ONE-SYSTEM INVENTORY

ANNEXE: MAIN NILE SUB-BASIN

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EASTERN NILE TECHNICAL REGIONAL OFFICE
ADDIS ABABA
ETHIOPIA

INTRODUCTION TO THE ONE SYSTEM INVENTORY

EASTERN NILE SUBSIDIARY ACTION PROGRAMME: The Eastern Nile Technical Regional Office (ENTRO) is an organization meant to plan and implement the ENSAP (Eastern Nile Subsidiary Action Program) in the three Eastern Nile Basin (ENB) countries of Egypt, Ethiopia and Sudan. ENSAP seeks to realize the NBI Shared Vision for the Eastern Nile region aimed at reducing poverty, foster economic growth and the reversal of environmental degradation.

ONE SYSTEM INVENTORY: To support its multipurpose development objectives, ENTRO began an exercise in 2006 to create a One System Inventory (OSI) to support the planning of the Joint Multipurpose Program (JMP). The OSI was to be a regional knowledge base across the three EN countries, initially focused on three themes, water resources, socio-economic and environmental issues. This information was expected to be useful for decision-makers and senior program and project coordinators at ENTRO to write terms of reference for new studies in the Inception Phase of the JMP and to aid the literature survey of these studies.

OSI DEVELOPMENT PROCESS: The process of development of the OSI is as follows:

- ***National reports:*** National consultants were appointed in 2005 to collect information but found it quite difficult to access national information. They submitted their reports in 2006, comprising all the information they were able to gather till then.
- ***Thematic reports:*** These national reports were compiled into three thematic reports, each reporting on the situation in four transboundary sub-basins, namely, the Baro-Akobo-Sobat-White Nile Sub-basin, the Abbay-Blue Nile Sub-basin, the Tekeze-Setit-Atbara Sub-basin and the Main Nile Sub-basin.
- ***Trans-boundary sub-basin reports:*** In Septemebr 2007, these thematic reports were compiled by an international consultant into four multiple-theme reports, divided according to trans-boundary sub-basins, to present issues 'without national borders'.
- ***Regional Workshop:*** The four sub-basin reports were presented in a Regional Workshop in Addis Ababa in November 2007 and several comments were received by country teams that reviewed the reports. The atmosphere in this regional meeting was quite positive and country teams acknowledged the usefulness of the information-gathering and sharing exercise of the OSI.
- ***Revised Outputs:*** Summaries of the four sub-basin reports were prepared in early 2008 and sent along with the more detailed Annexes to the three country ENSAP Teams by mid 2008 to receive corrected versions of information that were found to be incorrect or out-dated in the review done during the Regional Workshop. A CD kit was also prepared to demonstrate the interactive presentation of key data tables and maps.
- ***Country meetings:*** Meetings were organized with the country ENSAP teams in May 2009 to review and update the information in the Summaries, Annexes and CD kit. These country meetings were extremely positive and there was considerable willingness among the three countries to share all available and up-to-date information. However, time was too short for them to do much beyond providing feedback that some OSI data and information was incorrect and needed to be updated.

OTHER INITIATIVES AND FUTURE PLANS: The OSI was meant to be a small initiative to support the JMP. ENTRO subsequently initiated Eastern Nile Water Resources Planning Model (ENWRPM) Project, and began building an information database to feed and validate this model. Thereafter, the Nile Basin Initiative (NBI) initiated the Decision Support System (DSS) and a basin-wide information collection and model building exercise. Both used OSI information. It is expected that the OSI will be handed over to the ENWRPM Project.

QUICK OVERVIEW OF THE EASTERN NILE BASIN

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

EGYPT: With a total area of 997,739 square kilometres, Egypt 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. Egypt 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 kilometres from north to south, with a maximum width at its southern border, stretching east-west for some 1130 kilometres. Less than 10% of its area is identified to be cultivable, the bulk of its geographical area (more than 90%) being desert where life would hardly survive. With a total area of 69,722 square kilometres the Nile watershed in Egypt accounts only 7% of the country and 4% of the Eastern Nile Basin.

ETHIOPIA: Located in the horn of Africa, Ethiopia is 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 geographical area of 1,133,380 square kilometres, the highland plateau of the country (above 1,800 masl) is the heart of the country covering some 60% of its total area. The Great Rift Valley splits the Ethiopian highland plateaus diagonally in the north-eastern and south-eastern directions. The north-eastern half is largely drained by the Nile river system. The plateaus are drained by 12 major river basins and are characterized by deep valleys and canyons cut by numerous rivers and streams. 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 river system. The Abbay (the Blue Nile) takes the lion's share both in terms of area (18% of the total area of the country) and water resources potential (more than 50%). Including the upper courses of the Tekeze, Abbay and Baro-Akobo Sub-basins, the Nile watershed in Ethiopia accounts for about 32% of the total geographical area of the country and 22% of the Eastern Nile Basin.

SUDAN: Located in the north-eastern Africa Sudan is the largest land state in the continent (2,505,800 square kilometres). It is bounded on the north by Egypt, on the east by the Red Sea, Eritrea, and Ethiopia, on the south by Kenya, Uganda and the Democratic Republic of the Congo, and on the west by the Central African Republic, Chad, and Libya. The maximum stretch in Sudan is from north to south, with a total length of 2,250 kilometres, while its maximum east-west stretch is 1,730 kilometres. About 50% of Sudan is included in the Nile watershed, while 74% of the Eastern Nile Basin is located within Sudan.

SUB-BASINS: The Eastern Nile Basin can be divided into four major sub basins; the Baro-Akobo-Sobat-White Nile Sub-basin, the Abbay-Blue Nile Sub-basin, the Tekeze-Setit-Atbara Sub-basin and the Main Nile Sub-basin (see Table 1.1).

Table 1.1: Total Area of the Sub-basins

	Area (Square kilometers)	Mean Annual Inflow (billion cubic meters)	Proportion of Nile inflow at Aswan Dam (%)
Baro-Akobo-Sobat-White Nile	468,216	26	29%
Abbay-Blue Nile	311,548	51	57%
Tekeze-Setit-Atbara	219,570	12	13%
Main Nile	656,398	0	0%

THIS ANNEXE contains information on the Main Nile Sub basin and is part of the four annexes that support the summary OSI report prepared by ENTRO.

Figure 1.1: Main Nile sub-basin: Location map

***Source*:** ENTRO OSI database

[Raw data source: Sub-basin boundary -Delineation of SRTM 90m DEM, River Network - Traced from Landsat TM imageries 2000 , approximate country boundaries – USGS National Centre for Earth Resources Observation]

1. GENERAL CHARACTERISTICS

1.1. SUB-BASIN LOCATION AND AREA

LocationThe Main Nile Sub-basin is one of the four major sub-basins in the eastern 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 up to Mediterranean Sea. Geographically, it extends from 300 30' 35'' to the north down to 130 7' 20'' on the south. Similarity it goes from 260 46' 24'' to the west up to 360 27' 42'' to the east covering a total area of 789,660 km^2. Another estimate, however, puts the area at 656,398 km^{2}or about 40% of the total area of Eastern Nile Basin (OSI Environment Synthesis Summary Report p. 24).

Area: It is the largest sub-basin of the four sub-basins identified in the Eastern Nile and covers 586,398 km^{2}in the Sudan and 69,722 km^{2}in Egypt accounting for 89% and 11% of the total area of the sub-basin in the two countries respectively (OSI Environment Synthesis Summary Report p. 24).

1.2. ADMINISTRATIVE UNITS

The sub-basin covers 8 States in Sudan and three Governorates in Egypt (Table 1.1). The largest of these are the states are North Kordafan, Northern Nile and Red Sea in Sudan.

Table 1.1: Administrative Regions within the Main Nile Sub-basin with area (square kilometres)

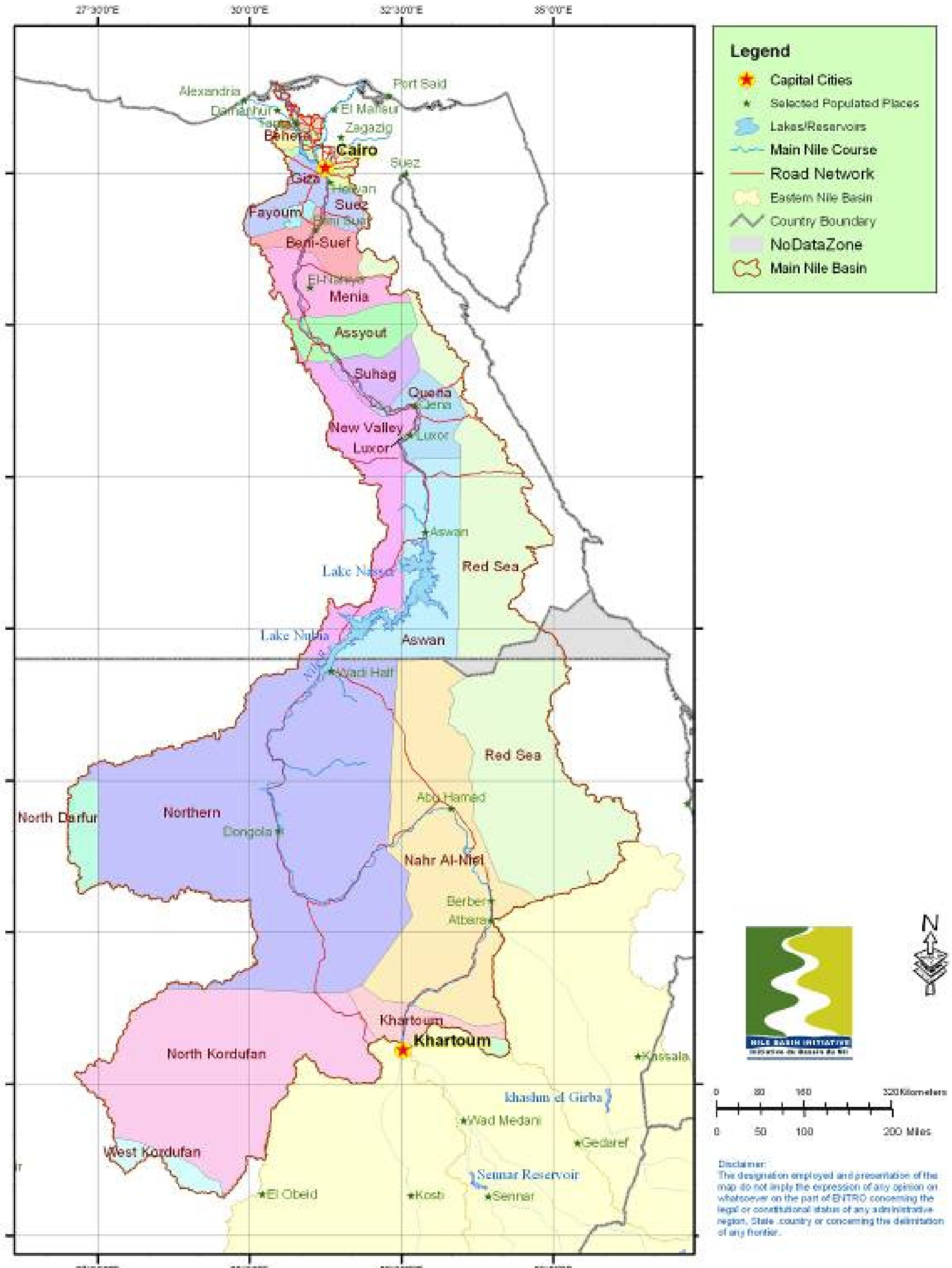
Country	Region	Area (km^2)	% of sub-basin
SUDAN	North Dafur	8,689	1.3%
	North Kordafan	123,958	18.9%
	West Kordafan	6,409	1.0%
	Northern	230,080	35.1%
	Khartoum	12,129	1.8%
	Nile	105,195	16.0%
	Gaderif	1,468	0.2%
	Red Sea	98,747	15.0%
EGYPT	Aswan	27,608	4.2%
	Red Sea	30,856	4.7%
	New Valley	11,258	1.7%
SUB-BASIN		656,398	100.0%

1.3. TOPOGRAPHY

1.3.1. Altitude

The total sub-basin area, as computed from DEM of 90 m resolution, is estimated at 789,140 square kilometres. Large proportion of the area (69%) is confined in an altitude that ranges from 200 masl to 500 masl 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 500 masl to 1,000 masl. Nearly 1% of the sub-basin has an altitude less than 20 masl 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 ranging from 20 masl to 100 masl and the remaining 4.5% has an altitude between 100 masl and 200 masl. Less than 0.1% of the sub-basin lies above 1,000 masl

Figure 1.2: Administrative Units of the main Nile Sub-basin

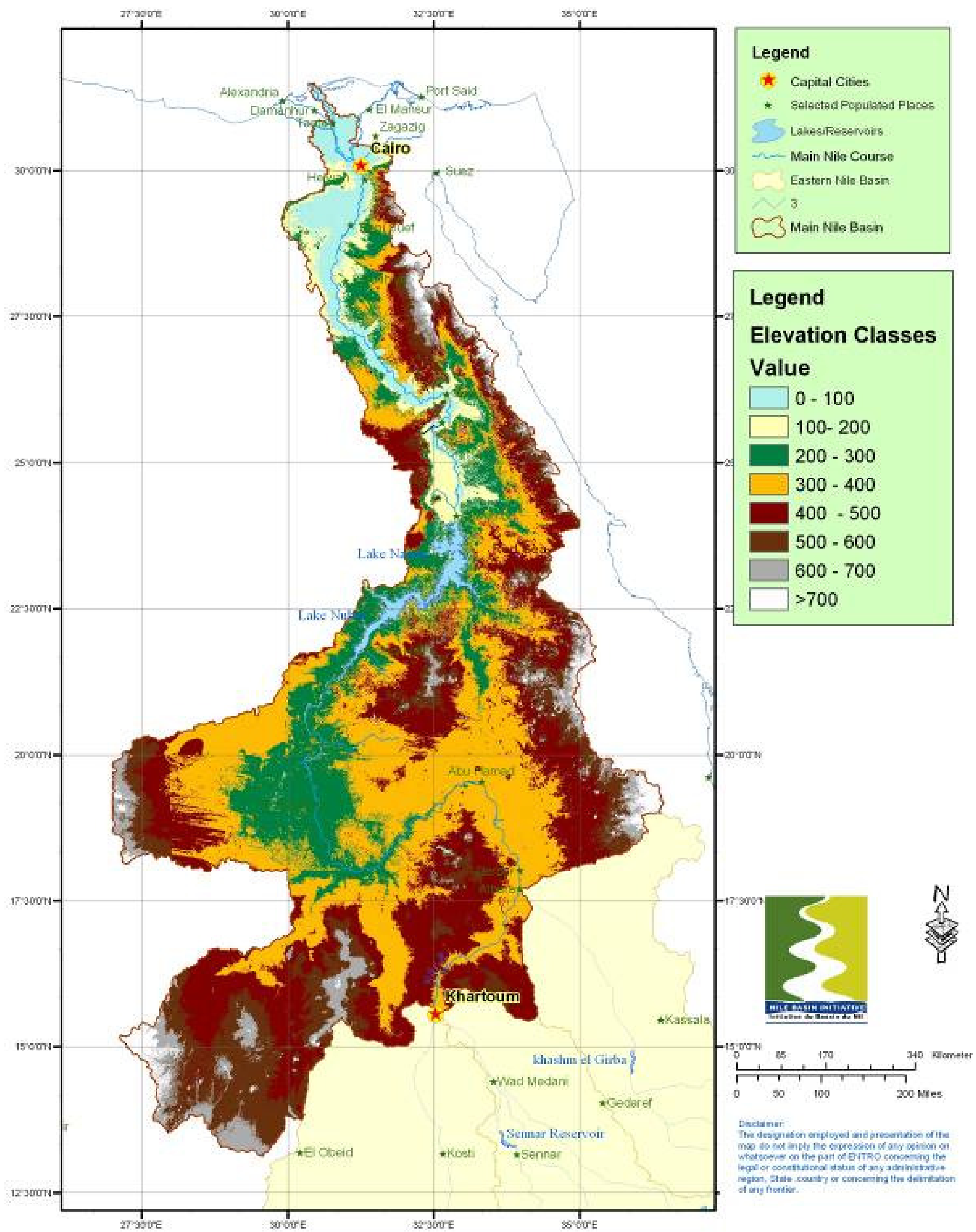


Source: ENTRO OSI database

1.3.2. Slope

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

Figure 1.3: Terrain Map of Main Nile sub-basin



Source: ENTRO OSI database
Raw data source: The Shuttle Radar Topography Mission (SRTM) 90m DEM

1.3.3. Relief

Except for the Sabaloka gorge about 80 kilometres north of Khartoum the main Nile flows through an arid plain with the occasional rocky outcrops. To the eastern edge of the Sub-basin are the Red Sea Hills that rise in parts to 1,800 masl. On the western edge reaches up to a broad plateau in Northern Darfur and Northern Kordofan at about 1,500 masl. A large wadi – the Wadi el Milk - intermittently drains this area but fails to reach the Nile. The main feature is large loop made by the Nile River when it suddenly turns southwest-wards as far as Abu Dom before resuming its northerly course. The river profile shows a gentle gradient to the 5th Cataract, followed by a steep segment between the 5th and 4th cataracts. There is a gentler gradient between Cataracts 4 and 3, followed by a steep reach between Cataracts 3 and 2 just above Wadi Halfa. The gradient is extremely variable: ranging between a minimum of 3.2 m per 10,000 and a maximum of 1 meter per 1,000. Average channel width is about 600 meters.

1.4. CLIMATE

1.4.1. General

Owing to its altitude, this portion of the Nile is known for its arid climate where moisture is almost non-existent. The presence of Nile has enabled to support life along its narrow banks of the downstream of Khartoum and the HAD and into the large Delta downstream of the Delta barrages. The Delta, where life including green area in the system is confined, accounts for less than 5% of the area of Egypt. The climate of the Main Nile sub basin in both Sudan and Egypt belongs to arid-desertic to semi-desertic conditions. It is characterised by long hot rainless summer and short rainy mild winter with scarce rainfall. The other seasons are also characterized by unstable climate. (OSI Environment Synthesis Summary Report p. 24)

1.4.2. Rainfall

Mean annual rainfall: The isohyet map produced for the sub-basin indicates that more than 65% of the sub-basin has mean annual rainfall of less than 50 mm and only 17% of the sub-basin has mean annual rainfall of above 100 mm. Mean annual rainfall at Khartoum is below 200 mm, reduced to less than 20 mm at Atbara, and almost less than 5 mm at Dongola and the High Aswan Dam. At Cairo it is 25 mm and increases to 200 mm (Alexandria) in the coastal line of the Mediterranean Sea.

Average runoff: Average runoff over the entire area of the Delta in Egypt is estimated at 1 bcm, accounting only for 3% of the runoff reaching the Delta through the Nile system (Water OSI Report of Egypt, May 2006).

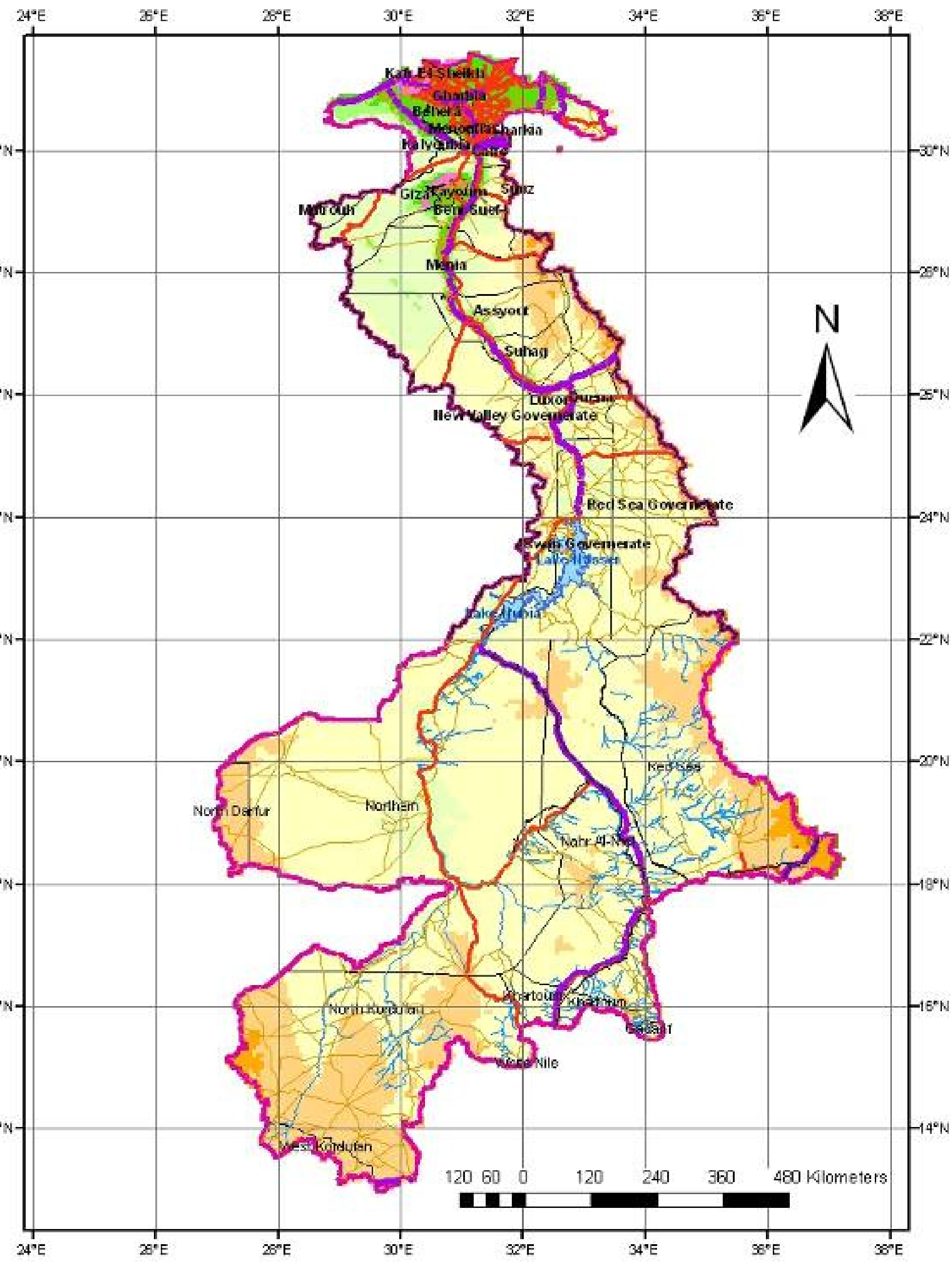
1.4.3. Temperature

General: The maximum air temperature is affected by the geographical location of both Sudan and Egypt north of the Equator. It increases generally from north to south. The temperature gradient varies from month to month, where the difference between the maximum temperatures from north to south reaches 15˚C in May and June, and 5¤C in January.

