil and rocks through cracks, joints and pores until it reaches the water table where it becomes groundwater. It is driven by gravity and pressure ($P_{pore} \leq P_{atmosphere}$) pores until it reaches the water table where it becomes groundwater. It is driven by gravity and pressure ($P_{pore} \leq P_{atmosphere}$).

Groundwater: Subterranean water is held in cracks and pore spaces. Depending on the geology, the groundwater can flow to support streams. It can also be tapped by wells. Some groundwater is very old and may have been there for thousands of years.

The endless circulation of water from the atmosphere to the earth and its return to the atmosphere through condensation, precipitation, evaporation and transpiration is called the hydrologic cycle.

GLOBAL WATER BUDGET:

The global water resources are estimated as follow: The total volume of water on Earth is about 1.4 billion km^3. The volume of freshwater resources is about 35 million km^3, or about 2.5% of the total volume. About 27 million km^3 (76.65% of the global freshwater) occur in the form of ***ice*** and permanent snow cover in mountainous regions, the Antarctic and Arctic regions. Groundwater represents about 22.76% of the global freshwater. The ***atmosphere*** holds about 0.04%. The annual precipitation for the earth is more than 30 times the atmosphere's total capacity to hold water, indicating the rapid recycling of water that must occur between the earth's surface and the atmosphere. Freshwater ***lakes*** and ***rivers*** contain an estimated 105,000 km^3 (0.3% of the world's freshwater). The surface freshwater is stored in streams, rivers and lakes only comprise 0.0001% of all water in the earth system. The largest store of water is the ***oceans*** that contain about 1,365 million km^3 (97.5% of the earth's water) of salty water.

Africa contains about 4,050 km^3/yr (9% of the world's total freshwater resources). These resources are distributed unevenly across Africa. They are concentrated in the central and western regions of the continent, where rainfall ranges from moderate to abundant. Democratic Republic of Congo is the wettest country in Africa. It contains 935 km^3/yr (about 25% of all of Africa's annual internal renewable water resources). By contrast, the driest country, Mauritania, has just 0.4 km^3/yr (0.01% of Africa's total).

Africa is home to some of the planet's largest desert regions, including the vast Sahara (the world's biggest desert), which spans the midsection of North Africa; the Horn Desert in the east; and the Kalahari and Namib deserts of Southern Africa. All told, approximately two-thirds of Africa is classified as desert or arid. It is the most tropical of all the continents with over 75% of its area falling between 23 °N and °S.

Distribution of the world water supply.

Reservoir	Volume million km^3	% Total	% of freshwater
Oceans	1,365	97. 5	
Ice Caps and Glaciers	26.88	1.92	76.655
Groundwater	7.98	0.57	22.757
Lakes	0.126	0.009	0.359
Soil Moisture	0.065	0.005	0.185
Atmosphere	0.014	0.001	0.040
Streams and Rivers	0.0014	0.0001	0.004
Total	1,400		

Freshwater resources in Africa

Significant features of water resources in Africa:

1. Low rainfall, most African countries also experience extremes of rainfall (periodic flooding or drought).
2. High evaporation (80%).
3. The extremely low runoff in relation to precipitation, in which the renewable water resources constitute only about 20% of the total rainfall.
4. Uneven water distribution, where great temporal and spatial variability of rainfall in Africa. The western Africa and central Africa have significantly greater precipitation than northern Africa, the Horn of Africa and southern Africa.
5. Water pollution in Africa is common.
6. Mismanagement of water resources in Africa. Water uses (90% in agriculture, 10% domestic and industrial). Some countries cultivate of crops of high water requirements such as rice, sugarcane and banana, which need more water than crops like millet or sorghum).
7. Irrigation in some countries (Egypt and Sudan) is an ancient flood irrigation method.
8. Non-renewable groundwater in most of the Northern African aquifers.
9. Overgrowth population in Africa forms excess demand of water.
10. The deterioration of water quality (pollution), salinization, and reduction of the yield of the heavily exploited aquifers.
11. Climate change affects some african regions (drought and rainfall changes).
12. There are some conflicts and political water tension of the transboundary surface and groundwater resources in Africa. Some of the main transboundary rivers are the Nile River (Sudan and Egypt), Congo River, Senegal River (Mauritania), the Juba and Shebilli rivers (Somalia).

Freshwater resources in the Arab region

The definition of **freshwater** is water containing less than 1000 milligrams per liter of dissolved solids, most often salt. It occurs in the form of stream flow, groundwater, soil moisture, or atmospheric water vapor.

Water resources, although globally abundant, are distributed in pronounced uneven patterns throughout the globe. Global renewable surface and groundwater resources amount for an average annual share of 6185 m^3/capita for year 2015.

More than 85% of the Arab Region is classified as arid and hyper-arid, receiving an average annual rainfall of less than 250 mm. The average annual precipitation for the Arab nations is 156 mm/year. Total rainfall is km^3 1488. More than 75% of the limited precipitation received by the region is evaporated indicating the highest aridity in the world.

The Arab Region annual renewable freshwater availability is 300 km^3, from which 54% of is originated from outside the region.

Fossil groundwater has been extensively tapped in the desert areas. A total of about 30 km^3/year of non-renewable and non-conventional water supplies are being produced.

Water challenges in the Arab World

1. Low rainfall (1488 km^3/year). The annual renewable surface water is 300 km^3 (0.67% of the world), although the Arab region forms 5% of the world population and 9.2% of the land surface.
2. High evaporation (80% of the rainfall).
3. Non-renewable groundwater.
4. Uneven water distribution (spatial and temporal):
    a. Three countries (Egypt, Sudan and Iraq) have more than 65% of the Arab water.
    b. Short rainfall season in winter.
5. Mostly deserts (flat and dry).
6. Overgrowth population (2.37%/year). It is increased from 262 millions in 1997 to 390 in 2015. It has 769 m^3/kapita in 2015 (world average is 6185 m^3/year/kapita).
7. Water Mismanagement:
    a. Water uses (81% in agriculture, 13% domestic and 6% industrial)
    b. Types of crops (cultivation of high water requirement plants such as rice, sugarcane and banana, which need more water than crops like millet or sorghum).
    c. Using ancient flood irrigation method.
8. The deterioration of water quality (pollution), salinization, and reduction of the yield of the heavily exploited aquifers.
9. Climate change (drought and rainfall changes).
10. The conflicts of the transboundary surface and groundwater resources. More than 54% of the available actual renewable water resources are being generated outside the Arab Region. The main transboundary rivers are the Nile River (Sudan and Egypt), Senegal River (Mauritania), the Juba and Shebilli rivers (Somalia), the Tigris and Euphrates (Syria and Iraq).

Irrigation Water Requirement of Crops

Water requirement of crops is defined as "the amount of water required by a crop in its whole production period". It includes evaporation and other unavoidable wastes.

Usually water requirement for crop is expressed in water depth per unit area. The amount of water taken by crops varies considerably.

Table of water requirement of different crops.

Crop	Water Requirement (mm)
Sugarcane	1500-2500
Rice	900-2500
Banana	1200-2200
Citrus	900-1200
Cotton	700-1300
Pineapple	700-1000
Tomato	600-800
Grape	500-1200
Maize	500-800
Potato	500-700
Groundnut	500-700
Wheat	450-650
Soybean	450-700
Sorghum	450-650
Chillies	500
Cabbage	380-500
Onion	350-550
Pea	350-500
Sunflower	350-500
Gingelly	350-400
Bean	300-500

RIVERS

Introduction

The total volume of water on Earth is about 1.4 billion km^3. The volume of freshwater resources is about 35 million km^3, or about 2.5% of the total volume. Freshwater ecosystems in rivers, lakes, and wetlands contain just a fraction—one-hundredth of 1 percent—of the Earth's water (i.e. 0.0001%) and occupy less than 1% of the Earth's surface (Watson et al. 1996; McAllister et al. 1997). There are about 263 international river basins covering 45.3% (~231,059,898 km^2) of the land surface area of the Earth.

River Basin?

A ***river basin*** is the portion of land drained by a river and its tributaries. It encompasses the entire land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into the main river.

