

Water Atlas of
**THE TEKEZE-ATBARA-SETIT
SUB-BASIN**



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Table of Content

Introduction	1
Quick Overview of the Eastern Nile Basin	3
General	3
1.1. Location of Baro-Akobo-Sobat Basin	
1.2. Administrative Units	
1.3. Demography	
1.4. Economy	
1.5. Historical and Cultural Places	
Land Surface Feature	4
2.1. Topography	
2.2. Slope and Terrain	
2.3. Relief	
2.3. Land and River Profiles	
Climate	5
3.1. Rainfall	
3.2. Air Temperature	
3.3. Evaporation	
3.4. Humidity	
Land	6
4.1. Land use /Land Cover	
4.2. Soil	
4.3. Geology	
4.4. Vegetation	
Hydrology	7
5.1. River network and Catchments	
5.2. Sub-Basin Runoff volumes and Water resource	
5.3. River System Schematics and Indicative Water Balance	
5.4. Sediment	
Infrastructure and Utilities	8
6.1. Dams and reservoirs	
6.2. Irrigations and Agriculture	
6.3. Hydropower and Electric	
6.4. Communication and Transport	
Environmental	9
7.1. Land Degradation	
7.2. Water quality Problems	
7.3. Parks , wetlands and Protected areas	
7.4. Water related Disease	

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Introduction

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

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

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

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

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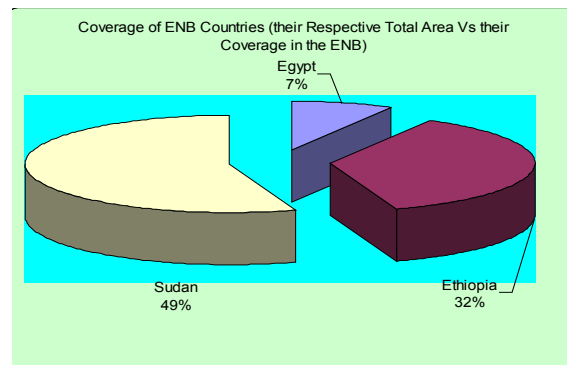
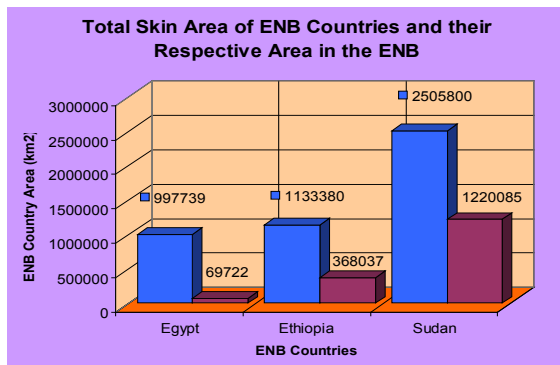
Quick Over View of the eastern Nile Basin

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

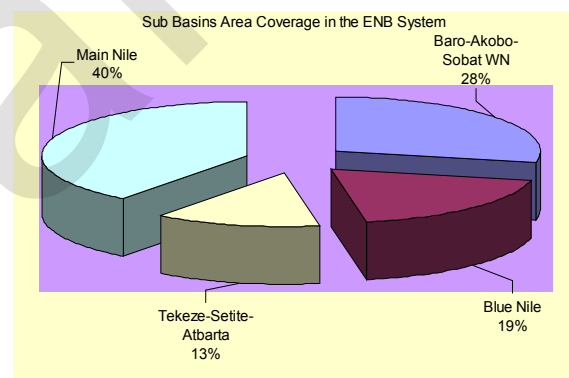
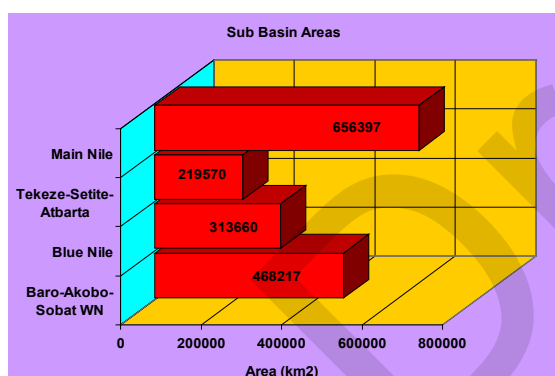
Egypt, with an estimated total area coverage of 997,739km² is located in the upper north portion of the Nile occupying the entire lower course of the Eastern Nile Basin including its mouth at the Mediterranean Sea. It is bounded on the north by the Mediterranean Sea; on the east by the Gaza strip, Israel and Red Sea; on the south by Sudan and on the west by Libya. The country has a maximum length of 1,105km stretching from north to south, with a maximum width at its south border, stretching east-west for some 1130km. Less than 10% of its area is identified to be cultivable, the bulk of its skin coverage (more than 90%) being desert where life could hardly survive. With a total area of 69722km² the Nile watershed in Egypt accounts only 7% of the country and 4% of the Eastern Nile Basin.

Ethiopia, is located in the horn of Africa, bounded on the northeast by Eritrea and Djibouti, on the east & south east by Somalia, on the south west by Kenya and on the west and northwest by Sudan. With total skin coverage of 1,133,380km². The highland plateau of the country (above 1800masl) is identified to be the heart of the country covering some 60% of its skin area. The Great Rift Valley splits the Ethiopian highland plateaus diagonally in northeastern and southeastern directions. The northeastern half largely drained by the Nile system. The plateaus are characterized with deep valleys and canyons cut by numerous rivers and streams drained by 12 major river basins, Abbay (the Blue Nile) being one of them taking the lion share both in terms of skin area coverage (18% of the country) and water resources potential (more than 50%). Ethiopia is the source of the Tekeze, Blue Nile and Baro-Akobo sub basins, which are believed to be the major contributor of the Nile water. Including the upper courses of Tekeze, Abbay & Baro-Akobo sub basins; the Nile watershed in Ethiopia accounts about 32% of the skin area of the country and 22% of the Eastern Nile Basin.

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



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

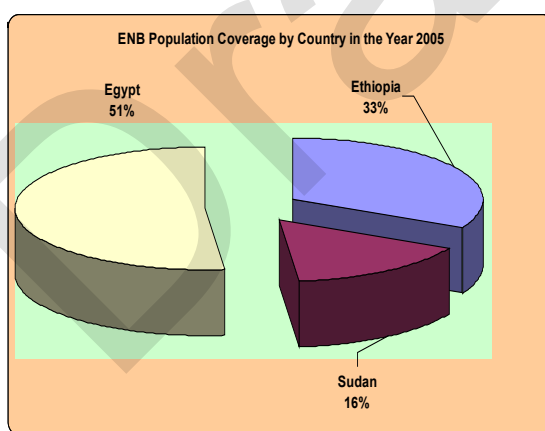
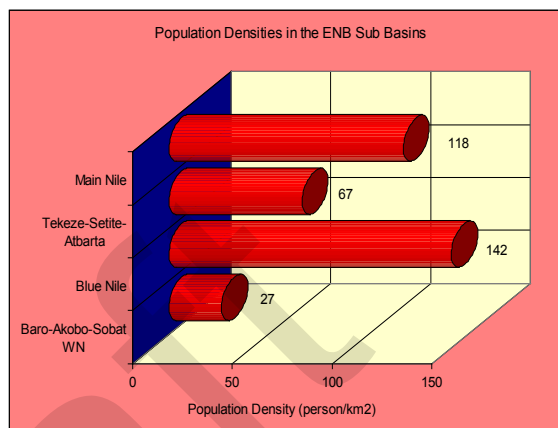
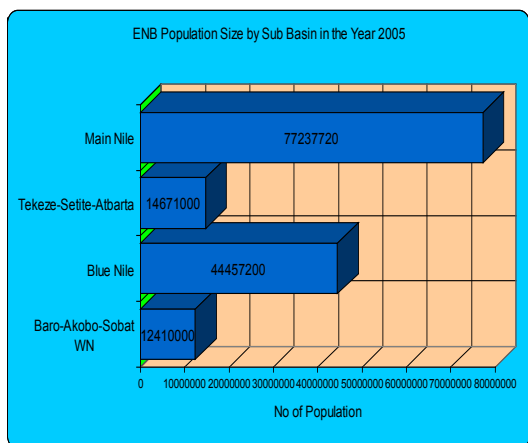


According to the OSI socioeconomic report the total population residing in the Eastern Nile Basin is estimated at 148,775,920 (projected to 2005). In the same report it is however, reported as 160million.

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



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



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

1. Generals

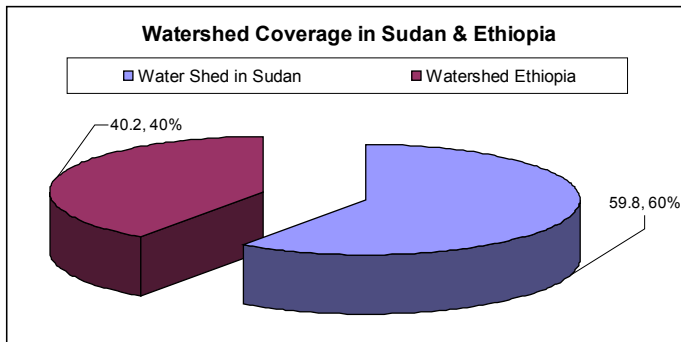
1.1 Location of Tekeze-Atbara-Setit Sub-Basin

The Tekeze-Setite-Atbara sub basin, located in the at most north-eastern portion of the ENB. Geographically its location extends from _____, ____ E to _____ east and ____ N to ____ N.

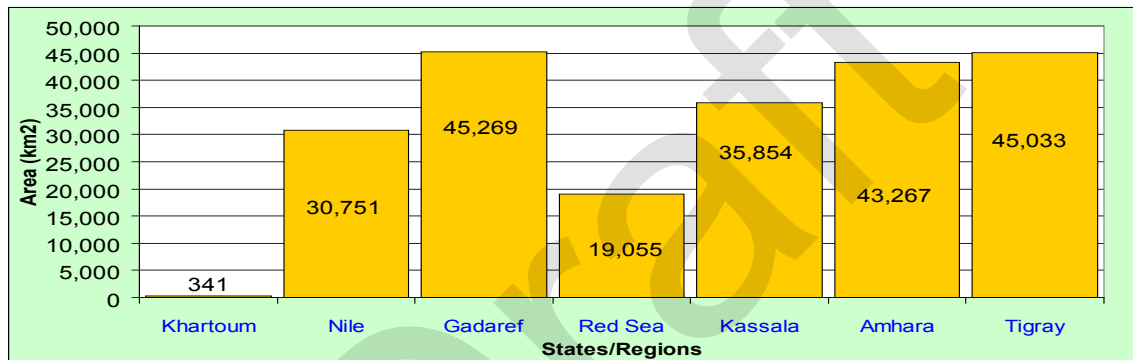
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1.2 Administrative Units in Tekeza-Atbara-Setit Sub-Basin

