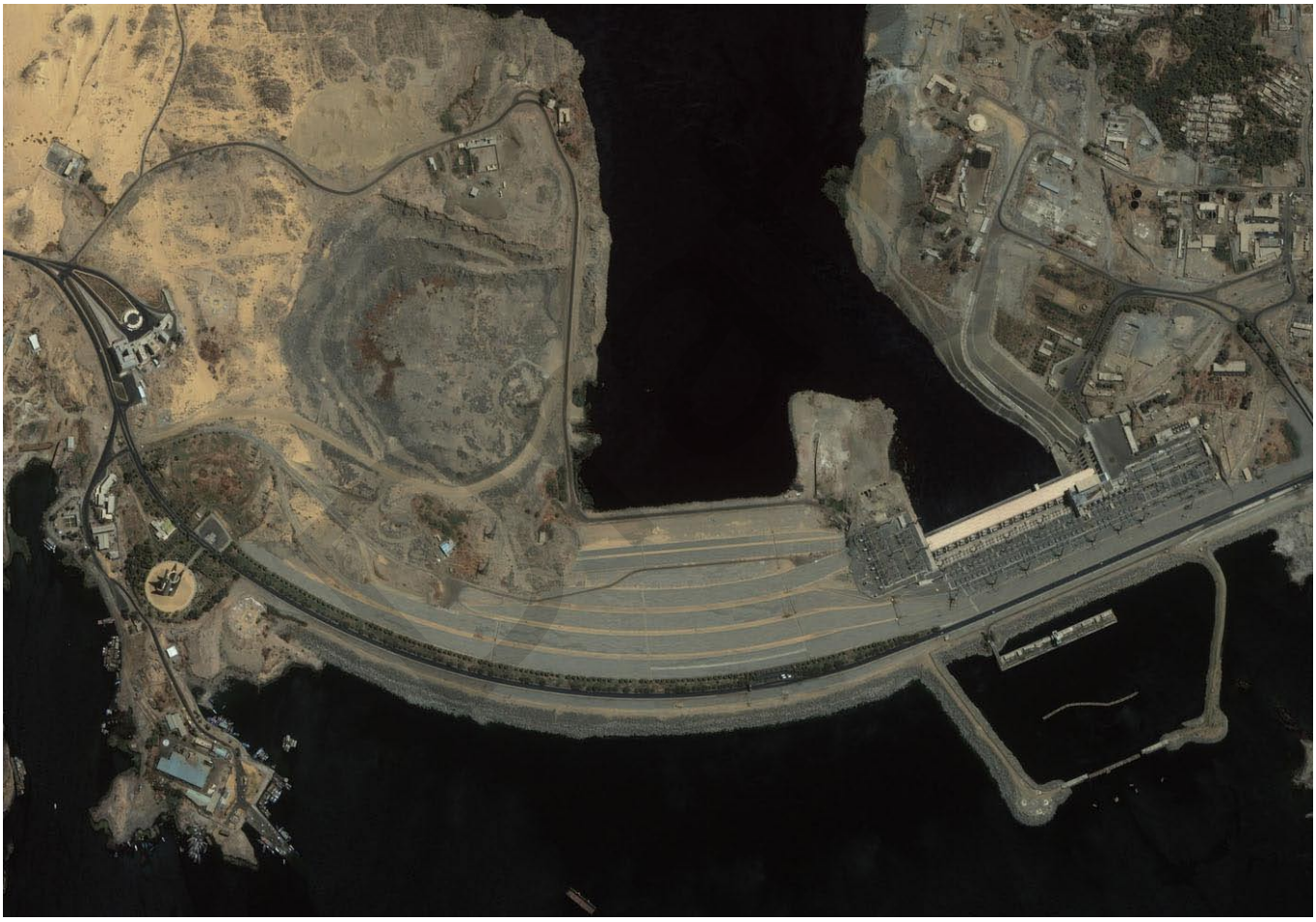
Water Atlas of
THE MAIN NILE SUB-BASIN



Joint multipurpose development Project

Eastern Nile Technical Regional Office (ENTRO) , 2007

Table of Content

Introduction

The Eastern Nile Technical Regional Office (ENTRO) is an organization meant to realize ENSAP (Eastern Nile Subsidiary Action Program) in the Eastern Nile Basin countries, namely Egypt, Ethiopia and Sudan. ENSAP seeks to realize the NBI Shared vision for the Easten Nile region aimed at reducing poverty, foster economic growth and the reversal of environmental degradation.

Currently, under ENSAP, planning is underway for the multipurpose development of the region. To support its multipurpose development objectives, ENTRO proposes to synthesize information at sub basin level categorized in three themes namely, Water Resources, Environment and Socioeconomy. To implement this objective the base line data compilation at national level has been conducted for the three Eastern Nile countries and compiled a report for each theme at national level. The present assignment is aimed at bringing the national level compiled data in to a sub basin level synthesized data, considering no boundary of the Eastern Nile countries.

The objective of this consultancy work is thus to synthesize essential information on water and related resources at sub basin level. The national level compilations are to be synthesized at sub basin level so that information's on these three themes could be presented at sub basin level, which can be used for proper planning of both resources and further investigation activities on resources in the Eastern Nile Sub-basins under the Easten Nile Multipurpose Development Program.

This work includes the preparation of the main report and sub basin level atlas preparations that could be annexed to the main report. This atlas specifically prepared for the Baro-Akobo-Sobat-White Nile sub basin is part of the four annexes that supports the main report This atlas is a summarized version of the main report with a more declarative fashion supported by few explanations and more base maps with the objective of providing basic features of each sub basin for decision makers and senior program/project coordinators.

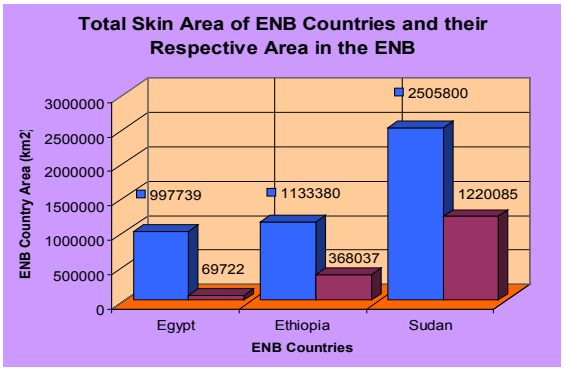
Quick Over View of the eastern Nile Basin

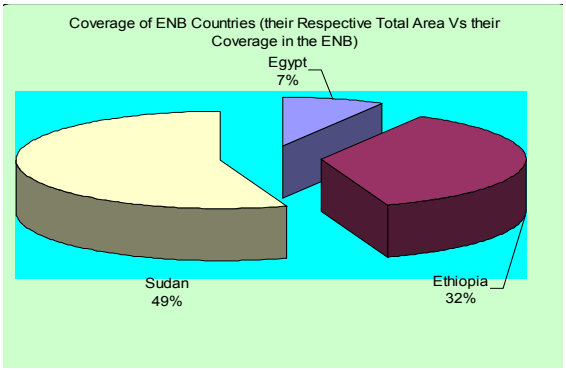
The Eastern Nile Basin is constituted of three riparian countries namely Egypt, Ethiopia and Sudan. A very few portion of Eritrea is also included in the Nile system.

Egypt, with an estimated total area coverage of 997,739km^2 is located in the upper north portion of the Nile occupying the entire lower course of the Eastern Nile Basin including its mouth at the Mediterranean Sea. It is bounded on the north by the Mediterranean Sea; on the east by the Gaza strip, Israel and Red Sea; on the south by Sudan and on the west by Libya. The country has a maximum length of 1,105 km stretching from north to south, with a maximum width at its south border, stretching east-west for some 1130 km. Less than 10% of its area is identified to be cultivable, the bulk of its skin coverage (more than 90%) being desert where life could hardly survive. With a total area of 69722 km^2 the Nile watershed in Egypt accounts only 7% of the country and 4% of the Eastern Nile Basin.

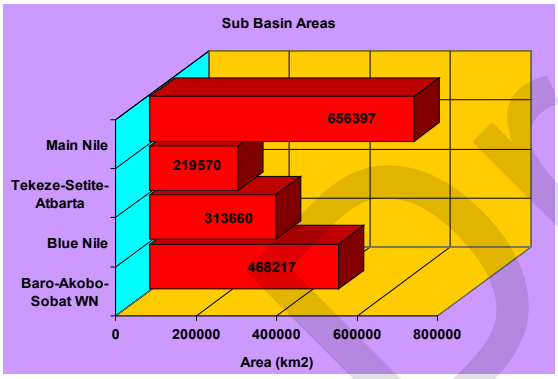
Ethiopia,is located in the horn of Africa, bounded on the northeast by Eritrea and Djibouti, on the east & south east by Somalia, on the south west by Kenya and on the west and northwest by Sudan. With total skin coverage of 1,133,380 km^2.The highland plateau of the country (above 1800masl) is identified to be the heart of the country covering some 60% of its skin area. The Great Rift Valley splits the Ethiopian highland plateaus diagonally in northeastern and southeastern directions. The northeastern half largely drained by the Nile system. The plateaus are characterized with deep valleys and canyons cut by numerous rivers and streams drained by 12 major river basins, Abbay (the Blue Nile) being one of them taking the lion share both in terms of skin area coverage (18% of the country) and water resources potential (more than 50%). Ethiopia is the source of the Tekeze, Blue Nile and Baro-Akobo sub basins, which are believed to be the major contributor of the Nile water. Including the upper courses of Tekeze, Abbay and Baro-Akobo sub basins; the Nile watershed in Ethiopia accounts about 32% of the skin area of the country and 22% of the Eastern Nile Basin.

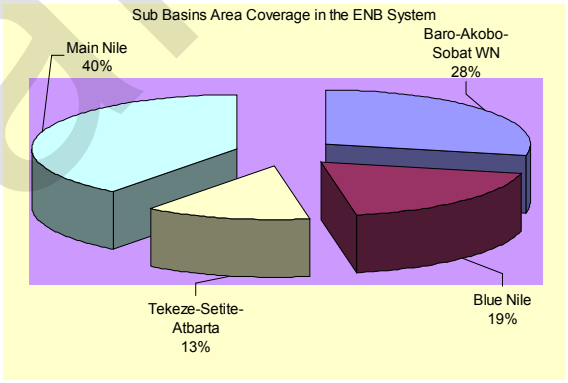
Sudan, located in the northeastern Africa and the largest land state (2,505,800km2) in the continent, is bounded on the north by Egypt, on the east by the Red Sea, Eritrea, and Ethiopia; on the south by Kenya, Uganda, & Democratic Republic of the Congo, and on the west by the Central Africa Republic, Chad, and Libya. The maximum stretch in Sudan is from North to South with a diameter of 2250km, along with its east-west extreme stretch width of 1730km. About 50% of Sudan is included in the Nile watershed. 74% of the Eastern Nile Basin is located within Sudan,





The Eastern Nile Basin is constituted with four major contributing sub basins; the Baro-Akobo-Sobat-White Nile sub basin (with mean annual inflow of 26bm3, that contributes 30% of the inflow at Aswan) from its southern tip, the Blue Nile (at 51bm3 contributes 60% of the inflow at Aswan) located in its middle-east direction, the Tekeze-Setite-Atbara sub basin (contributing 12bm3 per year & accounts 12% of the Nile inflow at Aswan) in its northeastern portion and the Main Nile in its lower course downstream of the Khartoum junction, at its northern tip.

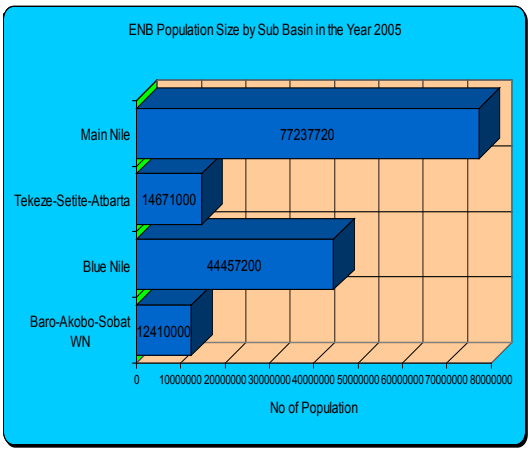


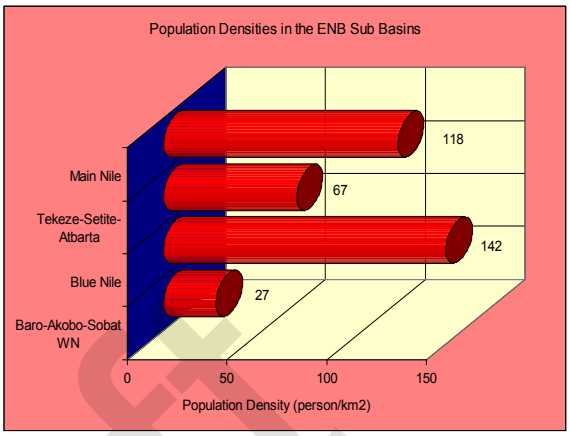


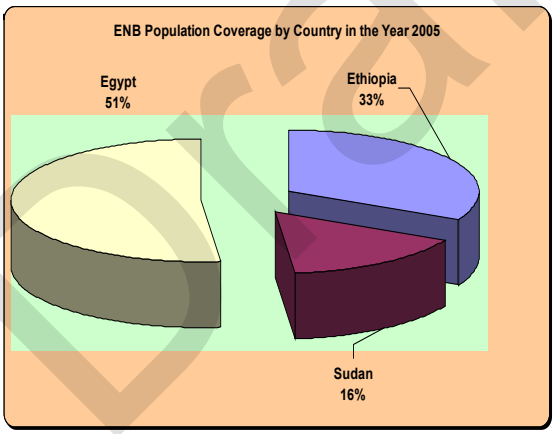
According to the OSI socioeconomic report the total population residing in the Eastern Nile Basin is estimated at 148,775,920 (projected to 2005). In the same report it is however, reported as 160million.

Egypt with a total population of 77million in the Eastern Nile Basin (1105 person/km^2 one of the worlds highest density) watershed accounts 52% of the population in the Eastern Nile Basin. Ethiopia, with its total Eastern Nile Basin population (population in the upper courses of the three Eastern Nile Basin sub basins) of 48,400,000 (135 persons/km2) , being the second largest populous state in the Eastern Nile Basin, accounts 33% of the ENB population. Sudan, with a total Eastern Nile Basin population of 23,375,920 (20person/km2) accounts 16% of the Eastern Nile Basin population and is the least populous country in the Eastern Nile Basin.

The Baro-Akobo-Sobat-White Nile sub basin (12,410,000) covers 8% of the Eastern Nile Basin population. The Blue Nile, the Tekeze-Setite-Atbara and the Main Nile sub basins with a total population of 44,457,200; 14671000; and 77,237,720 covers 30%, 10% and 52% of the ENB population respectively. Crude population densities (ppkm2) in the four sub basins: Baro-Akobo-Sobat and White Nile, Blue Nile, Tekeze-Setitite-Atbara and Main Nile, is estimated at 27, 142, 67 and 118 respectively.