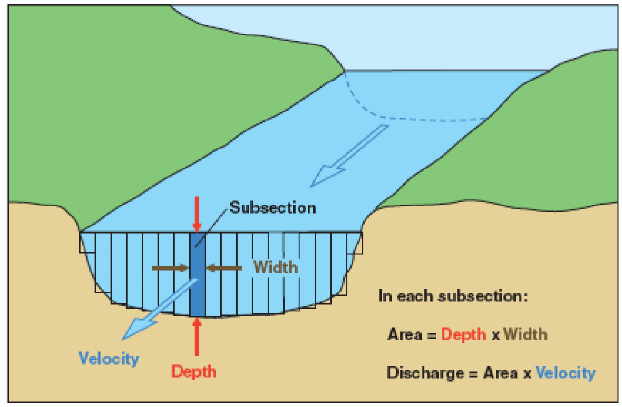
Watershed

A watershed is simply the area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater.

What is the difference between a River Basin and a Watershed?

Both river basins and watersheds are areas of land that drain to a particular water body, such as a lake, stream, river or estuary. In a river basin, all the water drains to a large river. The term watershed is used to describe a smaller area of land that drains to a smaller stream, lake or wetland. There are many smaller watersheds within a river basin.

River discharge (Q) is the volume of water moving down a stream or river per unit of time, commonly expressed in cubic meter per second (m^3/s).



In general, river discharge is computed by multiplying the area of water in a channel cross section by the average velocity of the water in that cross section:

Discharge = area x velocity

= (width x depth) x velocity

Q = W x D x V

Q = river discharge (m^3/sec)

W = average width (m)

D = average depth (m)

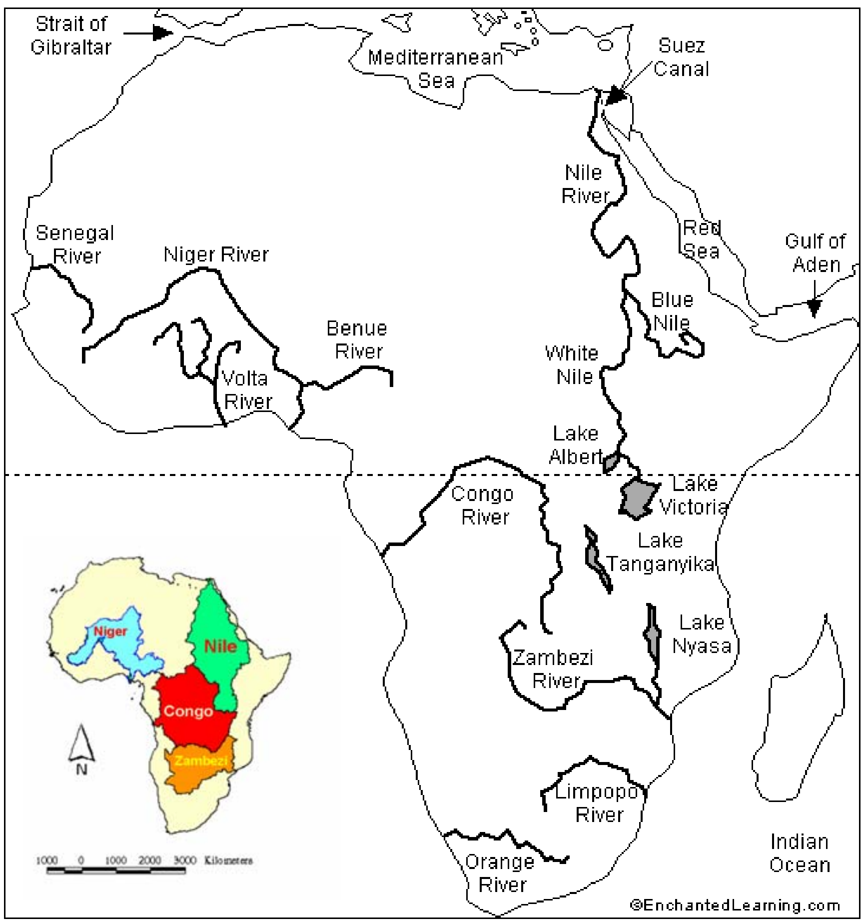
V = velocity of water (m/sec)

Average annual discharge of the Nile River at Aswan is 84 billion m^3.

Average annual discharge of the Congo River is 1300 billion m^3 (15 times the Nile).

MAJOR RIVERS IN AFRICA

There are 261 international rivers, covering almost one half of the total land surface of the globe. Africa contains half a dozen of global significance watersheds. The northeast quadrant of the continent is home to the Nile River, the longest river in the world at approximately 7,000 km. Other major river basins include the Congo River in central Africa, the Niger River in western Africa, the Zambezi River in southeastern Africa, and Orange River in southern Africa.



Major rivers in Africa.

The Nile River

The Nile is the longest river in the world with a length of 6,695 km from the headwaters of the Kagera River in Rwanda in the south, to the Egyptian delta on the Mediterranean coast in the north.

The Nile has a drainage area of about 3.2 million km^2. It is nearly 10% of the landmass of the African continent, covering parts of 11 countries. They are (from south to north) Rwanda, Burundi, Tanzania, Uganda, Kenya, DR Congo, Ethiopia, Eritrea, South Sudan, Sudan, and Egypt (Fig. 1),

Sources of the Nile:

It has two main tributaries:

1. **Ethiopian sources** originating in the highlands of Ethiopia.
   a) The Blue Nile, with its source in the Ethiopian highlands.
   b) Atbara (Tekeze)
   c) Baro-Akobbo-Sobat
2. **Equatorial Plateau of East Africa**, The White Nile, originating from the the headstreams of which flows into Lake Victoria, and Lake Victoria with the surface area of 66,700 km^2 is the world's second largest freshwater lake after Lake Superior in North America. The equatorial water flows to South Sudan and forms Bahr el Jebel.

The two principal branches of the Nile - the White Nile and the Blue Nile join at Khartoum to form the main Nile. The average of the annual Nile flow (discharge) is 84 km^3 at Aswan. About 85% of the Nile water comes from Ethiopian highlands, 15% flows from the Equatorial sources (Table 1).

Table (1): Contribution of the main Nile sources

Source	River	Water share km^3 at Aswan	%
Ethiopian Highlands	Blue Nile	50	60%
	Atbara (Tekeze)	10	12%
	Baro-Akobbo-Sobat	11	13%
Equatorial Plateau	Lake Victoria - Bahr el Jebel	13	15%
Total		**84**	**100%**

The Blue Nile

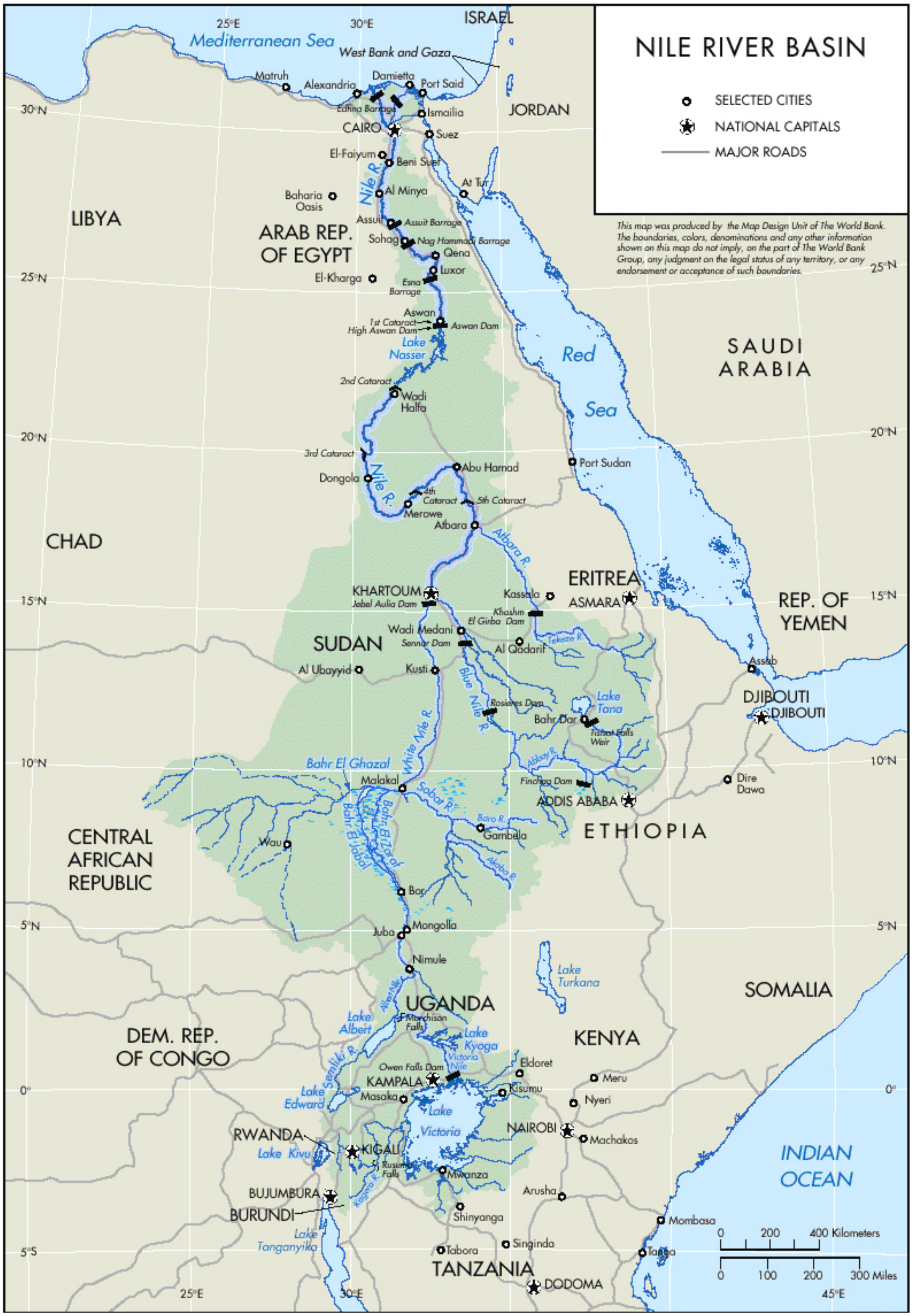
The Blue Nile flows about 1,400 km from Lake Tana to Khartoum, where the Blue Nile and White Nile join to form the main Nile. It provides the Nile by 50 billion km^3 annually (about 60%). It stretches nearly 850 km between Lake Tana and the Sudano-Ethiopian border, with a fall of 1300 m; the grades are steeper in the plateau region, and flatter along the low lands.