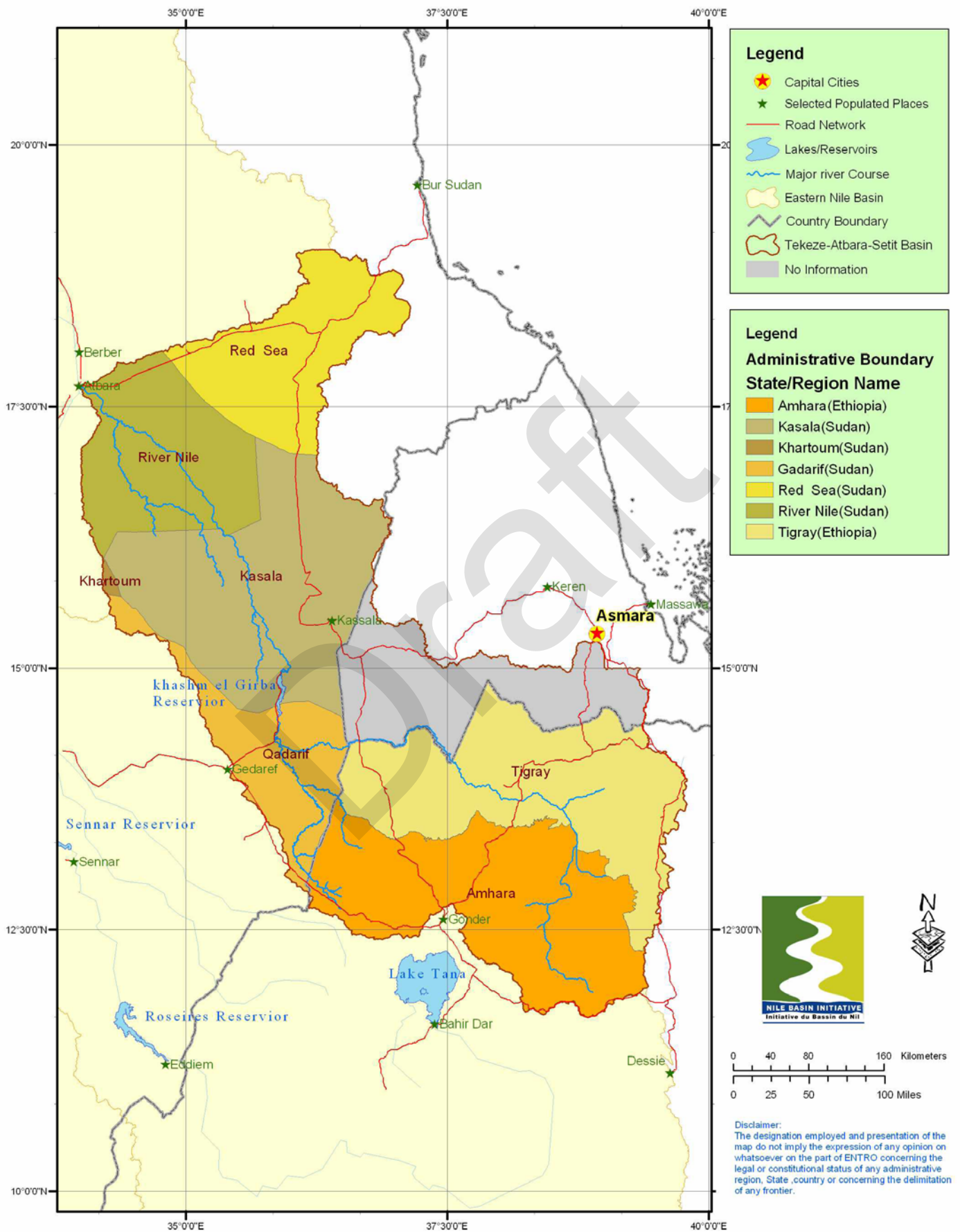


The Amhara (43,268km²) and Tigray (45,033km²) regions are the two regions constituting the upper course of the sub basin in Ethiopia. In Sudan five states, namely, Khartoum (341km²), Nile (30,751km²), Gadarif (45,269km²), Red Sea (19,055km²), and Kassala (35,854km²), constituted the sub basin. The sub total in Ethiopia is estimated at 88,300km² and that of Sudan 131,270km².



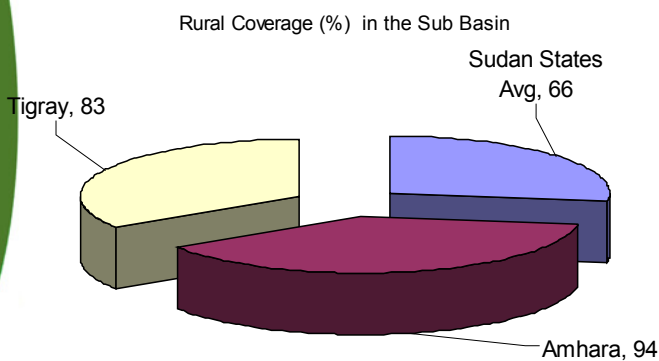
Administrative state/region division within Tekeze-Atbara-Setit sub-basin

Map - 1.2 : Administrative Divisions



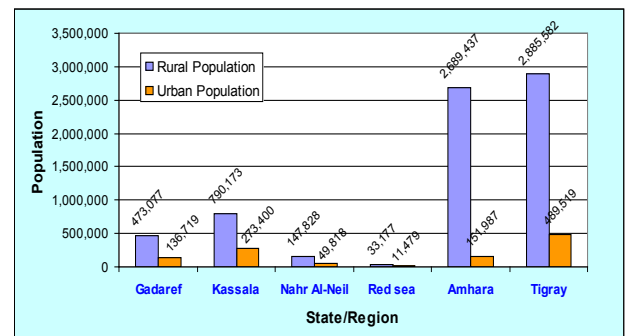
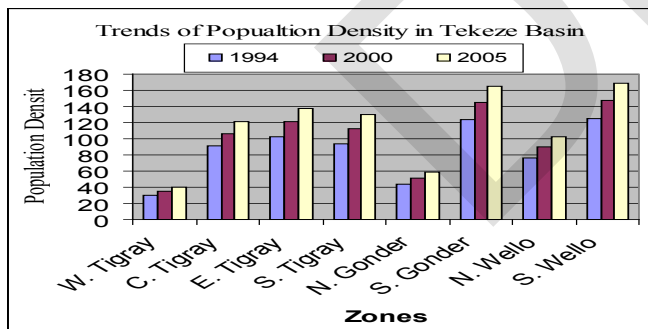
1.3 Demography

Data compiled from the Population and Housing Census of Ethiopia (1994) and The Sudanese National Census Bulletins give an estimated basin population of 10.4 million on the Ethiopian side and 4.271 million on the Sudanese portion of the basin. This makes the sub basin the third largest populated region of the three sub basins of the Nile River, after the Abbaya-Blue Nile sub basin. The sub basin is expected to experience relatively higher population growth rate on the Ethiopian side (for example, inter-censal growth rate between 1984-1994 was 2.6) compared to 2.5% on the Sudanese side of the basin. However, the projected population growth rate for Ethiopia is expected to decline from 2.9 % during 1995-2000 to 2.4 % in 2010-2015.



Regarding the composition of the basin population by sex and age, the sex ratio on the Ethiopian side is at parity (that is 100 males per 100 females) whereas on the Sudanese side there is a slight excess of males over females (i.e., 103 males per 100 females). Age-wise, the population throughout the sub basin tends to be dominated by a pyramidal structure that is characteristic of most developing countries having large width at the base (indicating the predominance of the relatively younger persons under the age of 15)

and gradual reduction of population concentration from middle through the uppermost section of the pyramid, signaling higher child dependency ratio. Old persons (aged 65+ in Ethiopia and 60+ in Sudan) account 8 % of the basin population on the Ethiopia side and 4.5 % on the Sudanese side.



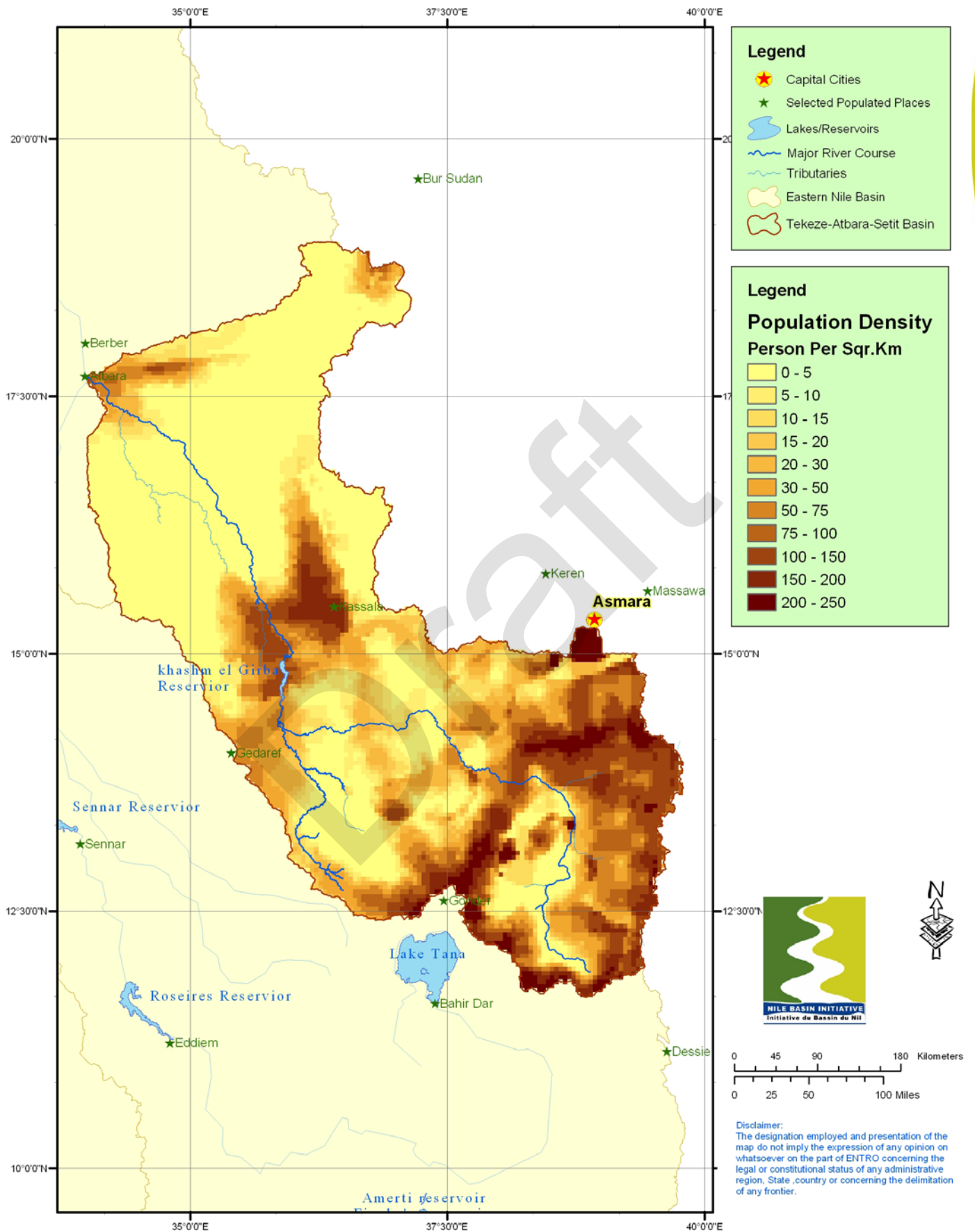
The Tekeze-Atbara basin appears to be characterized by uneven population distribution, with the Ethiopian highlands being more densely populated compared to the down-stream lowlands in the Sudan. Within Ethiopia there is variation between regions with crude population density varying from 39.6 persons per km² in West Tigray of the Tigray regional state to 147.4 persons per km² in South Wollo of the Amhara regional state. Generally, the Ethiopian side of the Tekeze basin has an average population density of 59 persons per km² and data was not made available for the Sudanese side of the sub basin

Data/Information Source

:One System Inventory Synthesis Report 2007

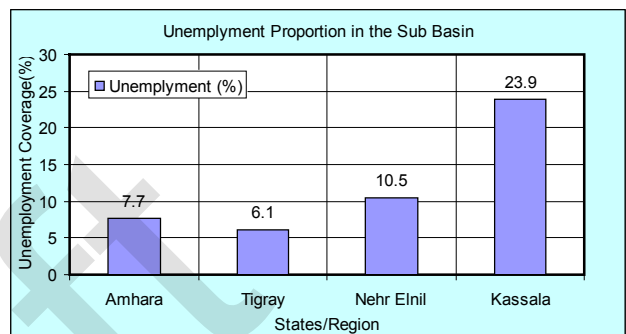
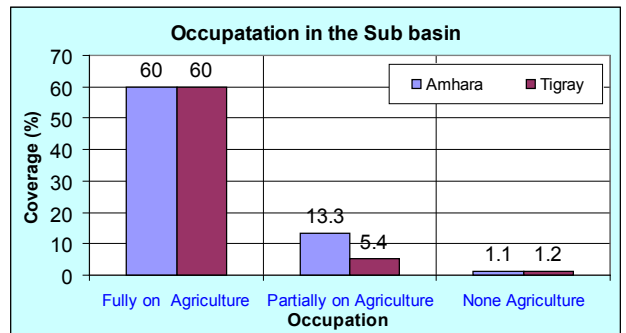


Map - 1.3 : Population density map of the Tekeze-Atbara-Setit Sub-Basin



1.4 Economy of Tekeze-Atbara-Setit Sub-Basin

The basin population depends for its livelihood on the natural endowments of land and water and other associated resources (such forestry and fishing) provided by the basin and its environs. The basin states of Amhara, and Tigray in Ethiopia respectively have an activity rate of 76.6%, and 71.4%; whereas in Sudan the two basin states of Nahr Elnil and Kassala have male activity rate of 67.5 and 74.1 respectively. This indicates that the overwhelming majority of the economically active population is engaged in some form of livelihood activities.



