Eastern Nile Technical Regional Office

ONE-SYSTEM INVENTORY

ANNEXE: BLUE NILE SUB BASIN

June 2009

EASTERN NILE TECHNICAL REGIONAL OFFICE
ADDIS ABABA
ETHIOPIA

CONTENTS

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 Abbay-Blue Nile Sub Basin and is part of the four annexes that support the summary OSI report prepared by ENTRO.

Figure 1.1: Blue Nile Sub-basin: Location map

Source: Sudan: ENTRO GIS data base: Ethiopia WBISPP GIS Database

1. GENERAL CHARACTERISTICS

1.1. SUB-BASIN LOCATION AND AREA

Location: The Blue Nile (Blue Nile) Sub-basin is one of the four major sub-basins in the Eastern Nile Basin.This sub-basin extends from the western Ethiopia to the lowlands of Sudan, meeting the Main Nile at Khartoum. The Dinder and Rahad rise to the west of Lake Tana flow westwards across the border joining the Blue Nile below Sennar.

Area: The sub-basin has a total area of 311, 548 square kilometres (65% in Ethiopia and 35% in Sudan)

1.2. ADMINISTRATIVE UNITS

In the Sudan there are five states and in Ethiopia three Regional States partially located within the sub-basin: 35 percent of the Sub-basin area is in Sudan and 65 percent in Ethiopia (Table 1.2 and Figure 1.1).

Table 1.2: Blue Nile Administrative States/Regional States and their areas

State/Regional State	Area (in square kilometres)	% of Sub-basin
SUDAN		**35%**
Sinnar	30,106	10%
Blue Nile	19,162	6%
El Gezira	15,686	5%
Gaderif	38,929	12%
Khartoum	6,880	2%
ETHIOPIA		**65%**
Amhara	93,565	30%
Beni-Shangul Gumuz	44,676	14%
Oromiya	62,478	20%
SUB-BASIN	**311,481**	**100%**

Source: Sudan: ENTRO GIS data base: Ethiopia WBISPP GIS Database

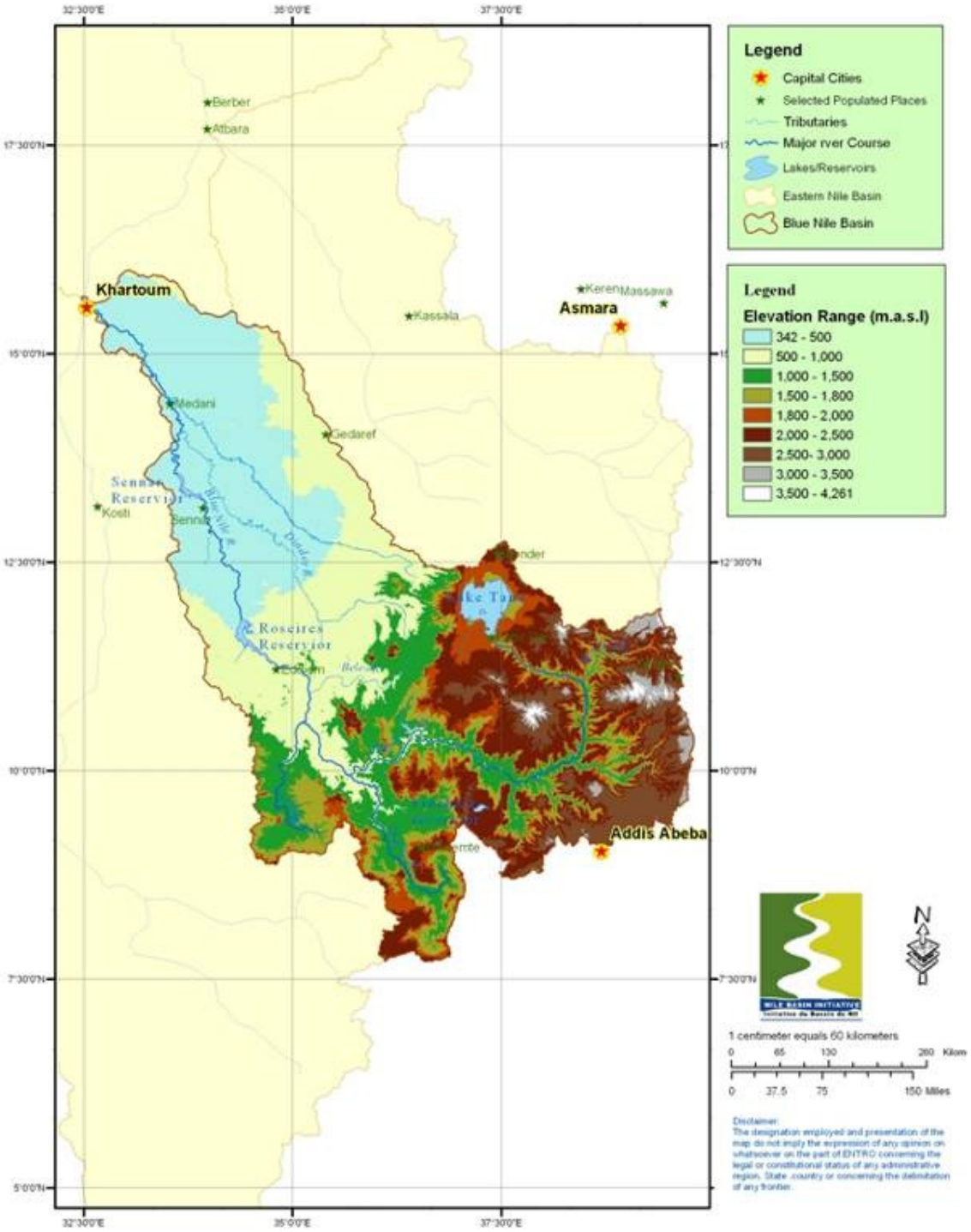
1.3. TOPOGRAPHY

1.3.1. Altitude

The Gelgel Abbay in the right bank of the main stem starts at the Choke Mountains in Gojjam with an altitude of above 3,800 masl. The Beshilo (a direct tributary of the Blue Nile main stem) and the Gummara & Rib Rivers (major tributaries of Lake Tana in the east) start flowing from the Guna peak, in south Gondar, with an altitude of above 4,000 masl. The major tributaries in its left bank start flowing from the central highland plateaus of north Showa with an average altitude of above 2,200 masl. In the south left bank its major tributaries like Guder, Fincha, Angar and Deddessa starts flowing from the western highland plateaus of Ethiopia with an average altitude of above 2,000 masl. Similarly tributaries in the right bank start flowing from the Gojjam highlands with peaks reaching above 3,000 masl. The Dabus in the left bank and the Rahad & Dindir in the right bank starts flowing in the mid altitude plateaus (about 2,000 masl) of west Wollega and North

Gondar respectively. At the Ethio-Sudan border the altitude drops to 600 masl. At Khartoum, its mouth, the altitude is dropped to 400 masl. Altitude variation in the sub basin is given in Figure 1.2.

Figure 1.2: Altitude Variation in the Blue Nile Sub-basin



Source: **SRTM** 90m **DEM** Digital Elevation Database

1.3.2. Slope

Areas in the sub-basin with less than 5% land slope covers 44%, and land slope ranging from 5% to 10% covers 13% of the sub basin. Land slope in the range of 10% to 15% and 15% to 20% cover 12% and 10% of the sub basin respectively. High land slope areas (>20%) with rugged and undulating land surfaces of non-uniform topography covers 24% of the sub basin. Mild slope area of the sub basin (<5%) is largely located in the lower course of the sub basin, with considerable pocket areas located at the foot of high mountains and highland plateaus (1,800 masl to 2,400 masl) in its upper course. The land slope classification map is given in Figure 1.3. The Sobat area which covers 20% of the sub basin at Malakal passes through a flat seasonally inundated flood plain with land slope less than 2%. Between the Malakal station and the junction with the Blue Nile at Khartoum, the White Nile drops only 13 metres over a reach of about 840 kilometres.

1.3.3. Relief and landforms

Two main landscape units are observed in Abbay-Blue Nile Sub-basin. A mountainous relief that extends in Ethiopia and a flat piedmont starting close to the Ethiopian border and extending out across the Sudanese portion (Figure 1.4). The Ethiopian Highlands generally present a gently undulating plateau from 2,000 to 2,500 masl with isolated volcanic remnants rising above the plateau to 3,500 to 4,200 masl. The Abbay River and its tributaries are deeply incised into the plateau leaving a series of isolated tablelands separated by deep gorges. In the Ethiopia the lowlands are undulating to rolling between 600 to 1,000 masl with isolated hilly or mountain outliers rising to 2,700 masl. Towards the border with Sudan and extending westwards to the Main Nile the topography is almost flat or slightly undulating, with just the occasional granite jebel rising above the clay plain. The lowland region between the Atbara River and the Blue Nile is occupied by the Butana Plains. 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 (Figure 1.4).

1.4. CLIMATE

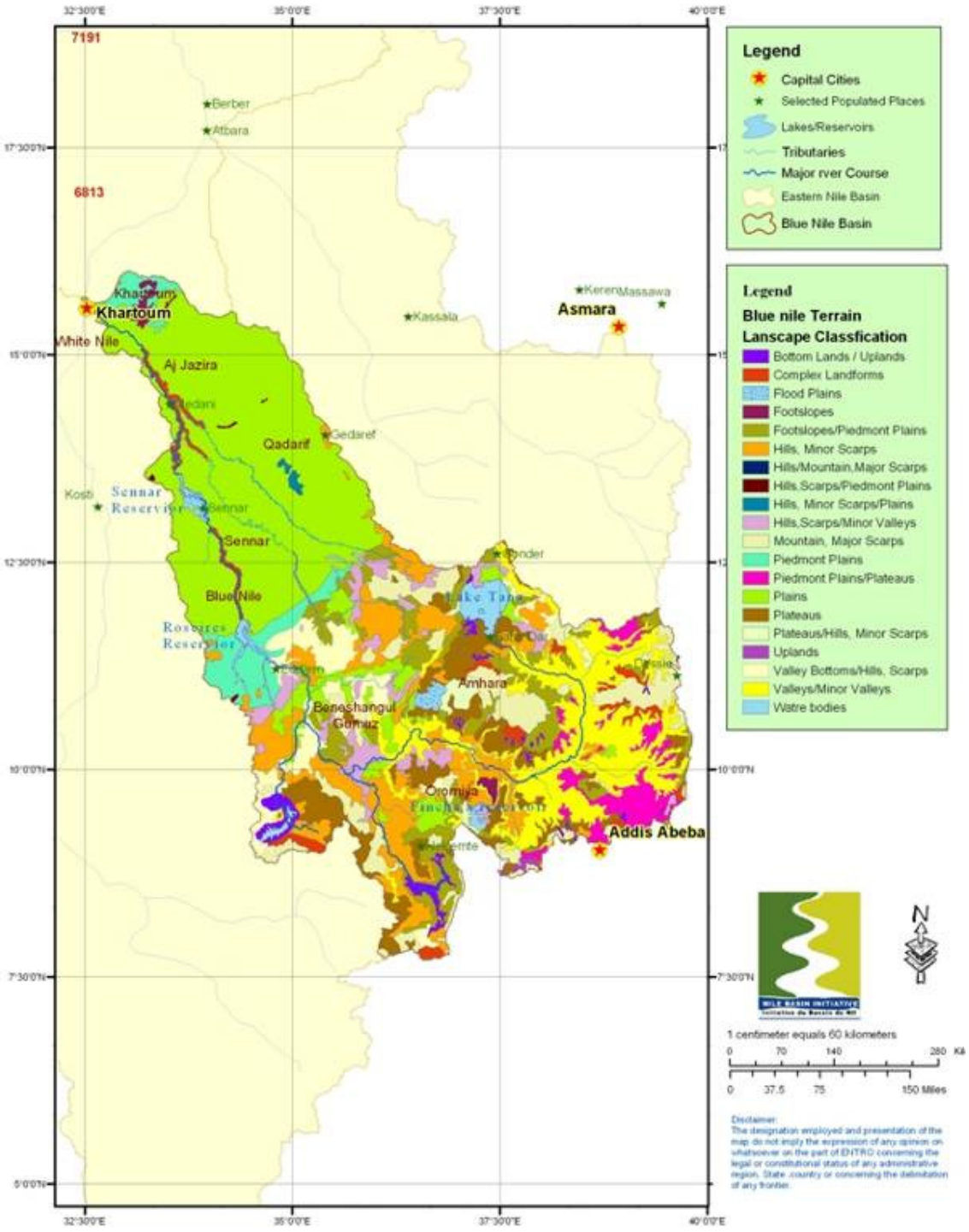
1.4.1. General

Climate in the upper course of the Blue Nile Sub-basin is of the humid and sub humid tropical type, where rainfall and temperature variations are governed by the movement of the ITCZ, the sun and altitude. The movement of the ITCZ from the south to the north gives access for the westerly dry moist winds to cover much portion of the Ethiopian highland plateaus causing wet fronts reaching much portion of the country. The western highlands of Ethiopia, where the upper course of the Blue Nile sub basin is located, is one of the major areas to fall under this wet season. The length of the wet season varies from south to north. The south has a relatively longer wet period and has a humid tropical type of climate while the northern portion, with relatively shorter wet period, has a sub-humid type of tropical climate.

Climate in the Ethiopian highlands is strongly influenced by the effects of elevation, which gives rise to distinct zones and characteristics. Traditional classifications based on altitude and temperature indicates presence of five zones, of which three are predominant in the Abbay River Basin.

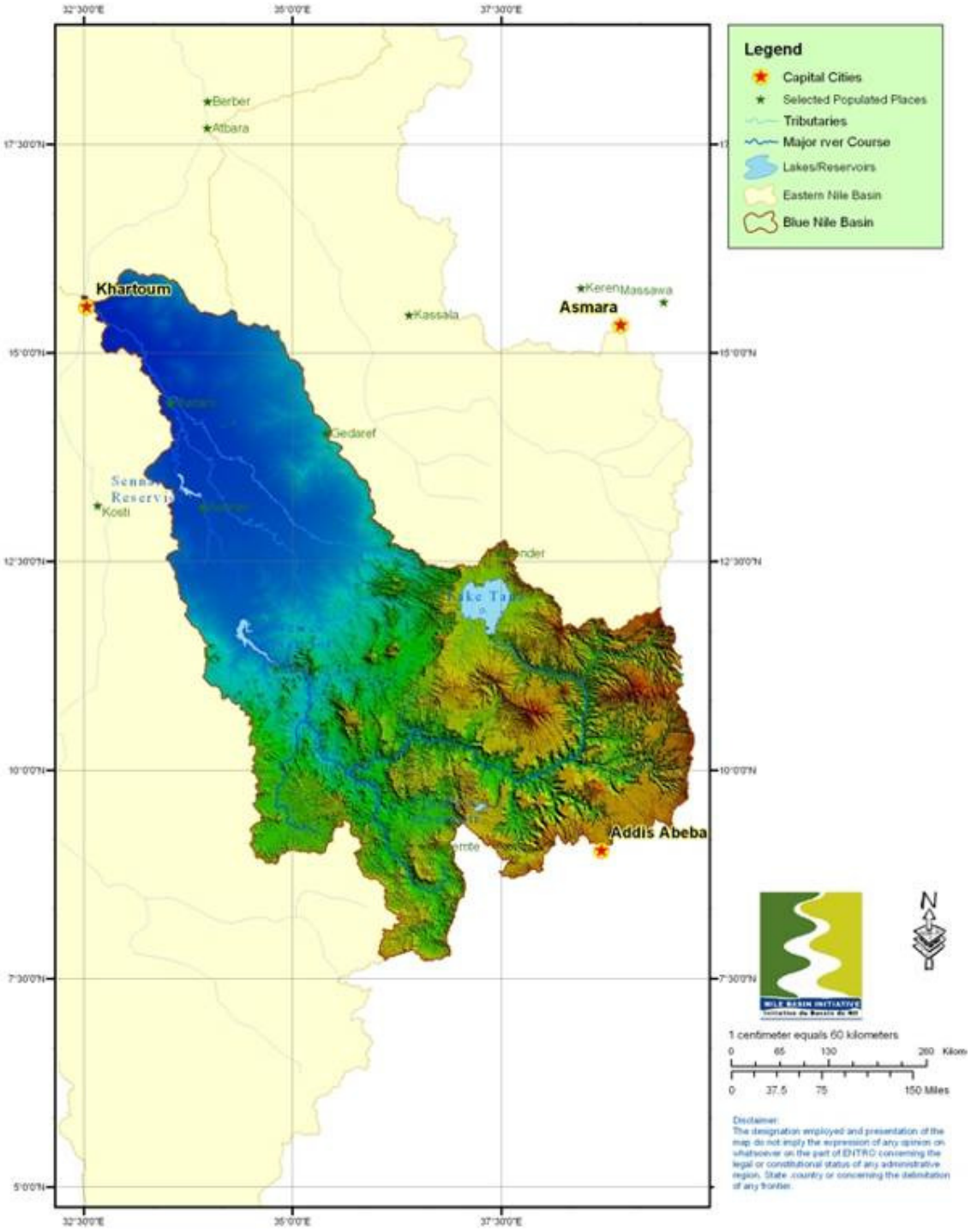
- **Kola** -tropical hot and arid type, below 1,500 metre altitude with mean temperature in the range 20-28ºC.
- **Woin Dega** – sub-tropical warm, between 1,500-2,500 metres altitude with mean temperature in the range 16-20ºC.
- **Dega** – temperate highland climate above 2,500 metres altitude with mean temperature in the range 6-16ºC.

Figure 1.3: Land slope classification in the Blue Nile sub-basin



Sudan: ENTRO GIS data base: Ethiopia WBISPP GIS Database

Figure 1.4: Blue Nile Sub-basin: Relief and drainage



Source: Shuttle Radar Terrain Mission (SRTM 90) digital terrain model.

Contemporary classifications according to Köppen, as adapted by NMSA/Lemma for Ethiopia defines 5 types within the Abbay River Basin comprising:

- Cwc – Cool highland (at highest elevations)
- Cfb – Warm temperate II (Didesa sub basin in the south)
- Cwb – Warm temperate I (across the plateau)
- Am/Aw – Tropical III/II (in the main river valley and at lower elevations)

There are three principal rainfall-inducing regional climatic mechanisms (MPFS, Section 4, pp. 41 & 43):

- Summer monsoon (Inter-tropical convergence zone - ITCZ)
- Tropical upper easterlies
- Local convergence in the Red Sea coastal region

Climate in the lower course of the Blue Nile (which is largely the sub basin beyond the Ethio-Sudan border) is hot tropical with a dominant dry spell. Wet and dry seasons here are also governed by the movement of the ITCZ, the sun and altitude. Further in the south where altitude is higher (in the Sude watershed) climate is of the sub humid tropical type while to the north, around Khartoum and Rosaries reservoir, climate is hot tropical. Dry and hot tropical type of climate dominates in the further northern reaches due to the vast coverage of the Sahara desert. (There are no climatological stations in or close to Mandaya dam site and reservoir location. Descriptions of climate are therefore based on regionally mapped data by the former Ethiopian Meteorological Service provided in the National Atlas of Ethiopia. Mandaya lies in the Tropical Climate II type of the nine types of the Koppen classification system occurring in Ethiopia. Areas with Tropical Climate II are mostly found in the west of Ethiopia and are characterized by dry winter months, the mean temperature of the coldest month being greater than 18°C and mean annual rainfall between 680 and 2,000 mm (MPFS, Section 4, pp. 41 & 43; BFPR, Section 4, pp. 4-1)

1.4.2. Rainfall

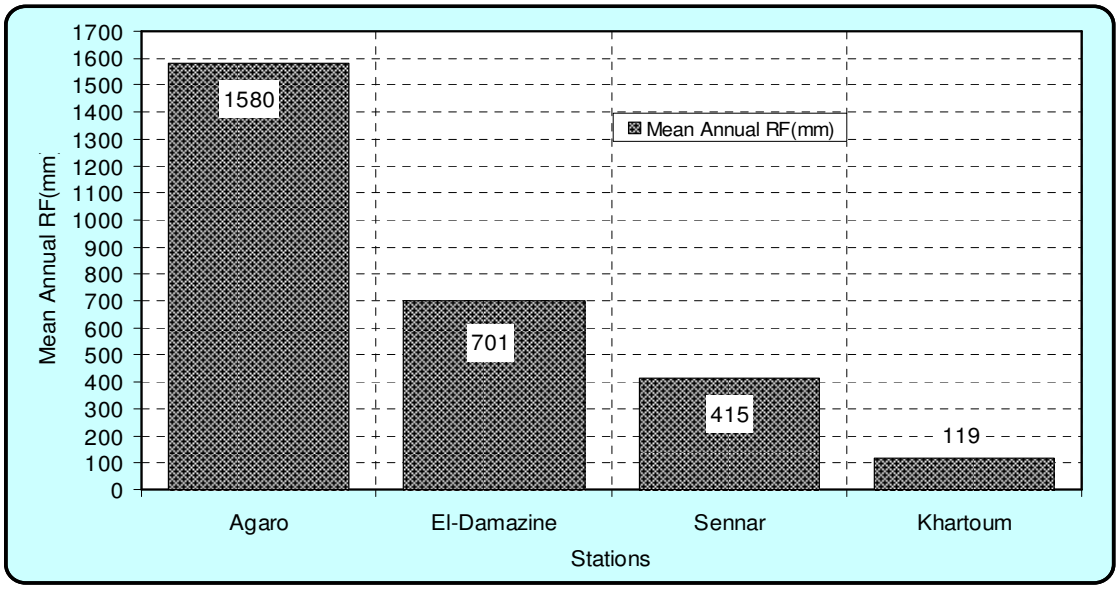
In regard to rainfall regimes and seasons, a standard nomenclature for Ethiopia has been compiled by NMSA. In different parts of the country rainfall regimes are described as Mono-modal, Bi-model and Diffuse. In much of the Abbay River Basin the mono-modal pattern pre¬dominates, as defined by just two distinct seasons: wet and dry (MPFS, Section 4, Pg. 43; BFPR, Section-4, pp.4-3);

Seasonal and spatial variation: Rainfall in the sub basin varies both seasonally and spatially. Spatial variability is both vertical (along the river course as given in Figure 1.5) and horizontal (south-north direction as depicted in Figure 1.6). Horizontal variation ranges from above 1,500 mm in the southern portion of its upper course to about 1,000 mm in the northern portion of its upper course. Similarly, in its lower course mean annual rainfall ranges from 700 mm (south portion at El-Damazin station) to less than 500 mm in its northern portion. Vertical variation ranges from above 1,500 mm (at the western highlands of Ethiopia) to 120 mm at Khartoum at its mouth.

Wet and dry seasons: Seasonal variability in the southern half of the upper course is less compared to its northern half. In the southern half of the upper course, the length of the wet spell is relatively longer, lasting for more than five months (April/May to October/November). The wet period is confined to three months and/or less (June/July to August/September) in the northern half of its upper course. In the wet period of the southern half seasonal variability is observed to range b/n 20% to 30% (July-Sept) and from 40% to 50% in April/May (sowing period) and in October/November (where most of the crops reach the development and/or the flowering stage). Any moisture stress during these crop development stages could bring considerable crop production losses in the sub

basin. Alike to the spatial variability, seasonal variation also increases north wards. The wet period variability is similar in nature. However, it is higher, exceeding 50%, in the sowing period (April, May/June) and in the development/flowering stage (October/November). In the most north part of the upper course of the Blue Nile sub basin, the wet period is limited to less than three months and seasonal variability is increased indicating the risk of the rain-fed agricultural system. At Gondar station, for instance, the wet period lasts for only three months (June/July to Aug/Sept). Rainfall variability in the wet period is above 25% and average variability in the sowing and flowering stages is well above 60%.

Figure 1.5: Spatial Variation of Rainfall, Blue Nile sub Basin



Source: ENTRO OSI data base (Original Source Ethiopia: Ministry of Water Resources Ethiopia; Sudan: Ministry of Agriculture and Water resources)

1.4.3. Temperature

Temperature and evaporation are well correlated with altitude in the Blue Nile sub basin. At high altitudes (>2,300masl) in the western highland plateau of Ethiopia mean annual temperature is in the range of 17ºC to 19.5ºC. Temperatures rise close to the Ethio-Sudan border where altitude is lowered to less than 1,000 masl, ranging from 24ºC to 26.5ºC. At its mouth, around Khartoum, altitude is below 500 masl and temperature ranges from 28.5ºC to 30.5ºC (Figure 1.7).

1.4.4. Evaporation

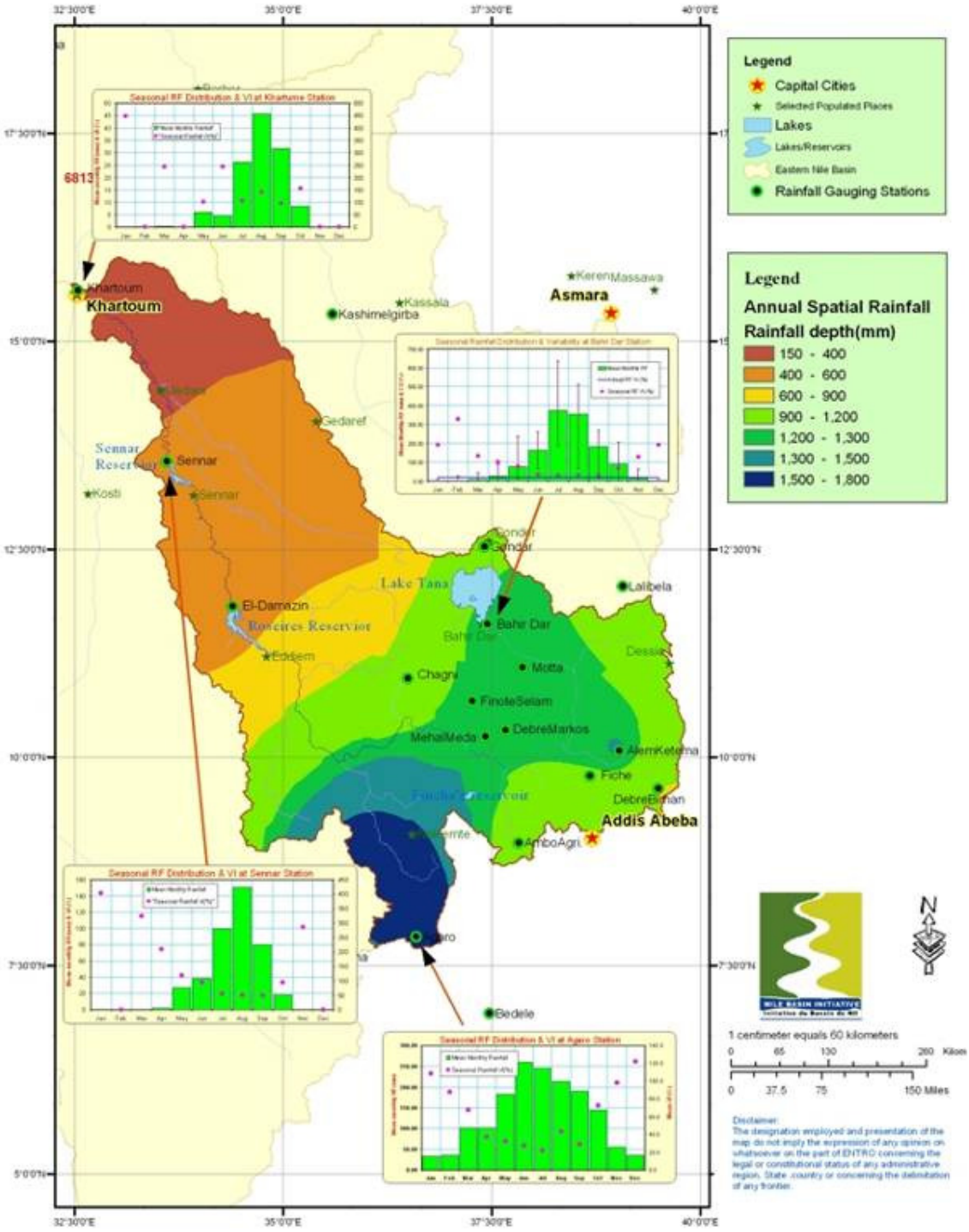
Mean annual evaporation: Variation of evaporation follows the same pattern as temperature. In the upper course, evaporation is less due to high altitudes. Mean annual evaporation ranges from about 1,500 mm (Fiche station (2,300 masl) in the Highlands of the sub-basin) to more than 6,800 mm around Khartoum (Figures 1.8 and 1.9).

Horizontal evaporation: Horizontal variation of evaporation is also significant. In the southern half of the upper course, mean annual evaporation is even below 1,500 mm and in the northern half, especially at its northern tip, evaporation is above 1,800 mm.

Data sources and calculations: Evaporation data was obtained for four sites, but the data series for Debre Markos is significantly longer than the recorded data the other three sites, Ambo, Chagni and Fiche. Equivalent pan evaporation was derived based on a relationship between Piché evaporimeter and pan data.

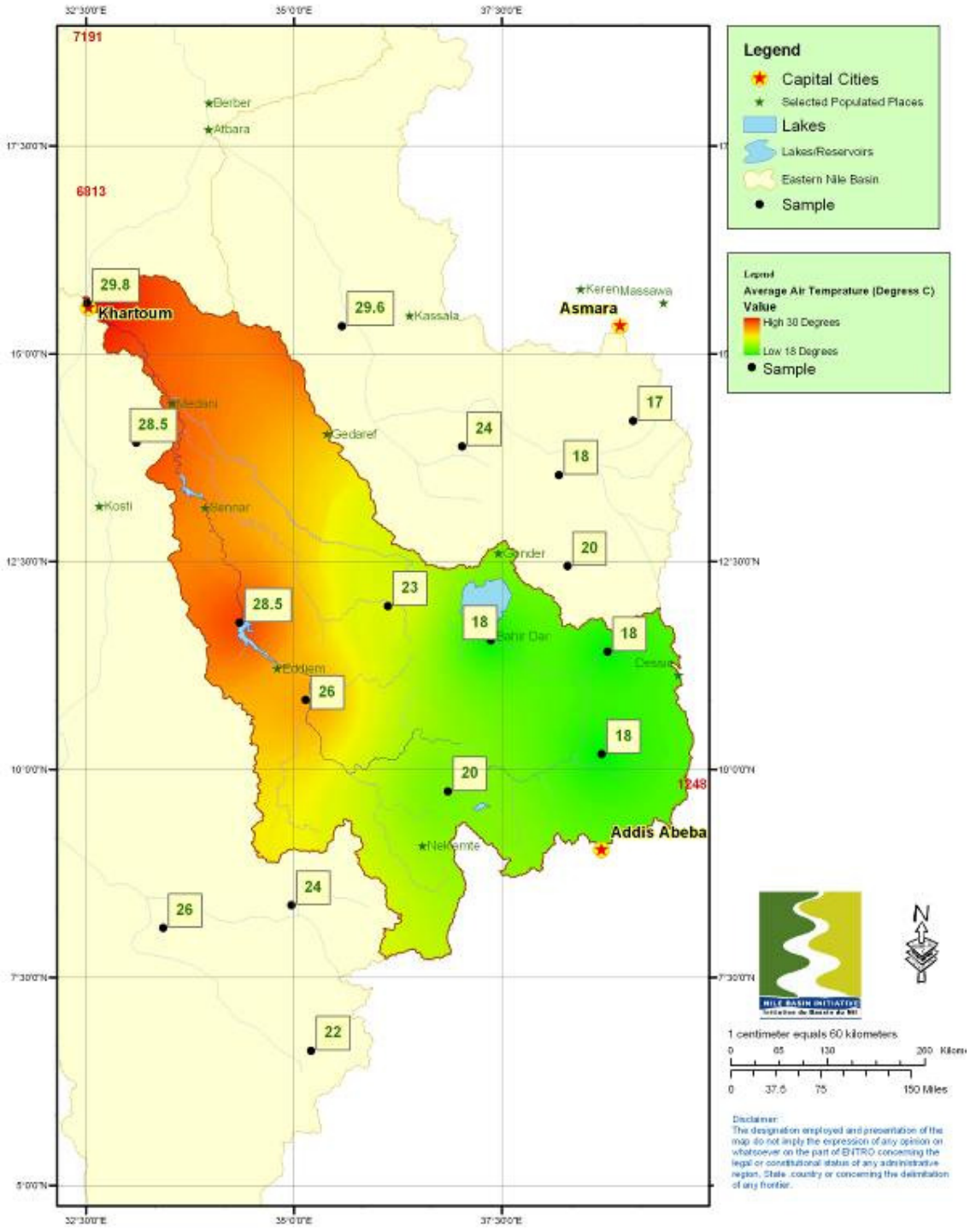
Evaporation losses in reservoirs: Lake evaporation for the Border reservoir has been determined based on a pan factor of 0.8 and the difference in elevation between the various evaporation measurement sites and the Border reservoir (BPFR, Section 4, pp. 4-41)

Figure 1.6: Mean Annual Rainfall Spatial Distribution (Isohyets), Blue Nile sub Basin



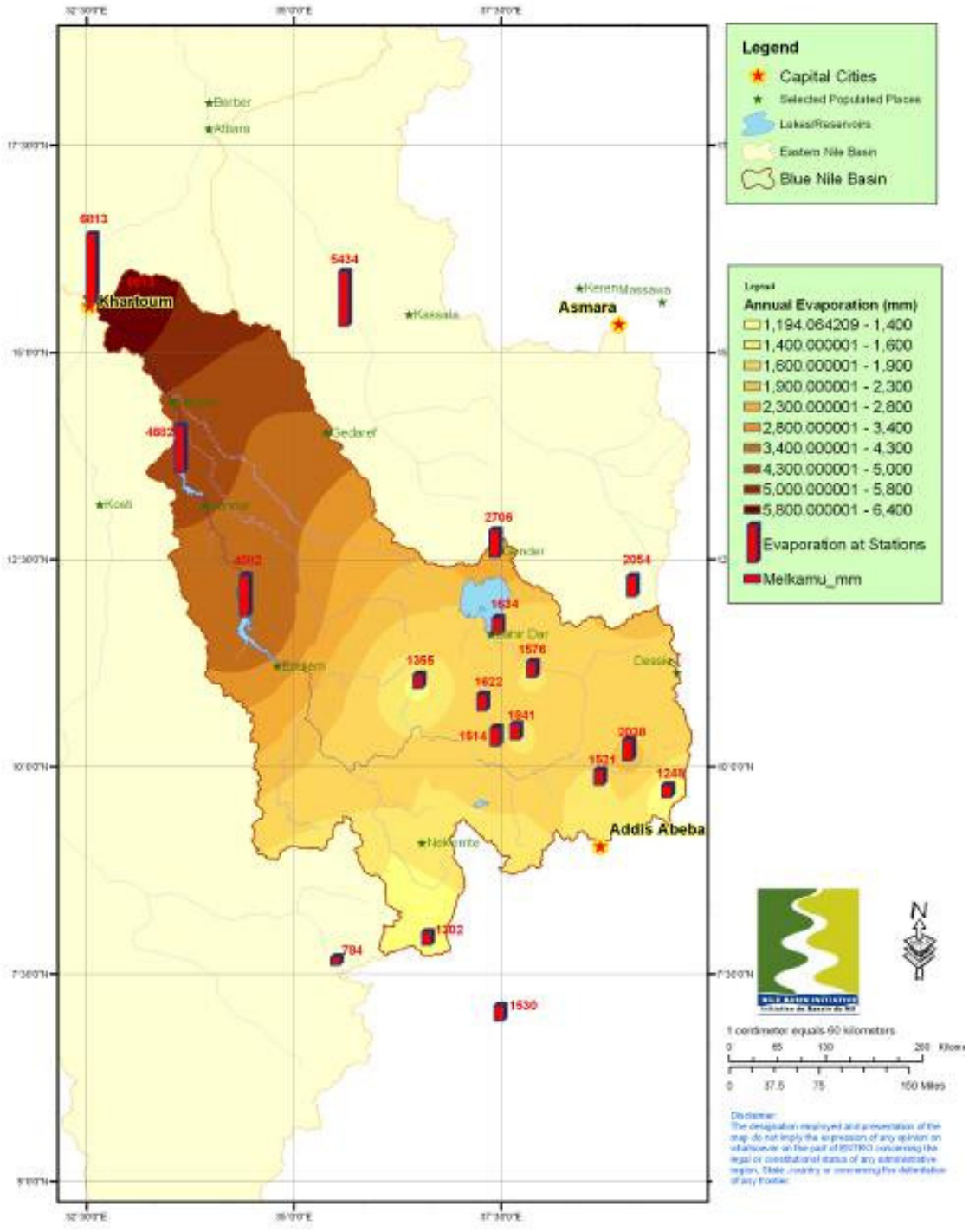
Source: ENTRO OSI data base

Figure 1.7: Spatial Distribution of Temperature (Isolines) in the sub basin



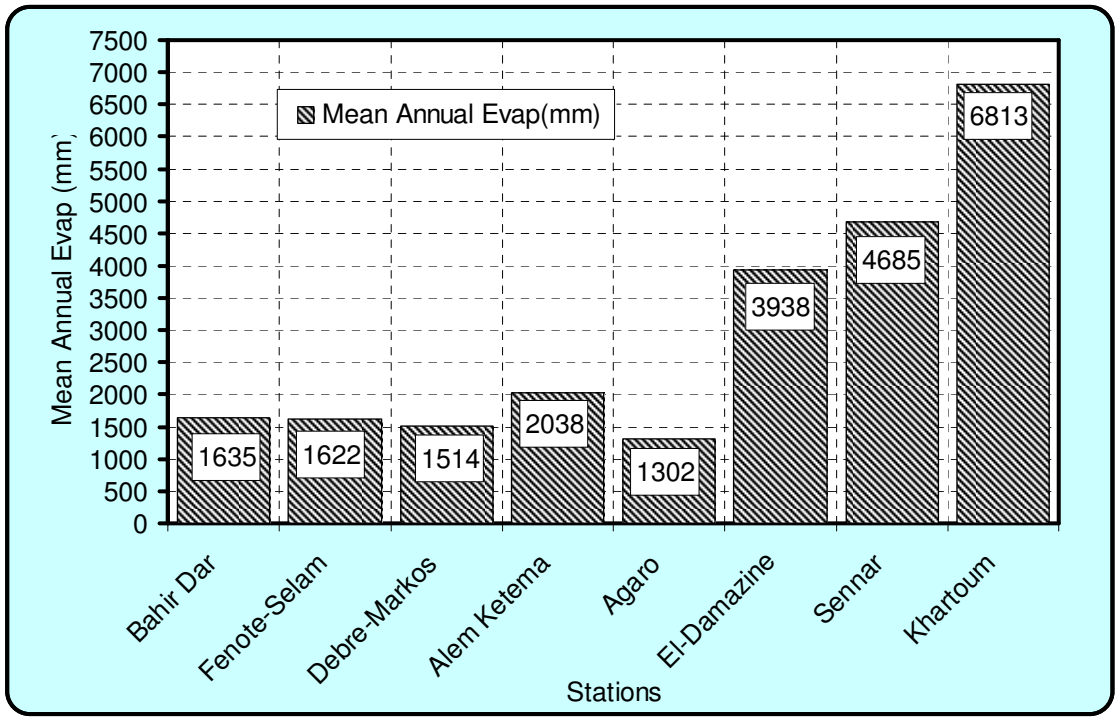
Source: ENTRO OSI data base

Figure 1.8: Spatial Distribution of Evaporation in the sub basin



Source: ENTRO OSI data base

Figure 1.9: Spatial Variation of Evaporation in the Blue Nile Sub Basin



Source: ENTRO OSI data base compiled during Synthesis

1.5. HUMIDITY

Mean annual relative humidity: Half of the sub basin is identified to have a mean annual relative humidity of above 55%. Some 16%, largely located in its mouth, is identified as dry area with mean annual relative humidity of less than 40%.

2. SOCIO-ECONOMIC CHARACTERISTICS

2.1 DEMOGRAPHIC CHARACTERISTICS

2.1.1. Population estimates

- Sub-basin: The Blue Nile is the second largest of the four sub-basins of the EN basin. It is home to an estimated 43,269,769 people, and accounting 27% of the total population of the EN basin. Accordingly, it is home to an estimated 44.3 million, 29% of the total population of the four sub-basins (OSI Socio-economic Synthesis Report, p. 22). An alternative estimate of 22.9 million people is based on the LandScan 2002 Global Population Database developed by Oak Ridge National Laboratory, USA which provides 2002 population estimates on a 1 kilometer grid. This was clipped by the State and Regional State boundaries in the sub-basin to provide population estimates by State and Regional State. National census estimates of the rural-urban distribution were used to provide estimates of total rural and urban populations (Table 2.1).

Table 2.1: Blue Nile Sub-basin: Population estimates, 2002

State or Regional State	Total Population	% of sub-basin population
Sudan	**6,606,361**	**29%**
Blue Nile	338,291	1%
El Gezira	1,919,580	8%
Khartoum	2,105,800	9%
Gaderif	1,151,050	5%
Sinner	1,091,640	5%
Ethiopia	**16,310,029**	**71%**
Amhara	10,256,425	45%
Beni-Shangul-Gumuz	452,427	2%
Oromiya	5,601,177	24%
Total sub-basin	**22,916,390**	**100%**

Sources: Ethiopia: CSA, 1999. Sudan: UN Population Fund & Sudan Central Bureau of Statistics (2002).
Note: These are not the full State populations as many states are "clipped" by sub-basin boundary.

- Ethiopia: In Ethiopia, the Abbay Basin comprises the major part of the Beni-Shangul-Gumuze and Amhara Regional States and some portion of the Oromiya Regional State. According to the 1994 Population and Housing Census of Ethiopia, the Basin had an estimated population of 22.6 million.

- Sudan: The estimated population of the sub basin in the Sudan in 2004 was 12,591,815.

2.1.2. Population Growth rates

- Ethiopia:In the Ethiopian part of the basin, the estimated population was projected to reach 30.7 million in 2005, which is a a 35% increase after the most recent census in 1995.