The Blue Nile River (also called Abbay River in Ethiopia) exits from the south east of Lake Tana and flows south and then westwards cutting a deep gorge towards the western part of Ethiopia.

More than 95% of the transported sediments (clay) carried by the Nile originates in Ethiopia, from the Blue Nile, Atbara, and Sobat, and small tributaries.

The White Nile:

The White Nile Sub-basin originates at the confluence of Bahr el Jebel River and Baro-Akobo-Sobat River above Malakal, South Sudan (see Figure 1). The Bahr el Jebel extends from the mountains of Burundi and Rwanda the Equatorial Lakes. A number of tributaries from Burundi and Rwanda eventually flow into the Kagera River, over Rusumu Falls and into Lake Victoria. The Victoria Nile flows out of the Northern end of Lake Victoria over the Owen Falls Dam and then into Lake Kyoga.


NILE RIVER BASIN
SELECTED CITIES
NATIONAL CAPITALS
MAJOR ROADS
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Mediterranean Sea
West Bank and Gaza
ISRAEL
JORDAN
LIBYA
ARAB REP. OF EGYPT
SAUDI ARABIA
Red Sea
CHAD
SUDAN
ERITREA
REP. OF YEMEN
DJIBOUTI
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
SOMALIA
UGANDA
KENYA
DEM. REP. OF CONGO
RWANDA
BURUNDI
TANZANIA
INDIAN OCEAN
Matruh
Alexandria
Damietta
Port Said
Ismailia
CAIRO
Suez
El-Faiyum
Beni Suef
Al Minya
Baharia Oasis
At Tur
Assuit
Sohag
Qena
Luxor
El-Kharga
Aswan
Aswan Dam
Lake Nasser
Wadi Halfa
Dongola
Merowe
Abu Hamad
Atbara
Port Sudan
KHARTOUM
Kassala
ASMARA
Wadi Medani
Al Qadarif
Al Ubayyid
Kusti
Assab
Bahr Dar
Lake Tana
Malakal
ADDIS ABABA
Gambela
Dire Dawa
Wau
Bor
Juba
Mongolla
Nimule
Lake Turkana
Lake Albert
Lake Kyoga
Eldoret
Meru
KAMPALA
Masaka
Kisumu
Nyeri
Lake Edward
Lake Victoria
NAIROBI
Machakos
Lake Kivu
KIGALI
Mwanza
BUJUMBURA
Arusha
Shinyanga
Lake Tanganyika
Tabora
Singinda
Mombasa
Tanga
DODOMA
Nile R.
Blue Nile R.
White Nile R.
Atbara R.
Sobat R.
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Bahr El Jabal
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0 200 400 Kilometers
0 100 200 300 Miles
25°E
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Fig. 1. Nile Basin.

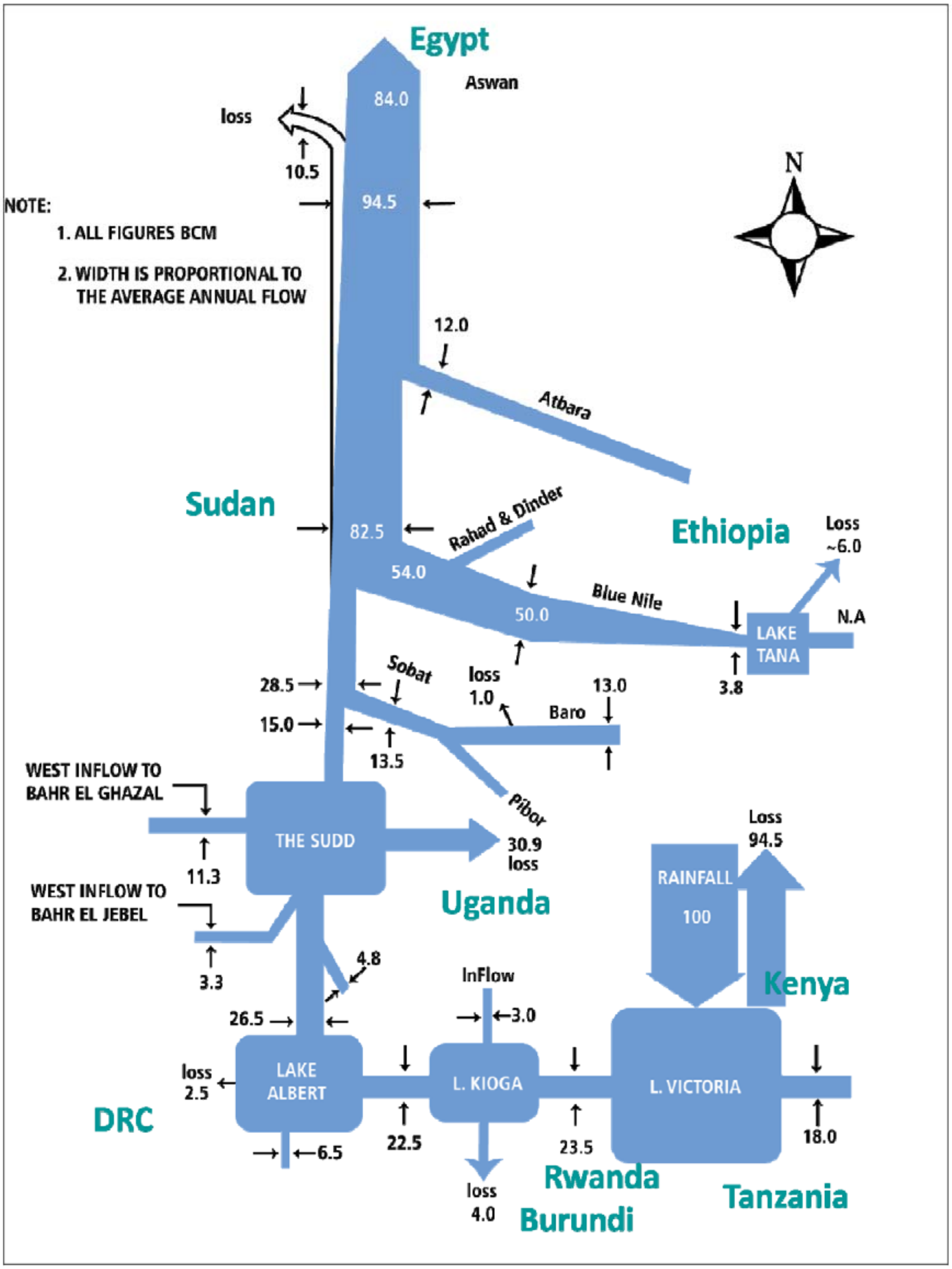


Fig. 2 Schematic of the Nile River Flow Fluxes.