Maximum and minimum temperatures: The maximum air temperature reaches its highest value in the south during June, while August is the hottest month in the northern coast. The minimum air temperature around the sub basin's part in Egypt occurs during January. The water surfaces and the highlands complicate such distribution, since the temperature gradient is well defined near the coasts of the Mediterranean and Red Sea during spring and summer seasons and turns to be weak during autumn and winter Seasons. This is due to the relatively low sea surface temperature during the first period and relatively high during the second one. (OSI Environment Synthesis Summary Report p. 24)

Mean daily temperature: Temperature in this sub-basin is very hot, owing to the prevalence of desert climate, with mean daily temperature varying from above 30ºC (around Dongola and HAD) to 18ºC in the coastal areas (Alexandria)

Figure 1.5: Main Nile Sub-basin: Relief and drainage



Source: EN Cooperative Regional Assessment for watershed management Report 2007

1.4.4. Evaporation

Evaporation is observed to be considerably high.

Evaporation losses in reservoirs: Lake evaporation at HAD is estimated at 2.6 meter per year (Egypt OSI report Water Component, May, 2006).

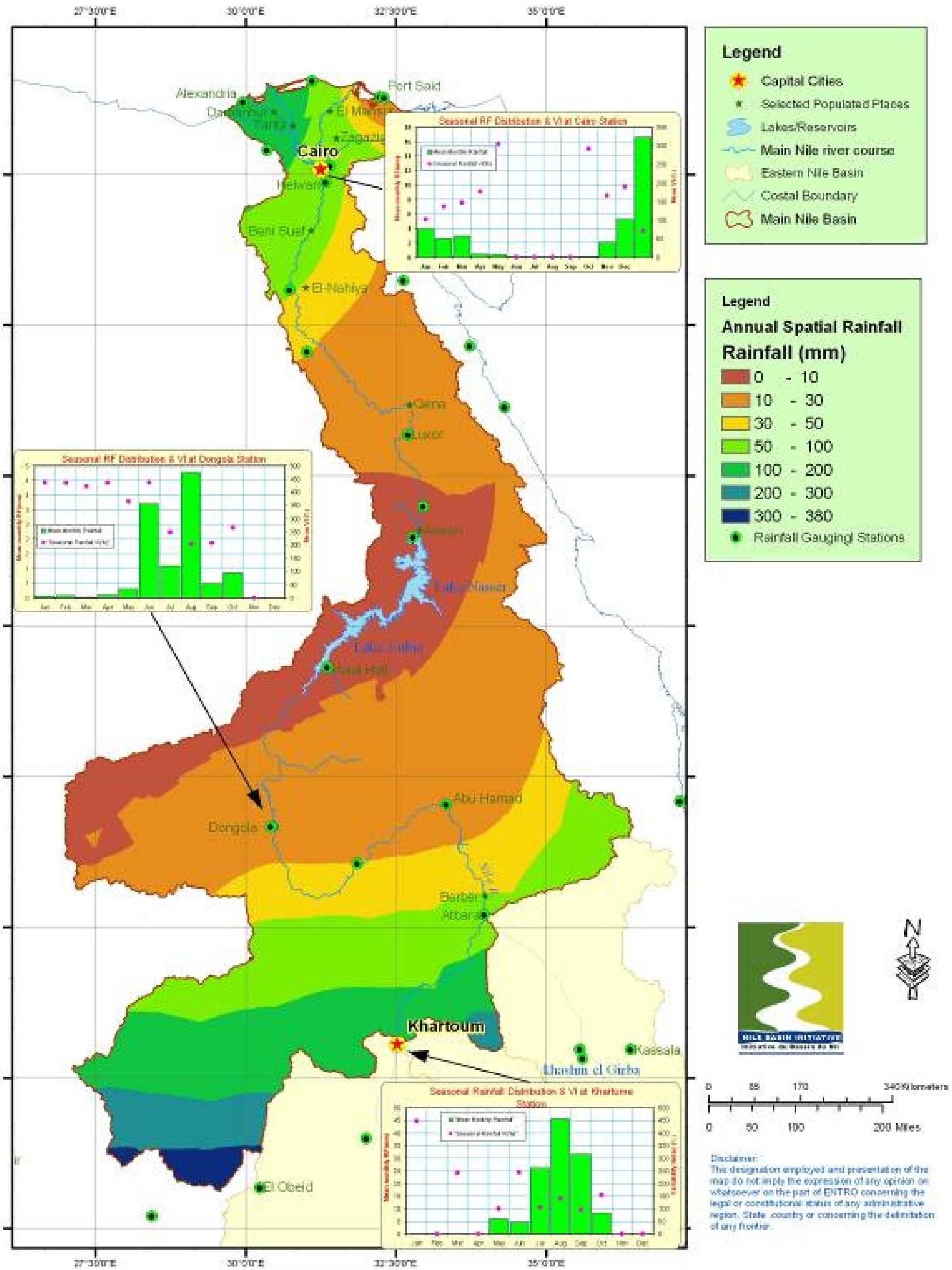
Potential evapotranspiration: The Potential evapotranspiration in the sub-basin is estimated at 6.8 m (Khartoum station), 7.8 meter (Dongola station), 5.8 meter (HAD station) and 1.8 meter (Alexandria) in the coastal line of the Mediterranean Sea.

1.5. HUMIDITY

Mean annual relative humidity: 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%.

Variations in relative humidity: Since the humidity distribution depends upon the nature of underlying surface, topography, distance from sea, and dominant synoptic situations, it is found that the highest Relative Humidity exists over northern coast of the country. During summer, reaching more than 70% and decreasing inwards to reach 20% far to the south with appreciable gradient at the north and weak gradient at the south. Moreover, a steep Relative Humidity gradient is evident near the Red Sea coast, which weakens westwards. While over Sinai, the humidity gradient is strong near the coasts circumventing low Relative Humidity region (30%) over southern mountains. In autumn, the values of Relative Humidity are greater than 70% in Nile Delta and the eastern coasts of the Mediterranean, while it is less than 70% over the eastern coasts and reaches 30% in the south. During winter, the humidity is still high in both east and south leading to well-defined decrease in the gradient than that observed over both northern coasts and Sinai. This feature is reversed during spring: humidity starts to decrease southwards resulting in gradient greater than the winter gradient to approach the characteristics of the summer distribution (OSI Environment Synthesis Summary Report p. 25).

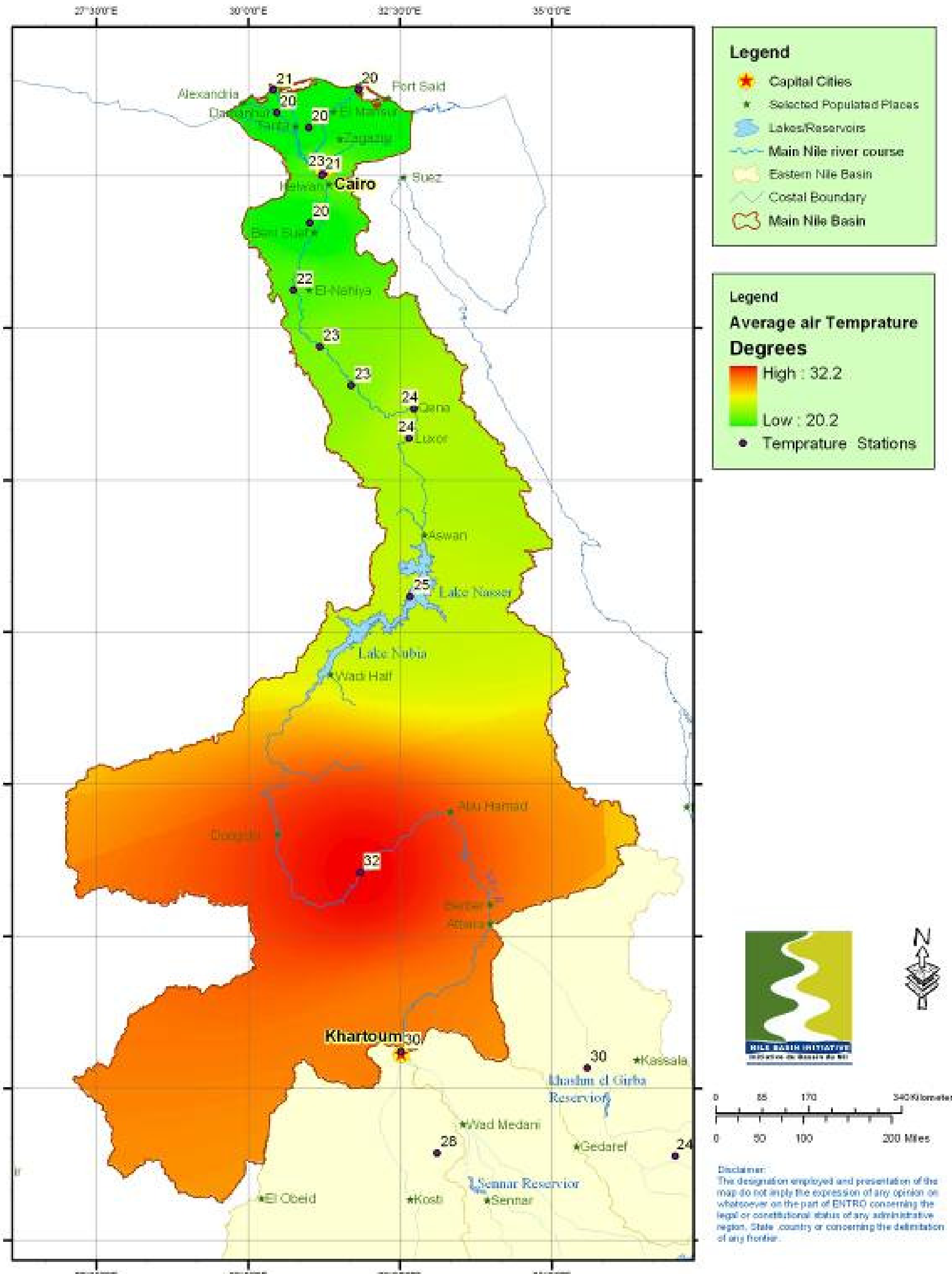
Figure 1.6: Mean Annual Rainfall Distribution (Isohyets) map for the Main Nile Sub-basin



Source: ENTRO OSI database

[Raw data source; EGYPT: Egyptian Meteorological Authority, Sudan: Meteorological Authority, Ministry of Aviation, Sudan, 2006]

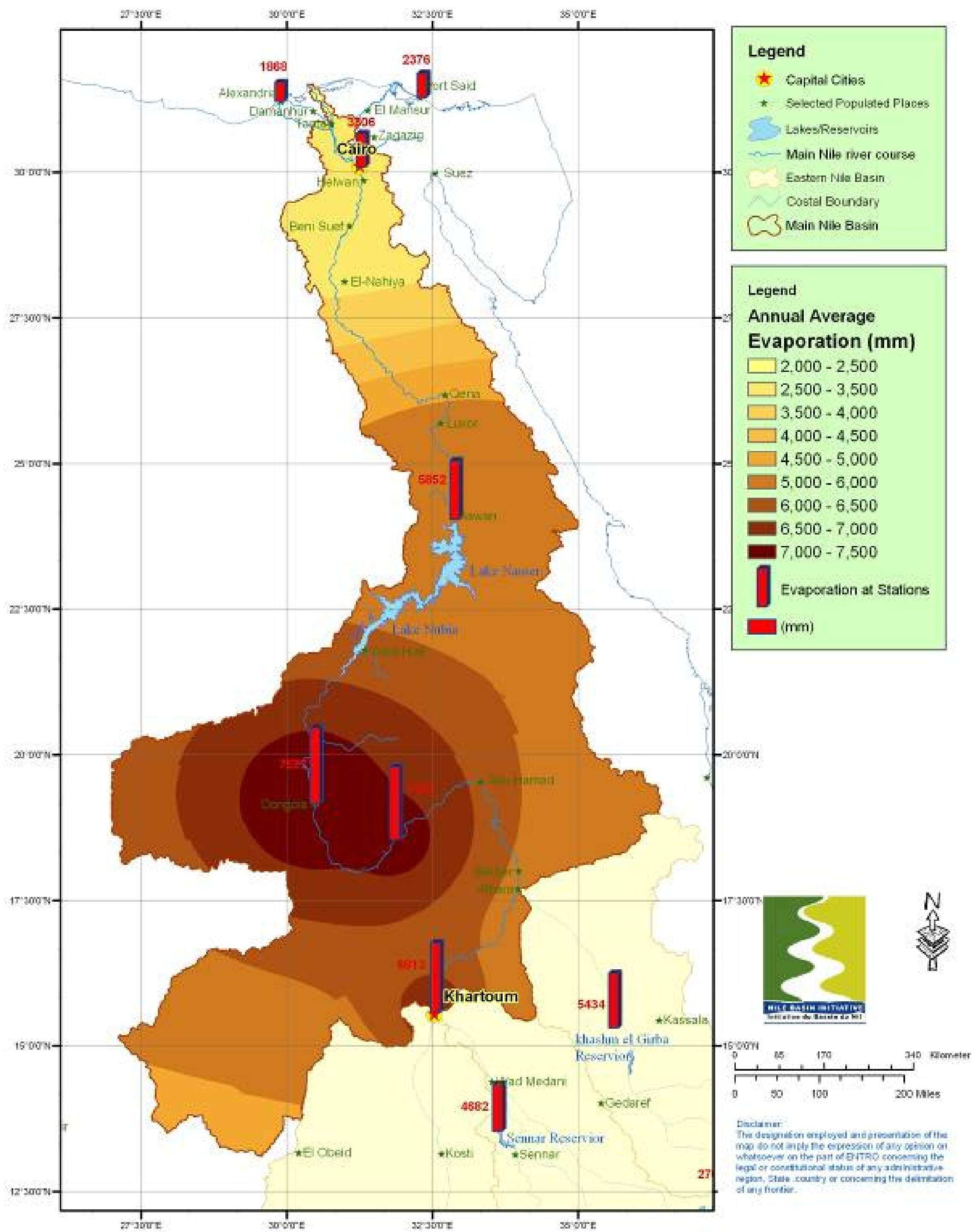
Figure 1.7 Temperature Isoline map of the sub-basin.



Source: ENTRO OSI database

[Raw data source; EGYPT: Egyptian Meteorological Authority, Sudan: Meteorological Authority Sudan, 2006]

Figure 1.8: Evaporation Iso-Line Map of the Sub-basin.



Source: ENTRO OSI database

[Raw data source; EGYPT: OSI National report on Water related Issues Egypt, Sudan: OSI National report on Water related Issues Sudan]

2. SOCIO-ECONOMIC CHARACTERISTICS

2.1. DEMOGRAPHIC CHARACTERISTICS

2.1.1. Population estimates

The Main Nile Basin with a total population of 78,425,160, accounting nearly 50% of the total population of the four sub-basins, is the most populous sub-basin in the EN system. The population in this region was estimated at 1,035,185 in 2004, and is projected to be 1,425,160 in 2005.

2.1.2. Population Growth Rates

- Egypt: 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 per cent, which dropped to 2.4 per cent by 2005. Projections indicated that Egypt's population would be 79 million in 2006, with the expectation that it would continue to grow to a figure of 127 million by the middle of the 21st century. By 2005, the projection indicates that the Egypt main Nile population was 77 million and 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. Table 2.1 reveals midyear population estimates and annual population growth rates for Egypt from 1950 to 2050.

Table 2.1: Midyear Population Estimates: 1950 – 2050

Year	Population ('000)	Year	Population ('000)
1950	21,198	2005	77,506
1960	26,847	2006	78,887
1970	33,574	2007	80,265
1980	42,634	2008	81,636
1990	56,694	2009	82,998
2000	70,492	2010	84,348
2001	71,902	2020	97,295
2002	73,313	2030	109,044
2003	74,719	2040	119,010
2004	76,117	2050	126,921

Source: U.S. Census Bureau, International Data Base, April 2005 Version.

Table 2.2: Average Annual Period Growth Rates: 1950 – 2050

Period	Growth Rate
1950-1960	2.4
1960-1970	2.2
1970-1980	2.4
1980-1990	2.9
1990-2000	2.2
2000-2010	1.8
2010-2020	1.4
2020-2030	1.1
2030-2040	0.9
2040-2050	0.6

Source: U.S. Census Bureau, International Data Base, April 2005 Version.

2.1.3. Population Density

Population density is defined as the total number of people per square kilometer.

- Sudan: In the northern region of Sudan population density is sparse, being less than 1.

- Egypt: Egypt's overall population density in 1990 was only about 54, but close to 99 %of all Egyptians live along the banks of the Nile River in nearly 4 per cent of the country's total area. The average population density in the Nile Valley exceeds 1,500, one of the world's highest densities (Figure 2.1). In this respect, the countries capital, Cairo, is unparalleled.

2.1.4. Crude Birth and Death Rates

- Egypt: In 2000, the crude birth rate (live births per 1000 population) was 26, while the crude death rate (deaths per 1000 population) was 6, giving a rate of natural increase of 2 in 2000. The crude birth rate is estimated to fall to 17 by 2025, while death rates are expected to stay the same at 6, leaving the annual rate of natural increase of around 1.1 (OSI Socio-economic report, p. 162).

2.1.5. Infant Mortality

- Egypt: The infant mortality rate was put at 33 deaths per 1,000 live births down from 94 deaths in the late 1980’s ((OSI Socio-economic report, p. 162).

2.1.6. Life Expectancy At Birth

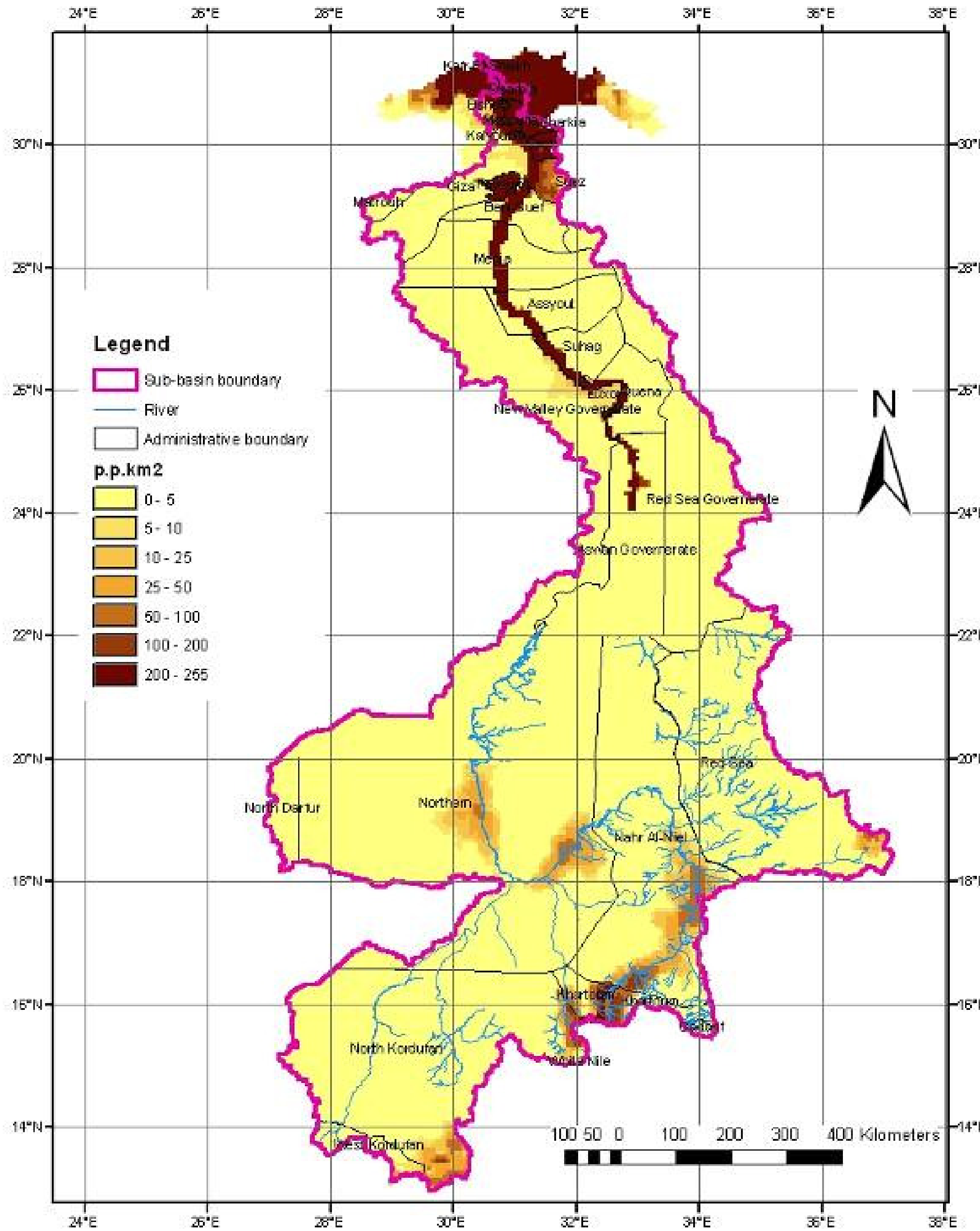
In 2005, average life expectancy in Egypt at birth was estimated at 70 years, up from 59 years for men and 60 years for women in 1989. It is expected to rise to 76 by 2025 (OSI Socio-economic report, p. 162).

2.1.7. Major Ethnic Groups

- Sudan: There is considerable socio-cultural diversity among the population of the Main Nile Sub-basin, mainly on the Sudan portion of the Sub-basin. The main groups are Nubians, Danagla, Bedirya and Rekabia. Along both banks of the Nile itself are the Gaa’lian people who have inherited the rights to use their land and being closest to water were able to survive the devastating drought of 1983/84. Also living both sides of the river are the Shaigia, Kawahla, Kababish and Hassaniya peoples, mainly pastoralists but who also cultivate sorghum along the wadis. As with all the pastoral/agro-pastoral groups wage labour is a major feature of livelihood strategies. Living mainly along the Wadi Muqadam and more recently along the Nile below Korti are the Hawaweer people. Their livelihoods too were devastated by the 1983/84 drought but many have returned and rebuilt their livelihoods
- Egypt: In the Egyptian portion of the sub-basin, there are only two main ethnic groups who live in the eastern part of the Lake sub-basin: the Ababda who comprise some two thirds of the population and the Bishari who make up the other third. The Ababda have live in the southern part of the Eastern Desert for centuries although since the end of the 19th century many have migrated to the towns of the Nile Valley. The current population is estimated to be 15,500. The majority of the inhabitants of the Main Nile Basin, Egyptians to be precise, are Sunni Muslims. They constitute at least 90% of the population, and in other claims 94% to 96%. The Copts, an indigenous Christian group, constitute Egypt's largest religious minority. Estimates of their numbers in 1990 ranged between 3 million and 7 million. The exact size of the Coptic community in Egypt is a

highly contested issue, Muslims and Copts claiming different figures. Other religious groups include Catholics and Protestants. A very meagre minority of Jews not exceeding one hundred individuals down from about 80 to 100 thousands in the early 1950's still live in Egypt. (OSI Socio-economic Synthesis Report p.164)

Figure 2.1: Main Nile Sub-basin: Population Densities and Distribution



Source: Oak Ridge National Laboratory. Landscan 2002 Global Population Database

2.2. ACCESS TO SOCIAL INFRASTRUCTURE

2.2.1. Literacy And Education

- Egypt: In the Main Nile (Egypt), by the academic year 1985-86, about 84% of the primary-school-age population (more than 6 million of the 7.2 million children between the ages of seven and twelve) were enrolled in primary school. Less than 30% of eligible youth, however, attended intermediate and secondary schools. Since as many as 16% of Egyptian children were receiving no education in the 1980s, the literacy rate continued to lag behind, despite the increase in school enrolments, in 1990 only 45% of the population could read and write.