- Sudan: The population of the sub basin in the Sudan is projected to be 12,569,769 in 2005, giving a natural rate of growth of 27.1% over the 2002 estimates.

2.1.3. Population Density

This is defined as the total number of people per square kilometre.

- Sudan: In Sudan high population densities are located along the Blue Nile River and the main road that runs parallel to the river (Table 2.2). The west-east band of high densities is located along the Sennar-Gederef railway line and not the main Khartoum to Port Sudan road. The urbanization of Khartoum and Gezira States accounts for their high overall densities.

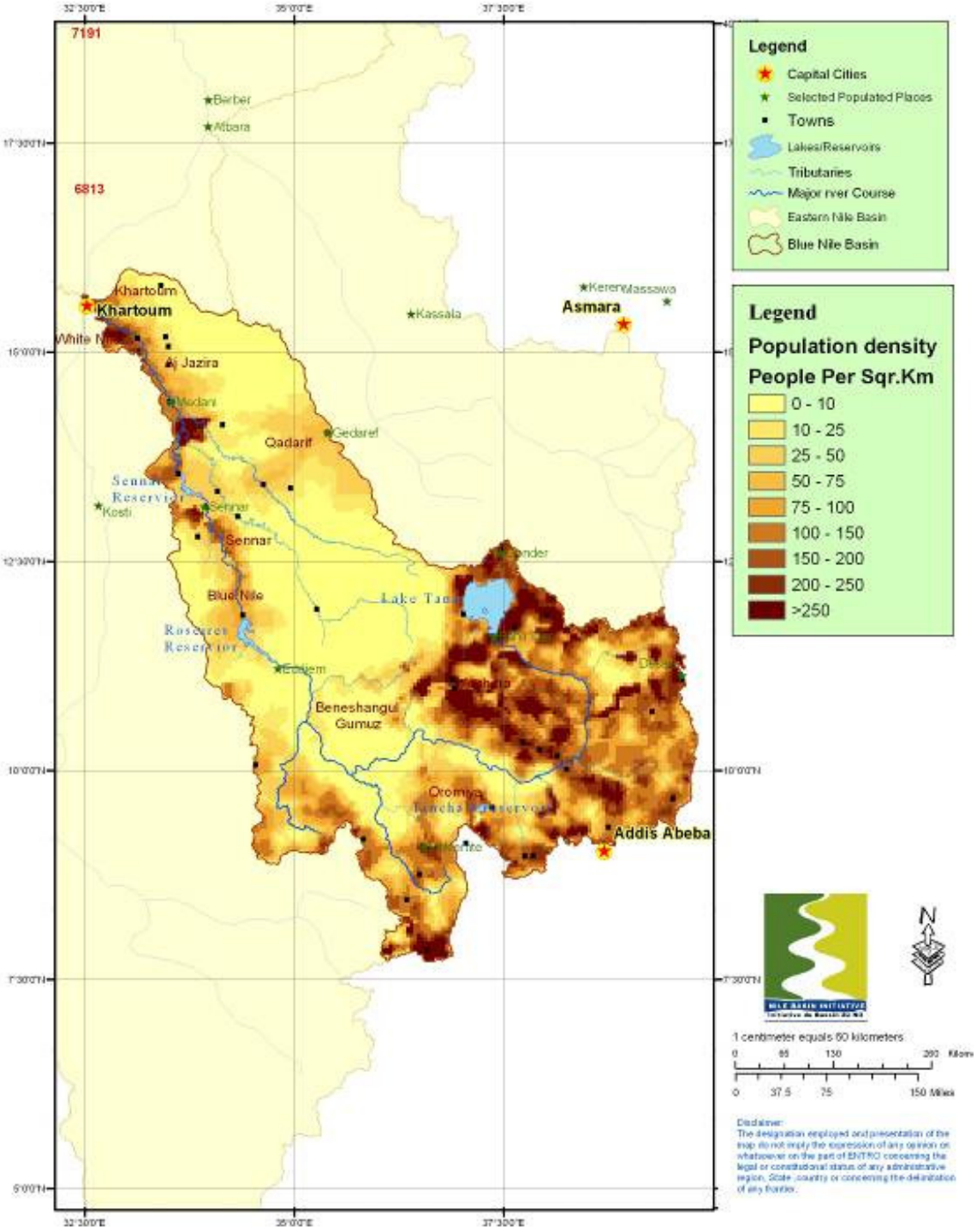
Table 2.2: Population Density in the sub-basin

Country	State or Regional State	Population density (persons per square kilometers)
Sudan	Blue Nile	17
	El Gezira	117
	Khartoum	296
	Gaderif	28
	Sinner	34
Ethiopia	Amhara	99
	Beni-Shangul-Gumuz	9
	Oromiya	80

Sources: Ethiopia: CSA, 1999. Sudan: UN Population Fund & Sudan Central Bureau of Statistics (2002). Population densities: LandScan 2002 Global Population Database developed by Oak Ridge National Laboratory.

- Ethiopia:In Ethiopia, even though there is a constant increase in the population per square kilometre in all administrative zones located in the watershed over time, there is considerable variation in terms of population pressure across regions and administrative zones. High population densities are in the Highlands (i.e. above 1,500 masl), where densities generally exceed 75, whereas it is below 25 in the Lowlands (Figure 2.1). This is a reflection of the favorable natural and health environment of the Highlands for human settlement. Population density ranges from 7.3 in Kamshi Administrative Zone of the Beni-Shangul-Gumuze Regional State to 127.4 in West Gojjam Administrative Zone, Amhara Regional State, in 1994. Density is extremely low in Beni-Shangul-Gumuze and highest in Amhara Regional State (except in some zones like North Gonder and North Wollo). Density is modest in most administrative zones of the Oromiya region in the watershed.

Figure 2.1: Blue Nile Sub-basin: Population densities and distribution



Sources: Ethiopia: CSA, 1999. Sudan: UN Population Fund & Sudan Central Bureau of Statistics. (2002) and LandScan 2002 Global Population Database, Oak Ridge National Laboratory.

2.1.4. Birth rates and death rates

- Sudan: Crude birth rate in the Sudanese part of the Blue Nile sub-basin is estimated to be 37.5%, and crude death rate, 10.4% (Table 2.2). Population growth rates and other demographic characteristics are shown in Table 2.2.

Table 2.2: Blue Nile Sub-basin: Demographic Characteristics

State	Growth Rate (%)		Age Proportions (%)		Sex Ratio	Crude Birth Rate	Crude Death Rate	Infant Mortality Rate**	
	Rural	Urban	Below 15	Above 60				Male	Female
SUDAN									
Blue Nile	3.00	25.2	42.7	3.7	108.3	38.5	12.3	137	122
Gadarif	3.40	28.9	43.1	3.7	105.3	40.3	11.7	135	122
Khartoum	4.00	86.7	36.5	3.8	111.3	33.7	8.8	98	85
El Gezira	3.00	22.4	42.5	4.4	96.8	38.5	9.5	101	76
Sinnar	2.60	28.3	44.5	4.0	98.8	39.9	10.9	121	109
ETHIOPIA*									
Amhara	2.55	10.4	43.25	6.0	99.9	36.6	10.9	83***	
Beneshangul -Gumuz	2.43	9.0	44.49	4.7	101.4	37.2	12.6	104***	
Oromiya	2.56	11.8	44.98	5.5	99.6	38.3	10.9	86***	

Source: Ethiopia: CSA, 1999. Sudan: UN Population Fund & Sudan Central Bureau of Statistics. (2,002).

- Ethiopia: In Ethiopia likewise there is a close relationship between the higher infant mortality and poverty rates in Beneshangul-Gumuz compared Amhara and Oromiya regional States.

2.1.5. Infant and child mortality

- Sub-basin: The infant mortality (number of deaths per 1000 live births) is 105 – 108 in the sub-basin.
- Ethiopia: Despite showing a slight decrease between 1994 and 2,000, infant and child mortality is still the highest in all regional states and administrative zones located in the Abbay watershed. Comparative analysis of data from the 1994 Population and Housing Census as well as the 2,000 demographic and health survey (DHS) revealed that the chances of infant and child survival are the worst in Beni-Shangul-Gumuze Regional State though it is relatively better among those residing in the Amhara Regional State. The same trend is also observed in the average number of years that a newly born child is expected to live across regions indicating that the quality of life is extremely low among residents of the Basin.
- Sudan: In the Sudanese part of the sub-basin, average infant mortality rate is reported to be 105 per 1,000 live births (112.3 for males and 97 for females). Under-5 mortality on the other hand goes up to an average of 152 persons per 1,000 live births (158.5 for males and 145.3 for females). In Sudan, there is a moderately strong relationship between infant mortality rates and poverty rates with Gaderif and Sinner States both having high infant mortality and poverty rates, although the case of Blue Nile confounds this relationship.

Table 2.5: Infant and Child mortality rates and life expectancy, Abbay-Blue Nile Basin, Ethiopia, 1994-2000

Location	IMR		Under 5 Mortality		Life Expectancy (1994)		
	1994	2000	1994	2000	Male	Female	Both
Ben Gumuz	**140**	**97.6**	**209**	**197.7**	**46.0**	**47.0**	**46.5**
Metekel	143		212		45.1	47.2	46.1
Assosa	143		213		46.1	46.0	46.1
Kamashi	123		181		49.1	50.0	49.6
Oromia	**118**	**116.2**	**173**	**193.8**	**49.2**	**51.7**	**50.4**
West Shewa	111		161		50.0	53.9	51.9
North Shewa	106		154		50.9	54.6	52.7
West Wellega	119		175		48.9	54.7	50.3
East Wellega	108		157		505	54.3	52.3
Illubabor	120		176		48.3	52.1	50.2
Jimma	147		219		43.8	47.2	45.5
Amhara	**116**	**112.4**	**170**	**183.4**	**49.6**	**52.2**	**50.8**
North Gonder	105		153		51.8	54.1	52.8
South Gonder	114		167		50.2	52.2	51.2
North Wollo	113		165		50.1	52.8	51.5
South Wollo	128		189		46.9	50.5	48.6
Agew	106		154		51.6	52.9	52.7
East Gojjam	142		211		45.1	47.6	46.3
West Gojjam	111		161		50.7	53.1	51.8
Bahir Dar	85		120		54.6	60.0	57.0
North Shewa	101		145		52.4	55.5	53.8

Sources: CSA (1999) The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Volume II Analytical Report; CSA (1998a) The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Volume II Analytical Report; CSA (1998b) The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Volume II Analytical Report.
CSA and ORC Macro (2001). Ethiopia Demographic and Health Survey 2000. Addis Ababa; quoted in the OSI Socio-economic Synthesis Report, p. 28.

2.1.6. Life expectancy at birth

- Ethiopia:In the Ethiopian part of the sub-basin, average life expectancy at birth ranges from 46.0 and 49.6 years for males and 46.5 and 50.8 for females.

- Sudan: In the Sudanese part of the sub-basin, average life expectancy is estimated to be 52.4 and 57.3 for males and females respectively.

2.1.7. Rural-urban divide

- Ethiopia:The majority of the population in Abbay River Basin is rural residents. Only about 10% of the estimated population of the Basin lives in urban areas. No significant variation is also observed in the pattern of residence by administrative zones located in the Basin.

- Sudan: In the Sudanese part of the sub-basin, 35% of the population is urban. Based on the Oak Ridge National Laboratory database and using 2002 national census estimates

of the rural-urban distribution provides estimates of rural and urban populations (Table 2.6).

Table 2.6: Blue Nile sub-basin: Population estimates, 2002

State or Regional State	Total Population	Rural population	Urban population	Rural %
Sudan	**6,606,361**	**3,623,810**	**2,982,551**	**55%**
Blue Nile	338,291	253,042	85,249	75%
El Gezira	1,919,580	1,489,594	429,986	78%
Khartoum	2,105,800	280,071	1,825,729	13%
Gaderif	1,151,050	818,397	332,653	71%
Sinner	1,091,640	782,706	308,934	72%
Ethiopia	**16,310,029**	**14,636,588**	**1,673,442**	**90%**
Amhara	10,256,425	9,230,783	1,025,643	90%
Beni-Shangul-Gumuz	452,427	420,757	31,670	93%
Oromiya	5,601,177	4,985,048	616,129	89%
Total sub-basin	**22,916,390**	**18,260,398**	**4,655,993**	**80%**

Sources: Ethiopia: CSA, 1999. Sudan: UN Population Fund & Sudan Central Bureau of Statistics (2002). Population densities: LandScan 2002 Global Population Database developed by Oak Ridge National Laboratory.
Note: These are not the full State populations as many states are "clipped" by sub-basin boundary.

2.1.8. Sex ratios

- Ethiopia:The overall sex ratio of the Abbay watershed population is about 1, i.e., 100 males per 100 females, with a slight variation in some of the administrative zones such as South Gonder (104.7 males per 100 females) and Illubabor (96.7 males per 100 females). The observed variation in sex ratio by administrative zones could be due to sex differentials in mortality and/or migration into and out of the area.

- Sudan: In the Sudanese part of the sub-basin, the sex ratio is estimated as 102 males for every 100 females.

2.1.9. Population age groups

- Ethiopia: Most of the population in the Abbay River watershed is in the younger age groups. Child dependency ratio, which is expressed as number of population under the age of 14 to those in the working age group (15 -64) is around 85, though the ratio for some of the administrative zones is lower. Child dependency ratio is the highest (93.1) in Oromiya Regional State, probably due to the effect of fertility rate in the region. Old age dependency ratio, on the other hand, is the lowest: around 7 persons per 100 persons in the working age group (15 – 64 years).

- Sudan: In the Sudanese part of the sub-basin, children under 14 years of age constitute 41 %, while old people (60 and above) make up 4.4 percent of the population.

2.1.10. Ethnic Groups

- Ethiopia: Even though the majority of the population residing in the Abbay River Basin in Ethiopia are followers of the Ethiopian Orthodox Church, there are also adherents of the Islamic faith, the Protestant Church and tradition beliefs. Table 2.22 indicates population distribution in percent by religion in the administrative regions and zones of the Abbay River Basin in Ethiopia.

Table 2.21: Relative proportions of ethnic groups in Regions in Ethiopia

Region	Number of ethnic groups	Main Ethnic groups	Relative proportion To rural population
Amhara	55	Amhara	91%
		Agew	4%
Beneshangul-Gumuz	6	Jebelaw/Koma/Mao	29%
		Gumuz	25%
		Amhara	20%
		Oromo	12%
		Sinashi	7%
		Agew	3%
Oromiya Region	71	Oromo	88.7%
		Amhara	7%

Table 2.22: Percentage distribution of population by religious groups in Abbay River Basin, 1994

Location	Religious Group					
	Orthodox	Protestan	Catholic	Muslim	Traditional	Others*
Benishangul-Gumuz	34.8	5.8	0.6	44.1	13.1	1.5
Metekel	53.5	3.8	0.6	18.7	21.3	2.2
Assosa	18.7	2.7	0.2	78.0	0.0	0.2
Kamashi	26.2	27.0	1.7	5.8	34.6	4.2
Oromia	41.3	8.6	0.6	44.3	4.2	1.0
West Shewa	80.6	6.6	0.2	5.3	7.0	0.2
North Shewa	94.0	0.6	0.0	5.0	0.2	0.1
West Wellega	44.0	37.3	1.1	16.9	0.4	0.2
East Wellega	61.7	16.4	0.9	8.3	12.4	0.1
Illubabor	45.8	9.8	0.3	42.6	1.3	0.1
Jimma	15.8	1.5	0.1	82.4	0.1	0.1
Amhara	81.2	0.1	0.0	18.6	0.1	0.0
North Gonder	95.3	0.0	0.0	4.5	0.0	0.0
South Gonder	95.5	0.1	0.0	4.4	0.0	0.0
North Wollo	83.4	0.0	0.0	16.6	0.0	0.0
South Wollo	29.5	0.1	0.0	70.3	0.0	0.0
Agew	93.5	0.1	0.0	5.4	0.0	0.8
East Gojjam	96.7	0.1	0.0	3.2	0.0	0.0
West Gojjam	98.3	0.1	0.0	1.6	0.0	0.0
Bahir Dar	87.5	0.8	0.1	11.5	0.0	0.0
North Shewa	94.5	0.2	0.0	5.3	0.0	0.0

Sources: CSA (1999) The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Volume II Analytical Report; CSA (1998a) The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Volume II Analytical Report; CSA (1998b) The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Volume II Analytical Report.

- Sudan: In terms of religious composition, the Blue Nile Basin in the Sudan is dominated by adherents of traditional beliefs, followed by Christians. A certain number of Muslims are also known to exist. (OSI Socio-economic Synthesis Report p. 33). With respect to ethnic composition, the southern zone of the Blue Nile Basin in the Sudan is the most diversified. The major ethnic groups in the administrative states of the Blue Nile Basin that are located south to the north include the following: the Ingassana, Berta, Watawit Danagla, Gumuz, Hamaj, Funj, Wwalla, Rufaa El Hoi, and Om Bararo. In the Northern State of the Northern Zone of the Blue Nile Basin are found the ethnic groups of Danagla, Halfawien, Bidirya, Manasir, Mahas, Shaiygia, and the nomadic Arabs.

Table 2.23 below presents the distribution of ethnic groups in the Blue Nile Basin. (OSI Socio-economic Synthesis Report pp. 31-32)

Table 2.23: Major Ethnic Groups in Blue Nile Basin, Sudan

Southern Zone	Northern Zone
Ingassana	Danagla
Berta	Halfawien
Watawit	Bidirya
Danagla	Manasir
Gumuz	Mahas
Hamaj	Shaiygia
Funj	
Walla	
Rufaa El Hoi	
Om Bararo	

2.1.11. Marital Status

Ethiopia: Marriage practice depends on the culture of the different ethnic groups and religions found in that place. The majority of the ethnic groups in the project area are the Amhara and the Oromo. The Gumuz have the tradition of marrying three wives (they are mostly Muslims). Among Christian Gumuz, marriage is one to one. The divorce rate among the Gumuz is reported to be very low (5%) compared to the Amhara. According to the 1994 census of Ethiopia conducted by CSA, the population reported "never married" is about 38%, relatively lower than the Amharas (33%).

2.1.12. Migration

Ethiopia: Migrations in the two regions are common but the purposes and degree are various. In Benishangul Gumuz, it is frequently happening and notably higher than in the rest of the country for a number of reasons. The major migration reason to the area is for resettlement. Temporary immigration took place in the past (mostly from the Sudan due to drought and conflicts, trade and other reasons). The biggest migration in to the region took place after 1984 famine when people from various parts of Ethiopia were resettled there. Table 2.4 shows migration statistics in the two project region in 1999. In the Amhara part of the project area (Guangua and Wonberma), very a low migration rate is seen due to the very conservative behaviour of the population. Most of the migrants move from rural areas to nearby towns in the same region (MEF, Section 4, part 2, 4-56).

Table 2.4: Migration in the Regions by Sex

Region	Gender	Migrants (%)	Non- migrants (%)
Benishangul Gumuz	Male	28.3	70.7
	Female	27.9	71.3
	Total	28.1	71.0
Amhara	Male	9.3	90.4
	Female	12.1	87.6
	Total	10.7	81.9

Source: CSA, Population and Housing Census of Ethiopia, 1999

2.2. ACCESS TO SOCIAL INFRASTRUCTURE

2.2.1. Literacy and education

- Ethiopia: The net enrolment rate in primary education[1] in Benishangul-Gumuz region of the Abbay Basin of Ethiopia in the year 2004 was 44% for males and 32% for females. The primary education enrolment rates for the same period were 40% for males and 33% for females in Oromia, and 35% for males and 39% for females in Amhara region. It is easy to deduce from this data that more than half of the primary school age population (7 to 12 years) in each region do not attend school. Enrolment at secondary school[2] level is even lower in all three regions. Over three-fourth of the population eligible for secondary education do not therefore have access to the service, appearing to be engaged in different other activities instead. This might partly be explained in terms of household poverty, which prevents parents from sending their children to school. (OSI Socio-economic Synthesis Report p. 38) Interestingly in Ethiopia the highest rates of enrolment are in relative remote Beneshangul-Gumuz Regional State (Table 2.6).

Table 2.6: Blue Nile Sub-basin: Literacy and Primary School Enrolment

State	Literacy Rates > 15 years			Population 6-13 years	Total Primary School Enrolment	% Enrolment
	Average	Male	Female			
SUDAN						
Blue Nile	31.3	41.8	20.4	143,305	48,914	34.1
Gaderif	55.6	72.9	38.4	311,547	142,313	45.7
Khartoum	73.6	81.1	65.0	795,983	659,028	82.8
El Gezira	65.2	75.5	55.8	658,547	538,183	81.7
Sinnar	52.0	64.5	40.0	267,649	146,090	54.6
ETHIOPIA*						
Amhara	17.8	23.5	12.1	4,102,557	2,483,603	61.0
Beneshangul-Gumuz	17.7	24.9	10.5	268,462	238,931	89.0
Oromiya	22.4	29.3	15.6	2,240,471	1,440,311	64.0

Sources: Sudan: UN Population Fund & Sudan Central Bureau of Statistics, 2002. Ethiopia: World Bank, 2004.

- Sudan: In Sudan high enrolment rates are clearly related to the high rates of urbanization in Khartoum and El Gezira States (Table 2.6). According to El-Medani, 2006), the literacy rate in the Northern State for people 6 years and over was 66% for both sexes, 74% for males and 58% for females. In urban areas, the literacy rate was 75% for both sexes, 81% and 69%, while the rate in the rural areas was 64% for both sexes, 73% and 57% in the same order as the preceding. The crude enrolment rate for junior secondary school age population (12-14 years) was 82% for both sexes, 84% for males and 80% for females. The crude enrolment rate for senior secondary school age population (15-17 years) was registered as 64%, for both sexes, 64% for males and 63% for females. The crude enrolment for the tertiary level age group (18- 24 years) was recorded as 24% for both sexes, 26% for males and 23 % for female. It can be deduced

[1]The net enrolment rate in primary education is defined as the number of pupils of primary school (age 7-12 years) who are currently attending primary school divided by the total number of children in the age group 7-12 years

[2]The net enrolment ratio at secondary school level is defined as the proportion of children aged 13-18 years and is attending secondary school (grade7-12) divided by the total number of children in age group13-18 years

from these figures that while the sex differentials persists in both literacy and crude enrolment rates, they are nevertheless only slightly higher for males in the latter cases. (OSI Socio-economic Synthesis Report p. 39)

In the Blue Nile State, the literacy rate for people 6 years and over is 30% for both sexes, 39% for males and 21% for females. In urban areas of the state, the rate is 58% for both sexes in urban areas while it is 69% for males and 47% for females. In rural areas, however, it is only 22% for both sexes and 30% for males and 13% for females. The crude enrolment rate for the primary school age population (6-11 years) was 29% for both sexes, 32% and 25% in the usual order. The crude enrolment rate for secondary school age population (12-14 years) topped 39% for both sexes, 44% for males and 33% for females (OSI Socio-economic Synthesis Report p. 39).

2.2.2. Water Supply

- Sudan: In terms of provision of piped water supply the urbanized States of Khartoum and El Gezira are clearly better endowed than the other more rural States. In Ethiopia the rate pf protected water supplies (tap and protected spring/well) is similar across all the regional States (Table 2.9).

Table 2.9: Blue Nile Sub-basin: Access to Drinking Water

	Main source of water						
	Piped into dwelling	**Public tap**	**Deep Well/pump**	**Dug Well/ bucket**	**River/canal**	**Rainwater**	**Others**
SUDAN							
Blue Nile	12.3	2.1	9.3	2.1	33.2	27.9	13
Gaderif	12.6	18.8	27.7	13.9	13.8	9.4	3.6
Khartoum	59.8	3.5	29.5	2.4	0.2	1.6	2.9
El Gezira	47.2	14.1	16.6	6.6	12	0.2	3.3
Sinnar	30.2	11.3	32.4	0.6	8.1	9.3	7.6
ETHIOPIA*	**Tap**		**Protected well/spring**	**Unprotected well/spring**	**River, Lake, pond**		**Other**
Amhara	9.1		12.3	41.6	36.3		0.3
BSG	12.5		5.7	0.2	63.1		0.4
Oromiya	11.2		11.2	34.2	43.1		0.3

Sources: Sudan: Sources: Sudan: UN Population Fund & Sudan Central Bureau of Statistics. (2002). Ethiopia: World Bank, 2004.

- Ethiopia: Wells and springs are the more prevalent source in the highland Regional States of Amhara and Oromiya, with rivers and ponds the more prevalent in lowland Beneshangul-Gumuz regional State (Table 2.9). Water sources for the majority of households are rivers and ponds. These sources are contaminated and unsafe. People travel on average 8 to 10 kilometres to fetch water. Fetching water is considered the responsibility of women and young girls. Overall, it is estimated that only 27% of people in Benishangul and 28% in Amhara have access to potable water. Water supply schemes involving shallow wells, hand dug wells, deep wells and springs are summarized in Table 2.11

Table 2.11: Water Supply Facilities by Woreda in Mandaya Project Area

Woreda	Type of Schemes			
	Shallow well	Hand Dug Well	Deep Well	Spring
Agalo Meti	0	10	0	3
Yaso	0	0	0	0
Dibate	8	66	2	32
Bulen	16	3	3	2
Wonbera	6	12	1	2
Wonberma				
Guangua				
Total	**30**	**91**	**6**	**39**

Source: Regional Water, Mines and Energy Resources Bureaus

Water provision in Benishangul Gumuz is done by carrying several containers full of water suspended at two ends of a rod put on the shoulder (Plate 9). The total weight carried by women is estimated at about 75 kilograms. According to Ethiopia's National Water Development Report (2004) only 31 % of the households have access to safe drinking water and the figure for rural areas is only 17 % and this is compared unfavorably to Egypt where 43 % of the rural villages have access portable water supply. Basin-by-basin comparison of safe water supply in Ethiopia indicates that the Baro-Akobo Basin states (except Oromia) have portable water coverage that is lower than the national average – 18 % for Gambella; 20 % for Benishangul Gumuz and 29 % for SNNPR. Relatively higher potable water coverage is reported for the two regional states (excluding Benishangul Gumuz) sharing the Abbay Basin – namely Oromia (31 %) and Amhara (31 %). The Tigray regional state, sharing Tekeze Basin along with Amhara, enjoys better safe water coverage (34 %) compared to other regional states, excluding the two city-states of Addis Ababa and Dire Dawa. (Socio-economic Report p. 13)

2.2.3. Sanitation

- Sudan: Khartoum with its relatively low and Gaderif with its high rate of no sanitation facilities follow the pattern of piped water provision. With the remaining States the relationship is not as clear. In the Blue Nile Basin of the Sudan, limited data available is for Sinnar State alone. This is presented below vis-à-vis the data at national level in the belief that it would provide a general picture of access to drinking water in the Basin. Accordingly, only 34% percent of the population in Sinnar State has access to piped water, and another 34% depend on wells. The following is a profile of the situation at country level in 2,000. Piped into dwelling, 24%; reservoir, 7%; wells, 28%; river/spring, 15%; rain water, 8% and other 6% (OSI Socio-economic Synthesis Report p. 43).

Table 2.10: Baro-Akobo-Sobat-White Nile Sub-basin: Access to Sanitation Facilities

State	Flush to Sewage System	Flush to septic tank	Traditional pit latrine	Soak away Pit	Others	Missing	No facilities
SUDAN							
Blue Nile	--	3.5	56.0	3.2	0.4	0.8	36.0
Gaderif	--	5.0	31.7	3.1	0	0	60.1

State	Flush to Sewage System	Flush to septic tank	Traditional pit latrine	Soak away Pit	Others	Missing	No facilities
Khartoum	1.1	11.2	73.8	0.9	3.1	0.4	9.5
El Gezira	--	4.2	51.7	2.1	1.7	0.2	40.0
Sinnar	--	2.7	46.6	5.3	2.1	0.7	42.7
ETHIOPIA*	**Flush - private**	**Flush - shared**	**Pit - private**	**Pit - shared**		**Not stated**	**No facilities**
Amhara	1.6	1.2	18.2	16.2	1.1		61.7
BSG	2.2	3.9	30.3	0.3	1.7		61.6
Oromiya	1.8	1.4	33.4	22.4	1.1		39.9

Sources: Sudan: UN Population Fund & Sudan Central Bureau of Statistics, 2002; Ethiopia: World Bank, 2004.

- Ethiopia: In Ethiopia the rates of no sanitation facilities do not parallel those for protected water supplies (Table 2.10). The sanitation infrastructure in Ethiopia (where Baro-Akobo, Abbay-Blue Nile and Tekeze-Setit-Atbara Basins are found) is on a very low scale: the poorest compared to many East African countries. According to the World Development Report of 1996 only 10% of the Ethiopian population had access to proper sanitation, compared to 30%, 60% and 77% in Kenya, Uganda and Tanzania respectively. The 1998 Welfare Monitoring Survey revealed that 83 % of the housing units in Ethiopia have no toilet facilities and people commonly use open defecation. While in Egypt 98 % of the population has access to improved drinking water sources and 68 % of the population uses adequate sanitation facilities. Lack of sanitation and safe sewage disposal facilities is a contributing factor to water and environmental pollution. Consequently, the upper courses of the three basins may be subjected to pollution resulting from unsafe disposal of human and animal wastes. (OSI Socio-economic Report p. 13). About 80% of people in Benishangul Gumuz region do not have toilets: around 66% of the people in Benishangul and 87% in Amhara use field or forest to defecate; 33% in Benishangul and 11% in Amhara have pit latrines (MEF, Section 4, part 3, pg. 4-71 and 72).

2.2.4. Health Facilities

Health centres and hospitals

- Ethiopia: There are only a few health centres and hospitals in each of the Ethiopian regions located in the Abbay River Basin. Only 2 health stations (clinics) and 11 health centres are located in Beni-Shangul-Gumuze Region, while there are 30 hospitals and 185 health centres, and 18 hospitals and 126 health services respectively in Oromiya and Amhara Regions. Hospitals in the regions are also equipped with limited hospital beds and specialized staff. The hospitals in Beni-Shangul-Gumuze are reported to be equipped with only 254 beds, while those in Oromiya and Amhara are furnished with 2,311 and 1,505 beds, respectively. According to the information compiled by the Ministry of Health (MOH), there are 19 private clinics in Beni-Shangul-Gumuze, while there are 672 and 304 in Oromiya and Amhara Regions respectively.

- Sudan: The average ratio of hospitals for the Basin in 2003 was 1.8 per 100,000 people in the region. The Blue Nile population in Sudan has better access to health services as seen in terms of number of health personnel (doctors/100,000 population is 17.6; 3.9 specialists; 1.0 dentists; 11.8 technicians; 30.1 medical assistants, and 77.7 nurses) (Socio-economic Synthesis Report p. 14). Disaggregated by state, the ratio was, 0.8 (Khartoum State), 1.3 (Gezira State), 1.0 (Sennar State), 1.7 (Blue Nile State), and 1.1

(White Nile State). The number of hospital beds for the Basin averaged 106.9, and by state it widely varied as 240.1, 103, 75.5, 83.8, 63.2, and 76 in the same order as the above.

Health professionals

- Ethiopia: The ratio of health professional (physicians, health officers, nurses, environment health and health extension workers) to the population is the lowest in Beni-Shangul-Gumuze (1 health professional for 43,536 residents), while the ratios are 138,802, and 142,184 in Oromiya and Amhara regions respectively. In regards to the regions in the Abbay River Basin, the population versus physician ratio is far below the standard set by the World Health Organization (WHO), (10,000 per physician. The gap observed in the stated ratios suggests that emphasis should be given to human resource development in the health sector, besides the expansion of health facilities. In Ethiopia the number of population per physician is 29,777 and this is far below the standard recommendation set by the WHO, which is 10,000 persons per physician. The situation of the basins' population is much below the national average – 43,536 for Benishangul-Gumuz, 138,802 for Oromiya and 142,184 for Amhara.

- Sudan: The human resource ratio in the health sector for the Basin was 3.9 specialists per 100,000 people on average in 2003. The share of the ratio for each state in the region was; 12.5 (Khartoum State), 2.6 (Gezira State), 2.0 (Sennar State), 1.0 (Blue Nile State), and 2.1 (White Nile State) (Table 2.12).

Table 2.12: Health facilities and Health Personnel in the Sudanese states of the Blue Nile Sub-Basin

Indicator		Blue Nile Basin States					
	Average	Northern	Khartoum	Elgezira	Sinnar	Blue Nile	White Nile
Health facilities per 100,000 population							
Hospital	1.8	4.9	0.8	1.3	1	1.7	1.1
Beds	106.9	240.1	103	75.5	83.8	63.2	76
Health personnel per 100,000 population							
Specialists	3.9	3.3	12.5	2.6	2	1	2.1
Dentists	1.0	0.8	3.1	0.6	0.6	0.3	0.3
Doctors	17.6	17.9	48.9	10.9	9.4	9.8	8.6
Technicians	11.8	8.3	39.3	6.4	4.1	5.9	7.0
Medical Assistants	30.1	53.4	39.1	23.8	19.8	18.1	26.3
Nurses	77.7	110.1	82.7	52.5	129.8	39.4	51.5
Public health officers/inspectors	1.4	1.174.9	2.3	2.1	0.7	1.1	1.3
Midwives	44.8		36.8	37.0	53.6	31.2	35.5

Source: El-Medani (2006) quoted in the OSI Socio-economic Synthesis Report p. 41.

2.2.5. The Burden of Diseases

- Ethiopia: Review of records available at woreda offices of health reveals that the burden of disease, as measured by premature deaths of all causes, emanates primarily from causes preventable by simple public health measures. Communicable diseases and diseases resulting from malnutrition predominate. The main factors responsible for the burden of ill health include inadequate access to health services; poor access to clean drinking water and sanitation facilities; widespread poverty and ignorance. Access, in this case, includes not only scarcity of health facilities but also distances and physical barriers. Women and children bear the brunt, chiefly due to their physiological make-up and the low social status accorded to them.

The major diseases in the project-affected areas include upper respiratory tract infections (URTI), malaria, diarrhoea and skin infections. Table 2.13 summarises the leading diseases treated in the Benishangul part of the project area. The patterns of disease are very similar in all project woredas, although there are slight variations in magnitude. There is similarity in disease prevalence and types in the Amhara part of the project area.

Table 2.13: Top 10 leading diseases in Mandaya area woredas

Type of disease	Number of Cases	% of Cases
Malaria	186,432	40
Bronchitis	88,345	19
Gastric	66,368	14
Intestinal Parasites	46,248	10
Dysentery	26,876	6
Unknown	18,448	4
Rheumatism	14,722	3
Skin diseases	12,786	3
Eye diseases	1,560	<1
TB	467	<1
Total	**462,657**	**99**

Reviews of monthly and annuals reports from all health facilities reveal that malaria is the single most important public health problem in the project woredas. It accounts for more than 50% of morbidities and mortalities in all health facilities in the project area taken as whole. The chief reasons for the widespread occurrence of malaria include lack of environmental management to destroy mosquito breeding sites at community levels, unavailability of insecticide-treated mosquito nets (ITN), resistance of malaria parasites to most drugs currently on the market, and resistance of mosquitoes to insecticides. HIV/AIDS is a new disease emerging in the area. Although there is no consolidated data, an in-depth interview with relevant officials showed that the disease is prevalent and on the rise. According to the same informants, the disease is being imported into the area with immigration of girls and young ladies from adjacent and outlying highland areas. Data is not available on major human diseases in the Abbay Basin (Ethiopia), except for HIV/AIDS. The 'HIV AIDS Main Indicators Report' produced by the Ethiopian Federal Ministry of Health (MoH, 2005) shows the incidence of HIV infection to be the highest among the population of age 15-49. According to this report, about 4% of the population in this age group in Benishangul-Gumuz Region gets infected with the HIV virus every year. In view of the huge health, economic and social implications of the disease, efforts should be stepped up by the general public, government, NGOs and other concerned bodies to combat the pandemic. Emphasis needs to be given especially to the Amhara Region where the HIV prevalence rate is said to be relatively higher.

- Sudan: In the Blue Nile Basin of the Sudan, the following ailments are reported to have been the leading causes of admission to hospital in 2003 (Table 2.14).

Table 2.14: The Leading Causes of Deaths in Hospitals, 2003

Disease specific deaths as % of total state		Blue Nile Basin States					
	Average	Northern	Khartoum	Elgezira	Sinnar	Blue Nile	White Nile
Malaria	24.6	14.5	7.7	8.1	23	44.6	49.6
Pneumonia	14.4	8.0	7.0	12.6	29.6	14.1	15.2

Disease specific deaths as % of total state		Blue Nile Basin States					
	Average	Northern	Khartoum	Elgezira	Sinnar	Blue Nile	White Nile
Septicemia	2.5	1.1	7.5	5.5	0.8	0	0.2
Circulatory system	1.8	0	6.8	3.0	1.1	0	0
Anemia	4.7	4.7	3.5	4.4	6.2	4.6	4.5
Malnutrition	3.2	1.1	3.1	5.3	0.4	9.5	0
Dehydration	2.5	1.8	4.0	5.6	0.8	0.7	1.8
Acute renal failure	2.2	3.3	4.3	5.2	0	0	0.6
Diarrhea	3.7	4.3	3.8	0	3.6	9.5	1.0
Other heart diseases	3.6	6.2	3.0	4.8	1.7	0	6.0
Total (10) deaths	63.2	44.9	50.6	54.7	67.0	83.0	78.8
Total of other deaths	36.8	55.1	49.4	45.3	33.0	17.0	21.2
Grand total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: OSI Socio-economic Synthesis Report p. 42.

The dominant water-borne and water-related diseases include Schistosomiasis, Malaria, Onchocerciasis and Trypanosomiasis (human sleeping sickness). Others include acute watery and bloody diarrhoeas, intestinal parasites, scabies, etc; these are rampant in the project area due to unacceptably poor water supplies and absence of basic sanitation facilities.

2.2.6. Harmful Traditional Practices

- Ethiopia: Harmful traditional practices (HTP) are rife and deep rooted in the project areas. The most common forms of HTP include the following:
  - Kumsangilla: This is a practice in which a Gumuz woman gives birth in a bush unassisted. According to the focal group discussion in Yaso and Wonbera woredas, almost all women used to give birth unassisted in bushes about 250 – 350 metres away from their homes. This is simply due to misconception that if a woman delivers at home, family members of the household in which a woman gives birth will be afflicted with a disease that, in their own words, 'mutilates or causes general swelling of the body" - possibly leprosy or liver cirrhosis from the descriptions, respectively. Some also perceive that a child born in that particular household will not grow up to adult age. The practice is an age-old one that has pervaded the entire fabric of the community. This practice is, however, fading away currently and many people are abandoning the tradition.
  - Female Genital Cutting/Mutilation(FGC/M): Although reportedly on the decline, FGC/M continues to be practised in the project woredas. The type of FGC commonly practiced is 'Excision', sometimes called Type I, more common in Amhara and Oromia. It is simply the removal of clitoral hood. Severe forms of FGC, such as infibulations, are performed in Benishangul region. The reasons for practising FGC/M, according to our focus group discussions, are to 'avoid sexiness' and to conform to the community.
  - Early Marriage: Early marriage is also a widely practised tradition in all project woredas. Families marry off their daughters early because families want to gain material benefits and to maintain the chastity of their daughters. Also, families feel obliged to reciprocate the wedding ceremony they attended (especially among Amhara people) in the community.

- Swinging of Women during Labour: This is a practice whereby a woman in labour is swung in order to expel the products of pregnancies. It is a harmful traditional practice that may cause rupture of the uterus, eventually leading to death.

2.2.7. Women's workload

Women often have a heavier workload in comparison to men. Work often involves heavy physical weight-bearing activities and other activities that can be risky to health. In addition women, as is in many parts of Ethiopia, have high birth rates (on average 7 children/woman) and thus spend much of their adult lives either pregnant or breastfeeding, a phenomenon that alone can take a heavy toll on a woman's health and well being.

When coupled with other common health concerns, such as poor nutrition and limited access to health care, a woman's daily workload may have an important impact on her health or the health of her children – unborn or born. Understanding the possible relationship between women's daily workload, nutrition and health care and care of their children is important not only to improve the health status of mothers and children but also to the overall goal of developing their communities in particular, and the region in general (MEF, Section 4, part 3, pg. 68,69,70 & 71).

2.3. TRANSPORT AND COMMUNICATIONS

2.3.1. Roads

Number of roads

- Sub-basin: There are no major road linkages between Ethiopia and Sudan within the Abbay-Blue Nile Sub-basin. Dry weather tracks cross the border at three points: Bambudi on the north bank of the Abbay-Blue Nile, Bizen and Kurmuk both south of the Abbay-Blue Nile. The main roads in Ethiopia terminate at Guba (north of the River) and Assossa (south of the river). On the Sudan side of the border the closest main road to the border terminates at Ad Damazin (Map 16).

- Ethiopia: Within Ethiopia, the total length of permanent roads is estimated at 50,000 kilometres, of which 1,700 kilometres are tarmacked, and work is underway on a number of intra-state and intra-basin highways (OSI Socio-economic Synthesis Report p. 44). Because of the extreme dissection of the highlands by the Abbay River and its tributaries road infrastructure is not well developed. All-weather roads tend to be confined to the ridges and plateaus between the deeply incised rivers. For example, the Abbay has only three road crossings. Thus both road construction and vehicle running costs are high.

Length and density of roads

- Ethiopia: The total existing road network in Benishangul Gumuz is 719 kilometres according to a compilation of GIS & RIS (BoFED, Dec. 2003). Out of this, 454 kilometres are all-weather roads and 278 kilometres of all-weather roads are under construction. In Amhara, there is a better road network compared to Benishangul Gumuz. Donkeys are used as means of transport for humans, animals and goods. The road density is much lower in the sparsely populated Beneshangul-Gumuz Region and West Wellega Zone of Oromiya.

Access to all-weather roads

- In terms of accessibility to all-weather roads some 45 percent of the area of the Sub-basin is more than 15 kilometres away. The main areas of inaccessibility are located in

the western parts of North and South Wello in the Abbay Gorge; the middle and the Lower Abbay Gorges; and the western Lowlands of the Dinder and Beles Valley.