From there the river drops from the Rift Valley at its peak to Lake Albert where it is reinforced by water from Lake George and Lake Edward and flows out of the Lake Plateau as the Albert Nile. At the border of Uganda at Nimule it becomes the Bahr el Jebel or the Upper Nile. Tributaries flowing into the upper White Nile (Bahr el Jebel) in southern Sudan also contribute water to the White Nile, although approximately half of the water flowing into the Sudd downstream is lost to evaporation and overflow into the extensive wetlands of this region.

Victoria Lake

Lake Victoria– the largest of the Nile Equatorial Lakes. It is 's surface area is about 66,700 km^2 and occupies a large proportion of the entire sub-basin.

Three countries Kenya (6%), Tanzania (51 %) and Uganda (43%) share the lake shoreline, and six countries share the basin: Burundi, DRC, Kenya, Rwanda, Tanzania and Uganda.

Lake Victoria, 1,134 m above sea level, is by far the largest lake (66,700 km2) in Africa, and the second largest freshwater lake in the world. Annual water inflow into Lake Victoria through the main tributaries is about 18 km3. It also receives about 100 km3/year from direct rainfall. Therefore, it has the most fresh water in Africa in terms of low TDS. Similar to most of the African continent, the annual evaporation rate is about 80%.

The net annual outflow from the lake through the Upper Victoria Nile is 23.5 km^3. The concentration of the metal content (salinity) of the Nile River increases with distance from the Aswan High Dam to the north due washing the surface rocks and the human activities. The average salinity of the Nile in Egypt is much greater than that of Victoria.

The Atbara River

The Atbara River is the last major tributary of the River Nile, and converges with it about 320 km downstream of Khartoum.

The Nile River experiences massive fluctuations throughout the year, with 80% of the annual discharge occurring between August and October. Prior to construction of the Aswan High Dam, the flow was not reliable throughout the year, and was not abundant during the long, hot and dry summer months, when it is especially critical to Egyptian agriculture. This inhibited the development of the river in many ways.

The Baro-Akobo-Sobat River

The Baro-Akobo-Sobat River includes the discharge from two tributaries: the Baro and Akobo River from the Ethiopian Highlands and the Pibor River from southern Sudan and northern Uganda. Most of the runoff develops in the mountains and foothills of Ethiopia.

The Bahr el Jebel River

Exiting Lake Albert, the river flows north into Sudan and is known as the Bahr el Jebel. The Bahr El Jebel Sub-basin is the most complex of the Nile reaches due to having many seasonal inflows. Below the Sudan-Uganda border, the river receives seasonal flow from torrential streams before entering the Sudd, south of Mongalla.

The Sudd is a region of permanent swamps and seasonal wetlands, within which approximately half of the Bahr el Jebel flow is lost to evaporation due to its large surface area and high rate of evaporation as well as overbank spillage; in fact, less than half the water entering the Sudd flows out to the White Nile.

Efforts to attempt to prevent water loss within the Sudd can be dated back to 1900 when the Under Secretary of State for the Egyptian Public Works Department stated the need to reduce water lost in the vast swamps.

Jonglei Canal

Construction of the Jonglei Canal, initiated in 1978 but discontinued in 1983 due to civil conflict, could lead to additional change in the Sudd ecosystem if completed; to date, 240 km of the planned 360 km canal length has been completed. Diversion of water around the Sudd could reduce the area of seasonally flooded grasslands, impact the distribution of other vegetation types, eliminate critical habitat, and displace thousands of Nubians from their homeland.

<u>Annual water per person in Egypt (2016)</u>:

- Population in 2018 = ~100 million
- Annual freshwater resources in Egypt:
    - Nile: 55.5 km^3
    - Rainfall: about 0.5 km^3

Total annual water budget = 56.0 km^3 = 56000 million m^3

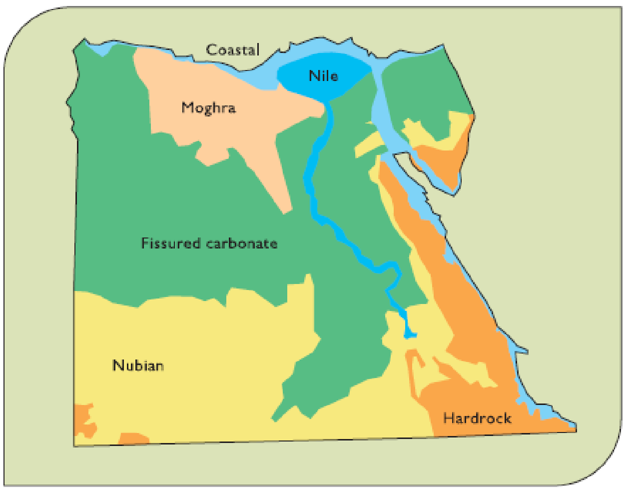
- Annual water per capita = Annual water budget / Population

= 56000 / 100 = **560 m^3/person/ year**

The physical characteristics and processes leading to water scarcity complement the discussion of concepts. Climatic conditions dominant in water scarce regions are analyzed, particularly rainfall variability and evaporation.

Groundwater in Egypt

Although in terms of quantity the contribution of groundwater to the total water supply in Egypt has been very moderate, groundwater is the sole source of water for people living in the desert areas. Because of limited options to increase the Nile water availability, there has been an increasing interest during the last decade to further develop the groundwater resources.



The major aquifer systems in Egypt

The major groundwater systems in Egypt are the following (see Figure 2-10):

- Nile aquifer
- Nubian sandstone aquifer
- Fissured carbonate aquifer
- Moghra aquifer
- Coastal aquifer
- Hardrock aquifer

The characteristics of these aquifers are described in more detail in NWRP Technical Reports 15 and 16 (NWRP 2001g and NWRP 2001h). Some major features are summarized below.

Nile aquifer

In terms of abstraction the most important aquifer in Egypt is the Nile aquifer (about 87% of the total groundwater abstraction in Egypt). However, since the aquifer is recharged by infiltration of excess irrigation water, and since the source of this irrigation water is Nile water released at Aswan, the groundwater in the Nile aquifer is not a separate resource.

The aquifer is composed of a thick layer of sand and gravel with clay intercalations. The sediments are covered by a clay cap of varying thickness, up to 50 m in the northern part of the Delta. The high productivity of the wells and the shallow depth of the groundwater table allow the abstraction of large quantities of water (100-300 m^3/hr) with relatively shallow wells at relatively low pumping cost. In some areas the groundwater is used by farmers in conjunction with surface water, especially during periods of peak irrigation demands.

Nubian Sandstone aquifer

Besides the Nile aquifer, by far the most important groundwater body is the Nubian Sandstone Aquifer which covers a total area of roughly 2 million km^2 and extends into Libya, Chad and Sudan. Its northern boundary is a fresh/salt water interface that follows a fault line north of Siwa oasis, crosses the Nile Valley between Minya and Beni Suef and bends north-east into the Sinai. The aquifer is phreatic in the south-western part of Egypt; elsewhere it is confined by a thick cover of carbonate rocks. The saturated thickness of the fresh part of the aquifer ranges from 200 m in East Oweinat to 3,500 m in the Great Sand Sea north-west of Farafra (see Figure 2-11).