Generally, crop production and livestock herding are the two most dominant economic activities along the basin. Information compiled from the 2001/02 Agricultural Census of Ethiopia showed that for the basin states of Amhara and Tigray a combination of crop and livestock holding (nearly about three-fourth) constitutes the primary source of livelihood, followed by crop only farming (about one-fifth of the holding) and livestock only holding (about 3.3% and 2.7% for Tigray and Amhara regions respectively). The Sudanese inhabitants in the lower bank of Tekeze-Atbara basin are also engaged in crop cultivation using Atbara River.

‘The dominance of sedentary agriculture in the basin area implies that crop farming is more important as a source of livelihood than pastoral production. A smaller proportion of ‘only livestock’ holdings is also an indicator of few pastoral population in the basin, though there is a substantial pastoral population (about 10 % in Sudan) engaged primarily in animal husbandry. In Ethiopia, regional level analysis shows that pastoralism as a way of life is very minimal in the Amhara region compared to Tigray region. A greater proportion of the population living in South and East Tigray are engaged in cattle herding and this supports the view of the relative nomadic character of the population living there.

The contribution of mechanized agriculture to employment creation in the area is very limited, mainly concentrated around Humera in Ethiopia and near Atbara River in Sudan. Most of the farms are undertaking crop production (for example, sesame and cotton in Ethiopia; wheat, beans, durra and vegetables in Sudan) and provide important source of supplementary cash income for the basin population by serving as important destinations for seasonal labor migration within and beyond the basin. Overall, with the exception of the Sudanese portion of the Tekeze-Atbara areas where there are a good number of industrial activities especially in Nahr Elnil state where the favous Portland Cement Factory in Atbara town and the Shendi and Norab Textile Factories are located, the basin population has very limited access to employment in the service and industrial sectors.



Data/Information Source

:One System Inverntory Synthesis Report 2007

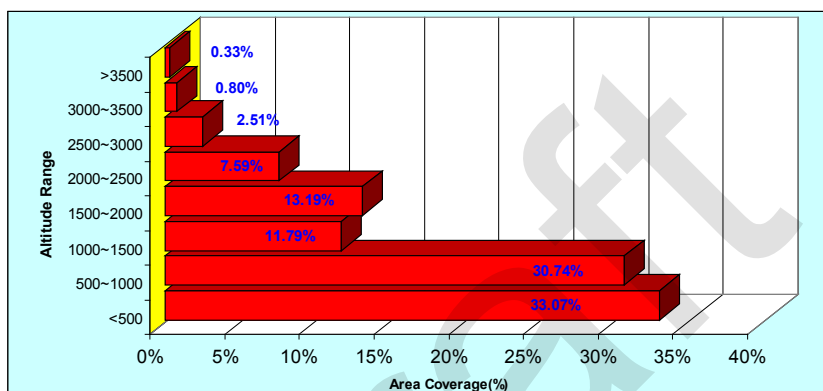
Map - 1.4 : Poverty ScaleMap of Tekeze-Atbara-Setit Sub-Basin

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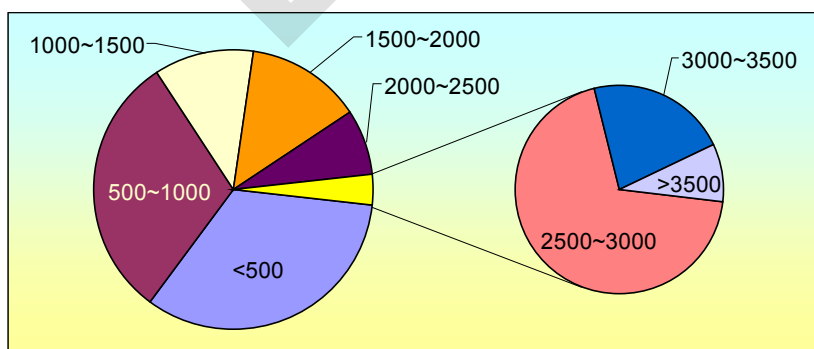
2. Land Surface Feature

2.1 Topography in Tekeze-Atbara-Setit Sub-Basin

The Tekeze-Setite-Atbara sub basin is categorized in four major land escapes: The first category constituting the major portion of the sub basin (33%) falls at an altitude lower than 500masl and predominantly covers the entire Sudanese portion of the sub basin. The second major category is identified to be part of the sub basin located u/s and around the border that falls at an altitude range of 500masl to 1000masl which covers 31% of the sub basin. This portion of the sub basin is largely identified as the low-lying plains of Humera and Metema including the Sheraro and the Wolkite low-lying plains in Ethiopia extended up to Abderafe in the Sudan. The area in the range of 1000masl to 1500masl covering 12% of the sub basin is the third category and located at the foot of the highland portions of the sub basin in its upstream reach. The Mid altitude areas (1500masl to 2500masl) covering 21% of the sub basin is identified to include the well known highland plateaus of Shere,



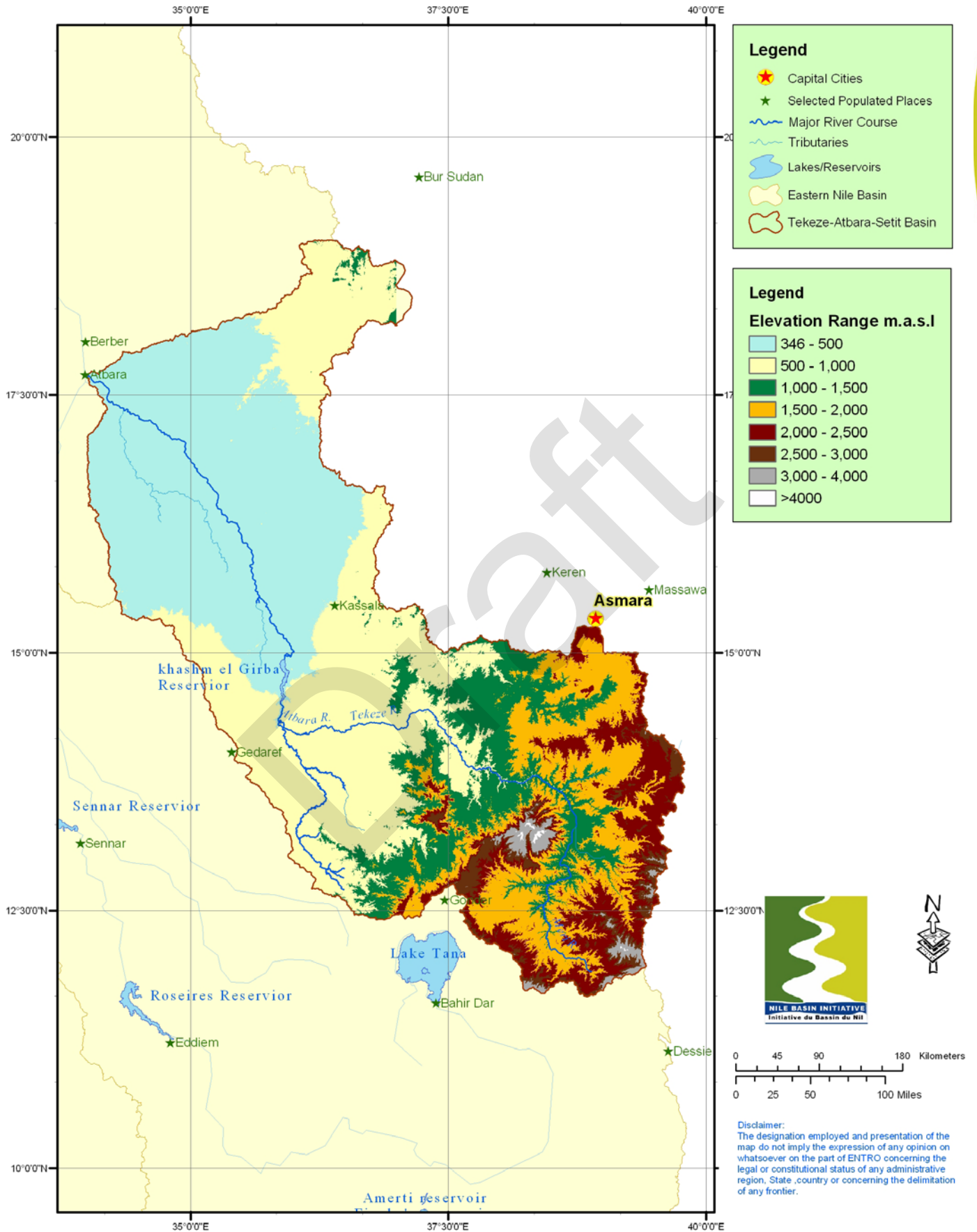
Wogera and Chilga considered as the fourth category. Less 5% of the sub basin is covered with highland massive of the Semen (north mountain chains) peaks of Ethiopia that includes the Ras Dashen mountain (4620masl, the highest peak in Ethiopia), the Abune Yosef mountain (above 4000masl), the western half of the Ambalage mountain (above 3500masl) etc.



Data/Information Source

:One System Inventory Synthesis Report 2007
:SRTM Global Elevation Dataset

Map - 2.1 : Elevation Model of the Tekeze-Atbara-Setit Sub-Basin

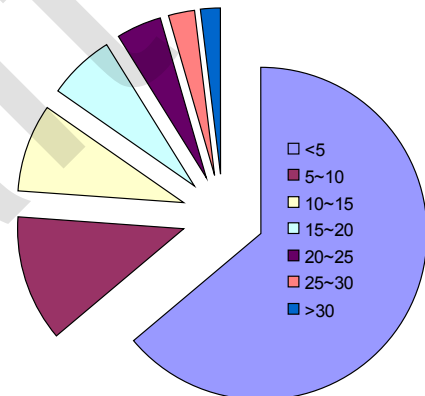


2.2 Landforms and Terrain of Tekeze-Atbara-Setit Sub-Basin

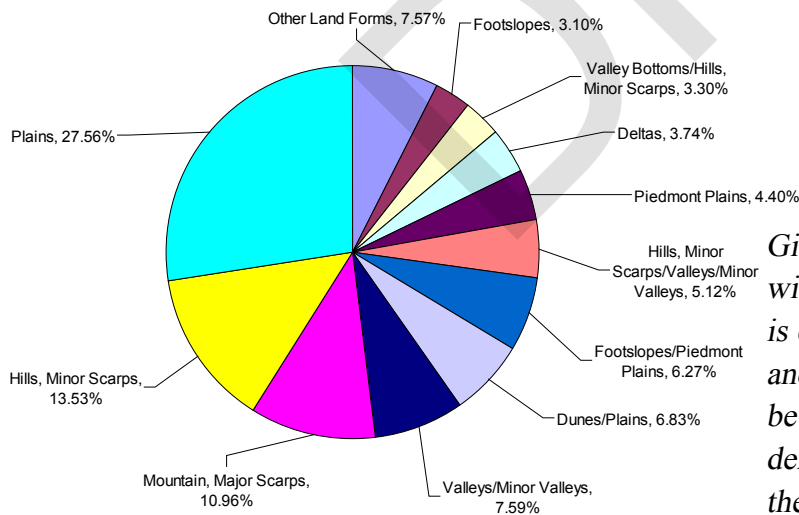
The incised nature of the Tekeze River and its tributaries in Ethiopian highlands mirrors that of the Blue Nile river though altitude ranges are smaller in the case of Tekeze and the drainage pattern is dendrite. The Tekeze sub basin is also characterized by the presence of isolated volcano necks contrasting sharply with the surrounding undulating and rolling land forms. Extremely rugged topography exists where the highland plateaus are cut in to a number of blocks by deeply incised gorges of the Tekeze River and its tributaries.