Currently irrigated agriculture is practiced in the lower course of both the Blue Nile, White Nile and in the Delta, at the mouth of the Nile. In Sudan current irrigation development is estimated at 1.5million hectares (Water Watch, Aug, 2006) and in Egypt it is about 3.25million hectares (Egypt Water Component OSI Report, Jan 2006). In Ethiopia, current irrigated agriculture practice is virtually none existence.

1.1 Location of Main Nile Sub-Basin

The Main Nile sub-basin is one of the four major sub-basins in the Easten Portion of the Nile basin.It is located in the northernmost portion of the Eastern Nile Basin The Main Nile sub basin starts at Khartoum downstream of the white Nile-Blue Nile confluence and extends upto mediteranian sea. Geographically ,it extends from 30^0 30' 35" to the north downto 13^0 7' 20" on the south.Similarlity it goes from 26^0 46' 24" to the west upto 36^0 27' 42" to the east covering a toatl area of 789,660 km^2.

Location of the Main Nile Sub-Basin

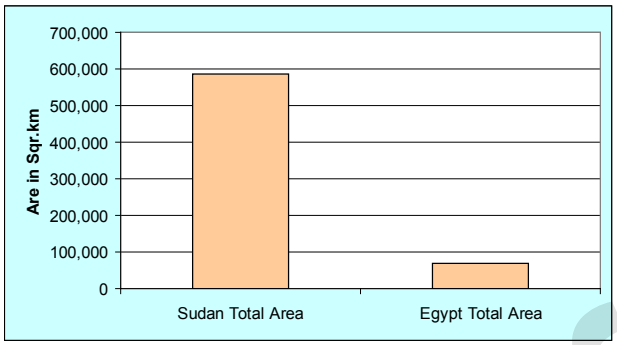
Data/Information Source :One System Inverntory Synthesis Report 2007

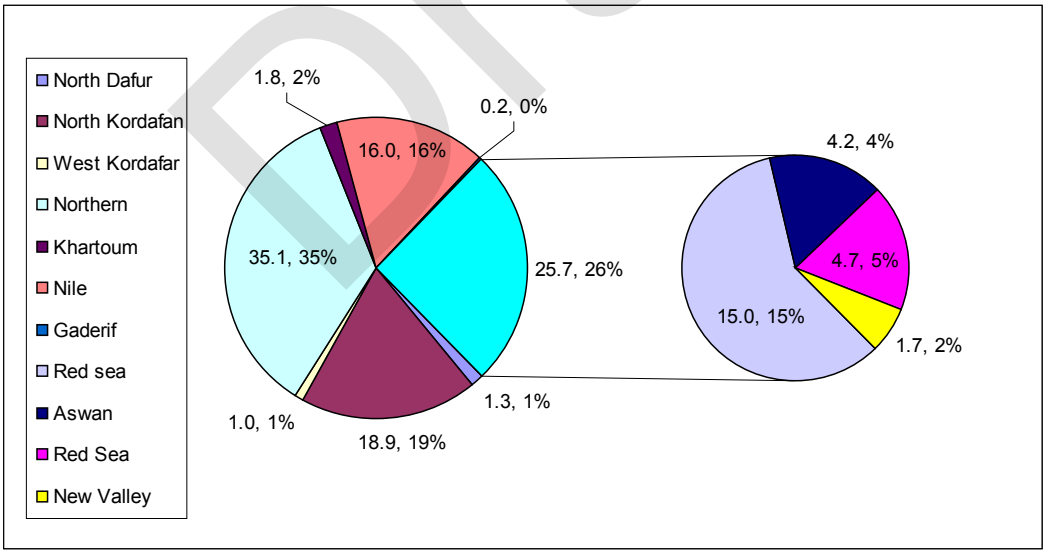
Map - 1.1 : Location Map of Main Nile Sub-Basin

1.2 Administrative Units

In this sub basin eight states from Sudan {North Darfur (8690km2), North Kordufan (123,958km2), West Kordufan (6409km2), Northern region (230,080km2), Khartoum(12129km2), Nile (105,195km2) Gadrife (1,468km2) and Red Sea (98747km2)}with a sub total drainage area of 584,876km2 and three governorates from Egypt {Aswan (27,608km2), Red Sea (30,856km2), and New Valley (11,258km2)} with a total drainage area of 654,600 are included.

Region	Area(km2)	Coverage (%)
	Sudan	
North Dafur	8,689	1.32%
North Kordafan	123,958	18.88%
West Kordafar	6,409	0.98%
Northern	230,080	35.05%
Khartoum	12,129	1.85%
Nile	105,195	16.03%
Gaderif	1,468	0.22%
Red sea	98,747	15.04%
Sudan sub total	**586,675**	89.38%
	Egypt	
Aswan	27,608	4.21%
Red Sea	30,856	4.70%
New Valley	11,258	1.72%
Egypt sub total	**69,722**	10.62%
Sub Basin total	**656,397**	**100.0**

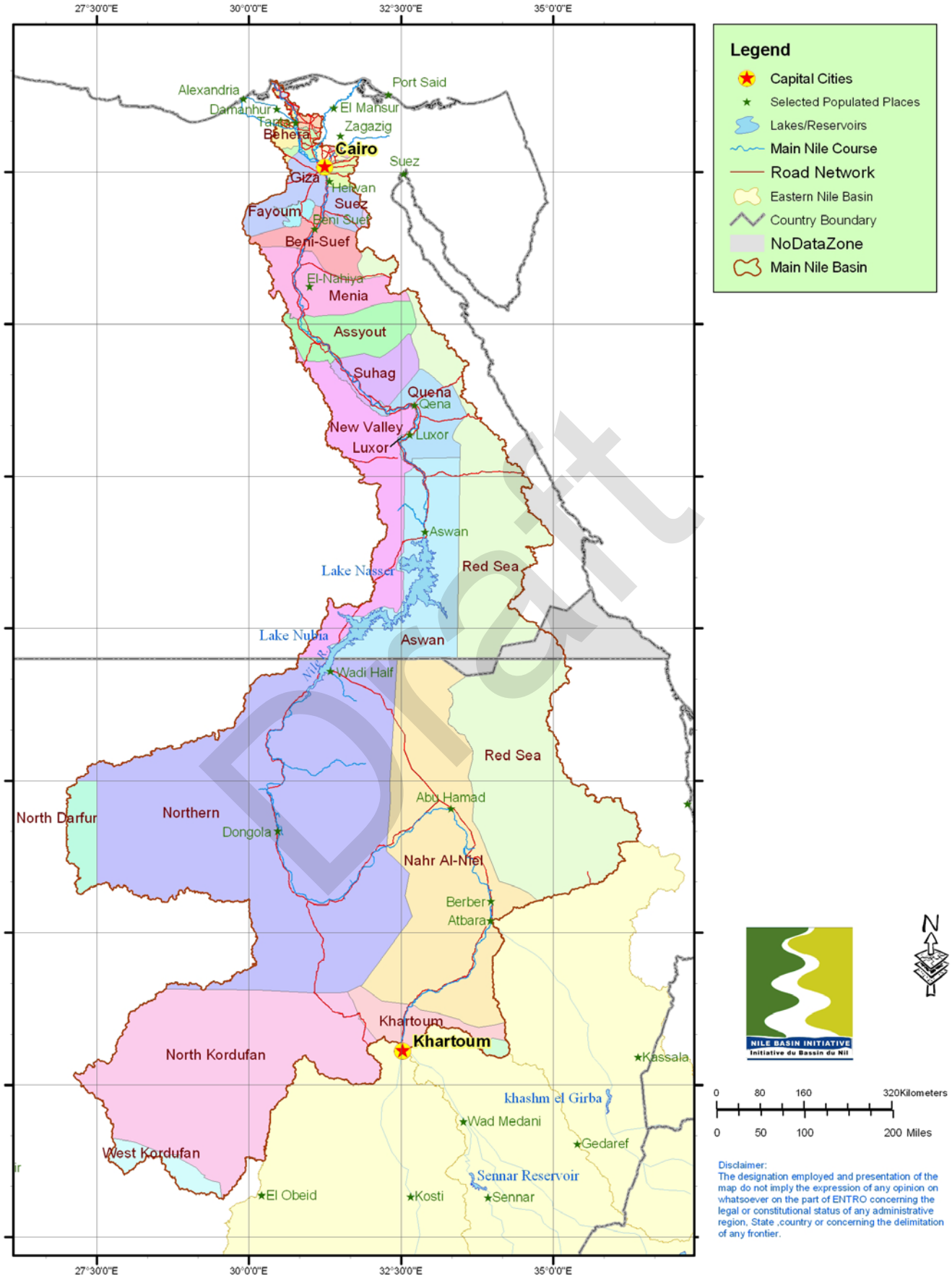




State/Governerate distributior in the Main Nile Sub-Basin

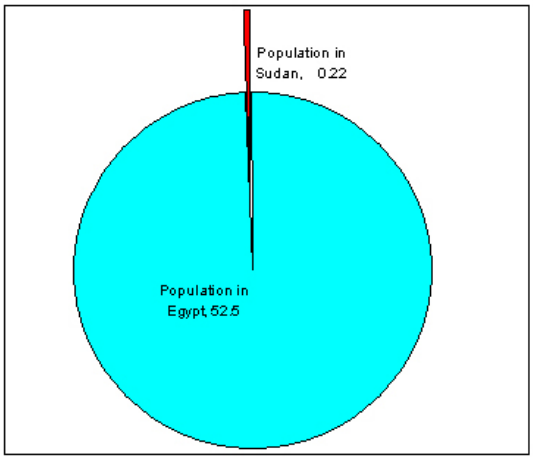
Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 1.2 : Administrative Divisions in the Main Nile Sub-basin



1.3 Demography

The main Nile with a total population of 77,237720, accounting 48% of the total population of the four sub basins, is the most populous sub basin in the ENB system.



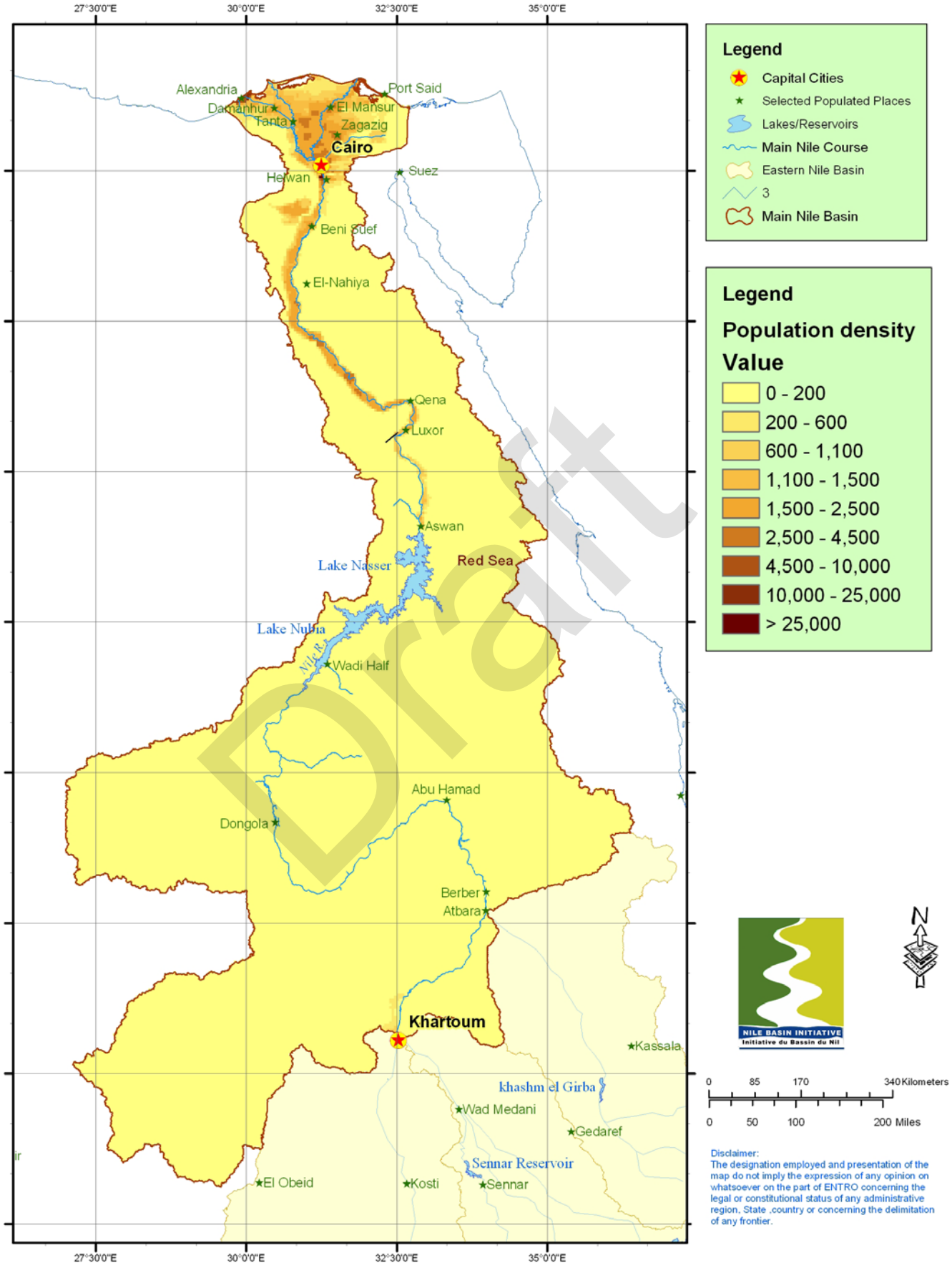
The Main Nile sub basin starts at Khartoum d/s of the white Nile-Blue Nile confluence. The Sudanese land from Khartoum to the Egyptian border is named as the Northern region. In the year 2004, the population in this region is estimated at 226,210, and projected to 237720 for the year 2005.

The population in the Egypt Main Nile was estimated at 52.5 million in 1990. Annual population growth rate at the time was 2.6 percent, which dropped to 2.4 percent by 2005. Projections indicated that Egypt's population would total 79 million in 2006, with the expectation that it would continue to grow to a figure of 127 million by the middle of the twenty-first century. By the year 2005 the projection indicates that the Egypt main Nile population is 77million.

In the northern region of Sudan population density is sparse with an average value less than a person per km2. Egypt's overall population density in 1990 was only about fifty-four people per square kilometer. However, close to 99 percent of all Egyptians live along the banks of the Nile River in 3.5 percent of the country's total area. The average population density in the Nile Valley exceeds 1,500 per square kilometer, one of the world's highest densities. In this respect, the countries capital, Cairo, is unparallel. According to the 1996 census, 51.1 percent of Egypt's population was male and 48.9 percent female. More than 34 percent of the population was twelve years old or younger, and 68 percent was under age thirty. Fewer than 3 percent of Egyptians were sixty-five years or older. In 2005, average life expectancy at birth was estimated at 71 years, up from fifty-nine years for men and sixty years for women in 1989. The infant mortality rate was put at 33 deaths per 1,000 live births down from 94 deaths in the late 1980's.