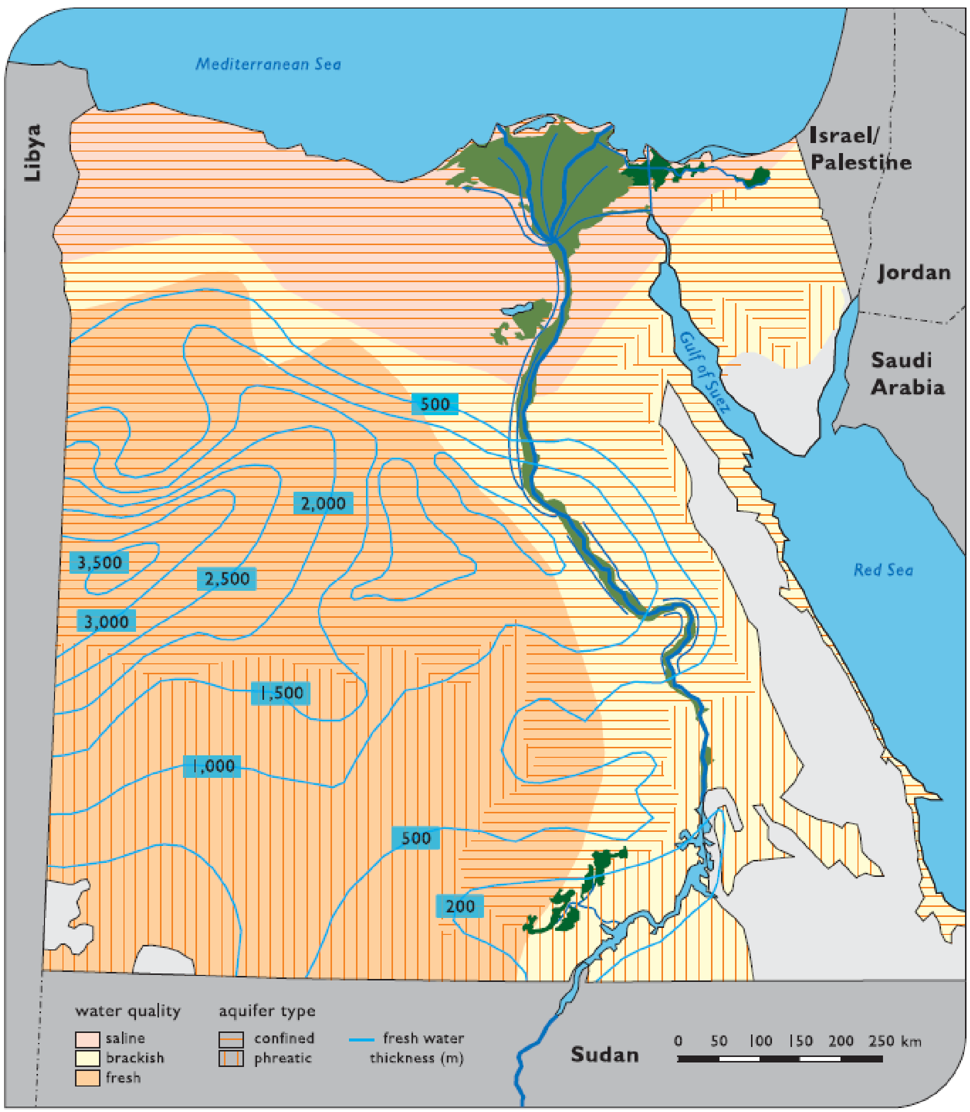


Figure 2-11 Extent and main characteristics of the Nubian Sandstone Aquifer in Egypt

Discharge takes place in the oases in the Western Desert through artesian wells and pumping. The total volume of fresh water stored in the aquifer has been subject of many studies and probably exceeds 150,000 BCM. However, this value merely is of academic interest since development in large areas will not be viable because of the large depth of the groundwater table (up to 2000 m).

The groundwater is of fossil origin and flows in a northern direction. The flow velocity in the aquifer is about 1 m/yr. This means that the travel time from the Sudanese border to the Qattara depression, over a distance of 800 km, would be roughly 800,000 years. During this time many climatic changes have taken place, including wet periods during which the aquifer system has been replenished. The transition to the current arid conditions has started some 8,000 years ago. The age of the groundwater in the central part of the Western Desert varies between 20,000 and 40,000 years which indicates that the aquifer has indeed been recharged by local rainfall.

Fissured carbonate aquifers

The fissured carbonate rocks occupy more than 50% of the surface area of Egypt and act as a confining layer on top of the Nubian Sandstone Aquifer. This aquifer system predominates in the northern part of the Western Desert and is also present in the Eastern Desert (with negligible recharge) and large areas of the Sinai (with recharge from rainfall). The aquifer has not received enough attention as regional aquifer system, irrespective of the fact that many natural springs occur. The aquifer recharge is unknown but is expected to be limited. Because of its low porosity, groundwater occurrence is restricted to isolated pockets of sedimentary deposits, fissures and fault systems. No reliable figures are available about the total groundwater potential. In Siwa the productivity of wells shows a large variation: from 5 to more than 300 m^3/hr.

Moghra aquifer

The Moghra aquifer is found at the surface from Wadi Natrun and Wadi Farigh towards the Qattara depression. It consists of coarse sand, gravel and sandstone with clay and silt stone intercalations. The groundwater flow is in general directed towards the Qattara depression. The aquifer is recharged by rainfall and lateral inflow from the Nile aquifer; the total yearly recharge of the aquifer is unknown. The aquifer contains fresh groundwater only near its eastern border (Wadi El Farigh). The salinity increases rapidly towards the north and west.

Due to the sharp increase in abstractions for groundwater-based reclamation projects and industrial and municipal supply, notably in the western fringes of the Nile Delta, the water quality and sustainability of this resource is at risk. Water levels are dropping and the water quality has deteriorated due to salinization and pollution.

Coastal aquifer systems

The coastal aquifer systems occupy the northern and western coasts. These aquifers are recharged by rainfall. Quantities that can be abstracted are limited due to the presence of saline water underneath the fresh water lens.

Fissured and weathered hard rock aquifer system

This Pre-Cambrian aquifer system, predominates in the Eastern Desert and the Southern Sinai. The aquifer system is recharged by small quantities of infiltrating rainwater.

Causes for water scarcity:

Annual renewable freshwater availability of less than 1,000 m^3 per person is defined by as water scarcity that may result from a range of phenomena. These may be produced by natural causes, may be induced by human activities, or may result from the interaction of both.

1. Natural:
    a. Climate factors (temperature, evaporation, rainfall (intensity, variability in time and space).
    b. Geologic factors (topography, rock types, soil, fractures, ..).
    c. Vegetation cover.
2. Human influences:
    a. Pollution and contamination degrade the water quality and lead to water unavailability for many uses.
    b. Population growth
    c. Poor water management.

Worldwide, agriculture is the sector which has the highest demand for water. As a result of its large water use irrigated agriculture is often considered the main cause for water scarcity. The sustainable use of water implies resource conservation, environmental friendliness, technological appropriateness, economic viability, and social acceptability of development issues.

Water shortage is also a man-induced, sometimes temporary water imbalance including groundwater and surface waters over-exploitation resulting from attempts to use more than the natural supply, or from degraded water quality, which is often associated with disturbed land use and altered carrying capacity of the ecosystems.

The arid environments

Aridity is usually expressed as a function of rainfall and temperature. A useful "representation" of aridity is the following climatic aridity index: p/ETP

Where:

P is the mean value of annual precipitation,

ETP is the mean annual potential evapotranspiration calculated by method of Penman, taking into account atmospheric humidity, solar radiation, and wind.

1- **The hyper-arid zone** (arid index 0.03)

The hyper-arid zone comprises dryland areas without vegetation, with the exception of a few scattered shrubs. True nomadic pastoralism is frequently practiced. Annual rainfall is low, rarely exceeding 100 millimeters. The rains are infrequent and irregular, sometimes with no rain during long periods of several years.

Average rainfall in Egypt is 50 mm/year

2- **The arid zone** (arid index 0.03-0.20):

The arid zone is characterized by pastoralizm and no farming except with irrigation. For the most part, the native vegetation is sparse, being comprised of annual and perennial grasses and other herbaceous vegetation, and shrubs and small trees. There is high rainfall variability, with annual amounts ranging between 100 and 300 millimeters.

3- **The semi-arid zone** (arid index 0.20-0.50):

The semi-arid zone can support rain-fed agriculture with more or less sustained levels of production. Sedentary livestock production also occurs. Native vegetation is represented by a variety of species, such as grasses and grass-like plants, fortes and half-shrubs, and shrubs and trees. Annual precipitation varies from 300-600 to 700-800 millimeters, with summer rains, and from 200-250 to 450-500 millimeters with winter rains.