The 2004 Welfare Monitoring Survey conducted by the CSA reveals that about 47% of the rural households in Beni-Shangul-Gumuze live less than five kilometres away from the closest all weather roads. The corresponding figures for Oromiya and Amhara regions are 48% and 42% respectively, indicating that over half of the populations in the Abbay Basin area are without access to all weather roads. Public transport service is rarely available as most of the towns in the basin are inaccessible to asphalt or all weather paved roads. The roads and towns in the sub-basin are given in Figure 2.1.

The road infrastructure in and around the Mandaya Project area is one of the poorest in the country and hence travelling from one place to another is difficult and expensive. Even transportation by pack animal is reported to be very expensive.

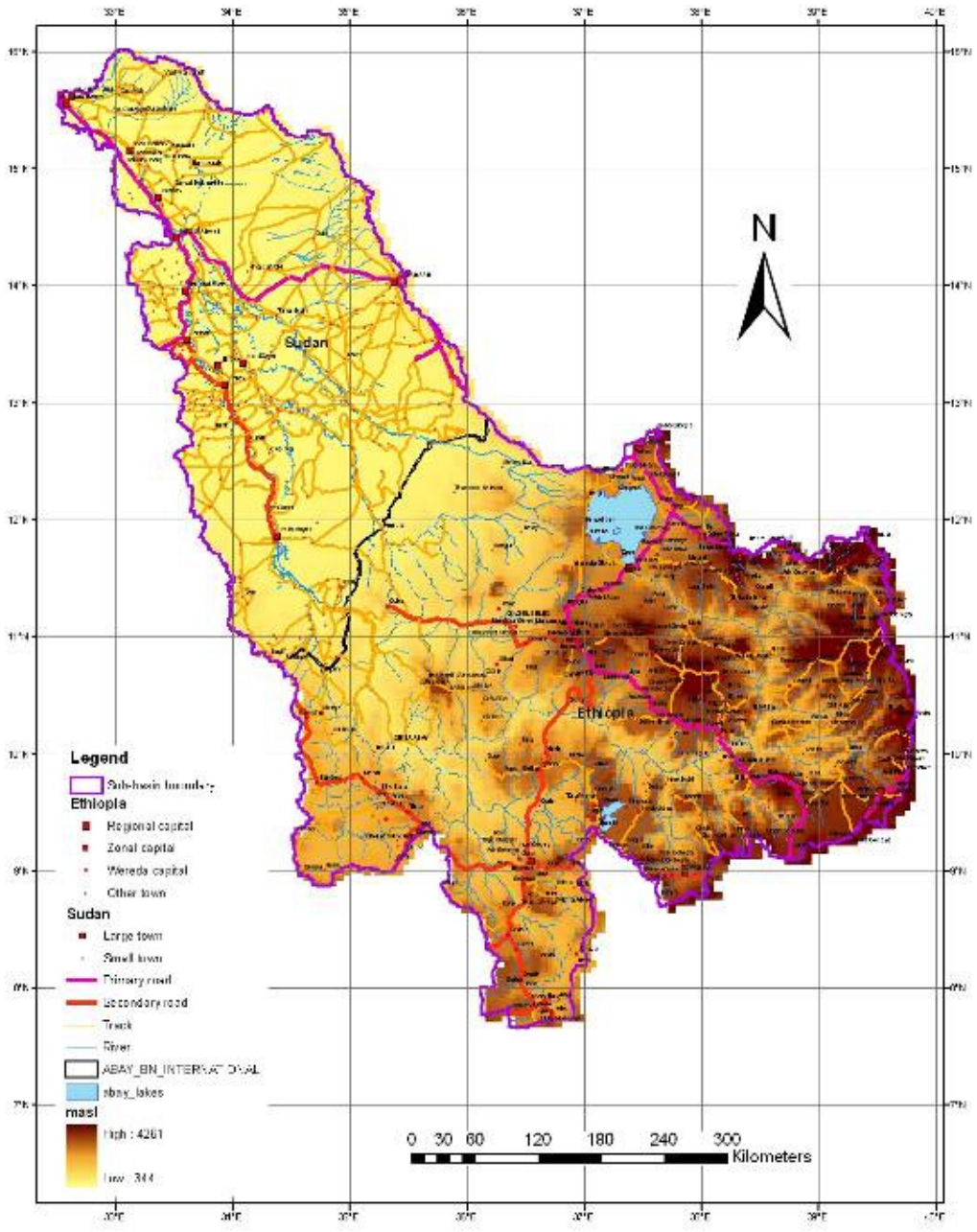
- Sudan: Within Sudan there are two primary (asphalt) and one all-weather secondary roads. The primary roads are: (1) Khartoum- Wad Medani (187 kilometres) – El Gederif (187 kilometres) and (2) Wad Medani - Sennar (107 kilometres) – Damazin (278 kilometres). The secondary road is from El Gederif to Metema (159 kilometres). Other roads are generally in poor condition and on the clay plains often impassable during the rains.

- Ethiopia: The length of all-weather roads is significantly greater than dry-weather roads, partly reflecting the degree to which dry weather roads have been mapped (Table 2.16).

Table 2.16: Length and density of All-weather and Dry-weather Roads in Ethiopian Regions

Type	Length (km)	Road density (kms/1000 km^2)
All weather	6,324	32
Dry weather	2,922	68
Total	**9,246**	**47**
Amhara		46
BSG		29
Oromiya – West Wellega		17
Oromiya – East Wellega		38
Ethiopia		**31**

Figure 2.3: Blue Nile Sub-basin – Roads, Railways and Towns



Source: Sudan Afriroads (2002) and FAO Africover. Ethiopia: Ethiopian Mapping agency 1:50,000 map sheets.

2.3.2. Railways

- Sudan: There is one railway line in the Sudanese part of the sub-basin: Khartoum – Sennar – Gederif.

- Ethiopia: No town or city in the Ethiopian regions of the Blue Nile basin is connected to a railway line.

2.3.3. River Transport

- Ethiopia: People cross the Abbay River for trade, visiting relatives, health services and other personal reasons. They use traditional boats for these purposes and pay about ETB 5 for a single trip per person. For livestock, the charge is about ETB 20 per animal per single trip. There are one or two crossing routes along the river in the potential Mandaya reservoir area (MEF, Section 4, part 3, pg. 4-75, 76, 77).

2.3.4. Air transport

- Ethiopia: In Ethiopia, only one town in Beni-Shangul-Gumuze, four in Oromiya and six in the Amhara Region can be reached by air.

2.3.5. Telecommunications

- Ethiopia: According to CSA's 1994 census information, only 2% of all urban and 0.1% of all Benishangul Gumuz households have telephone facilities. There is no figure for current status. Even though very low, there are better telecommunication services in Amhara parts. There is a plan to connect all woredas in the nation with telephone lines using broadband (MEF, Section 4, part 3, pg. 4-78).

2.3.6. Energy

- Ethiopia: The principal energy source of the region is fuel wood. Cooking is the major end use and a large number of people use fuel wood for lighting. 97% of energy consumed in 2004 came from wood, 2% from agricultural residues and the remaining from modern fuels (Benishangul Gumuz Profile, BoFED, 2005). In Amhara, in addition to fuel wood, people use dung and branches, leaves and twigs (BLT). Cooking is major use of fuel wood but kerosene is used for lighting in the Amhara region.. About 72% of energy in Amhara comes from biomass fuel. 40% of light energy comes from kerosene. (MEF, SECTION 4, part 3, pg. 4-78)

2.4. NON-GOVERNMENTAL INSTITUTIONAL ARRANGEMENTS

2.4.1. Community Based Organizations

- Ethiopia: Historically, **grass root community-based organizations** have played an important role in Ethiopia in the mobilization of self-initiated collective action. *Idir/kire* (burial associations), *Iqub* (saving societies) and *Maheber* (socio-religious groupings) are the most common such community organizations among the Amhara and Oromo populations living in the Abby Basin area. The high influence they wield and the trust and social acceptance that they enjoy in their respective communities gives them the leverage to mobilize their memberships for collective action. **Farmers' cooperatives**, which are more recent rural economic institutions introduced since the time of the socialist military regime in Ethiopia, are the other important organizations to be considered when contemplating the promotion of any development-oriented projects in the basin. (OSI Socio-economic Synthesis Report p. 25). Major community based organizations are kebele and sub-kebele. The kebele or the sub-kebele is a basic structure under the woreda administration. Each has its own administrative organ consisting of a chairperson, an assistant as well as a secretary. This organization is responsible for mobilizing people under their jurisdiction for any development work. In addition, the kebele or the sub-kebele may consist of voluntary associations like the Idir, Ikub, etc which are mainly instituted to create cooperation and mutual assistance among members.

2.4.2. NGOs

- Ethiopia: A study report produced by the Christian Relief and Development Association (CRDA) in 2004 indicated that the bulk of the **registered NGO** investment in the Abbay Basin is concentrated in the Amhara Region. As many as 43 NGOs were operating in the region at the time. The Abbay Basin Master Plan document indicates that about 40 known NGOs and 10 to 15 unknown NGOs had also been engaged in different activities in 93 woredas in the area (OSI Socio-economic Synthesis p. 25). According the CRDA compilation report, about 16 NGOs are operating in Benishangul Gumuz, Amhara and Oromia Regions. These are members of the CRDA, but others that are not registered as members are also operating particularly in Amhara. A greater number of NGOs is engaged in Amhara region than Benishangul (Table 2.17). Activities of those in service in the project area are education, health, water, harmful traditional practices and, in rare cases, integrated development (MEF, Section 4, pg. 4-47)

Table 2.17: NGOs operating in Mandaya project area woredas

Name of NGO	Origin	Intervention	Host Woreda
Amhara Development Associations (ADA)	Local	Health, education, basic skills	Whole of Amhara
Anti-Malarial Association (AMA)	Local	Malaria eradication	Whole of Amhara
Association for Development and Construction of Dessie and the Environs (ADCDE)	Local		Whole of Amhara, woreda
Canadian physician for AIDS and Relief	International	AIDS, medicines	Dibate
Catholic Relief Service – Ethiopia program	International	Financier	Sherkole
Mujejeguura Loka Harmful practices on Women Organization	Local	Genital Mutilation, Women's Rights	Guba
Comitato Internazionale Per Il Sviluppo de Populi (CISP)	International	Integrated Development	Bullen Dibate
Communita Volontari per Il Mondo (CVM)	International	Integrated Rural Development	East and West Gojam
Ethiopian Catholic Secretariat (ECS)	Local	Health, education	Sherkole, Guba
Integrated Service for AIDS Prevention & Support Organization	Local	AIDS, health	Amhara, Oromia target area
Norwegian Church Aid (NCA)	International	Integrated development	Sirba Abbay
Organization for Social Service for AIDS (OSSA)	Local	AIDS	Amhara, Oromia
Voluntary Service Overseas (VSO)	International	Welfare for street mother & children	Sherkole
Rehabilitation and Development Organization (RDO)	Local	Provision of Physical Rehabilitation	Sherkole
ZOA Refugee Care	Local	Refugee	Sherkole, Guba
OXFAM/GB	International	Livelihood improvement	Various areas

2.5. ECONOMIC ACTIVITIES

2.5.1. 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. Data available from the Ethiopian side of the sub-basin is presented in Table 2.18 below.

Table 2.18: Activity rates of Ethiopian states

State	Activity rate
Amhara	76%
Oromiya	70.4%
Beni-Shangul-Gumuze	69.6%

The data available on activity and unemployment rates in the Sudan portion of the Blue Nile sub-basin is only for one state of the five states, namely the Sennar State. By 1993, the Sennar State had an estimated active population of 252,287 (40%) out of 633,593 people in the age group 10 and over. The refined activity rates for males and females were 73% and 8% respectively. The urban and rural activity rates for males were 69% and 75%, as compared with 11% and 7% for females. The reasons given earlier for the lower female activity rates in the Northern State are also applicable in the Sennar State.

2.5.2. Livelihood Patterns

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

In the Abbay watershed, more than 90% of the populations are rural inhabitants. According to the 2001/2002 Agricultural Enumeration Survey, the majority (60%) of the population in the three regions in the basin (Beni-Shangul-Gumuze, Amhara, and Oromiya) are engaged in fully agricultural occupations. The same survey also showed the dominant (about three-fourth) form of agriculture in each of the regions in the Basin is mixed farming (crop production and livestock raising), followed by crop only farming (about one-fifth) and animal husbandry. The dominance of crop and livestock holdings in most of the zones located in the Basin area implies that mixed farming (i.e., sedentary agriculture) is more practiced than pastoralism. A smaller proportion of 'only livestock' holdings is also an indicator of few pastoralists in the Basin.

The type of activity that residents engaged in could also describe the livelihood pattern of the population living in urban areas of the Abbay Basin. According to the 1999 National Labour Force Survey, the service sector accommodates almost half of the urban employed population for each of the regions. About 20% of the urban population working in Amhara Region are involved in the manufacturing sector (the second highest) while agriculture employs 22% of the Beni-Shangul-Gumuze urban residents and 18% of the Oromiya's urban employed population. Employment opportunity in the public administration is relatively higher (12%) in the Beni-Shangul-Gumuze regional state compared to the others in the sub-basin.

Only few 2%, 2% and 4% of the population in Beni-Shangul-Gumuze, Oromiya and Amhara regions, respectively engage in non-agricultural types of occupation mainly cottage industries, sale of firewood and other forest products, as well as trade and hired labour(MoLSA, 1997, Tassaw, 2002).

Sedentary agriculture, (rain-fed and irrigated), and shifting cultivation, and migratory pastoralism constitute the basic livelihood strategies in the Sudan portion of the Blue Nile sub basin, with variations in the size of groups engaged in the activities. In the same area,

artisan gold mining also employs a small labour force, entirely comprising members of the Berta ethnic group, albeit in small numbers

2.5.3. Unemployment and underemployment

The unemployment rates in the Ethiopian states are given in Table 2.19. Further breakdown of the data by urban and rural parts of the regions shows that the former represent lower activity and higher unemployment rates, as contrasted with those of the latter. Lower activity rates in the urban areas are attributed to the engagement of a large part of the of population in schooling, high number of residents depending on pensions, the number of women confined to the home as housewives, and the reliance of relatively many on remittances, among other factors. Higher rates of unemployment in the urban areas are explained in terms of mainly the less absorbing capacity of the urban labour market and the large-scale rural-to-urban migration.

Table 2.19: Unemployment rates of Ethiopian states

State	Unemployment rate
Amhara	7.7%
Oromiya	6.1%
Beni-Shangul-Gumuze	5.2%

Table 2.20: Activity and Unemployment Rates for Persons aged 10 years and over: 1999

Region	Total		Urban		Rural	
	Activity rate	Unemployment rate	Activity Rate	Unemployment rate	Activity Rate	Unemployment rate
Amhara	76.6	7.7	54.2	22.5	78.8	6.4
Oromia	70.4	6.1	55.9	19.0	72.3	4.6
Benishangul-Gumuz	69.6	5.2	57.7	18.8	70.7	4.0

Source: CSA, 1994 National Labour Force Survey (OSI Socio-economic Synthesis Report p. 35)

Concerning the underemployment situation in the Abbay Basin, the available data reveals that time related underemployment ranges between 33% in Beni-Shangul-Gumuze, 49 % in Oromiya Region, and 42% in Amhara. On the basis these indicators, it is possible to infer that over two-fifth of the employed human power in the Basin is able and willing to engage in some type of work for additional number of hours.

The unemployment rate in the Sennar State was 17% of active population for sexes, 14% for males and 41% for females. The unemployment rate in urban areas was 13% for males and 27% for females, as compared with 15% and 50% in the rural areas.

Unemployment rate is reported to be 6% in the Abbay Basin, although the problem is known to be pronounced more in urban than in rural areas. Although a conclusive figure on the rate of unemployment for the Blue Nile basin does not exist, the crude labour force participation rate is estimated at 27%. Nonetheless, urban unemployment rates in both basins is reportedly high, explained in terms of the less absorbing capacity of the urban labour market and high rural-urban migration. (OSI Socio-economic Synthesis Report pp. 11-12)

According to the source material used for the Blue Nile Basin part of the synthesis report (El-Medani, 2006), the Sudanese State of Sinnar had an estimated active population of 252,287 (40%) out of 633,593 people in the age group of 10 and over, by 1993. The refined activity rates for males and females were 73% and 7.8% respectively. The urban and rural

activity rates for males were 69% and 75%, as compared with 11% and 7% for females. The reasons given earlier for the lower female activity rates in the Northern State are also applicable in the Sinnar State. The unemployment rate in the Sinnar State was 17% of active population for both sexes, 14% for males and 41% for females. The unemployment rate in urban areas was 13% for males and 27% for females, as compared with 15% and 50% in the rural areas (OSI Socio-economic Report p. 37).

2.6. POVERTY PROFILE

2.6.1. Overall

Some studies carried out on the state of poverty in the Abbay River Basin (Dessalegn, 2003; Yared, 2003) show that rural poverty has been growing in 'severity and magnitude for the last fifty years mainly due to population growth, lack of access to productive assets, crop failures and the like. According to the results of the Welfare Monitoring Survey conducted by the Central Statistical Authority (CSA), 47.5% of all rural households are believed to be poor (CSA, 2004).

Poverty and destitution have also been well studied from livelihood perspective, in which both were understood as 'states of livelihood deprivation differing in degree'. For instance, Dessalegn (2003) examined the transition from poverty to destitution using data on frequency of famine, declining food consumption, and increasing malnutrition and associated health status. Based on the results of such a study, it is possible to argue that destitution as a 'downward slide from poverty' has been increasing in all segments of the Ethiopian population. Currently, destitute households are expected to constitute no less than a third of the Ethiopian rural population (Dessalegn, 2003).

A policy study conducted in Wello, one of the regions in the Basin, by the Institute of Development Studies (IDS, 2002) also revealed that the incidence of destitution has dramatically increased in the 1990s, while the number of households which were 'doing well' has decreased on the contrary. This agrees with other study findings (Aklilu and Dessalegn 2000) that indicated "an upward trend in poverty and a downward trend in well being". The argument that states a substantial increase in the proportion of destitute households in Ethiopia has also been supported by other studies conducted by Devereux, Sharp and Yared (2002) and Ministry of Economic Development and Cooperation (2000).

Other studies revealed that the clan-based societies in the western part of the Abbay Basin are also characterized by widespread poverty and vulnerability. According to the observations made by Fekadu (1988), the Gumuz are very poor, living a "hand to mouth" existence, and are "below the threshold" of peasants' subsistence economy.

Existing literature has also showed that vulnerability has been studied from different perspectives, including ecological and social dimensions. A study conducted by Dessalegn (2003), for instance, revealed that peasant vulnerability is the outcome of a relentless ecological stress and large-scale degradation of environmental resources. According to him, peasants in Wello and Wag Hamra, both located in the Abbay Basin area, remained to be one of the poorest in the country due to virulent and repeated famine and drought in the area. The people living in the area are identified as those who often suffer from sever food insecurity as ecological vulnerability continues to depress crop and livestock production.

Community and household studies conducted in Wag Hamra and Wello (Dessalegn 1988; IDS, 2002; Yared, 2003), as well as in North Shewa (Yared, 1995; Teferi, 1994) also revealed that rural poverty and destitution is increasing over time. Poverty puts households of 'variable vulnerability' in crisis by eliminating their capacity to cope from time to time. According to Yared (2003), most of the households in Wello and Wag Hamra became destitute following severe or repeated crop failures due to natural causes. The

situation is, however, slightly different in North Shewa as households without any or, at best, with only small-sized land, and those which are active male labour deficient constituted the larger proportion of households that have fallen into chronic/long-term poverty.

Similarly, Dessalegn (2003) argues that virulent famine has been the most important causal factor for household/community impoverishment and vulnerability in the major part of the Abbay River Basin. According to him, most of the households in Wello and the Northeast did not yet recover from the 'abject poverty they were thrown into by the famine of mid-1980s'. Substantiating this argument, he states: "The millions of peasants who become vulnerable to food shortage each year … are in large measure, the victims of harvest failures" (Dessalegn, 2003), which are induced by natural hazards. This implies that the increasing livelihood vulnerability among farming households appears to increase the extent of rural poverty, and the situation is likely to continue affecting a large proportion of the population residing in the area. According to Mesfin (1984), peasant vulnerability is not necessarily a consequence of environmental hazard, rather a possible outcome of the prevailing social and political practices. As Chambers (1989) indicates, this is because people are not equally exposed to risks as they have socially differentiated capacities to cope with crises.

Available data on poverty and vulnerability also show that there is a strong link between poverty and gender, age as well as other characteristics of the population living in the Abbay River Basin. For instance, Yared (2002) indicates that female-headed households make up a large proportion of the poorest and most vulnerable households in rural areas of North Shewa and South Wello, both in the Abbay Basin. He also argues that the living conditions and asset possession of young people is significantly lower as compared to their parents at same age in the past. Furthermore, a study conducted by the Institute of Development Studies (2002) revealed that 13.8% of the households of the study areas in Wello are destitute, while a greater proportion of them belong to female-headed households and households headed by old men. These households are identified as victims of poverty mainly due to shortage of labour power to engage in productive activities.

Critical assessment of the situation in the Abbay Basin area has also showed that wealth and poverty are not distributed equally among various social groups. For instance, farmland is concentrated in the hands of the older generation than the young (CSA, 2003) and the plough farming system continued to marginalize females from the management of the land, even if their right to use the land is preserved upon divorce or death of their husbands. The chances of being poor or destitute are greater for certain segments of the population basically due to socio-economic differentials among residents of the area. It is, therefore, possible to argue that the likelihood to fall into poverty and the capability to avoid or move out of poverty varies according to someone's position in the prevailing social structure. It is, thus, important to identify as to who is poor and vulnerable in terms of gender, age, household type, occupation, ethnicity/religion and other socio-economic characteristics within the context of the river basin.

2.6.2. Major Health Problems

Of the water related diseases in the upper course of the Blue Nile sub basin the major concern is malaria which is increasing, difficult to control, and has potential to infect a very large population in epidemic outbreaks. The other water related diseases in the area are Schistosomiasis, Typhoid, Diarrhea, Helminthiasis, Leshimaniasis, and Onchocerchiasis.

The 'HIV AIDS Main Indicators Report' produced by the Ethiopian Federal Ministry of Health in 2005 shows the incidence of HIV virus among the population aged 15-49 years. According to this report, about 4% of the population aged 15-49 years of Beni-Shangul-Gumuze Region is infected with the HIV virus every year. The incidence rate in Oromiya Region is about 3%, while that in Amhara Region is 8%. In view of the huge health, economic and

social implications of the disease, efforts should be stepped up by the general public, government, NGOs and other concerned bodies to combat the pandemic. Emphasis needs to be given especially to the Amhara Region where the HIV prevalence rate is said to be relatively higher.

In the Blue Nile Basin, the following ailments are reported to have been the leading causes of admission to hospital in 2003. Malaria, 32%; pneumonia, 12%; S.S delivery, 7%; obstetrics and gynecology, 5%; and asthma, 2%. The top ten killer diseases reported were malaria, 25%; pneumonia, 14%; Septicemia, 3%; circulatory cyst, 2%; anemia, 5%; malnutrition, 3%; dehydration, 3%; acute renal failure, 2%; diarrhea, 4%; heart diseases, 4%, and total death from the above ten diseases was 63%.

2.7. EMPLOYMENT AND INCOME GENERATION

2.7.1. Main livelihoods

The majority of people (over 90%) in the reservoir area obtain their livelihood from subsistence agriculture. Agriculture practices included farming and livestock. Small numbers of people are engaged in trade, in government organizations and other activities. Generally the incomes generated from these activities are very small. The incomes are insufficient to cover even basic necessities hence they live in poverty with the exception of Wonberma in Amhara Region where per capita income is reported to be USD 780 per year - much higher than the national average.

A large number of the farmers and urban dwellers in Benishangul Gumuz (men and women) woredas are also engaged in gold panning. Many people in the woredas go to the Abbay River channel to extract gold traditionally, especially in the months of January to April.

In general, the project affected area has very high untapped potential of natural resources that could be utilized for income generation. However, the contribution of the resources for the well-being of the society, so far, is minimal. The income obtained by people is barely sufficient for survival and inadequate to improve the life style of the inhabitants. Most households in the project area generate their cash need from other sources, such as by selling crops and livestock. Gold extraction is also an activity as additional income for the people who are characterized by poverty.

A study conducted by Benishangul Gumuz government shows that per capita income obtained from the sale of agricultural produce and other non-farm income is from ETB 169 (Guba) to ETB 537 (Sirba Abbay). In Amhara, the figure is higher (compare Wonberma with ETB 6,786 per person per year).

Major constraints of the people to generate sufficient income for their needs are reported to be lack of appropriate technologies, lack of awareness and inadequate skills; poor market infrastructure that is made worse by the poor all-weather road network, as well as unorganised market places and low private investment.

Unemployment in the project area is said to be lower than other places in the nation, about 5% in Benishangul Gumuz and 8% in Amhara. Rural unemployment is 4% and 6% for Benishangul and Amhara respectively.

Persistent poverty is therefore due to low income (55% of the people of Benishangul Gumuz are under food poverty line). In Oromia it is 6%, and in Amhara it goes up to 8% (CSA, for 1999).

Mining

The existence of gold and gold mining is long known in the Benishangul Gumuz region. Historical records state that a concession was given to one British mining company in January 1900 by Emperor Menelik II (BoFED, General Economic Characteristics of

Benishangul Gumuz, 2003). Currently, traditional gold mining (by panning) is widespread in Benishangul Gumuz region in general.

The BoFed of Benishangul Gumuz estimates the current traditional gold miners to be about 50,000 people and extraction of 180 kg gold per year on average. (These figures have not been substantiated for this study). The areas of activity are mainly downstream of Mandaya. Gold panning is among the seasonal activities in the Border project area, particularly along Abbay, Beles and Dabus Rivers. It is reported that gold panning is carried out along the Abbay River by almost all woreda people adjacent to the river and that almost all able adults including men and women are engaged in this for at least three months a year (during low flows). The amount of gold extracted is reported to be small in quantity in general, depending on luck rather than hard labour. Some confirmed extracting a couple of kilos (rarely) and many reported only small amounts. Whatever the amount collected, gold panning is a source of income generating activity that helps to support families to buy non-farm commodities (e.g. clothes, salt, sugar).

Currently two private companies have licences and are operational in exploration and exploitation of gold and base metals (Guba, Dibate and Bulen woredas).

Marble is extracted by private sector investors and by the Federal Government's Marble Industry of Ethiopia. Dibate, Bulen, Guba and Yaso woredas have marble quarry sites in the project affected area but not, so far as could be ascertained, in the potential impoundment or other construction areas.

Hunting

As everywhere in the nation, hunting is illegal unless one has a licence to hunt. There is a controlled hunting area in the lower Dabus valley (downstream of Mandaya) but no information was made available about it. The Dabus valley controlled hunting area is a tentative candidate to become designated as an Important Bird Area of Ethiopia but a decision on promoting this has been deferred until such time as surveys are conducted and a proper assessment is made.

Although the woreda authorities cautiously indicate that hunting is not exercised in the project area, they mentioned that there might be a few people hunting illegally. According to consultations with local people, however, hunting is known to be a traditional and cultural practice in the area. Individuals hunt antelope, porcupine, monkeys and other animals for food. Hunting among the Gumuz has social esteem where hunters occupy high status in the community. Hunting is done using spears and arrows. Moreover, there is a traditional hunting ceremony known as Feda among the Bertas (noted in a report compiled by BoFED of Benishangul Gumuz).

Trade and other services

Trade activities in Amhara are generally exercised, but to a lesser extent in Benishangul Gumuz Region. There is no well organized market structure and market places except in few places in Benishangul Gumuz. On the other hand, in Amhara project woredas' markets seem better organized.

There are limited commercial service providers in the project woredas. Hotels and restaurants exist in the Mandaya project area but provision is weak in general. There are tea rooms and small restaurant in all larger settlements of project area (Table 4.21).

2.8. AGRICULTURE AND PEOPLE

2.8.1. Major livelihood activities of ethnic groups

There are a number of groups of people who retain their original way of life, although now somewhat altered. The Rufa'a al-Hoi are an Arab speaking Muslim nomadic people with sheep, cattle and camels and are divided into two groups: the northern Badiya located on the Blue Nile (dry season) and who move north towards the Dinder River (wet season); and the southern Badiya who used to move between the Yabus (in the dry season) and the Gezira/Managil schemes In the wet season). Also do livestock production gum collection (from A. seyal) and sorghum cropping supplement livelihoods.

In the past two decades and particularly after the 1984 drought, there have been an increasing number of Rufa'a al-Hoi people without livestock becoming sedentarized. Following the abolition of the Native Authorities many sedentary villages ran their own village councils and the power of the Rufa'a al-Hoi declined. The recent installation of the Federal structure has further weakened the power of the Rufa'a al-Hoi and so increased that of the sedentary people.

The Kenana are also Arab speaking pastoralists who move between the Blue Nile northwards beyond the Dinder River. They come into contact with the northern Badiya group of Rufa'a el-Hoi along the Blue Nile.

The Fulani are in fact a mixture of many ethnic groups from West Africa who moved into the Funj in the mid 1940's, were expelled to western Sudan in 1954 but have since returned. They have the West African long horned cattle that are fast walkers but poor milkers. The Fulani follow the same transhumant patterns as the Rufa'a al-Hoi but at slightly different times usually leaving the dry season grazing area later. They are said to remain out of contact with government tax and veterinary agents, often moving at night. They are known to cross the border into Ethiopia in the vicinity of the Dinder national park.

The Ingessana is a name given to the people living in the Ingessana Hills with a distinctive language and culture. They are predominantly agriculturalists cultivating the foothills. Cattle, goats and camels are socially and economically important. Livestock are kept in the hills during the wet season and move either south-eastwards to the Machar Marches and the Yabus, and to the east to the Blue Nile and the border with Ethiopia. They maintain a spirit of cooperation with the Rufa'a al-Hoi and many Ingessana work as herders for them. As well as the Ingessana there are a number of smaller groups who practice sedentary agriculture. These include the Berta, Gumuz and Burun, and along the Blue Nile many peoples from western and northern Sudan who arrived after the Mahdist rule.

2.8.2. Main Agricultural Land Use Systems

The main agricultural land use systems in the Abbay-Blue Nile Sub-basin in Sudan and Ethiopia are relatively distinct except along the international border where the ago-environment in one case and cultural affinities in another have given rise to very similar systems. Nevertheless, three broad systems can be identified: (i) rainfed cropping, (ii) irrigated cropping and (iii) extensive livestock production (with minor cropping). Differences in the scale of operations, tenure type and to a lesser extent cropping patterns give rise to a number of recognizable sub-categories. These are summarized in Table 2.24.

Table 2.24: Main Agricultural Systems in the Blue Nile Sub-basin

Main Category	Scale of operations	Tenure type	Main Components	Location
RAINFED CROPPING	Small-scale traditional; sedentary	State land: Individual and Communal use rights	Cropping (Cereals, pulses, oil seeds) Small Livestock holdings (Communal	Ethiopia: Highlands

Main Category	Scale of operations	Tenure type	Main Components	Location
			grazing, crop residues)	
	Small-scale traditional; shifting	State land: Individual and Communal use rights	Cropping (cereals, pulses): Small livestock holdings (Communal grazing, crop residues)	Ethiopia & Sudan: Lowlands
	Large-scale: Semi-mechanized	State land: Medium-term Leases	Cropping (Sorghum, cotton, sesame)	Ethiopia & Sudan: Lowlands
IRRIGATED CROPPING	Small schemes Small-scale operations (< 1.0ha) Gravity:	State Land: Individual use rights: additional to rainfed land	Cropping (cereals, vegetables)	Ethiopian Highlands
	Small-scale:(<20 ha) Pump	Individual Freehold	Cropping: Sorghum, wheat, Alfalfa	Blue Nile
	Large schemes Small-scale (< 1.0ha) Gravity:	State Land: Individual use rights: additional to rainfed land	Cropping (cereals, vegetables)	Ethiopian Highlands
	Large scheme: small-scale operations (<40 feddans) Gravity	State land: Individual long-term leases	Cropping: Cotton, Sorghum, wheat Small-livestock holdings	Sudan: Gezira and Rahad Schemes
	Large scheme: large-scale operations	State land	Cropping: Sugar	Ethiopia: Fincha'a Sudan: Senner and Guneid Sugar Schemes
LIVESTOCK	Small-scale: Extensive Pastoral Transhumant	State land: Communal use (grazing, water) rights	Cattle, small-ruminants	Sudan
	Small-scale: Extensive Agro-pastoral Transhumant-sedentary	State land: Communal use (grazing, water) rights	Cattle, small-ruminants Small-scale cropping	Sudan

2.8.3. Rainfed cropping

Rainfed cropping operates at the traditional small-scale and the large and semi-mechanized scale (Figure 2.5). The former is under individual use rights for cropping and communal use rights for grazing and fuelwood collection. Mixed cropping and livestock production are the main production components. In the Highlands cropping is sedentary whilst in the lowlands it incorporates bush fallowing and shifting cultivation. In both the highland and lowland systems use of improved inputs (chemical fertilizer and seeds) is low.

2.8.4. Semi-mechanised farms

Conversely, the large-scale semi-mechanized systems are under state lease-hold tenure (25 years leases) and a number of cultural operations (ploughing, harrowing and seeding) are mechanized. Nevertheless, the use of improved inputs (fertilizer, seed) is minimal.

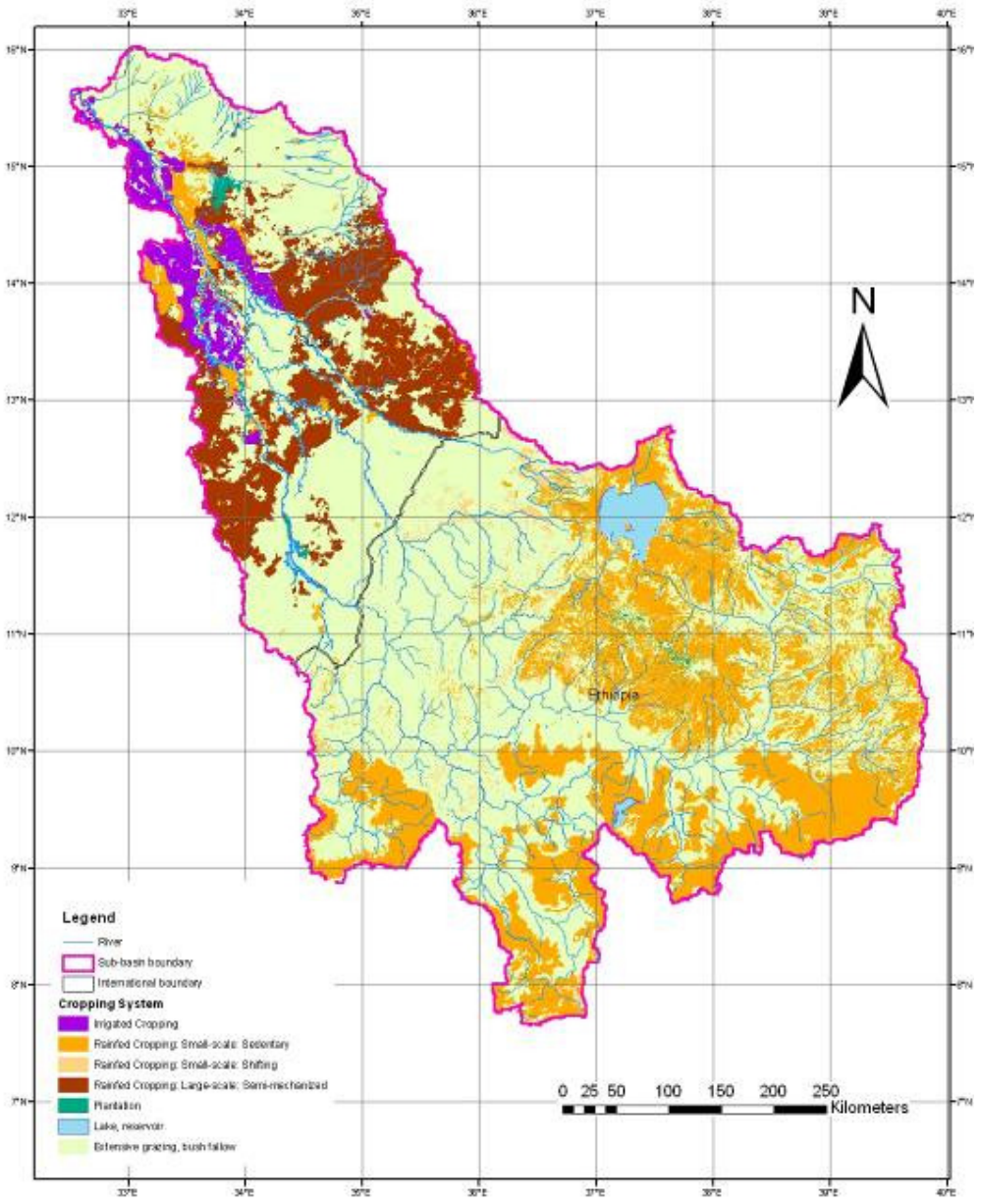
2.8.5. Irrigated cropping

There are a number of sub-categories of irrigated cropping. A convenient division can be made firstly between large and small schemes. In Ethiopia large schemes are represented by the Fincha'a and Koga Schemes and in Sudan by the Gezira and Rahad Schemes.

- **Small schemes**: The small schemes include both traditional and modern small schemes in Ethiopia and the small pump schemes along the Blue Nile in Sudan.

- **Large schemes**: The large schemes are divided those with large and those with small-scale operations (not possible to separate out in Map 13 because of the small areas of the latter). The large schemes with large scale operations: one Ethiopia and the other in Sudan both are under sugar cane production. The large schemes with small-scale operations can be divided between those in Ethiopia that have small farms with cropping use rights on State land and those in Sudan with tenancy rights. The one large scheme with small-scale operators in Ethiopia within the Blue Nile sub-basin is still under construction.
- The two major schemes in Sudan in the sub-category are the Gezira and the Rahad. In the Gezira Scheme some 60 percent of the land is owned by the State and 40 percent compulsory leased by the State from the original freeholders (World Bank, 2000, Wallach, 2004). The Sudan Gezira Board (SGB) manages all land within the Scheme and leaseholders are not allowed to sub-lease. Tenancies are for 20 feddans (8 ha) and can be inherited and sub-divided to a maximum of one half. There are 114,000 tenancies but with half tenancies this may be as high as 120,000. Most tenants use hired labour. Cropping intensity is 70 percent with a 5 course rotation (cotton. sorghum, groundnuts, wheat and fallow. Given the very low profitability of cropping, most tenants have taken up livestock production. The Rahad scheme has similar characteristics.

Figure 2.5: Blue Nile Sub-basin: Major Cropping Systems



Sources: FAO Africover Sudan (2002), WBISPP (2001-2003)

2.8.6. Livestock

Field observation and consultations with local people indicated the practice of recession agriculture in Yaso and Wonberma parts of Mandaya reservoir on banks of the Abbay River. The total area flooded during the rainy season is estimated at about 800 ha.

Livestock: The Bureaus of Agriculture and Rural Development in respective regions conducted livestock population, livestock per capita and density surveys in 1998. According to theses surveys, Wonberma has the highest livestock population among the woredas of the project areas, followed by Dibate and Wonbera (Table 2.25). With regard

to livestock densities, Yaso has one of the lowest densities in the region as is the case for human population density.

Table 2.25: Livestock population in Mandaya project area woredas

Woreda	Number of Livestock							
	Cattle	Sheep	Goat	Horse	Mule	Donkey	Poultry	Beehives
Agalo Meti	4,407	1,584	11,981	-	25	585	21,904	11,737
Yaso	9,871	2,680	7,131	-	40	576	22,141	6,838
Dibate	57,395	6,045	15,147	-	114	2,385	79,006	14,039
Bulen	30,511	5,794	3,312	-	17	1,884	60,611	13,063
Wonbera	43,194	9,054	14,787	530	333	4,655	67,739	16,636
Wonberma	60,286	14,515	5,810	62	6,915	144	-	4,213
Guangua	NA	NA	NA	NA	NA	NA	NA	NA
Total	**414,625**	**63,049**	**82,224**	**3,166**	**9,768**	**23,832**	**308,919**	**66,526**

Source: Regional offices.

Animal disease is prevalent in the affected woredas and an insufficient number of veterinary services and medicines make the situation worse. Livestock diseases have imposed negative impacts on productivity of herds.

Major effects of animal diseases in the project area are cited as loss of weight, reduced growth, poor fertility performance, decrease in physical power and animal mortality (Socio-economic Characteristics of EN Basin Ethiopia, 2006). Livestock diseases are more severe in Benishangul Gumuz project woredas than in Amhara (78% of cattle diseased, and 60% died - according to the CSA 2003 report).

The most critical problems affecting livestock development in Benishangul Gumuz are cited as killer livestock diseases of all types (especially trypanosomiasis), shortage of water and feed during dry seasons, poor livestock husbandry practices and other related factors. The indigenous people are especially weak in managing the available feed.

A veterinary survey was conducted in Benishangul Gumuz in June 2004. It found that the mean herd incidence of trypanosomiasis in the year 2003 was 33%, and that the mean herd mortality due to the same disease during the same year was 22%. Livestock disease is leading the households to extreme poverty/vulnerability as indicated by the survey. Other results of the study are summarized below:

The direct mortality of animals is estimated to be in the order of 46% of the cattle herd and 38% of the sheep and goat flocks per annum respectively,

The losses in live weight due to disease morbidity and numerous factors have chronic debilitating effects on livestock, (MEF, Section 4, part 2, pg. 4-59, 60)

Trypanosomiasis reduces the quantity and quality of animal products such as meat, hides and skins. The cumulative effect resulted in economic losses that were greater than those suffered from mortality from all causes, including the widespread distribution of trypanosomiasis, biting flies, ticks and liver fluke infestations. The large extent of tsetse-infested areas is most significant.