Data/Information Source :One System Inverntory Synthesis Report 2007

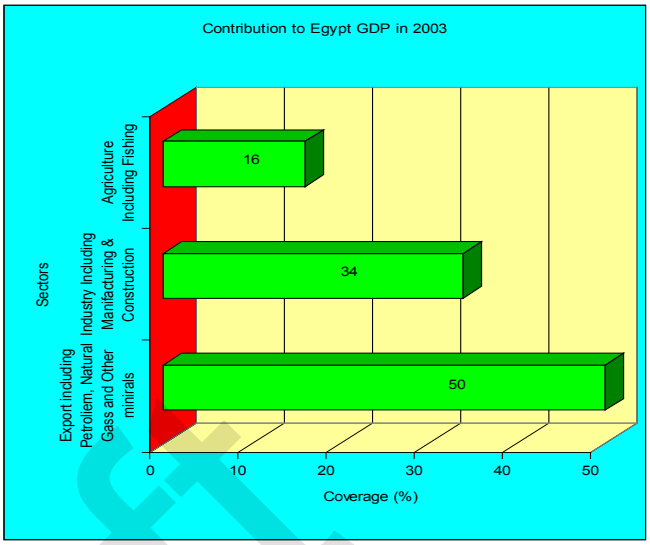
Map - 1.3 : Population density map within the Main Nile Sub-Basin



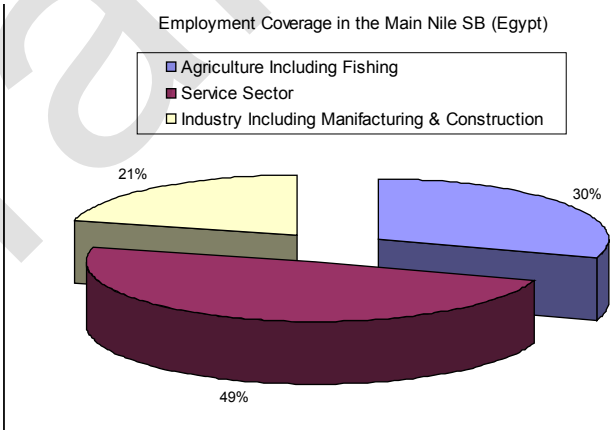
1.4 Economy of Main Nile Sub-Basin

A large proportion of the Main Nile sub-basin remains characteristically rural, which perhaps best explains the livelihood structures of the inhabitants in general. Agriculture, rain fed, notably, irrigated and shifting, and migratory pastoralism form the livelihood base of the population and the mainstay of the economy in the sub basin.

Sedentary agriculture, (rain-fed and irrigated), and shifting cultivation, and migratory pastoralism constitute the basic livelihood strategies in the Sudan portion of the sub basin, with variations in the size of groups engaged in the activities. In the same area, artisan gold mining also employs a small labor force albeit in small numbers



For most of Egypt's history, its economy was based almost entirely on farming, despite the fact that more than 95 percent of the country's land area is infertile desert. Long an exporter of cereals, in the 19th century, Egypt began to specialize in growing cotton, which is still an important cash crop. In the late 20th century other important sources of revenue included tourism, oil production, and remittances from the 3 million Egyptians working in the Persian Gulf states. Egypt's labor force of 26.7 million is 69 percent male and 31 percent female. The largest proportion of the labor force works in agriculture or fishing, which employ 30 percent of all workers. The services sector employs 49 percent, and industry (including manufacturing and construction) employs the remaining 21 percent. There are few skilled workers, since training is usually rudimentary and one-third of the adult population is illiterate.



Data/Information Source :One System Inverntory Synthesis Report 2007

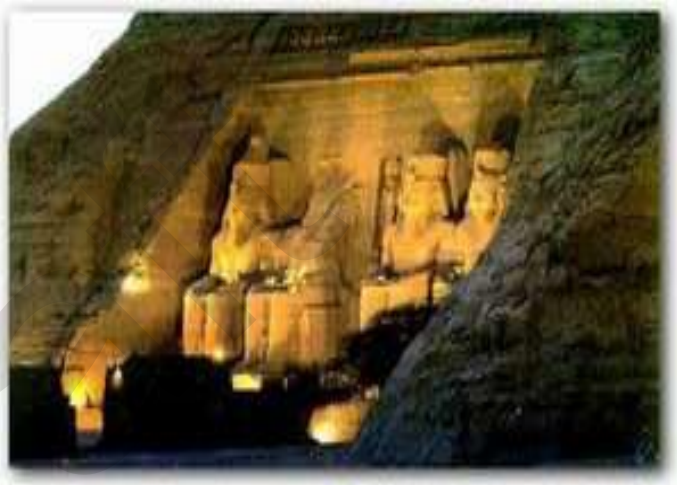
Map - 1.4 : Economy ScaleMap of Main Nile Sub-Basin

1.5 Historical and Cultural Places in Main Nile Sub-Basin

Egypt exhibits more than 30 well known historic places which have paramount importance in tourist attractions. Accordingly. Egypt is identified as one of the few well known states in the world with development of the smokeless industry, tourism.

Of the various tourist attraction places the great pyramids are widely spoken in the world.

Karnak, Temple of Amun-Ra



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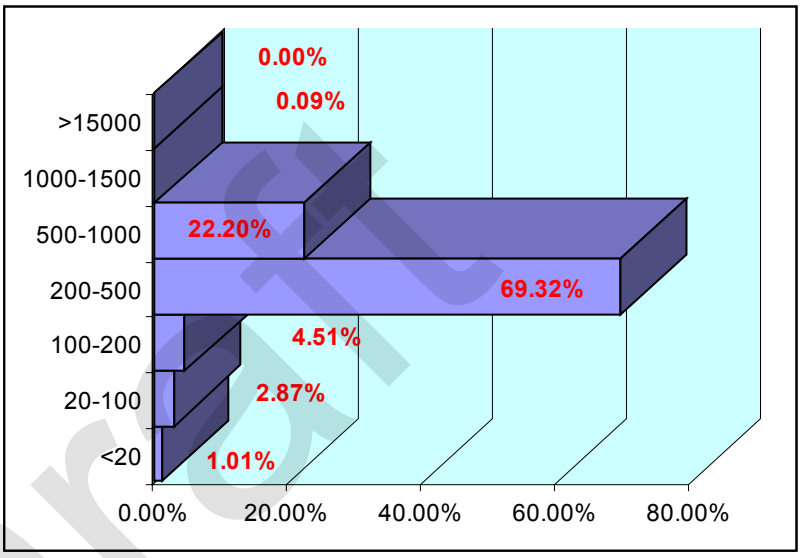
Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 1.5 : Map of Historical and Cultural Places in Main Nile Sub-Basin

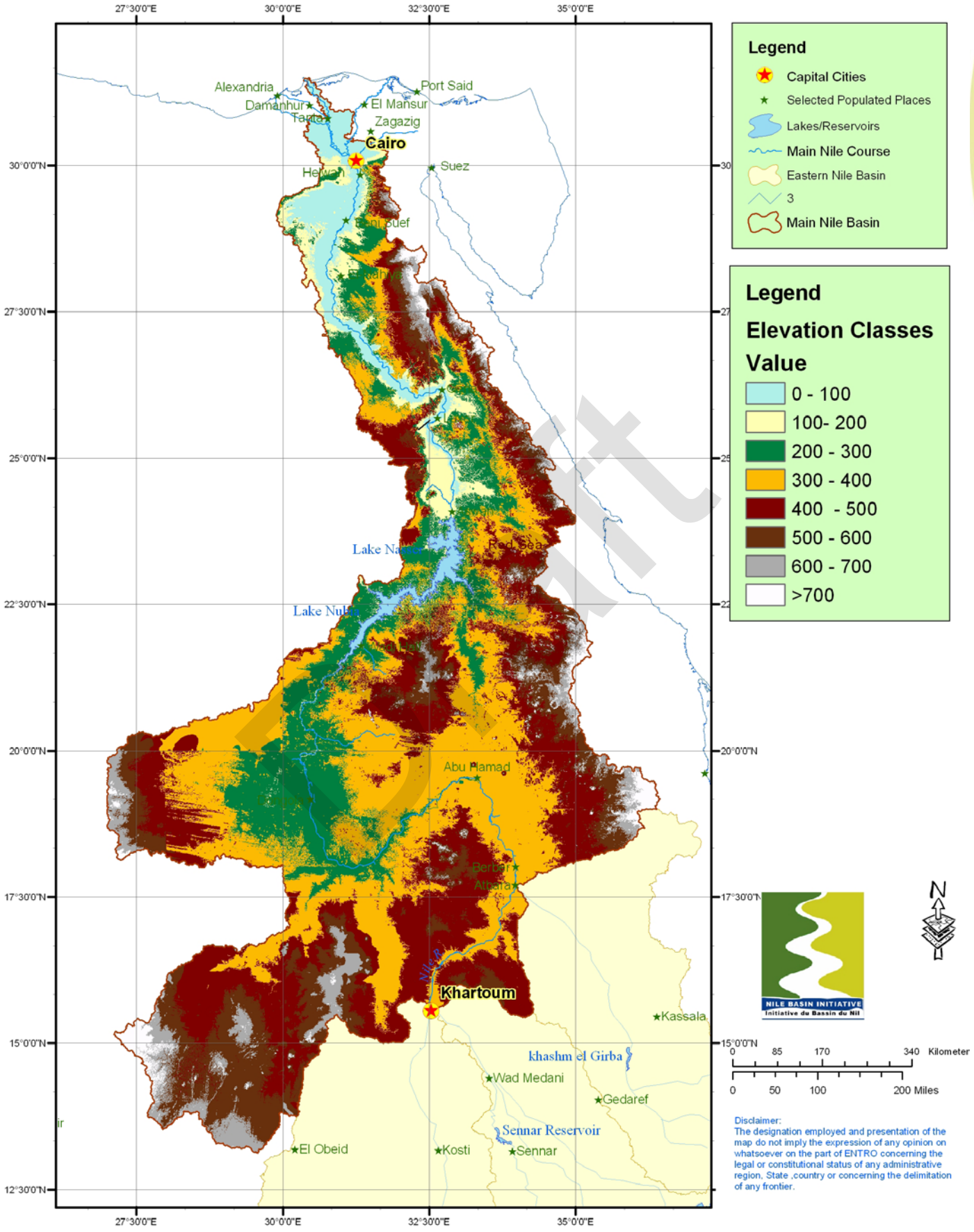
2.1 Topography in Main Nile Sub basin

The total sub basin area, as developed from satellite Digital Elevation Models of 90m resolution, is estimated at 789,140km2. Large proportion of the area (69%) is confined in an altitude that ranges from 200masl to 500masl and it occupies the central area of the sub basin extending from Khartoum to the Delta in Egypt, evenly distributed on both banks of the Nile. About 22% of the sub basin is identified having an altitude from 500masl to 1000masl. Nearly 1% of the sub basin has an altitude less than 20masl and this area is largely confined in the delta around the mouth of the sub basin. Some 3% of the sub basin has an altitude that ranges from 20masl to 100masl and the remaining 4.5% has an altitude between 100masl and 200masl. It is less than 0.1% of the sub basin identified to fall above an altitude of 1000masl.



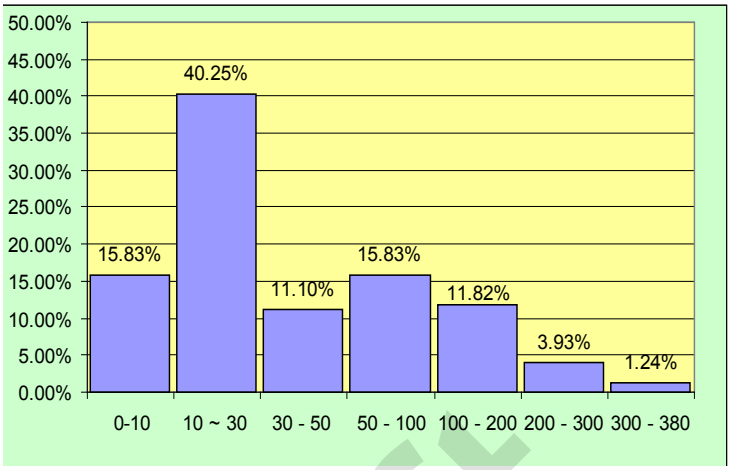
Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 2.1 : Elevation Model of the Main Nile basin



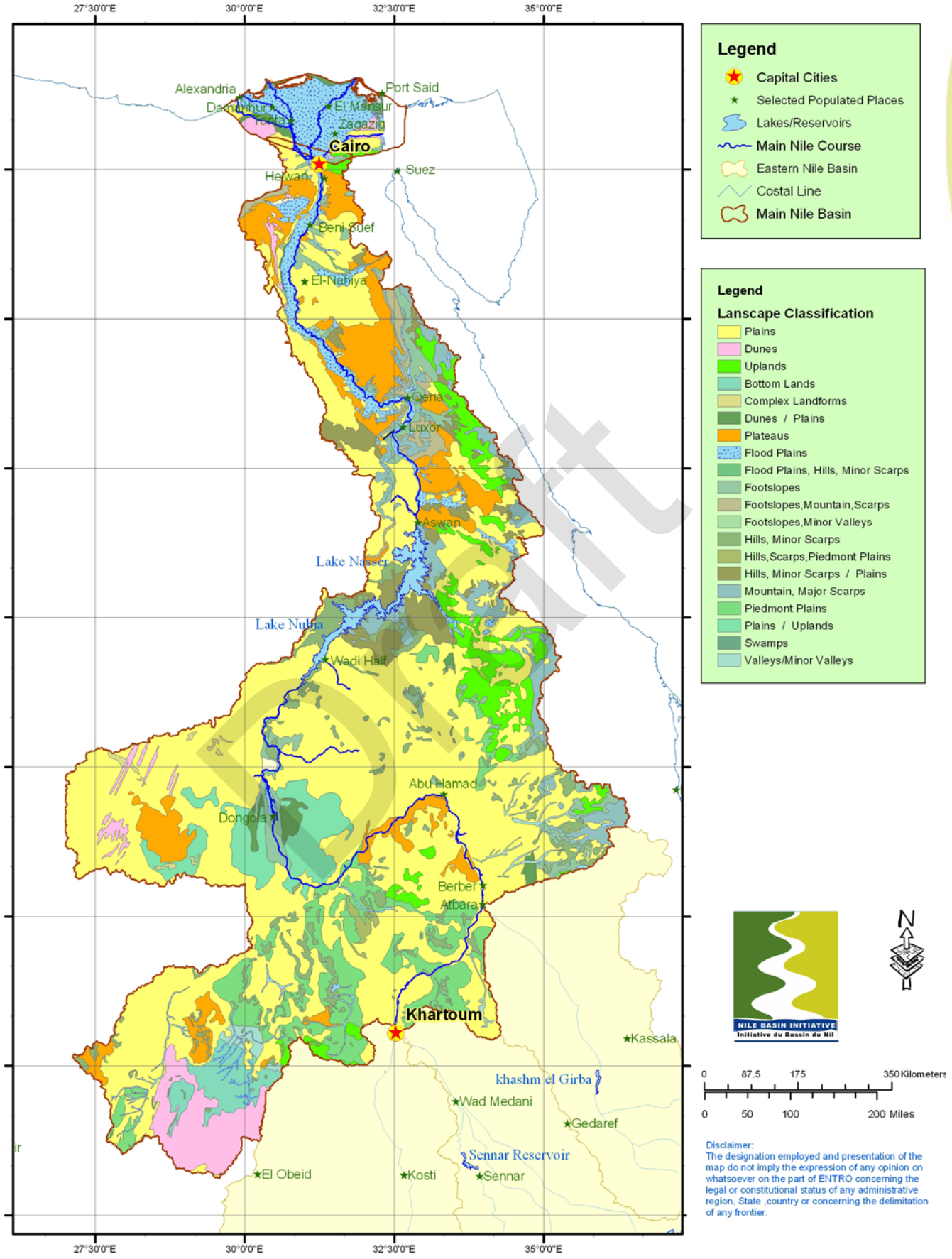
2.2 Landforms and Terrain of Main Nile Basin

The main Nile sub basin is characterized predominantly with mild land slope (96%) less than 5%. Land slope ranging from 5% to 10% covers nearly 3% of the sub basin and the remaining area that accounts less than 1% is identified to have land slope greater than 10%.



Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 2.2 : Terrain Map of Main Nile Basin

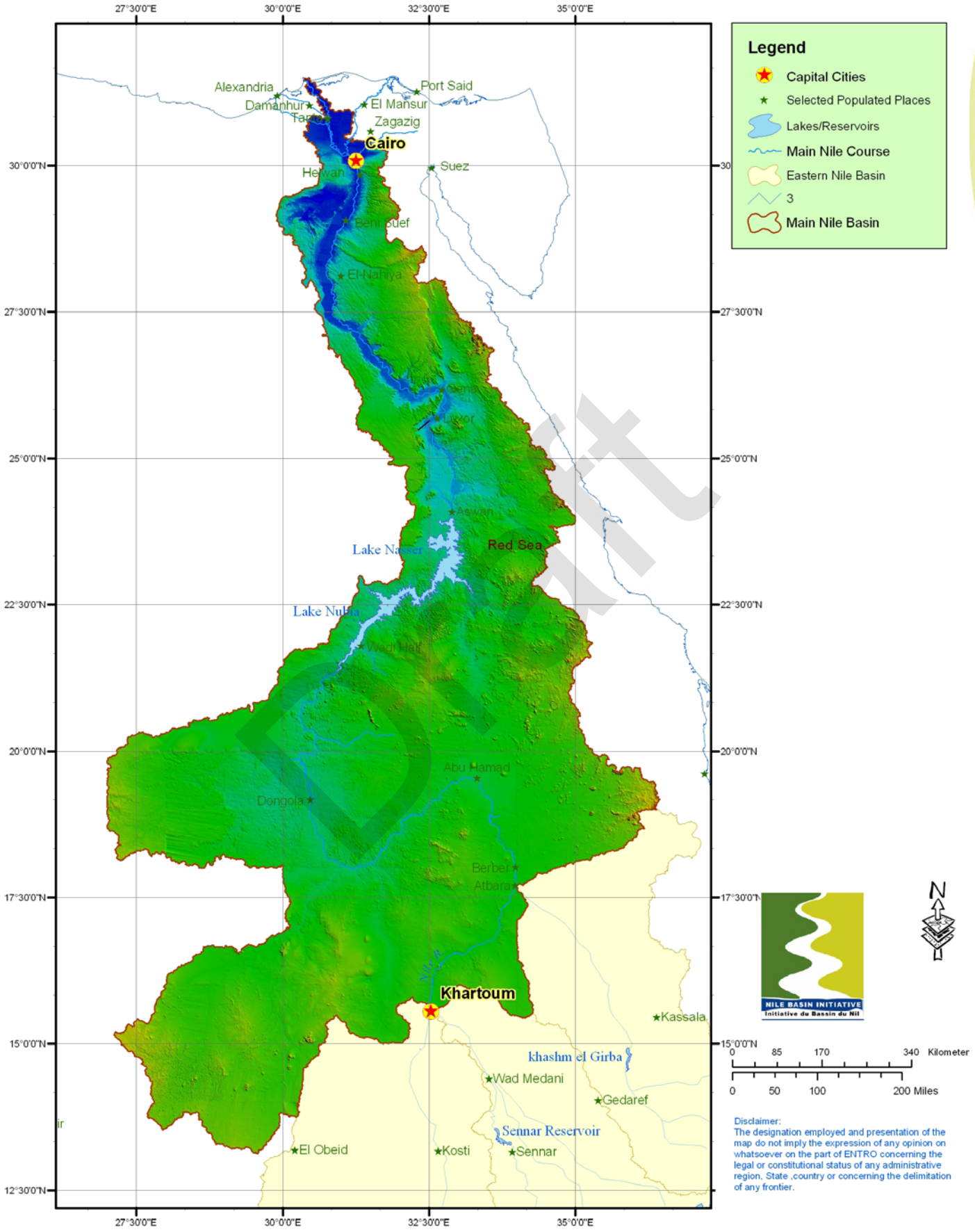


2.3 Relief of Main Nile Basin

The main Nile sub basin is characterized predominantly with mild land slope (96%) less than 5%. Land slope ranging from 5% to 10% covers nearly 3% of the sub basin and the remaining area that accounts less than 1% is identified to have land slope greater than 10%.

Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 2.3 : Relief Map of Main Nile Basin

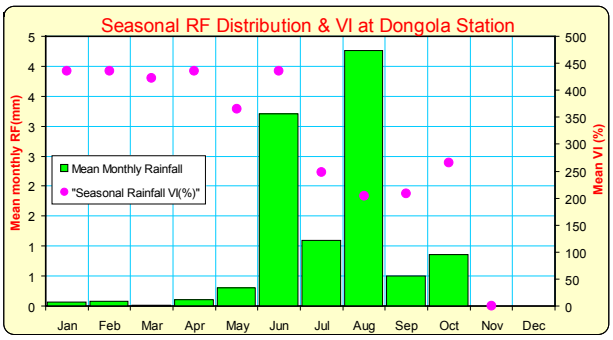


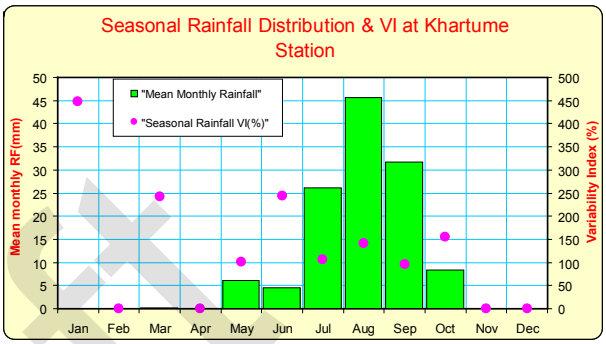
3.1 Climate-Rainfall in the Main Nile Sub-basin

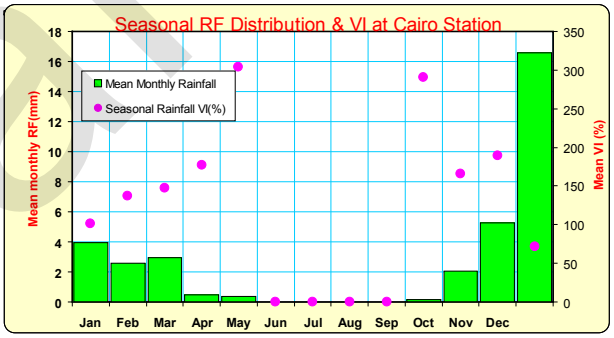
Owing to its altitude, this portion of the Nile in general and the Eastern Nile Basin, in particular, is virtually known for its arid climate where moisture is almost non-existence. The presence of Nile has enabled to support life along the narrow banks of the Nile d/s of Khartoum and HAD and in to the large Delta d/s of the Delta barrages. The Delta, where life including green area in the system is confined at large, accounts less than 5% of the skin area of Egypt.

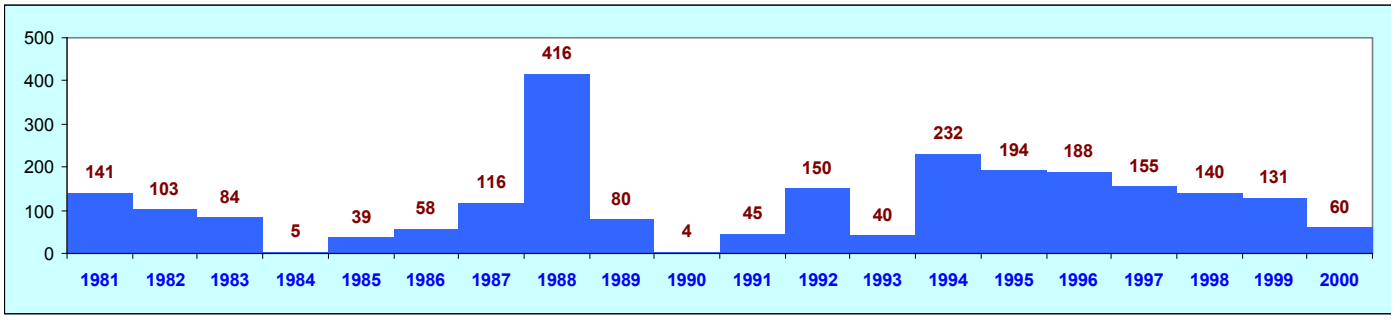
Mean annual rainfall at Khartoum is below 200mm, reduced to less than 20mm at Atbara, and almost less than 5mm at Dongola and the High Aswan Dam. At Cairo it is 25mm and increases to 200mm (Alexandria) in the coastal line of the Mediterranean Sea Average runoff over the entire area of the Delta in Egypt is estimated at 1bm3, that accounts only 3% of the runoff reaching the Delta through the Nile system (Water OSI Report of Egypt, May 2006).

As per to the isohyet map produced for the sub basin indicate that more than 65% of the sub basin has mean annual rainfall of less than 50mm and only 17% of the sub basin has mean annual rainfall of above 100mm.





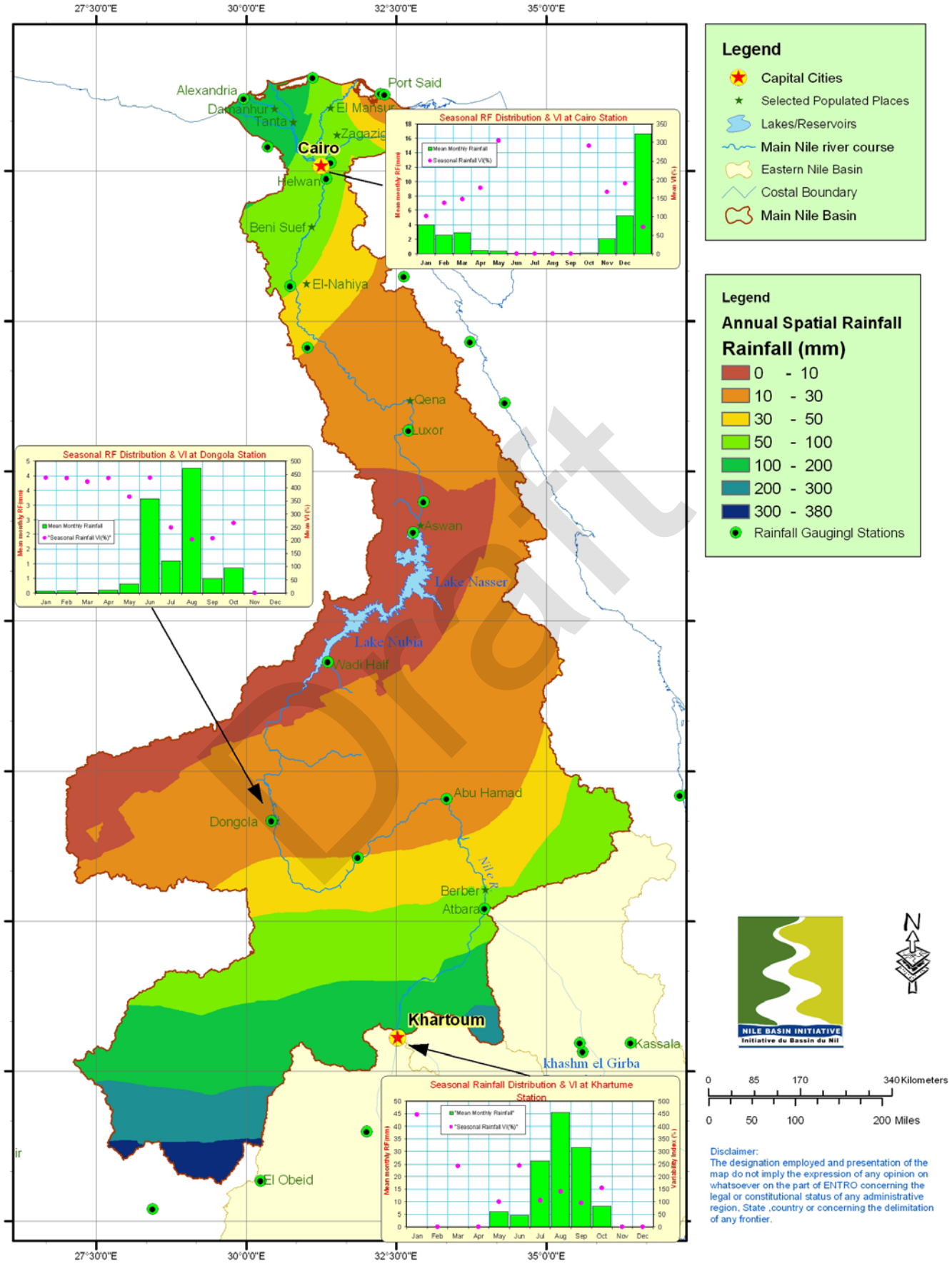




Khartoum Station Annual Rainfall in mm

Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 3.1 : Rainfall Map of Main Nile Basin