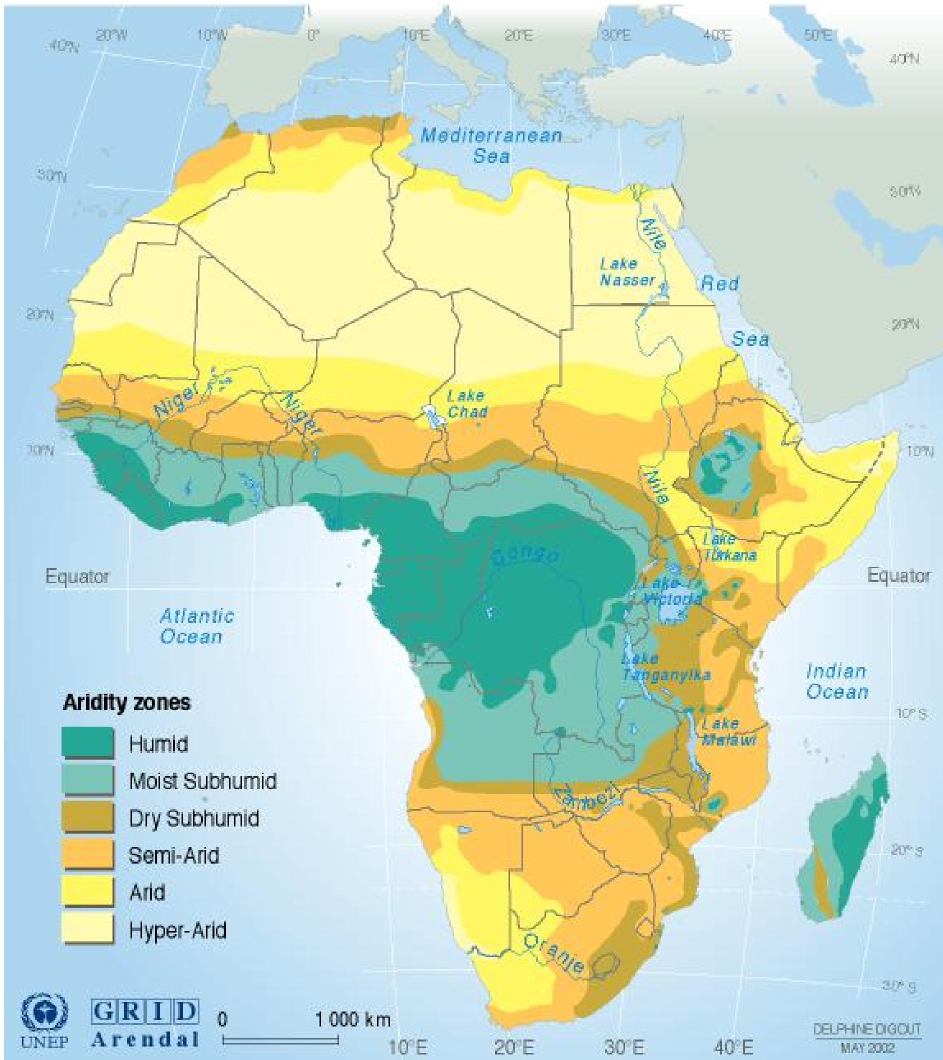
4- **Sub-humid zone** (arid index 0.50-0.75):

5- **Humid zone (**arid index >0.75)

When the rainy season lasts more than ten months per year, it creates a **humid climate**, in which more water falls than can evaporate.

In arid climates annual precipitation ranges 0–200 mm and in semi-arid climates it ranges 200–500 mm. In the first, most rainfall (70% or more) is used as evaporation and evapotranspiration, less than 30% becomes runoff, and groundwater recharge is generally negligible. In semiarid climates the rainfall converted into runoff is about the same, groundwater recharge increases to near 20% and real evaporation and evapotranspiration then average around 50% (UNESCO 2006).

Aridity Zones



Source: World Meteorological Organization (WMO), United Nations Environment Programme (UNEP), *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Grand Ethiopian Renaissance Dam

Historical Background

The U.S Bureau of Reclamation carried out a substantial hydrological work on the Blue Nile Basin from 1956 to 1964, the time of constructing the Egyptian High Dam (1960-1970). It proposed 26 water projects in the Blue Nile basin. Four of them are located on the main river and other 22 are located on the tributaries. The **Renaissance Dam** is one of the four major projects.

The Blue Nile is an international river, flowing from Ethiopia to Sudan and Egypt. The average annual flow at the Sudan border is 50 billion m^3 per annum.

Location:

The Grand Ethiopian Renaissance Dam (GERD) is being built on the Blue Nile River in North western Ethiopia, a few Kilometers from the Ethio– Sudan common border (5 – 15 km) at elevation 550 m above sea level. The site is approximately 445 km North West of Addis Ababa.

The Blue Nile valley slopes from the river gorge in the Ethiopian highlands (>2000 m above seal level) to the lowland desert in Sudan. It is heavily laden with silt and brown in color. This silt results from heavy erosion in the Ethiopian highlands.

Names	**Storage capacity (BCM)**
1. Border Dam (1964 – Feb. 26, 2011) **:** 84.5 m high	11.1
2. Project X, Feb. 26, 2011. **:** 90 m high	14-17
3. Grand Ethiopian Millennium Dam (April 2, 2011) **:** 145 m high	62
4. Grand Ethiopian Renaissance Dam (GERD) (April 15, 2011) sometimes referred to as Hidase Dam.	67, 74

Structure of the Dam:

The dam is to be 145 m high and 1780 m long. The reservoir will have the capacity to hold up to 74 billion km^3 of water, which occupies more than 2000 km^2. A curved saddle dam, supporting the dam and reservoir, will be a 5 km long and 50 m tall.

The size of the reservoir is about half of the size of Lake Aswan Dam, which holds 162 billion km^3 at its peak.

Electricity

The powerhouses are to be located one on the Right bank and one on the Left bank of the river and will accommodate ten and five Francis Turbine Units respectively, each with an installed generating capacity of 350 MW. That is: 15x350MW=5250MW total installed capacity.

A concrete lined Gated Spillway and a 5 km long, 50 m high Saddle Dam, both located on the Left Bank.

Upgrade: On March 27, 2012, the government announced a revision of the design. Thus, the total installed capacity of the dam will accommodate 16 turbines 375 MW installed capacity. Ten turbines will be on the left bank, while another six turbines on the right bank.

16 turbines X 375 MW=6000 MW will be the total installed capacity of the dam.

They increased in 2017 to be 6450 MW.

Project life span:

The dam is scheduled to start delivering electricity in September 2014, when 2 turbine units (thus, 700 MW) become operational. It is postponed to Sep. 2015. The project completion is scheduled for September 2017. It is expected to last at least 2 more years.

Cost estimate and financing:

The total cost is estimated at 78 billion birr (3.350 Bln Euros or 4.8 Bln USD) and is to be covered by government budget. It will exceed 8 Bln USD.

Purpose/Use:

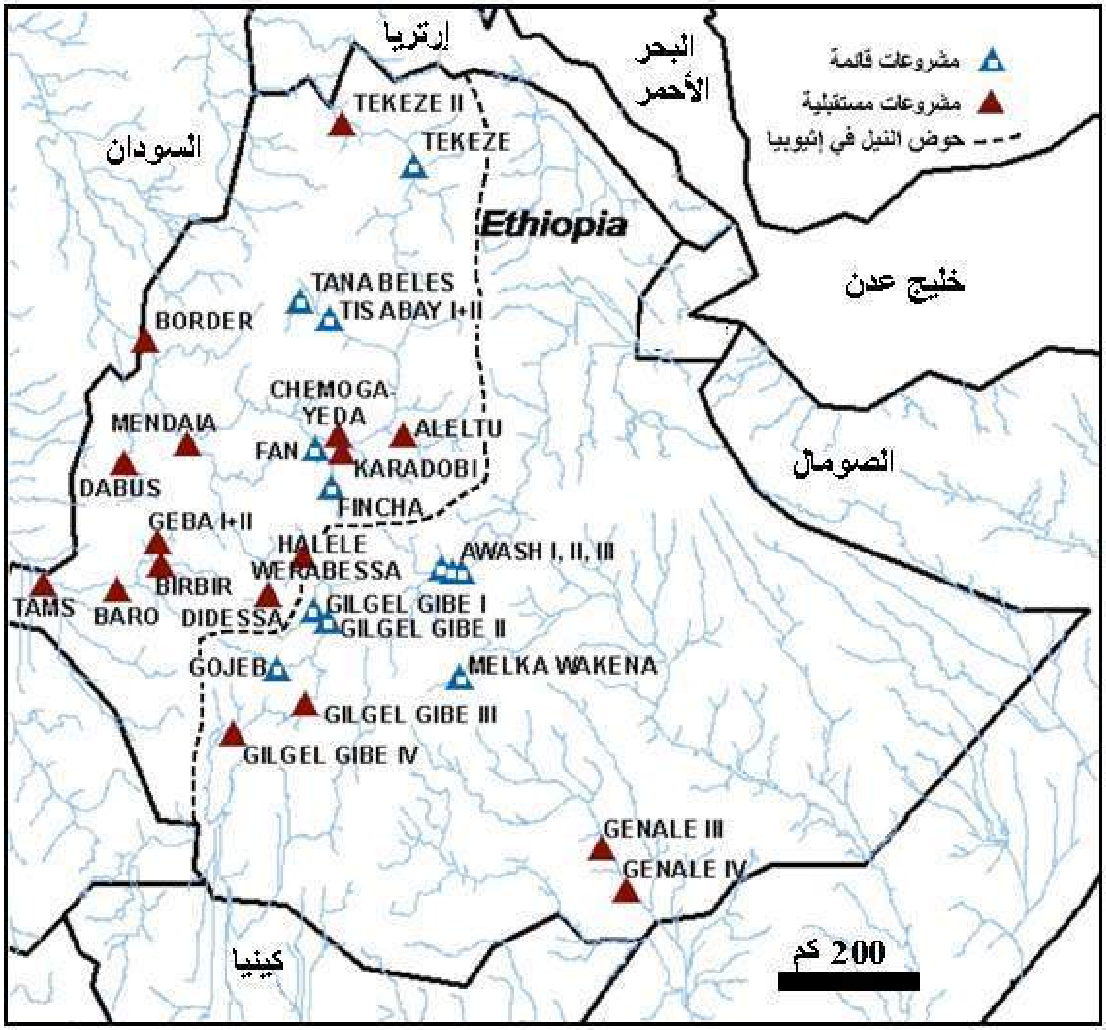
The dam will ‘mostly’ be used for generating hydroelectric power.