Land Forms	Area Percentage
Bottom Lands/Uplands	0.01%
Plateaus/Plains	0.01%
Mountain, Major Scarps/Plateaus	0.23%
Piedmont Plains/Plateaus	0.32%
Complex Landforms	0.35%
Flood Plains	0.36%
Plateaus/Hills, Minor Scarps	0.49%
Uplands	0.95%
Bad Lands	1.31%
Bottom Lands	1.37%
Plateaus	2.17%
Footslopes	3.10%
Valley Bottoms/Hills, Minor Scarps	3.30%
Deltas	3.74%
Piedmont Plains	4.40%
Hills, Minor Scarps/Valleys/Minor Valleys	5.12%
Footslopes/Piedmont Plains	6.27%
Dunes/Plains	6.83%
Valleys/Minor Valleys	7.59%
Mountain, Major Scarps	10.96%
Hills, Minor Scarps	13.53%
Plains	27.56%

Plain areas with land slope of less than 3% covers nearly 28% of the sub basin. Hills and Minor Scarps are the next major land forms in the sub-basin constituting about 14% of the area. Mountains and Major Scarps cover some 11% of the area. Dunes, Valleys Scarps cover 7.6 and 6.8% of the area respectively. the remaining 33.5 is miscellaneous land forms.



Land Slope Classification and area Coverage



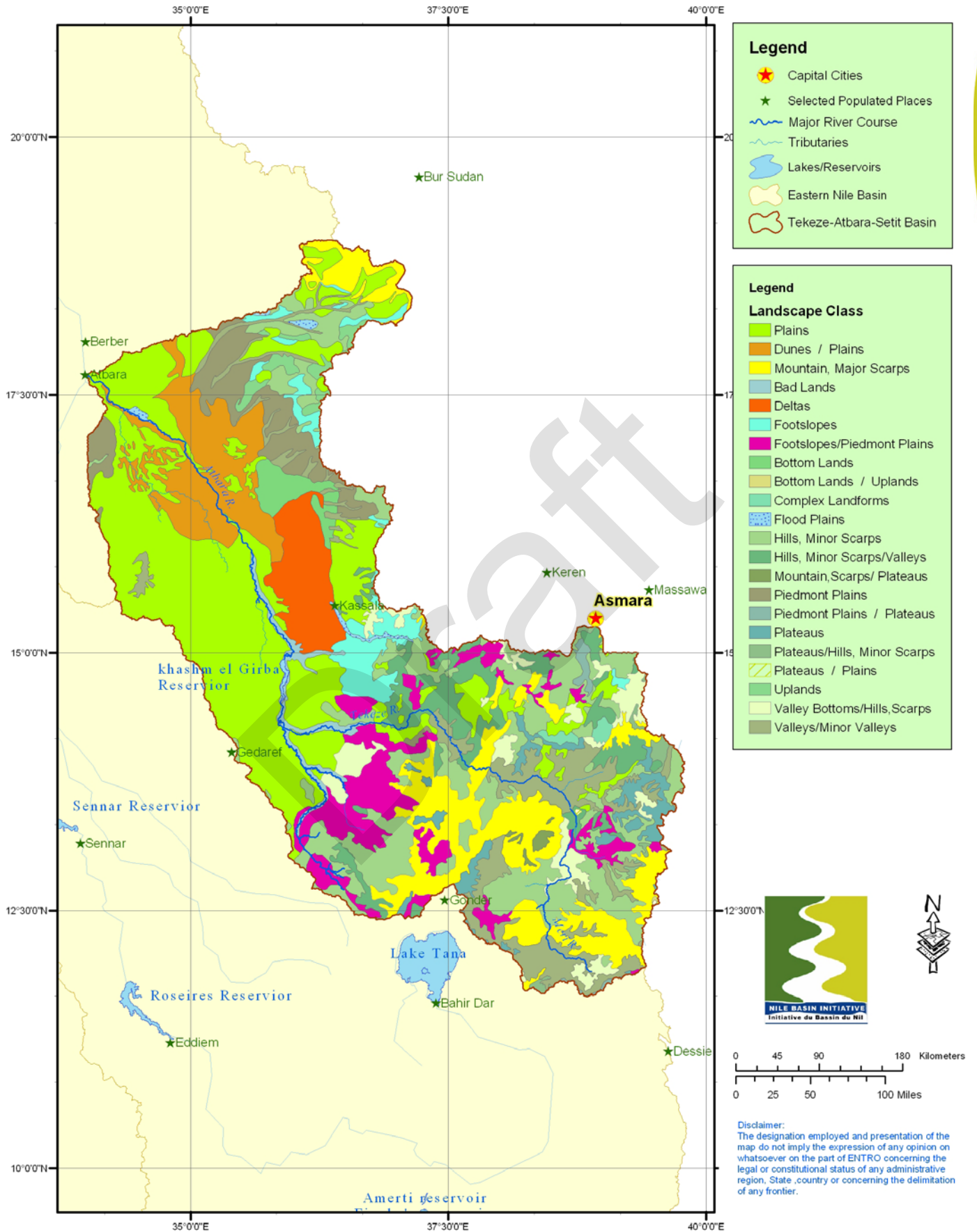
Given the extent of the lowlands, in proportion with the mountainous relief, most of the sub-basin is characterized by slopes lower than 2.5 percent and nearly 65% of the sub basin is identified to be low-lying plain with land slope less than 5%, demonstrating the existence of high potential for the development of agriculture in general and irrigated agriculture in particular.



Data/Information Source

:One System Inventory Synthesis Report 2007
:SEA East Africa Soil and Land Database(FAO)

Map - 2.2 : Terrain Map of Tekeze-Atbara-Setit Sub-Basin

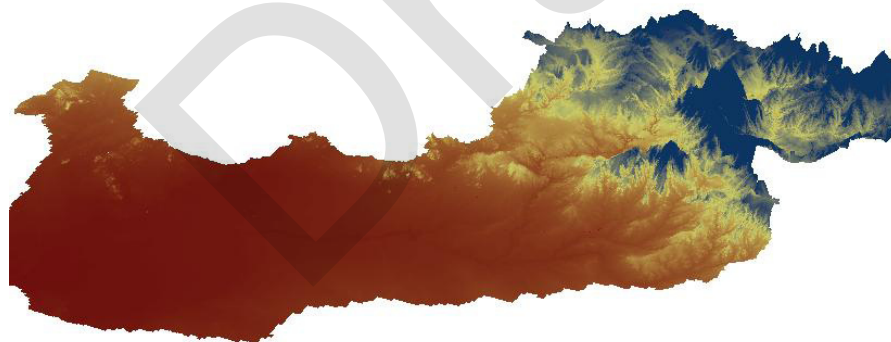


2.3 Relief of Tekeze-Atbara-Setit Sub-Basin

Two main landscape units are observed in Tekeze-Atbara sub-basin. A mountainous relief that extends in Ethiopia and Eritrea and a flat piedmont starting close to the Ethiopian border and extending across the Sudanese portion.

The incised nature of the Tekeze River in the Ethiopian highlands mirrors that of the Abay River. However, the altitude ranges are smaller within the Tekeze basin and the drainage pattern is more dendritic. The Tekeze basin is also characterized by the presence of isolated volcano necks contrasting sharply with the surrounding undulating relief. The upper reaches of the basin are surrounded by mountain ranges with a maximum altitude of 4,600 masl at the mountain of Ancua, part of the Ras Dashan system. Plateaus and benches terminate in steeply dissected escarpments, where resistant strata have been broken down by geological erosion. Extremely rugged topography exists where the highlands are cut into a number of blocks by deeply incised gorges of the Tekeze River and its tributaries.

In the Ethiopian and Sudan Lowlands the topography is almost flat or slightly undulating becoming increasingly more undulating to the east. The elevation of the lowlands varies between 500 and 1 500 masl. The lowland region between the Atbara River and the Blue Nile is occupied by the Butana Plains.



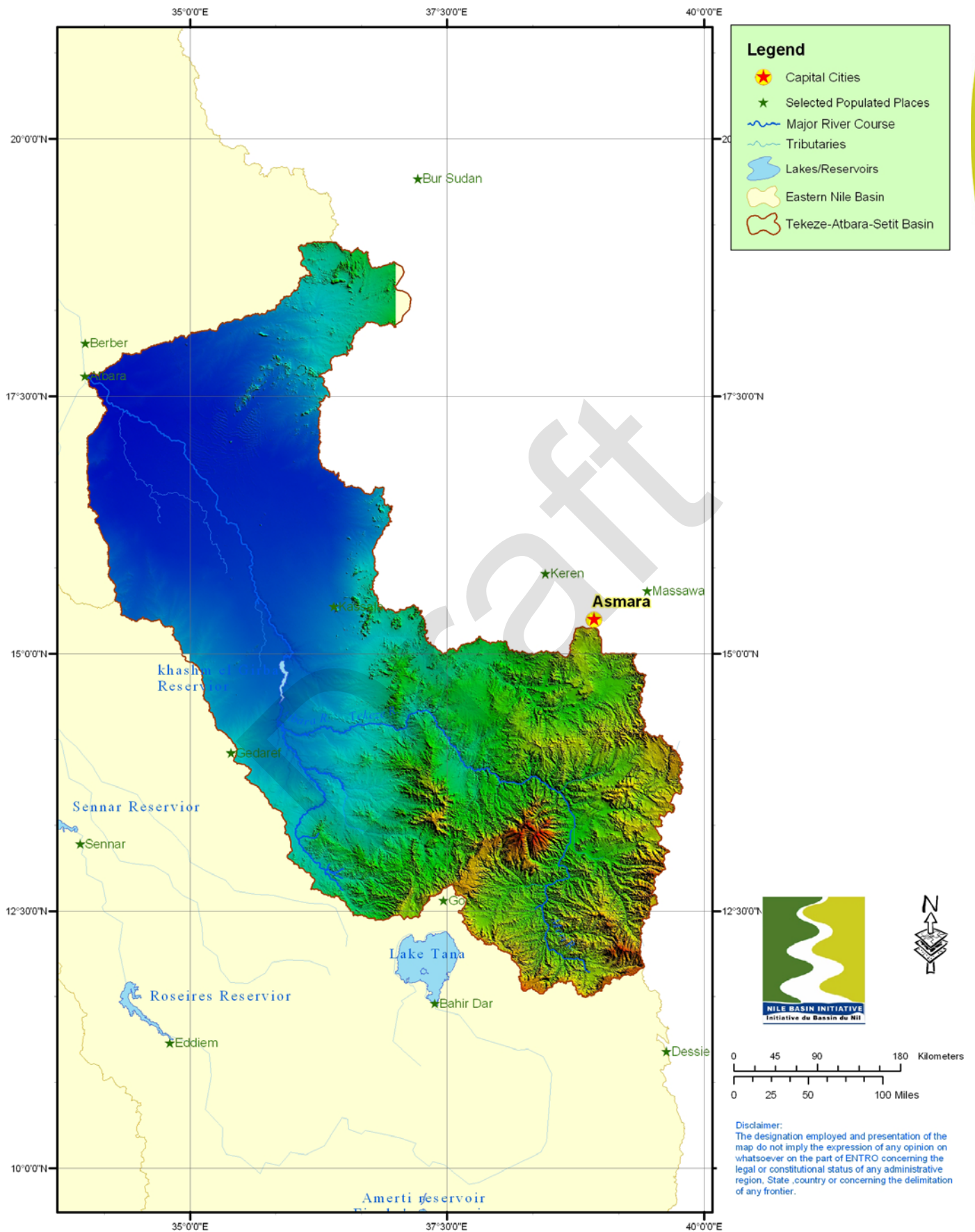
Computer Terrain 3d view of the baro-Akobo-Sobat and White Nile



Data/Information Source

:One System Inventory Synthesis Report 2007
:SRTM Global Elevation Dataset

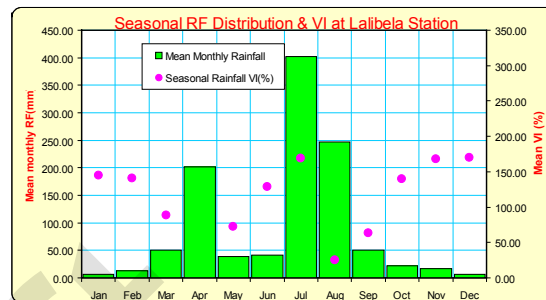
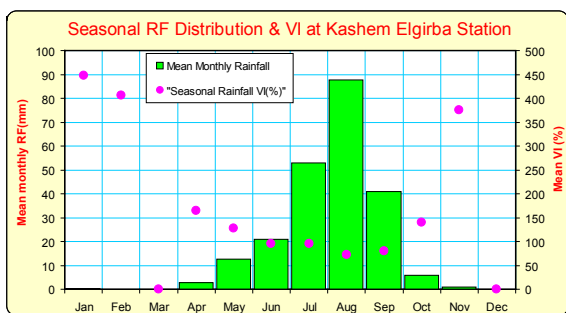
Map - 2.3 : Relief Map of Tekeze-Atbara-Setit Sub-Basin