  Girls' primary school enrolment was lowest in Upper Egypt, accounting for only less than 30% of all students. Girls also dropped out of primary school more frequently than boys. About 66% of the boys beginning primary school completed the primary cycle, while only 57% of the girls completed all six grades. Girls accounted for about 41% of total intermediate school enrolment and 39% of secondary school enrolment. Among all girls aged twelve to eighteen in 1985-86, only 46% were enrolled in school (OSI Socio-economic Synthesis Report p. 168)

  Sudan: In Sudan, where data on education is lacking, there are very clear differences in literacy and primary school enrolment rates between Northern and Nile States and Red Sea and North Kordofan States, with the former considerably above the Northern Sudan average. Female rates are below those of males, with Red Sea State well below the average for the Northern States.

Table 2.4: Literacy and Primary School Enrolment Rates for Main Nile Sub-basin States of the Sudan

State	Literate % >15yrs % Average	Literacy >15yrs % Male	Literacy > 15yrs % Female	Pop. 6-13yrs	Total Primary school Enroll.	% Enroll.
SUDAN						
Northern	65.2	75.0	56.6	114,040	100,336	88.0
Nile	64.5	73.6	56.5	186,851	147,477	78.9
Red Sea	47.9	54.5	40.1	154,210	69,290	44.9
North Kordofan	39.1	52.0	29.4	364,719	170,023	46.6

2.2.2. Water Supply

- Egypt: In 1990, approximately 25% of the total population, including 36% of all villagers, in the Main Nile did not have access to safe water for drinking. By the 2000s, the Nile provides almost all the fresh water used by more than 75 million Egyptians living along its banks. Because of limited water resources and high population density, water share per person in Egypt is less than 1,000 cubic meters per year per person, which is relatively low compared to internationally accepted standard (OSI Socio-Economic Synthesis Report pp. 171-172)..

2.2.3. Sanitation

- Egypt: The current situation for potable water and sanitation is far from being satisfactory: Egypt has 217 cities that are 100% covered by potable water network, while the sanitation network covers only 38%. There are also 4,617 villages, 43% of which are covered by potable water network while sanitation network is extended to only 11% (OSI Socio-Economic Synthesis Report pp. 171-172).

2.2.4. Health Facilities

- Sub-basin: The average ratio of hospitals for the sub-basin in 2003 was 1.8.

- Sudan: Disaggregated by state, the ratio was 4.9 (Northern State), 0.8 (Khartoum State). The specialist ratio for the Basin averaged 3.9 per 100,000 people in 2003. The share of the ratio for each state in the region was 3.3 (Northern State) and 12.5 (Khartoum State).

  Egypt: In the main Nile sub-basin in Egypt, the Ministry of Health provides free, basic health care at hundreds of public medical facilities. General health centres offered routine medical care, maternal and child care, family planning services, and screening for hospital admittance. Although public health clinics were distributed relatively evenly throughout the country, their services are generally inadequate because of the shortage of doctors and nurses and the lack of modern equipment. In both cities and villages, patients using the free or low-cost government facilities expect a lengthy journey and a long wait to see a physician; service was usually impersonal and perfunctory. Dissatisfaction with public clinics forced even low-income patients to patronize the expensive private clinics. In rural areas, village midwives assisted between 50% and 80% of all births. Even when women used the maternal care available, prenatal care was minimal, and most births occurred before trained personnel arrived. The government established 1,300 social service centres and 5,100 social care cooperatives by 1990. The social service centres provide instruction in adult literacy, health education, vocational training, and family planning. The social care cooperatives provide similar services and also provided child care service for working mothers, assist the handicapped, and make transport service available for the elderly and infirm. About 65% of the social service centres are in villages while 65% of social care cooperatives are in cities. In many villages, the social service centres were associated with the local public health clinic and supplement the primary health care services. (OSI Socio-economic Synthesis Report p. 170)

2.3. TRANSPORT AND COMMUNICATIONS

2.3.1. Roads

- Egypt: By 1996, there were 64,000 kilometres of roads in Egypt, of which 50,000 were paved and 14,000 unpaved (The World Fact Book, 2003). The highway system is concentrated in the Nile Valley north of Aswan and throughout the Delta; paved roads also extend along the Mediterranean coast from the Libyan border in the west to the border with Israel. In the east, a surfaced road ran south from Suez along the Red Sea, and another connected areas along the southern coast of Sinai from Suez to the Israeli town of Elat. A well maintained route circled through several western oases and tied into the main Nile corridor of highways at Cairo in the north and Asyut in the south. Large areas of the Western Desert, the mountainous areas near the Red Sea, and the interior of the Sinai Peninsula, however, remain without any permanent-surface roads, (OSI Socio-economic Synthesis Report p. 172).

2.3.2. Railways

- Egypt: The state-owned Egyptian Railways has more than 4,800 kilometres of track running through the populated areas of the Nile Valley and the coastal regions. Most of the track is 1.435-meter standard gauge, although 347 kilometres are 0.750-meter narrow gauge. Portions of the main route connecting Luxor with Cairo and Alexandria were double tracked and a commuter line linking Cairo with the suburb of Helwan was electrified. Built primarily to transport people, the passenger service along the Nile is heavily used (OSI Socio-economic Synthesis Report p. 172).

2.3.3. River Transport

- Egypt: Egypt has about 3,500 kilometres of inland waterways. The Nile constituted about half of this system, and the rest was canals. Several canals in the Delta accommodate ocean-going vessels, and a canal from the Nile just north of Cairo to the Suez Canal at Ismailia (Al Ismailiyah) permits ships to pass from the Nile to the Red Sea without entering the Mediterranean Sea. Extensive boat and ferry service on Lake Nasser move cargo and passengers between Aswan and Sudan.

2.3.4. Air Transport

- Egypt: Egypt had sixty-six airfields with paved runways but only the airports at Cairo and Alexandria handled international traffic. Egypt Air, the principal government airline, maintained an extensive international network and had domestic flights from Cairo and Alexandria to Luxor, Aswan, Abu Simbel (Abu Sunbul), and Al Ghardaqah on the Red Sea. A smaller, state-owned airline, Air Sinai, provides service from Cairo to points in the Sinai Peninsula. Zas Passenger Service, the newest airline and the only one that was privately owned, has daily flights from Cairo to Aswan, Luxor, Al Ghardaqah, and points in Sinai.

2.4. ECONOMIC ACTIVITIES

2.4.1. Activity Rates

An activity rate is defined as the proportion of the total economically active (employed plus unemployed) population to the total working age population. The data available on activity rates in the northern region of Sudan, a region downstream of Khartoum and part of the main Nile Sub-basin, indicates that 35% of the population of the Northern State (age 10+ estimated at 363,349 by 1993) was reported to be economically active during the same period. The refined activity rates for males and females were 69% and 6% respectively.

2.4.2. Unemployment Rates

In the main Nile (Egypt), existing data indicate that unemployment levels are increasing among new entrants into the labour market. The rate of unemployment is highest among those who are 15-30 years old (30% unemployment, compared to an overall level of 8-9% according to official statistics). Almost 95% of the unemployed are new entrants into the labour market. The average duration of unemployment is highest among the youth, reaching 39, 63 and 65 months for the age group 20-25 years, 25-30 years and 30-40 years respectively. In the northern region of Sudan, unemployment rate accounts for 9% of the active population for both sexes, 7% for males and 23% for females.

There are significant discrepancies in the unemployment estimates from different sources. The overall unemployment rate was 8% in 1999/2000 according to official estimates, while unofficial estimates suggest that it had reached almost 12%. (Assad, R. 1999; Nassar, H. 1999, Nassar, H. 2001). In 2001/2002, it reached 9.2% according to 2001 census (Labour force Survey, 2001).

In addition to unemployment, economists drew attention to underemployment, or disguised unemployment, which represents the proportion of employed people with the desire and ability to perform additional hours of work, but without access to further work opportunities at the existing wage rate during a particular reference period. There was a consensus that underemployment was rampant in the government bureaucracy, because of overstaffing and low remuneration. In 1990, the government was considering paying private-sector employers a two year salary for every new graduate they hired. It viewed the measure as a means of checking the expansion of the bureaucracy and ameliorating the unemployment problem.

Although Egypt had a high percentage of high-school and college graduates, the country continued to face shortages in skilled labour. Probably 35% of civil servants and 60% of persons in public-sector enterprises were unskilled. The lack of skilled labour was blamed on, among other things, the cultural bias against manual work, the theoretical nature of courses in most higher education institutions, and the emigration of skilled personnel abroad, where they received higher wages. There were complaints that the implementation of development plans was hampered by the insufficient supply of skilled labour (Mohieddin, 2006). (Socio-economic Synthesis Report p. 167)

2.4.3. Livelihood patterns

In Egypt the agricultural sector, fishing included, contributed 16 percent of the GDP in 2003. Before industrialization, agriculture provided most of Egypt's exports, but by 2002 it contributed less than one percent of the exports (Mohieddin, 2006). The most important crops include cotton, cereal grains, fruits and vegetables, and animal fodder. Egypt's area of cultivable land is small but highly fertile. It is located for the most part along the Nile and in the Nile Delta. Yields are high, and almost every piece of land growing at least two crops a year.

Industry, including manufacturing, mining, and construction, contributed 34 per cent of Egypt's GDP in 2003. The main manufactured goods are textiles, chemicals, metals, and petroleum products. More liberal economic policies have led to the establishment of a number of private companies involved in automobile assembly, electronics, consumer durable goods such as refrigerators and other appliances, and pharmaceuticals. The majority of factories are concentrated around the two major cities of Cairo and Alexandria and in industrial zones along the Suez Canal.

Petroleum is Egypt's most important mineral product. It is a major source of export earnings. In the 1980s the government developed the production of natural gas for domestic energy needs. It began exporting natural gas in the 1990's. The main oil and gas fields are located along the Red Sea coast and in the Libyan Desert. Other minerals produced in Egypt include phosphate rock (a source of fertilizer), iron ore, and salt. The sector contributed 50 percent of the GDP in 2003. Important services include government social services such as health and education, financial services, and personal services.

Egypt has a labour force of 26.7 million in which 69 percent male and 31 percent are female, the labour involved in industry (including manufacturing and construction) is 21 per cent. There are few skilled workers, since training is usually rudimentary and one-third of the adult population is illiterate (Mohieddin, 2006). (Socio-economic Synthesis Report p. 164)

2.5. AGRICULTURAL AND PEOPLE

2.5.1. Major Livelihood Activities of Ethnic Groups

There is little difference between the livelihoods of the two major ethnic groups in Egypt. Their economy is based on five elements. In order of preference these are: (i) charcoal production, (ii) sheep herding, (iii) camel herding, (iv) collecting medicinal plants and (v) residual moisture cultivation.

There are seasonal differences: with charcoal production and sheep herding taking place between December and April, cultivation between May and September, and camel herding and medicinal plant collection throughout the year. In the hill areas to the east winter rains are common and people migrate there for sheep herding and charcoal production. One person can produce five sacks of charcoal at £E50 (US$14 at 1993 prices) a sack. For a production unit of three people over a four-month production season this can realize an income of E£3,000 per household. Overheads are negligible and harvesting is reported to be sustainable. Sacks are transported to Allaqi by camel and then either sold to truck drivers of a local quarry, AHDLA or WFP, or get lifts on such lorries.

2.5.2. Agricultural Development around Lake Nasser

There are two main strategies for agricultural expansion in Egypt. The first is agricultural development above the high water level (182 masl) that will require pumping. Two types of pump are proposed: large fixed electric pumps and small portable motor pumps. This development could be large and small scale. The second strategy is the development of land below the full supply level using residual soil moisture and supplementary irrigation (mobile pumps or temporary wells).

The estimates of suitable land above the high water level vary from 0.103 million to 3.82 million feddans. Currently the first phase development is envisaged to be 50,000 feddans in four designated areas. Below the full storage level it is estimated that there is the potential to develop 200,000 feddans. Given the seasonal and year-on-year fluctuations in the Lake level and as a consequence the lateral area available for cultivation this figure is not fixed.

There are a number of potential impacts that such a substantial development could have on the environmental with the Lake Nasser/Nubia catchments. The use of fertilizers and agro-chemicals and their leakages in drainage water into the Lake is an immediate and obvious concern. Currently, experience from the Wadi Allaqi indicates that the regular inundation of the Lake and the nutrients it brings with the sediment is sufficient to keep soils fertile, in particular in terms of nitrogen and phosphorous.

Whilst, cultivation without fertilizers and agro-chemicals may provide adequate yields for the small-scale subsistence farmer they may not be adequate for the large-scale commercial operation. Given the very light textures of the soils the use of chemical fertilizers could give rise to a serious increase in nitrogen levels in the Lake where eutrophication would be possible outcome. Currently, the levels of substances in the lake are well below the danger levels but the use of insecticides and herbicides could rapidly change this.

Currently, there are strict controls on the use of fertilizer and agro-chemicals close the Lake shore. The Bio-organic Control project at Aswan has developed a number of biological controls of plant pests that will obviate the need to use insecticides and fungicides. However, there is an urgent need to establish a comprehensive system of monitoring of agricultural developments and of water quality in the lake.

Large-scale agricultural development will bring with it a number of additional impacts. There will be a substantial rise in the population: some temporary such as the winter cultivators who come from the middle Nile Valley each year to grow vegetables on the residual moisture, but others permanent such as the labourers and support staff for the large-scale developments. These people will require housing and supporting utilities: electricity and water. This will require careful settlement and supporting infrastructure planning as well as adequate waste disposal facilities to prevent pollution of both the Lake and the groundwater resources.

2.5.3. Agricultural development of the Tushka Project

The Tushka Project aims to develop some 500,000 feddans of land using water from the Sheik Fayed canal and from local groundwater resources. Much of this development will be large-scale and thus the numbers of people is likely to smaller than if this was a resettlement scheme for small farmers.

The Government has already installed strict regulations on the use of fertilizers and agro-chemicals. Nevertheless, there will need to be a comprehensive system of monitoring install at the outset if severe pollution of groundwater is to be prevented. Similarly, there is a need for careful planning of settlements and supporting infrastructure and waste disposal facilities.

The modelling by Jeongkon Kim and Mohamed Sultan (2002) to investigate the long-term hydrological impacts of the proposed large scale irrigation development in the Tushka Depression has indicated the danger to the Nubian aquifer of irrigation drainage water causing flooding and salinization. Again, a comprehensive system of groundwater monitoring should be in place at the outset if these negative impacts are to be avoided.

2.5.4. Tourism

In Egypt, tourism is the other important economic sectors, attracted as many as 5.7 million tourists into the country in 2003, providing $4.6 billion in revenues. The majority of visitors make a simple tour that includes Cairo, the great pyramids nearby, and the sites of other ruins and arti-facts of ancient Egypt up the Nile. Many tourists also visit Egypt's Red Sea resorts to take advantage of the warm winter weather. In 1992 attacks on foreigners by Islamic extremists scared off most tourists, but the industry soon recovered. The tourism industry is made up entirely of privately owned businesses.

2.6. FORESTRY AND AGRO-FORESTRY

2.6.1. Man-Made Forests And Programme Implementation Sites

This is to be achieved by establishing forest plantations, i.e. man-made forests. Most of the man-made forests in Egypt are irrigated with treated sewage water, resulting in the production of trees with high quality timber (Figures 2.2).

In addition, Egypt has developed, and is currently implementing, a strategy for combating desertification. This includes the establishment of nurseries for the afforestation of new roads, the improvement of existing plantings along roads, and the stabilization of sand dunes through tree planting. Some of the main objectives of this National Program or NAP are as follows:

- Solve the problem of 2.4 billion cubic meter of accumulated wastewater; disposal of such quantity represents a major environmental problem;
- Benefiting from this huge water quantity and not squandering a water resource that could be exploited economically;
- Limiting the discharge of wastewater into the River Nile or in seas in order to prevent bacteriological and chemical pollution of water (from heavy elements and harmful organic compounds), and the degradation of fish wealth, river and marine bio-ecological systems
- Transforming an area of 400,000 feddans from desert into ecologically rich areas in terms of: Preserving the soil; enriching natural and biological components in arid and semi-arid areas; forming attraction and development zones for potential inhabitants of these areas; and, adding productive desert lands to the agricultural environmental system.

2.6.2. Other Cultivators

After 1988 reservoir levels began to rise, with full storage levels again reached during the 1990s. In 1989 the World Food Program (WFP) agreed to launch a joint program with the

High Dam Lake Development Authority whereby WFP would provide food for work to reclaim land along the lake-shore for agriculture as well as for the eventual construction of 33,000 houses (Poeschke 1996). By the mid-1990s 10,000 feddans had been reclaimed in three upper reservoir areas that Nubians had first attempted to pioneer in the late 1970s. Nubians, however, are only one of the people involved; others included non-Nubian fisher/farmers from Upper Egypt as well as Beja pastoralists from the eastern desert and the Red Sea coast who have begun to graze and water their stock around the edges of the reservoir. Whether or not the Nubians, as the former residents of the area, will be able to compete successfully against these other pioneers remains to be seen.

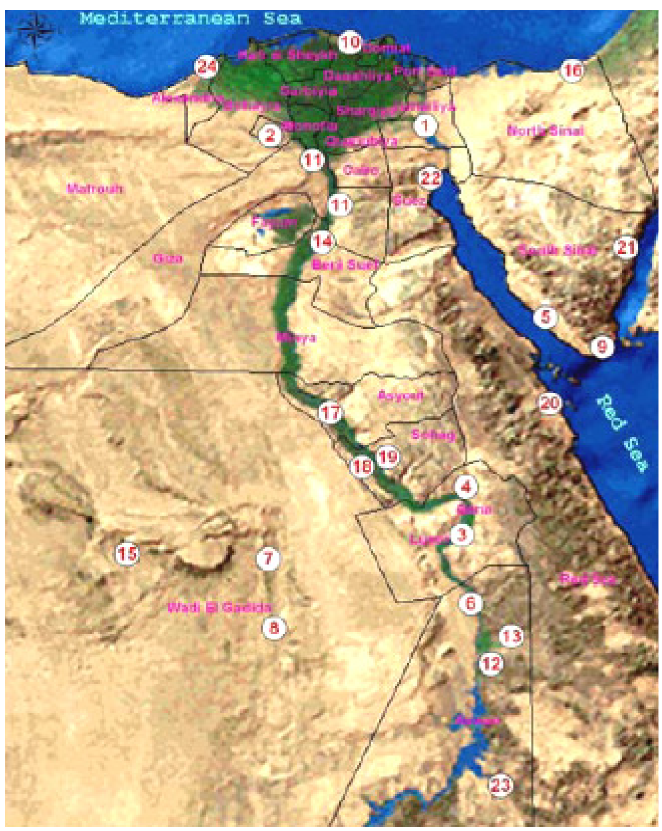
2.7. FISHERY

Fishing is a significant industry in Egypt. Large quantities of fish live in the Nile, the Mediterranean Sea, and the Red Sea. It accounts for about 20 percent of both GDP and total exports, and about 34 percent of total employment (OSI Socio-economic Synthesis Report p. 165).

2.8. ON-GOING FOREST ACTIVITIES AND FUTURE PLANS

Afforestation are currently cultivated and irrigated with treated sewage water (Figure 3). Some timber forests have been planted, and there are plans for providing necessary funding for cultivating 80 thousand feddans of forest-trees (10 thousand feddans annually), adjacent to sewage water treatment plants on the desert backlog. The project aims to cultivate 400,000 feddans using 2.4 billion cubic meter of treated wastewater annually.

Figure 2.2: Forest locations in Egypt



Source: OSI Environmental National report of Egypt, Section: “Ecological Zones & Forest”

2.2 POVERTY PROFILE

2.2.1 Poverty Measurement

There are considerable regional disparities in the accessibility of social services in Egypt. The main features of access to social services are: the appropriation and concentration of most of the services in Cairo with the other urban governorates of Alexandria, Port Said and Suez combined running a distant second. Rural areas are mostly deprived of such services, be it cultural, religious, health, entertainment, and so on.

A recent survey in Suhaj governorate indicates that health facilities "are limited in the rural areas. In the Governorate there are 149 rural health units, one school health unit, 35 health centres and 9 hospitals. Of the 16 villages surveyed, 10 had a health unit within the village, and for others distance to be travelled varied from 0.5 kilometres to 5 kilometres. Although the overall number of health facilities in the Governorate is reasonable, existing facilities are primarily in the towns and many of them are insufficiently equipped, as well as lacking in most basic supplies for much of the time.

2.2.2 Vulnerability Indicators

Vulnerability is also considered in the Main Nile Basin in view of women and workers rights. Domestic violence is a serious social problem in Egypt. According to one report, one out of three married women has been beaten by their husbands. Additionally, marital rape is legal. Female Genital Mutilation still occurs, and the majority of women have to undergo this procedure. In the business world, women are guaranteed pay equal to that of men, but there are strong societal pressures against women being employed.

Legally, many laws, particularly inheritance laws, favour males, and men who kill women receive lighter sentences than women who kill men under similar circumstances. Labour laws in Egypt do not provide adequately for union members; work strike is illegal and punishable by imprisonment. Many governments-mandated labour laws are not enforced, such as minimum wages and maximum hours. While child labour was a serious problem in Egypt in the past, there has been marked improvement recently.

Children in poverty, working children, as well as the elderly are the other groups which are especially vulnerable. Children in the Upper Egypt are considered to be especially more vulnerable than others in this regard. The status of other minorities like the Bedouins, Copts, and other linguistic groups is also subject investigation as far as their vulnerability is concerned. Human Rights Watch reports provide ample documentation on the situation of these groups. Prison inmates and AIDS patients, among others, are also other groups considered vulnerable.

3. NATURAL RESOURCES AND ENVIRONMENTAL ISSUES

3.1. GEOLOGY

The main underlying geological formations within the Main Nile Sub-basin include the older Basement Complex rocks, the Nubian Sandstones, Tertiary unconsolidated sediments and recent superficial wind blown sands. The Basement Complex comprises gneisses, schists, marbles and intrusive granites and basic rocks. The Nubian Sandstones overly unconformably? 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.