Field investigation and discussions with communities in the project area showed that the effects of animal diseases are further exacerbated by the shortage of veterinary services including veterinary personnel, drugs, vaccines, and equipment for the prevention and control of animal diseases. (MEF, Section 4, part 3, pg.4-61)

In the rainfed small-scale systems and on the large irrigation schemes livestock are an important component and livelihood strategy despite the small number per household. They provide additional sources of income and thus help to spread the risks associated

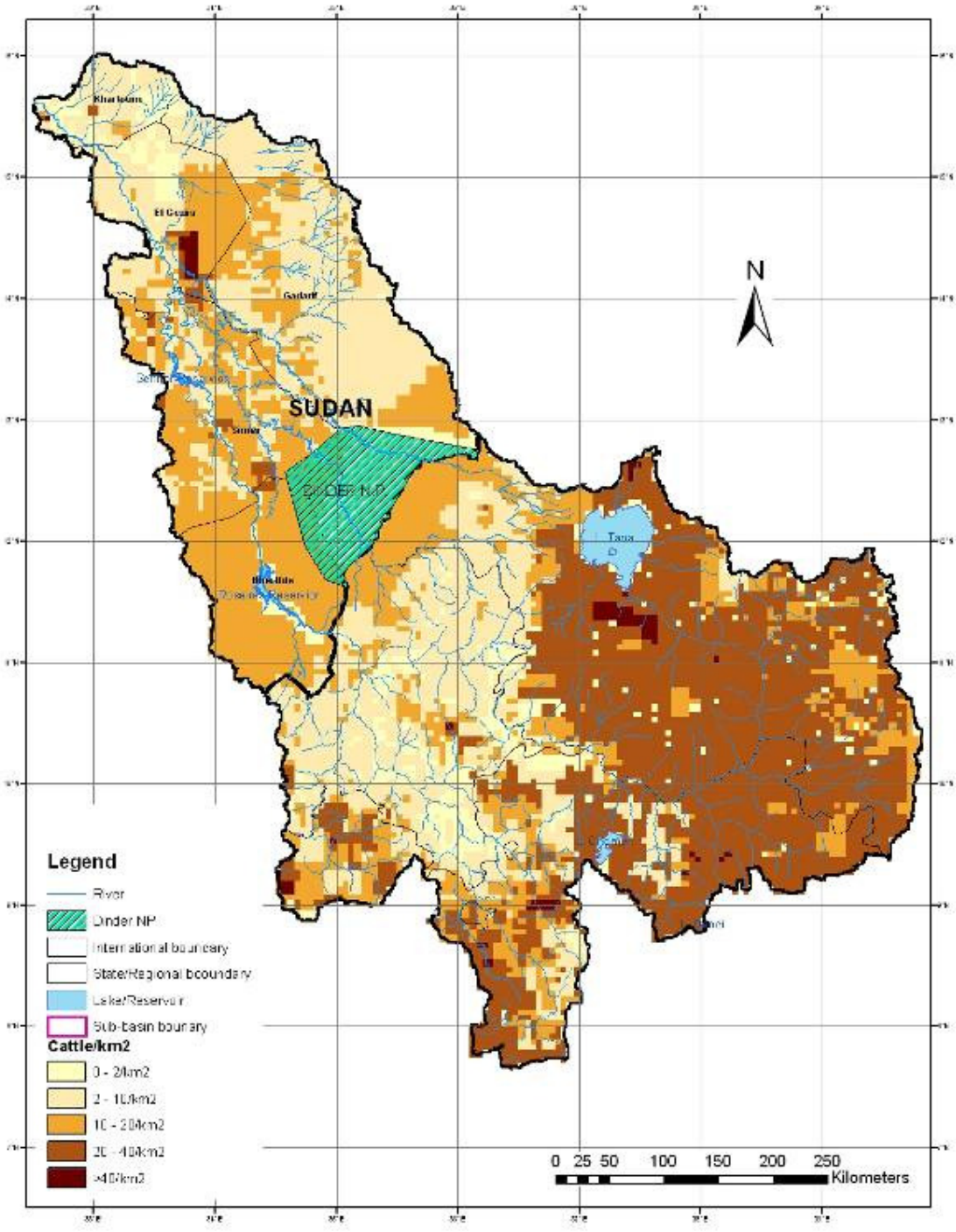
with rainfed cropping. In the highlands they are a valuable source of soil nutrients and in fuelwood scare areas of fuel. In Sudan dung is not used as farmers believe they are a source of weeds (Kibreab, 1996).

The extensive livestock production systems are distinguished only by the inclusion of some rainfed crop production. The reliance on crop production may in fact change in both the short and long-term due to the high variability of rainfall. Over the past two decades many households have and are still making the transition from pastoralism to agro-pastoralism to sedentarized crop cultivation and vice versa as household and external conditions change. These changes in household production systems are the result of the massive losses in household and community livestock assets during the drought of the early 1980's exacerbated by the increasingly loss of wet season grazing areas and water resources from the big expansion of large-scale semi-mechanized farms during the 1980's and 90's. With the restoration of exports to Middle East livestock production makes a significant contribution to the agricultural GDP.

Data from the FAO Livestock Atlas for Africa are used to derived Figures 2.5 and 2.6 to show the distribution of cattle, sheep and goats. Whilst the maps indicate that the Dinder National Park has no livestock it is known that in fact there are considerable incursions of livestock into the park. The high densities of cattle in the Ethiopian Highlands and low densities in the Lowlands are readily apparent. In the wooded Lowlands south of the Dinder Catchment the area is infested with tsetse fly and trypanosomiasis is very prevalent. In Sudan densities are relatively high in the higher rainfall areas of the southeast. Elsewhere the large areas of semi-mechanized farms and large-scale irrigation schemes largely preclude even moderate densities of cattle, although as indicated above livestock are an important livelihood strategy for tenant and labourer households in these schemes.

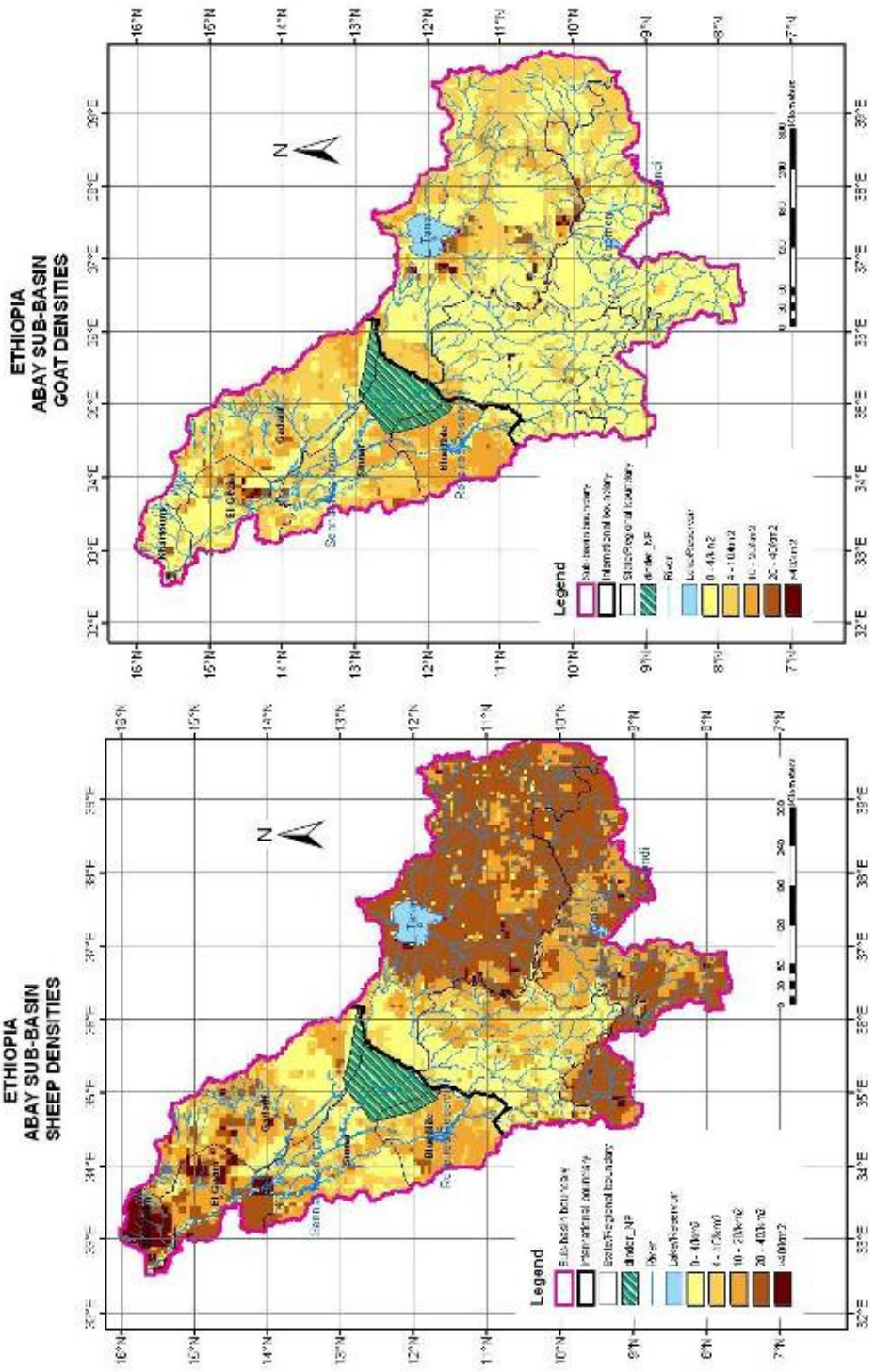
The distribution of sheep and goats are essentially reversed: with higher densities of sheep in the Ethiopian Highlands than the Ethiopian or Sudan Lowlands, with the picture reversed with respect to goats. Overall densities of sheep are nearly everywhere higher than goats. In Sudan they are the preferred animal for export to the Middle Eastern countries.

Figure 2.6: Blue Nile Sub-basin: Cattle densities



Source: FAO (2003)

Figure 2.7: Abbay-Blue Nile Sub-basin: Sheep and Goat densities



Source: FAO (2003)

2.9. FORESTRY AND AGRO-FORESTRY

2.9.1. Forestry Contribution to the Economy

In Sudan in the Abbay-Blue Nile Sub-basin approximately 10.7 million cubic meters of wood fuel and charcoal (per capita consumption of 1.4 cubic meters) are consumed forming about 80 percent of the total energy consumption. Woodlands provide all building materials in rural areas. They constitute 33 percent of the national livestock feed as browse. They also provide a number of non-timber forest products the most important of which is gum arabic.

In addition to these products the woodlands give a number of services which have no direct monetary values such as environmental protection, increase in crop production, conservation of soil fertility, biodiversity, protection of cultural heritage, forming habitat for wildlife and eco-tourism attraction.

The contribution of forestry sector to the GDP is around 3 percent in 1999 but taking into account the outputs collected/consumed by local communities the forestry sector's contribution to the national economy is around 12% of the national GDP (Forest Products Consumption Survey, 1995).

The situation in Ethiopia is not dissimilar to that in Sudan. In Ethiopia in the Abbay-Blue Nile Sub-basin some 23.4 million m^3per year of fuelwood and charcoal (wood equivalent) are consumed as fuel forming about 65 percent of domestic energy consumption. Browse is of little importance in the Ethiopian Highland livestock systems. However, resins are of importance in the Lowlands north of the Abbay River. As most passes into the domestic market through informal channels data on harvesting levels are not known, although national estimates are of 2,067 tons of gums and resins were harvested with 65 percent being consumed within the country, the remainder being exported. The official figures for timber production do not include timber and poles produced and used outside the official marketing structures, in particular, for domestic use in rural areas.

2.9.2. Agro-forestry

In Sudan the main components of agro-forestry are the harvesting of Gum Arabic and browse for livestock as mentioned above. The Gum Arabic Belt (GAB) in the Abbay-Blue Nile Sub-basin comprises the major part of the low rainfall woodland savannah zone extending from the border with Ethiopia to the Main Nile almost all on clay soils. There is a distinct difference between the clay and the sand provenances of Acacia senegal in terms of their water-use efficiency and gum yield (Raddad & Luukkanen, 2006). The clay provenances were distinctly superior to the sand provenances in all traits studied especially in their basal diameter and crown width. The clay provenances are adapted for fast growth rates and high biomass and gum productivity.

There are a number of direct (production) and indirect (environmental) benefits accruing to gum production (Barbier, 1990). In terms of direct benefits the trees provides fodder for cattle, sheep, goats and camels. Older trees (i.e. 15 years or more) that no longer produce good quality gum are often cut for fuelwood and for charcoal production. In terms of indirect benefits the deep tap root and its extensive lateral root system means that it assists in reducing soil erosion and water runoff and for stabilizing soils. Because of its leguminous characteristics the tree fixes nitrogen, which encourages grass growth for grazing by livestock. The trees can act as wind breaks and can assist in the stabilization of shifting sand and moving dunes.

Seasonal labourers from other parts of the country migrate to the Gum Arabic Belt (GAB) seeking employment and thus its production system supports and extends livelihood strategies.

Currently, Gum Arabic production is unstable due to climatic factors and marketing policies, in particular the ban on private companies exporting unprocessed Gum Arabic. The floor prices paid by the government-owned Gum Arabic Corporation as a percent of export prices (f.o.b. Port Sudan) declined from 70 percent in 1994 to only 21 percent 2000/2001 (World Bank (2003). In 1990-1992 the government temporarily waived controls and the percent of export price rocketed to 160 percent! The gum Arabic plays an important role as major source of foreign exchange, accounting for 14 percent of the annual export income excluding petroleum.

In Ethiopia agro-forestry takes the form of planted trees (invariably Eucalyptus spp.) around the homestead and indigenous trees left in croplands. In the Highland areas north of the Abbay River Eucalyptus spp. dominate on-farm trees comprising nearly 90 percent of all on-farm trees. In the Highlands south of the Abbay River the proportion of Eucalyptus spp. fall to about 40 percent of on-farm trees and to virtually zero in the Lowlands, with indigenous and cash crop trees (mainly coffee in the Highlands) making up the remainder.

Prior to 1991 cutting of trees was prohibited and as a consequence very little on-farm tree planting took place under the Derg. With the installation of the Transitional Government the prohibition on tree planting was lifted and the tenure and use rights to planted trees were secured. With the accelerating economy and the subsequent building boom, there was a tremendous increase in the demand for construction poles in all the major and many of the minor centres. This in turn triggered an increase in on-farm tree planting of Eucalyptus.

However, the speed and the degree of response varied considerable within and between areas. Those areas with good market access exhibited the highest rates of planting, whilst those areas away from road access, areas with lower and more variable rainfall (eastern part of the Upper Abbay-Blue Nile Sub-basin) and those areas with considerable stocks of indigenous trees (Highland areas south of the Abbay River and the Lowlands) had much lower rates of Eucalyptus planting.

Trees in croplands are generally moderately to heavily pollarded for timber, fuelwood, forage and to reduce shade.

2.10. POVERTY PROFILE

The basis for determining the poverty lines in Ethiopia and Sudan are different and thus can not be compared with each other. The poverty line in Sudan is US$1.00 per capita per day, while in Ethiopia it is based on a basket of food and essential non-food goods worth EBirr 1,070.00 per capita per year (approximately US$0.34 per capita per day) in 1995/96 prices. The percentages of population below the official poverty line are shown in Figure 2.2.

2.10.1. Estimates of Poverty

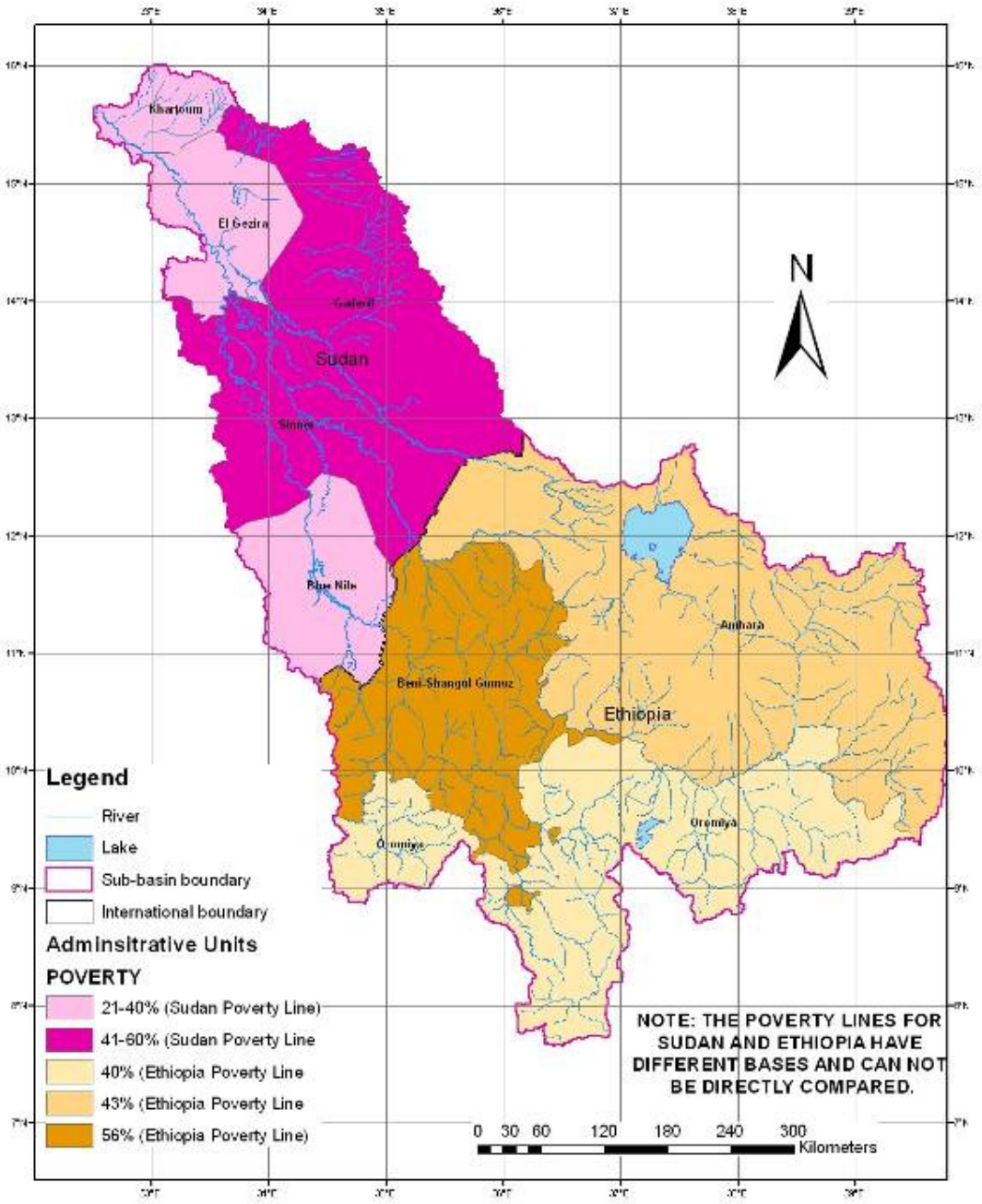
In Sudan Gezira and Blue Nile States have lower poverty rates than do Gaderef and Sinner States. In Ethiopia poverty rates in Amhara and Oromiya Regional States are very similar with those in Beneshangul-Gumuz regional significantly higher.

The extent and dynamics of poverty in the Sudan since the 1990's has been examined by the Joint Assessment Mission (JAM, 2005). Despite the sustained growth since 1997 many experts believe that poverty has remained widespread and has actually increased. The gap between the "haves" and the "have nots" has increased. Thus whilst the traditional agricultural sector has shown a rebound in the past decade this is only to levels that prevailed before the massive droughts of the early 1980's. In Ethiopia a comprehensive

review of poverty was undertaken (FDRE-MOFED, 2002) as input to the Country's Sustainable Development and Poverty Reduction Programme (SDPRP). Between 1995/96 and 1999/2000 in Ethiopia rural poverty rates declined by 4 percent, although it increased in urban areas (by 11 percent).

Data is virtually absent on the state of vulnerability in the Blue Nile Basin from social, political and ecological perspectives

Figure 2.2: Distribution of percent of population (Sudan- Total) and Ethiopia (Rural) below the official poverty line as determined in each country.



Sources: Sudan (JAM, 2005), Ethiopia (FDRE-MOFED, 2002).

2.10.2. Poverty and Food Security

As discussed above, poverty in the project area is prevalent. Both men and women work on the farm and off farm but the income they earn is very meagre to satisfy their needs. Backward farming system, failure of rainfall, pests and time consuming labour (such as gold panning) contribute to this. Chronic poverty is evident by the fact that a large number of people in the project area have to rely on relief assistance.

A report (Food Security Strategy, 2004) describes the nutrition status of people in Benishangul Gumuz Region. Low nutrition, protein-energy deficiency as well as nutrition and micronutrient deficiency are widespread in most places of Benishangul Gumuz including the project area. Chronic malnutrition (shunting), acute malnutrition (wasting) and underweight (for age) are very high in Benishangul Gumuz, particularly among the indigenous people of the region. The report concludes that the Benishangul part of project area is one of food insecure places in the region. The Amhara portion is better placed (MEF, Section 4, part 3, pg.4-63, 64,65 and 66).

3. NATURAL RESOURCES AND ENVIRONMENTAL ISSUES

3.1. GEOLOGY

The geology of Abbay-Blue Nile Sub-basin can be summarized as follows: the Highlands the Sub-basin is composed of basic rocks, mainly basalts, while the Ethiopian lowlands are mainly composed of Basement Complex rocks as well as metamorphic rocks, such as gneisses and marble. Where the Abbay has cut through the basalts there are restricted areas of limestones and then sandstones before the Basement Complex is reached.

The main part of the Sudan Lowlands is underlain by deep unconsolidated colluvial sediments of tertiary and Quarternary age. To the north are older Basement Complex rocks and the Nubian Sandstones. The Nubian Sandstones are located in the northwest corner and overly uncomfortably the Basement Complex rocks and comprise mainly sandstones, siltstones and conglomerates. (The gold over geological time is eroded away and ends up as tiny grains in the alluvial sands of the Abbay flood plain, and older river terraces. The Abbay River does not carry much coarse or medium grained sand. Instead the alluvium comprises silt, very fine micaceous quartz sand, and channel lag gravels. Durable and heavy minerals, like gold and base metals tend to become incorporated into the channel lag gravels, where they form a loose, fine to medium grained, black sand-matrix, usually in pockets.) (MPFS, Section 6, Pg. 6-8)

About 8 kilometres downstream of the Abbay/Didessa confluence, the Abbay enters a well-defined narrow gorge that extends all the way to the Mandaya dam site, and continues a further 1.5 kilometres where it abruptly terminates. From here on the river enters a broad dissected pedeplain, as mentioned previously. The narrow gorge at Mandaya is strongly controlled by geology. The gorge is cut through a flat layer of very strong durable basalt of Tertiary age. The horizontal basalt flow results in “table-top”, plateau, morphology. The edge of the plateau elements is formed by a vertical cliff of 15 to 45 m height, depending on the local thickness of the basalt flow. At the Mandaya site the top of the basalt on the left bank is at 901 masl and about 910 masl on the right bank side. Below the basalt caprock the Abbay has carved out a symmetric U-shaped valley in the underlying gneiss, with a distinct Rocky River section of 300 meter width. The riverbed level is around 611 m.

The valley flanks are corrugated with gullies that in their upper reaches expose decomposed metatonalite gneiss. Large boulders of basalt (up to 1,000 m^3 in volume) have detached from the upper escarpment and rolled down the steep valley slopes. Accumulations of boulders and talus are evident at the lower reaches of the side valley gullies. (MEF, Section 4, Pg. 4-3)

3.1.1. Construction Materials

A possible source of hard rock for aggregate would be pebble beds in the river alluvium particularly near the river channel. Such materials are found close to Abbay Goli where high river terrace deposits are found just east of this village. Gravels are also present on the islands north of Abbay Goli. These gravels are about 12 kilometres downstream of the dam. A more reliable source of aggregate would be the basalt capping. This rock is considered as ideal for aggregate as it is very hard and durable, and homogenic. The basalt cap rock is considered to be 25 meter thick on average, and it appears to be quite unweathered throughout the layer. A very good quarry site could be established anywhere within the various plateau areas that are adjacent to the dam (MEF, Section 4, pg 4-5).

3.1.2. Rock-Fill Material

There are abundant resources for rock fill as detailed in the next section.

3.1.3. Coarse Aggregate

An ideal source of hard rock for aggregate would be pebble beds in the river alluvium particularly near the river channel. At this stage is would seem that for a major RCC dam the total resource of all the pebble beds is too small but some pitting of the alluvial beds might be worthwhile to determine if significant reserves are available.

A more reliable source of aggregate would be the granite/granodiorite gneiss which forms all the high ground around the dam. These rocks are ideal for aggregate as they are very hard and durable when unweathered. They contain no chalcedony and no strained quartz and no sulphides, and therefore adverse alkali-reactions will not happen. The only problem might be flakiness in the case of gneissic rock varieties. Petrographic analysis of the granite gneiss confirms the suitability of this rock type for aggregate use.

Two possible quarry sites are shown on Drawing B5, and in the photo album. Site 1 is very close to the dam, and Site 2 is 2.5 kilometres due East of the dam. The favoured Site 2 comprises a giant dome of flawless rock. The elevation of the dome is around 570 to 620 meter. The access road to the quarry from the dam would be 4 kilometres long and on a max. grade of 1 to. Flooding of the reservoir would partially inundate the quarry.

- **Sand:** Large quantities of river sand are available from the alluvial terraces found on each side of the river. However the sands are exclusively very fine with high proportions of silt and mica flakes. Therefore they are considered unusable. High quality sand for concrete will rather, have to be obtained from crushed rock obtained from the quarry, therefore.
- **Impermeable Soils:** No obvious sources were found.
- **Pozzolana Materials and Cement:** The marble hills of Sirba Abbay might provide a source for cement. Concerning pozzolana, no obvious sources were found (BPFR, Section 6, pg. 6-12 & 6-13).

3.2. SOILS

The Vertisol – Nitisol boundary runs almost along the international boundary. Nitisols (24%) dominate the western Highlands whilst shallower and more infertile Leptosols (19%) occupy the eastern Highlands. Vertisols (29%) dominate the unconsolidated sediments of the Sudan plains.

On the flat plateaus in the Ethiopian Highlands are extensive areas of Vertisols. On the deep soils in the high rainfall areas around Lake Tana there are extensive areas of Luvisols.

Table 3.1: Blue Nile Sub-basin: Dominant Soil Types

Soil Type	% Area
Vertisols	28.9%
Nitisols	23.9%
Leptosols	18.7%
Luvisols	12.7%
Water body	5.1%
Cambisols	3.6%
Regosols	2.8%
Alisols	2.8%
Phaeozems	0.9%

Soil Type	% Area
Fluvisols	0.4%
Swamp	0.2%
Solonchaks	0.0%

Source: FAO, 1998 'Soil and Terrain Database for Northeast Africa'

Soils in the Border area are broadly classified as Nitosols and Alfisols, two of the nine major soil groups covering the Abbay Basin (Figure 3.1). These units are capable of cultivation but their acidity reduces the availability of nutrients like phosphorus, calcium and magnesium (BEF, Section 4, part 1, pg. 4-5).

Abbay River Integrated Development Master Plan Project carried out reconnaissance soil survey throughout the sub basin. Accessible areas were surveyed by using 4WD vehicles, while remote areas were accessed using helicopter. The mapping bases used in the reconnaissance field survey were Landsat TM images at a scale of 1:250,000, and topographic map of the same scale. Previous studies were also reviewed and incorporated in the soil analysis of the sub basin.

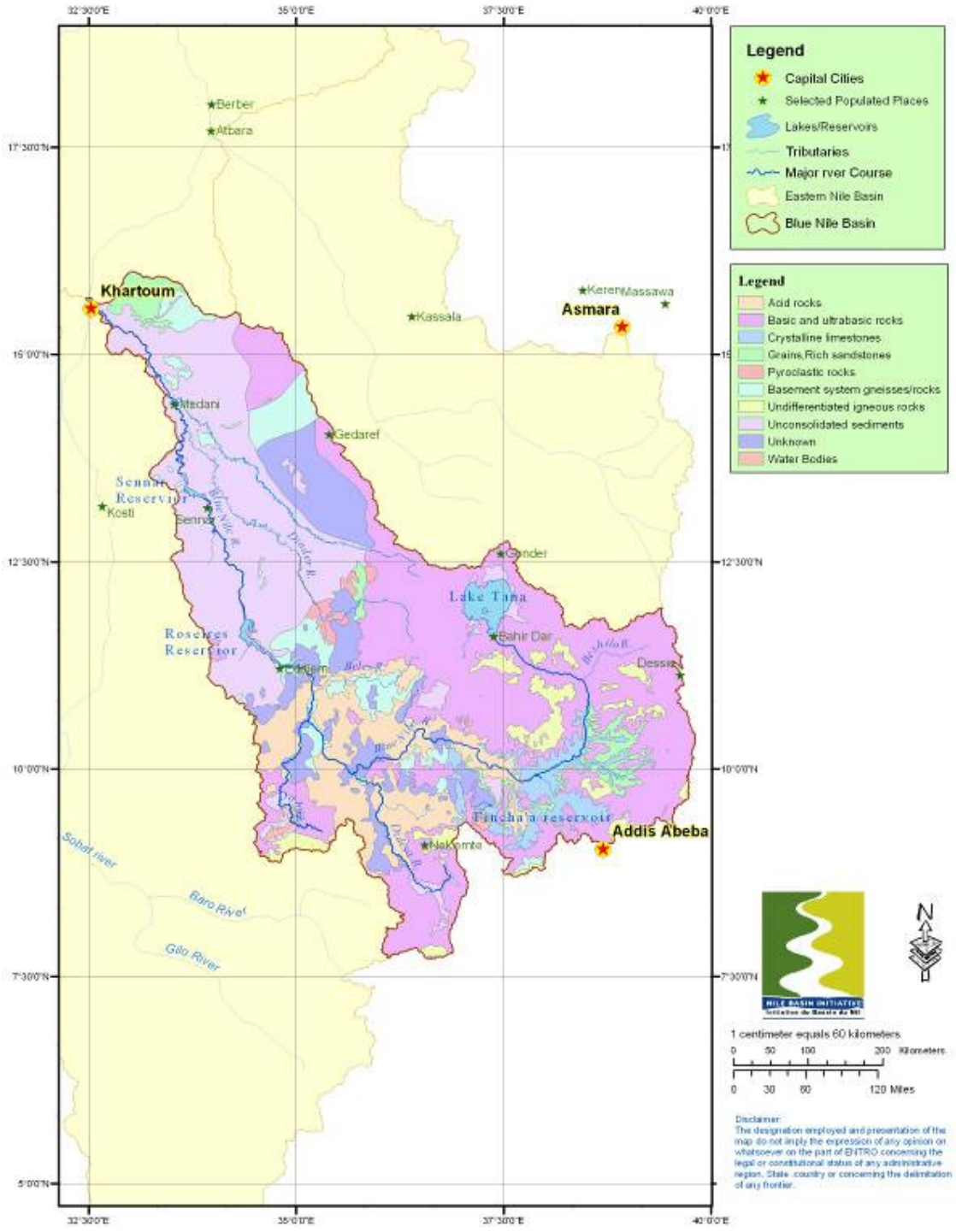
Table 3.2: Summary of reconnaissance survey observations

Data Source	**Number of Observations**	**Area (hectares)**
Reconnaissance primary observation	910	
Selected (20%) semi-detailed observations	261	
Observations from previous studies integrated into reconnaissance soil survey	3,229	
Total observations integrated into reconnaissance soil survey	4,440	
Basin area		19,981,200
Inaccessible areas		4,995,300
Leptosols and rocks		4,083,626
Marshes and water		428,927
Effective basin area		10,473,347
Hectares per observation in reconnaissance survey	2,359	
Hectares per observations in previous studies	5,010	

Source: Ministry of Water Resources (Ethiopia)

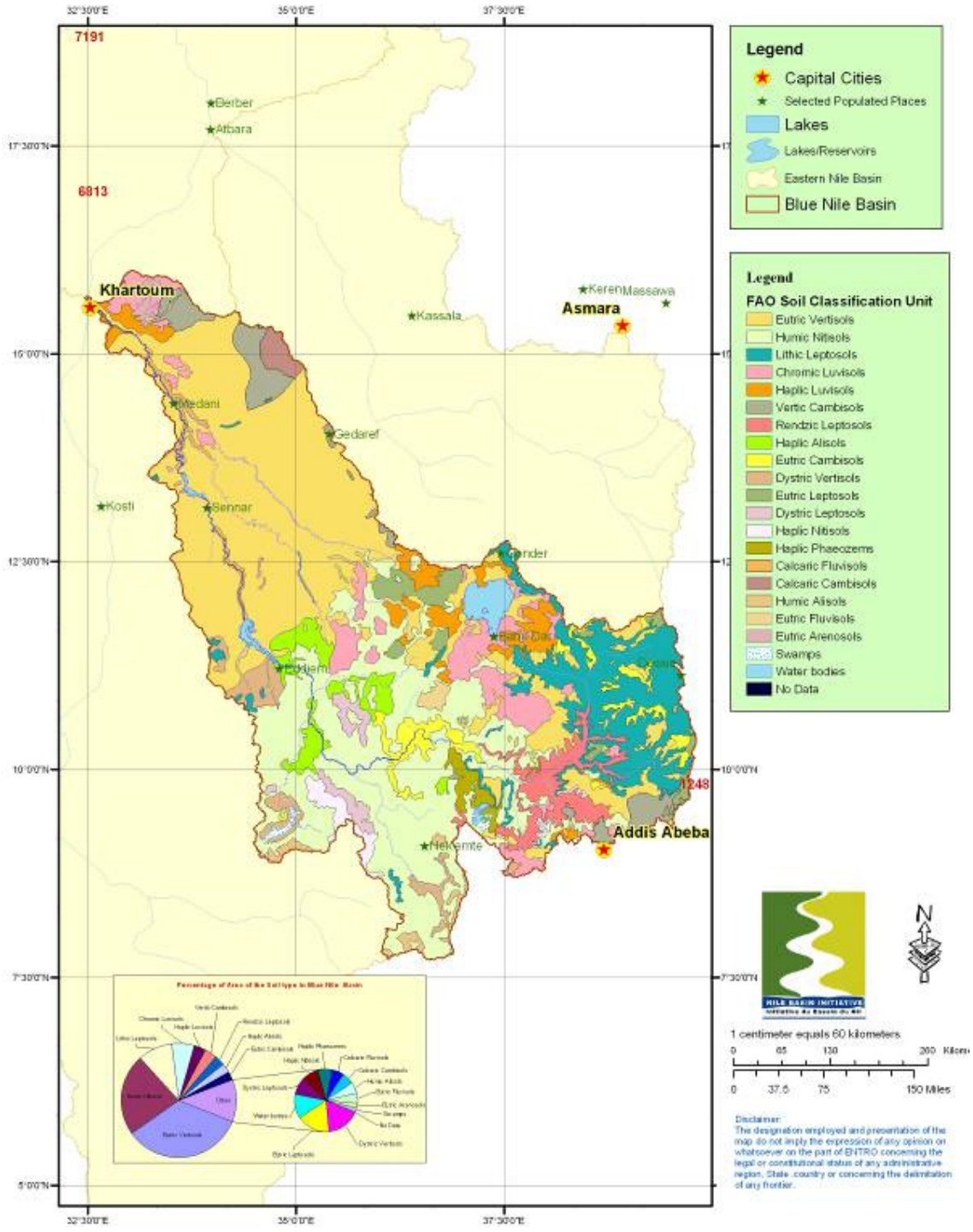
c

Figure 3.1: Abbay-Blue Nile Sub-basin: Geology



Source: FAO, 1998 'Soil and Terrain Database for Northeast Africa'

Figure 3.2: Abbay-Blue Nile Sub-basin: Dominant Soil Types (FAO Classification)



Source: FAO, 1998 "Soil and Terrain Database for Northeast Africa

Soils classification: The soils of the basin were classified based on the revised FAO-UNESCO-ISRIC legend to the Soil Map of the world (1988). The FAO-UNESCO-ISRIC legend contains 28 major soil groupings at the highest level and 153 soil units, which are subdivisions of the soil groupings, at the second level. The soil units are further differentiated into soil sub-units on the basis of differential criteria that relate to important soil properties at the third level. The classification of soils within the basin was carried out based on observable and inferred characteristics of soils based on the field observations and from laboratory analytical data on the physical and chemical characteristics determined. Soils formed in the eastern part of the basin form the basaltic rock cap are deep, productive, well structured and inherently well-drained agricultural soils. The basaltic derived soils are mostly classified by the FAO system (1988) as Luvisols and are intensively cultivated for peasant agriculture. Those soils formed in the western part of the basin form the underlying strata are somewhat less productive and are classified into a variety of major soils including Nitosols and Vertisols (black cracking clay soils). Other major soils found within the basin include Rendzinas (derived from calcareous deposits) and Lithosols (shallow rocky soils) (OSI Environment Summary Report pp. 10-11).

3.3. LAND USE AND LAND COVER

3.3.1. Land Use

Figure 3.3 indicates the Land Cover for the sub-basin. The data source for Sudan is the FAO Africover map and that for Ethiopia was WBISPP-MARD Land Cover Maps for Amhara, Beneshangul-Gumuz and Oromiya Regional States. The two land cover classifications were standardized to the FAO Land Cover Classification System (LCCS) (FAO, 2000). Table 3.3 indicates the areas of the dominant land cover types. Woodlands and Shrublands cover some 28 percent and grasslands 25 percent of the Sub-basin. Sedentary rainfed cropping covers nearly 26 percent of the area mainly located in the Ethiopian Highlands. Semi-mechanized farms cover 10 percent and land under irrigated crops, 2.6 percent. In fact much of the Gezira and all of Managil Schemes lie in the White Nile Sub-basin.

Table 3.3: Blue Nile Sub-basin: Dominant Land Cover

Land Cover Type	Area (kilometers^2)	% Total
Rainfed Crops: Sedentary	8,037,337	25.8%
Grassland	7,777,274	25.0%
Woodland	5,225,555	16.8%
Shrubland	3,671,919	11.8%
Cultivated land: Semi-mechanized farms	3,123,087	10.0%
Cultivated land: Irrigated Crops	815,480	2.6%
Rock	732,392	2.4%
High Forest	429,777	1.4%
Water	420,103	1.3%
Cultivated land: Rainfed Crops: Shifting	340,930	1.1%
Plantation	211,977	0.7%
Bare land: Loose sand	128,804	0.4%
Seasonal Swamp	94,518	0.3%
Permanent Swamp	51,831	0.2%
Built up: Urban	65,136	0.2%
Grassland: Afro-alpine	28,680	0.1%
SUB-BASIN	**31,154,800**	

Source: FAO Africover Sudan (2002) & WBISPP-MARD (2001 -2003)

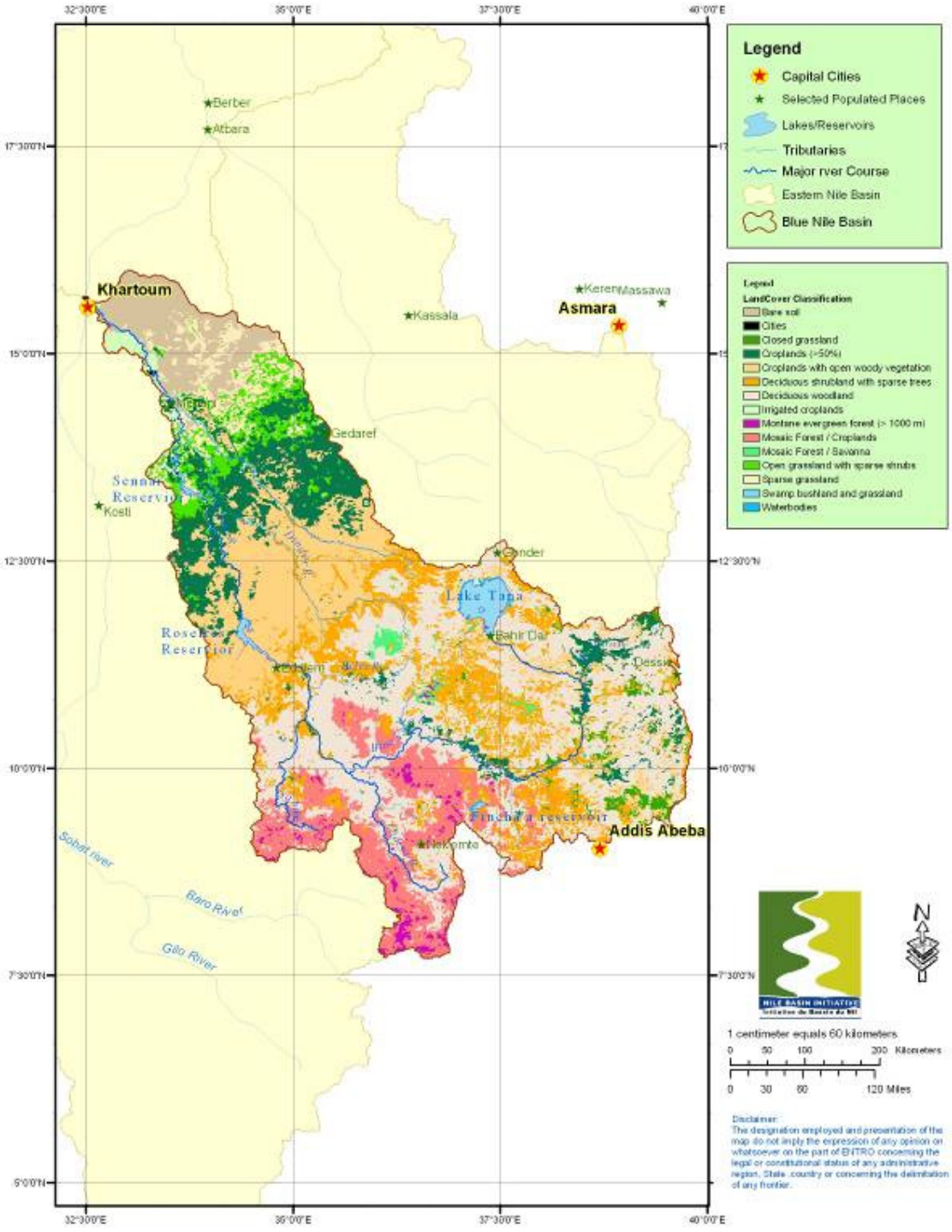
The various land use and land cover categories found within the Abbay are shown in the table below.