3. Climate

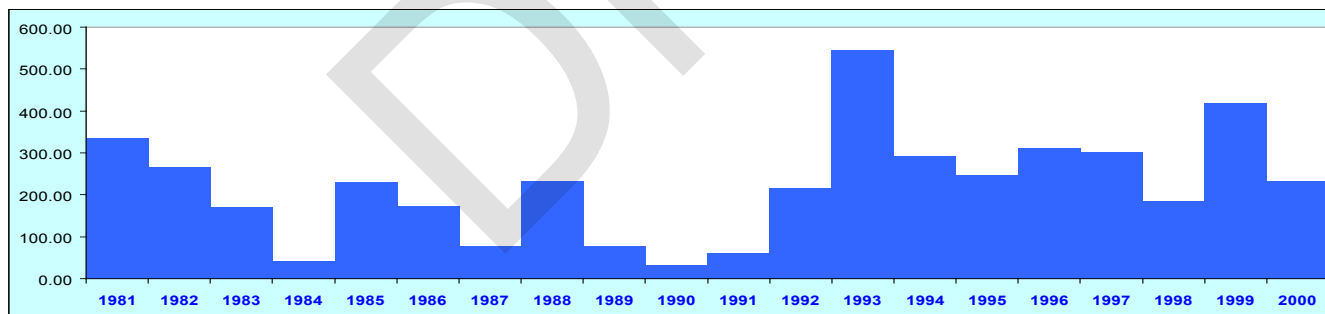
3.1 Climate-Rainfall in the Tekeze-Atbara-Setit Sub-Basin

The Tekeze-Setite-Atbara is the most seasonal of the major contributing sub basins of the ENB. Climate in the sub basin is tropical type with the wettest season limited to less than three months (June/July to August/September). In the u/s course of the ENB, rainfall reduces north wards varying from above 2000mm per year in the Baro-Akobo watershed to less than 700mm in the northern part of the Tekeze watershed. With weighted mean annual rainfall of less than 900mm, rainfall in the upper course of the sub basin ranges from little more than 1000mm to less than 600mm at the Ethio-Sudan border.

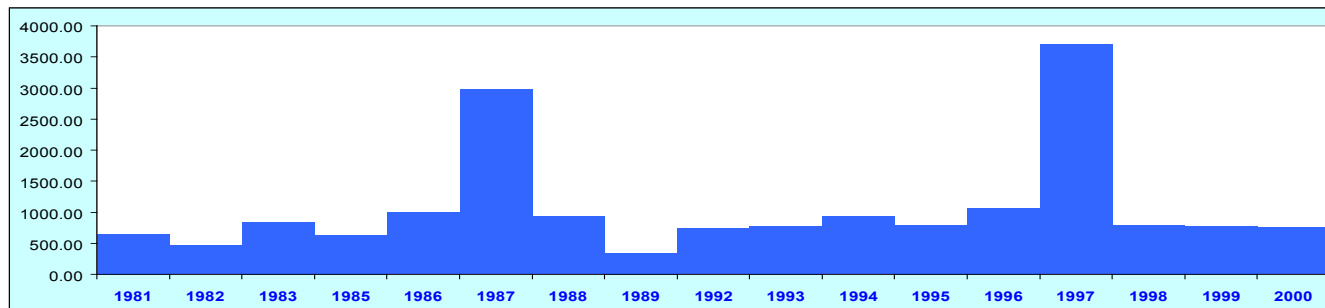


Mean annual rainfall at Girba reservoir is estimated at less than 200mm and it reduces to less than 50mm at Atbara, the mouth of the sub basin. Hydrologic variability is significant and highly seasonal. The variability index for the annual series is averaged at more than 30%. Seasonal distribution is more erratic and variable affecting agricultural production significantly. The upper course of the Tekeze-Atbara watershed is identified as one of the most draught prone area in Ethiopia

Girba Station Annual Rainfall in mm

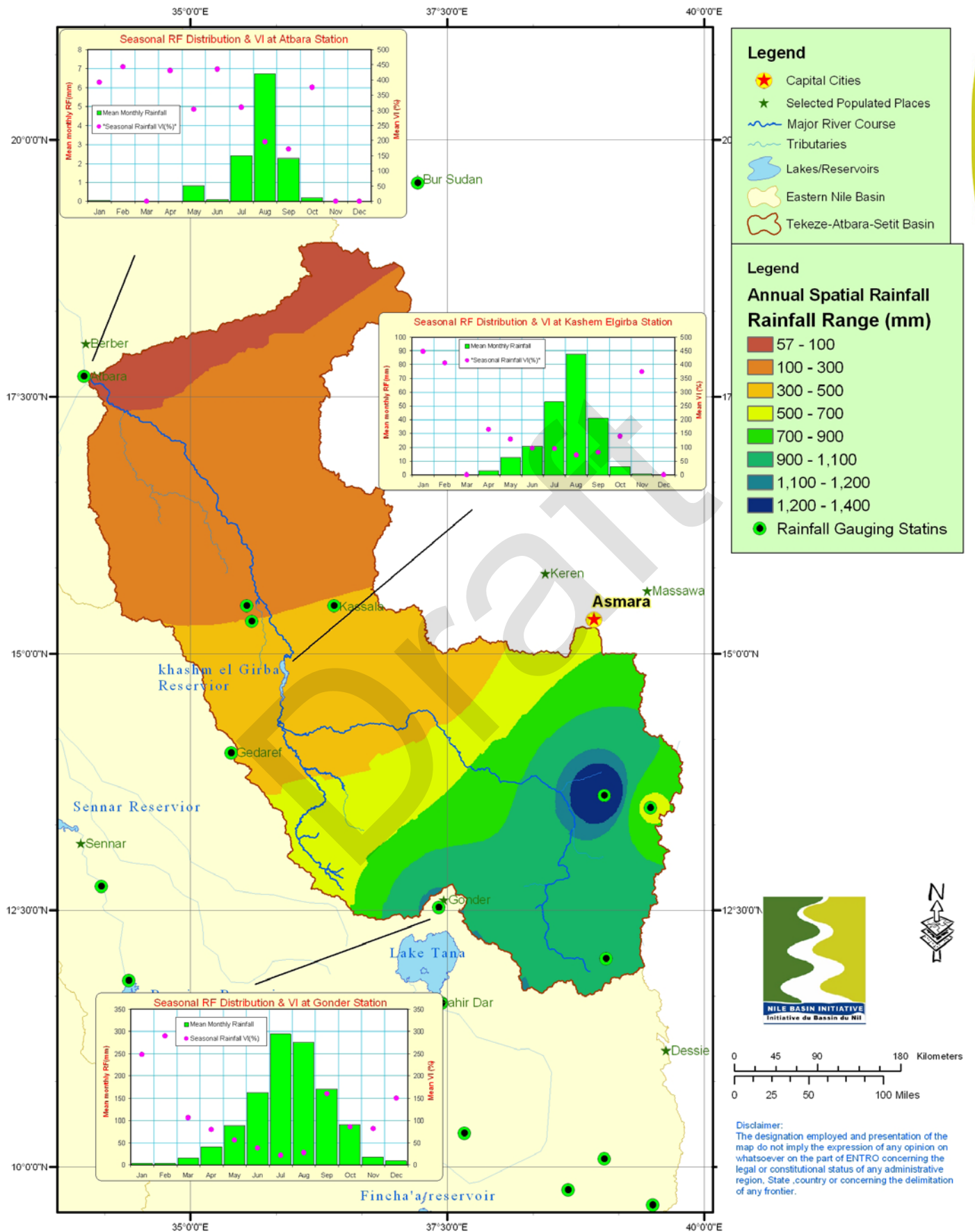


Lalibela Station Annual Rainfall in mm



Data/Information Source : One System Inventory Synthesis Report 2007

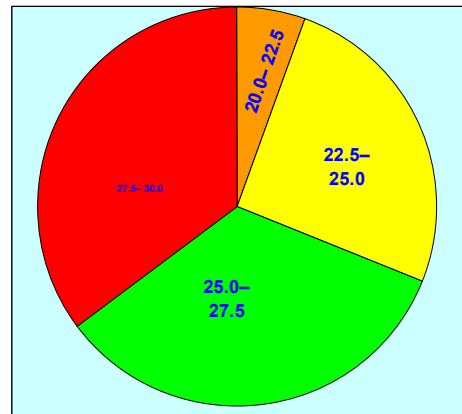
Map - 3.1 : Rainfall Map of Tekeze-Atbara-Setit Sub-Basin



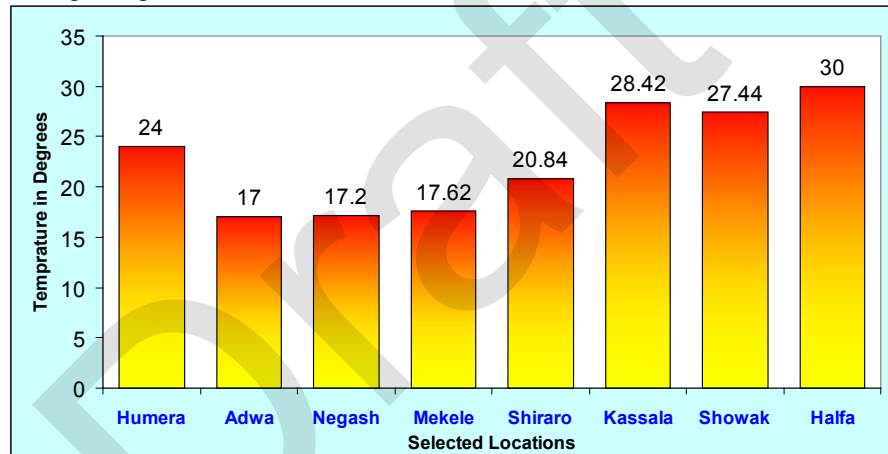
3.2 Climate-Temperature in the Tekeze-Atbara-Setit Sub-Basin

Temperature in the highland plateaus of the sub basin is pleasant where mean annual air temperature not exceeding 20°C. Large proportion of this highland plateau exhibits mean annual temperature of 18°C. In the western low-lying area of the sub basin, around the border, mean annual temperature is in the order of 25°C. Further in the downstream reach of the sub basin, around the Girba reservoir and in its immediate upstream reach, mean annual temperature is observed to be 30°C. In the lower course, at Atbara, the mouth of the sub basin, temperature exceeds 30°C.