Advantages
Grand Renaissance Dam

1. **Clean renewable energy production 5,250-6,000 MW.**
2. **Irrigation (250,000 Acres) in the dry season.**
3. **Navigation.**
4. **Sediment manage. and life span for Sudan-Egypt’s dams.**
5. **Minimizing the evaporation.**
6. **Flood control.**
7. **Reducing water load at the High Dam Lake.**
8. **Water flow all year in Sudan.**

Disadvantages of the Grand Renaissance Dam

1. High cost US $4.5 billions (> US $ 8 billions.
2. Loss of agricultural (250,000 Acres), grazing and forest lands.
3. People displacement (30,000 capita).
4. Loss of the dead storage (5-25 km^3) ➔12 km^3 and 1-2 km^3 /yr.
5. Low power generation in the High Dam.
6. Partial control of Ethiopia to water flowing to Sudan & Egypt.
7. Flooding of some mining areas (Au, Fe, Cu, Pt, building stones, ...
8. Short life span (30 years at 400 Mm^3/yr sediments from 50 km^3.
9. Decreasing soil fertile in Sudan.
10. Increasing of earthquakes in the storage area.
11. Political conflicts with downstream countries.
12. increase the transmission of malaria.
13. Failure risk (Tsunami-like flooding).



Water projects in Ethiopia.

World Energy Issues

Energy is involved in all life cycles, and it is essential in agriculture as much as in all other productive activities. An elementary food chain already shows the need for energy: crops need energy from solar radiation to grow, harvesting needs energy from the human body in work, and cooking needs energy from biomass in a fire. The food, in its turn, provides the human body with energy.

The world's energy resources can be divided into **fossil fuel**, **nuclear fuel and renewable resources**. Secure, reliable, affordable, clean and equitable energy supply is fundamental to global economic growth and human development and presents huge challenges for us all. Energy demand will continue to increase.

Energy Resources

I. Renewable Energy:

Renewable resources are available each year, unlike non-renewable resources, which are eventually depleted. A simple comparison is a coal mine and a forest. While the forest could be depleted, if it is managed it represents a continuous supply of energy, vs. the coal mine, which once has been exhausted is gone.
Most of earth's available energy resources are renewable resources. Renewable resources account for more than 93 percent of total U.S. energy reserves.

Biomass. We distinguish between: woody biomass (stems, branches, shrubs, hedges, twigs), non-woody biomass (stalks, leaves, grass, etc.), and crop residues (bagasse, husks, stalks, shells, cobs, etc.). The energy is converted through combustion (burning), gasification (transformation into gas) or anaerobic digestion (biogas production). Combustion and gasification ideally require dry biomass, whereas anaerobic digestion can very well take wet biomass. Fuel preparations can include chopping, mixing, drying, carbonising (i.e. charcoal making) and briqueting (i.e. densification of residues of crops and other biomass).

Dung from animals, and human excreta. The energy is converted through direct combustion or through anaerobic digestion.

Animate energy. This is the energy which can be delivered by human beings and animals by doing work.

Solar radiation, i.e. energy from the sun. We distinguish between direct beam radiation and diffuse (reflected) radiation. Direct radiation is only collected when the collector faces the sun. Diffuse radiation is less intense, but comes from all directions, and is also present on a cloudy day. Solar energy can be converted through thermal solar devices (generating heat) or through photovoltaic cells (generating electricity). Direct beam solar devices (whether thermal or photovoltaic) would need a tracking mechanism to have the device continuously facing the sun.

Hydro resources, i.e. energy from water reservoirs and streams. We distinguish between: lakes with storage dams, natural heads (waterfalls), weirs, and run-of-river systems. Hydro energy can be converted by waterwheels or hydro turbines.

Wind energy, i.e. energy from wind. Wind machines can be designed either for electricity generating or for water lifting (for irrigation and drinking water).

Geothermal energy, that is, the energy contained in the form of heat in the earth. A distinction is made between tectonic plates (in volcanic areas) and geopressed reservoirs (could be anywhere). Geothermal energy is, strictly speaking, non-renewable, but the amount of heat in the earth is so large that for practical reasons geothermal energy is generally ranked with the renewable energy. Geothermal energy can only be tapped at places where high earth temperatures come close to the earth's surface.

II. Non-renewable Energy:

Fossil fuels, like coal, oil and natural gas. Unlike the previous energy sources, the fossil energy sources are non-renewable.

Nuclear power is currently non-renewable as it depends on mined uranium. In the future we may be able to use readily available hydrogen as a fuel, making it renewable.

Energy in Africa

Africa is well endowed with renewable and non-renewable energy resources that far exceed its energy demand requirements for the next century. But paradoxically, most African countries are characterized by energy poverty and poor energy access, a reflection of their low income and general state of economic under development. In Africa, energy use per capita is very low, compared to other regions of the world.

Energy resources in Africa

Africa is the world's second largest and second most populous continent, its landmass of 30.3 million km², an area equivalent to the United States of America, Europe, Australia, Brazil and Japan combined. Africa is the house of 1136 million people (PRB, 2014) in 54 countries of various sizes, socio-cultural entities, and resource endowments, including fossil and renewable energy resources. Most of these energy resources are yet to be exploited, and that is a reason why the continent is the lowest consumer of energy.

It has been estimated that Africa's energy resource endowments with respect to the world totals are in the following order of magnitude:

Oil 9.5%, Coal 5.6%, Natural Gas 8.0%.

Africa's uranium deposits, estimated at over 600 kilo tons, are among the largest in the world. South Africa, Namibia and Niger Republic are currently ranked among the 10 leading global producers of uranium, which is the main fuel for nuclear energy production.

Africa also hosts in its Western, Central and Eastern regions some of the largest river courses of our world. These are the Nile, Congo, Niger, Volta and Zambezi river systems. This makes Africa's hydroelectric potentials most attractive, especially as a renewable energy source. The hydroelectric potentials of the Democratic Republic of Congo (DRC) alone, is estimated to be sufficient for over 300 percent of current Africa energy consumption. Indeed, some parts of Europe are already thinking of subscribing to cheap hydroelectric power imports from the DRC.

Africa also has tremendous solar energy potentials, because of the proximity of a greater bulk of its land mass to the equator. At this privileged center of the earth's location, Africa has most of its land mass exposed to nothing less than 325 days of strong sunlight.

In spite of all this impressive primary resource content, Africa is embarrassingly behind in electrical energy production and consumption.