Table 3.4: Major Land Cover of Abbay Sub-basin

Land cover	Total area kilometers^2	Total (%)
Cultivated	68150	34.1
Tree crops	260	0.1
Plantation	537	0.3
Afro-alpine	1103	0.6
Disturbed forest	2276	1.1
Bamboo	7326	3.7
Woodland, Bush land, Shrub land	60438	30.2
Grassland	46143	23.1
Wetland	2384	1.2
Water body	3415	1.6
Rock	7932	4
Urban areas	108	0.05
Total	199812	100

Source: Ministry of Water Resources (Ethiopia)
(OSI Environment Summary Report p. 11)

Figure 3.3: Blue Nile Sub-basin: Dominant Land Cover



Source: FAO Africover Sudan (2002) & WBISPP (2001 -2003)

3.3.2. Agro-ecological zones

The potential Mandaya reservoir area lies within the Wet Kolla agro-ecological zone. This is one of 14 agro-ecological zones, based on a combination of annual temperature and rainfall, which covers a large area of the western sections of the Abbay Gorge, the lower Didessa valley and the lower Beles valley and MEF, Section 4, pp. 4-30 & 4-31).

3.4. VEGETATION

3.4.1. Vegetation Types

Semi-desert Scrub and Grassland

- ***Semi-desert Scrub***: In the far north 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. Grasses are mainly annuals in Sudan. 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.
- ***Semi-desert grassland***: South-eastwards, from the 250 mm to the 360 mm isohyet, the vegetation type becomes semi-desert grassland. Much of this vegetation is now covered by the Gezira and Managil Irrigation Schemes. On the heavy alkaline clay soils the natural vegetation is grassland without trees or shrubs.

Acacia Thorn-land alternating with Grassland

- ***Acacia thornland***: Between the 360 mm and 570 mm isohyets on the heavy clays grassland merges into A. mellifera thornland. Other tree species include A. nubica, C. decidua, Cadaba glandulosa, C. rotundifolia and Boscia senegalensis. The last three species often persist after A. mellifera has been cleared. Much of this vegetation is being cleared for small-scale sedentary and large-scale semi mechanised agriculture.
- Grass species include Cymbopogan nervantus, Sorghum purpereo-sericeum, Hypparhenia ruffa, Tetropogan cenchriformis and Cenchrus cilliaris. Sufficient grass dry matter is produced to provide material for annual burning.

Acacia seyal-Balanites Savanna

- ***Acacia***: Above 570 mm to the escarpment with Highland 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 resistant, does not produce good charcoal and is hard to cut.
- ***Savanna***: The grasses tend to occur in pure stands of Hyparrhenia anthistirriodes or Cymbopogon nervatus with Sorghum spp. in the higher rainfall areas. These grasses become largely unpalatable to livestock during the dry season. There is abundant material for annual fires.

Terminalia-Combretum (Deciduous) Woodland

- ***Woodlands***: These woodlands are found in the higher rainfall areas, generally with above 700 mm mean annual rainfall. Apart from the two dominant species others include: Boswellia papyrifera, Lannea schimperi, Anogeissus leiocarpus, and Stereospermum kunthianum. The main land use systems are agro-pastoral and shifting cultivation.

- ***Lowland bamboo (Oxytenanthera abyssinica) occurs in two man forms***: in pure continuous stands with few or no trees or shrubs (dense bamboo) and as clumps scattered with woodland and shrubland (open bamboo). A total of 273,817 hectare of dense bamboo and 220,747 hectare of open bamboo have been mapped (WBISPP, 2003). In the dense pure stand of bamboo comprising the Ambessa Chaka Forest, LusoConsult estimated an average of 8,124 live culms per hectare whilst the density of culms in open "clumped bamboo/woodland-shrubland" is probably about 20 percent of that in the dense pure stands.

3.4.2. Forests Types

Riverine Woodland

Riverine/riverain forests lie along both banks of the Blue Nile as detached areas. They form a very unique forest ecosystem covering a vast area and are of vital economic importance for the economy of Sudan and its nature conservation. They played important environmental and social roles. They provide fuelwood (a major source of rural energy) poles and sawn timber for construction and furniture. They protect the Nile System watershed and soil against wind and water erosion. Riverine Forests are valuable both in terms of their direct use and indirect use values. Examples of indirect use values are the ecological values provided by the forest, which indirectly support economic activities. e.g. prevention of soil erosion, wildlife habitat and microclimate. (OSI Environment Summary Report p. 11)

- ***Lowlands***: In the Lowlands (below 1,500 masl) pure stands of riverine woodland – "sunt" – are increasingly under pressure. The first trees to colonize a newly formed river bank are Salix subserrata and Tamarix nilotica. As the bank builds up xerophytic species such as Ziziphus spina-christi become established. On the lower terrace A. nilotica establishes itself, with A. seyal on the higher ground.
- ***Upper sub-basin***: In the upper parts of the Abbay/Blue Nile Sub-basin these are varied and have been little studied. They include Apodytes dimidiata, Carrisa edulis, Euclea racemosa, Ficus vasta, Syzygium guineense, Mimusops kummel, Phoenix reclinata, and Tamarindus indica.

Montane High Forest

- Highland high forest areas represent less than 2 % of the basin and are now much fragmented and located in relatively small patches. Three main types are found; (a) Undifferentiated Afro-montane Forest (Transitional Broadleaf Forest and (bi) Mixed Juniper-Podocarpus Upland Evergreen Forest), and (c) Single Dominant Evergreen Forest (Juniperus procera).

Undifferentiated Afro-montane Forest (Transitional Broadleaf Forest)

- These forests are found as dispersed patches of forest in areas southwest and southeast of Lake Tana north of the Abbay River and in West Wellega south of the Abbay. They are found between 1,500 to 2,700 masl where annual rainfall is between 700 and 2,200 mm. Mean annual temperature ranges between 14º and 20º C.
- North of the Abbay the main area of natural forest occurs some 150 kilometres southwest of Lake Tana where some 32,450 ha of high forest occur. South of the Abbay overlooking the Anger Valley are some 80,500 ha of high forest. In these areas the annual rainfall is 1,800-2,200 mm. This sub-type appears transitional to the mixed broadleaf forests of the highlands in the upper Baro-Sobat-White Nile Sub-basin. The species composition is similar to these forests but without either Podocarpus gracilior or Aningeria adolfi-friederici. The two main canopy species

are Albizia gummifera and Olea welwitschii. Many of the other species are those found in "disturbed" forest.

- Another more humid sub-type occurs around Lake Tana on the islands and on the Zege Peninsula. Canopy trees include Albizia gummifera, with Ehretia cymosa, Millettia ferruginea and Mimusops kummel.
- East of Lake Tana just to the north of Addis Zemen in North Gonder Zone is the Tara Gedam Monastery forest. This appears to be a seral stage of this type of forest. It has a canopy of A. abyssinica, with understory trees of Bersama abyssinica, Ficus thonningi, Maesa lanceolata, Ritchiea albesii, and Schrebera alata.

Mixed Juniper-Podocarpus Upland Evergreen Forest

- The Anabe and Denkoro forests in North Wello have been studied by Mesfin Tadesse. The main canopy species are J.procera and P. gracilor between 20 and 30 meters high, with a well developed strata of small to medium trees, chiefly O. europaea cuspidata, Allophylus abyssinicus, Celtis africana, Croton macrostachyus, Dombeya spp., Ekebergia capensis, Olea hochstetteri and Prunus africana.

Single dominant Montane Dry Evergreen (Juniperus procera) Forest

- This type of forest is found on the plateaus and hills in North and South Wello, North and South Gonder and North Shewa between 1,600 and 3,200 masl. Annual rainfall is between 500 and 1,500 mm and often but not always bi-modal in distribution. Mean annual temperature is between 12ºC and 18ºC. It comprises an open forest tending towards Juniper woodland with a canopy of 10 to 15 meters. The dominant species is J. procera often with Olea europaea cuspidata in the canopy. Species in an upper strata below the canopy include Acokanthera schimperi, Bursama abyssinica, Calpurnia aurea, Dombeya torrida and Teclea nobilis. In the lowest strata Psydrax schimperii and Carissa edulis occur. In some areas the number of Juniperus trees is very small and the canopy is then dominated by O. europaea cuspidata. Where disturbance has been more severe A. abyssinica dominates the canopy and few if any Juniperus or Olea are seen.

Mountain Woodlands

- These woodlands are found at higher altitudes above 2,500 masl. Common species are A. abyssinica, Protea, Cussonia, Hagenia abyssinica, Erica arborea, and Hypericum.

Afro-alpine Grasslands and Erica Woodland

- These alpine grasslands are generally found above 3,200 masl. Mean annual temperature is generally below 11 degrees C and frost will occur most nights. No rainfall stations are found at this altitude but it is generally agreed that rainfall increases up to 3,800 masl and then starts to decrease. Palatable grasses found in this grassland type include Eragrostis spp., Deschampsia flexuosa, Helictotrichon milanjianum, Molinia caerulia, and Poa spp. On Mount Choke substantial areas of giant heather (Erica arborea) woodland occur.

Table 3.5: Land Use/Cover of Border reservoir area with FSL 580 masl

Land Cover	Land Use Category	Land use Area ha	Land cover Area ha	Land cover Area %
Cultivation	with few stock of woody biomass with light stock of woody biomass	30 230	260	<1
Dense vegetation	Dense Bamboo Dense Shrubland Dense Riverine Forest Dense Woodland	811 588 6,049 14,638	22,086	38
Grassland	With Few Stocks of woody plant With Light Stocks of woody plant With Moderate Stock of woody plant	25 1,981 16	2,022	4
Wood/Shrubland	Open Shrubland Open Woodland	14,838 15,092	29,930	52
Water	Water body	3,102	3,102	5
All/Total		**57,400**	**57,400**	**100**

Source: BEF, Section 4, part 1, pg. 4-33

3.5. WETLANDS

Based on field investigations and reviews of collected data, there exists no permanent wetland in the Border project area other than the Abbay River and perennial tributaries. In the river reaches where seasonal flooding occurs, the flood recession areas are used for crop production and no vegetation typical of wetland ecosystems is found.

There are wetlands in the sub basin. These areas can be either permanent swamps such as the Dabus swamp or, else they may seasonally recede as around Lake Tana. The main wetland areas within the sub basin occur around Lake Tana, the Finchaa, Chomen and the large Dabus swamp. The wetlands have been important bird and wildlife areas and have significance for congregational bird species (Flamingos, cranes, ducks, geese, etc.) and over-wintering areas for a variety of migratory Palaearctic bird life.

Similarly, the Dinder/Rahad wetlands in the Sobat-White Nile sub basin in the Sudan are floodplains occupying areas between Dinder and Rahad Rivers, both flowing from Ethiopian highlands; wetlands with an area of 500,000 hectares consisting of flood plain; tributaries with numerous oxbow lakes lie between the rivers and much of the intervening land flooded during rainy season; swampy area around lakes, lagoons, pans, pools and depressions, It forms good grazing sites for wildlife during dry season; home for important migratory and water birds. (OSI Environment Summary Report p. 14)

Four major types of wetland occur in the Sub-basin: (a) the lowland wetlands of the Dinder-Rahad catchment located mainly within Sudan, (b) lacustrine wetlands that fringe Lake Tana and lake Fincha'a, (c) narrow valley bottom wetlands found in western Ethiopia south of the Abbay, and (d) the very wide valley wetlands of the upper Dabus River also in western Ethiopia south of the Abbay.

- ***Dinder-Rahad Wetlands***: These wetlands are located on and between the Dinder and Rahad Rivers and are locally known as "maya'as". They are depressions along and between the rivers. The area way from the river is covered with fossil streams and rivers. The depressions are abandoned meanders which have formed forming "ox-bow" lakes. These lakes however are ephemeral as they gradually silt up, fill with swamp vegetation and then as they silt up dry out.

- ***Lacustrine Wetlands***: These are located fringing Lake Take and in the lower Gishe Abbay River and around Lake Chomen. Those around Lake Tana have been considerably reduced in extent, most particularly around the Fogera Plain having been converted to cropland. The Fogera plains are fed by the Rib River and bounded by the Gumera River to the south. A perennial swamp has formed at their junction. Lake Tana also floods back 1.5 meters during the rainy season. The vegetation along the Lake shore is almost purely papyrus whilst inland swamp grasses such as Echinochloa spp. and Cynodon aethiopicus dominate. These form excellent dry season grazing. A number of globally threatened birds occur including the Wattled Crane, the Lesser Kestral, Pallid Harrier and Great Snipe.
- ***Fincha'a and Chomen wetlands***: Those around Lake Chomen comprise two main wetlands: the Fincha'a to the north and the Chomen to the south. They are separated by a low ridge. Water flows from Chomen into Fincha'a through the ridge. The Fincha'a swamps cover some 28,000 hectare and the Chomen an area slightly larger. The streams flowing to the swamps are short (average about 9 kilometres) and thus rainfall over the swamps is an important source of water for the swamps. During the rains the water level rises by some 2 meters. The swamps are covered by floating vegetation the dominant species being the perennial grass Panicum hygrocharis (EWNHS. 1996). The wetlands are of particular conservation importance as a location for the globally threatened Wattle Crane.
- ***Narrow Valley-bottom Wetlands***: These are mainly located in the high rainfall areas southwest of Lake Tana and in the western Highlands south of the Abbay River. A survey and inventory of wetlands in the Amahra Region (Enyu Adgo et al., 2005) found that many of these wetlands were under threat due to land degradation and sedimentation, and the lack of bylaws and community rules regarding their use. Many are used for dry season grazing, hay production, thatching grass and grass mats (cheffe). In the area between Gimbe and Nejo within the Dabus and Abbay Sub-basins many wetlands are used for cultivation. Because of severe degradation on the upland granite soils the wetlands have become vital elements in sustaining peoples' livelihoods. However, in some areas there have been reports of over-draining of these wetlands leading to the destruction of their delicate hydrography and loss of value for cultivation (Wood, 2000).
- ***Upper Dabus Wetlands***: The Upper Dabus comprises two wide (50 kilometres) shallow east-west trending valleys of seasonal and permanently flooded grassland and sedges. The area is very remote and no research appears to have been carried out on these extensive wetlands. The area is little utilized except along its edges for dry season grazing. The area acts as a sponge retaining runoff and prolonging the main peak of the Dabus flow.

3.6. WILDLIFE

In this sub basin in general, there has been severe reduction in wildlife habitats and numbers due to the conversion of large areas of land for agricultural use. This has particularly affected the more densely populated and human favored higher and cooler altitude areas in its upper course. Introduction of state farms and settlement activities in the lower altitude plain areas have also affected the life of wildlife.

In the lower course of the sub basin, the Dinder National Park covering an area of about 8900 kilometres preserves natural wildlife migration corridor between the lower and the upper part of the sub basin. The park is the last remaining wildlife sanctuary in the south-eastern clay plains. It supports a population of Tiang, Reedbuck, waterbuck, bushbuck, Pribi, roan antelope, warthog, buffalo, greater kudu and red fronted gazelle. Many birds

are found in the park such as ostrich, marabou stork, Clappertoni francolin, cattle egret, crowned crane, grey heron, sacred ibis, hooded vulture, pink backed pelican, bee-eaters, starling and guinea fowl. The annual reports on the park show continuous decline in the population size of nearly all species.

3.6.1. Fauna

Ethiopia is endowed with rich floral and faunal resources, and possesses some of the richest endemic fauna and flora in the African continent. This occurs as a result of the immense topographic and climatic diversity in the country. Ethiopia's biodiversity is illustrated in Table 3.7.

Table 3.7: Biodiversity in Ethiopia

Category	Species in Ethiopia Approximate number No.	Proportion of species endemic in Ethiopia %
Higher plants	6,500 – 7,000	12
Mammals	277	31
Birds	862	17
Reptiles	210	9
Amphibians	63	24
Fish	150	4

Source: Tefetro, EPA Magazine, August 2004

With regard to birds, Ethiopia provides habitats for more than 862 species. Of these 17 are wholly restricted to Ethiopia and are thus endemic. 14 others are shared with Eritrea. Of the Palaeo-arctic migrants, some 45 over-summer in Ethiopia. A large number of these birds have breeding populations in Ethiopia. The biology of many obvious and common endemic bird species remains poorly known. The nest and eggs of several are not described. The ecology, behaviour and breeding biology have not been fully documented, or there is no information. This background requires developers to conduct adequate surveys as part of good EIA practice, and employ experts for surveys who are aware of this background.

3.6.2. Aquatic flora and fauna

Available baseline data for aquatic biota other than fishes is desperately poor. The data for fish is comparatively better.

Samples taken in March 2007 from Abbay River at an island between Boka and Abagole, located some 15 kilometres downstream of the Mandaya dam site, as well as samples from the Mandaya dam site, indicate the dominance of diatoms of different genera (Appendix 4.1). There is also indication of the presence, to a smaller extent, of blue green and green algae.

Samples taken from the Abbay at the Bure-Nekemte Bridge indicate the dominance of diatoms and the presence of some blue green and green algae (Appendix 4.2).

Talling & Rzoska (1967, in Morris et al, 1976) have also reported the presence of rudiments of phytoplankton especially Cyclotella in the Abbay River below Tisissat Falls. However, generally, there is little prospect of permanent plankton populations being established along considerable stretches of the Abbay River (Morris et al, 1976).

Observations of the Blue Nile in Sudan indicate that very little of the headwater lacustrine phytoplankton survive and prosper after the descent to the Sudan plain. The Lake Tana plankton was scantily represented at the Tissisat Falls, and not seen at all at a station further down the Abbay gorge. In the gorge, the phytoplankton appears to be present in low densities. According to Talling (1976) it is composed predominantly of the diatom

Melosira granulata and its elongate variety angustissima, with smaller numbers of the blue green Lyngbya limnetica often accompanied by Anabaena flos-aquae.

Macrophytes are only seen in relatively static areas out of the main stream and in tributaries.

3.6.3. Zooplankton and benthos

Due to the rocky and turbulent nature of the Abbay River, it is unlikely that a population of zooplankton is established in a considerable proportion of the river. The benthos of the Abbay is generally believed to be poor mainly because of the drastic changes in flow rates and water level.

Samples taken in March 2007 from Abbay River at an island between Boka and Abagole, located some 15 kilometres downstream of the Mandaya dam site, as well as samples from the Mandaya dam site, indicated the presence of two zooplankton species, namely, Mesocyclops sp. and Cyclopoid nauplii.

In a recent survey conducted on Beles River at Babizenda, Diaphinosoma and Thermocyclops of the zooplankton community and Chironomids, mayflies, beetles, dragonflies, water penny and stoneflies of the Arthropod community have been recorded.

Samples taken from under the Bure-Nekemte Bridge, further upstream, revealed the presence of no group of zooplankton. Due to the rocky and turbulent nature of the river, there is little probability of the presence of established communities of zooplankton. The benthos of the Abbay, likewise, is believed to be generally poor because of the steep riverbed and banks in places and the drastic changes of water level.

3.6.4. Fish and other aquatic life

Fish collections were made in March 2007 from Abbay River at an island between Boka and Abagole, downstream of the Mandaya dam site. About 150 specimens were caught - most of them small specimens captured by beach seine. 10 species were recorded belonging to six families (Appendix 4.3). They differ to some extent to fish species reported from Bure-Nekemte Bridge by JERBE (Appendix 4.4).

Some of the species, especially of the Family Cyprinidae, are migratory and need smaller streams for reproduction. Although it is very difficult, indeed impossible without detailed studies, to determine which tributaries these fishes go to and use for spawning, it is considered that some or all of the local tributaries in the 25 kilometres Abbay reach between Boka and Mandaya dam site (e.g. Boka, Sirba, Geli, Jali and Gember on the left bank, and Dura and Mecha on the right bank) could serve as breeding grounds during the rainy season. At the time of sampling, only Boka tributary was flowing, the others being dry.

Anecdotal information from a missionary nurse, resident for two years at Boka, indicated that fish of between 10 to 12 kilograms are caught in Abbay River locally, whilst smaller fish are caught in tributaries. Also, she reported that in some years a small silvery fish enters tributaries from the Abbay, and these tributaries become “crowded” with these fishes which villagers catch continuously over a long time. She reported that villagers say that these fish come from Sudan. In all cases, the names of the 10-20 kilogram and the small fish species, and of those which can sometimes “crowd” tributaries which are believed to migrate from Sudan, were not known. This anecdotal information became available after field surveys were completed in March 2007 and will require following up in any further investigations.

A recent repeated survey of Beles River at Babizenda, made by the consultant and a postgraduate student at Addis Ababa University, has indicated 23 fish species belonging to seven families (Appendix 4.5).

The Joint Ethio-Russian Biological Expedition (JERBE) reported 24 species in Abbay River, some 35 kilometres from Mankush (Appendix 4.6). Fish samples taken by JERBE from the Dabus River at the bridge along Nekemte-Asosa road, indicated the presence of seven fish species, mainly of the East African forms (Appendix 4.7). JERBE also surveyed Abbay River at Bure-Nekemte bridge located much further upstream. Six families with 15 species were recorded (Appendix 4.4). Most of the species (e.g. Mormyridae, Bagridae) are Nilo-Sudanic forms while few (e.g. Labeo, Barbus intermedius, Garra spp.) are East African forms. Many of the fish species are adapted to life in turbid and muddy waters.

Because of the difficulties in the accessibility of the Abbay gorge below the Tisissat Falls, few fish diversity studies have been conducted through the years. On the other hand, the fish fauna and other aquatic life of the Abbay River above Tisissat Falls has been thoroughly studied and identified. The two sets of fauna are believed to be quite different from each other although there are some common elements.

During the Abbay River expedition through the Abbay Gorge, including the Mandaya gorge, in 1968 biologists reported an apparent general scarcity of fish in the Abbay and attributed this to the extreme force of the currents and muddiness of the water. They considered that food for fish must be in short supply, the currents sweeping away any small prey or suspended matter, though during the dry season there is probably an abundance of insect larvae in the shallow river water. Another indication of fish scarcity was the small number of fish predators seen. A few egrets, herons, fish eagles and crocodiles were observed but these were relatively infrequent compared with their abundance in waterside habitats elsewhere in other drainage basins in Ethiopia. Very few other common riverside species of birds were seen, also suggestive of food shortage (Morris et al., 1976, citing the Great Abbay Expedition in 1968).

Observations at the Bure-Nekemte Bridge revealed that large freshwater molluscs (from their shells) and at least two species of lizards (from live specimens) inhabit Abbay riverbank areas.

During surveys made in March 2007 in the Abbay reach near Mandaya, hippopotami were observed to be abundant and crocodiles present in various locations (Appendix 4.8). Storks, herons, finches, guinea fowl, guereza and baboons were also seen at the upper end of this reach.

Earlier reported observations along Abbay further upstream (Morris et al, 1976) confirm the presence of aquatic animals, such as Hippotamus amphibious, Nile monitor (Varanus niloticus), Nile crocodile (Crocodylus niloticus), leathery turtle (Trionyx triunguis) and the side-necked terrapin (Pelomedusa subrufa). A golden frog (Ptychadena huguettae) was also reportedly collected by the Didessa River. Another frog species (Rana occipitalis) was collected at Sirba (where the Great Abbay Expedition ended, close to Boka). The widely distributed freshwater crab, Potamonautes antheus, has also been reported (Williams, 1976).

Insects (especially mosquitoes) were noticeably scarce during the wet season (October and November 2006 were unseasonably wet), but earlier travellers have reported plagues of them (Morris et al., 1976) and, as will be seen later, malaria is rife in the area. It may be presumed that the principal aquatic insects are those with short life cycles that can develop during the dry periods in great numbers, be flushed out by the rains, and later swiftly re-colonize the river from small reservoir populations in backwaters.

3.6.5. Endemic Aquatic Species

There are no endemic aquatic species so far reported from the area of the Mandaya dam site, reservoir area or downstream in Ethiopia. However, it is noted that this assertion is based on incomplete baseline data. Rare species, with restricted range distributions, are not easily sampled and brief surveys can easily miss these species (MEF, Section 4, Pg. 4-40).

3.6.6. Fisheries

The upper course of the Blue Nile sub basin has limited fish reserves in both lake and riverine systems. Lake Tana, on the other hand, has the most important fish resource. Fishing is carried out on a subsistence basis and limited commercial purposes both in the main river channels and many of the floodplain lakes. Virtually, every family that lives near water fishes to supplement its diet. Nile perch (Lates niloticus) Nile tilapia (Oreochromis niloticus), Catsish (Clarias sp), Bargrus, Barbus and Labeo species are known to be important both in ecological and commercial terms.

However, there is little information on fish species and no systematic fish identification has been done in the upper sub-basin of the Blue Nile. Neither the number of fishery operations nor evaluation of their catch is available. The fisheries department has not yet collected such information. However, studies have documented two separate fish faunal provinces, which are mainly determined by water temperature. These are (i) the Nilotic lowland fauna and (ii) the Ethiopian Highland fauna.

Table 3.6. Fish within Abbay and tributary Rivers

Family Species	Abbay River	Tributary river
Mormyridae		
Hyperopisus bebe	X	
Mormyrops spp	X	
Mormyrus hasselquistii	X	X
Mormyrus spp.	X	
Characidae		
Micralestes spp.	X	
Cyprinidae		
Barbus paludinosus		X
Barbus trispilopeura		
Barbus intermedius		X
Barbus spp		X
Chelaethiops bibie	X	X
Garra spp.	X	X
Labeo coubie	X	X
Labeo spp.	X	
Leptocypris spp.	X	
Raiamas spp.	X	
Varicorhinus beso	X	X
Bagridae		
Bagrus spp.	X	

Source: JERBE, 1996

3.7. PROTECTED AND CONSERVATION WORTHY AREAS

The Abbay River Basin is regarded as an important area for a wide variety of resident and migratory water birds. The area is particularly important for water birds and watering grounds of large number of migrants. Very many Palaeo-arctic migrant birds cross the Sahara desert from Europe and Asia using the area for feeding and wintering. As the area is significant in the national and international context, and because Ethiopia is a signatory

state to the African-Eurasian Waterbird Agreement (AEWA), particular care is required to ensure the protection of these species throughout their natural range.

The main wetland areas within the sub basin occur around Lake Tana, the Finchaa, Chomen and the large Dabus swamp. The wetlands have been important bird and wildlife areas and have significance for congregational bird species (Flamingos, cranes, ducks, geese, etc.) and over-wintering areas for a variety of migratory Palaearctic bird life. (OSI Environment Summary Report p. 14). Information on insects, reptiles and other fauna in the area is similarly severely limited.

Ethiopia has issued a number of regulations aimed at conserving and protecting the remaining natural ecosystems of the country. These protected areas have been divided into four categories according to management objectives: National Parks, Game reserves, Sanctuaries and Controlled hunting areas. The Dabus Valley controlled hunting area, downstream of Mandaya dam site, is the nearest protected area to the project.

Table 3.8: Protected and Managed Protected Areas in Ethiopia

Protected Area	Total Protected Area kilometers^2	Managed Protected Area kilometers^2	%
Dabus Valley controlled hunting area	194,000	30,316	16

Source: Tefetro, EPA Magazine, August 2004

The Dabus Valley controlled hunting area has been registered by Ethiopia with the World Commission on Protected Areas (WCPA) which maintains a world database of protected areas. Dabus is registered as Site Code 13752. Websites provide little information on plants and animals, though elephant and lions are mentioned (MEF, Section 4, pg.4-38).

3.8. LIVESTOCK

In the upper course of the Blue Nile sub basin (Abbay Basin in Ethiopia), livestock conditions are deteriorating, as more and more traditional grazing areas are being cultivated and the growing livestock population is increasingly being relegated to more marginal lands. Finding feed for the growing livestock population will become ever more difficult and the traditional option of grazing new areas is no longer available.

In the rainfed small-scale systems and on the large irrigation schemes livestock are an important component and livelihood strategy despite the small number per household. They provide additional sources of income and thus help to spread the risks associated with rainfed cropping. In the highlands they are a valuable source of soil nutrients and in fuelwood scare areas of fuel. In Sudan dung is not used as farmers believe they are a source of weeds (Kibreab, 1996).

The extensive livestock production systems are distinguished only by the inclusion of some rainfed crop production. The reliance on crop production may in fact change in both the short and long-term due to the high variability of rainfall. Over the past two decades many households have and are still making the transition from pastoralism to agro-pastoralism to sedentarized crop cultivation and vice versa as household and external conditions change. These changes in household production systems are the result of the massive losses in household and community livestock assets during the drought of the early 1980's exacerbated by the increasingly loss of wet season grazing areas and water resources from the big expansion of large-scale semi-mechanized farms during the 1980's and 90's. With the restoration of exports to Middle East livestock production makes a significant contribution to the agricultural GDP.

Data from the FAO Livestock Atlas for Africa are used to derived Map 14 and 15 to show the distribution of cattle, sheep and goats. Whilst the maps indicate that the Dinder National Park has no livestock it is known that in fact there are considerable incursions of livestock into the park. The high densities of cattle in the Ethiopian Highlands and low densities in the Lowlands are readily apparent. In the wooded Lowlands south of the Dinder Catchment the area is infested with tsetse fly and trypanosomiasis is very prevalent. In Sudan densities are relatively high in the higher rainfall areas of the southeast. Elsewhere the large areas of semi-mechanized farms and large-scale irrigation schemes largely preclude even moderate densities of cattle, although as indicated above livestock are an important livelihood strategy for tenant and labourer households in these schemes.

The distribution of sheep and goats are essentially reversed: with higher densities of sheep in the Ethiopian Highlands than the Ethiopian or Sudan Lowlands, with the picture reversed with respect to goats. Overall densities of sheep are nearly everywhere higher than goats. In Sudan they are the preferred animal for export to the Middle Eastern countries.

3.9. BIODIVERSITY

In the highland areas of the Blue Nile sub basin, farming and grazing practices have significantly altered the original flora so that only remnant vegetation now exists in only a few places. There have also been significant introduction of exotic species, which may be both useful to the farmers or they may be present as weeds. In the lower western area of the basin, extensive agriculture is practiced and in these areas flora has not been significantly altered like the highland areas.

A west-east transect of the upper course of the sub basin would show a wide range of potential faunal habitats ranging from tropical dry land savannah areas near the Sudanese border to montane vegetation in the eastern part of the basin.

Ethiopia occupies a unique position in the world with regard to plant and animal diversity. There is a high level of endemism within the country with 99 endemic animals and about 800 endemic plants. However, the ability of Ethiopia to maintain this high degree of inherent biodiversity is now under threat as human use moves insatiably into the few remaining areas. EWNHS (1996) has identified that, of the 16 endemic bird species within Ethiopia, half of these are still found in the upper course of the Blue Nile sub basin, of these two (the Ankober Serin and Harwood's Francolin) are categorized as vulnerable in the list of globally threatened species. Wild habitats are shrinking and apart from those savannah woodland areas in the northwest part of this upper course of the sub basin, or those areas that have tsetse fly infestation few habitats remain intact. Urgent action is needed to address this problem of shrinking habitat and biodiversity loss before extinctions occur.

3.9.1. National Park Area

No national park exists in the upper course of the Blue Nile Sub basin. The Dindir national park is located in the lower course of the sub basin, with the following basic features

Dinder National Park: - Dinder National Park is bordered by three States: in Sudan namely Sennar, Gadrife and the Blue Nile. The Park is bordered by Rahad River at latitude 12o26'N and longitude 35o 02'E, and then continues in a north western direction up to lat. 12o 42' N and long. 34o 48'E at Dinder River. The boundary continues again up to lat. 12o 32'N and long. 34o 32' E along Khor Kenana and finally the boundary slightly diverts to the southeast to lat. 11o55'N and long. 34o 44'E Occupies an area of 8,900 kilometres. The two seasonal rivers, Rahad and Dinder; water the Park during the rainy season. They descend from the Ethiopian highlands and flow in a north-westerly direction across the flat plain to empty their waters into the Blue Nile River. The Dinder River flows through the

middle of the Park. It starts to flow around the middle of June. It ceases flowing in November. The park preserves natural wildlife migration corridor between Sudan and Ethiopia. It is the last remaining wildlife sanctuary in the south-eastern clay plains. The park supports a population of tiang, reedbuck, waterbuck, bushbuck, orbit, roan antelope, warthog, buffalo, greater kudu and red fronted gazelle. These are the major herbivores. Other animals such as baboon and red hussar monkey are frequent. The major predators of the park are lion, striped hyena, spotted hyena and the jackal. Many birds are found in the park such as ostrich, marabu stork, clappertoni francolin, cattle egret, crowned crane, grey heron, sacred ibis, hooded vulture, pink backed pelican, bee-eaters, starling and guinea fowl. The annual reports on the park show continuous decline in the population size of nearly all species. There are many population pressures. (HCENR, UNDP, IUCN, 2000).

Major sources of impacts is the trespassing by nomads for grazing and firewood, fish bonds poisoning poaching and illegal hunting (World Bank, 2001)

3.10. MINERAL RESOURCES

3.10.1. Gold and Base Metals

The Precambrian rocks falling within the Blue Nile basin contain a significant proportion of greenstone rocks; these are ancient meta-sediments, marbles, and meta-volcanics having a low grade of metamorphism. The main green stone belt forms a broad swathe, about 20 to 50 kilometres wide, and orientated north south, which intersects the Abbay River along a strip which is East of Najo, and West of Gimbi. This suite of rocks contains gold, and other base metals, disseminated within minor quartz veins. To date; no vein deposits have been found that are large enough to sustain gold mines. The gold over geological time is eroded away and ends up as tiny grains in the alluvial sands of the Abbay flood plain, and older river terraces. The Abbay River does not carry much coarse or medium grained sand. Instead the alluvium comprises silt, very fine micaceous quartz sand, and channel lag gravels. Durable and heavy minerals, like gold and base metals tend to become incorporated into the channel lag gravels, where they form a loose, fine to medium grained, black sand-matrix, usually in pockets.

For a long time gold has been extracted from alluvium by the indigenous peoples that live next to the Abbay River and its major tributaries. The method of extraction is to sieve the channel lag gravels in order to concentrate the metallic rich sandy matrix. These matrix-fines are then panned to isolate the gold fraction. Every year the waters of the Abbay recede over a 3-month period, and it is during this period that panning is carried out. Annual flooding of the Abbay causes replenishment of the gold bearing sands as the channel lag deposits are re-distributed during maximum flow events.

The extent of the alluvial and primary gold resource in the Abbay Basin is unknown and unknowable. The Environmental Team working for the EDF/Scott Wilson Consortium, report that in the Assosa and Guba provinces alone there are 50,000 people who seasonally extract alluvial gold. This figure appears to be wildly exaggerated. The author saw only one location in the Border area where gold was being extracted, just downstream of the centerline.

In recent times the alluvial gold deposits of the Abbay Basin have attracted the attention of South African, Sudanese and local mining companies. For example JCI have a concession somewhere near Gimbi, and Sudanese financiers have prospective interests near Assosa, and the local company, ARDCO, are said to have obtained a gold concession in the Beles Valley. It would be prudent if the Ethiopian government were to stop issuing mining concessions for extraction of alluvial gold in the basin area of Border Dam. The

owners of these concessions would demand compensation for inundation of their concession areas.

Construction of Border dam would flood a considerable length of the Abbay River and side valleys. All these lengths of river contain alluvial gold, and therefore this renewable resource will be lost to the people living in these areas. It must also be noted that the Border dam will halt migration of alluvial gold downstream of Border, and this could also have long term detrimental affects on the casual alluvial diggers.

3.10.2. Marble

Minor outcrops of marble have been mapped in the reservoir area, but they are too small to be commercially viable. Significant resources of high quality marble are found in the Koncho area at the headwaters of the Border basin, but the quarry working areas are confined to elevated hills which are all well above the proposed reservoir full supply level (BPFR, Section 6, pg. 6-5 to 6-10).

3.11. MAJOR ENVIRONMENTAL ISSUES RELATED TO WATER

3.11.1. Overview

Agricultural soil loss and land degradation are important issues. The main area of sheet erosion is within the Ethiopian Highlands. Gulley erosion occurs in both Ethiopia and Sudan. On the large Semi-mechanized and small traditional farms the key soil degradation problem is nutrient mining. They are located on the clay plains north and south of the Blue Nile.

The main locations for sedimentation are the Roseires and Senner dams, and the irrigation canals within the Geizera-Managil and Rahad Irrigation Schemes. High suspended sediment loads affect pumps for irrigation and increase costs of water purification for domestic and industrial water supplies. Sedimentation is negatively affecting the wetlands of the Rahad and Dinder River systems, in turn affecting human and livestock water supplies and biodiversity.

3.11.2. Water Quality

Apart from high sediment loads, the water quality of all rivers that are distant from urban centres appears to be adequate for most uses. Lake Tana with a surface area of 3,100 square kilometres is the largest freshwater inland lake and remains an important regulating feature for the Blue Nile River at its head. The lake's water quality seems to be satisfactory and is used as a minor source of supply for the town of Bihar Dar. The remainder of the town's water supply is being pumped from shallow groundwater bores.

Several areas and cities in Sudan depend on the Nile system for their drinking water. The watershed erosion and heavy sediment movement during floods seasons cause high turbidity and suspended solids in the Nile River water. For example at Khartoum, the turbidity has tremendously increased during the last decade. It was increased from 5000 NTU to above 20,000 NTU during flood in 1999 to 2003. Water treatment plants at Khartoum abstracting raw water from River Nile have been affected by such heavy sediment load. Treatment plants being designed initially to treat raw water of maximum turbidity of 8000 NTU utilizing Alum salt as coagulant are now producing poor quality of water when maximum allowable dose of Alum (150 mg/l) is being utilized. Khartoum Water Corporation (KWC) has been applying many alternatives to overcome the problem of turbid water in piped water network.

The presence of sediment in the Blue Nile produces poor quality of water for domestic use with the following impacts: -

- Accumulation of sediments at the dead ends of water network, which encourages after growth of micro organisms, and hence affects the health of consumers.
- Clogging of pipe network and increasing the incidence of pipes burst and occurrence of cross connection pollutes drinking water. If chlorine is utilized for disinfections of such water of poor quality, chlorine oxidizes organic matter in water usually generating complex compounds leading to health hazards of consumers.
- Utilizing a polymer of organic nature for treating water during the flood season. High dose of polymer (more than 5 mg/l) was used by KWC during the flood seasons (1999-2002), Accumulation of polymer residual in water may cause serious health risk for the consumers, if it is utilized over a long period of time.
- Combination of inorganic salts are being utilized, (Alum + Poly Aluminium Chloride) producing better quality of water during flood season. However, the effects of both salts in combination over a long period of time have not being determined.

Historical records of water quality at the Mandaya dam site are not available. As part of the fieldwork for this study, single water quality samples were obtained from Abbay River at the Bure-Nekemte Bridge at the upper end of the potential Mandaya Reservoir and at the proposed Border dam site downstream. A sample was also taken of Beles River at Beles River Bridge (23 kilometres from Mankush). Physical and chemical parameters are shown in Table 4.6 along with a sample for Abbay at Karadobi for comparison.

These records are snapshots only. They necessarily cannot begin to describe water quality in flood conditions in July to September when most water is delivered. Having noted this, no pollution or nutrient level is out of the expected range. ((MEF, Section 4, Pg. 4-15) and Also refer to the table on Pg. 4-16).

3.11.3. Water-related diseases

The major concern is malaria which is increasing, is difficult to control, has potential to infect a vary large population in epidemic outbreaks. The other water related diseases are Schistosomiasis, Typhoid, Diarrhea, Helminthiasis, Leshimaniasis, Onch ocerchiasis.