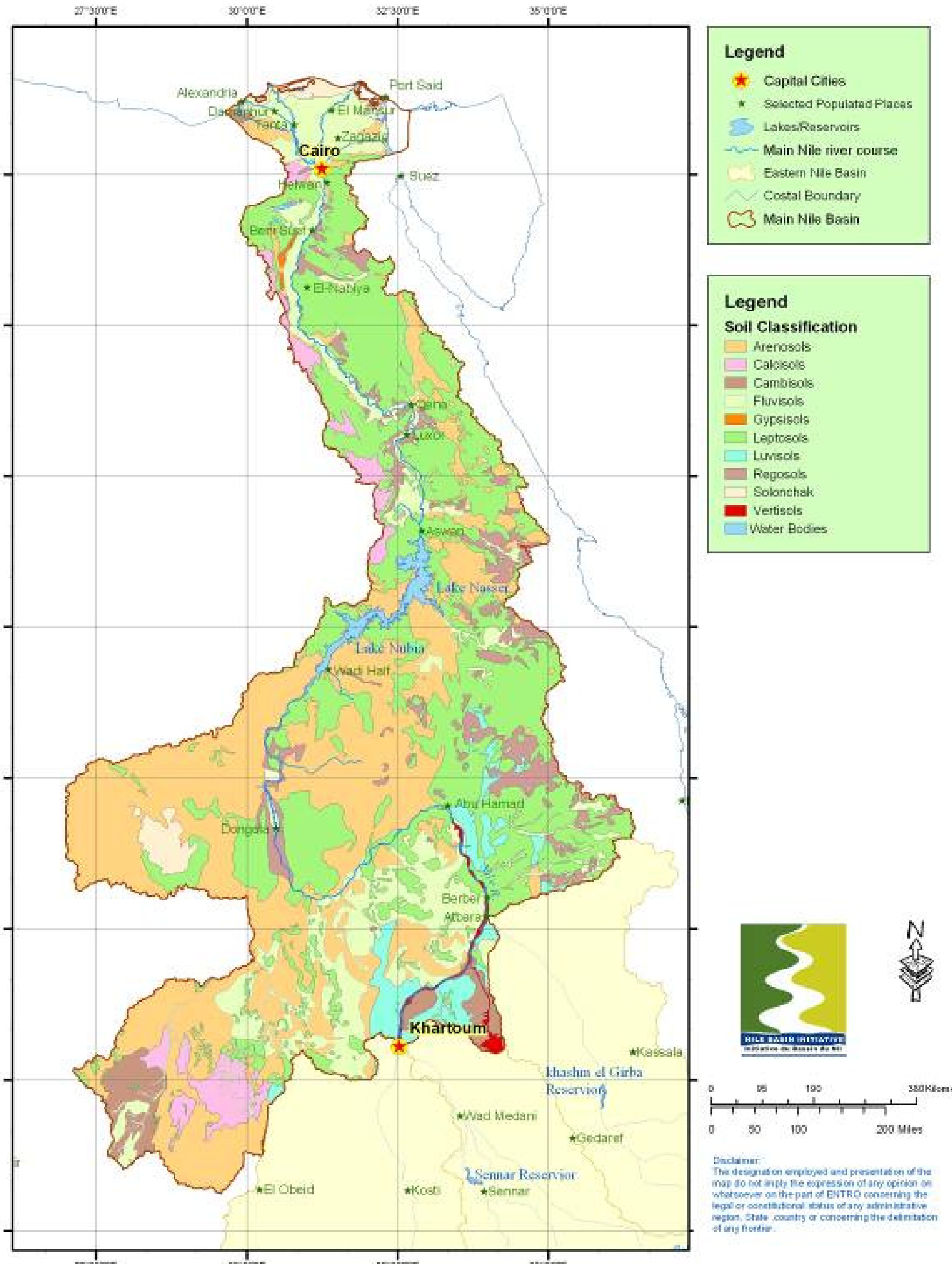
3.2. SOILS

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 are 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 valley 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 of 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. Running water (although extremely infrequent) represents the most important source of soil parent material.

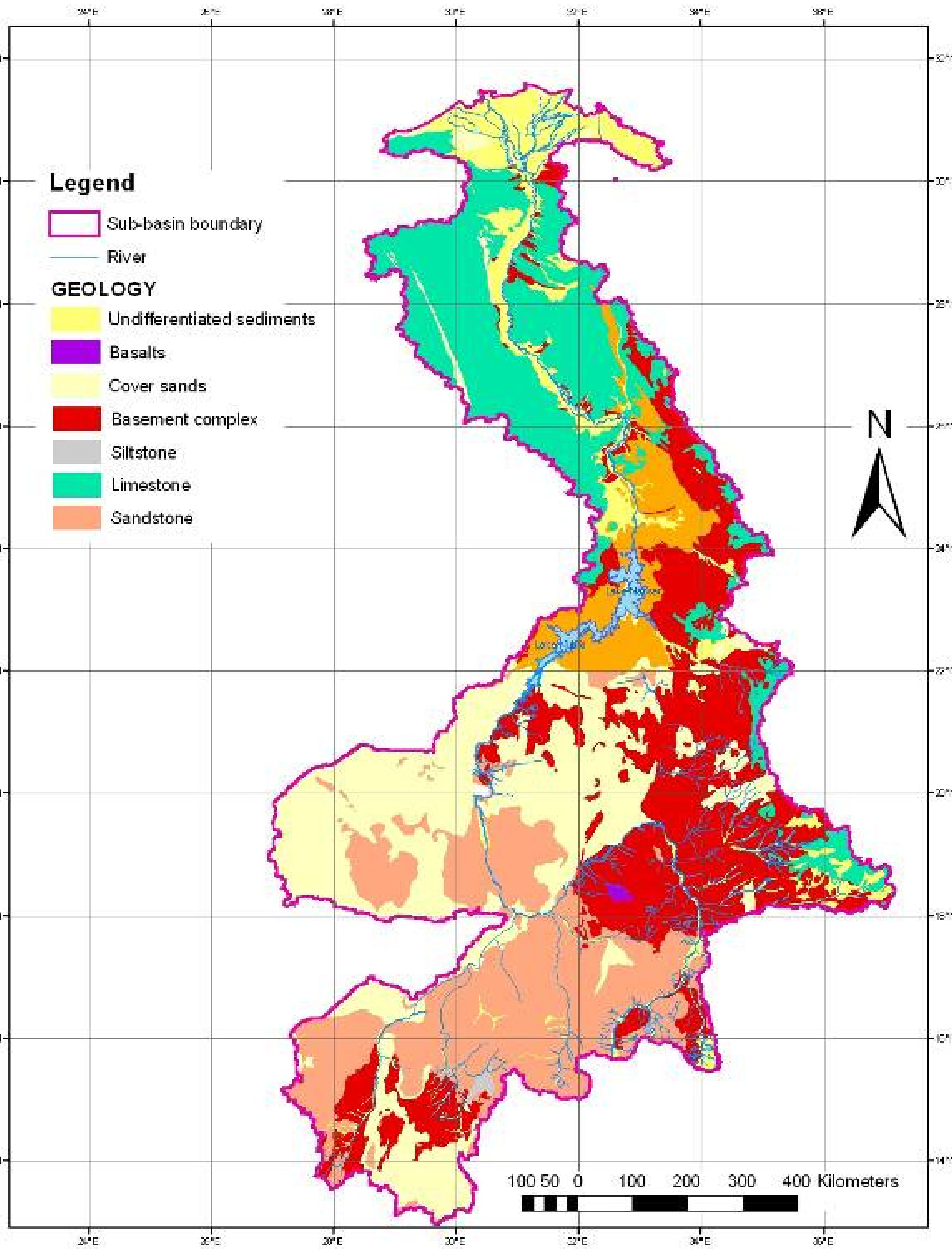
The greatest effect on soil quality is the influence of lake water on soil properties. The position of the lake shore is highly variable depending on the annual variations superimposed on larger long-term variations. Annual variations are in the range of 6 to 7 meters, whilst the 1978 -1988 range was 37 meters. Two processes are important: deposition of silt from the lake during inundation and changes in chemistry of the surface soil layers during and immediately after inundation. The lake sediment 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 a lower pH – from 9.00 where the soil 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 soil's ability to supply phosphate and some trace elements.

Map 3.1 Main Nile Sub-basin: Geology



***Source*:** ENTRO OSI database
[Raw data source: FAO, 1998 "Soil and Terrain Database for Northeast Africa]

Map 3.2 Main Nile Sub-basin: Geology



***Source*:** EN Cooperative Regional Assessment for watershed management Report 2007
[Raw data source: FAO, 1998 "Soil and Terrain Database for Northeast Africa]

Table 3.1: Characteristics and classification of soils in the Nile Delta

Order	Suborder	Order	Suborder	Great groups	Sub groups
Entisols	Fluvents	Torrifluvents	Typic Torrifluvent	6.1	Sandy loam, fluvial, non saline
		Ustifluvents	Typic Ustifluvents	1.1	Fine loam, highly saline, 1% slope
			Veritc Ustifluvents	2.0	Fluviomarine, clay, highly saline 1-2% slope.
	Psamments	Quartzi-psamments	Tyic quartzi-psamments	2.3	Sandy, slightly saline, 2% slope.
Aridisols	Orthids	Salorthids	Aquolic salorthids	9.9	Sandy to clay, highly saline, 1-2% slope
Vertisols	Torrerts	Haploterrerts	Typic haplotorrerts	77.1	Caly, non saline, 1-2% slope
		Salitorrerts	Typic salitorrerts	1.5	Clay, highly saline, 1-2% slope

Source: – OSI Environment Synthesis Report, p. 33

3.3. LAND COVER AND LAND USE

The patterns of natural vegetation closely follow those of mean annual rainfall, although locally edaphic conditions can provide a stronger influence. However, the biotic factors (grazing, cutting, burning and cultivation) are now of almost equal importance to the physical environment in determining the exact composition of vegetation communities.

On 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 100 mm isohyets. Semi desert scrub exists in those areas of the sub basin that falls above the 100 mm isohyets and accounts only 5% of the sub basin. (OSI Water Synthesis Report, p. 181)

3.4. VEGETATION

3.4.1. Vegetative Types in the sub-basin

- **Desert:** North of the 75 mm isohyet generally desert or semi-desert conditions prevail with little or vegetation except along wadis with a high water table. Occasional years of very good rainfall can transform areas of desert into valuable grazing areas known as "gizzu".

- **Semi-Desert Scrub:** Between the 75 and about 250 mm isohyets "Semi-desert Scrub" is the most prevalent vegetation type, and comprises a varying mixture of grasses and herbs, generally with a variable scatter of shrubs up to 4 meters high interspersed with bare earth.

- **Tree species:** On sandy soils to the west of the Main Nile tree species include Leptadenia pyrotechnica, A. Senegal and A. tortilis subsp. spirocarpa and raddiana. On the clay plains there are a number of plant communities associated with specific habitat characteristics related to local topography and eroded, runoff and run-on sites. The most common tree species that have a wide "sociological tolerance" include: Acacia tortilis subsp. tortilis and raddiana, A. nubica, and Caparis decidua. A. Nubia and Calotropis procera are common in the vicinity of villages and are indicators of overgrazing. Along the inundated areas of the Blue Nile A. nilotica, A. albida and

A.seyal are common. A. nilotica is also found at the outlets to wadis which pour into the Nile and which receive flood water.

- **Grasses:** The grasses are mainly annuals. Heavy grazing and low rainfall ensures that there is insufficient dry matter for annual fires. In years of low rainfall and heavy grazing there can be an almost complete failure of annual plant growth. On very sandy soils Panicum turgidum is likely to be the dominant grass. This is an excellent grass for stabilizing sand dunes as well providing adequate browse. Aristida spp. are usually dominant on stabilized sands and on the shallow light textured surface materials, with Schoenefeldia gracilis dominating on the clay soils. Other ephemeral grass species include Sporobulus cordofanus, Dactyloctenium aegyptium, Eragrostis cilianensis and Tragus berteronianus.

3.4.2. Vegetation around Lake Nasser

There is a zoning of vegetation around the Lake Nasser/Nubia from the water's edge. Normally, this stretches only tens to hundreds of meters from the Lake shore but along the Wadi Allaqi this zoning has been stretched over some 30 kilometres from the lowest water mark recorded to the highest (177.5 masl). Annuals characterize the zone closest to the water's edge typically dominated by Glinus blitoides, together with Portulaca oleracea, Helianthemum spinum, Amaranthus blitoides and the grasses Erogrostis aegyptica, Fimbrystilis bis-umbellata and Crypsis schoenoides.

In the middle zone Tamarix nilotica is dominant. In the central section the stands are mono-specific, and individual plants may be large, exceeding 5 meters. The highest zone is characterized by a vegetative type dominated by the composite shrub Pulicaria crispa that replaces T. nilotica. It appears to mark the highest levels attained by Lake Nasser. Associated with P. crispa are Acacia ahrenbergiana, A. raddiana, Cassia senna and Citrillus colocynthis.

A recent study suggests that the Tamarix nilotica community is both new and almost unique within this desert area. It has a clear affinity with the flora present in earlier pluvial periods in this area of North Africa. Evidence for this is provided in fossil plant remains found in sand hillocks of the upper wadi Allaqi dated to about 500-800 years BP. There is no record of T. nilotica being found in its present position prior to the filling of Lake Nasser other than along the river bank zone.

Burning and cutting of T. nilotica by local communities, as well mechanical clearing by the Aswan high Dam lake Authority are leading to its destruction. The upper Pulicaria community is being uprooted by machine and taken by the truck load as fuel.

3.4.3. Changes in vegetation

Comparison of floristic composition from past studies with recent annual field observations of the Khartoum State range department have revealed no drastic change in floristic composition. However, a change in the species density could be observed. There are indications of movement or shift to the south for all subdivisions in this ecological zone. This shift is understandable and could be attributed to recent changes in rainfall, drought and man activities. The tree layer, and specially that of Maerua crassifolia and Commiphora africana, is the most affected due to browsing, over cutting and effects of drought.

3.5. WETLANDS

Lakes and Wetlands: 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). Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al, 1979). Wetlands in the Main Nile sub basin 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). (OSI Environment Summary Report p. 25)

3.6. BIODIVERSITY

Egypt's unique geographical position at the junction between two large continents (Africa and Asia), and its inclusion as part of the Mediterranean Basin, has permanently influenced both the people and the biota of the country socially, economically and biologically.

As part of the Sahara of North Africa, Egypt has the climate of the arid Mediterranean region, with notable differences between the coastal and inland areas. Under such harsh geographical and bio climatic conditions, it is to be expected that the biotic wealth of Egypt is not only poor relative to the total area of the country, but also sparse and widely scattered.

In the process of identifying the different types of fauna and flora in Egypt, certain groups (e.g. flowering plants) have been carefully surveyed and well documented, while others (e.g. mosses and liverworts) have not received adequate attention. Each of these habitats has its unique fauna and flora and numerous land and marine areas are listed as protected sites. An estimated 18,000 species of flora and fauna are in Egypt. With regard to flora, there are 44 species of viruses, 238 bacteria, 1,260 fungi, 1,148 algae, 369 non-flowering vascular plants and 2,072 flowering plants species. The fauna include 10,000 species of insects, 1,422 other vertebrates, 755 fishes, 105 reptiles and amphibians, 470 birds and 126 species of mammals. However, until to date, there are no clear statistics that quantify the rate of biodiversity loss in Egypt (OSI Environment Synthesis Report p. 35).

Table 3.2: Status of Species in Egypt

Category	Known	Common	Uncom mon	Rare	Threaten-ed	Vulnera ble	Endang ered	Extin ct	Insufficie ntly known
Marine algae	753	260		493					
Freshwater algae	871	794						77	
Avifauna	452	436			5	10	1		
Mammals	98	41		28			10	5	14
Terrestrial Reptiles	91	41		22	11	6	11		
Terrestrial Amphibians	7	4		3					
Freshwater Reptiles	4			3				1	
Freshwater Amphibians	7	3		4					
Mollusks	41	24		16				1	
Echinoderms in the Red Sea, Gulfs of Aqaba and Suez, and Suez Canal	207	131		76					
Echinoderms in the Mediterranean Waters	48	30		18					
Cartilaginous Fishes	56	12	35	9					

Category	Known	Common	Uncom mon	Rare	Threaten-ed	Vulnera ble	Endang ered	Extin ct	Insufficie ntly known
in the Mediterranean									
Bony Fishes in the Mediterranean Waters	297	84	177	35				1	

Egypt's biodiversity has faced threats from various sources. These include intensive agriculture systems, which entail the widespread use of agricultural chemicals in the form of fertilizers and pesticides. Another source of threat is the effects of industrialization. Industrialization programs have accelerated enormously in the second half of the 20th century, and have contributed to the rapid deterioration of the environment. Moreover, excessive hunting of animals and destruction of plant life have endangered the existence of several species of resident and migratory birds, as well as a number of hoofed animals (e.g. gazelles and antelopes).

Accordingly, Egypt is exerting tremendous effort to combat the threats to biodiversity through the conservation of wildlife, natural resources and natural habitat. This is clearly manifested in the declaration of 21 protected areas by prime ministerial decrees in accordance with Law 102/1983, covering about 8% of the total national surface, with plans to have this extended further to 17% by 2017.

3.7. MAJOR ENVIRONMENTAL ISSUES RELATED TO WATER

3.7.1. Overview

The Egyptian coastline extends for 3,000 kilometres (World Resources 2004) along the Mediterranean Sea and Red Sea beaches in addition to the Suez and Aqaba gulfs. Natural conditions on Egyptian Mediterranean coasts differ significantly from those on the Red Sea coasts in terms of salinity, sea currents and temperature. Such difference has led to different biodiversity and ecosystems in each. Nearly 40% of industrial development activities are practiced in Egyptian coastal zones, in addition to a number of urban and tourism development activities. Furthermore, coastal zones monopolize the seaports infrastructure, in addition to agricultural and land reclamation sectors, as well as a developed road network capable of accommodating all development aspects. Egyptian coastal zones production is estimated at 85% of Egypt's production of oil and natural gas; The Gulf of Suez production alone is estimated to be 36 million tons. In addition, the crude oil and natural gas production in the Mediterranean coastal zones is increasing every year.

Through many joint efforts on the regional and international levels under the Global Program of Action for the Prevention of Marine Pollution From land-based Activities (GPA/LBA & MEDPOL), it was possible to identify many polluted areas in need of urgent action. Most of the adverse impacts were identified and their volume estimated in order to enable their elimination. Data pointed out to the existence of hot spots that need special attention where pollution has exceeded permissible limits, such as Abu Qir and El Max. Environmental inspection program results indicated an increase in the number of land-based sources that have adjusted their status and complied with Egyptian Laws and regulations, or that have active environmental compliance programs in place.

Moreover, evidence provided by applied marine environment quality monitoring programs showed a noticeable improvement in the quality of marine environment since the launching of these programs in 1998, particularly at hot spots in the Mediterranean Sea.

The policy measures to tackle environmental degradation comprise both preventive measures and long-term policies. The preventive measures are carried out through the regular assessment of the water quality status and suitability for various uses. Moreover preventive measures include enforcement of laws to protect water resources from pollution. The Ministry of Water Resources and Irrigation formulated a National Program for Water Quality Monitoring in the Nile, canals and drains and Lake Nasser. The Central Laboratory carries out the substantial lab work for Environmental Quality Management affiliated to National Water Research Centre. The monitoring program includes 300 locations for surface water and 230 locations for groundwater. The long term policies to control pollution include covering open conveyance system passing through urban system to closed conduits; coordinating with other concerned ministries to set priorities for wastewater treatment plants due to budget limitation; introducing environmentally safe weed control methods either mechanical, biological or manual and banning the use of chemical herbicides. Subsidies on fertilizers and pesticides were removed and some long lasting agricultural chemicals were also banned. Public awareness programs are introduced to promote the issue of conserving Egypt's water resources in terms of quality and quantity. (OSI Environment Synthesis Report pp. 44-45)

3.7.2. Water Related Diseases

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 diarrhoea 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 contaminated 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 faecal 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.

3.7.3. Soil Degradation and Contamination

The use of traditional inefficient irrigation techniques and the inadequacy of drainage systems have led to the increase in water logging and salinization. Salinity is a potential limiting factor that stifles land productivity in Egypt. Over-exploitation of water for irrigation has led to the depletion of groundwater resources, which has resulted in excessive intrusion of salt water from sea into ground water aquifers.

According to published research, vehicle emissions affect the soil of the agricultural land around traffic roads. A strip of at least 40 meter parallel to the Cairo-Alexandria Agricultural Road receives air pollutants, mainly lead, carbon monoxide, nitrogen oxides and sulphur dioxide. These pollutants fall on the plants as well as passing directly into the soil.

Pollutants carried by irrigation water are also a major source of soil pollution. An estimated 50 per cent loss of productivity of agricultural land was recorded at Helwan and Shoubrah El-Kheima. Severe damage to plants has been reported in areas close to the industry in Kafr El-Zayat, Edfu, Abu Za'abal and others. Toxic heavy metals accumulate in the tissues of vegetation grown adjacent to sources of air pollution, such as lead smelters, and near traffic roads.

3.7.4. Baseline Status of Lakes and Wet Lands

Lake Manzala: Lake Manzala is the largest northern lake. It is situated in the northeast corner of the Nile Delta, and falling in the jurisdiction of five governorates. It is separated from the Mediterranean Sea by a sandy beach ridge, which has three open connections (bugaz) between the lake and the sea. The surface area of the lake is 280,000 feddans. Lake Manzala has the largest fishery production (78,261 tons in 1998) compared to the other northern lakes. The fish species of the lake have been changed, which previously were characterized as marine fish. After the construction of Aswan High Dam (AHD), the mullet –based brackish water fishery has been replaced by tilapia–based fisheries due to the constant inflow of freshwater with high nutrient concentration. Tilapia represented about 51% of the lake fishery, while mullet represented about 3.6% of the total harvest. (OSI Environment Synthesis Report p. 26)

Lake Burullus: Burullus Lake is situated along the Mediterranean coast and occupies a more or less central position between the two branches of River Nile. The lake is oval in shape with estimated area of about 114,520 feddans. It is a shallow basin with variable depth ranging between 0.6 and 1.6 meters. The lake has about 70 islands, of which 55 are artificially created by filling reed-infested area with soil. Burullus Lake receives its water from different sources:

- Sea water, through natural inlet at it's northeast border;
- Brackish water dumping from agricultural reclaimed areas and drains; and
- Brackish-salty water, through the bramble Manila on the wet coast.