Temperature categories in degree Centigrade



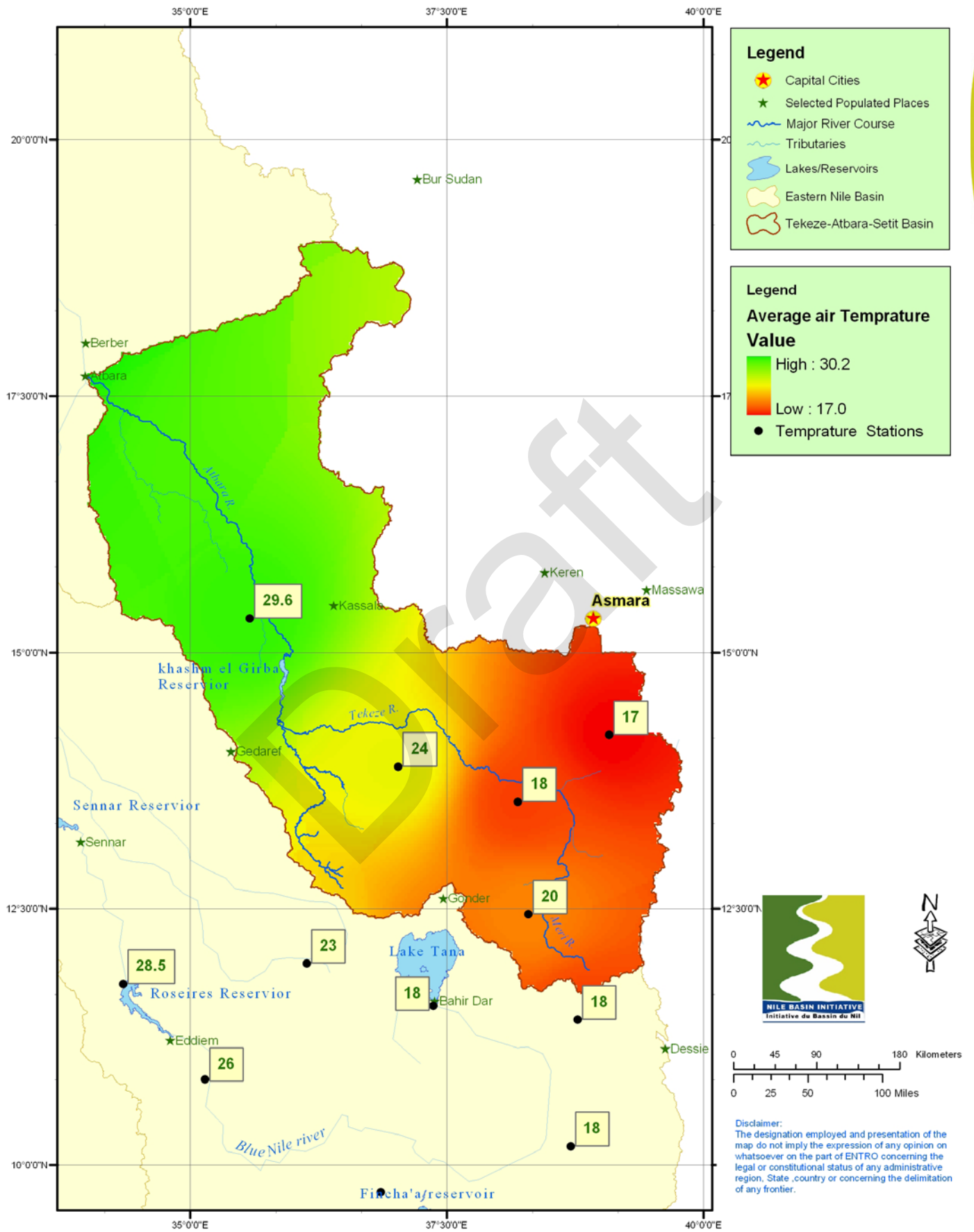
Average temperature values at selected locations



The spatial distribution of temperature values is strongly related to altitude. The area located in the highlands of Ethiopia is characterized by lowest minimum mean monthly temperatures that range between 3 and 21°C, and that occur between December and February.

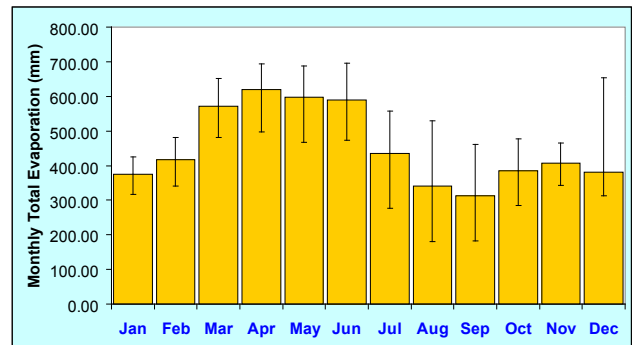


Map - 3.2 : Temperature Map of Tekeze-Atbara-Setit Sub-Basin

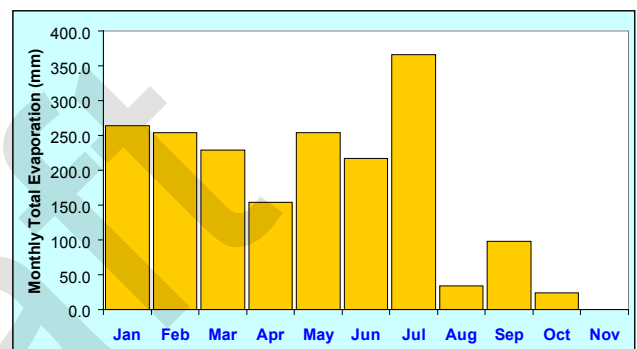


3.3 Climate-Evaporation in the Tekeze-Atbara-Setit Sub-Basin

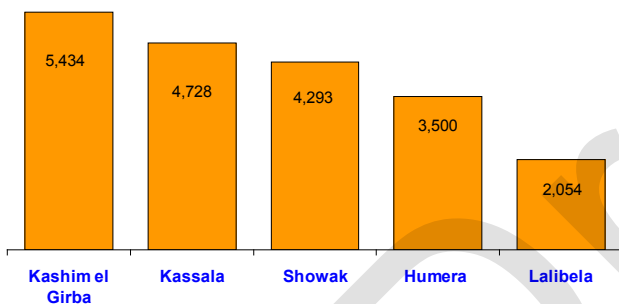
Mean annual Potential Evapotranspiration (PE) follows similar trend as that of temperature. It is well below 2000mm per annum in the highland plateaus of the sub basin and accounts only 2.5% of the sub basin. PE exceeds 2000mm in the valleys of these highland plateaus. The low-lying area (below 1500masl) located at the foot of the highland plateaus in the western face, up until the border and a little beyond experiences mean annual PE that ranges from 2000mm to 3000mm and covers some 40% of the sub basin. Further in the Sudan lowland area until the Girba reservoir, PE is observed to exceed 5000mm and covers 30% of the sub basin. In the lower reach of the sub basin and at Atbara, the mouth of the sub basin, PE is observed to rise up to 6000mm.



Total Monthly evaporation at Girba Station

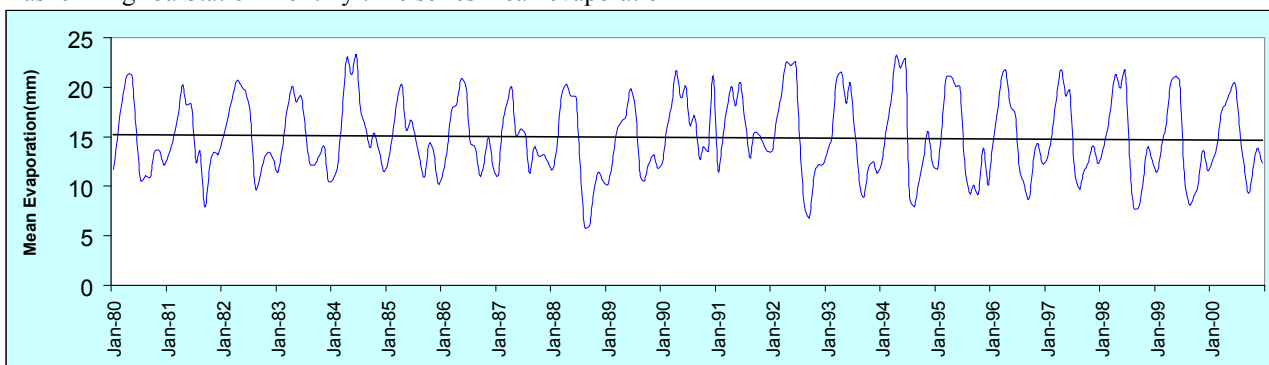


Total Monthly evaporation at Lalibela Station for 2000

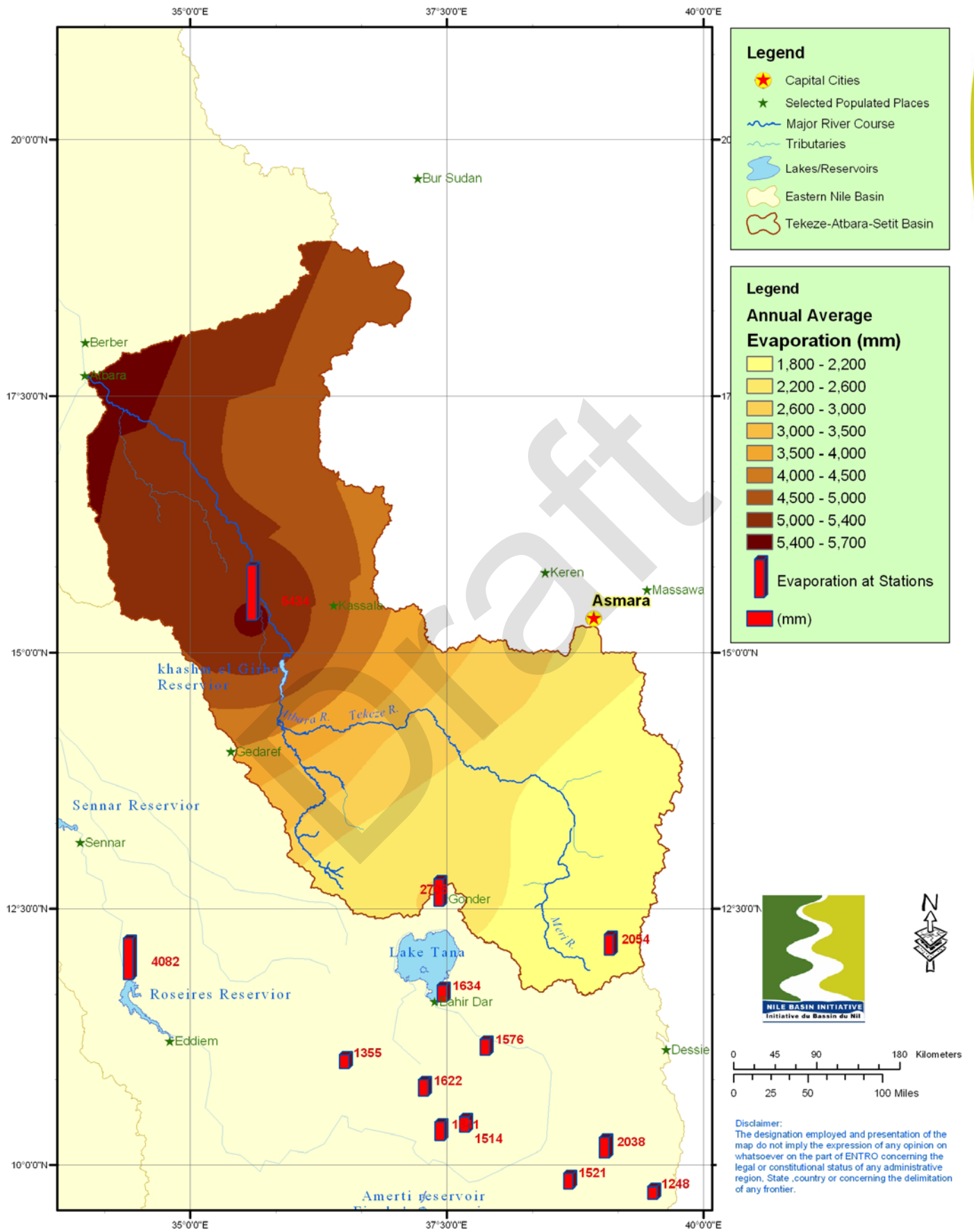


Annual Average Evaporation values(mm) from selected locations in Tekeze-Atbara-Setit sub-basin.