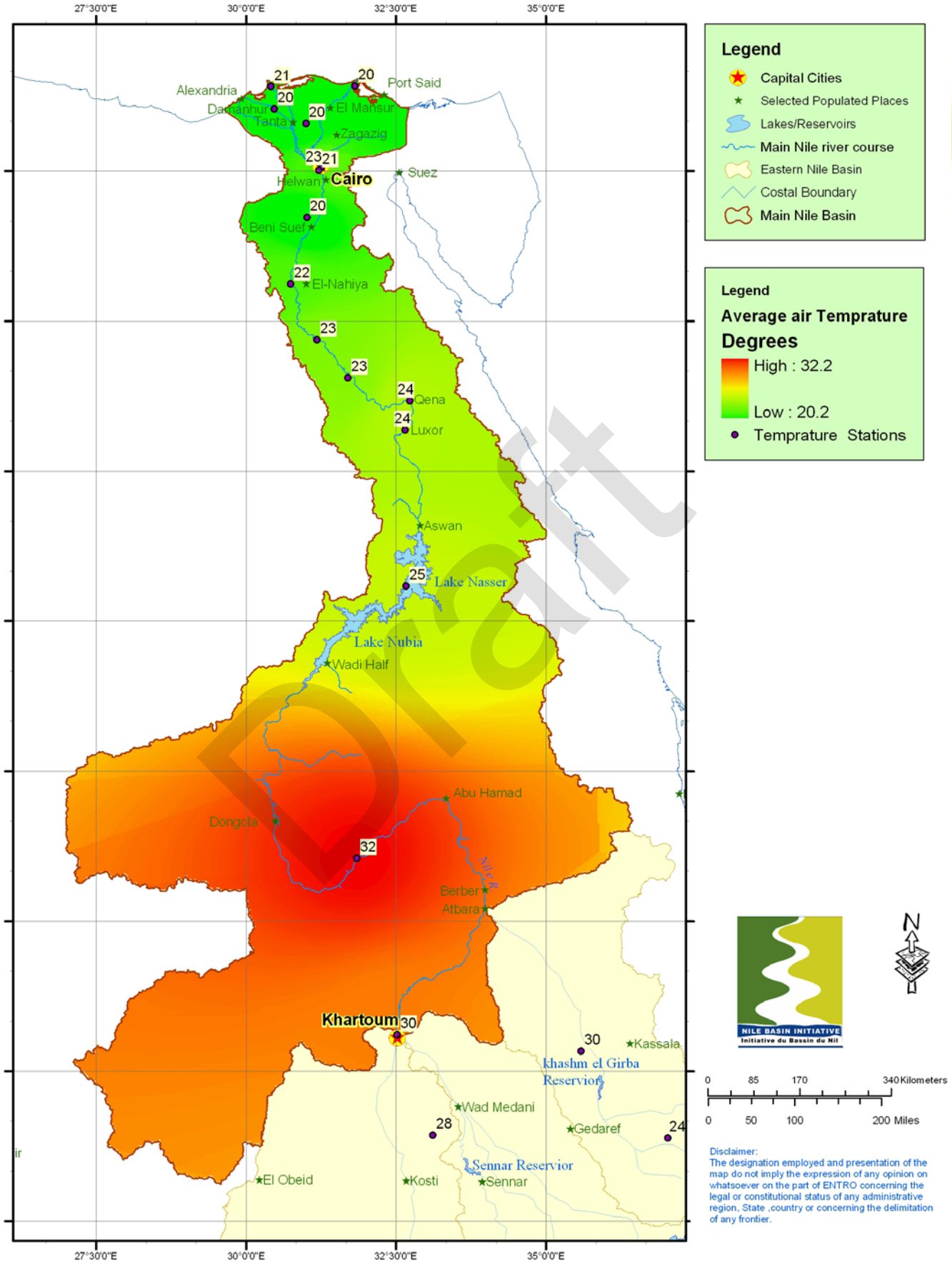


3.2 Climate-Temprature in the Main Nile Sub-basin

Temperature in this sub basin is experienced to be the hottest, owing to the prevalence of desert climate; with mean annual daily temperature varying from above 30°C (around Dongola and HAD) to 18°C in the coastal areas (Alexandria) .

Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 3.2 : Temprature Map of Main Nile Basin

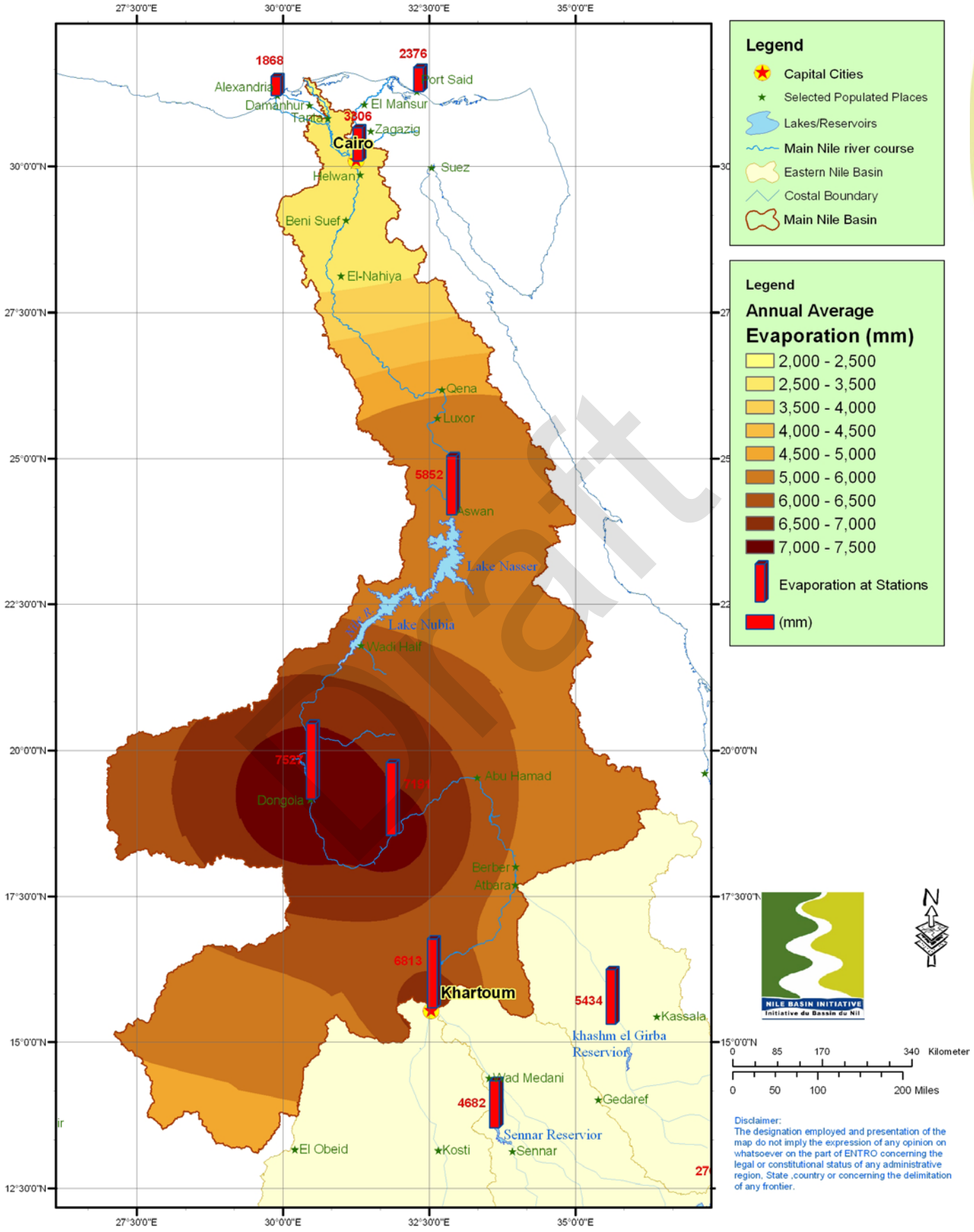


3.3 Evaporation within the Main Nile Sub-basin

Evaporation is observed to be considerably high. Lake evaporation at HAD is estimated at 2.6m/year (Egypt OSI report Water Component, May, 2006). The Potential evapotranspiration in the sub basin is estimated at 6.8m (Khartoum station), 7.8m (Dongola station), 5.8m (HAD station) and 1.8m (Alexandria) in the coastal line of the Mediterranean Sea. .(Include Iso-Evapo Line Map.

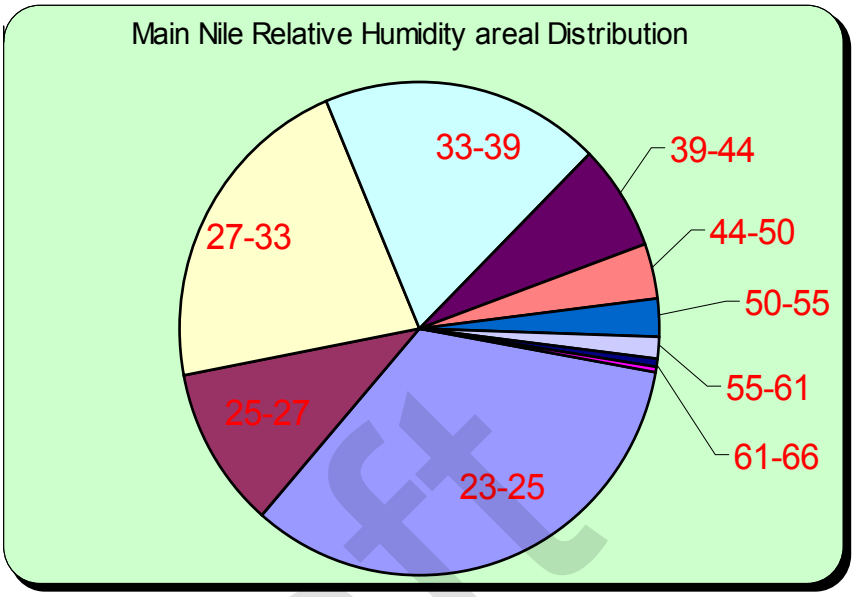
Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 3.3 : Evaporation Map of Main Nile Sub-basin



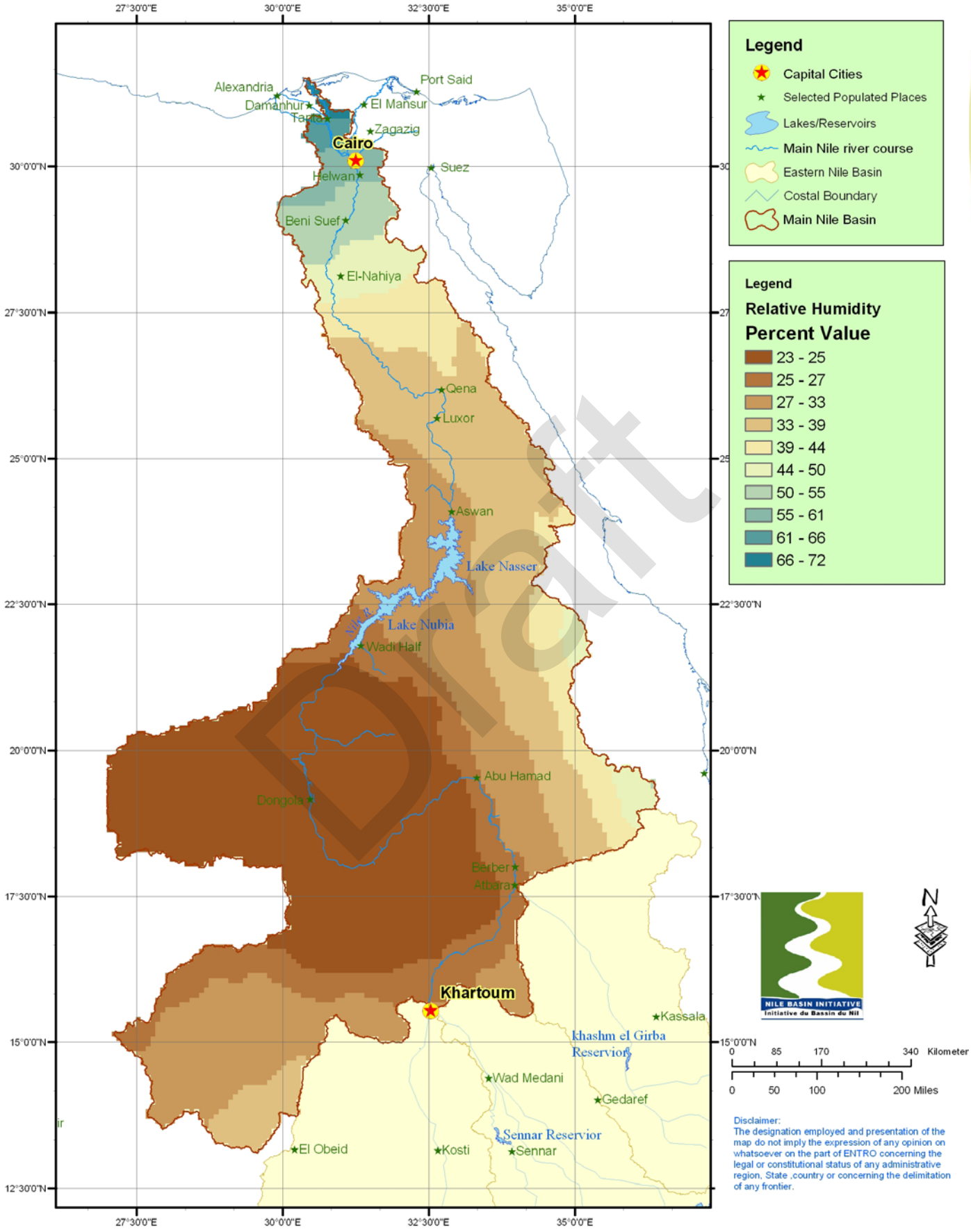
3.4 Climate-Humidity in the Main Nile Sub-basin

Nearly 85% of the sub basin is identified to be dry with mean annual relative humidity of less than 40%. It is only 5% of the sub basin with mean annual relative humidity of above 50%.



Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 3.4 : Reletive Humidity Map of Main Nile Sub-Basin



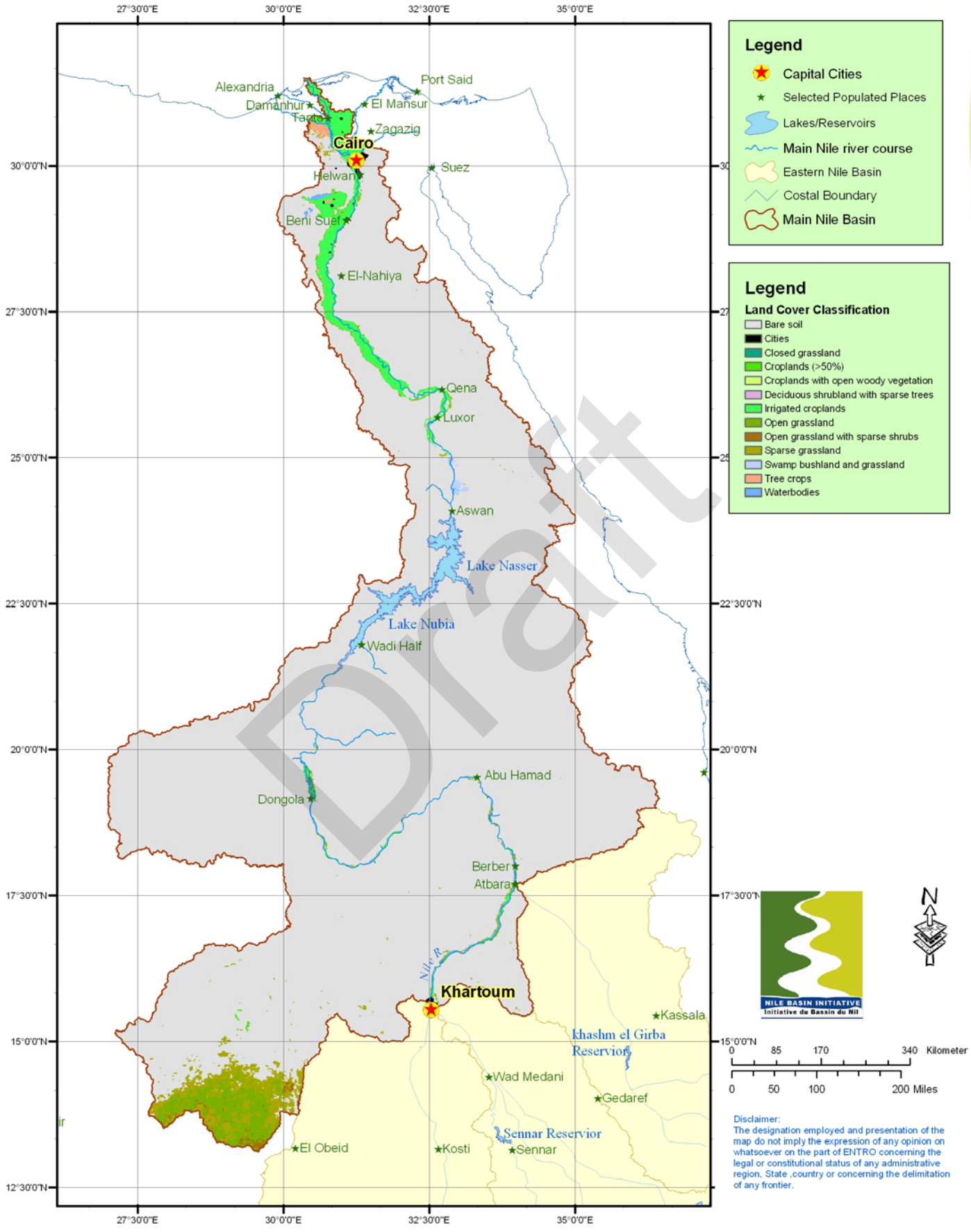
4. Land

4.1 Land use and Land Cover of the Main Nile Sub-basin

Nearly on 95% of the sub basin, a general desert or semi-desert conditions with little or no vegetation except along the wadis with high water table prevails as it falls below the 100mm isohyets. Semi desert scrub exists in those areas of the sub basin that falls above the 100mm isohyets and accounts only 5% of the sub basin.

Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 4.1 : LandCover Map of the Main Nile Sub-Basin



4.2 Soil of the Main Nile Sub-basin

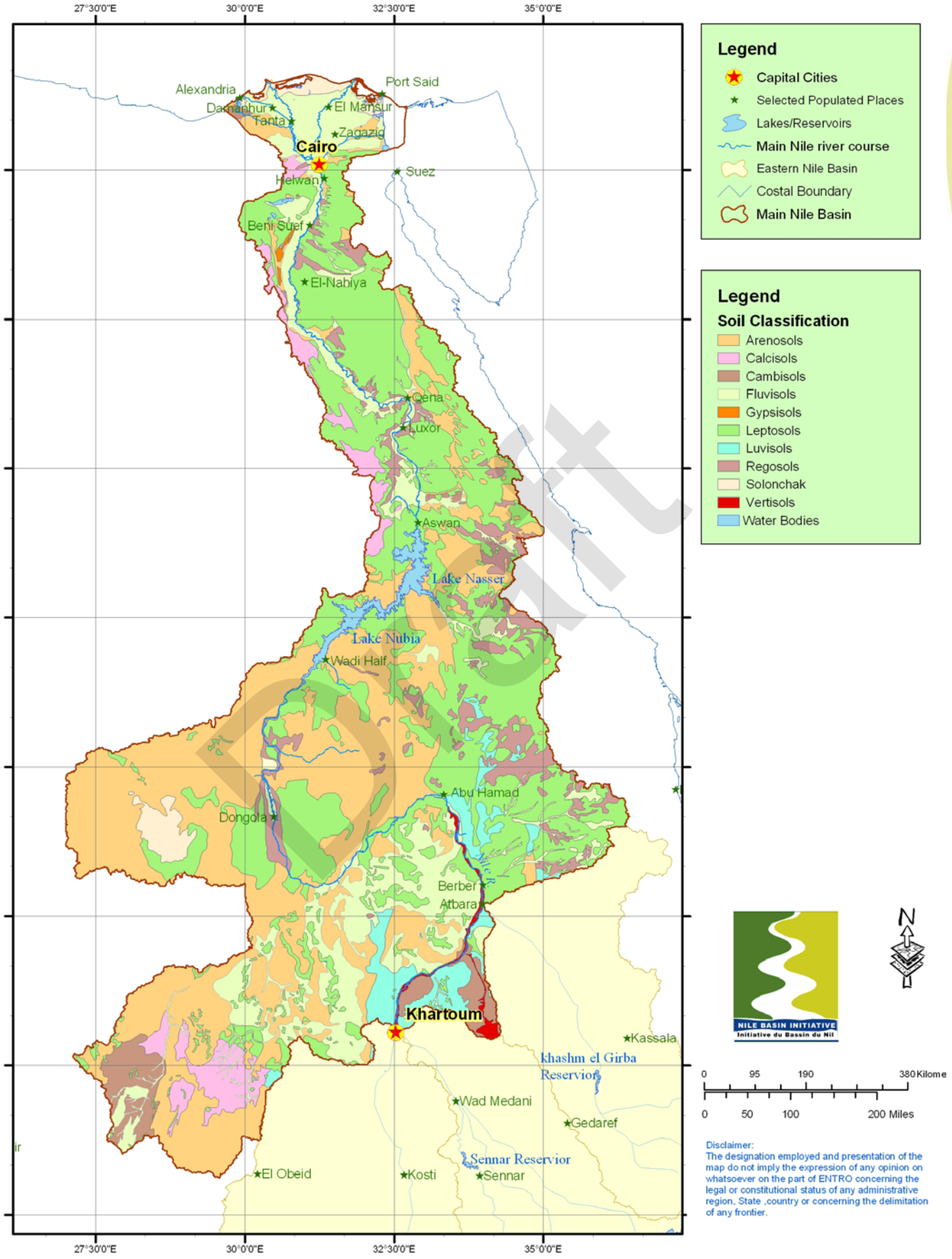
In the northeast on the hills and ridges of the Basement complex rocks are shallow, stony and light textured Regosols, Leptosols and Phaeozems of low fertility. These soils are highly Erodible. Across the northern part of the sub basin Arenosols are widespread and are derived from unconsolidated sediments and textures are very sandy. Soils are deep but excessively well drained. These soils are extremely susceptible to wind erosion. Where rock is near the surface these grade into shallow and stony Leptosols. Along the Nile River is a narrow band of Vertisols and Fluvisols.

The dominant soil types around Lake Nasser are Leptosols on rock and Arenosols derived from the cover sands. Locally Calcisols are found derived from crystalline limestones. In valleys bottoms Fluvisols are very important as they comprise the main soils for irrigation around the lake shore and in the Wadi Allaqi where they have been intensively studied. Their parent material is from one or more the three sources: sediment in the lake, wind blown sand and flowing water. Laboratory analysis of the soils in the Wadi Allaqi indicated that wind blown sand was the least significant although there is some reworking of fine sediment by wind. Run-n9ing water (although extremely infrequent) represented the most important source of soil parent material.

The greatest effect on soil quality is the influence of lake water on soil properties. The position of lake shore is highly variable depending on the annual variations superimposed on larger long-term variations. Annual variations are in the range of 6 to 7 meters, whilst the 1978 1988 was 37meters. Two processes are important: deposition of silt from lake during inundation and changes in chemistry of surface soil layers during and immediately after inundation. The lake sediments is identifiable by its high content of shells and may contain high amounts of soil nutrients. Soils located at higher elevations and which are inundated less frequently have lower pH from 9.00 where the soils is frequently inundated to 8.00 where inundation is less frequent, whilst the subsoil remains constant at 8.8. Less frequently inundated soils also have high oxidized iron contents that could have important consequences of the soils ability to supply phosphates and some trace elements.

Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 4.2 : Soil Map of the Main Nile Basin

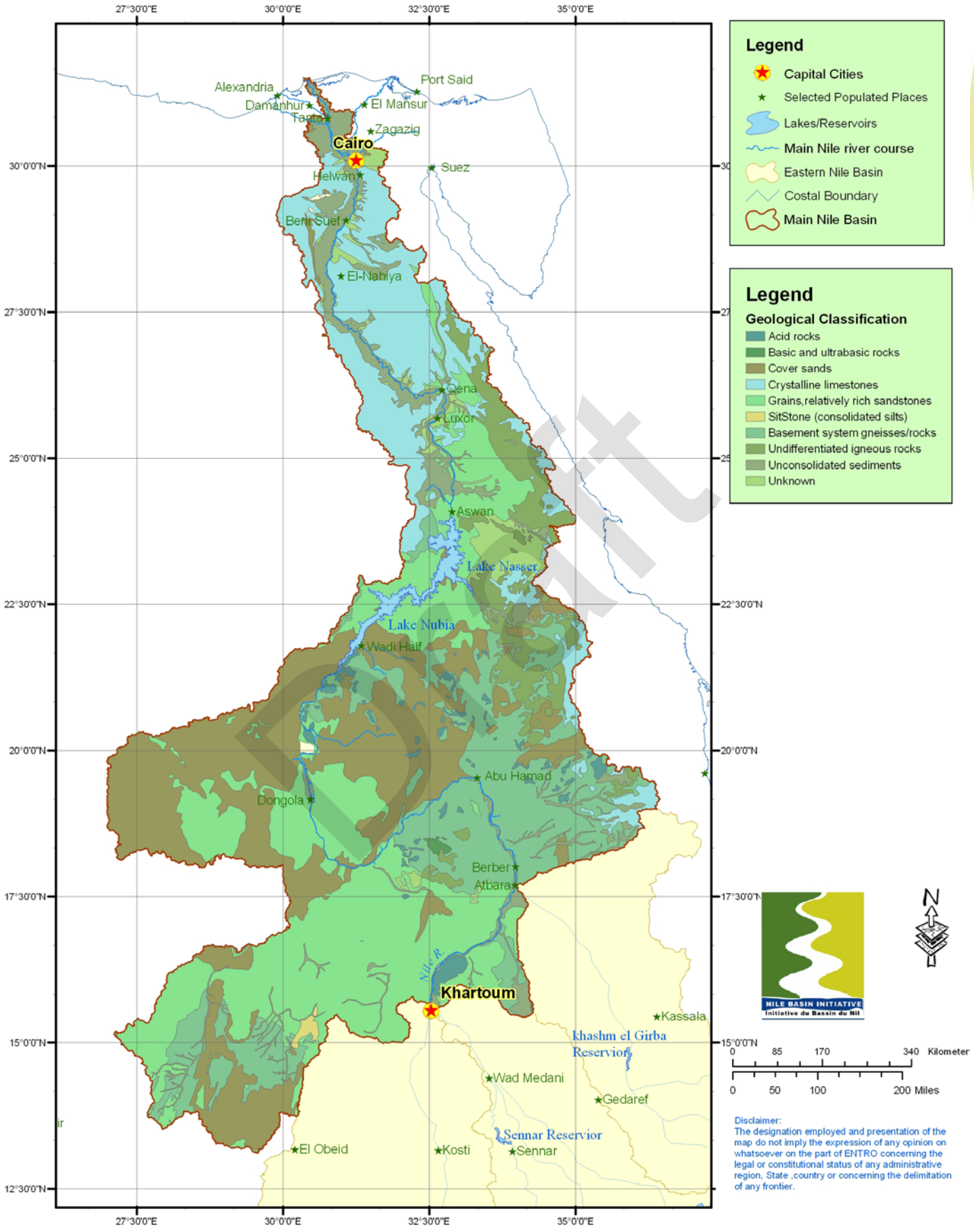


4.3 Geology of Main Nile Sub-basin

The main underling geological formation within the Main Nile sub basin include the older Basement complex rocks, the Nubian sand stones, Tertiary unconsolidated sediments and Recent superficial wind blown sands. The basement complex comprises gneisses, schist's, marbles and intrusive granites and basic rocks. The Nubian sand stones overly uncomformably the Basement complex rocks and comprises mainly sandstones. Siltstones and conglomerates. This formation forms the main groundwater basins in Sudan and Egypt. The Recent deposits include the Nile alluvium, sand dunes and the black clays of the flood plains.