After the closure of AHD, margins of the lake were made to develop for land reclamation for agriculture expansion. Eight drains were constructed to leach the soil salinity into the southern shore of the lake. Burullus Lake is considered one of the highly productive lakes in the Mediterranean with about 31% of the delta lake's area. Burullus Lake produced 59,033 tons, representing about 42% of all delta lakes. It has the most productive mullet fishery of the delta lakes due to wide lake- sea connection, which allows high recruitment of mullet fry from the sea each year. (OSI Environment Synthesis Report p. 26)

Edku Lake: It is the smallest northern delta lakes. It is located about 30 kilometres to the Northeast of Alexandria. The lake area reaches about 27,470 feddans. Edku lake is the third fishery productive among delta lakes (10,280 tons in 2001). The source of lake water is coming from two agricultural drains. Bersik drain enters the lake from the southern edge and Edku drain enters from eastern side of the lake. Exchange of water between the northern side of the lake and the sea is insured through a narrow slit 'Boughaz El-Maadia'. The area of the lake is divided into three basins due to emergence of a number of islets. The salinity of Edku lake varies locally and seasonally. It fluctuates from less than 0.09 % in the eastern basin to about 1.4 % at El-Maadia region inside the Boughaz. Edku lake contributes 7% of the overall production of northern lakes (10,300 tons), of which 90% Tilapia and only 5% mullet. (OSI Environment Synthesis Report p. 27)

Qarun Lake: Qarun lake is an inland closed basin of 23,000 hectare, and an average depth of 8 meters. In the ancient times, Qarun Lake was connected with river Nile forming a natural reservoir of freshwater, which supplied Fayoum depression with floodwater of the Nile. Whenever the lake became disconnected from the river Nile, its water level lowered and its surface shrunk due to evaporation, until a new flood raised its level and size again. Consequently, salinity has been steadily increasing. The mean salinity had increased from about 11 ppt in 1906 to about 34 ppt in 1982, and at present, the average salinity reaches 39 ppt. It is estimated that 589,000 tons of salt enters the lake annually. If the level of salinity continues to increase, it may reach 50 ppt by the year 2020 transforming the lake into a dead sea. The only source of water supplying the lake is the agricultural drains (especially wadi and Bats drains). (OSI Environment Synthesis Report p. 27)

Coastal Zone: The Egyptian coastline extends for 3,000 kilometres (World Resources 2004) along the Mediterranean Sea and Red Sea beaches in addition to the Suez and Aqaba gulfs. Natural conditions on Egyptian Mediterranean coasts differ significantly from those on the Red Sea coasts in terms of salinity, sea currents and temperature. Such difference has led to different biodiversity and ecosystems in each. Nearly 40% of industrial development activities are practiced in Egyptian coastal zones, in addition to a number of urban and tourism development activities. Furthermore, coastal zones monopolize the seaports infrastructure, in addition to agricultural and land reclamation sectors, as well as a developed road network capable of accommodating all development aspects. Egyptian coastal zones production is estimated at 85% of Egypt's production of oil and natural gas; The Gulf of Suez production alone is estimated to be 36 million tons. In addition, the crude oil and natural gas production in the Mediterranean coastal zones is increasing every year.

Through many joint efforts on the regional and international levels under the Global Program of Action for the Prevention of Marine Pollution From land-based Activities (GPA/LBA & MEDPOL), it was possible to identify many polluted areas in need of urgent action. Most of the adverse impacts were identified and their volume estimated in order to enable their elimination. Data pointed out to the existence of hot spots that need special attention where pollution has exceeded permissible limits, such as Abu Qir and El Max.

Environmental inspection program results indicated an increase in the number of land-based sources that have adjusted their status and complied with Egyptian Laws and regulations, or that have active environmental compliance programs in place.

Moreover, evidence provided by applied marine environment quality monitoring programs showed a noticeable improvement in the quality of marine environment since the launching of these programs in 1998, particularly in the Mediterranean Sea at the Hot Spots.

3.8. WATER QUALITY

3.8.1. Water quality

- **Pollution of the Nile**

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.

The 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.

- **Assessment of Ambient Water Quality Status**

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.

3.8.2. Industrial and Agricultural Pollution

At present industrial use of water is estimated at 5.9 bcm per year out of which 550 mcm per 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. More detailed information about water consumption, wastewater discharge and point sources of pollution and loads from different industrial sectors are provided in Tables 3.2 to 3.5.

Table 3.2: Industrial wastewater discharge to the river Nile system

District	Ultimate sink (M m3/yr.)*				Total
	Nile	Canals	Drains	Lakes	
Upper Egypt	192	5	2	5	204
Greater Cairo	80	21	20	7	128
Delta	27	85	13	1	126
Alexandria	13	7	33	35	88
Others	0	0	3	1	4
Total	312	118	71	49	550

Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.3: Water use and wastewater discharged from different industrial sectors

Industrial Sectors	(Mcubic meter/yr.)			
	No. of Plants	Water Use	Water Discharge	Consumption
Chemical	53	127	98	29
Food	119	296	277	19
Textile	75	114	88	26

Industrial Sectors	(Mcubic meter/yr.)			
	No. of Plants	Water Use	Water Discharge	Consumption
Engineering	39	13	12	1
Mining	11	69	60	9
Metal	33	19	14	5
Total	330	638	549	89

Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.4: Pollution loads discharged to different districts

District	Flow (Mm^3/d)	(ton/day)					
		BOD	COD	Oil	TSS	TDS	HM
Upper Egypt	204	37	72	5	68	532	0.2
Greater Cairo	128	71	120	93	97	135	0.75
Delta	125	34	42	24	86	224	0.5
Alexandria	88	91	186	45	40	246	0.17
Other Gov.	5	2	3	1	5	15	0.03
Total	550	235	423	168	296	1152	1.65

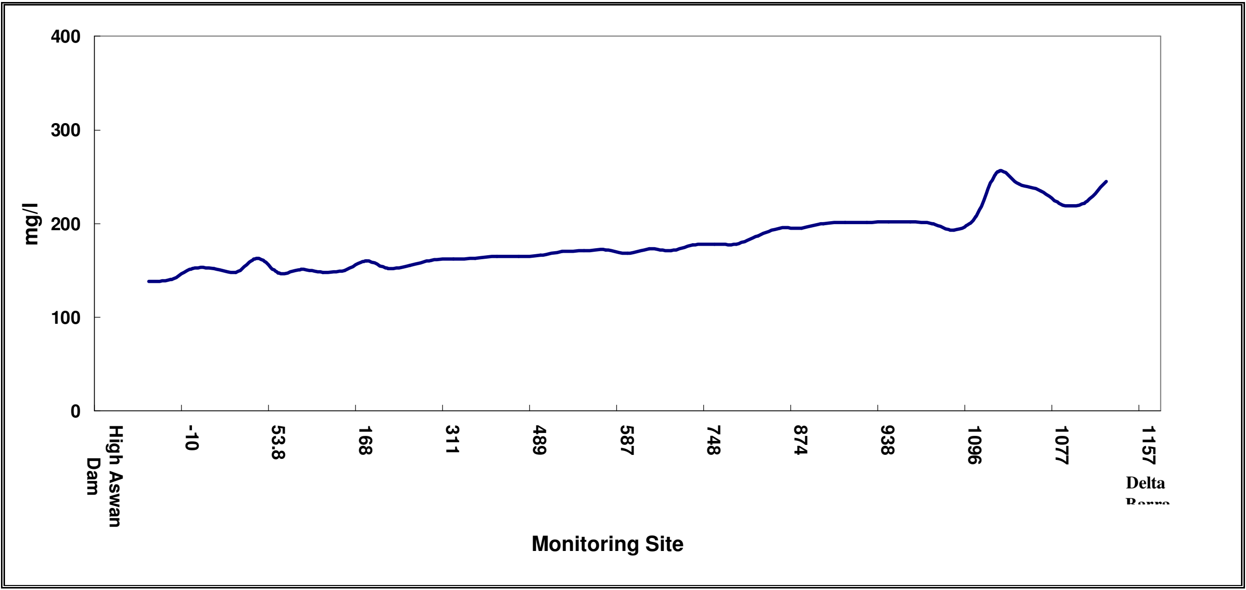
Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.5: Pollution loads from different industrial sectors

Industrial Sectors	Flow (Mm^3/d)	Ton/day					
		BOD	COD	Oil	TSS	TDS	HM
Chemical	98	26	178	23	33	241	0.94
Food	277	142	182	110	168	666	0.17
Textile	88	39	47	24	64	191	0.3
Engineering	12	5	7	2	3	13	0.03
Mining	60	14	17	8	24	29	0.2
Metal	14	3	-	1	4	11	0.01
Total	549	225	431	168	296	1151	1.65

Source: Wahaab, R.A.and Badawy, M.I. (2004)

Figure 3.2: TDS for the River Nile as of February 2000



Source: OSI Environmental National report of Egypt, Section: “water Quality and Monitoring”

3.8.3. Sources of pollution

- **Upper Egypt:** Sources of industrial pollution along the Nile in Upper Egypt area are mainly agro-industrial and small private industries. Sugar cane industries significantly influence Nile water quality at Upper Egypt-South zone. Hydrogenated oil and onion drying factories influence Nile water quality at Upper Egypt-North zone.
- **Greater Cairo:** The area has a population of approximately 18 million and encompasses many industrial and commercial activities. Heavy industry is located around, south and north of Cairo. Many small industries and some heavy industry are randomly located throughout the city. Although wastewater discharges of the small industries are generally low, concentrations of certain industries in specific areas, such as the tanning industry may cause local contamination problems. An overview of pollution sources include 23 chemical industries, 27 textile and spinning industries, 7 steel and galvanizing industries, 32 food processing industries (including a brewery), 29 engineering industries, 9 mining and refraction industries, and petrol and car service stations, bakeries (>350), marble and tile factories (>120) and tanneries in South Cairo.
- **Lake Nasser:** Generally speaking, water released from Lake Nasser mostly exhibits the same seasonal variation and the same overall characteristics from one year to another. Downstream changes in river water quality 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.
- **River Nile from Aswan to Delta Barrage:** ***Chemical Contamination***: From the available data, the following can be concluded that Dissolved Oxygen Concentration (DO) situation is not alarming. Specific “hot spots”could not be detected. In all monitored sites, DO concentrations were higher than 7.0 mg O2/l, indicating the high assimilation capacity of the Nile. Chemical Oxygen Demand (COD) values showed slight, but steady increase from south to north. 21 samples out of the 35 samples were not complying with the standard value given by law 48/1982 for ambient water quality (10 mg O2/l). Biochemical oxygen Demand (BOD5) which is a measure for

biodegradable organic compounds showed a random distribution but did not exceed the standard value (6 mg O2/l) given by the law. The relationship between COD/BOD values indicates the presence of non-biodegradable organic compounds, from industrial sources. An increase in TDS from 171 mg/l at Aswan to 240 mg/l at the Delta Barrage has been recorded. But this is within the permissible limit given by the law.

Biological Contamination: Law 48/1982 did not specify a standard for faecal coliform (FC) counts for the ambient water quality of the Nile River. Therefore, the value given by the WHO (1989) as a guideline for use of water for unrestricted irrigation (103/MPN 100ml) has been taken as a guide for the evaluation of the water quality in this report. The results of the microbiological examination indicated a great variation in the spatial distribution of the faecal coliforms counts. Great excesses have been found around the catchments areas of Kom Ombo, El-Berba, Main Ekleet and Fatera drains. FC counts in the water samples taken from the specific bank side, where the drain water is pumped, are even higher. This proves the presence of untreated human wastes in these drains.

- **Damietta and Rosetta Branches:** The Rosetta receives water of a number of agricultural drains, which are heavily polluted by industrial and domestic sewage. The drains receive large parts of the wastewater of Cairo. The wastes in the drains contain high levels of suspended and dissolved solids, oil, grease, nutrients, pesticides and organic matter. It is suspected that toxic substances are present as well. The Damietta Branch also receives polluted water from a number of agricultural drains; The Fertilizer Company is considering the major point source of industrial pollution at Damietta branch.

Table 3.6: Industrial wastewater discharge to the river Nile system

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Others	0	0	3	1	4
Total	312	118	71	49	550

Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.7: Water use and wastewater discharged from industrial sectors (cubic metres/year)

Industrial Sectors	No. of Plants	Water Use	Water Discharge	Consumption
Chemical	53	127	98	29
Food	119	296	277	19
Textile	75	114	88	26
Engineering	39	13	12	1
Mining	11	69	60	9
Metal	33	19	14	5
Total	330	638	549	89

Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.8: Pollution loads discharged to different districts

District	Flow (Mm^3/d)	(ton/day)					
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Other Gov.	5	2	3	1	5	15	0.03
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Source: Wahaab, R.A.and Badawy, M.I. (2004)

Table 3.9 Pollution loads from different industrial sectors

Industrial Sectors	Flow (Mm^3/d)	Ton/day					
		BOD	COD	Oil	TSS	TDS	HM
Chemical	98	26	178	23	33	241	0.94
Food	277	142	182	110	168	666	0.17
Textile	88	39	47	24	64	191	0.3
Engineering	12	5	7	2	3	13	0.03
Mining	60	14	17	8	24	29	0.2
Metal	14	3	-	1	4	11	0.01
Total	549	225	431	168	296	1151	1.65

Source: Wahaab, R.A.and Badawy, M.I. (2004)

- **Alexandria Area:** Alexandria is a major industrial centre with some 175 industries, about 25 per cent of the total in Egypt. These industries include paper, metal, chemical, textile, plastic, pharmaceutical, oil and soap and food processing. The plants are reported to contribute some 20 percent of the total wastewater of Alexandria. The industries discharge their effluents mainly to Lake Mariut and partially to the sewerage network. According to a survey made by Drainage Research Institute, different types of industrial wastes are disposed to Lake Mariut. At least 17 factories discharging directly to the lake through pipelines, 4 factories collect their wastewater in trenches. Moreover, nineteen factories are lying in the vicinity of the treatment plants, 22 factories discharging to nearby drains and then to the lake.

3.8.4. Factors responsible for contamination of Egyptian Waters

Eighty percent of the urban population is reported to have acceptable sanitation, including toilet facilities (55% in developing countries). Seventy-seven percent of the urban population is connected to public sewers.

In rural areas only 5% of the population is connected to sewers and only about 25% is considered as having some sanitary facilities (15% in developing countries) (Egypt Environment Action Plan).

About 20% percent of the total population (5% urban and 25% rural) lacks safe public drinking water supplies and rely instead on potentially contaminated, untreated surface water or hand pumps which tap often contaminated shallow groundwater.

Not all the existing sewage treatment facilities are providing complete secondary treatment of wastewater, and the effluents discharged are either only partially treated or left untreated, especially in the rural areas of Egypt. In addition, in most cases many industries combine their wastes with sewage, discharging them into fresh waterways.

It is worth mentioning that the total amount of BOD discharged to the river Nile by industrial plants equals 270 ton per day. This amount corresponds to the untreated discharge of wastewater from more than six million people. It can be concluded that these substances are discharged mainly from the industrial activities in the Greater Cairo region and in Delta (0.75 and 0.50 ton per day). The average concentration of heavy metals (HM) in the effluent is less than 5 g/1, which is slightly, more than a normal background.

The chemical industry is responsible for more than 60% of the heavy metal discharges. The high BOD load from the food processing industry is attributable to 10 sugar factories between Aswan and Cairo, for which the total BOD load was estimated at 490 ton/day in 1980. More recently the BOD load from some sugar factories has been reduced significantly due to recovery of molasses at the source. Since the economic viability of this industry is not clear, a restructuring program for the industry would need to consider both environmental and economic viability issues for the industry.

The contamination of natural water results in increased water purification costs and rates. Currently, there are a total of 63 drinking water treatment plants drawing from surface waters, 13 from the Nile and 50 from canals. In 13 of the 26 provinces, drinking water comes from unsafe sources, water samples collected from these provinces showed a high percentage of samples not complying with the bacteriological standards. This was more evident in northern delta, in Damietta, Ismailia, Port Said, Matrouh and Giza.

One of the major problems in potable water supply is the estimated 50 percent loss of water in the distribution networks. This problem costs the Government a huge amount of money every year. The annual amount of lost water in networks is estimated at 2.95 BCM. If the estimated cost of operation and maintenance for one cubic meter is L.E. 0.45, the annual wasted fund is almost L.E. 1.3 billion. This amount is equivalent to the total annual investment of the National Organization for Potable Water, And Sanitation Drainage (NOPWASD).

Poor quality of drinking water is a concern in many parts of Egypt. This is due, in part, to the fact that sources of raw water for many areas have become increasingly polluted, and therefore require more sophisticated treatment to produce drinking water of adequate quality. Furthermore, water treatment units are not always functioning properly as a result of lacking maintenance and proper operation. Even when water treatment is satisfactory, drinking water is sometimes contaminated in leaking distribution network, which are infiltrated for example by sewage. Rooftop water storage tanks have also been identified as another source of bacterial contamination of drinking water (OSI Environment Synthesis Report p. 46).

Domestic Pollution: Available information revealed that the total wastewater flows generated by all governorates, assuming full coverage by wastewater facilities, is estimated to be 3.5 bcm per year. Approximately, 1.6 bcm per year receives treatment. By the year 2017, an additional capacity of treatment plants equivalent to 1.7 bcm is targeted (National Water Resources Plan, 2002). Although the capacity increase is significant, it will not be sufficient to cope with the future increase in wastewater production from municipal sources, and therefore, the untreated loads that will reach water bodies are not expected to decline in the coming years, as demonstrated in Table 5.

In many cases, domestic wastewater is collected from the centre of the towns and from the villages and, dumping it into a nearby irrigation canal is quite common. Therefore, domestic waste disposal significantly contributes towards water quality degradation. It is worse mentioning that no well-controlled sludge management program exists in Egypt. This may, especially in urban areas such as Greater Cairo, lead to inadequate sludge disposal, cause general environmental problem and, in the worst case, eventually influence water quality in a negative way.

Table 3.10 Projections of wastewater treatment coverage

Year	Population	People Served	People Not Served
1997	60 Million	18 Million	42 Million
2017	83 Million	39 Million	44 Million

The constituents of concern in domestic and municipal wastewater are: pathogens, parasites, nutrients, oxygen demanding compounds and suspended solids. In Greater Cairo and other cities, the sewerage systems also serve industrial and commercial activities. Therefore, instances of high levels of toxic substances in wastewater have been reported. As these toxic substances (heavy metals and organic micro-pollutants) are mainly attached to suspended material, most of it accumulates in the sludge. Improper sludge disposal and/or reuse may lead to contamination of surface and ground water.

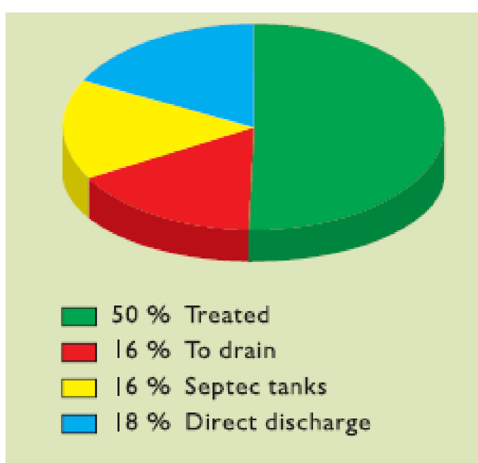
In general, the bulk of treated and untreated domestic wastewater is discharged into agricultural drains. Total coliform bacteria reach 106 MPN/100 ml as recorded in some drains of Eastern Delta. It is important to mention that all drains of Upper Egypt flow back into the Nile. Many irrigation canals and agricultural drains may be contaminated with pollutants from domestic and industrial sources. Moreover, many of irrigation and agricultural drain are used for irrigation.

The total amount of domestic wastewater has been estimated at 3.6 BCM for the year 1995/96.

Approximately 24 percent of the population of Egypt is connected to sewerage services; however this value is expected to grow rapidly, due to works under construction. The population without connection to sewerage systems relies on individual means of treatment and disposal, mainly on-site treatment such as septic tanks. Often on-site solutions are ill designed and poorly maintained. There is, however, little information available to support this argument.

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. (Source – OSI Environment Synthesis Report pp. 46-47)

Figure 3.4: Domestic Wastewater in Egypt



Source: Egyptian Ministry of Water resources and irrigations, 2005

Agricultural Pollution resulting from Use of Agrochemicals: Agriculture is also a major water polluter. Wastewater seeping from agriculture fields is considered non-point sources of pollution. These non-point sources are, however, concentrated through collecting agricultural drains from point sources of pollution for the River Nile, the Northern Lakes or irrigation canals in case of mixing water for reuse. Moreover, these non-point sources of pollution may also influence the groundwater quality. Major pollutants in agricultural drains are salts; nutrients (phosphorus and nitrogen); pesticide residues (from irrigated fields), pathogens (from wastewater), and toxic organic and inorganic pollutants (from domestic and industrial sources) (OSI Environment Synthesis Report p. 47). Agricultural pesticides are both a potential diffuse source of water contamination.

Agricultural Drains: According to the National Water Resources Plan for Egypt (NWRP 2001), the Nile River from Aswan to Delta Barrage receives wastewater discharge from 124 point sources, of which 67 are agricultural drains and the remainder is industrial sources. Figures (2, 3) show the industrial and the agricultural drain outfall points schematically.

- **Drains in Upper Egypt and South Cairo**: - Physico-chemical characteristics and faecal coliform counts of 43 major drains at the tail ends, before discharge into the Nile are presented in Table 9. The parameters that are non-compliant with Law 48 are shown shaded in the table. The data indicates that out of the 43 drains, only 10 are complying with the standards set by Law 48/1982 (Article 65) regulating the quality of drainage water, which can be mixed with fresh water. This is demonstrated graphically in Figures (2 and 3) for selected parameters. The remainder of the drains exceeds the consent standards in one or more of the parameters. The worst water quality is that of Khour El-Sail Aswan, Kom Ombo, Berba and Etsa drains. In terms of organic load, it was found that the highest organic load is discharged from Kom Ombo drain (218.1 ton COD/d, 59.7 ton BOD/d). This is followed by El-Berba drain (172.7 ton COD/d; 59.7 ton BOD/d), (Table 13). The shaded values highlight the drains that are the worst cases by far. It is worth mentioning that these two drains contribute 76% of the total organic load (calculated as COD) discharged into the Nile by drains from Aswan to Delta Barrage. This is followed by Etsa drain which contributes about 11% of the total COD load (56.8 ton COD/d).
- **Drains in the Delta**: Delta drains are mainly used for discharge of predominantly untreated or poorly treated wastewater (domestic and industrial), and for drainage of agricultural areas. Therefore, they contain high concentrations of various pollutants such as organic matter (BOD, COD), nutrients, faecal bacteria, heavy metals and pesticides. The drainage water is becoming more saline; on average its salinity increased from 2,400 g/m3 in 1985 to 2,750 g/m^3 in 1995. But there are local variations. For example, in the southern part of the Nile Delta drainage water has salinity between 750 and 1,000 g/m^3, whereas the salinity in the middle parts of the Delta reaches about 2,000 g/m^3 and in the northern parts between 3,500 and 6,000 g/m^3. In a recent study published by DRI (2000), it has been estimated that the Delta and Fayoum drains receive about 13.5 BCM/year. Almost 90% of which is contributed from agricultural diffuse source, 6.2% from domestic point sources, 3.5% from domestic diffuse sources and the rest (3.5%) from industrial point sources. It was also found that Bahr El-Baqar receives the greatest part of wastewater (about 3 BCM/year). This is followed by Bahr Hados, Gharbia, Edko and El-Umoum, with an average flow of 1.75 BCM/year for each. The wastewater received by the rest of the drains is less than 0.5 BCM/year for each. In terms of organic loads, as expressed by COD and BOD values, Bahr El-Baqar drain receives the highest load followed by Abu-Keer drain. Also, El-Gharbia Main receives significant amounts of organic pollutants.