Kashem Elgirba Station monthly time series mean evaporation in mm

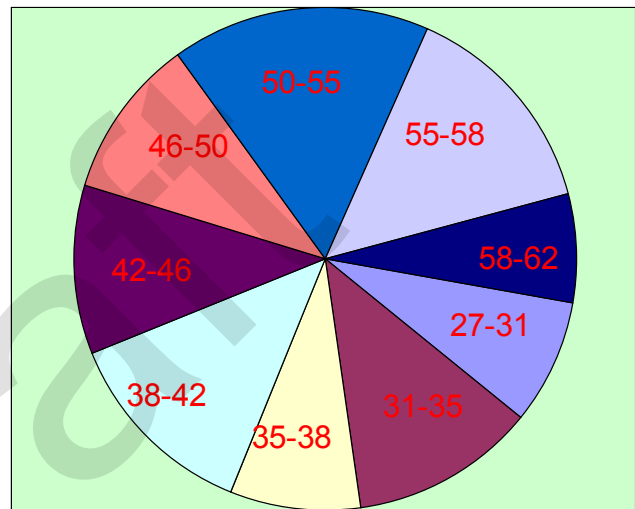


Map - 3.3 : Evaporation Map of Tekeze-Atbara-Setit Sub-Basin



3.4 Climate-Humidity in the Tekeze-Atbara-Setit Sub-Basin

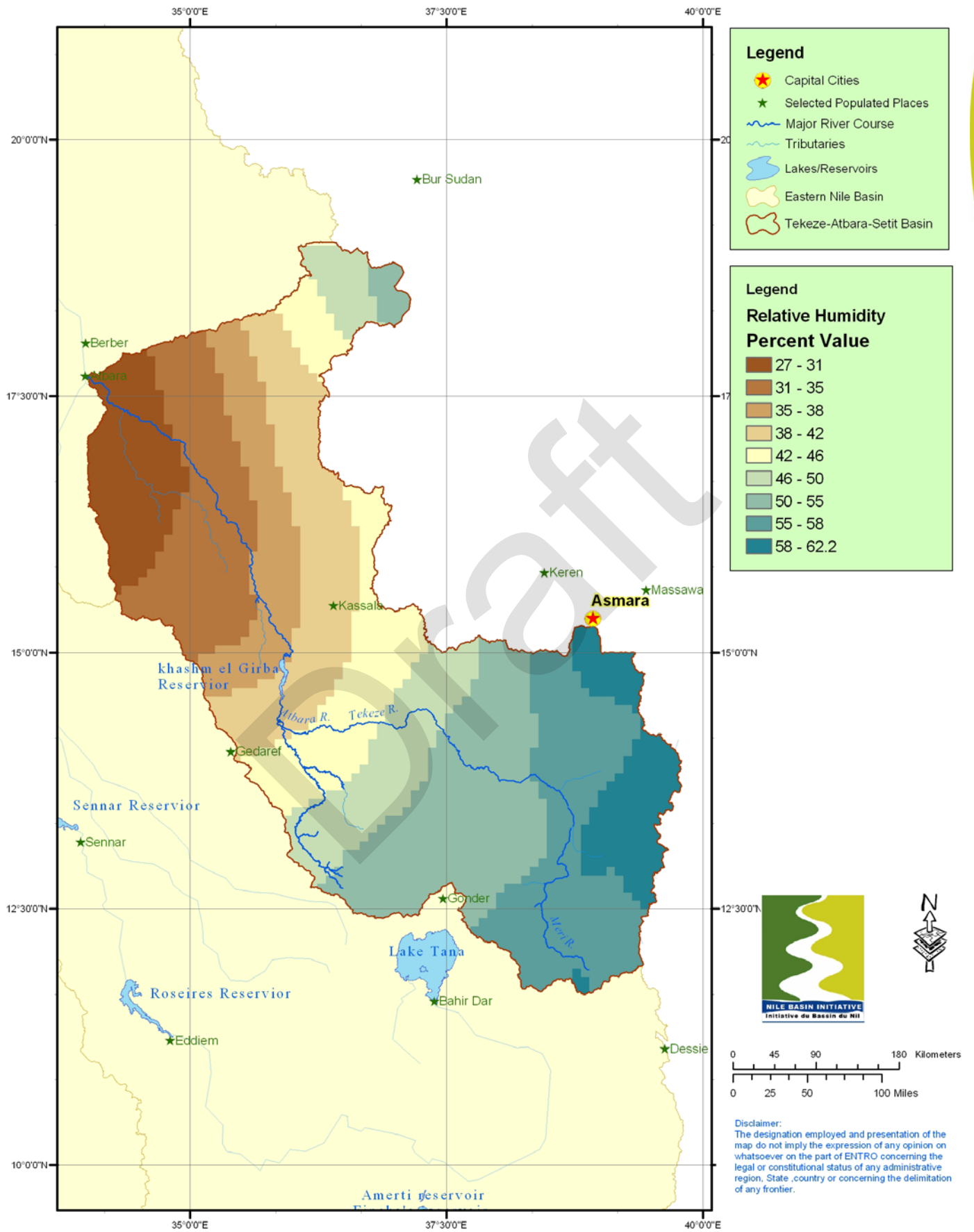
As it could be resulted from sever land and environment degradations, nearly 80% of the sub basin is identified to have mean annual relative humidity of less than 55%. Out of this nearly 30% is with relative humidity of less than 40%. It is only 20% of the sub basin with relative humidity exceeding 55%. This portion of the sub basin is confined in the highland plateaus of the “Semen” (North) mountains of Ethiopia.



Relative Humidity area Distribution in Tekeze-Atbara-Setit

Relative Humidity Value	percentage of areal coverage
27-30	1.64%
30-35	6.81%
35-40	11.34%
40-45	15.27%
45-50	7.77%
50-55	9.26%
55-60	33.15%
60-65	12.69%
65-67	2.06%

Map - 3.4 : Relative Humidity Map of Tekeze-Atbara-Setit Sub-Basin



4. Land

4.1 Land use and Land cover of the Tekeze-Atbara-Setit Sub-Basin

The lower course of the sub basin, where mean annual rainfall is less than 100mm, is generally characterized with desert or semi-desert condition with little or no vegetation. In this region of the sub basin vegetation is observed along some wadis with high ground water table. In some years where rainfall is above average, the area is seasonally transformed in to valuable grazing areas known as “gizzu”.

Semi-desert scrubs is dominant in regions with mean annual rainfall of above 100mm and less than 250mm. This vegetation comprises varying mixture of grasses and herbs, generally with a variable scatter of shrubs up to 4m high.

Grasses are largely annuals in Sudan. Heavy grazing and low rainfall ensures that there is insufficient dry matter for annual fires. In years of annual rainfall below average and heavy grazing there can be a complete failure of annual plant growth.

South-east wards, from the 250mm to 360mm isohyets, the vegetation type become “Semi-Desert Grass Land”. On the heavy alkaline clay soils the natural vegetation is grassed without trees or shrubs.

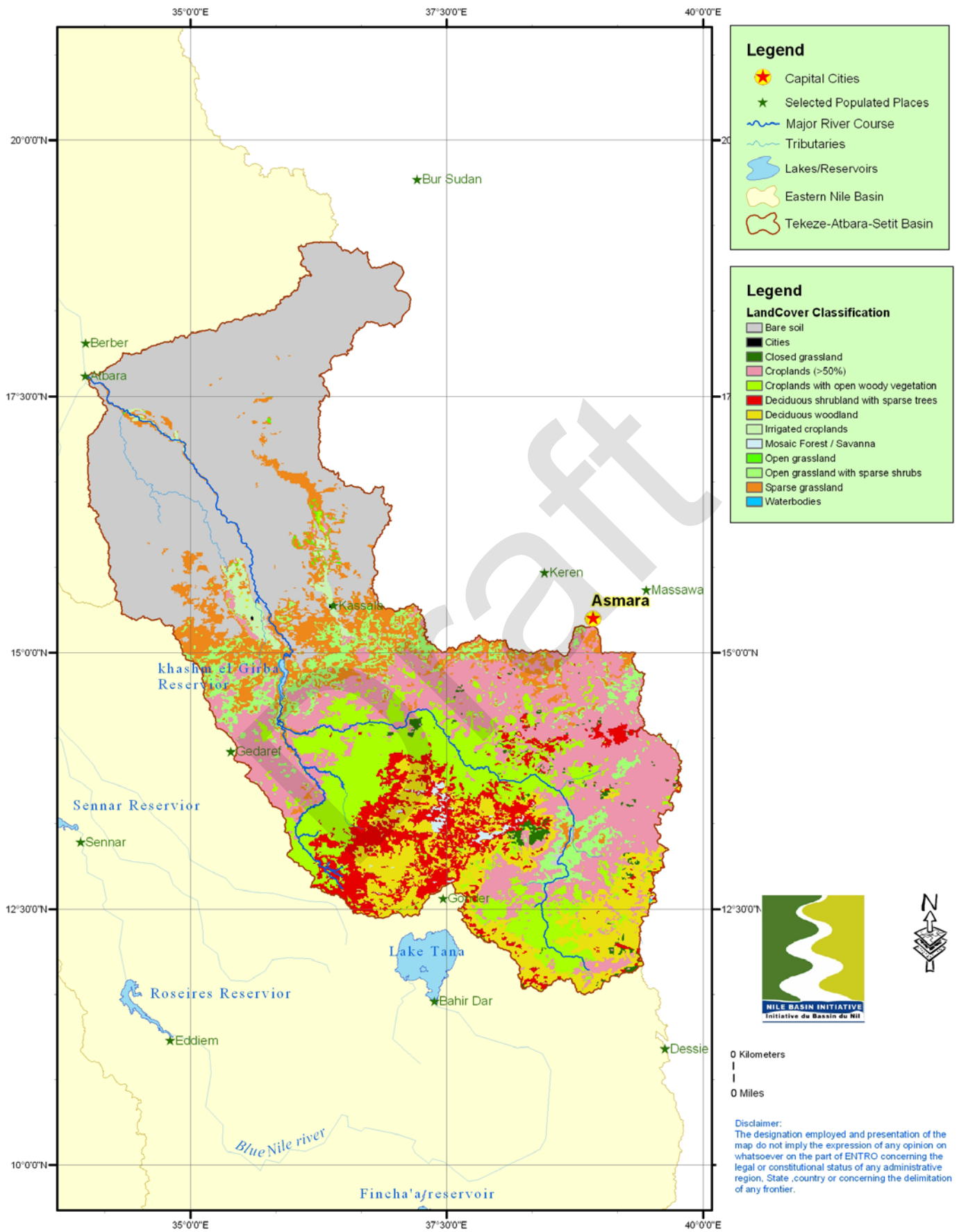
Between the 360mm and 570mm isohyets, on the heavy clay soils grass land merges into *A. mellifera* thorn land. Above 570mm to the border with Ethiopia there is increasing dominance by *A. seyal* in association with *Balanites aegyptiaca*. *A. Senegal* is retained for gum Arabic harvesting whilst *A. seyal* is used for charcoal production. *B. aegyptiaca* becomes increasing prevalent because it is fire resistance. The lowlands located in Ethiopia mainly covered by shrub lands. This land cover type is also observed in the dissected highlands around the upper head of Tekeze River in the south-east.

Cultivated lands are well distributed over the upstream region of Tekeze-Atbara sub basin. A higher percentage is observed in the north and the high plateau that reaches to Lake Tana. Woodlands are mainly located in the south-west part of the lowlands. Bare lands (rock and bare soil) are scattered in the highlands, with a higher concentration within the gorge of Tekeze river, as well as within the central mountainous ridge. Forest and afro-alpine vegetation represent less than 1% of Tekeze basin.

Below the Kashm el Girba dam is the New Halfa irrigation scheme totaling some 190,000ha. Above the dam are extensive areas of semi-mechanized farms that stretch over into the Blue Nile sub basin.