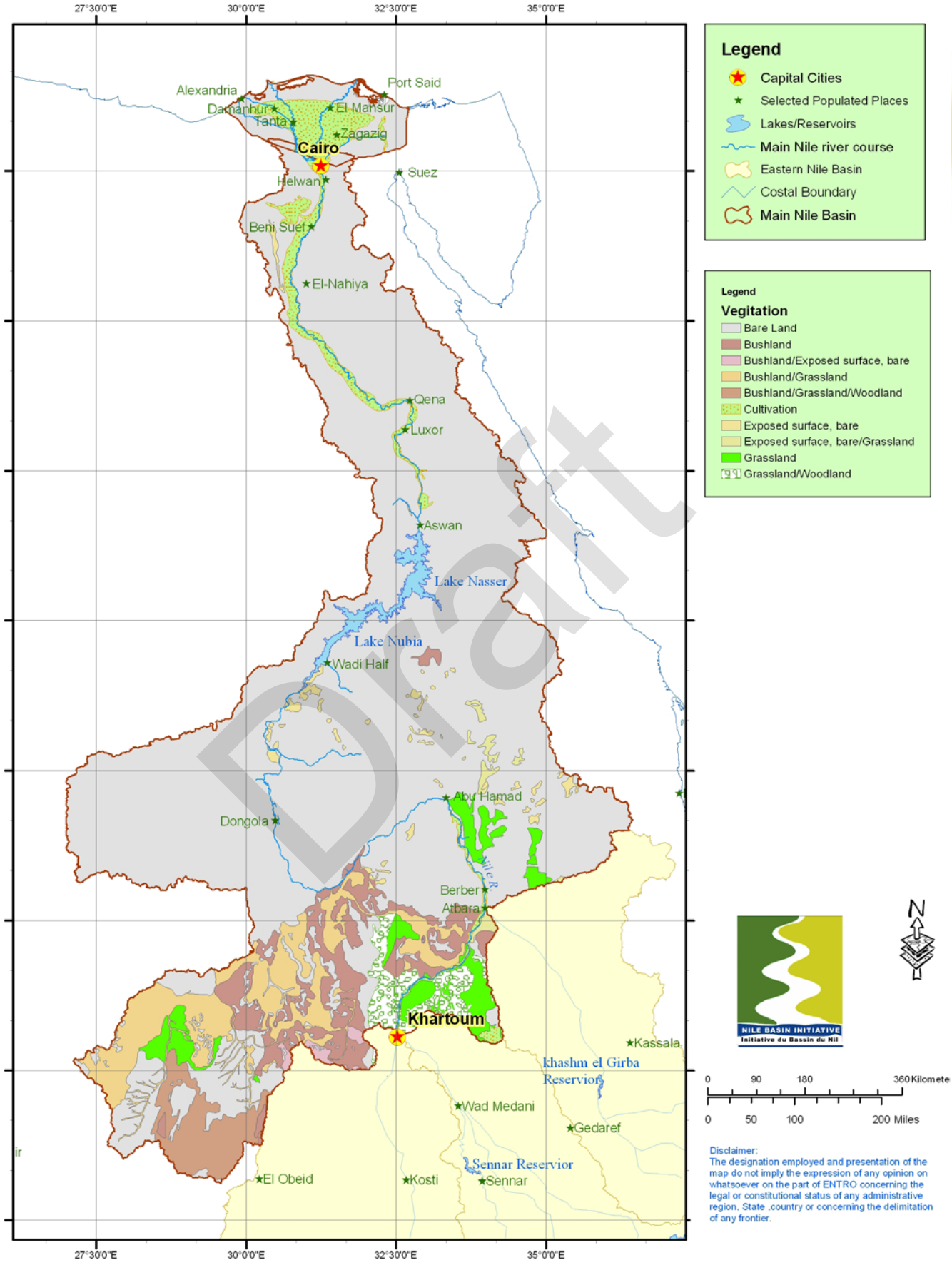
Data/Information Source :One System Inverntory Synthesis Report 2007

Map - 4.3 : Geology Map of the Main Nile Basin



4.4 Vegitaion of the Main Nile Sub-basin

Map - 4.4 : Vegetation Map of the Main Nile Basin



5.1 Drainage Network and Catchment of the Main Nile sub-basin

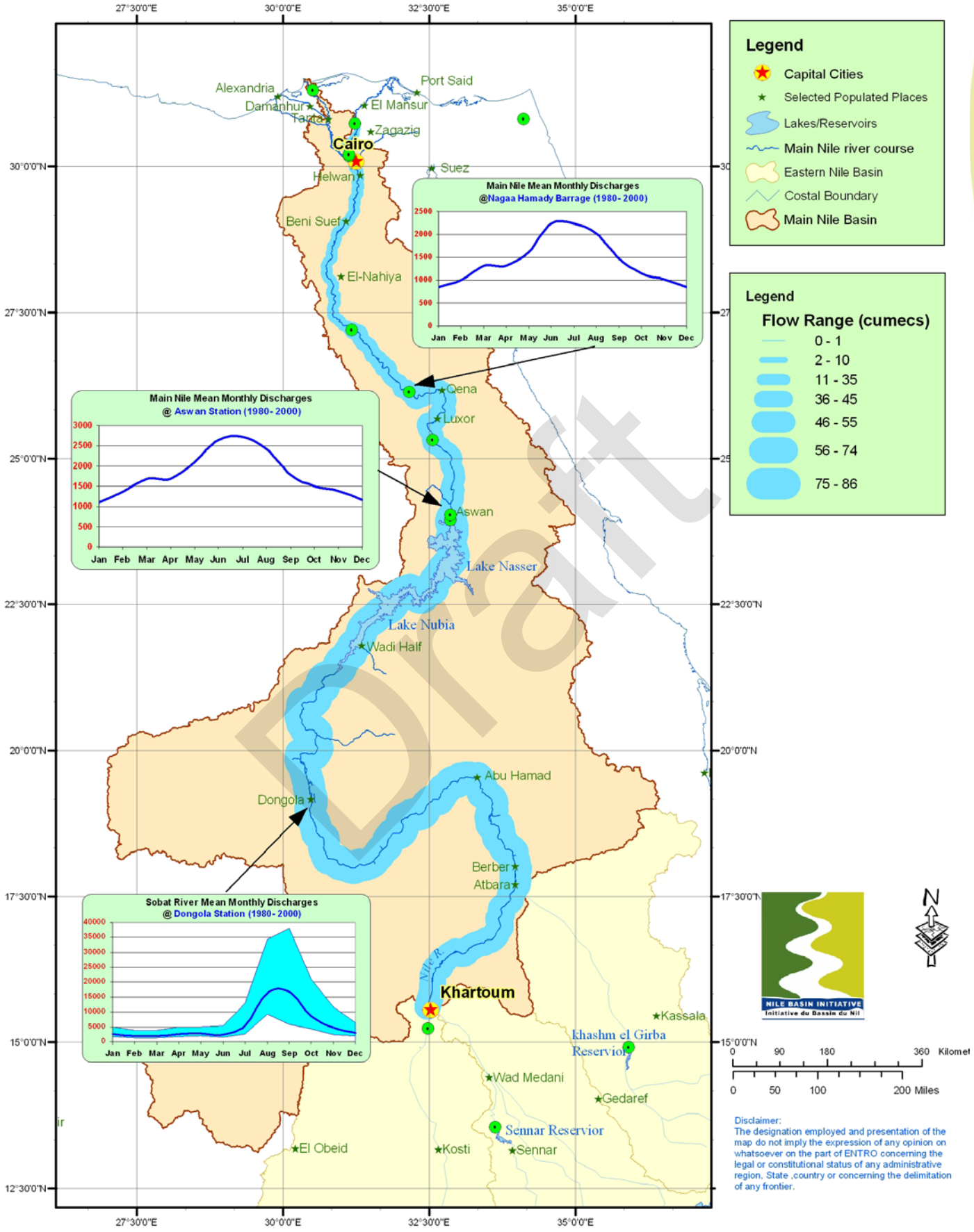
The main Nile sub basin is the ENB system is understood to start at Khartoum, right after the confluence of the White Nile and Blue Nile systems/sub basins. From Khartoum the main Nile flows in a general north direction before it meets its first tributary, the Tekeze-Setite-Atbara sub basin, and then flows to the general north-west direction to the Dongola station, some 1000miles from Khartoum. After Dongola it a gain flows in a general north directions for very few miles and enters in to the Nubian lake, an upstream extension of the Nasser Lake or the Aswan reservoir. The Nile, d/s of the Aswan dam continuous to flow in a general north direction traversing some 1500km before it reaches its mouth, the Mediterranean Sea. Some 500km before the Mediterranean Sea the Nile is bifurcated in to two branches, the west branch known as Rosetta branch and the east branch known as the Damietta branch. Downstream of its confluence with the Tekeze-Setite-Atbara sub basin at Atbara, the Nile has no any significant tributaries joining its system and almost no contribution is generated in terms of runoff, all along its downstream reach to its mouth.

Map - 5.1 : Drainage Network and Catchments in the main Nile Sub-Basin

5.2 Surface Water Resource of the Main Nile Sub-basin

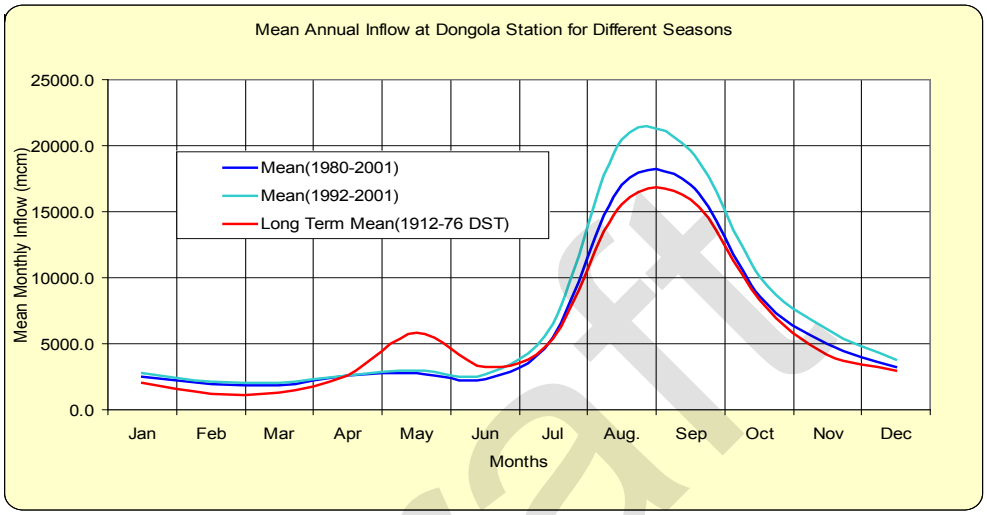
The inflow to the main Nile system at the Khartoum junction is estimated to be 74bcm. The total BN inflow including Rahad and Dindir is 56bcm. Accounting mean annual abstraction of about 6.50bcm, and 0.786bcm evaporation from Roseires and Sennar reservoirs respectively in the Sudan BN system, 48bcm reaches Khartoum. The 30.5bcm inflow of the Sobat-White Nile system at Malakal is reduced to 26bcm d/s of the Jebel Awlia reservoir, the balance being for the abstractions in the Assalaya & Kenan sugar farms (all together 1.3bcm), evaporation losses (estimated at 2.12bcm) from the Gebel Awlia reservoir and losses through seepage & spillage along its route from Malakal to Jebel Awlia reservoir. At Atbara, some 300km d/s of the Khartoum junction, the Atbara-Setite-Tekeze sub basin contributes mean annual inflow of 12bcm, which makes the inflow of the main Nile d/s of the Atbara confluence to be more than 84bcm. Sudan's abstraction d/s of the Khartoum confluence is insignificant (0.534bcm). Also contribution from the Torrents d/s of both the Khartoum and the Atbara confluences is almost non-existence. The mean annual inflow at Dongola (1980-2001) is observed to be 70.3bcm and from 1992-2001 is observed to be 82bcm (Sudan OSI Water Component, May 2006). The long-term mean (1913-76) as obtained from the Nile DST data base is estimated at 70bcm. According to Said (1993) deduced for the record periods of 1912 to 1982, inflow at Aswan is averaged at 84.4bcm and Shahin (1985), for record period from 1912 to 1973 has average the inflow to Aswan at 84bcm (Tekeze Master Plan Studies, Hydrology, May 1998). More over both in the Sudan and Egypt OSI water component report it is indicated that mean annual inflow (1980-2000) entering the Aswan reservoir is 84bcm (Sudan & Egypt OSI water components, May 2006), these all indicate inconsistency with the information at this node of the system. Mean annual abstraction from the Aswan dam by the Egyptians system is reported to be 56bcm with evaporation and other losses averaged to be 10bcm.

Map - 5.2 : River Runoff Map of the Main Nile Sub-Basin

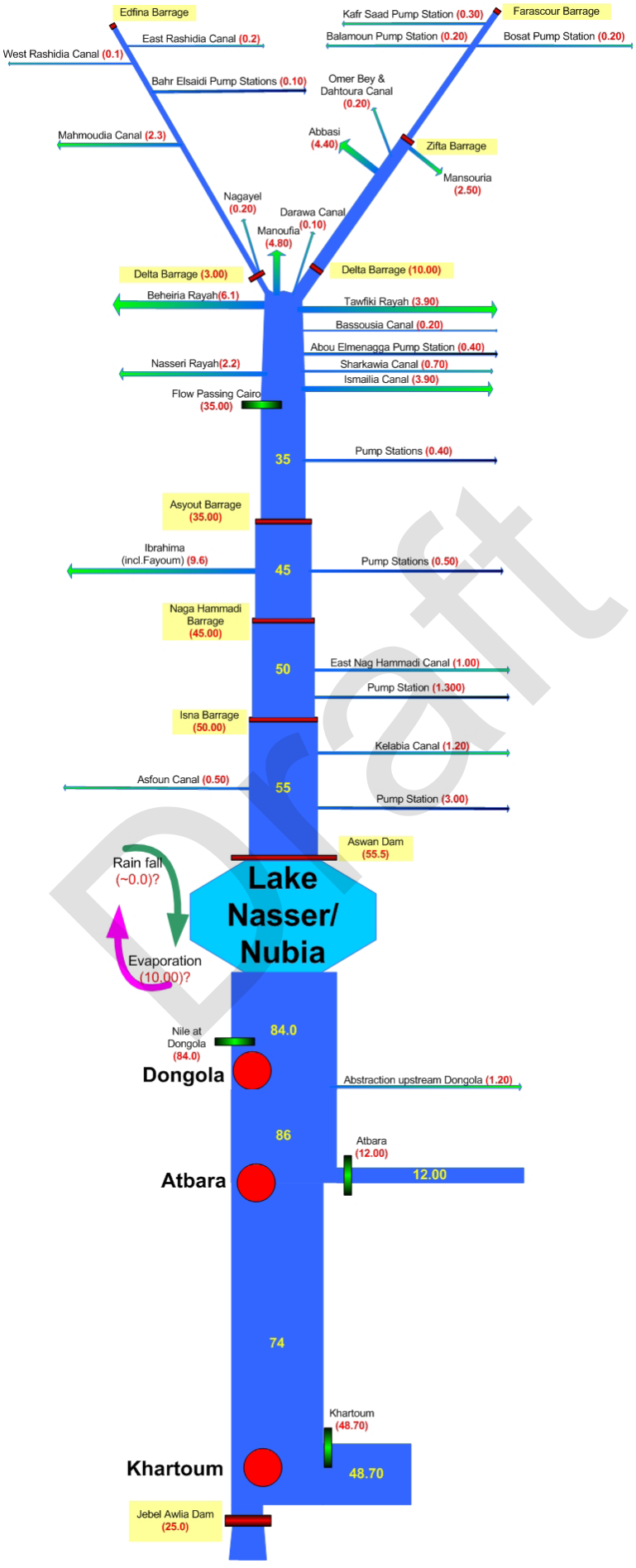


5.3 River System Schematics and Indicative Water Balance

From the Egypt water sector OSI report it is indicated that mean annual evaporation from the Nasser Lake is averaged at 10bm3, which is equivalent to 2.56m at an average lake area of the Nasser Lake. At Aswan station, however, pitch reading indicates that mean annual evaporation is 5.85m (4.102m using 0.70 pan coefficient), which is equivalent to 16.04bm3 of water using 0.70 pan coefficient and at an average reservoir area of the Nasser Lake. This leads that water available for abstraction d/s of the AHD is 74bm3 and or 68bm3. However, from similar sources it is indicated that mean annual abstraction for the water resources system in Egypt is averaged at 55.5bm3. As per to this indicative water balance simulation work a volume of water ranging from 12bm3 to 19bm3 is demonstrated as an imbalance in the system.