Table 3.3: Water Quality of Agricultural Drains: Upper Egypt.

No.	Drain Name	Location (KM)	Discharge mm3/day	COD mg O_2/l	BOD mg O_2/l	DO mgO_2/l	TDS mg/l	FC MPN/100ml	Heavy Metals
	Consent Standard			15 mg/l	10 mg/l	5 mgO_2/l	500 mg/l	5.00E+03	3
1	Khour El sail Aswan	9.9	0.10	102	32.80	1.91	1190	3.25E+04	0.31
2	El Tawansa	37.3	0.01	8	1.01	6.16	710	3.50E+03	0.50
3	El Ghaba	46.6	0.19	11	1.00	7.8	570	1.85E+03	0.75
4	Abu Wanass	47.2	0.20	7	1.28	7.03	463	3.00E+03	0.39
5	Main Draw	48.9	40 l/s	17	1.48	7.34	460	3.00E+04	0.61
6	El Berba	49.1	0.15	113	42.70	3.85	414	2.25E+04	0.70
7	Com Ombo	51.0	0.14	151.6	41.50	2.25	325	2.25E+04	2.15
8	Menaha	55.0	-	4	1.52	7.86	285	7.50E+03	0.26
9	Main Ekleet	57.0	0.02	4	1.53	9.21	340	1.50E+03	2.44
10	El Raghama	64.7	0.04	10	1.55	8.56	390	1.75E+03	0.30
11	Fatera	70.5	0.78	5	2.04	7.7	564	3.50E+03	0.54
12	Khour El sail	70.8	0.17	2	1.05	9.07	500	2.00E+03	0.34
13	Selsela	73.9	50 l/s	3	1.25	6.38	380	3.20E+03	1.26
14	Radisia	99.9	0.13	16	3.06	9.02	1430	2.30E+03	0.22
15	Edfu	116.2	0.27	15	1.59	9.49	817	3.00E+03	2.37
16	Houd El Sebaia	139.5	0.05	16	1.83	6.77	495	1.75E+04	0.76
17	Hegr El Sebaia	149.1	0.05	19	2.55	7.82	670	4.50E+03	0.51
18	Mataana	187.7	0.12	39	3.15	6.45	613	1.75E+04	1.29
19	El Zeinia	236.0	NA	NA	NA	*	*	*	NA
20	Habil El Sharky	237.7	0.08	30	1.78	8.45	560	4.00E+02	1.06
21	Danfik	251.6	0.01	34	2.52	8.51	367	1.50E+03	1.05
22	Sheikia	265.3	0.06	37	1.72	7.55	662	3.75E+03	4.68
23	El Ballas	270.7	0.01	144	10.78	9.17	1395	1.50E+04	0.59
24	Qift	275.9	0.03	30	1.60	9.11	375	2.50E+03	0.39
25	Hamed	331.2	0.07	11	1.00	7.18	1015	9.00E+02	0.35
26	Magrour Hoe	340.4	0.06	21	3.24	8.2	185	1.60E+03	1.05
27	Naga Hammadie	377.8	0.21	13	2.17	8.11	375	3.30E+03	1.67
28	Mazata	392.8	0.01	10	2.19	8.37	495	2.50E+02	0.23
29	Essawia	432.7	0.07	9	2.43	6.61	200	1.50E+03	0.51
30	Souhag	444.6	0.05	9	2.81	7.42	440	8.00E+02	0.38
31	Tahta	486.4	0.01	21	2.01	7.86	980	1.40E+03	0.29
32	El Badary	525.4	0.12	6	3.27	7.25	255	9.00E+02	0.48
33	Bany Shaker	588.6	0.02	13	2.25	7.47	485	1.00E+04	0.30
34	El Rayamoun	637.4	NA	21	15.85	2.77	290	1.50E+03	0.16
35	Etsa	701.2	0.57	100	38.00	1.58	575	3.50E+04	0.19
36	Absoug	780.5	0.19	29	1.89	7.34	640	3.00E+03	0.34
37	Ahnasia	807.2	0.54	14	1.31	7.08	610	3.75E+03	0.26
38	El Saff	871.3	NA	NA	NA	*	*	*	NA
39	El Massanda	879.6	0.14	45	4.99	5.57	715	3.00E+03	0.19
40	Ghamaza El Soghra	884.5	0.06	42	2.52	6.37	235	9.50E+02	0.46
41	Ghamaza El Kobra	885.0	0.05	32	3.79	7.39	290	7.50E+02	0.28

***Source*:** OSI Environmental National report of Egypt, Section: “water Quality and Monitoring”

Fig 3.5: COD values of Upper Egypt drains at their points of discharge into the Nile

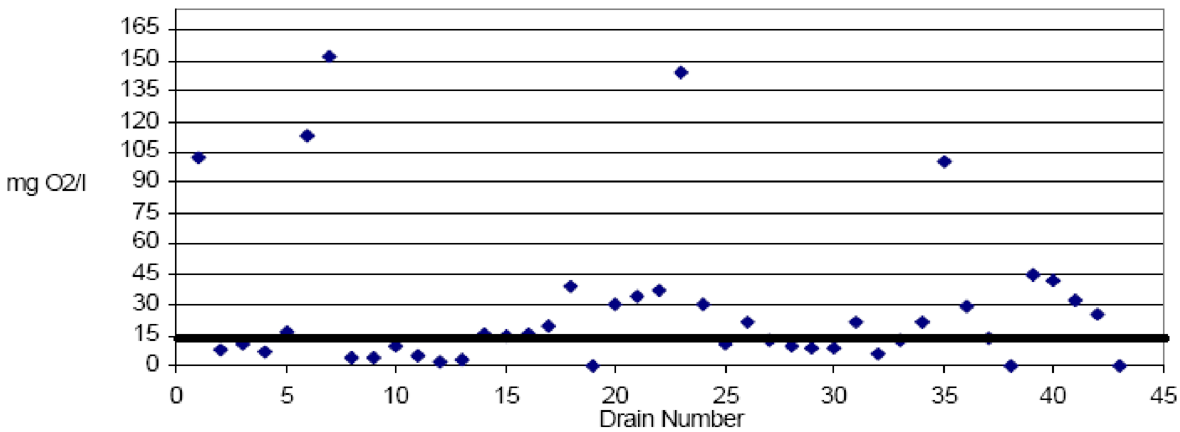


Fig 3.6: BOD values of Upper Egypt drains at their points of discharge into the Nile.

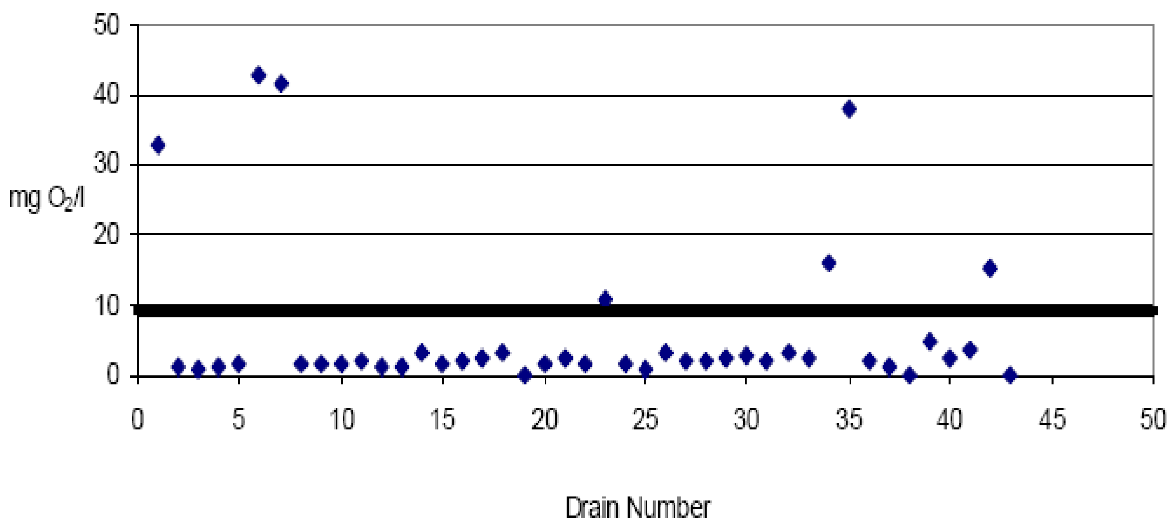


Fig 3.7: TDS values of Upper Egypt drains at their points of discharge into the Nile.

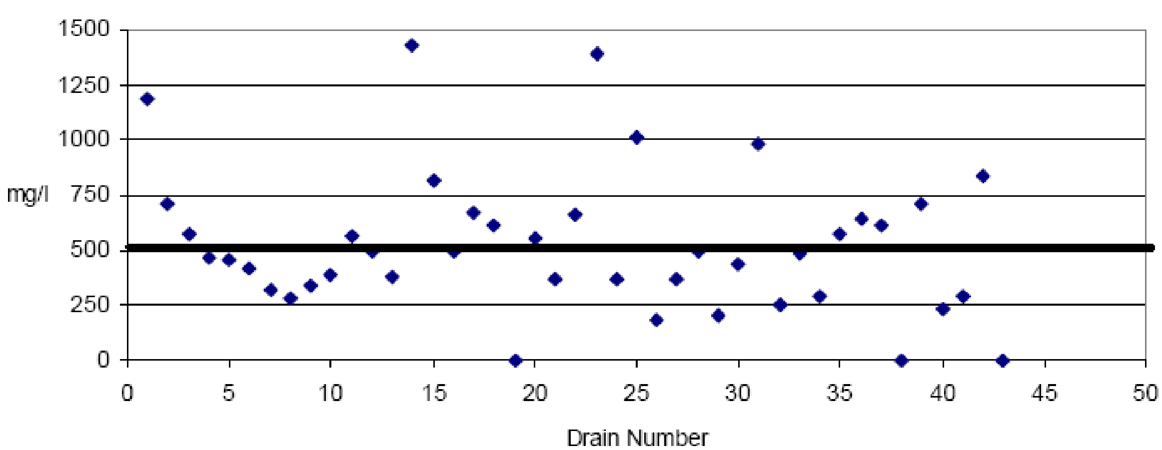


Fig 3.8: FC count in Upper Egypt drains at their points of discharge into the Nile.

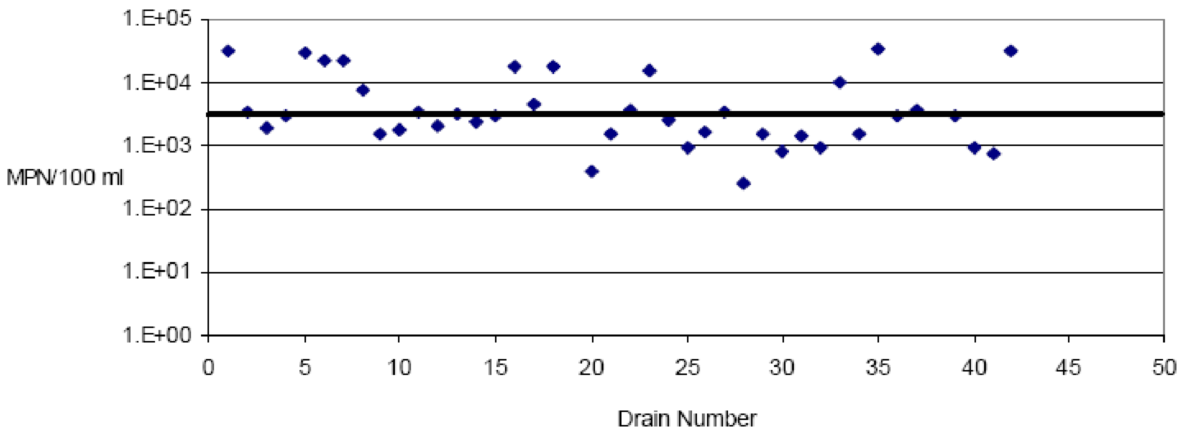
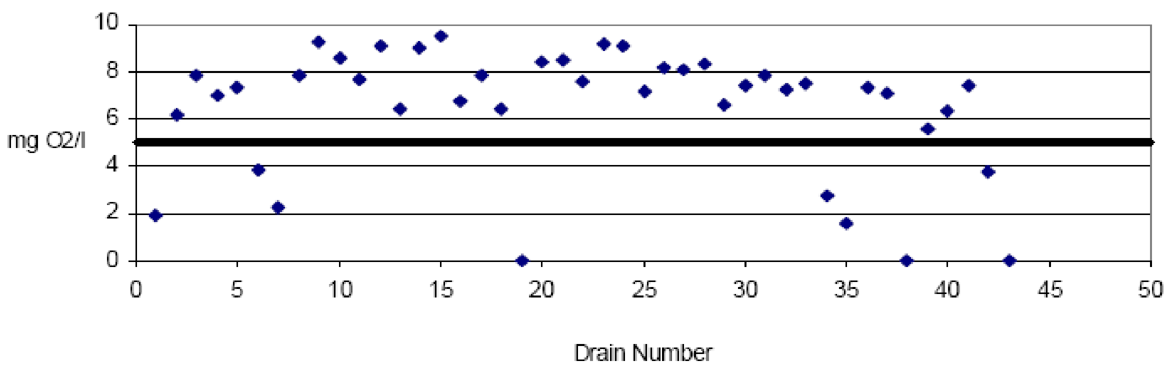


Fig 3.9: DO concentrations of Upper Egypt drains at their points of discharge into the Nile.



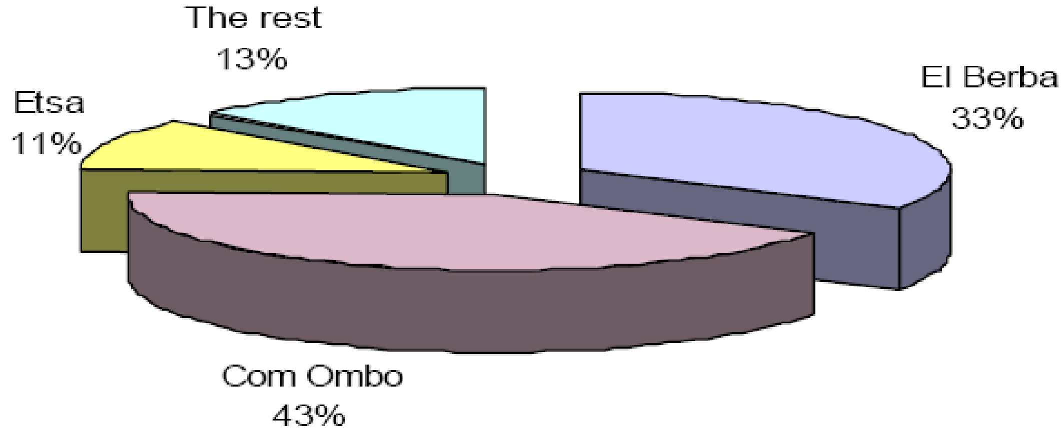
Sources of the above figures: Monitoring Campaign by MWRI, 2001

Table 3.4: Loads of organic and inorganic pollutants into the Nile from Upper Egypt drains.

No.	Drain Name	Location (KM)	Discharge mm3/day	COD kg/day	BOD kg/day	Heavy metals kg/day
1	Khour El sail Aswan	9.9	0.098837	10.08137	3.241854	0.030333075
2	El Tawansa	37.25	0.006484	0.051872	0.006549	0.003245242
3	El Ghaba	46.55	0.194087	2.134957	0.194087	0.146341598
4	Abu Wanass	47.15	0.199061	1.393427	0.254798	0.078330504
5	Main Draw	48.85	0.003456	0.058752	0.005115	0.002106432
6	El Berba	49.1	0.15282	172.6866	65.25414	0.10720323
7	Com Ombo	51	0.143865	218.0993	59.70398	0.309122726
8	Menaha	55	NA	0	0	0
9	Main Ekleet	57	0.020166	0.080664	0.030854	0.049174791
10	El Raghama	64.65	0.044712	0.44712	0.069304	0.013346532
11	Fatera	70.45	0.779492	3.89746	1.590164	0.418197458
12	Khour El sail	70.75	0.170387	0.340774	0.178906	0.058016774
13	Selsela	73.85	0.00432	0.01296	0.0054	0.005454
14	Radisia	99.85	0.1307	2.0912	0.399942	0.02908075
15	Edfu	116.2	0.2689	4.0335	0.427551	0.63742745
16	Houd El Sebaia	139.5	0.048989	0.783824	0.08965	0.037256135
17	Hegr El Sebaia	149.1	0.049541	0.941279	0.12633	0.02524114
18	Mataana	187.7	0.122499	4.777461	0.385872	0.158207459
19	El Zeinia	236	NA	0	0	0
20	Habil El Sharky	237.7	0.079119	2.37357	0.140832	0.084222176
21	Danfik	251.55	0.008224	0.279616	0.020724	0.00865576
22	Sheikia	265.3	0.05983	2.21371	0.102908	0.279794995
23	El Ballas	270.7	0.006383	0.919152	0.068809	0.003788311
24	Qift	275.9	0.032637	0.97911	0.052219	0.012744749
25	Hamed	331.2	0.067068	0.737748	0.067068	0.023239062
26	Magrour Hoe	340.35	0.058709	1.232889	0.190217	0.061497678
27	Naga Hammadie	377.8	0.2149	2.7937	0.466333	0.35920535
28	Mazata	392.75	0.005868	0.05868	0.012851	0.001329102
29	Essawia	432.7	0.074202	0.667818	0.180311	0.037731717
30	Souhag	444.55	0.0475	0.4275	0.133475	0.01826375
31	Tahta	486.4	0.006276	0.131796	0.012615	0.001829454
32	El Badary	525.4	0.11994	0.71964	0.392204	0.05703147
33	Bany Shaker	588.6	0.019602	0.254826	0.044105	0.005968809
34	El Rayamoun	637.4	NA	0	0	0
35	Etsa	701.15	0.567976	56.7976	21.58309	0.105359548
36	Absoug	780.5	0.194386	5.637194	0.36739	0.066965977
37	Ahnasia	807.2	0.541652	7.583128	0.709564	0.138933738
38	El Saff	871.3	NA	0	0	0
39	El Massanda	879.6	0.14148	6.3666	0.705985	0.02624454
40	Ghamaza El Soghra	884.5	0.059616	2.503872	0.150232	0.027214704
41	Ghamaza El Kobra	884.95	0.048036	1.537152	0.182056	0.013618206
42	El Tibeen	898.1	0.02017	0.50425	0.306584	0.007795705
43	Khour Sail Badrashin	910.15	NA	0	0	0
sum				516.6321	157.8541	3.449520092

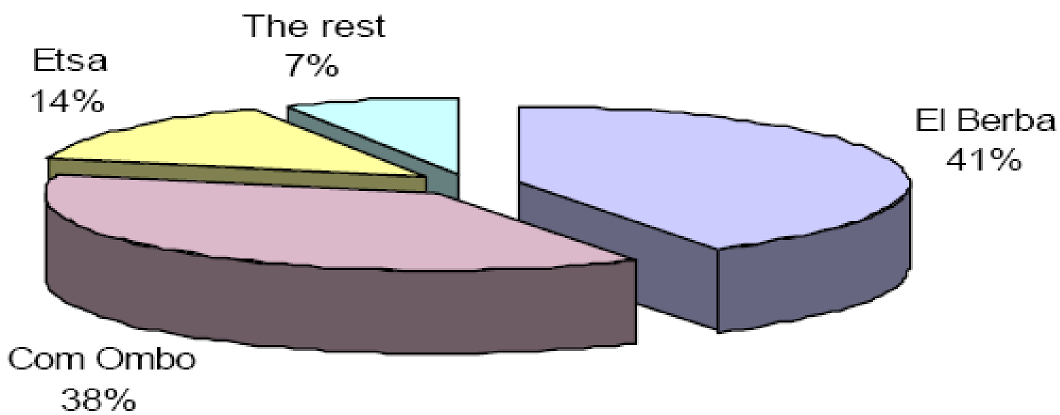
***Source*:** OSI Environmental National report of Egypt, Section: "water Quality and Monitoring"

Figure 3.10: COD loads contributed by the agricultural drains from Aswan to delta barrage.



Source: Egyptian Ministry of Water resources and irrigations, 2001

Figure 3.11: BOD loads contributed by the agricultural drains from Aswan to delta barrage



Source: Egyptian Ministry of Water resources and irrigations, 2001

Figure 3.3 Effluent (m^3/day) discharged to agriculture drains in Delta

Drain	Domestic point Sources m³/day	Industrial Point Sources m³/day	Domestic Diffuse source m³/day	Agricultural Diffuse source m³/day	Total m³/day
Bahr El-Baqar	184000.0	64268.0	122795.0	4521678.0	6548741.0
Bahr Hados	80000.0	6135.0	207754.0	4836000.0	5129889.0
Faraskour	2490.0	0.0	13272.0	186758.0	202520.0
El-Serw El-Asfal	7710.0	0.0	18769.0	508515.0	534994.0
El-Gharbia Main	156500.0	44460.0	293315.0	3927556.0	4421831.0
Tala	179.0	300.0	45076.0	1087148.0	1134318.0
Sabal	79000.0	0.0	39925.0	1196384.0	1315309.0
No. 8	0.0	0.0	42428.0	469848.0	512276.0
Bahr Nashart	22000.0	13968.0	108915.0	968859.0	1113742.0
No. 7	12500.0	0.0	39778.0	390056.0	442334.0
No. 1	39350.0	20960.0	78329.0	1204654.0	1343293.0
No. 9	0.0	0.0	88029.0	595644.0	683673.0
Zaghloul	0.0	0.0	1838.0	122890.0	124728.0
Edko	20000.0	7470.0	57346.0	4232034.0	4316850.0
Borg Rashid	0.0	0.0	0.0	311246.0	311246.0
El-Umoum	25000.0	0.0	81890.0	5163208.9	5270098.9
Abu-Keer	0.0	22897.0	15803.0	621592.2	660292.2
El-Batts	22396.0	0.0	26213.0	1468340.8	1516949.8
El-Wadi	3000.0	0.0	13272.0	1600340.6	1616612.6
Total (m³/day)	2311740.0	180458.0	1294747.0	33412752.5	37199697.5
Total Billion m³/year	0.84	0.066	0.47	12.2	13.6
% Ratio	6.2%	0.5%	3.5%	89.7%	

Source: OSI Environmental National report of Egypt, Section: “water Quality and Monitoring”

3.8.5. Water Logging/Salinity/Sodicity

Salinity: It is estimated that in Upper Egypt, approximately 4 bcm of drainage water returns to the Nile every year. This drainage water has a much higher salinity than the originally ingested irrigation water and contributes to an increase of salinity of the River Nile along its course from the High Aswan Dam to the Delta. Fortunately, the high mixing ratio of Nile and drainage water keeps the increase of salinity within acceptable limits. Salinity increases from 160 mg per litre at the High Aswan Dam to 250 mg per litre in Cairo. In the Delta, because of the domestic and industrial pollution from Cairo and because of intensive agriculture, salinity in the drainage and irrigation systems further increase; salinity of drainage water discharged into the Mediterranean Sea or the northern Lakes averaged 2260 mg per litre. More than half of this drainage water has a salinity < 2,000 mg per litre and could be potentially reused for irrigation and drinking water supply after appropriate treatment and mixing. Due to more intensive use, salinity of the discharged drainage water may increase in the next years and re-use of drainage water may become more complicated than before. With the construction of the High Aswan Dam in 1964, silt deposits on the Nile flood plains have decreased from 24 million tons per year to 2.1 million tons per year. This decrease has been responsible for a significant increase in the use of chemical fertilizers, resulting in increased values of nutrients in canals and drains.