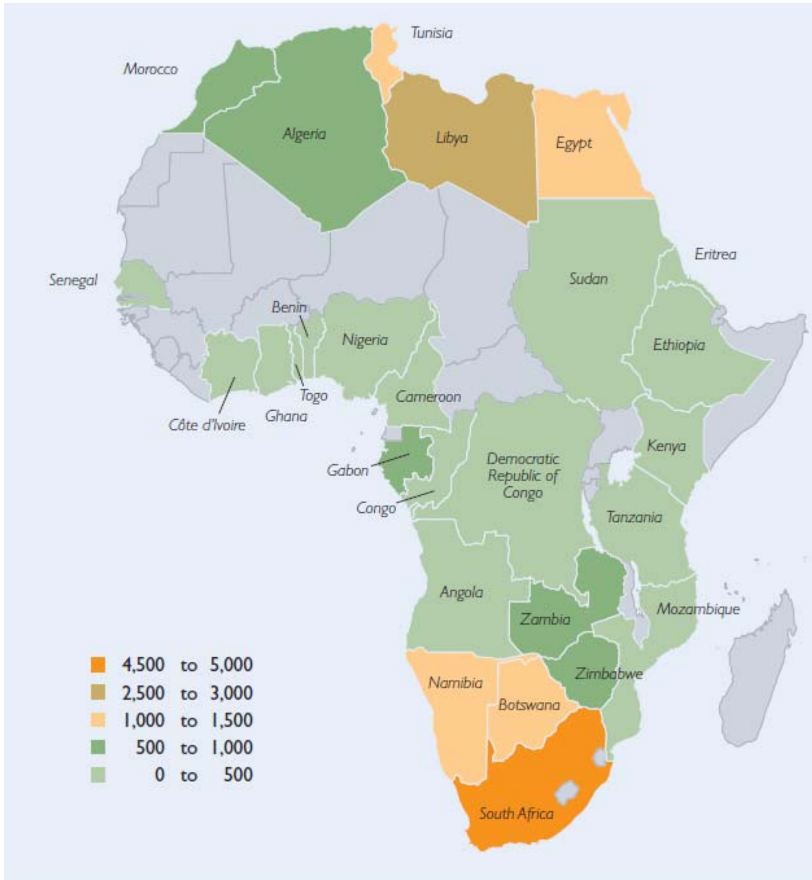
The sustainable development of these energy assets will ensure that national resources are managed to meet the needs of the present and succeeding generations. However, large foreign investments are required to develop these resources.

The most striking feature of the African energy situation is over-consumption of low-grade traditional energy sources (fuel wood, charcoal and non-woody biomass), on the one hand, and under-consumption of high-quality modern fuels (coal, Liquefied Petroleum Gas (LPG), natural gas, NRSE) on the other.

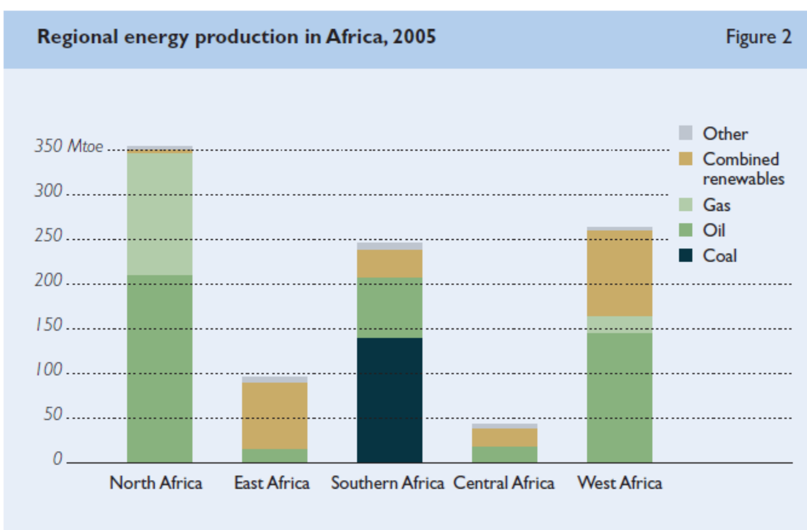
Africa accounts for 3% of world energy consumption – the lowest per capita modern energy consumption in the world (50% of world average).On the other hand, Africa has the highest share of biomass in total energy consumption in the world (59% of total energy consumed).

Africa is a diverse continent. There is considerable variation in energy consumption among the different regions and countries. For example, the share of biomass energy in total energy exceeds 81 percent in Africa compared to only 4.1 percent in North Africa and 16.5 percent in Southern Africa.

Figure 1 illustrates that Southern Africa and North Africa have high levels of modern energy consumption, while SSA countries continue to rely heavily on biomass and traditional energy. This heavy reliance on traditional energy sources means a low level of energy efficiency; heavy deforestation and biodiversity loss; greater health hazards due to indoor air pollution; and reduced capacity to mitigate climate changes.



Electricity consumption / population (kWh per capita)
(Source: OECD / IEA 2006)**.**



Source: IEA (2007b)

Desertification

What is desertification?

Desertification is recognized as ***"a process of land degradation in arid, semi-arid, and dry sub-humid areas that is the result of several factors, including human activities and climate variation"***. (UNCCD, 1999).

Desertification *is a process in which some of the productive lands change into desert or non productive lands.*
It is most likely to occur in areas where rainfall is scarce.

Desertification is a worldwide phenomenon estimated to affect 40 million km^2 or approximately one-third of the Earth's surface area and >1 billion people in over 110 countries.

Desertification is especially important problem in Africa. Two-thirds of the continent is desert or dry lands, and 74% of its agricultural dry lands are already seriously or moderately degraded.

Root causes of desertification have been identified as population growth and climate change which contribute to the nature and extent of environmental stress. Environmental stress represents both environmental degradation and scarcity of natural renewable resource

What are the major causes of desertification?

There are many factors that trigger desertification, including the unpredictable effects of drought, fragile soils and geological erosion, livestock pressures, nutrient mining, growing populations, … etc.

I. CLIMATIC VARIATIONS:

High and sustained temperatures lasting for months with infrequent and irregular rainfall, leads to drought with the effect that vegetation has difficulty growing. This natural phenomenon occurs when rainfall is less than the average recorded levels. As a result, severe hydrological imbalances jeopardize production systems.

II. HUMAN ACTIVITIES:

Over-exploitation of natural resources represents the most immediate causes for desertification.

1. **Overcultivation** exhausts the soil. Farmers are clearing average land, and using it which takes away the richness in the soil. Unsustainable agricultural practices especially under the intensive and frequent cultivation, which resulted in salinity, water-logging, depletion of soil fertility and excessive use of pesticides, fertilizers as well the inappropriate time and machines of tillage which led to problems of physical and chemical desertification, e.g. compaction, pollution … etc.
2. **Overgrazing** removes the vegetation cover that protects it from erosion. It was not as large of a problem long ago because animals would move in response to rainfall. People would move with the animals so it prevented overgrazing in such areas. Now, humans have a steady food supply so they do not have to move about. Therefore, people use fences to keep their animals in one place which causes overgrazing.
3. **Deforestation** destroys the trees that bind the soil to the land. Destruction of plants in dry regions is causing desertification to occur. People are cutting down tress to use them as a source of fuel. Once all these trees are cut down there is nothing to protect the soil. Therefore, it turns to dust and is blown away by the wind

4. **Poorly drained irrigation** systems turn croplands salty. Poor water management due to the inefficiency of traditional irrigation system, inadequate drainage networks and overabstracting of groundwater with consequent sea water intrusion in the coastal areas.
5. **Urbanization on a fertile cultivated lands** such as urban encroachment on the Nile Delta. The loss of prime agricultural lands to illegal urban encroachment is about 1 million acre.

The effects of desertification

1. Soil becomes less usable.

   The soil can be blown away by wind or washed away rain. Nutrients in the soil can be removed by wind or water. Salt can build up in the soil which makes it harder for plant growth.
2. Vegetation is lacked or damaged.

   Loosened soil may bury plants or leave their roots exposed. Also, when overgrazing occurs, plant species may be lost.
3. Famine

   Places that have war and poverty are most likely to have famine occur. Drought and poor land management contribute to famine.
4. Food loss

   The soil is not suited for growing food; therefore the amount of food being made will decline. If the population is growing, this will cause economic problems and starvation.
5. People near Affected Areas

   Desertification can cause flooding, poor water quality, dust storms, and pollution. All of these effects can hurt people living near an affected region.

Desertification in Egypt

Egypt as located in the arid and hyper arid zones, it severely affected by various types and forms of desertification, the major consequences of desertification in Egypt include:

• 16% of the total cultivated lands were lost due to urbanization.

• More than 30% of the irrigation farmlands are salt affected.

• Pollution as a result of excessive use of fertilizers and pesticides, the use of industrial and agricultural drainage water in irrigation and the lack of adequate sanitation in the rural areas, has led to serious impacts on public health and environmental risk.

• Some 45% of the total range lands areas (4 million ha) are severely degraded.

• Sand dunes cover about 16% of the total country area.

About 5% of such dunes are active and seriously affected the cultivated lands in the vicinities of Nile Valley and delta and High Dam Lake.