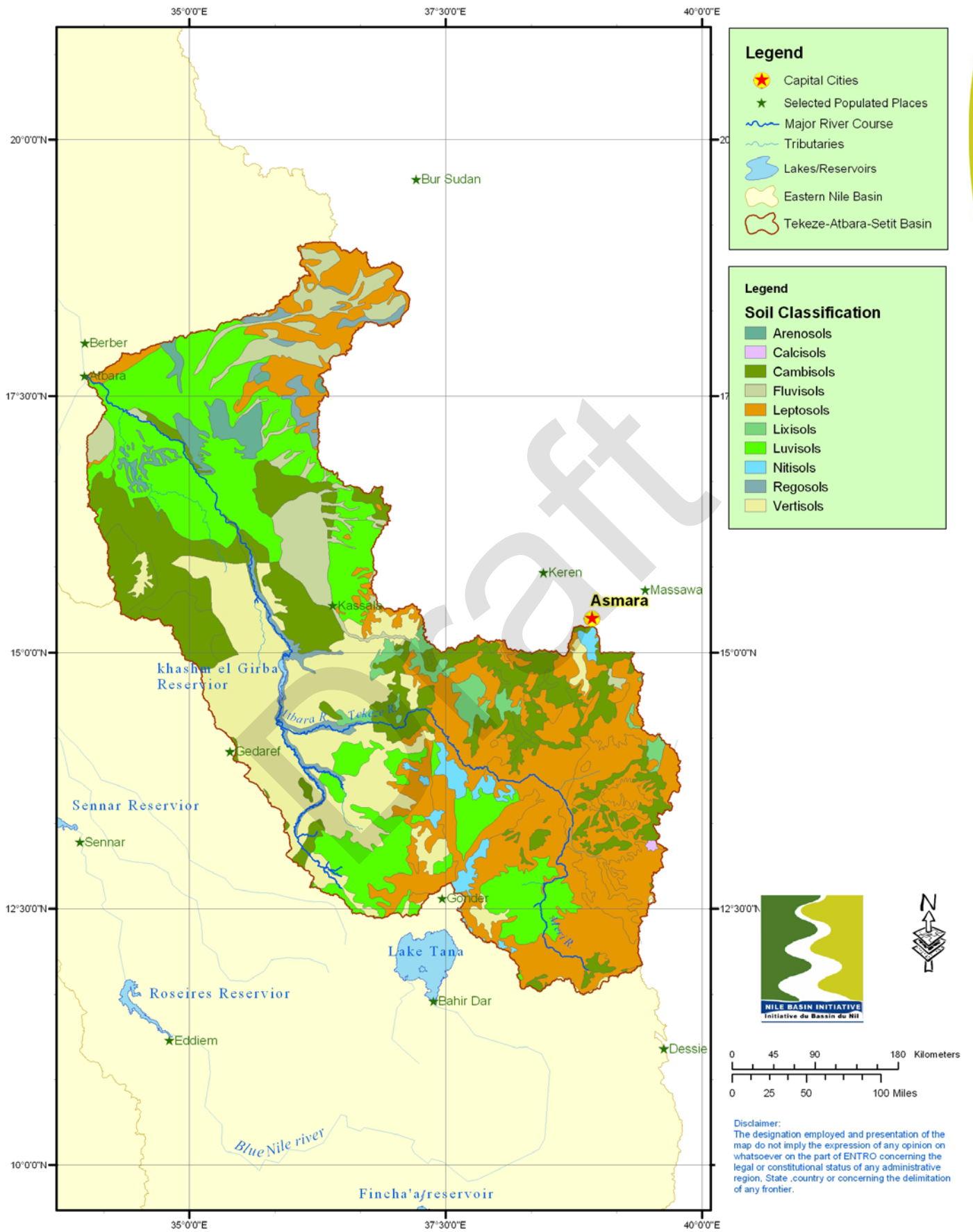


Map - 4.1 : Land Cover Map of Tekeze-Atbara-Setit Sub-Basin



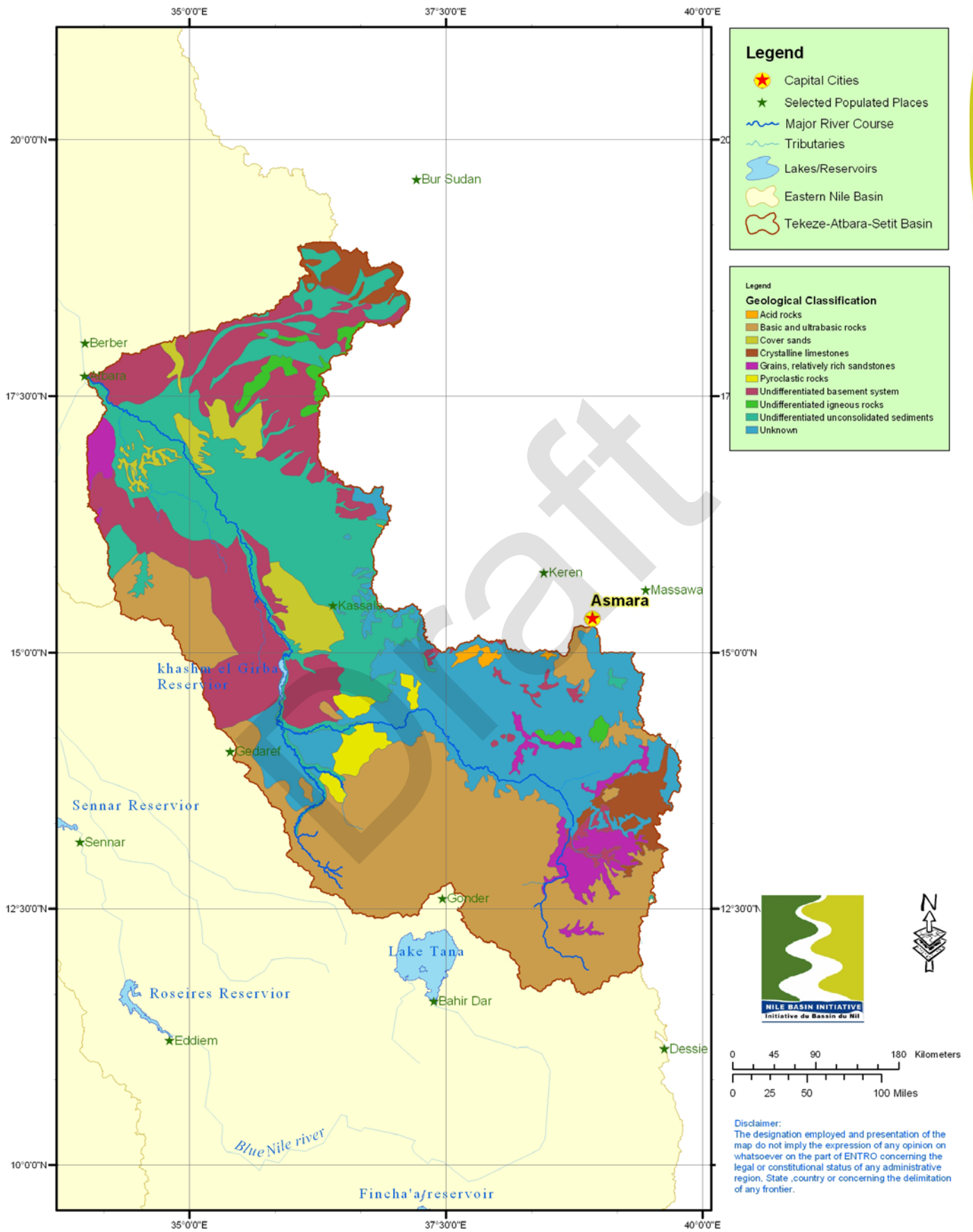
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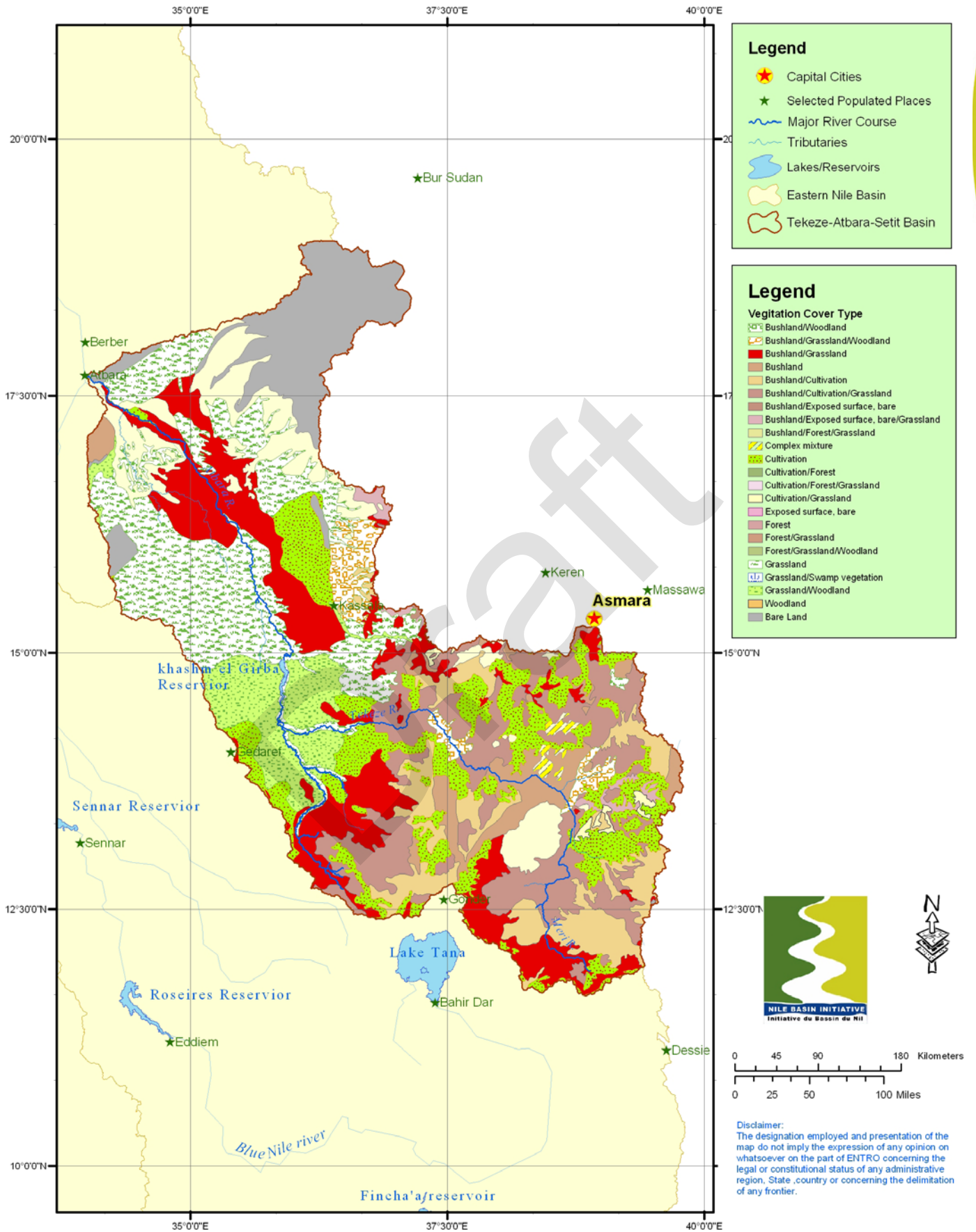
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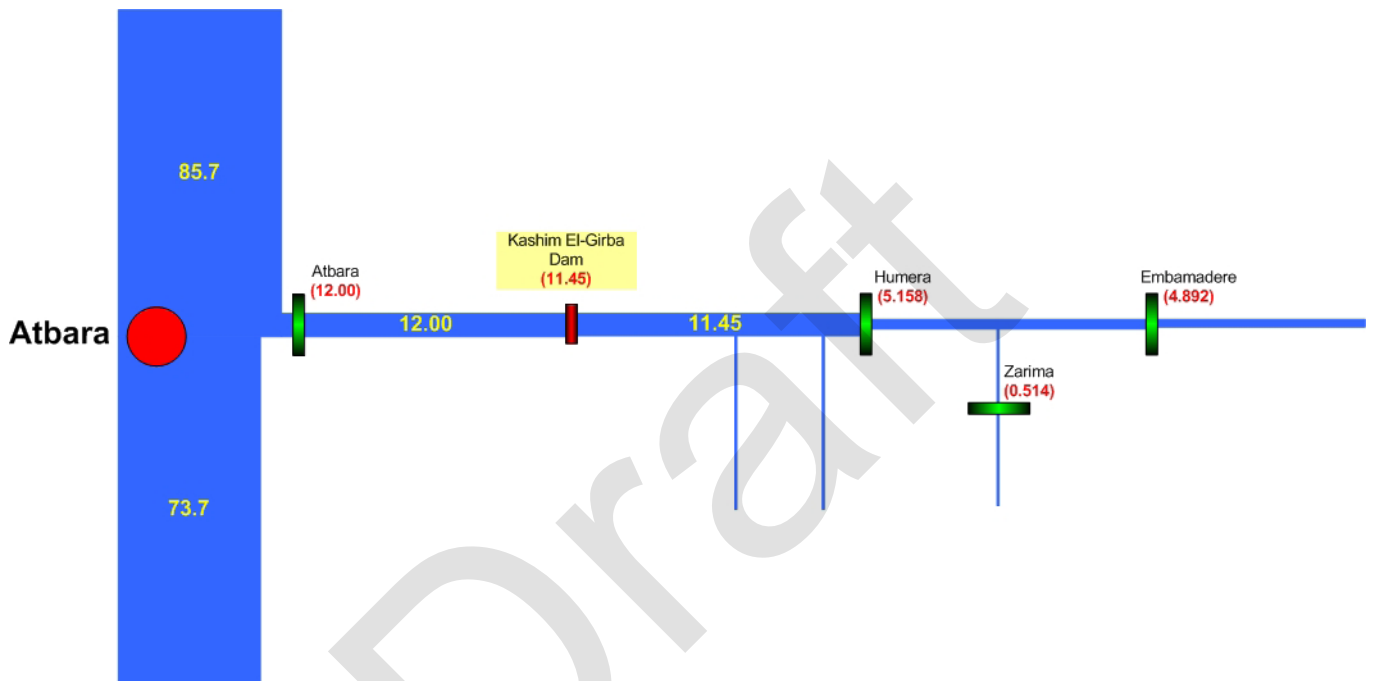
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