3.11.4. Soil Erosion

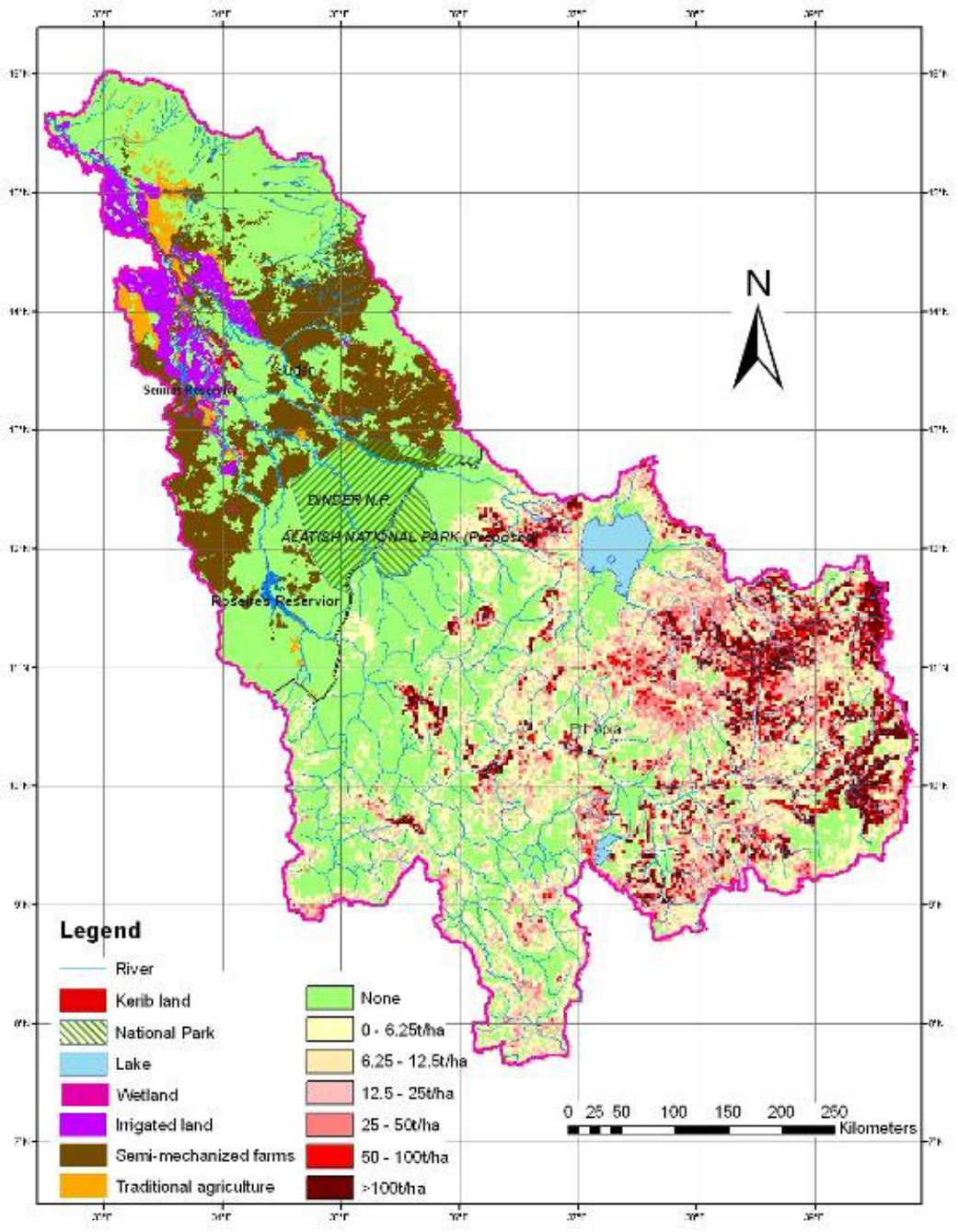
A key issue of soil degradation within the sub-basin is declining soil fertility, the immediate cause of which is soil nutrient "mining". Whilst some of the underlying causes may be nationally specific (e.g. land policy) the impact on the rural population of the Sub-basin is the same: declining livelihoods and increasing rates of poverty. For this reason it is considered a basin-wide issue. The locations of the various types and degrees of soil erosion and deposition within the Abbay-Blue Nile Sub-basin are shown in Figure 3.6.

Sheet erosion

- ***Key areas***: Most sheet erosion in the Sub-basin occurs in the Ethiopian Highlands. Some sheet erosion occurs within Sudan, mainly on and around the rock hills (Jebels), which have become devoid of vegetative cover. Most of this is deposited on the footslope and does not enter the drainage system. Some water induced soil movement also occurs on the flat clay plains, but given the poorly developed surface drainage system little sediment reaches the main rivers. Four main areas of high sheet erosion are found in the Abbay Basin. The steep slopes around Mount Choke in East and West Gojam stand out as a significant area with a high sheet erosion hazard. This is an area with high rainfall causing problems in developing physical soil conservation structures because of the problems of providing effective water disposal structures. The second widespread area of high erosion hazards occurs north and east of the Abbay River in the Lake Tana Basin. This area includes the steep cultivated slopes around Mounts Guna (South Gonder) and Molle (South Wello). A third more restricted area is found in the upper Jema sub-basin in South

Wello on the high hills north and west of Debre Birhan. A fourth area is found south of the Abbay and encompasses the upper and middle steep and cultivated slopes of the Middle Abbay Gorge Sub-basin in East Wellega. Two subsidiary areas with a high erosion hazard can be seen in the Upper Didessa Valley and along the escarpment hills to the west of Lake Tana in the upper Dinder and Beles valleys.

Figure 3.6: Blue Nile Sub-basin: Distribution of Soil Degradation and Sedimentation



Source: CRA Watershed report Abbay-Blue Nile

- ***Total soil eroded***: The total soil eroded within the landscape in the Abbay Basin is estimated to be 363.4 million tons per annum and that from cultivated land is

estimated to be 122.2 million tons per annum. Thus about 66 percent of soil being eroded is from non-cultivated land, i.e. mainly from communal grazing and settlement areas.

- ***Impacts on agricultural production***: The current annual crop grain production for the Abbay Basin is 4.35 million tons. The annual loss due to soil erosion as a proportion of total production is 0.6 percent in the Abbay Basin. However, after 10 years this rises to 6 percent and after 25 years to 15 percent of annual crop production.

Gully erosion

- ***Ethiopia***: Although some work has been undertaken on gully formation and extension (Billie & Dramis, 1993), (Shribrus Daba et al., 1993), there is no information on gully distribution, density, erosion rates and sediment delivery ratios. Very recent research by the Universities of Makelle, Ethiopia and KU Leuven, Belgium in Tigray (Nyssen, J et al., 2005) have provided information of gulley erosion rates, sediment yields and sediment delivery ratios in northern Ethiopia. They report that gullies were initiated by a variety of changes in environmental conditions: removal of vegetation between fields, Eucalyptus planting in valley bottoms and new road construction. Gullies followed a sigmoidal evolution in volume, with a rapid increase until the mid 1990's when the rate of growth declined to almost nothing. This has been due to the considerable development of soil conservation structures and communal area closures that have occurred since 2000. Thus, where soil conservation measures have been introduced and gullies are relatively stable they contribute approximately 5 percent to sediment load. Where there are no conservation measures the average rate is 32 percent.
- ***Sudan***: The main erosion problem in the Blue Nile Sub-basin is the gully erosion along the Blue Nile and Dinder Rivers producing kerib land. The plains are overlain with Vertisols (black cracking clays). The Vertisols develop very wide cracks during the dry season. At the onset of the rains water enters the cracks. Whilst the soils are covered with deep rooted vegetation there is no problem as roots take up any excess sub-soil water. However, once this vegetation is removed there is excess water in the subsoil and tunnels develop in the subsoil. These eventually collapse leaving an incipient gulley. These gradually extend back into the plain stripping the soil away from the underlying weathered rock of unconsolidated sediments, which are extremely soft and erodible. The weathered rock is quickly gullied. The Dinder is gullied for about 50 kilometres upstream from its confluence with the Blue Nile. The Rahad River does not appear to be affected except very locally near its confluence with the Blue Nile. However it is not as extensive nor has it gullied back to the same extent as it has along the Atbara. Most the kerib land along the Atbara has gullied upto 2.5 kilometres from the river, whilst along the Dinder it about 500 meters. It is possible that the Dinder is not as incised as the Atbara River. An interpretation of 2,000 Landsat TM imagery gave an estimate of 337,640 feddans (141,810 ha) of land that is affected. Some kerib land adjoins rainfed and some irrigated cropland. As no information is available on erosion rates it is difficult to estimate the impact on loss of cultivated land.

River bank erosion

- Possibly a bigger problem in terms of sediment delivery to the river is bank erosion, particularly along the Blue Nile. Much of it is a natural phenomenon caused by river meandering over flat flood plains and subject to a complex array of hydraulic factors. Along the Blue Nile bank material is mainly clay and silt.
- Human influences can alter the very delicate balance of hydraulic forces and set in chain accelerated bank erosion. Excavation of soil for brick making and building,

the removal of tree vegetation along the banks, different cropping patterns and dumping of material into the river can all causes accelerated bank erosion. A change from deep rooting fruit trees to shallow rooting bananas is reported to have caused accelerated bank erosion along the Blue Nile (Mekki Abdel Latif, 2005).

3.11.5. Soil Degradation and loss of agricultural productivity

A key issue of soil degradation within the Sub-basin is declining soil fertility, the immediate cause of which is soil nutrient "mining". Whilst some of the underlying causes may be nationally specific (e.g. land policy) the impact on the rural population of the Sub-basin is the same: declining livelihoods and increasing rates of poverty. For this reason it is considered a basin-wide issue.

- ***Ethiopia Highlands***: In the Ethiopian Highlands the immediate causes are the burning of dung, removal of grain and soil erosion. Within the Abbay Basin some 1,751,600 tons of dung collected from crop fields (about 40% of total dung produced) and some 3,207,046 tons of crop residues were burnt as household fuel. This resulted in a loss of some 44,060 tons of N and 9,250 tons of P. An estimated 515,626 tons of grain is removed from cropland annually. This would account for an additional 10,292 tons of N and 2,058 tons of P being removed. Using Barber's (1983) estimated annual nutrient losses from different soil erosion rates losses of available N would be approximately 7,058 tons and 1,233 tons of available P on 7.4 million ha of cultivated land losing 101.8 million tons of soil annually. The net annual loss of available N from cultivated land of approximately 37,640 tons or 5.1 kgs/ha of available N. The rate of loss of nutrients is nearly 2.5 times the rate of loss occurring in the Tekeze Basin, confirming the work of other workers (e.g. Desta et al, 1999, World Bank, 2004) that soil nutrient breaches and decline in soil nutrient status is major problem in the higher rainfall areas. It is noticeable that in contrast to the Tekeze Sub-basin where the greatest losses are from burning dung and residues, losses from grain removal make the largest contribution to total losses in the Abbay Basin.
- ***Sudan***: **Semi-mechanized Farms**: Within the Abbay-Blue Nile Basin in Sudan, the Africover mapping of rainfed cropping with large to medium size fields suggest that there are approximately 7.454 million feddans (3.131 million ha) of large to medium semi-mechanized farms (SMF). However, a proportion of this land has gone out of production and in some cases has been abandoned. The FAO/WFP crop survey for 2005 estimated cereal production from the SMF Sector for Gederef State as 589,000 tons. Average yields are 0.36 tons per ha, which suggests that approximately 1.636 million hectares were under crops. The Africover estimate for land under SMF's in Gederef State (in 2000) was 3.1 million hectares. This suggests that in 2005 (a good rainfall year with high sorghum prices) only 50 percent of the SMF land was cropped.During the 1990's the area harvested on the SMF's contracted by 2.4 percent per annum whilst yields declined even further by 5.1 percent per annum (World Bank, 2005). This resulted in a decline of GDP from SMF sector of 7 percent. These reductions in yield are partly due to a decline in soil fertility in the absence of fallowing or fertilizer application. There has also been a decline in productivity partly due to the build-up of weeds (including striga) and partly to an expansion onto marginal land resulting in destruction of soil structure, soil erosion and soil fertility. The removal of natural predators (snakes and cats) has led to an increase in rats and other vermin. Insect eating birds have disappeared leading to a big increase in the use of insecticides and insect damage. With only approximately 50 percent of the land being cropped and yields declining at just over 5 percent per annum this represents a substantial waste of natural resources.

- ***Sudan*: Small-scale Traditional Farm Sector**: There are approximately 1,129,240 feddans (474,282 ha) of small-scale rainfed cropping. Spatial expansion of the traditional sector is severely constrained by the SMF's and the State Forest reserves. This is resulting in shortening fallow periods and thus declining crop yields. Sorghum yields in the traditional crop sector have declined in line with those in the SMF sector and are currently about 0.4 tons/ha, down from about 0.9 tons/ha in the 1970's.

3.11.6. Dam and Reservoir Siltation

The most important off-site negative impacts of soil erosion are sedimentation of streams and water storage infrastructures. High sediment loads in streams pollute water supplies, and cause siltation of dams, reservoirs, water-harvesting structures and irrigation canals, reducing their effective capacities, shortening their service lives, and incurring high maintenance cost, at national, community and individual levels.

The two main dams in the Blue Nile Basin are Roseires completed in 1966 with a storage capacity of 2.4 cubic kilometres and the Sennar completed in 1925 with a capacity of 0.7 cubic kilometres. The hydro-electric facilities at each of the dams have installed capacities of 250 MW and 15 MW at Roseires and Sennar respectively. Both dams are affected by siltation. The Sudan Ministry of Irrigation and Water Resources report that sedimentation in the Roseires Dam rose from 300 million m^3 in 1970 to 1,264 million m^3 in 2000 resulting in a loss of 38.3 percent of its designed capacity. Sedimentation is now reducing the live storage. As well as the loss of storage impact on crop area that can be irrigated there is also a reduction of hydro power generation. In addition, there is damage to turbine blades caused by the heavy suspended sediment. Because the dam gates have to be kept open and turbines closed down during the high flood peak to avoid excessive siltation there are corresponding losses of irrigation water and hydro power. In 1991 some 9.78 million m^3 of silt entered the irrigation canal system of which 62 percent is deposited in the canals with the remainder being deposited in the fields (World Bank, 2002). Desilting of the 17,244 kilometres of irrigation and 10,650 kilometres of drainage canals in the Gezira scheme alone is an enormous and expensive operation estimated in 1997-98 to cost SD 1,366.8 million. High sediment loads in the rivers used as sources for domestic and industrial water supplies cause problems and additional expenditures for water treatment plants.

3.11.7. Deforestation and degradation of woody biomass

Deforestation and degradation are two different processes that cannot be directly compared. Clearing woody biomass for agriculture is a sudden and complete process. The "degradation" of woody biomass stocks caused by wood removal for fuelwood and charcoal is gradual and partial. The conversion of forest land to crop land and then grazing land has implications for hydrology. Although there is much debate at present about the role of forest land in affecting the volume of flow, due to evapotranspiration by trees, there are clear implications of forest loss upon the moderation of stream flow, especially the storage of water from the rainy season into the dry season. Hence, linked to the loss of forest are trends towards higher floods and lower dry season flows.

- ***Ethiopian Highlands***: In the northern Highlands in the Abbay-Blue Nile Basin there is little or no potential for expansion of agriculture except in very local situations. However, south of the Abbay River in Oromiya Region there is some potential for agricultural expansion and this taking place into areas covered by shrubland, woodland and forest. In the western lowlands, mainly encompassing Beneshangul-Gumuz Region there remains considerable areas for agricultural expansion. Hitherto settlement and expansion of agriculture in these areas have been

constrained by the presence of human diseases (particularly malaria) and cattle diseases (particularly trypanosomiasis). In the late 1970's a large-scale mechanized farm of 96,000 ha was cleared and developed in the lower Didessa and Anger Valleys. It experienced continued declining yields and following the fall of the Derg it was abandoned. Such was the efficiency of the clearing of the original woodland that even after 10 years it remains grassland with no woody vegetation. Since 1991 a new voluntary resettlement programme is being implemented in Oromiya region and to a much lesser extent in Amhara region. The main areas for resettlement are in the Didessa and Anger valleys. The Pawi scheme has also continued to receive settlers. In BSG Region some 128,000 ha have been allocated for medium-large scale agricultural investment. There has been no monitoring of landcover changes in response to the new resettlement and agricultural investment programmes. The WBISPP attempted to forecast future landcover changes resulting from natural population increase in Oromiya and BSG Regions, using 1990 and 2000 as the base years respectively (Oromiya landcover was mapped using 1989 landsat imagery and BSG using 2000 imagery). Because of the ease of clearing, the landcover change model assumed that potentially arable land with shrubland would be cleared first, followed by woodland and then forest.

- By 2015 some 56 percent of forests, 61 percent of woodlands and 43 percent of shrublands will have been cleared for agriculture and settlement as a result of natural population increase. No account is taken of resettlement and migration, or of expansion of large-medium scale commercial agriculture.
- In BSG given its low population densities the rates of clearing are much lower and only some 5 percent of Acacia-Commifera woodland and 27 percent of shrubland are estimated to be cleared for agricultural expansion due to natural population increase. Again no account is taken of expansion of agriculture for irrigation (e.g. the Beles scheme), resettlement for rainfed agriculture or large-medium scale commercial agriculture. Removal of wood in excess of the sustainable yield (after accounting for removal of dead wood and fallen branches, leaves and twigs) leads to declining stocks, which in turn leads to declining yields and so to progressive degradation of woody biomass. Note that this does not include wood removal for new house construction and current house maintenance. The pattern of weredas consuming in excess of sustainable yield mirrors that of the weredas with high proportions of their area experiencing moderate to severe soil erosion.
- Most weredas that are consuming more wood than the sustainable yield are located in the highlands a clear reflection of the low population densities in the lowlands. The map shows the current rates of consumption and supply. In practice there is substantial development of on-farm trees in many areas of the higher rainfall areas of the highlands. However, in the drier areas of the eastern highlands development of on-farm tree production has been slower, partly because of the more difficult tree planting environment and partly because of the lack of markets for construction poles.
- ***Sudan***: **Semi-mechanized farms**: Substantial areas in the Abbay-Blue Nile Sub-basin have been cleared to make way for the Semi-mechanized farms. These now cover some 1.32 million hectare. This was formerly woodland and shrubland. The clearing has been particularly severe in the west of the Blue Nile and towards the Ingessena Hills. Map 19 indicates the encroachment of these farms towards the Ingesenna Hills (near to Bau). An unknown area of Semi-mechanized Farms is abandoned each year because of falling crop yields. Because the land is totally cleared of all tree cover and combined with years of constant harrowing and disking the tree seed bank in the soil has been completely destroyed. The

abandoned areas are a waste land with no tree cover. The quality of the grass cover is very poor because of the very low levels of soil fertility.

- The remaining woodlands are under severe threat from fuelwood harvesting and charcoal production. The latter is mainly for export to the urban centres as far away as Khartoum. It can be seen on Map 19 that there are large areas of grassland (mainly fallow land with scattered cultivation) where the tree cover has been removed. In addition to the local population the area has received considerable numbers of IDP's. Collecting fire wood and charcoal production has become an important livelihood strategy in the area.
- The Fast Track assessment provides data for Bau Locality where there are 12 weekly markets with weekly sales of 800 m^3 at each market, 1,000 m^3 of charcoal per market, 50 m^3 for furniture and 100 m^3 for lime processing. This adds up to 22,900 meter per week across all markets or some 1.15 million cubic meter a year. Glen (1996) estimated the wood stocking density around Roseires at 5.04 meter per hectare. This would indicate some 224,180 ha of woodland are being cleared annually.

3.11.8. Degradation of Herbaceous Biomass

- ***Ethiopia***: An indicator of overgrazing can be determined by examining the livestock feed energy balance at the wereda level. Energy requirements of all livestock are computed using energy requirements for maintenance, draught power and lactation, and balanced against estimates of energy supply from natural pastures and crop residues (WBISPP/MARD, 2003). The main areas of livestock feed deficits are the upper slopes of Mount Choke in East and West Gojam, the eastern weredas in North Shewa and South Wello, with more isolated areas in East and West Wellega. These areas are largely coincident with the areas of high soil erosion hazard.

- ***Sudan***: The loss of pasture land due to the expansion of the Semi-mechanized farms has put additional grazing pressure on the remaining rangelands. These have become severely degraded due to overgrazing. This has been exacerbated over the past two decades by declining rainfall. Rangeland degradation has taken the form an increase in unpalatable species or species of low forage quality. This in turn reinforces overgrazing. The Ministry of Agriculture now estimate that 50 percent of the rangelands are degraded. There is some evidence of this already occurring in the sub-basin, with the Sor hydro-power plant (near Metu) becoming more seasonal in its power generation and the Baro River at Gambela having more frequent high floods which are affecting long-established villages and low flows which allow the river to be forded in the dry season. Further, as forest in the upper sub-basin is replaced by farm land sediment loads are reported to be increasing with their implications for dam development in the upper sub-basin and for river bed levels and channel overflow in the lower sub-basin.

3.11.9. Extent and Degradation of Wetlands

- ***Ethiopia***: The WBISPP landcover map covering the Abbay Basin estimates the area of permanent swamp as 49,943 hectare and of seasonal swamp 59,250 hectare. Much of these wetlands are located in the highlands. The most extensive are found around the shores of Lake Tana, around the shore of Finchaa reservoir and in the headwaters of the Dabus River. However, across the highlands are hundreds of small poorly drained valley bottoms. A survey and inventory of wetlands in the Amahra Region (Enyew Adgo, 2005) found that many of these wetlands were under

threat due to land degradation and sedimentation, and the lack of bylaws and community rules regarding their use. Many are used for dry season grazing, hay production, thatching grass and grass mats (cheffe). In the area between Gimbe and Nejo within the Dabus and Abbay Sub-basins many wetlands are used for cultivation. Because of severe degradation on the upland granite soils the wetlands have become vital elements in sustaining peoples' livelihoods. However, in some areas there have been reports of over-draining of these wetlands leading to the destruction of their delicate hydrography and loss of value for cultivation (Wood, 2000).

- ***Sudan***: The main wetlands in the Blue Nile Sub-basin are located on and between the Dinder and Rahad Rivers and are locally known as "maya'as". These are depressions along and between the rivers. The area way from the river is covered with fossil streams and rivers. The depressions are abandoned meanders which have formed forming "ox-bow" lakes. These lakes however are ephemeral as they gradually silt up, fill with swamp vegetation and then as they silt up dry out. The vast majority of these wetlands are found outside the Dinder National park and most are within large to medium semi-mechanized farms. The area shown in map 53 is largely covered with large rainfed farms. There appears to be very few of these wetlands within the park. Thus the greatest danger to the Dinder-Rahad wetlands are from agriculture.This area is frequently subject to severe flooding. Wetlands have the capacity to "buffers" flood peaks allowing the flow to pass through the system more easily. Many of the Dinder-Rahad wetlands are now cut-off from the main river systems by the expansion of large-scale rainfed agriculture. It is not known how far this is responsible for the recent flooding and far they are due to silting up of small lakes and ponds from sediment derived from the Ethiopian highlands. However, it a subject that requires immediate and detailed investigation.

3.11.10. Soil Degradation with no Watershed Management Programme

Expansion of cropped land will exacerbate soil degradation in the absence of a watershed management programme.

Ethiopia: In the Abbay Sub-basin the main expansion of cropland will take place in the two Highland domains with High Agricultural Potential and Poor market access and in the domain with Medium Agricultural Potential and Poor market access. (figure 10) One Lowland Domain will also see a considerable expansion in cropland: the domain with Medium Agricultural Potential and poor market access. After ten years all Highland domains see a decline in the rate of expansion as weredas reached their population support capacities. The total expansion of cropland within the Sub-basin by the year 2025 is estimated to be 1.63 million ha or approximately 22 percent of the current area. Because inter-Regional resettlement is currently not permitted the potential for cropland expansion in the Lowlands is not realized. The additional annual soil erosion by the year 2025 occasioned by the expansion of cropland is estimated to be 17.7 million tons or an increase of 17.4 percent of the current annual loss

3.11.11. Loss of biodiversity

- ***Dinder National Park***: This Park has a high level of biodiversity with over 160 species of birds, 27 species of large mammals and unknown number of small mammals. It comprises the last extensive tract of woodland in eastern Sudan. Its importance to conservation can be summarized as follows (ArabMAB, 2006):
- The proximity of the Park to the desert and semi-desert makes it an important buffer zone for the vegetation cover of central Africa in addition to its significance in providing genetic material for the rehabilitation in the semi-arid and arid areas.

- The Park is an important watershed area protecting the most important feeders of the Blue Nile, the Dinder and Rahad Rivers.
- The Park, together with the south-western corner of the Ethiopian Plateau make a complete Ecosystem for wild animals, for which the Park is the dry season habitat for migratory species.
- The Park supports a high diversity of fauna and flora, including such animals of international conservation importance as the African elephant, African buffalo and the lion.

There are three groups of people who have an interest in the park.

(1) The first is the original inhabitants of the areas - a small group of Maganu people who continue to live in the south-eastern part. This community has a unique culture that needs to be preserved. They depend on subsistence farming in the rainy season and supplement their diet by collecting fruits and wild honey. In the dry season they move to the Dinder for fishing.

(2) The second group are pastoralists and agro-pastoralists who enter the Park in the Dry Season looking for forage and water because much their rangeland has been converted into semi-mechanized farms. Included in this group is the Um Barrarow or Falata who use the Park in the dry season along the Dinder River and move into Ethiopia during the wet season. They burn the tall grasses in the dry season to make green grass available, but in doing so eliminate susceptible herbs and shrubs.

(3) Around the Park are a considerable number of Internally Displaced Peoples taking refuge from the war in Dafur in the 1970's and are settled along the Dinder ands Rahad rivers and enter the Park for fishing, fuelwood and honey collection but also for illegal hunting and present the most serious threat to the wildlife. It is estimated that 100,000 people live around the park in 36 villages.

- ***The Maya'a***: The Dinder and the Rahad Rivers and their tributaries drain the Park. They rise in the Ethiopian Highlands and are highly seasonal almost drying out in the dry season. Due to the abrupt change in gradient the rivers meandering a large number of cut-off meanders have been formed locally called Maya'as. They are generally flat and cover an area some 0.16 to 4.5 sqaure kilometer. Rain and flood water fill them during the rainy season. The maya'as provides a valuable source of water and forage for domestic livestock and wildlife, as well as unique habits rich in biodiversity. Under natural conditions there is a constant evolutionary sequence of the formation of young maya'as that are deeper with clear water. Gradually they pass through stages of becoming gradually silted up. Over long periods of time with the meandering new maya'as are being formed. The spectrum runs from young productive maya'as to old non-productive dry ones. With the accelerated erosion in the Ethiopian Highlands this gradual and long term evolutionary process has been disturbed because increased flood peaks and high sediment loads. The area is now subject to annual flooding and many of the Maya'as are becoming silted up with a consequent loss of habitat biodiversity and forage productivity.
- ***Alatish Regional Park***: In Ethiopia the Amhara regional Government has proposed to develop the Alatish Regional Park in Quara wereda of North Gonder Zone, almost opposite the Dinder national Park in the Sudan. The area represents the Sudan-Guinea Biome. The park has been gazetted as a Regional Park and demarcated. However, the Park lacks national legislation and international recognition (Cherie Enawgaw et al., 2006). The Park covers an area of 2,666 sqaure kilometer to the north of the Dinder River, which forms its southern boundary, and to the south of the Gelegu River that forms its northern boundary. The Alatish and other ephemeral streams drain the central area. Its altitude ranges from 500 to 900 masl. The main vegetation is woodland, shrubland and lowland bamboo thicket. Studies

so far have revealed that the Park contains 48 mammal species and 180 bird species. It contains such endangered species as Loxodonta africana, Panthera pardus and Panthera leo. The area is intact with no permanent settlement, although Fellata pastoralists enter the Park in the dry season with over 10,000 head of livestock. The northern and eastern sides have a 2 kilometres buffer zone, but the southern boundary has no buffer zone as it border Beneshangul-Gumuz regional State. The Gumuz people have settled to the south of the Park and practice poaching and fishing along the Dinder River. Settlement is increasing and agriculture expanding along the northern boundary and numbers are being swelled by migrants from other parts of Amhara region. People enter the Park area to collect honey, gums and resins. There is an urgent need to collaborate with the Beneshangul-Gumuz Regional government and with the Government of Sudan to secure the area. The Ethiopian Wildlife Conservation Organization has strongly recommended that the Alatish Park been proclaimed a National park and that in the future it should form part of a Transboundary Park with the Dinder National Park. There is also an urgent need to develop a park management plan in participation with local communities.

3.12. LOCAL GEOLOGY AND GEOMORPHOLOGY

3.12.1. Local Geomorphology

Border dam site is situated some 30 kilometres downstream of the Abbay / Beles confluence. After the confluence the Abbay flows due north for 15 kilometres before turning sharply towards the west, from this turn the river traverses an area of mountainous terrain with peaks rising from river level at 490 meter up to elevation 1850 meter. These mountains are the topographic expression of a complex intrusion of granite, granitic gneiss, and granodiorite gneiss. Typically the mountains are dome shaped with concave slopes extending down to the river. The mountain summits and upper slopes are often formed by large exfoliated domes of granite or gneiss. Where the Abbay River crosses these granitic rocks the valley becomes quite narrow and incised with a rocky river bed and frequent rapids, indicative of relatively fast flow and only shallow accumulation of alluvium. The geomorphologic setting and the optimum position of the Border site are shown on Drawing B5. As can be seen from this map: immediately upstream of the dam centre line the river valley opens up dramatically into a wide open plain, with average slopes of 1 in 25 to 1 in 50. This pediment slope is underlain by relatively weaker basement rocks comprising marble, schist, meta-volcanic greenstone, and biotite gneiss, etc.

This contrast in morphology between the two differing rock formations ensures a relatively narrow valley for the dam on granitic foundation, with a wide open valley upstream of the dam, ensuring high storage potential. This combination of morphological factors determines the favourable characteristics of the Border dam site.

3.12.2. Local Geological Formations and Petrography

Geological mapping at the site confirmed the existence of the two broad geological formations divisions; namely the Granite /Granite Gneiss Formation and the Biotite Schist / Marble Formations. The latter formation presents a significantly weaker rock mass than the former, and therefore needs to be avoided as a foundation rock for the dam. The boundary of the 2 formations on the left side of the river section is at WP45, at co-ordinates: 728458 m easting, 1240146 m northing. The dam founding area should be entirely west of this point.

3.12.3. Granite / Gneissic Granite Formation

The granitic rock found at the border site corresponds to the generalized description given in Memoir 17 (see section 4.2 above). Several samples of granitic and granodiorite rock were taken close to the centreline and submitted to the Geological Survey for petrographic analysis (see Appendix 1 for results). The three thin sections, from way-points 1, 43, and 44. All three thin sections confirm that the rock is granodiorite or quartz-syenite in composition, with significant quartz content, suggesting an igneous intrusion borderline between true granite and intermediate type rock. The typical composition indicated by the 3 thins sections is the following:

- Potassium feldspar 35 to 40%.
- Plagioclase feldspar 16 to 19%.
- Quartz 8 to 25%.
- Hornblende 0 to 18%
- Biotite 0 to 10%
- Others 7 to 17% mainly sphene, epidote, and opaques, minor garnet.

The petrologist's report identifies these rocks as gneisses due to their foliation and presence of garnet and hornblende. However field evidence is conclusive that these gneisses are part of a regional intrusive body, as xenoliths and 'rafts, of older country rock are commonly seen. Therefore the rock is properly called a gneissic granite, or gneissic granodiorite, or gneissic quartz-syenite depending on relative proportions of quartz, K-Feldspar, and Na-Feldspar. The presence of foliation and metamorphic minerals is indication of syn-tectonic and post-tectonic deformation. For engineering purposes, such as in this report, these rocks are simply termed granite or gneissic granite.

The typical rock mass condition of the gneissic granite, such as often seen in the scoured river section is as follows: the rock is unweathered to slightly weathered, and hard to extremely hard with variable foliation, sometimes the foliation is dispersed and the rock is geomechanically massive with estimated UCS in the range 150 to 250 MPa. Some times the foliation is well developed with high concentration of biotite; these rocks have estimated UCS in the range of 100 to 200 MPa, with some degree of strength anisotropy.

At all occurrences the foliation is oblique to the river bed, having strike of 0500, dipping on average 850 to the north-west, this is a favourable orientation in respect of foundation conditions.

Three joint sets are commonly developed; the main set 1 is parallel to the foliation (320/850). The secondary Set 3, orthogonal joints are orientated at (045/800). Set 3 joints corresponds to a population of sub- horizontal stress relief joints, caused by unloading, their average orientation is (165/050). These main three sets define small to large rectangular blocks, with 2 vertical and one horizontal axis's. The long axis defined by set 2, the short axis by set 1, and intermediate axis by set 3. In the river section joint spacing is very variable due to the local influence of minor faults, xenoliths, degree of foliation etc., but on average the block size, defined by the three intersecting sets, is in the range of 0.1 to $1m^3$.

Many random joints are also present, they seem to define 4 or 5 sub sets that are only locally developed, some appear to be shear joints having dips of 40 to 65 degrees towards the South East hemisphere, and other sub- sets are vertical. Discontinuity data is provided in Appendix 2 to this report, "DIPS" software was used to plot angular data.

Within unweathered rock masses the rock mass quality is not constant but influenced by macroscopic features such as granite dykes, aplite dykes, basic dykes, pegmatite veins, quartz veins, minor faults and shears, etc., these features are often quite random in orientation. Such features may be very numerous in some outcrops but absent in others.

Away from the river section outcrops are only found as exfoliated domes and pavements in the steeper mountain slopes and on mountain crests. These outcrops give the impression of almost flawless rock, but this is a deceptive and biased sample as it is possible that adjacent zones of weaker rock are not exposed.

3.12.4. Biotite Schist /Marble Formation

Biotite Schist and Other Schist Rock Masses: The unweathered rock is grey or black with shiny mica flakes. The grain size of the rock is medium, occasionally fine. The schist could be described as psammitic-schist meaning that the schistosity surfaces, formed by mica concentration, are not fully developed, but rather broken up by asperities corresponding to the coarser grains of feldspar, garnet and quartz. Nevertheless the rock does tend to split into thin slabs due to separation along preferential parting planes. The petrography of two different schists sampled near the dam, at way-point 38, is given in the thin section report. The composition of these rocks is summarised as follows: Feldspar 7 to 27%.; Garnet 18 to 20%; Quartz 0 to 10%.; Hornblende 0 to 69%; Mica 5 to 39%; Others 4 to 7% mainly opaques, chlorite.

This big variation in petrology is explained by the heterogenic nature of this rock mass as the formation is comprised of metamorphosed volcanic and sedimentary rock.

Outcrops of this rock mass type are quite localised along the banks of the river, due to the lower durability of the rock. The typical rock mass condition, as seen in the river section is as follows: the rock is slightly too moderately weathered and hard with variable schistosity. The rock is geomechanically fissile with estimated UCS in the range 50 to 150 MPa, depending on variable mineralogy. Often the schistosity is oblique to the river bed (strike 0550), and dipping 40 to 700 to the North West, sometimes there are developed isoclinal folds with axial planes parallel to the regional foliation. The variability of the dip of the schistosity does imply the existence of large scale folds also

One joint set is dominant, that one being parallel to the schistosity, such joints are smooth and continuous with soft mineralized filling. Other joints and fractures tend to be randomly orientated.

Joint spacing is very variable due to the local influence of and frequent changes in lithology, such as: greenstone metavolcanic, meta-quartzite, amphibolite gneiss, and actinolite tremolite schist. In general however, all these variant rock types tend to break up into narrow slithers and slabs of rock, say 1 to 10 cm thick. The rock mass condition is very erratic due to the influence of macroscopic features such as described previously, in the granitic rock masses.

Away from the river section outcrops of biotite schist are not found as they are deeply weathered and covered by colluvium and silt.

Marble Rock Masses: Beautiful, coarse, crystalline pink, green and white marbles form mappable units within the meta-sedimentary/meta-volcanic complex. The typical rock, when it is unweathered consists of crystalline calcite with crystal size in the range of 1 to 10mm diameter. Traces of other dark minerals are sometimes present. Inclusions of contorted and isoclinal folded green calc-silicate rocks are often enclosed in the marble, but essentially the rock is hard and homogenous. A weak foliation may be defined by the long axis of calcite crystals. The petrography of the marble sampled near the dam, is given in Appendix 1. The petrology of the marble, from way-points 37 (two samples of different colour) and 42 can be summarised as follows:

Calcite 84 to 90% (no dolomite)

Chlorite 1 to 8%

Other minerals trace to 4%

These are high quality marbles. They are erroneously described as schistose marbles in the petrologist's report, because in the field, they display no tendency to split and are quite homogenic. Some weak fabric may be developed due to alignment of c-axis of calcite crystals.

Outcrops of this rock mass type are quite localised along the banks of the river. The typical rock mass condition is as follows: the rock is unweathered and massive with bright white or pink, surface colour (no metallic surface patina like other rock types). The rock is hard with estimated UCS in the range 100 to 150 MPa

Often the marble appears to be unjointed, but in weathered rock masses at higher elevations above the river, vertical sets are developed parallel to the 0550 striking regional foliation. These joints are often widely separated due to karst weathering phenomena. Other joints and fractures tend to be randomly orientated, and these also form preferential solution paths.

Joint sets are often absent in the marble rock mass owing to its tendency to deform as a ductile, or plastic mass. Always the marble rock mass is broken up into small 'windows' due to complex multi-episodic pegmatite intrusions. These small intrusive bodies have random orientation, they tend to be black due to patina development, and they stand proud of the marble due to the differential solubility of the differing rock types.

Away from the river section outcrops of marble are uncommon but may occur sporadically along minor stream courses.

4. HYDROLOGY AND WATER INFRASTRUCTURE

4.1. SURFACE HYDROLOGY

4.1.1. Watershed physiography

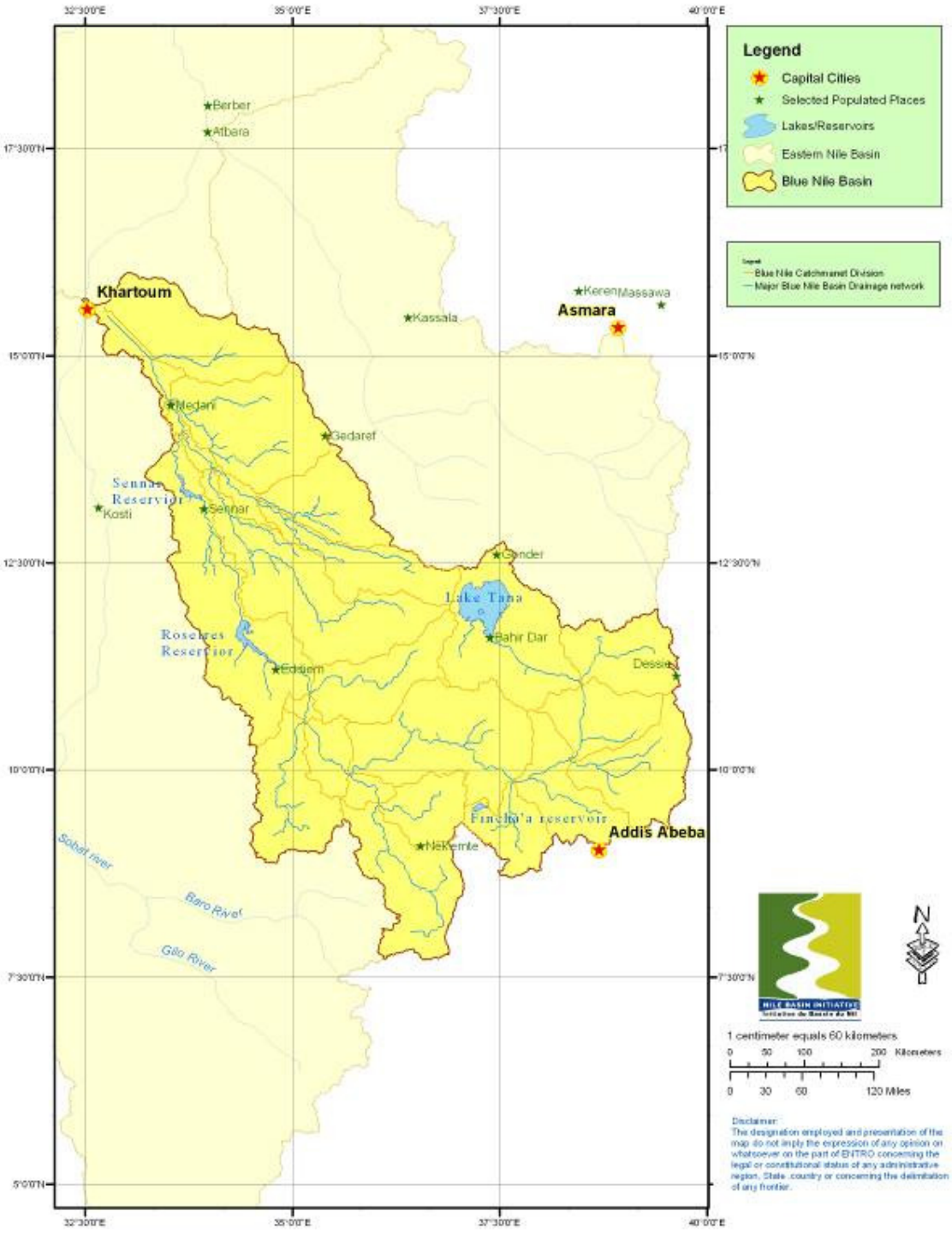
The Gelgel Abbay, one of the major tributaries of Lake Tana, (MPFR, Section 4, pg. 41) is believed to be the start of Blue Nile. "Gelgel Abbay" literally equivalent to little Abbay, starts in the highland plateaus of Gojjam flowing in a general north direction to Lake Tana. The major course of the Blue Nile starts at the outflow of Lake Tana at Bihar Dar. Blue Nile flows in a general south direction on medium altitude (1,800 masl) plateau for some 30 kilometres to Tiss Esat (water that smokes), where, it is intercepted by a 50 metre deep fall, usually known as Tiss Esat Fall. Thereafter it enters the Abbay/Blue Nile gorge.

The Blue Nile drains the Gojjam highlands (part of the Central highland plateaus of Ethiopia) in its right bank and the North Gondar, South Wollo and North Showa highland plateaus (also part of the central highland plateaus of Ethiopia) in its left bank. The Blue Nile after entering the gorge, flows in a clockwise spiral and in a general south direction, collecting runoff from major tributaries such as Beshilo, Walaka, and Jemma on the left bank and the Abbaya, Suha, and Muga on its right bank.

From the Addis-Bihar Dar highway bridge the Blue Nile flows in a general westerly direction following the same clockwise direction and collects runoff from the west Showa and Wollega highland plateaus (part of the western highland plateaus of Ethiopia) on its left bank through major tributaries such as Muger, Fincha, Angar, Deddessa, and Dabus and on its right bank collecting runoff from the Gojjam highland plateaus (part of the Central and western highland plateaus of Ethiopia) through major tributaries such as Yeda, Chemoga, Birr, Fettam, Dura and Beles. From Lake Tana to the Ethio-Sudan border the Blue Nile traverses a total distance of about 1,000 kilometres with an average river bed slope of 2%.

Downstream of the border, the Blue Nile is intercepted by the Rosaries reservoir after traversing some 100 kilometres in to the Sudanese land. No major tributaries join the system in this reach. Downstream of the Rosaries dam is the Sennar dam which is located on the main stem of the system. Two major tributaries entering the system downstream of the Sennar reservoir are the Dinder and Rahad, both of which originate from the north western highland plateaus of Gondar in Ethiopia. The Blue Nile forms a confluence with the White Nile at Khartoum to create the main Nile system.