Map - 5.3 : Flow Schematics of the Main Nile Sub-Basin



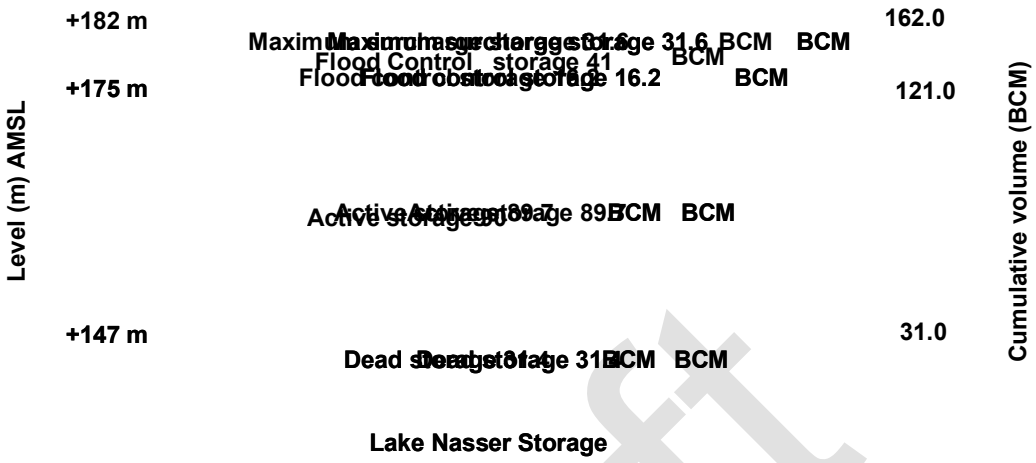
5.4 Sediment in the Main Nile Sub-basin

Map - 5.4 : Sediment Map of the Main Sub-Basin

6. Infrastructure and Utilities

6.1 Dams and Reserviors in the Main Nile Sub-basin

Currently the main Nile sub basin in Egypt is dominated with one reservoir that constitutes the Nubian (u/s part) and the Nasser (d/s) lakes. The total storage HAD is 162bcm at maximum reservoir level of 182masl. The dead storage is fixed at 147masl with storage of 31bcm. The full supply level for the reservoir is designed at 175bcm with storage capacity of 121bcm indicating a live storage of the reservoir being 90bcm.



Lake Nasser Storage capacities

In Sudan part of the Main Nile Sub-basin the Merowe reservoir at a storage capacity of 11bcm is under implementation currently and located upStream of the Dongola station

Map - 6.1: Dams/Reservoir in the Main Nile Sub-Basin

6.2 Irrigation and Agriculture in the Main Nile Sub-basin

At High Aswan Dam (HAD), the system abstracts mean annual flow of 55.6bcm, out of which 78% is abstracted to meet irrigation requirements and the remaining 12% is for water supply, industrial and other related purposes(Egypt OSI report Water Component, May 2006).

The system d/s of the HAD until the Mediterranean Sea is sub divided in to two major areas, upstream of the Delta, usually known as upper Egypt and the area subtended by the two branches (Damietta & Rosetta) located d/s of the Delta Barrages usually known as the Delta area or lower Egypt. The River Nile has a total length of about 1532 km inside Egypt, starting from Egypt-Sudan border in the south and terminating in to the Mediterranean Sea in the North. The construction of AHD, nearly 350 km north of the Egypt-Sudan border, created Lake Nasser, which is the largest man-made lake in the world. Lake Nasser has a length of 350 km inside Egypt and 150 km inside Sudan. The lake has an average width of 12 km and surface area of 6000 km2 at the highest water level.

The River Nile provides Egypt with a gently sloping water path 1428-Km in length divided into three major parts. The first part is 946 Km long extending between HAD and Delta Barrages. This part is segregated into four reaches separated by the historic barrages, Isna, Nag Hammadi, and Asyut barrages. At the apex of the delta, the Nile is bifurcated into two parts, Damietta and Rosetta branches. The length of Damietta branch is 246 Km while Rosetta branch reaches 236 Km.

The width of the Nile differs from Aswan to Delta Barrages. At the reach Nile has one channel, its width varies between 300 m and 650 m, but it varies between 1200 and 1500m or more, along reaches, where the river flows in two or more channels, with central islands in the branching channels. In plan, the Nile is relatively straight with some sinuous reaches over short distances which are related to a steeper valley slope. The increase in sinuosity appears to occur with a valley slope in excess of 7 -10 cm/km.

More than 95% of the Egypt water supply comes from the Nile sources. Currently major abstraction in the Nile system is made at four nodes using the five historic barrages. Irrigated agriculture development is meant to be high value based agricultural interventions. The current development is estimated at 3.25Mha with a cropping pattern largely constituting rice, sugarcane, cereals, perennial fruits and vegetables. Cropping intensity reaches more than 290% per annum.

With increasing population, the need in agricultural expansion arises through an increase of agricultural land coverage. Increasing the cropping intensity is another area of intervention being made by the Egyptian Government to combat the problem of food security that would be resulted from increased population. Shortage of irrigation water is the major bottleneck problem facing in realizing the preceding objectives of the Egypt economy. Reuse of drainage water, shifting farm water distribution mechanisms from surface delivery system to automated systems, abstraction of ground water resources and reinforcing water harvesting techniques are among the interventions carried out by Egypt to reduce pressure on the Nile water use system (Egypt, OSI Water Component May 2006).

The Egypt Government has the plan to effect a huge expansion in the development of irrigated agriculture

Map - 6.2: Irrigation and Agriculture in the Main Nile Sub-basin

6.3 Hydropower and Transmission in the Main Nile Sub-basin

Both the HAD and the old Aswan dams are used for the development of hydropower in addition to their major task, regulating the inflow in the Nile system. The historic barrages like Isna and Naghammadi are also used for production of hydropower energy. Major proportion of the hydropower energy production comes from HAD and Aswan I & II. In general the major power generation in Egypt comes from thermal sources. As of 1999, total annual energy production is estimated at 70695.11GWH, out of which hydropower generation from the Nile system accounts only 20% with a total production of 14425.61GWH. Compared to the 1980, energy production in Egypt has been increased by more than three fold in the year 1999. It has been increased from 18425GWH (1980) to 70695GWH (1999) (Egypt OSI Water Component Report, May 2006)

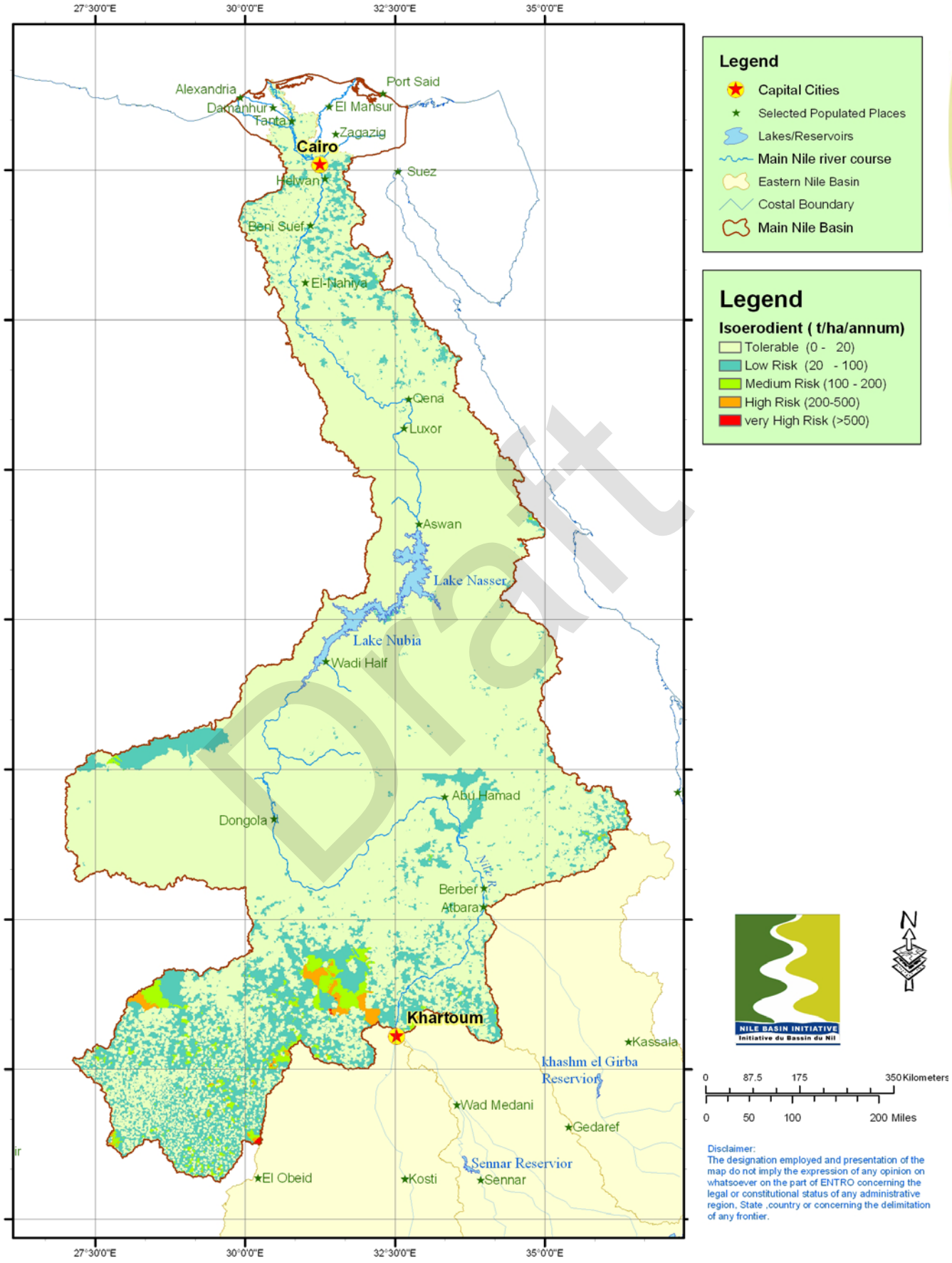
Hydropower generated at HAD and Aswan I & II, is connected to Cairo through the ultra-HV of 500KV transmission line and the upper Egypt HV 220 & 132KVs were used largely to connect power stations and facilitate power transmissions to the load centers(Egypt OSI Water Component Report, May 2006).

6.3 Hydropower and Transmission Map of the Main Nile Sub-basin

7. Environmental

7.1 Land Degradation/Errosion in Main Nile Sub-basin

Map - 7.1: Isoerodient map of Main Nile Sub-Basin



7.2 Water quality in Main Nile Sub-basin

Water quality is one of the most important environmental issues in the Main Nile largely in Egypt. Due to intensive agricultural and industrial uses pollution is significantly higher and is important economic problem in the sub basin.Therefor, protection of water resources is one of the most critical environmental issues in Egypt.

Egypt is facing an increasing demand for water due to the rapidly growing population, as well as the growth in urbanization, agriculture and industry. In the meantime, Egypt faces a rapidly increasing deterioration of its surface and groundwater due to increasing discharges of heavily polluted domestic and industrial effluents into its waterways. Excessive use of pesticides and fertilizers in agriculture also causes water pollution problems.

An assessment of water quality in Egypt indicated that the major water quality problems are pathogenic bacteria/parasites, heavy metals and pesticides. Major sources of these pollutants are the uncontrolled discharge of human, industrial and agricultural wastes

Generally speaking, water released from Lake Nasser generally exhibits the same seasonal variation and the same overall characteristics from one year to another. Downstream changes in river water quality,however, are primarily due to a combination of land and water use as well as water management interventions such as: Different hydrodynamic regimes regulated by the Nile barrages, Agricultural return flows, and Domestic and industrial waste discharges, including oil and wastes from passenger and riverboats.

7.3 Water related disease in Main Nile Sub-basin

Throughout history, epidemics related to water- borne or water-related pathogens have plagued Egypt. Some of these events are briefly recounted (Helwa, 1995) here as follows:

- *The 1973 typhoid epidemics was localized in a small village in Damietta Province, where about 400 students and villagers fell ill.*
- *In the summer of 1983, infective diarrhea started in a small village in Giza Province and later spread to other areas. The causative organisms were isolated in drinking water network, which was contami nated by an overflow of sewage caused by broken pipe connection.*
- *The 1986 typhoid epidemic affected the old section of Suez City. It was the result of heavy contamination of the old water treatment plant intake by untreated human wastes.*

The Ministry of Health monitors routinely for pathogenic bacteria, viruses, and parasites in natural water around Egypt. Results of these surveys indicate that the following pathogens have been found in Egyptian waters:

- *Salmonella: Have been detected in Alexandria sewage discharged into Mariut Lake, El-Mahmoudia canal and Alexandria beach.*
- *Shigella: The causative agents of bacillary dysentery were isolated from Mariut Lake. E.histlita and E.coli were detected also in tap water in Abbis II village even though water is treated and chlorinated.*
- *Vibrio Cholera: As a preventive measure, local health authorities in Egypt collect 110 water samples daily from the Nile and main canals, at the intake point of water treatment plants, and from drains and sewage discharges. The samples have been analyzed for Vibrio cholera, with results so far negative.*
- *Parasites: A clear decline in the presence of infective stage of human with Schistosomiasis (Cercaria).The results indicated a decreasing infected snails (intermediate host) population. Infected canals are by now treated with molluscicide.*
- *Hepatitis A virus: No figures are available in Egypt*
- *Hepatitis E virus: Have been detected among children, especially in the rural areas.*
- *Viral gastroenteritis: Gastroenteritis and diarrheal diseases are the most common diseases transmitted by water. These viruses are responsible for 40% among children's under five years of age in Egypt. These diseases are spread by fecal contamination and transmitted to humans via contaminated water supply and food.*
- *Poliomyelitis virus: These viruses have been detected in sewage in Egypt. It is the only water-borne disease, which has a potent vaccine giving testing immunity to vaccinated children. For this reason, the disease is now being eradicated in Egypt.*

Data/Information Source :One System Inverntory Synthesis Report 2007

7.4 Industrial Pollutions in the Main Nile Sub-basin

At present industrial use of water is estimated at 5.9 BCM/year out of which 550 MCM/year is discharged untreated into the River Nile. About 125 major industrial plants are located in the Nile valley, which represent about 18% of the existing industries and discharging 15% of the heavy metal loads. About 250 industrial plants are located in Greater Cairo, which represents 35% and contributing about 40% of the total metal discharges. The Delta excluding Alexandria has some 150 industries, which contribute about 25% of the heavy metals discharging to drains. Alexandria is a major heavy industrial centre with some 175 industries, about 25% of the total in Egypt.

7.5 Parks and Wetlands in the Main Nile Sub-basin

There are about 356 islands in the Nile channel between Aswan and Cairo with an average of one island every 3 Km. This number includes all type of islands, permanent ones (defined as having permanent vegetation and are distinct from sand bars), the submerged islands which appear only in low flow seasons, sand bar islands, and weed islands. Many islands are attached to the main bank of the river and the secondary channels are blocked in many parts of the river.

Egyptian wetlands are classified into two broad categories: coastal and inland wetlands. The major problem of coastal wetlands in the northern part of Nile Delta is the intrusion of saline water into fresh water aquifer. Depressions of western desert or other areas along the Nile valley can be further classified as either natural wetlands (Wadi el Natrun depression), or manmade wetlands (Siwa oasis).