The salt affected soils in Egypt are located in the north, east and west of Nile Delta, soils adjacent to lakes Edko, Maryut, El-Burrullus and El Manzala; and also in some areas such as Wadi El-Natrun, Oases and El-Fayoum. This is mainly due to the wide use of flood irrigation and unaccounted-for water usage, water irrigation from the Nile is exaggerated leading to soil water logging and poor drainage of excessive water that exceeds the growing plants needs. Thus, soil salinity components reach a level causing damage to plant production and deterioration to some of the chemical and biological soil elements. Some lands become so rich in soda due to the increase in sodium element causing more degradation in physical elements. During the seventies, sedimentary soil area affected by salinity and soda was estimated to be 30 to 35% of the total Nile valley and Delta area (State of Environment Report, 2005).

The salinity measurements made by (Drainage Research Institute (DRI) in the Delta show that closer to the Mediterranean Sea, salinity in the drainage water increases, to reach level close to 10,000 mg per litre close to the coast. Although part of the salinity increase may be caused by leaching of salts from the soil, it is believed that most of this increase is caused by upward seepage of brackish groundwater. This theory is supported by observations from DRI and RIGW with regard to chemical composition (major ions) of adjacent drainage and ground water.

3.8.6. Threats to the Biodiversity

Status and Protection of Species

Egypt's unique geographical position at the junction between two large continents (Africa and Asia), and its inclusion as part of the Mediterranean Basin, has permanently influenced both the people and the biota of the country socially, economically and biologically.

As part of the Sahara of North Africa, Egypt has the climate of the arid Mediterranean region, with notable differences between the coastal and inland areas. Under such harsh geographical and bio climatic conditions, it is to be expected that the biotic wealth of Egypt is not only poor relative to the total area of the country, but also sparse and widely scattered.

In the process of identifying the different types of fauna and flora in Egypt, certain groups (e.g. flowering plants) have been carefully surveyed and well documented, while others (e.g. mosses and liverworts) have not received adequate attention. Each of these habitats has its unique fauna and flora and numerous land and marine areas are listed as protected sites. An estimated 18,000 species of flora and fauna are in Egypt. With regard to flora, there are 44 species of viruses, 238 bacteria, 1,260 fungi, 1,148 algae, 369 non-flowering vascular plants and 2,072 flowering plants species. The fauna include 10,000 species of insects, 1,422 other vertebrates, 755 fishes, 105 reptiles and amphibians, 470 birds and 126 species of mammals. However, until to date, there are no clear statistics that quantify the rate of biodiversity loss in Egypt. (OSI Environment Synthesis Report p. 35)

Table 3.15: Status of Species in Egypt

Category	Known Species	Common Species	Uncommon Species	Rare Species	Threatened Species	Vulnerable Species	Endangered Species	Extinct Species	Insufficiently known
Marine Algae	753	260		493					
Freshwater Algae	871	794						77	
Avifauna	452	436			5	10	1		
Mammals	98	41		28			10	5	14
Terrestrial Reptiles	91	41		22	11	6	11		
Terrestrial Amphibians	7	4		3					
Freshwater Reptiles	4			3				1	
Freshwater Amphibians	7	3		4					
Mollusks	41	24		16				1	
Echinoderms in the Red Sea, Gulfs of Aqaba and Suez, and Suez Canal	207	131		76					
Echinoderms in the Mediterranean Waters	48	30		18					
Cartilaginous Fishes in the Mediterranean	56	12	35	9					
Bony Fishes in the Mediterranean Waters	297	84	177	35				1	

Egypt's biodiversity has faced threats from various sources. These include intensive agriculture systems, which entail the widespread use of agricultural chemicals in the form of fertilizers and pesticides. Another source of threat is the effects of industrialization. Industrialization programs have accelerated enormously in the second half of the 20th century, and have contributed to the rapid deterioration of the environment. Moreover, excessive hunting of animals and destruction of plant life have endangered the existence of several species of resident and migratory birds, as well as a number of hoofed animals (e.g. gazelles and antelopes).

Accordingly, Egypt is exerting tremendous effort to combat the threats to biodiversity through the conservation of wildlife, natural resources and natural habitat. This is clearly manifested in the declaration of 21 protected areas by prime ministerial decrees in accordance with Law 102/1983, covering about 8% of the total national surface, with plans to have this extended further to 17% by 2017.

3.8.7. Wastewater Treatment Systems

The treatment systems in Egypt can be divided into two basic types: aerobic and anaerobic treatment. The four most common aerobic treatment technologies are activated sludge, aerated lagoons, oxidation ponds, trickling filters and rotating biological contactors (RBC). Activated sludge and oxidation dishes represent 58% of the technologies and 72% of the total wastewater treatment capacity (El-Gohary, 2002). In Greater Cairo, the capacity of the El Gabal El Asfar secondary treatment plant (WWTP) was 3 Mm^3 per day and services 12 million people. A secondary WWTP with 0.33 Mcubic meter/day treatment capacity exists at El-Zenein and 0.4Mm³ per day treatment plants exist at Berka (0.6 Mm³ per day to primary standard) and Shoubra El-Kheima (about 0.6 Mm³ per day).

Fifty-nine waste water treatment plants with total capacity of approx. 3,700,000 m³ per day are operational; 34 are under construction, with a total capacity of almost 5,000,000 m³ per day (Table 3.16). Most of the installed treatment plants provide some form of secondary treatment, although not all of them are functioning well.

Table 3.16 Overview of types of operating Wastewater Treatment Plants in Egypt

Type of Treatment	Number of WTP	Installed Capacity	Average Capacity	Minimum Capacity	Maximum Capacity
Primary Treatment Only	1	720	720	720	720
Fixed Film reactors Trickling Filter	19	625	32.895	12	75
Activated Sludge					
Conventional Act. Sludge	9	1.911.000	212.333	26	600
Oxidation Ditch	14	88.74	6.339	550	50
Small Ready Made Systems	4	4.04	1.01	600	2.2
Oxidation Ponds	9	242.6	26.956	300	75
Aerated Oxidation Ponds	3	108	36	22	60
Total	**59**	**3.699.380**	**62.701**	**781.45**	**1.582.200**

Table 3.17: Wastewater Treatment Facilities & Ultimate sinks along the river Nile System.

Region	Type of Treatment	Discharge Towards	*Capacity [m³/day]
1. Upper Egypt			
8 Treatment Plants	1 aerated Oxidation Pond		
	7 Trickling Filter	Mainly Agricultural Drains, Some to Land Reclamation	225
2. Greater Cairo			
Helwan	Activated Sludge	Land Reclamation	35
Berka	Activated Sludge	Agricultural Drain	600
Zenein	Activated Sludge	Agricultural Drain	330
Abu-Rawash	Only Primary Treatment	Land Reclamation	720
3. Alexandria			
East	Activated Sludge	Lake Mariut	475
West	Activated Sludge	Lake Mariut	175
4. Delta Governorates			
Zegazig	Activated Sludge	Agricultural Drain	90
Banha	Trickling Filter	Agricultural Drain	75
Shibeen Al-Kawn	Trickling Filter	Agricultural Drain	74
Tanta	Aerated Oxidation Pond	Agricultural Drain	60
Mahalla Kubra	Trickling Filter	Agricultural Drain	60
Kafr Al-Zayat	Activated Sludge	Agricultural Drain	90
Mit Mazah	Oxidation Pond	Agricultural Drain	75
Damietta	Activated Sludge	Lake Manzala	90

Region	Type of Treatment	Discharge Towards	*Capacity [m³/day]
Ras El-Bar	Extended Aeration	Mediterranean Sea	50
Dakhla	Oxidation Pond	Agricultural Drain	62
28 Other Facilities	Oxidation Pond Aerated Oxidation Pond Extended Aeration Oxidation Ditch Trickling Filter Activated Sludge Aqualife	Mainly Agricultural Drains and Lake Manzala	228

3.9. MAJOR ENVIRONMENTAL ISSUES

Heavy mass pollution discharged both from the Industrial and agricultural sectors, development of salinity, water being a scarce resource and the need for huge expansions in agriculture and the effect of urbanization etc summed up in the system are real challenging issues in the main Nile system in general and in Egypt in particular.

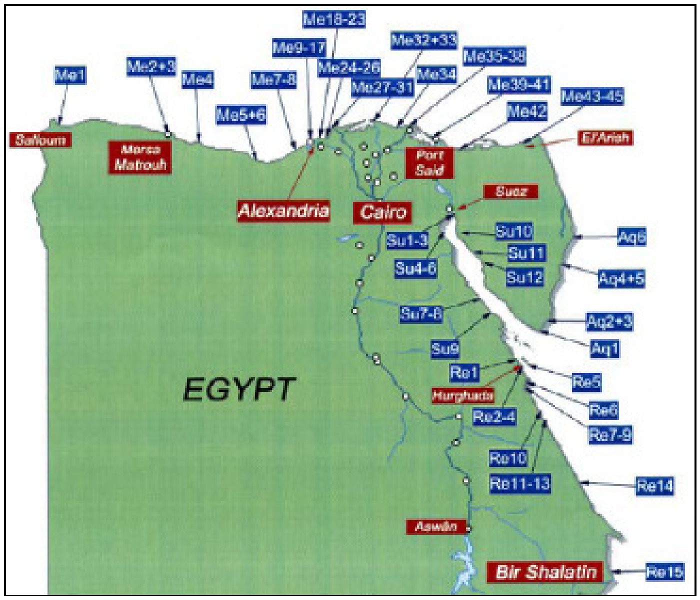
Coastal Zone: The Egyptian coastline extends for 3,000 kilometres (World Resources 2004) along the Mediterranean Sea and Red Sea beaches in addition to the Suez and Aqaba gulfs. Natural conditions on Egyptian Mediterranean coasts differ significantly from those on the Red Sea coasts in terms of salinity, sea currents and temperature. Such difference has led to different biodiversity and ecosystems in each.

Nearly 40% of industrial development activities are located in Egyptian coastal zones, in addition to a number of urban and tourism development activities. Furthermore, coastal zones monopolize the seaports infrastructure, in addition to agricultural and land reclamation sectors, as well as a developed road network capable of accommodating all development aspects. Egyptian coastal zones production is estimated at 85% of Egypt's production of oil and natural gas; The Gulf of Suez production alone is estimated to be 36 million tons. In addition, the crude oil and natural gas production in the Mediterranean coastal zones is increasing every year.

Through many joint efforts on the regional and international levels under the Global Program of Action for the Prevention of Marine Pollution From Land-based Activities (GPA/LBA & MEDPOL), it was possible to identify many polluted areas in need of urgent action. Most of the adverse impacts were identified and their volume estimated in order to enable their elimination.

Data pointed out to the existence of hot spots that need special attention where pollution has exceeded permissible limits, such as Abu Qir and El Max. Environmental inspection program results indicated an increase in the number of land-based sources that have adjusted their status and complied with Egyptian Laws and regulations, or that have active environmental compliance programs in place. Moreover, evidence provided by applied marine environment quality monitoring programs showed a noticeable improvement in the quality of marine environment since the launching of these programs in 1998, particularly in the Mediterranean Sea Hot Spots.

Figure 3.6: Monitoring sites on Mediterranean Sea and Red Sea in Egypt



Source**:** Applied marine environment quality monitoring programs ,1998

4. HYDROLOGY AND WATER INFRASTRUCTURE

4.1. SURFACE HYDROLOGY

River System: The Main Nile sub-basin covers an area of 656,398 square kilometres (Figure 1), including the catchment of Lake Nasser to the Aswan High Dam (AHD). This sub-basin extends from the junction of the White and the Blue Niles at Khartoum in the south to the Aswan High Dam in the north, over 14 degrees of latitude. From Khartoum to Wadi Half it is 1,490 kilometres. Its only tributary along the way is the Tekeze-Atbara River at Atbara. Except in years of exceptional rainfall (e.g. August 1988) there is no other inflow. Between Khartoum and the AHD there are no dams except for on-going construction of the Meroe Dam at the Fourth Cataract.

Watershed Physiology: The main Nile starts its flow at Khartoum where the Blue Nile from the general east direction and the White Nile from a general south direction converge. Khartoum has an average altitude of 400 masl. Downstream of Khartoum, the Nile flows in a general north direction to the Mediterranean Sea through the Sabaloka gorge in the Sudan to meet its last tributary, the Tekeze-Setite-Atbara Sub-basin, at Atbara after traversing 325 kilometres. Downstream of Atbara it flows in a series of wide loops through an arid area of successive small waterfall and flatter river bed slopes.

The Nile enters Egypt through Dongola station, the last gauging station in the Sudan, then through the Nubian Lake, an extension of the Aswan/Lake Nasser in Sudan. The Aswan has an average altitude of 100 masl. The Nile has a total length of about 1532 kilometer inside Egypt, starting from Egypt-Sudan border in the south and ending at the Mediterranean Sea in the North with an altitude of 0 masl. The construction of Aswan High Dam has created Lake Nasser with a length of 500 kilometres (350 kilometres in Egypt and 150 kilometres in Sudan usually known as Lake Nubian). The lake has an average width of 12 kilometres and surface area of 6,000 square kilometres at the highest water level.

Downstream of the Aswan High Dam (HAD), to its mouth in the Mediterranean Sea has a total length of 1428 Kilometres sub divided into three major parts. The first part is located between the HAD and the Delta Barrage having a length of 946 kilometres. This upstream part is again sub-divided into four reaches separated by the historic barrages, namely Isna, Nag Hammadi, and Asyut barrages. At the apex of the delta, the Nile bifurcated into two branches, Damietta-the east branch and Rosetta the west branch. The length of Damietta branch is 246 kilometres and that of the Rosetta branch is 236 kilometres.

The width of the Nile differs from Aswan to Delta Barrages. Wherever Nile has one channel, its width varies between 300 meter and 650 meter, but it varies between 1200 and 1500 meter or more, along reaches, where the river flows in two or more channels, with central islands. 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 centimetres per square kilometres.

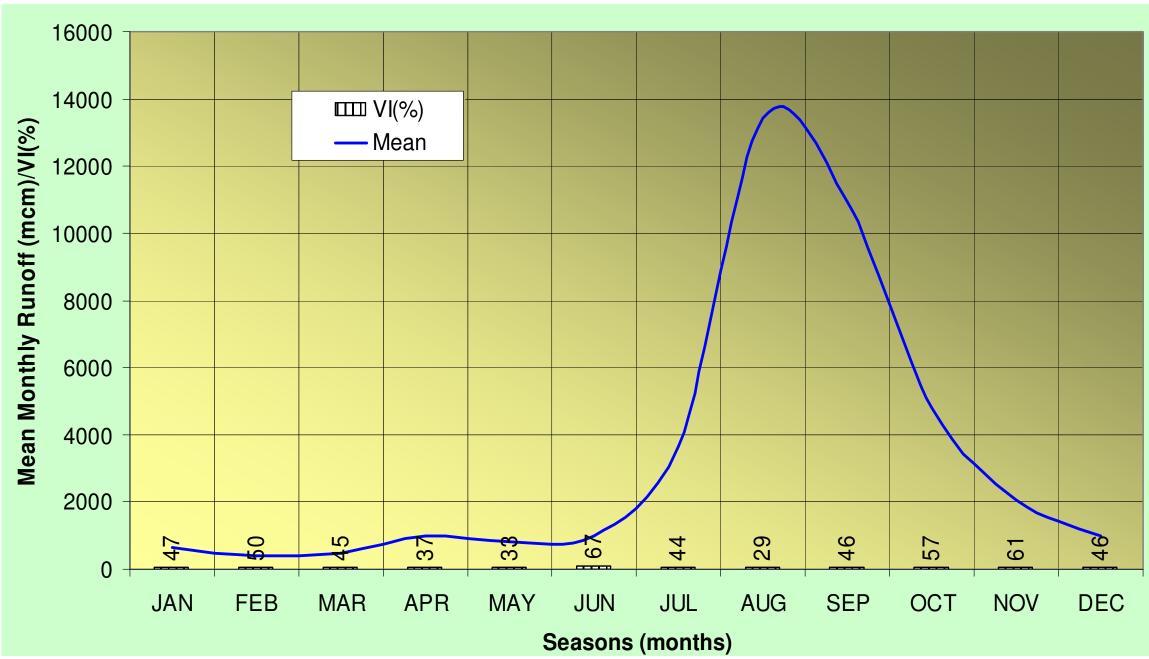
There are about 356 islands in the Nile channel between Aswan and Cairo with an average of one island every 3 kilometres. This number includes all types of islands, permanent ones (defined as having permanent vegetation and are distinct from sand bars), the submerged islands which appear only in low stage 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.

4.2. RUNOFF

4.2.1 The Nile at Khartoum

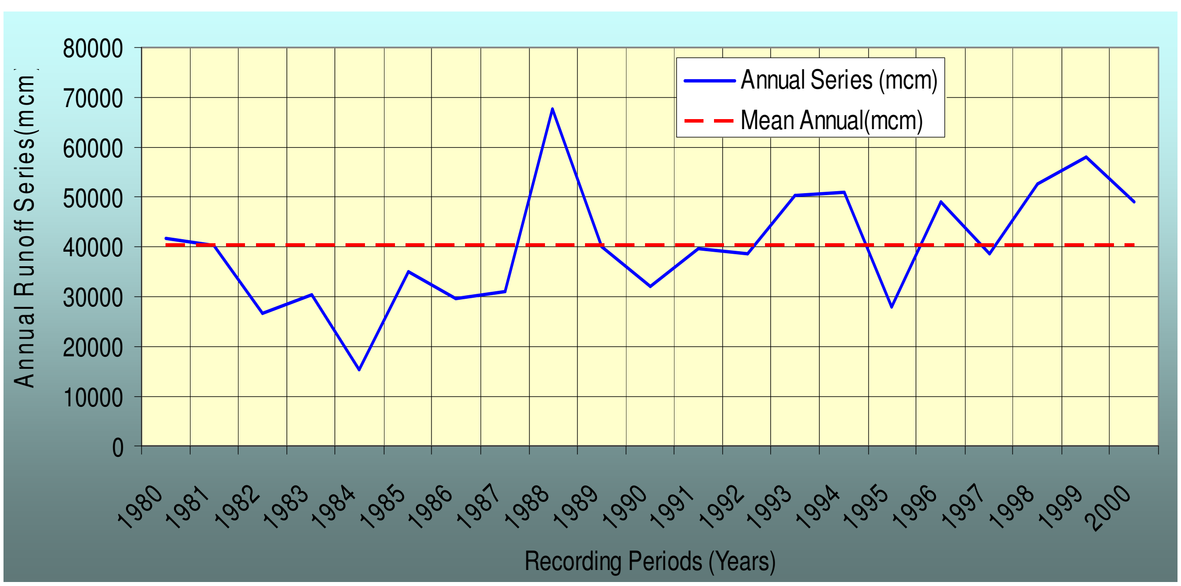
Two major sub-basins contribute to the flow passing the Khartoum node and entering the main Nile: the Blue Nile, which constitutes 66% of the flow enters from the east; and the White Nile, constituting 34% of the flow, enters from the south. Mean annual flow contributed from the south through the White Nile is 25 bcm on average, while the inflow from the Blue Nile averages 48.7 bcm (long-term average is taken to be 50 bcm).

Figure 4.1: Runoff Seasonal Distribution and Variability of the Main Nile at Khartoum Station



Source: OSI synthesis report on Water resource related issues
Raw data: Sudan Ministry of Irrigation and Water Resources

Figure 4.2: Mean Annual runoff Contribution to the Main Nile at Khartoum



Source: OSI synthesis report on Water resource related issues
Raw data: Sudan Ministry of Irrigation and Water Resources

4.2.2 The Nile at Atbara and Dongola Stations

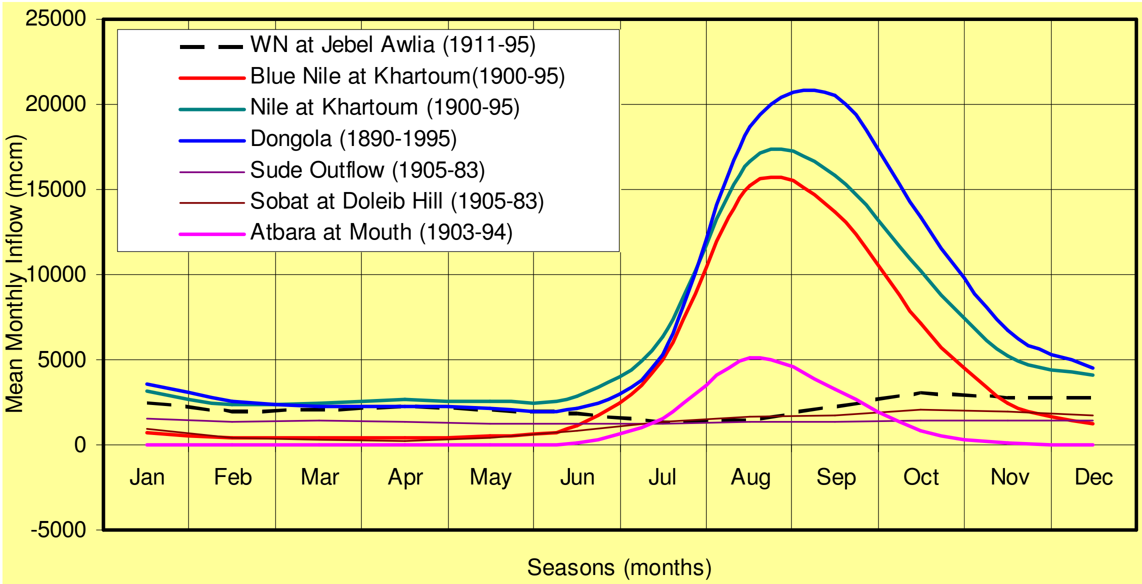
The Nile receives a mean annual inflow of 12 bcm at Atbara from the Tekeze-Setite-Atbara Sub-basin that drains the northern highland plateaus of Ethiopia. At this node the mean annual inflow through the Main Nile is increased to 86.70 bcm. Between Atbara and Dongola stations, there is an abstraction of 1.2 bcm for the purpose of irrigated agriculture in Sudan. This leads to a conclusion that the mean annual flow passing the Dongola station is 85.6 bcm, which is confirmed from many investigations made for the Nile including the water OSI report of the Sudan. Table 4.1 below indicates long-term mean flows in the main Nile at important nodes from the Khartoum station to the Dongola station. Seasonal distribution of mean flows at important river nodes between the Khartoum and Dongola stations is presented in Figure 4.3 below. Figure 4.4 indicates the contributions of the sub-basins to the main Nile system.