Figure 4.1: Watershed morphology, major torrents and river flow networks of the sub basin



Source: ENTRO OSI Database

4.1.2. Catchments

The sub-basin is divided into 10 3rd order catchments and 103 6th order catchments using the Pfafstetter system (Table 4.1 and Figure 4.3). This system is based on the topology of the drainage network and the drainage area (Verdin, 1997). The source of the data is the USGS/EROS gtopo30 HYDRO1k data set published by UNEP/DEWA/Grid.

Table 4.1: Blue Nile sub-basin: Pfafstetter 3rd Order Catchments

3rd Order Catchment	Area in square kilometres	% of total Sub-basin area
Lower Blue Nile	42,860	14%
Dinder-Rahad	62,011	20%
Dabus	14,488	5%
Lower Abbay	5,530	2%
Didessa	29,247	9%
Middle Abbay	47,199	15%
Durame	15,409	5%
Beshilo	47,037	15%
Upper Blue Nile	33,804	11%
Beles	13,963	4%
Sub-basin	**311,548**	

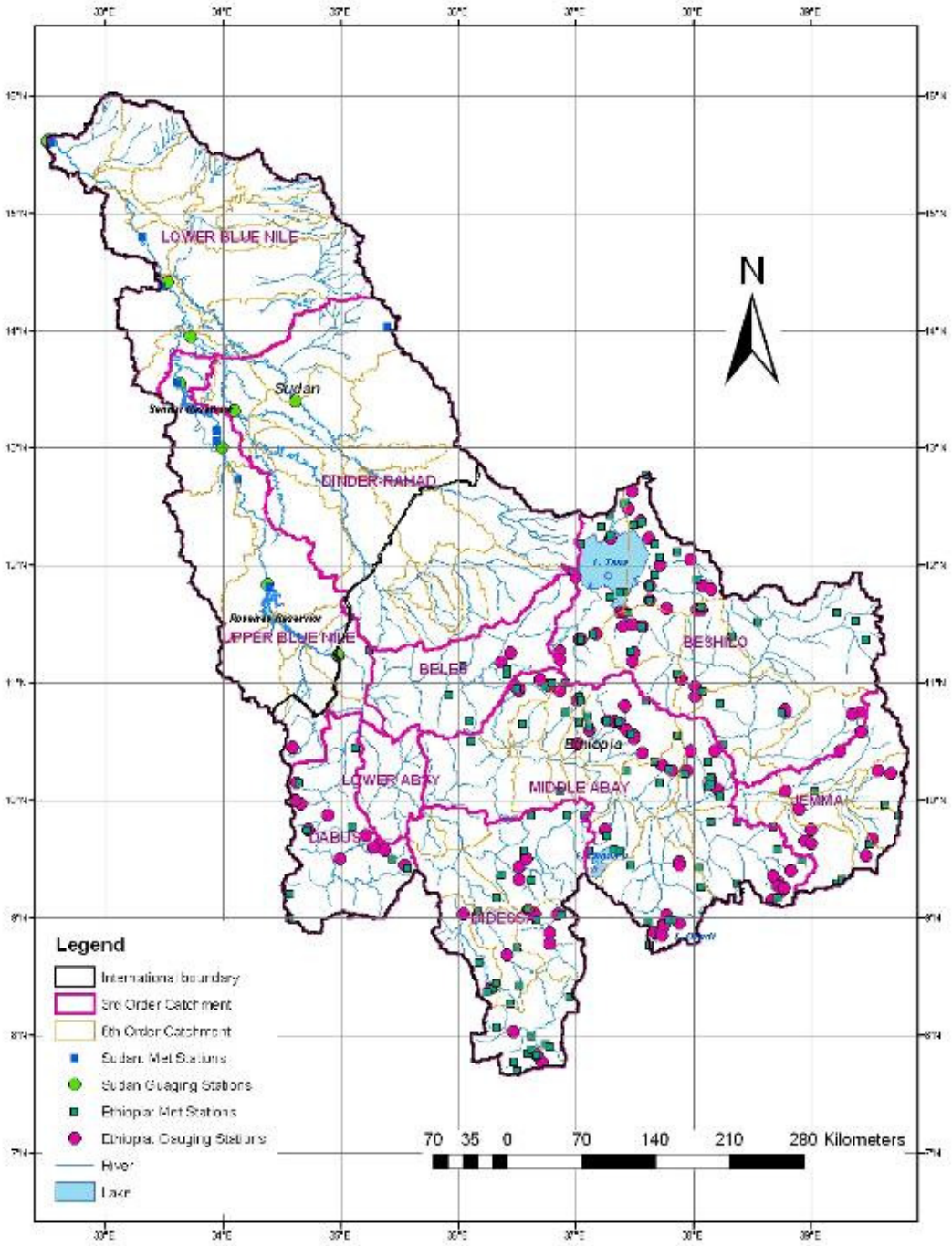
Source: Basin boundaries: USGS/gtopo30/HYDRO30

4.2. RUNOFF

4.2.1. The Lake Tana Watershed

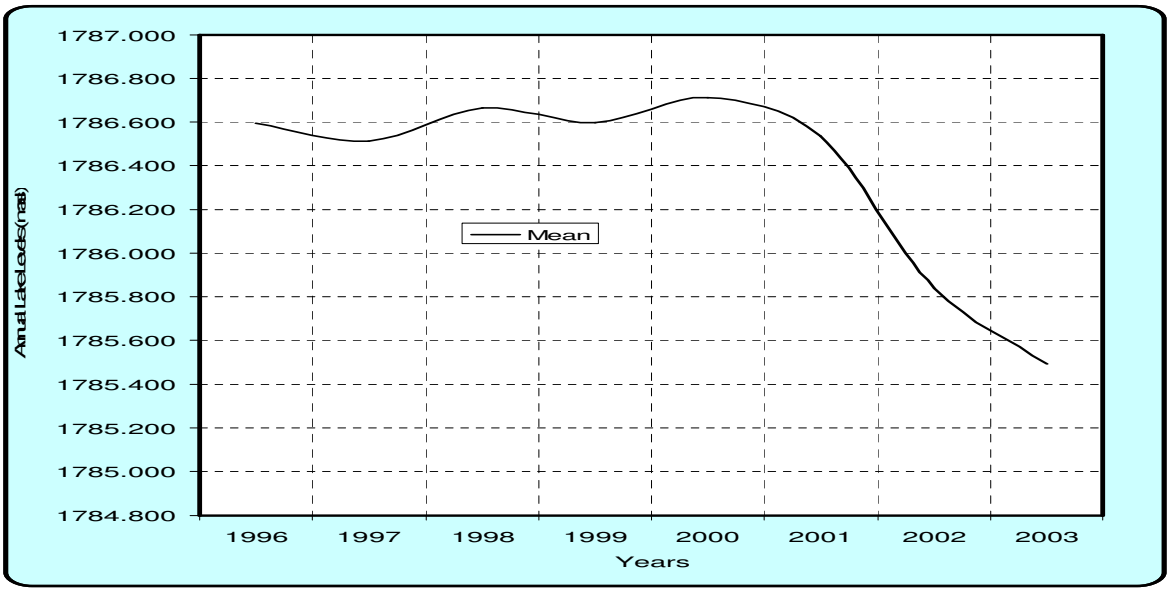
Lake Tana constitutes one of the major sub watersheds in the sub basin, estimated at 15,320 square kilometres. It is a highland lake at an average altitude of 1,800 masl, with water surface area of 3,060 square kilometre at a historic average lake level of 1,786.03 masl (1964-1995). It is fed by four major tributaries, Gelgel Abbay in the South, Rib & Gummara in the east and Megech in the north. At its outlet, its southern tip at Bahir Dar, a regulating weir known as Chara-Chara weir has been constructed to regulate outflow for the generation of hydropower at Tiss Abbay, a natural fall located some 30 kilometres downstream of the Lake outlet in the main stem of the Blue Nile sub basin. The chara-chara weir was commissioned in July 2001, after which the average lake level, was 1786.37 masl until 2003, while the long term (1964-2003) average lake level is estimated at 1786.10 masl. The minimum lake level recorded so far (1964-2003) is 1,784.394 masl in June 2003 (Figure 4.4). The historic minimum (1964-95) of 1785.129 occurred in June 1983 (Figure 4.5) after the 1982 heavy drought in Ethiopia. The Tiss Abbay-II hydropower began generating power in July 2001. (The headwaters of the Blue Nile are in the mountains surrounding Lake Tana, the largest tributary of which is the Gilgel Abbay. Lake Tana, at an elevation of approximately EL. 1,785 metre provides significant regulation of the natural river flow in the upper reaches of the Blue Nile. The Didessa River is one of the largest tributaries of the Blue Nile and drains an area to the west of Addis Ababa.) (MPFS, Section 2, Pg. 2-1)

Figure 4.4: Abbay-Blue Nile Sub-basin: Pffaftetter 3rd and 6th Order Watershed



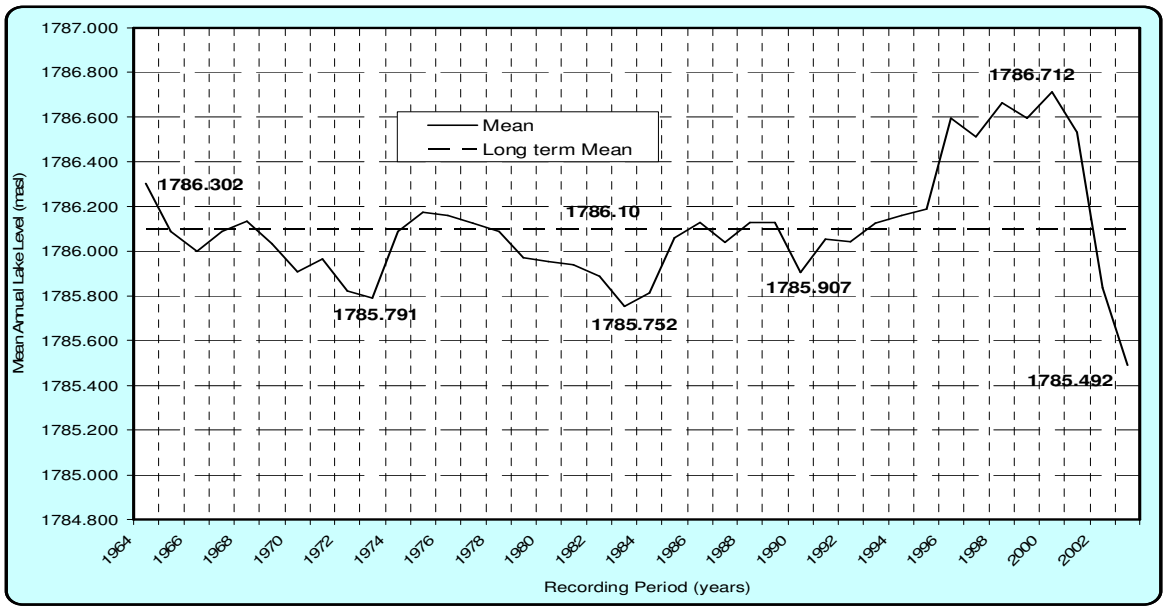
Source: Basin boundaries: USGS/gtopo30/HYDRO30. Gauges/met stns. ENTRO GIS Database

Figure 4.5: Annual Lake Level After Commissioning the Chara-Chara Weir (1996-2003)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Figure 4.6: Lake Level Annual Series at Lake Tana (1964-2003)

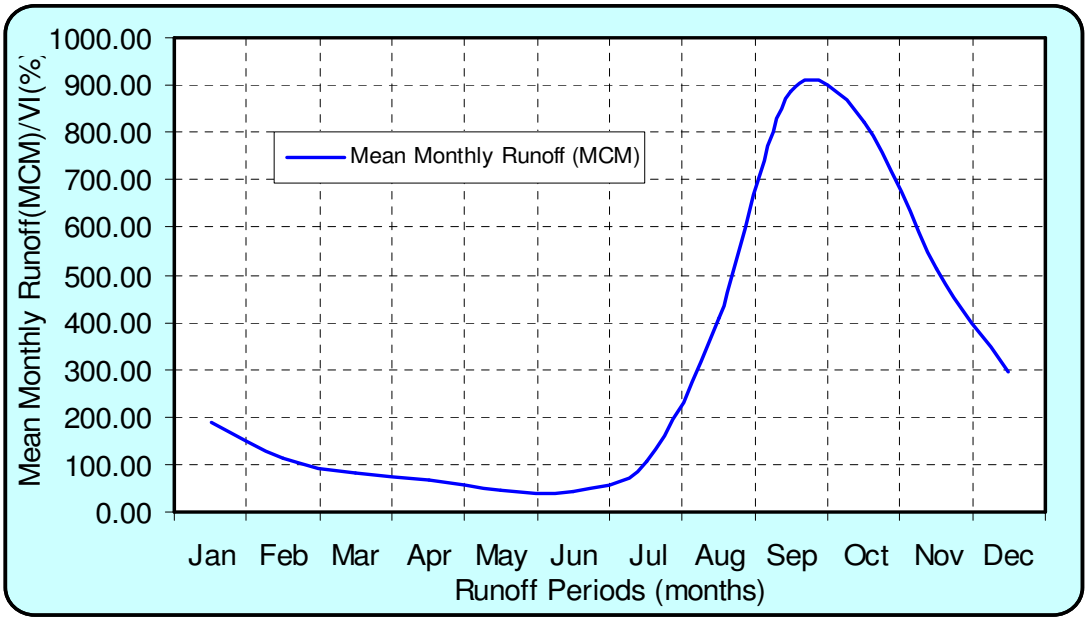


Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Mean annual runoff generated from Lake Tana watershed (12260 square kilometers) to the Lake Tana reservoir is estimated at 9.38 bcm (Studio Peterangiele, 1990). Runoff directly at the water surface is averaged at about 2bcm. Mean annual rainfall over the watershed is estimated at 1100 mm. The annual inflow contributed by Gelgel Abbay to the Lake Tana reservoir, is averaged at 1.8 bcm, the Rib and Gummara, at 0.68 bcm and 0.83 bcm respectively and the Megech at 0.45 bcm. More than 60% of the watershed is not gauged.

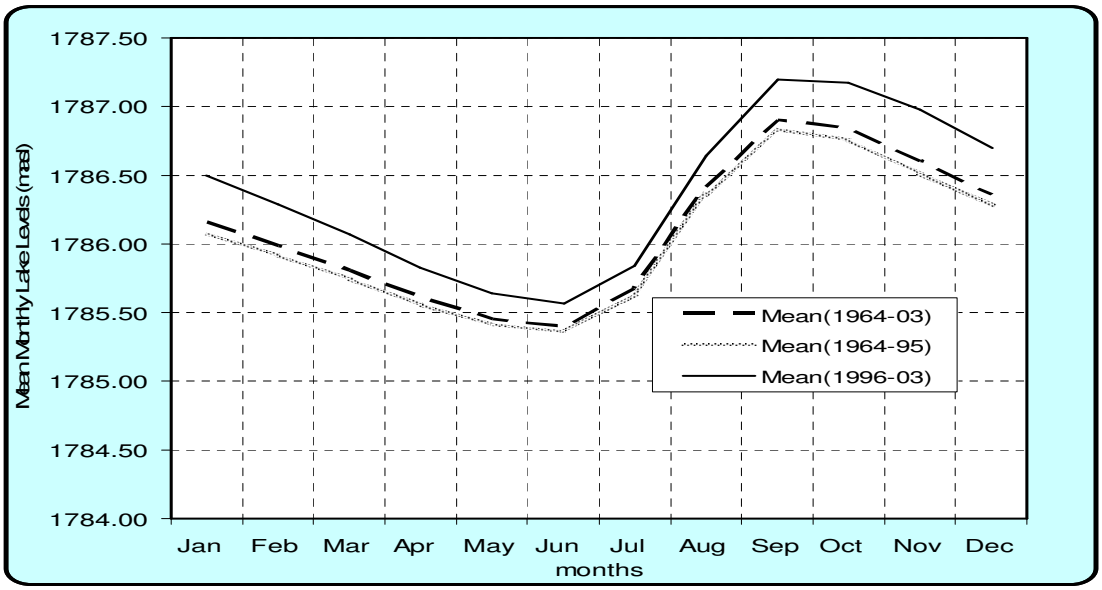
The Blue Nile is gauged Near Bihar Dar at the outlet of the lake. Data from 1980 to 2000 yield a mean annual inflow to the Blue Nile system at the Lake outlet is averaged at 3.56 bm^3. Seasonal outflow distribution is presented in Figure 4.7 and its annual series is presented in Figure 4.8 below.

Figure 4.7: Seasonal Distribution of Outflow of Lake Tana near Bahir Dar



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

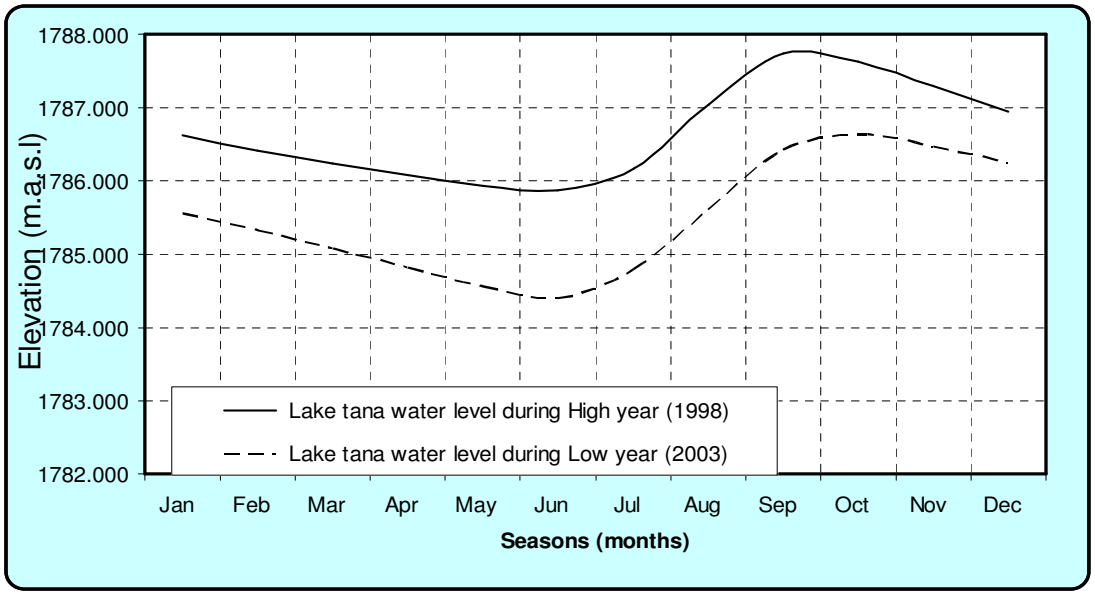
Figure 4.8: Seasonal Distribution of Lake Level at Different Periods (Average Values)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

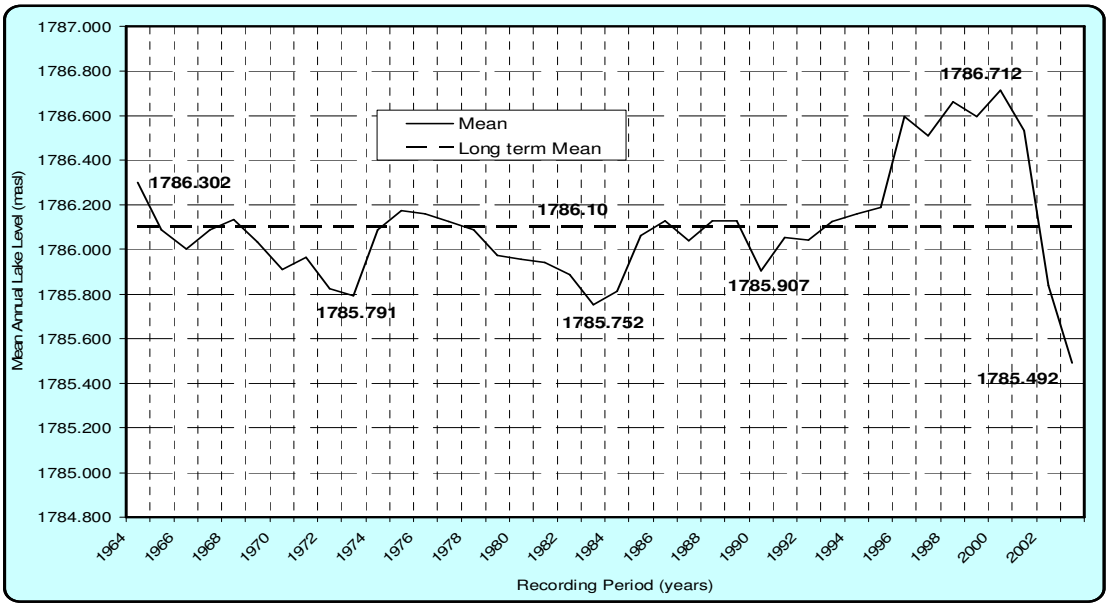
The Lake level record for the period of 1964 to 2003 has been taken from the Abbay Master Plan studies (Feb 1998). Seasonal distribution of lake levels (Figure 3.7) indicates the lake level attains its maximum level in August/September and starts receding in November/December. In June/July lake level is at its minimum level. Until 1996, water surface level fluctuation seems to have a regular pattern indicating that its balance is maintained over a long period (Figure 4.9). After commissioning the Chara-Chara weir (1996), an increasing trend is observed.

Figure 4.9: Lake Tana Seasonal Water Level Fluctuations (1964-2003)



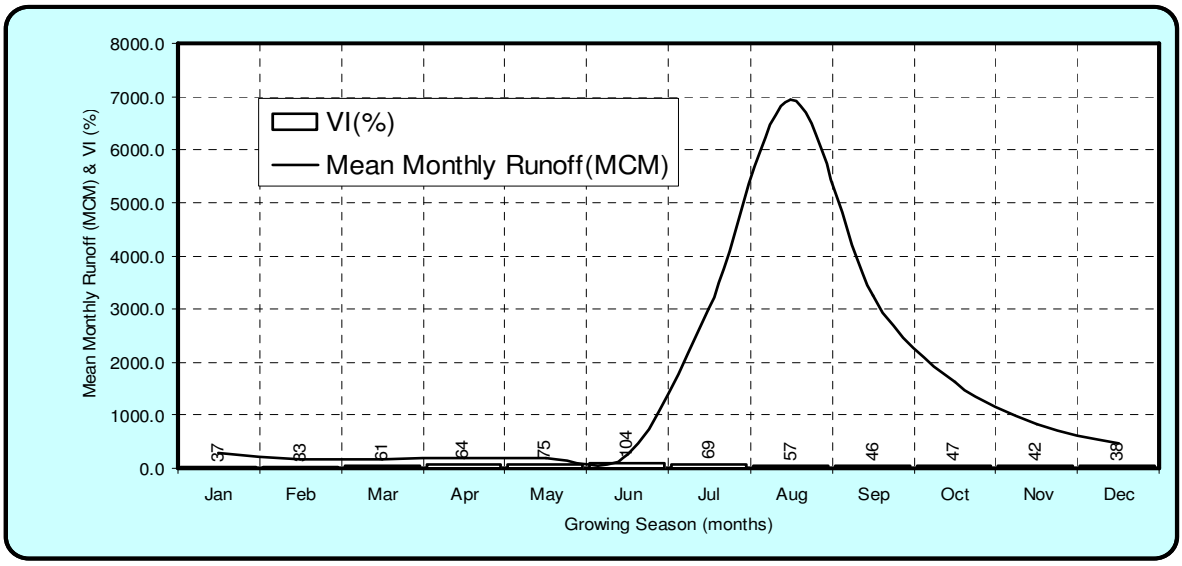
Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Figure 4.10: Lake Level Annual Series at Lake Tana (1964-2003)



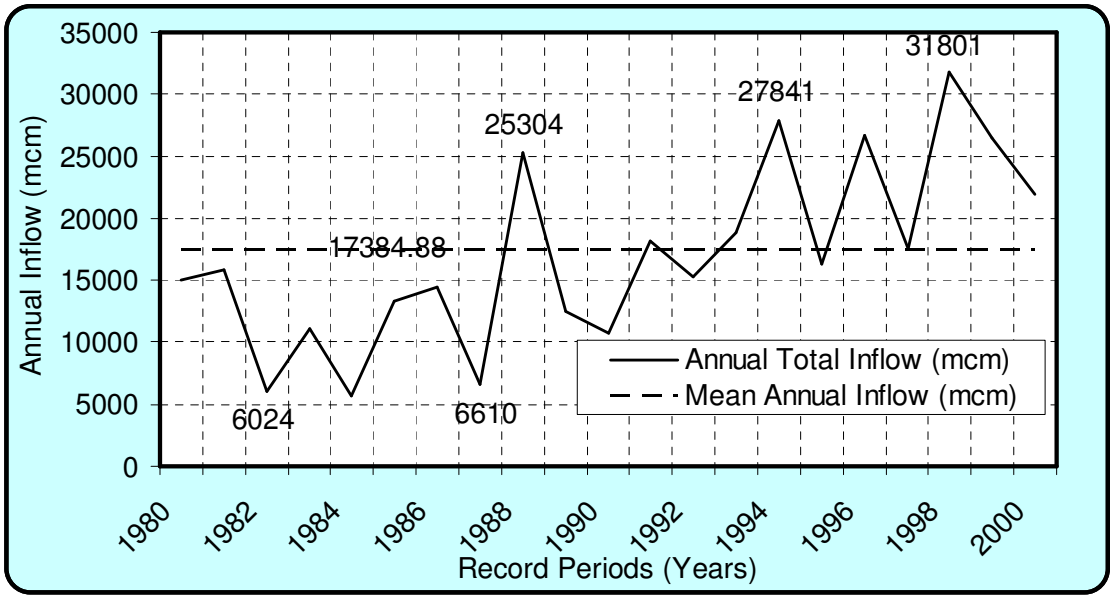
Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Figure 4.11: Seasonal Distribution of Runoff & Variability of Abbay at Kessie (1980-2000)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Figure 4.12: Annual Runoff Series of Abbay at Kesie (1980-2000)

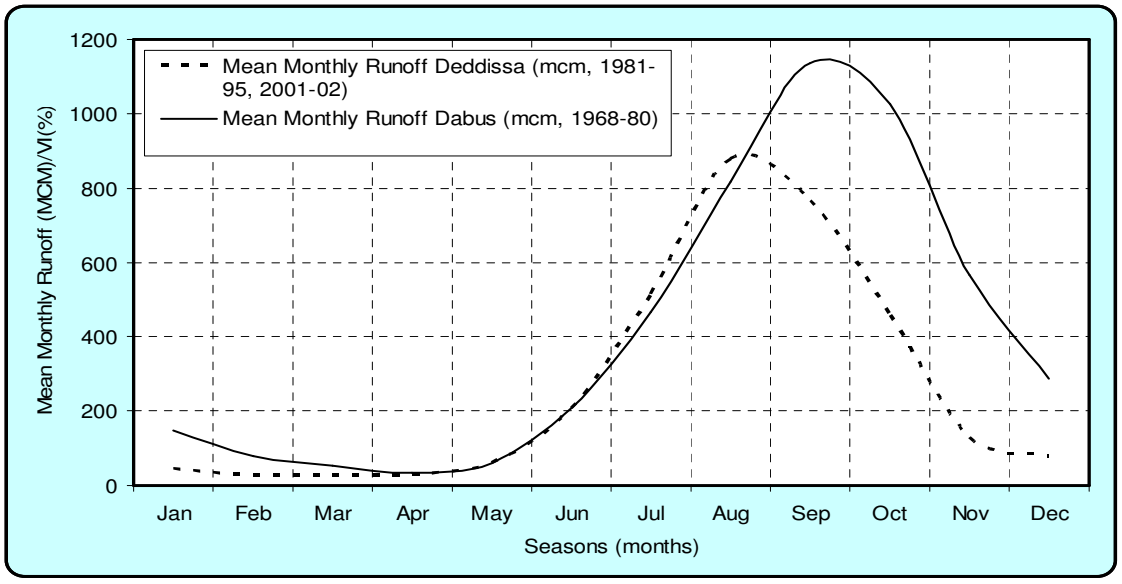


Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

4.2.2. The Deddessa, Dabus and Angar Rivers

These are the three major rivers meeting the main stem of the Blue Nile downstream of the Kessie station in its left bank. The mean annual contribution of Deddessa River is averaged at 4.6 bcm, the Angar at 1.8 bm^3 and that of the Dabus at 3.2 bcm (Figures 4.13 and 4.14).

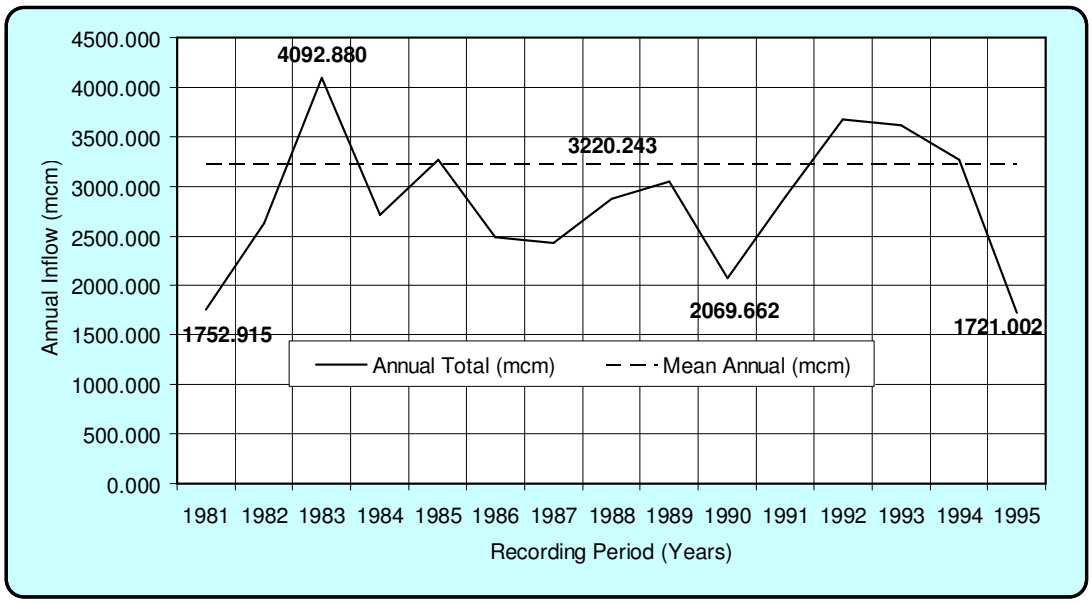
Figure 4.13: Deddissa & Dabus Rivers at Arjo & Assossa, Seasonal Runoff Distribution & Variability (1980-2000)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

The peak in the Dabus watershed happens about one-month latter than the peak in the Deddessa watershed. That the Dabus is in the furthest downstream reach (the last tributary in the left bank of the Blue Nile before the border) could be the possible explanation for this delay.

Figure 4.14: Annual Runoff Series for Deddissa River at Arjo (1980-2000)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

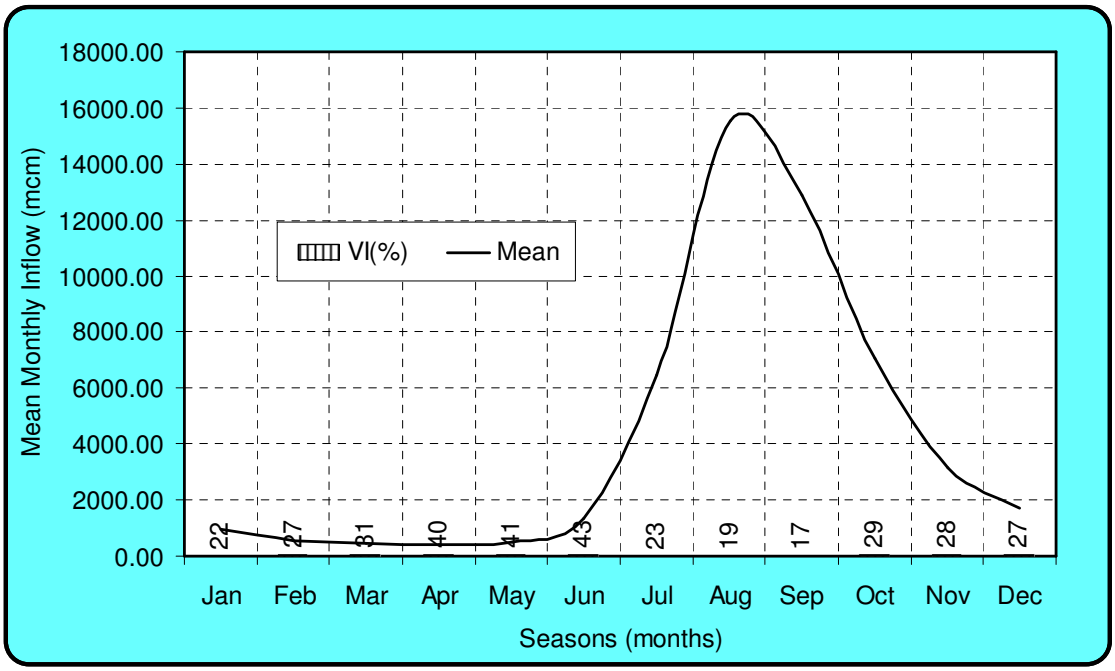
4.2.3. The Beles River

The Beles River has two major tributaries, upper Beles and the Gelgel Beles. At the mouth the mean annual contribution of the Beles River to the main stem of the Blue Nile is averaged at 1.6 bcm. It is the last major tributary of the Blue Nile before the border in its right bank.

4.2.4. Blue Nile at the Ethiopia-Sudan Border

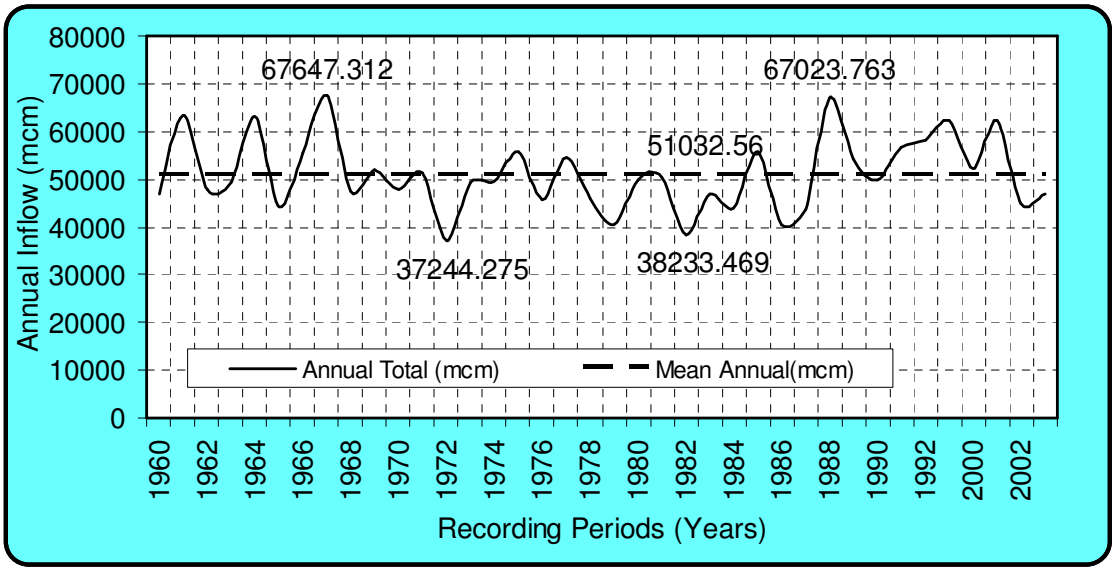
The runoff of the Blue Nile sub-basin at the border has been measured since 1960. The data recorded for a period of 1980 to 2000 and the long-term average (1960 – 2003) from the Abbay Master Plan Studies (Feb 1998) indicates that mean annual inflow of the Blue Nile at the border is 51.30 bcm on average (Figure 4.15). The short term (1999 - 2003) mean inflow is 54 bcm on average (Figure 4.16).

Figure 4.15: Seasonal Runoff Distribution & Variability, Blue Nile at the Border (1960-92, 1999-2003)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Figure 4.16: Annual Runoff Series for Blue Nile at the Border (1960-92, 1999-2003)



Source: ENTRO OSI Database [Rawdata source: Ethiopian Ministry of water resources]

Hydrologic variability for the wet season (June-Oct) is averaged at 26% and for the dry season (Nov-May) is averaged at 30%. Hydrologic variability for the annual series is also averaged at 15%.

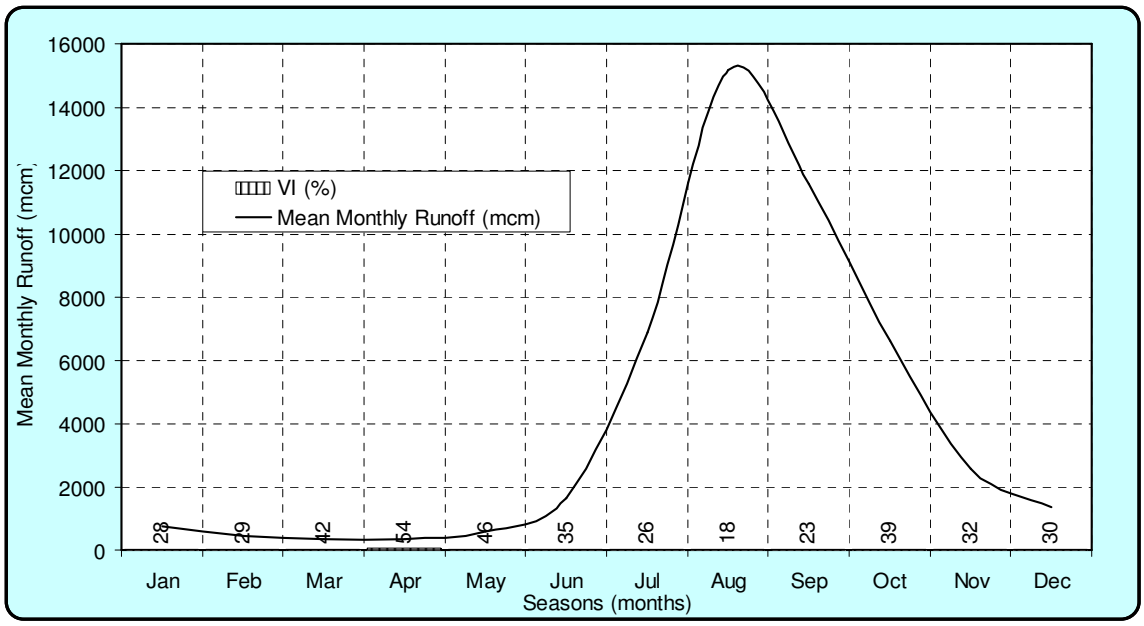
The time series for the annual inflow shows a general increasing trend for recent recording periods which might be attributed due to the impact of the regulation of Lake Tana at the Chara-Chara weir. Also the mean inflow for recent periods (1999-2003) indicates an increment of 4 bcm over the long-term mean annual inflow. This feature is also observed at the Kessie station, with a pronounced impact, which could be perhaps attributed to the scale effect.

4.2.5. Blue Nile at Roseires

The inflow of the Blue Nile at Roseires station has been gauged since 1912. A monthly inflow series from 1980 to 2000 has been made available for the analysis of this synthesis work (Sudan national OSI report, water component, May 2006). The Tekeze Integrated Master Plan project (Vol-VI, 1998) has presented the record from 1912 to 1995. This long-term data has been analyzed and some statistical features pertinent to this synthesis work have been derived. Accordingly the mean annual inflow entering the Roseires dam from the Blue Nile is averaged at 49.30 bcm, which is less by 1.73 bcm compared to the inflow (51.03bcm) recorded at the Ethio-Sudan border. It shall be noted that no significant tributaries join the main stem of the Blue Nile between the border and the Roseires station.

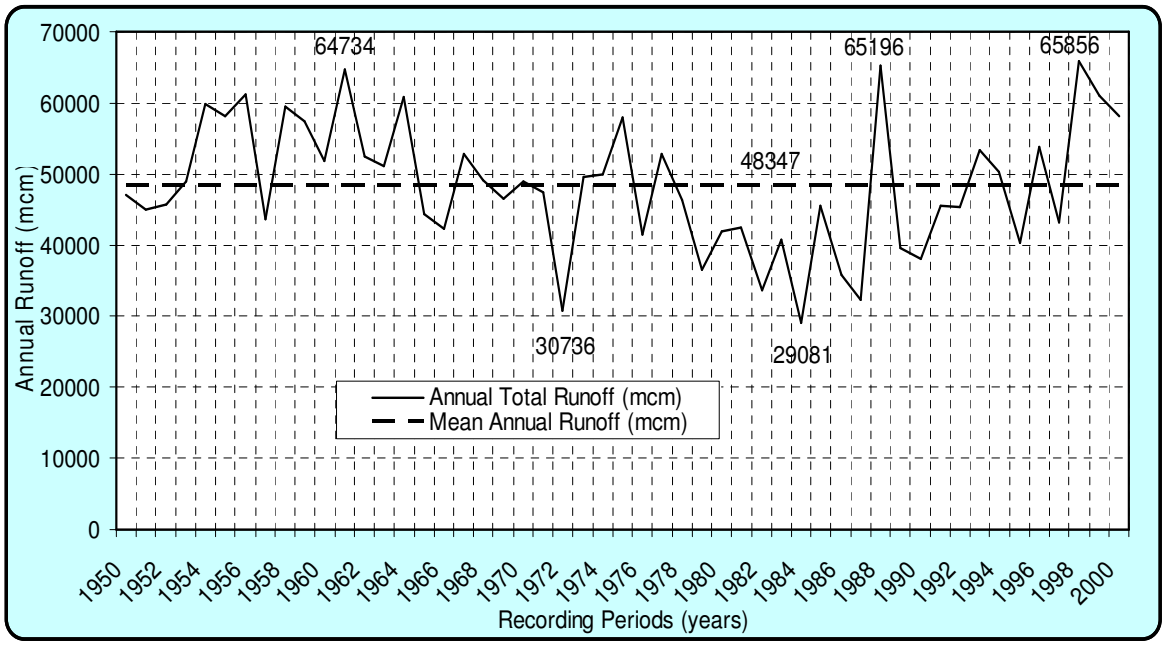
The seasonal distribution and annual time series of the inflow at Roseires Reservoir is presented below in Figures 4.17 and 4.18 respectively. Seasonal hydrologic variability is about 30% in the wet period (June-Oct) and 36% for the dry season (Nov-May). The annual hydrologic variability averages 20%. The time series for the annual inflow shows a general no trend condition with some positive trends exhibit in recent years. The trend at this node is much less pronounced as compare to the conditions at the border and Abbay at Kessie, which might be due to scale factor.