Table 4.1: Mean Monthly Inflows to the Main Nile between the Khartoum & Dongola Stations (After J.V. Sutcliffe & Y.P.Parks, The Hydrology of the Nile, Feb, 1999)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual Flow (mcm)
WN at Jebel Aulia(1911-95)												
2469	1905	2014	2225	2026	1792	1368	1435	2236	3024	2786	2774	26054
Blue Nile at Khartoum (1900-95)												
724	448	406	427	503	1084	4989	15237	13625	7130	2451	1257	48281
Main Nile at Khartoum (1900-1995)												
3193	2353	2420	2652	2529	2876	6357	16672	15861	10154	5237	4031	74335
Main Nile at Wadi Halfa/Kajnarty/Dongola (1890-1995)												
3577	2547	2268	2239	2175	2169	5268	18701	20554	13337	6767	4538	84140

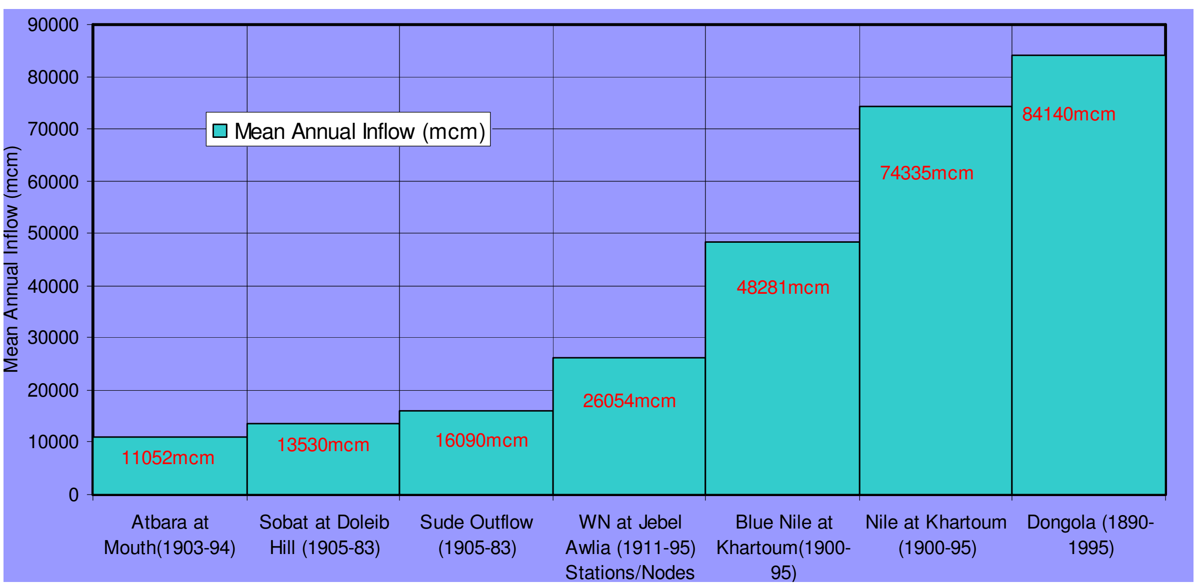
From Figure 4.3 below it is clearly observed that the base flow of Nile at Khartoum is of the same magnitude as the inflow coming from the general south direction indicating its base flow is largely coming from the White Nile. Similarly, the peak runoff at this junction is also with similar magnitude to the inflow coming from the general east direction indicating almost all of the peak runoff component is coming from the central and western highland plateaus of Ethiopia through the Blue Nile with some runoff elements added from the south western highland plateaus of Ethiopia through the Baro-Akobo Sub watershed. This data is also helpful to fairly conclude that the base flow in the Nile accounts nearly 40% and the peak runoff 60%. At Dongola station the gap between the peak runoff at the Nile and Blue Nile is wide indicating the contribution of the Atbara inflow to the peak runoff of the Nile inflow. The base flow component does not show much difference as the inflow coming from the northern highland plateaus of Ethiopia through the Tekeze-Setite-Atbara Sub-basin is more importantly a flushing runoff type with almost none and/or little base flow component.

Figure 4.3: Seasonal Runoff Distribution at Major River Nodes in the main Nile sub-basin



Source: J V Sutclife & Y P Parks, The hydrology of the Nile Feb 1999

Figure 4.4: Mean Annual Inflow to the Main Nile at Major river Nodes



Source: OSI synthesis report on Water resource related issues
[Raw data source: Sudan Ministry of Irrigation and Water Resources]

4.3 The Nile Between the HAD and its Mouth

As per the report from the Egypt Water OSI component (May 2006), the water resources system downstream of the HAD abstracts mean annual flow of 55.5 bcm from the Nasser reservoir/Lake. Including the delta barrage, four barrages are constructed along the reach of the Nile downstream of the HAD to its mouth for the purpose of regulation and to facilitate abstractions in the system.

Esna barrage is the first barrage located some 150 kilometres downstream of the HAD. At this node two canals, Asfoun in the left bank and Kelabia in the right bank, are constructed to abstract mean annual inflow of 0.5 bcm (OSI Water Synthesis Report p. 173) and 1.2 bcm respectively. Pump abstraction equivalent to 3 bcm on both banks of the system is also made which makes the total mean annual abstraction at this node to be about 5bcm. The mean annual inflow passing the Esna barrage is then deduced to be 5 bcm. The mean annual inflow passing the Esna barrage is then deduced to be 50 b cubic meter (OSI Water Synthesis Report p. 173)

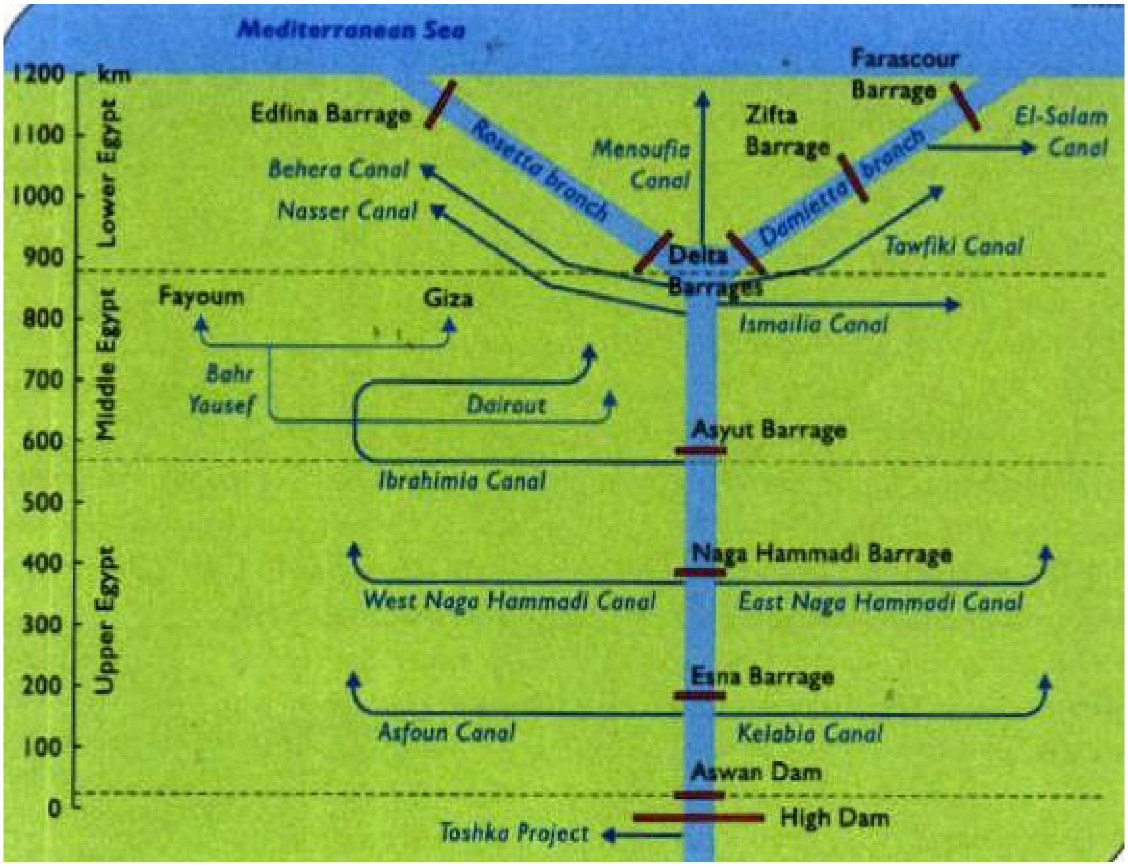
The Naga Hammadi Barrage is the second barrage located some 400 km downstream of the HAD. Two canals, the east Naga Hammadi in the right bank and west Naga Hammadi in the left bank, are constructed to abstract mean annual inflow of 1 bcm and 2.8 bcm respectively. Mean annual inflow passing this node is thus deduced to be 46 bcm.

The Asyut barrage is the third barrage in the system some 600 kilometres downstream of the HAD. Ibrahimia canal is the major abstraction located in the left bank with mean annual abstraction of 9.6 bcm (OSI Water Synthesis Report p. 173). In the right bank of the system pump abstraction with mean annual flow of 0.5 bcm is made which makes total mean abstraction at this node to be 10 bcm. Mean annual inflow passing this node is thus 36 bcm. This inflow is equivalent to the inflow passing Cairo and entering the Delta Barrage.

The Delta barrages are located some 1,000 kilometres downstream of the HAD. The Lower Nile is bifurcated in to branches, the Rosetta branch in the left bank and the Damietta branch in the right bank. These branches are usually known as the west and east branches respectively. In the east branch two barrages, Zifta and Farascour are located and Edfina barrage is located at the mouth of the west branch.

Right upstream of the Delta barrages, abstraction which is equivalent to mean annual inflow of 17.4 bcm is made both in the right and left banks of the system. Mean annual flow of 5.1 bcm (OSI Water Synthesis Report p. 174) is abstracted using the central canals located between the west and east branches. The west branch abstracts 3 bcm (OSI Water Synthesis Report p. 174) and the east branch abstracts 10 bcm which makes the total abstraction at the node to be summed up to 36 bcm. The schematic of the water resources system downstream of the HAD is presented in Figure 4.5 below.

Figure 4.5: Schematics of Water Resources System downstream of the HAD



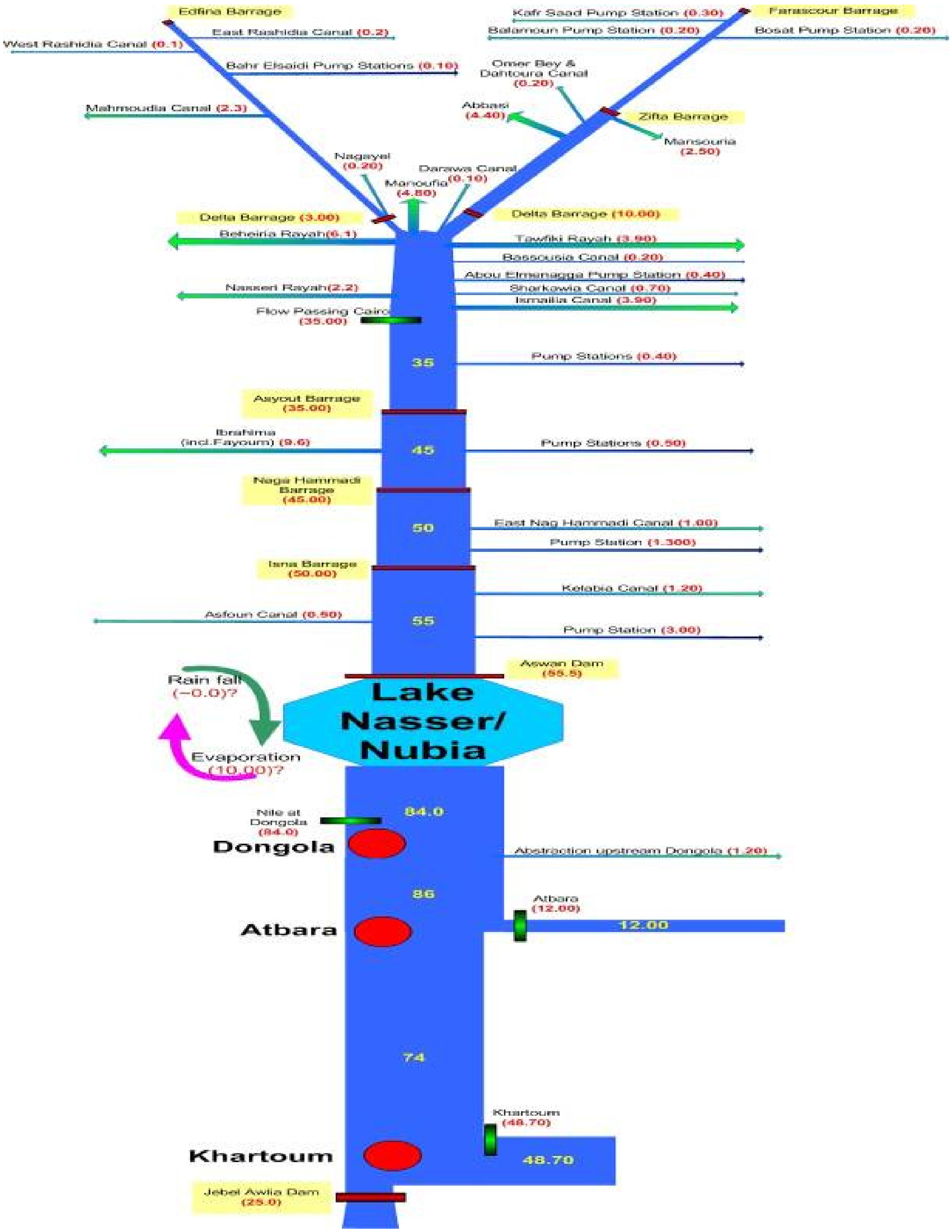
Source: OSI national Report on Water Egypt

4.4. INDICATIVE WATER BALANCE OF THE MAIN NILE SUB-BASIN

Mean annual inflow reaching the Aswan reservoir is estimated to be 84 bcm (OSI Water Synthesis Report p. 174).The Blue Nile with mean annual inflow of 50 bcm (OSI Water Synthesis Report p. 174) contributes 60% of the inflow entering the Aswan reservoir. The White Nile with mean annual inflow of 26 bcm (OSI Water Synthesis Report p. 174) and Tekeze-Setit-Atbara with mean annual inflow of 12 bcm (OSI Water Synthesis Report p. 175) contributes 25% and 15% of the inflow entering the Aswan reservoir respectively.

Schematic diagram of the Main Nile Sub-basin and the Eastern Basin are presented in Figure 4.6 below.

Figure 4.6: Indicative Water Balance Schematic for Main Nile Sub-basin



Source: OSI synthesis report on Water resource related issues
Raw data: Sudan Ministry of Irrigation and Water Resources, J V Sutclife & Y P Parks, The hydrology of the Nile Feb 1999, Egypt Ministry of Water Resources and Irrigation.

4.5. GROUNDWATER

Four categories of ground water basins have been recognized based on the geological formations:

- Nubian Sandstone Basins
- Detrital Quaternary-Tertiary Basins
- Recent Alluvium Basins.

Basement complex rocks only have a limited ground water yield. The Nubian sedimentary formation forms the most extensive and largest ground water basin in Egypt. Although recharge from rainfall is very limited a substantial annual amount is received from the Nile River system. The quality is good to excellent with salinity values rarely exceeding 600 mg per litre.

The Nubian sedimentary formation forms the most extensive and largest ground water basin in Sudan and Egypt. Although recharge from rainfall is limited an annual amount of 1,074 million cubic meters is received from the Nile River system. The quality is good to excellent with salinity values rarely exceeding 600 mg per litre.

The Quaternary-Tertiary aquifers are located in a steep sided rifted basin in the Blue Nile Rift in Sennar State. The total annual recharge is estimated at 160 million cubic meters. Water quality is variable with local highly salinized zones.

The alluvial basins are located along most seasonal streams and are recharged from rainfall and season flows. Water quality is generally good. Along the Gash and other streams shallow hand dug wells are used to irrigate small plots of vegetables.

The long axis of the Wadi Allaqi follows fault zone between the basement complex rocks to the northeast and the Nubian Sandstones to the southwest. These are overlain by unconsolidated wadi sediments of Holocene and Recent age when the local climate was wetter. The Wadi floor has a very gentle gradient of 0.5 degrees. Groundwater is from two sources. The first is deep percolating water from the Red Sea Hills over which there is varying amounts of rainfall annually. This is normally 30 meters below the surface and of poor quality. The second source of groundwater is from the Lake. This is usually available about 2 to 3 meters below the surface, and is extremely variable because changes in Lake level. (One meter change in lake level causes a one kilometres change in inundation of the Wadi.) The quality of the water is good.

4.6. EXISTING WATER RESOURCES INFRASTRUCTURES

4.6.1. Dam and Reservoirs

- <u>Merowe Dam</u>: The Merowe Dam upstream of the Dongola station, in the Sudan, is under construction
- <u>Old Aswan Dam</u>: Egypt has also built the old Aswan Dam, downstream of the HAD, in 1902 which had been raised twice, the last one being in 1934 and with a final reservoir capacity of 5.1 bcm.
- <u>The Aswan High Dam (HAD)</u>: The Aswan High Dam is the major water conservation dam in operation in the Main Nile Sub-Basin. It was constructed to meet the demand for high capacity storage of Nile waters for use downstream in Egypt. The construction of the dam took ten years from 1960 to 1970. The dam has a reservoir capacity of 164 bcm, of which 107 bcm is active storage, and is 3,830 meters long, 980 meters wide at the bottom and 111 meters high above the river bed. A hydro-electric power station, built downstream of the dam has twelve generating units, each with a capacity of 175

MW. It's total generation capacity being 2,100 MW, producing ten billion KWH of electric energy annually. The reservoir formed by the Aswan High Dam is 500 kilometres long, (350 kilometres in Egypt known as Lake Nasser, and 150 kilometres in the Sudan, called Lake Nubia) with a total water surface area of 6,000 square kilometres at maximum water level. It has an average width of 12 kilometres. Its position being in an area of extreme aridity provides stark contrast between desert and water.

4.6.2. Irrigation Infrastructure

More than 95% of the Egypt water supply comes from the Nile sources. Currently major abstraction in the Nile system is made at four points using the historic barrages. Irrigated agriculture development is extremely important economic activity for the Egyptian economy. The current development is estimated at 3.25 Mha with a cropping pattern largely constituting rice, sugarcane, cereals, perennial fruits and vegetables. Cropping intensity reaches more than 290% per annum.

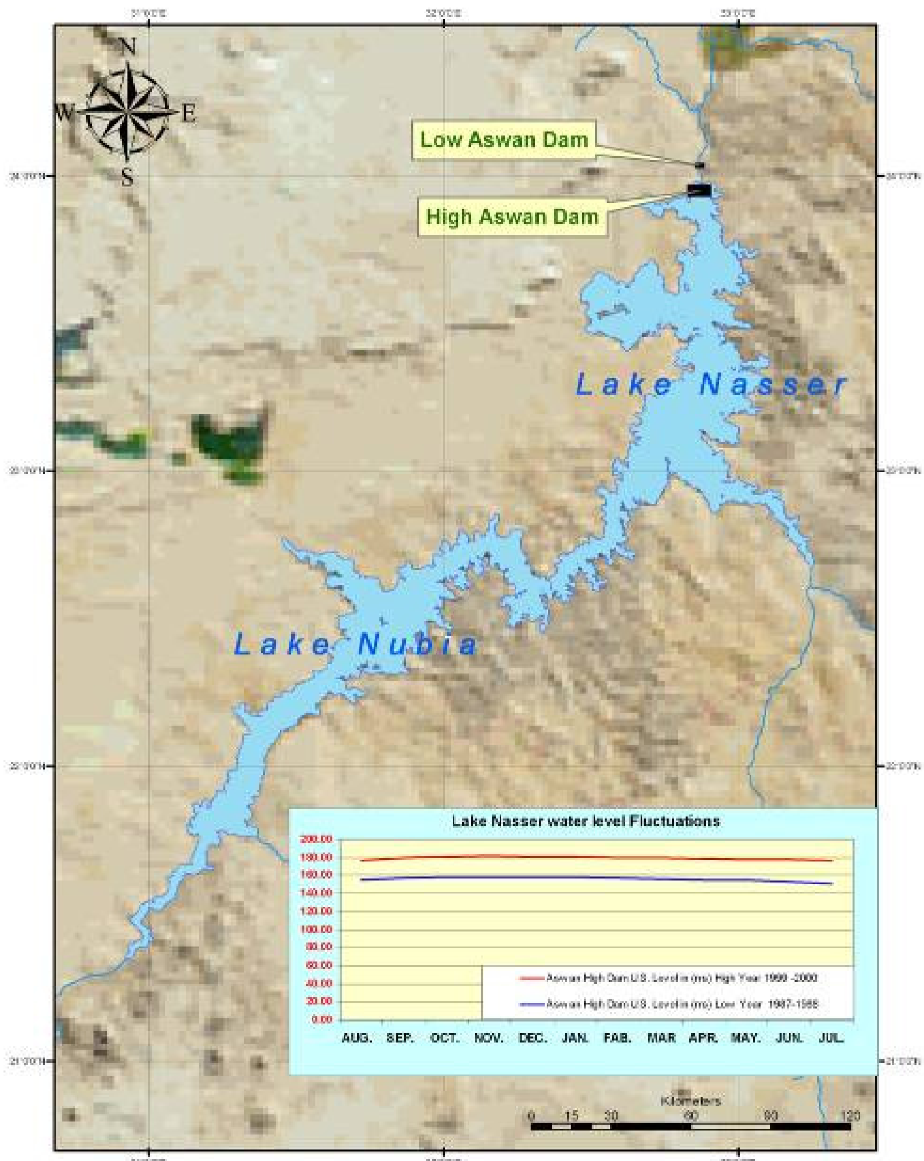
4.6.3. Hydropower Generation and Transmission

Both the HAD and the old Aswan Dam are used for the generation of hydroelectric power 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 the old Aswan Dam.

In general the major power generation in Egypt comes from thermal sources. As of 1999, total annual energy production is estimated at 70,695.11 GWH, out of which hydropower generation from the Nile system accounts only 20% with a total production of 14,425.61 GWH. 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 18,425 GWH (1980) to 70,695 GWH (1999).

Hydropower energy generated at HAD and Old Aswan, is connected to Cairo through the ultra-HV of 500 KV transmission line and the upper Egypt HV 220 & 132KVs were used largely to connect power stations and facilitate power transmissions to the load centres (Egypt OSI Water Component Report, May 2006). (OSI Water Synthesis Report p. 179)

Figure 4.7: Map of the Aswan High Dam and the Reservoir including the Nubian Lake



Source: ENTRO OSI database
Raw data: Egypt Ministry of Water Resources and Irrigation , Landsat TM imageries 2000 , The U.S. Geological Survey's (USGS) National Center for Earth Resources Observation and Science (EROS)