Figure 4.17: Seasonal Distribution & Variability of Runoff for the Blue Nile at Rosaries (1913-2000)



Source: ENTRO OSI Database [Raw data source: Sudan OSI National water report]

Figure 4.18: Blue Nile Annual Series of the Runoff at Rosaries Reservoir

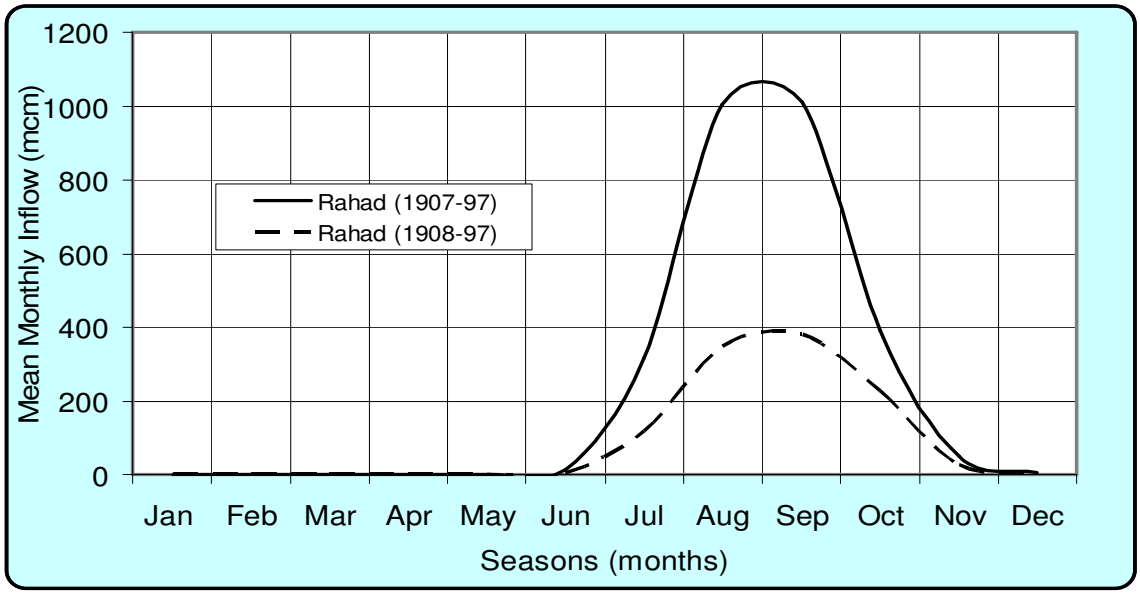


Source: ENTRO OSI Database [Raw data source: Sudan OSI National water report]

4.2.6. Blue Nile Down Stream of Sennar Reservoir

The Rahad and Dinder Rivers originated from the north-western highlands of Ethiopia joins the main stem of the Blue Nile downstream of the Sennar Reservoir with mean annual inflow of 4.0 bcm. Hydrologic variability in these two rivers is considerably high. Dinder has mean annual variability index of about 50% and Rahad has 40%. Inflow at the mouth of the respective rivers is intermittent. The runoff is concentrated in the wet period (June – Oct) with little flow coming in November and December. Almost no flow enters the Blue Nile in the months of January to May (Figure 4.19 and 4.20).

Figure 4.19: Rahad & Dindir Rivers Seasonal Distribution of Runoff at their Mouths



Source: After Sutcliffe & Parks Feb 1999

Figure 4.20: Rahad & Dindir Rivers, Annual Runoff Series at their Mouths (1980-2000)

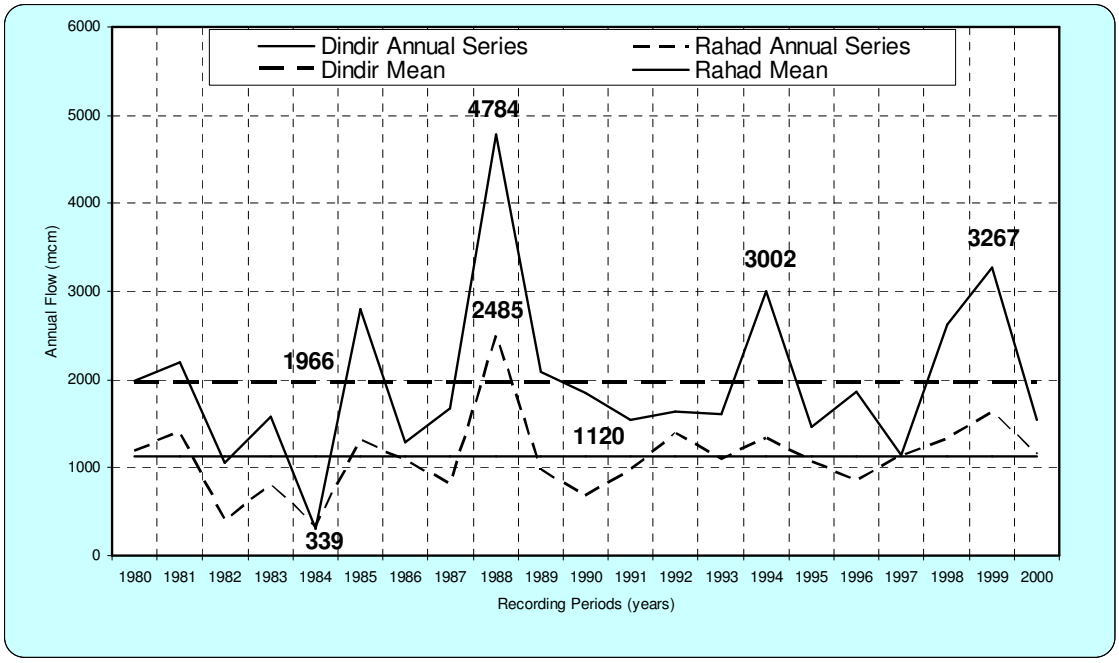


Table 4.2: Mean monthly Flows of Rahad & Dindir downstream of Sennar Reservoir (mcm)

Dindir at Mouth/Giwasi Station(1907-1960)												
Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
0	0	0	0	0	17	355	1085	1123	433	64	8	3085
					(1961 - 1997)							
0	0	0	0	0	15	265	887	841	333	31	2	2374
					(1907 - 1997)							
0	0	0	0	0	16	318	1005	1009	392	51	6	2797
Rahad at Mouth/El-Hawata Station (1908 - 1960)												
0	0	0	0	0	2	106	350	396	259	29	3	1145
					(1961 - 1997)							
0	0	0	0	0	2	137	342	353	185	25	1	1045
					(1908 - 1997)							
0	0	0	0	0	2	119	346	378	228	27	2	1102

Source: The Hydrology of the Nile: After J.V.Sutcliffe & Y.P.Parks (February, 1999)

4.2.7. Blue Nile at Khartoum

The flow of Blue Nile at Khartoum has been recorded since 1900 (Table 4.3). From the monthly series from 1980 -2000 the mean annual inflow at Khartoum averages 50.4 bcm (1900-1960), 46.4 bcm (1961-95) and 40.2 bcm (1980-2000). The long-term inflow (1900 – 1995) averages at 48.7 bcm (usually taken as 50 bcm), which is considered as a long-term mean annual flow of Blue Nile at Khartoum.

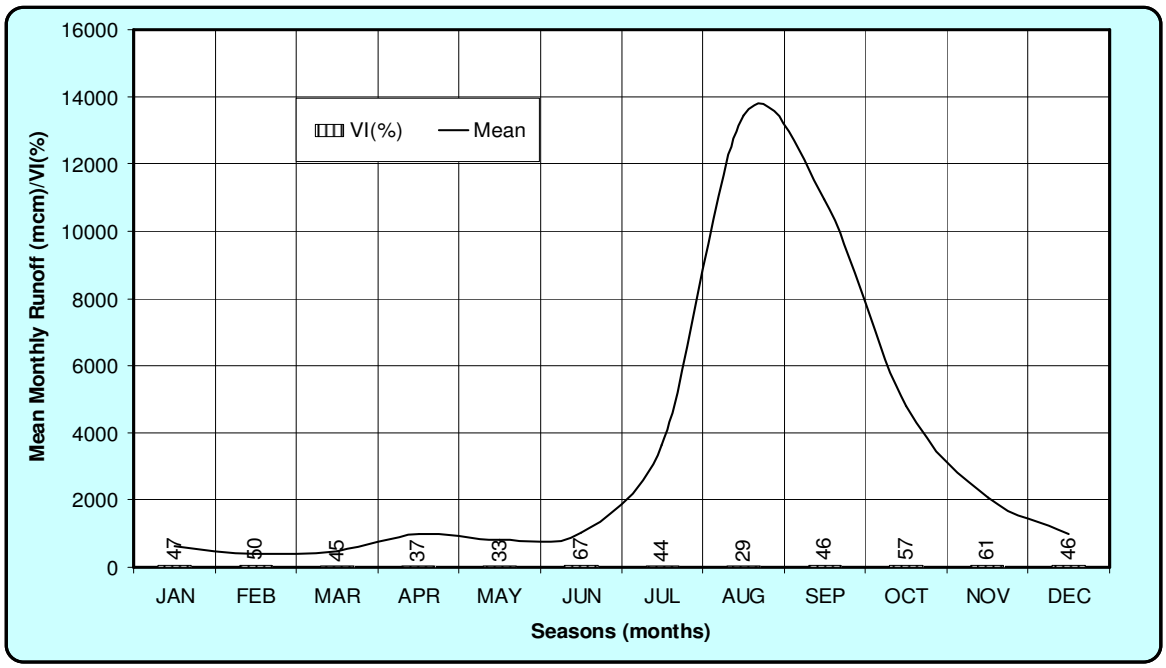
Table 4.3: Mean monthly Flows at Major Nodes of the Blue Nile (mcm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual
Blue Nile (Abbay) at Outlet of Lake Tana (1920 - 1933)												
208	124	83	43	28	26	97	503	995	841	519	344	3811
Blue Nile at Roseires/El-Deim Station (1912 - 1960)												
796	468	376	331	621	1648	6651	15647	12859	6889	2684	1385	50355
				(1961-1997)								
716	417	348	315	600	1672	6911	14672	11119	5946	2394	1299	46409
				(1912-1997)								
762	446	364	324	612	1659	6763	15228	12111	6484	2559	1348	48660
Blue Nile at Khartoum (1900-1960)												
852	509	437	367	490	1210	5401	15963	14931	8245	2889	1497	52791
				(1961 - 1995)								
501	342	352	532	526	865	4248	13933	11280	5128	1665	826	40198
				(1900 - 1995)								
724	448	406	427	503	1084	4989	15237	13625	7130	2451	1257	48281

Source: After Sutcliffe & Parks (February, 1999) Hydrology of the Nile

With nearly 45% of hydrologic variability, more than 80% of the mean annual inflow at Khartoum station is concentrated in the wet season from July to October (Fig 4.20).

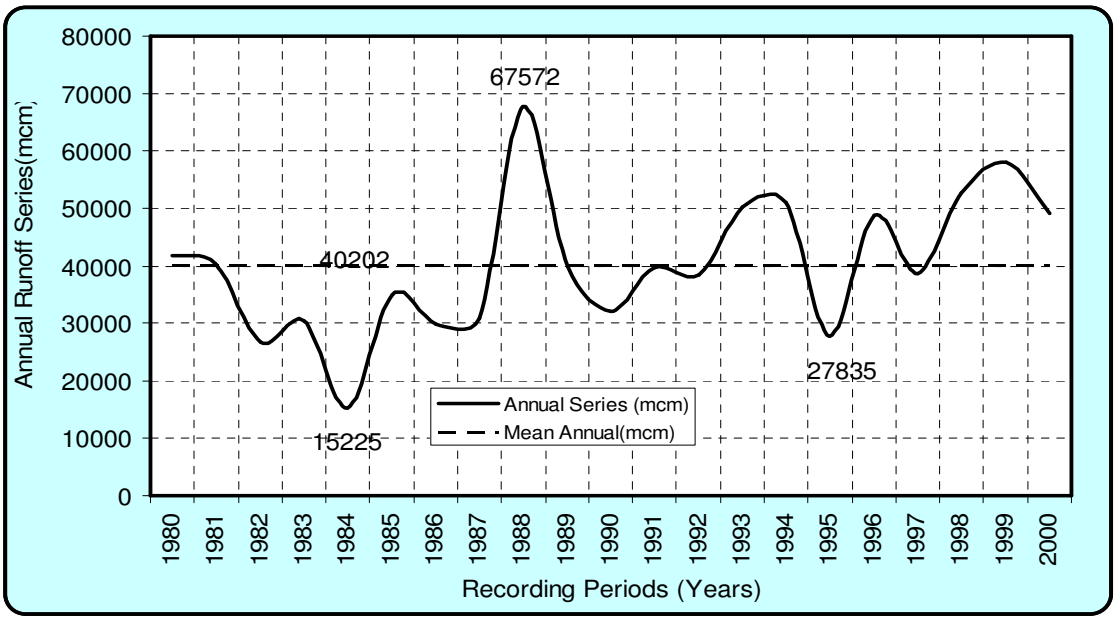
Figure 4.20: Blue Nile Mean Monthly Runoff at Khartoum Station (1980-2000)



Source: ENTRO OSI Database [Raw data source: Sudan OSI National water report]

Hydrologic variability in the dry season is averaged at about 50% and the annual series has a hydrologic variability of 30% (Figure 4.21). Inflow at Khartoum station for the periods of 1980 to 1987 is observed to be drier than the average (Figure 4.22). In recent years (since 1996), an increasing trend is observed though not highly pronounced as it is in the case of the Abbay at the Kesse and border stations.

Figure 4.21: Annual Runoff Series Blue Nile at Khartoum (1980-2000)



Source: ENTRO OSI Database [Raw data source: Sudan OSI National water report]

The White Nile from the south makes a confluence with the Blue Nile at Khartoum. The mean annual inflow carried by the White Nile to the Blue Nile averages 25 bcm, which makes the mean annual inflow in to the main Nile passing the node at Khartoum 73.3 bcm.

4.2.8. Runoff in the sub-basin

Overview: Although the Abbay Basin is the second largest drainage area in Ethiopia, it has the highest runoff, estimated to be 51 cubic kilometre per year. The Abbay Basin accounts for 50 percent of water runoff in Ethiopia. It also contributes 62 percent of the Nile discharge into Lake Nasser/Nubia and 72 % of the total Ethiopian contribution to the Nile waters. The Abbay River has a channel length of 922 kilometres and falls 1,295 m from Lake Tana (1,785 masl) to the Sudan border (490 masl). Shortly after leaving Lake Tana, the river plunges over the spectacular Tis-Isat falls and, thereafter enters the deep Abbay River gorge. Comparing the mean monthly discharges of Abbay River at Lake Tana and at the Sudan border indicate that there is a 10 times increase in discharge between that at Lake Tana and at the Sudan border. Figure 4.22 shows the spatial pattern of the mean annual runoff (mm/yr) in relation to the 3rd order catchments. The highest runoff areas are located to the southwest of Mount Choke, the East Wellega and the West Wellega Highlands. The Didessa, Dabus, Middle Abbay and Beles Catchments have the highest runoff rates. The Beshilo, Durame and Dinder-Rahad have significantly lower rates.

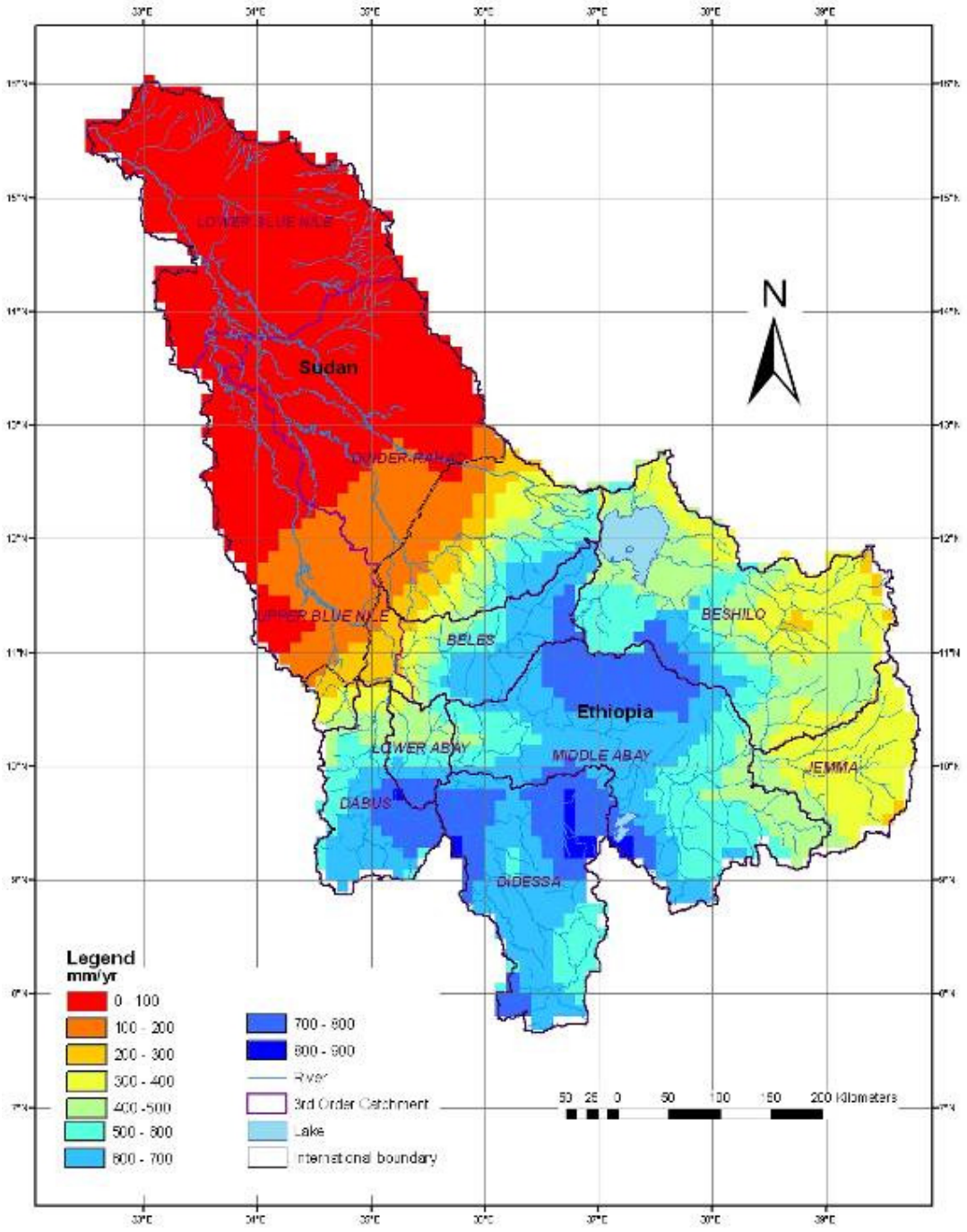
Figure 4.22 presents the area and gross runoff depth of the various catchments and sub catchment of Abbay Basin. The runoff from the individual drainage unit is gross runoff, which means, no allowances are made for evaporation and other channel losses.

Table 4.4: Area and average gross runoff depth of the sixteen main drainage basin units of the Abbay River basin (rank order by gross runoff depth)

Unit Name	Area (square kilometres)	Gross runoff depth (mm)
Didessa	19,943	651
South Gojam	17,029	543
Guder	7,123	537
Anger	8,027	527
Lake Tana	15,294	514
North Gojam	14,618	486
Dabus	21,367	466
Beshilo	13,453	455
Fincha	4,154	450
Muger	8,318	423
Jemma	16,033	422
Welaka	6,517	410
Wombera	13,163	410
Beles	14,426	378
Rahad	8,401	339
Dinder	15,128	276
Abbay at border	**202,994**	**255**

Source: MWRI, Addis Ababa, 2006.

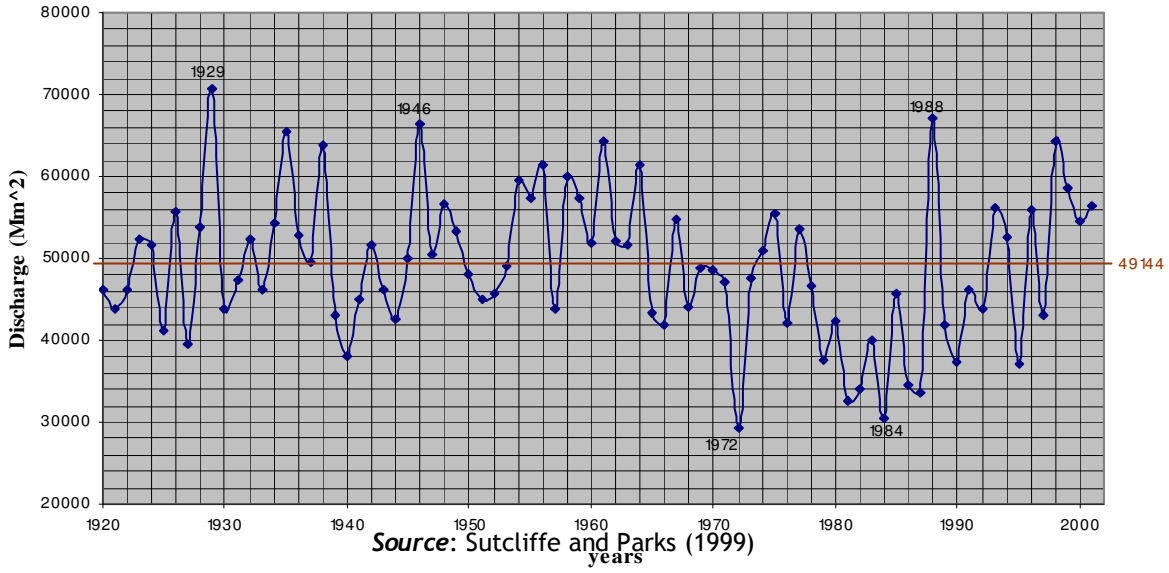
Figure 4.22: Blue Nile Sub-basin: Mean Annual Runoff (mm/yr)



Source: USGS/gtopo30/HYDRO30.

Seasonal variations in flow: There are considerable seasonal variations in flow. The monthly low flow of the Blue Nile is 302 million m^3 per month in February and the peak flow 13,151 million m3 per month in August. In contrast to the White Nile the flow is highly seasonal being concentrated between July and October (figure 2). The peak flow at Roseires occurs in August whilst that at Lake Tana outlet is September indicating that the downstream tributaries are peaking earlier. Similarly, there are considerable variations in annual discharge. The annual discharge for the Blue Nile from 1920 to 2001 is shown in Figure 4.24.

Figure 4.24: Sudan – Blue Nile Sub-basin: Blue Nile Hydrograph 1920-2001
million cubic metres



Source: Sutcliffe and Parks (1999)

Between 1920 and 1960 the annual discharge appeared to have oscillated around the mean. From 1960 to 1984 there appears to have been a general decrease in discharge until 1985. Thereafter discharges have gradually increased.

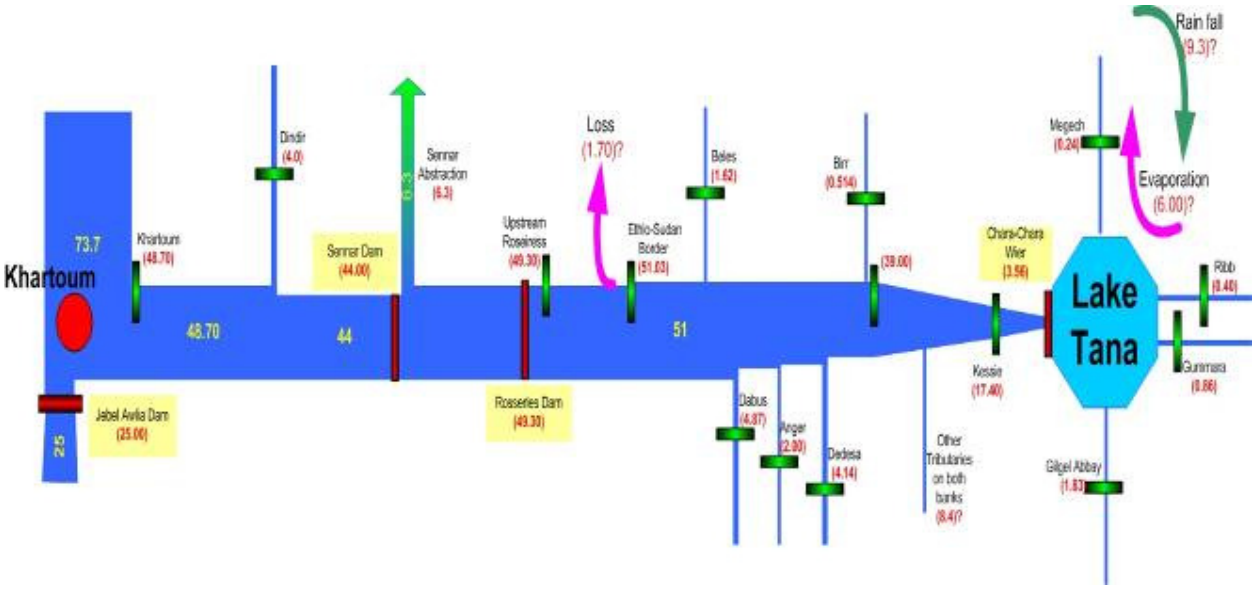
4.2.9. Water balance of the sub-basin

The indicative water balance for the Blue Nile system is presented in Figure 4.25. The water balance accounts for abstractions in the system but evaporation is not presented in the system due to data shortage at Roseires and Sennar Reservoirs in the Sudan.

From the data available for the sub basin, the Blue Nile provides mean annual inflow of 51 bcm at the border and 49.3 bcm at the Roseires station. Most of the irrigation abstractions in the Sudan are made from the Sennar reservoir and through pumping downstream of the Sennar reservoir. Mean annual abstraction for the reach beneath the Roseires dam and Khartoum averages 6.38 bcm.

The Rahad and Dindir rivers contribute man annual inflow of 4.0 bcm to the Blue Nile main stem d/s of the Sennar reservoir, making the mean annual inflow of the Blue Nile before Khartoum 55.3 bcm. After accounting the abstractions for irrigation, mean annual inflow reaching the Khartoum node is 48.92 bcm. Data recorded in the Blue Nile at Khartoum (1900 – 1995) is 48.7 bcm on average (usually taken as 50 bcm in most of the reports including the water component OSI report of the Sudan). As a result it is believed that the long-term mean annual inflow of the Blue Nile at Khartoum averages 48.7 bums. The Blue Nile alone is thus believed to contribute nearly 66% of the inflow to the Main Nile at Khartoum.

Figure 4.25: Indicative Water Balance Schematic for Blue Nile Sub Basin



Source:ENTRO OSI database [raw data source :Ethiopia

4.2.10. Groundwater

In the highlands ground water is almost exclusively confined to consolidated rocks, which include basalts, limestone and sandstone and metamorphic basement rocks. The retention capacity of these rocks is low and any groundwater is linked to the occurrence of fractures within these rocks. The presence of a thick basalt cap overlaying the normally better yielding sedimentary rocks restricts possible recharge of these areas and limits exploitation of shallow aquifers, such as springs and wells. The presence of deep gorges along the Abbey escarpment also provides relatively free drainage for the aquifers which may emerge as springs in the lower slopes. This effectively draws the groundwater table down deeper in the locality of the escarpment which significantly reduces the potential storage ability of the aquifers.

On the Sudan plains the hydro-geological system comprises two aquifers: an upper and a lower (Farad, E.A. et al., 1997). The upper aquifer includes mainly the Upper Geezer Formation, the upper part of the Lower Geezer formation in the area between the Blue and White Nile, and the upper part of the Lower Motorman Formation to the north of the Blue Nile. The lower aquifer is developed mainly in the deeper Nubian Sandstones. The water storage in the lower aquifer is some eight times that of the upper aquifer. Except for a few isolated localities water quality is free from impurities for drinking and irrigation requirements.

4.3. DAMS AND RESERVOIRS

The Blue Nile system currently has four reservoirs, three man made and one natural, which make up the existing water resources infrastructure. The two reservoirs in the Ethiopian highlands are Lake Tina and Finch reservoirs, and the other two reservoirs are Rosaries and Sonar, located in the Sudanese land upstream of the Khartoum station.

4.3.1. Existing Dams and Reservoirs

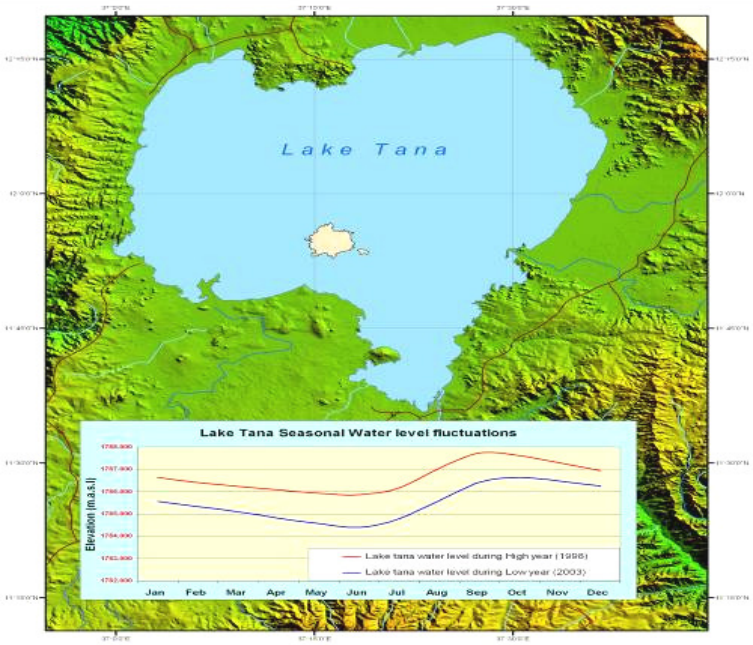
Lake Tina and the Caracara Weir

- **Reservoir Features**: Lake Tina is a natural reservoir located in the upper course of the Blue Nile watershed at an altitude of 1,800masl. The physical topography of

the lake and its flood plains are indicated in Figure 4.26 below. It is believed to be the source of Blue Nile. It has a total watershed area of 15,320 square kilometres including the water body (3,060 square kilometres). It has four major tributaries and other small tributaries with a total mean annual inflow of 9.38 bcm. Mean annual evaporation is estimated to range from 5.1 bcm (Melkamu A, 2005) to 6.0 bcm (Studio Pietrangele, 1990). Historic mean outflow (1964-95) is averaged at 3.56 bcm. Outflow is regulated using the Chara-Chara regulation weir implemented in 1996. It has a total crest length of 700 m, seven radial gates (five operational) with a total maximum capacity of 180 m^3 per second. The crest level of the regulation weir is fixed at 1787.00 masl. The minimum operating level of the natural reservoir is fixed at 1784masl and the maximum operating level at 1787.5 masl. Currently the regulation work is meant for hydropower production at Tiss Esat, a natural 50 meter deep water fall, located some 30 kilometres downstream of the regulation weir at the course of the main stem of the Blue Nile.

- **Reservoir Sedimentation**: Mean annual sediment inflow to the Lake reservoir is estimated at 10 mcm (Studio Pietrangele, 1990).
- **Evaporation losses**: The lake is surrounded with flood plains of Fogera in the east, Dembia and Bichign in the North & North West and Achefer in the south. These flood plains are flooded during the wet period (June – September) and remain wet up until November. Runoff loss through evaporation is believed to be considerable in these flood plains. The flood plains are hydraulically connected to the Lake. During peak wet periods (After mid August and September to Mid October) the lake level attains its maximum level during which water enters from the Lake into the flood plains and during November and December, as the lake level starts receding water flows from flood plains to the Lake reservoir. During these months considerable amount of runoff stays idle in these flood plains and is exposed for evaporation loss. In some preliminary level estimates, this evaporation loss is estimated to be in the order of 1.0 bcm to 1.5 bcm.

Figure 4.26: Physical features of Lake Tana, the Source of Blue Nile



Source: ENTRO databse [raw data source: SRTM 90m DEM ; Ethiopian Ministry of water resources]

Roseires Reservoir/Dam

- **Reservoir Features**: The Roseires reservoir is located some 100kilometers d/s of the Ethio-Sudan border on the main stem of the Blue Nile. The dam is built in 1964 at an initial storage capacity of 3.364 bcm. The reservoir is largely used for storage purposes to satisfy irrigation and hydropower demands. The mean annual inflow (1913-1995) to the Roseires reservoir is estimated at 49.3 bcm.
- **Reservoir Sedimentation**: Currently the storage capacity is reduced to 2.227 bcm, the balance (1.127 bcm) filled by sediment (Sudan country OSI water report, May 2006), indicating mean annual sediment inflow to the reservoir is in the order of 140 mcm. Figure 4.27 below indicates sedimentation problems at Roseires reservoir. The sediment retention rate for the Roseires reservoir is estimated at 10 which yield an average deposition of 21.06 Mt/yr (equivalent to 19.82 mcm/yr).

Figure 4.27: Sedimentation Problems at Roseires Reservoir

Plate (a) the Sedimentation Problem in Roseires Dam

Plate (b) Debris in front of Turbines U/S Roseires Dam

Source: Sudan OSI Report, water component, May 2006.

Sennar Reservoir/Dam

- **Reservoir Features**: - The Sennar reservoir largely built for regulation purpose is implemented in 1925, with initial storage capacity of 930 mcm. The reservoir is built for the purpose of regulating the inflow coming from the Roseires reservoir for developing irrigation and hydropower.
- Mean annual inflow of Blue Nile at Sennar reservoir remains the same as that of the Roseires inflow (49.3bm^3, - (1912-1995) as there is no major tributary entering the system between the reach of Roseires and Sennar reservoirs.
- Reservoir Sedimentation: - Currently, the storage capacity is reduced to 370 bcm, the balance (560 mcm) being filled with sediment (Sudan Country Level Water Component OSI report, May 2006), indicating annual sediment inflow to the reservoir averaged at about 10.80 mcm (11.56 Mt/yr) with retention rate of 10% per year. Sediment inflow at the Sennar reservoir is far less than the inflow to Roseires, the reason being the Roseires reservoir is acting as check dam for the Sennar reservoir.

4.3.2. Sediment Analysis

Background

Various studies have described the overall picture of soil erosion and sediment transport within the Abbay River Basin in Ethiopia. In the CRA Country Paper for Ethiopia, a comprehensive synopsis of the watershed management problems in the Abbay Basin is given. It is noted that the highland plateaus have been deeply dissected by the Abbay and tributaries providing severe constraints to road communications and access to markets. Agriculture expansion on to steep slopes and the consequent loss of vegetation have accelerated geological rates of soil erosion. Steep slopes and lack of vegetative cover result in relatively high rates of sediment delivery to the main rivers. Millennia of cultivation coupled with breaches in soil nutrient cycling caused by residue and dung use as fuel, grain removal and soil erosion have led to low levels of crop and pasture productivity.

Detrimental government policies in the past have left a legacy of tenure insecurity and poverty with severe constraints on farmers' willingness and ability to invest in sustainable land management. Past large-scale programmes of soil conservation and afforestation were top-down and alienated the rural population. High rainfall in the highlands can cause problems with physical soil conservation structures of poor drainage and of structure breaches and severe erosion.

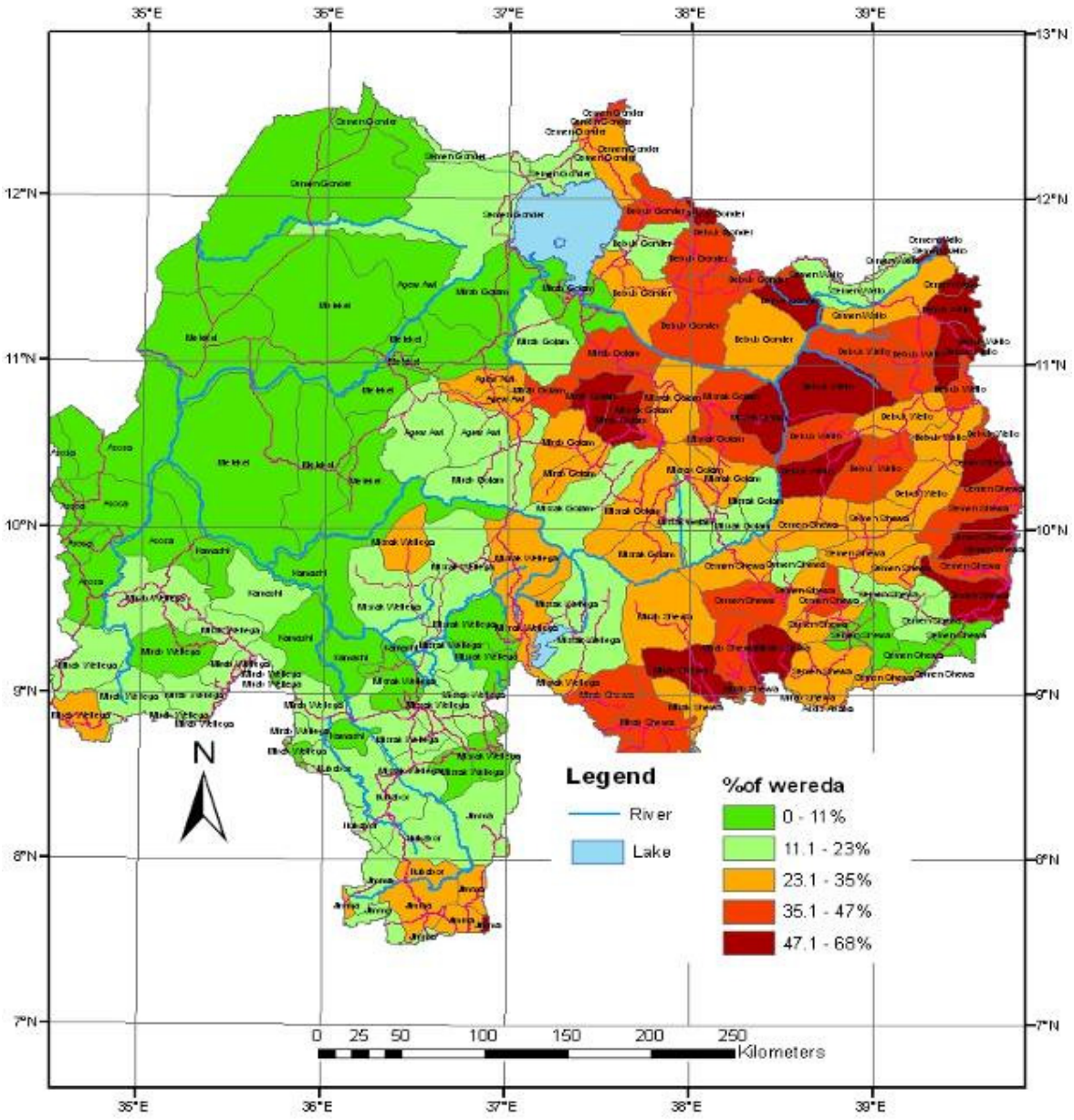
The western Lowlands (within which the Border project is located) for long sparsely populated because of the prevalence human and livestock diseases, provides the potential for agricultural expansion.

The CRA Country Paper assesses the extent of soil degradation in terms of sheet and rill erosion (Figure 4.28), gully erosion and mass movements.

With this background to sedimentation, the Country Paper goes on to state “Infrequent, unsystematic and incomplete suspended sediment data for the El Deim gauging station just across the border in Sudan is available. This has been analysed by Group 1 of the NBCBN/River Morphology Research Cluster. They estimated that the long-term mean suspended sediment at El Deim to be 123 M tons. They estimated bed load to be 15% giving a total mean annual sediment inflow of 140 M tons”. These figures give a mean annual suspended sediment yield for the Abbay Basin of approximately 700t/kilometers^2 per year, and approximately 800t square kilometre per year for total load (including bed load).

The original NBCBN/River Morphology Research Cluster report (2005) on “Assessment of the current state of the Nile basin reservoir sedimentation problems” describes the sampling data and procedures on which these estimates are based. They are very instructive. The suspended sediment was “measured by bottle sampling taken once a day from the channel bank” at El Deim gauging station. Approximately 125 samples were taken in the months of July, August, September and October in 10 individual years spanning from July 1970 to August 1994. The plotted data reveal hysteresis looping with July and early August data normally giving distinctly greater sediment loads than the same flows on flood recession. Separate ratings were developed for rising and falling flood stages. Flow duration curves for 30-years record at El Deim gauging station (1966 – 1995) were developed for each 10-day period of the flood months (July to September) and sediment ratings applied to these. The resulting sediment loads are summarised in Table 4.13, below.

Figure 4.28: Abbay Basin - Moderate to Severe Erosion Hazard by Woreda



Source: Final Country Report, Ethiopia, Hydrosult, 2006

This work is the basis for the estimate of 140 M tons total mean annual sediment inflow at Roseires. The following cautionary points may be noted:

- Sediment samples at El Deim were taken at five points in five verticals across the river from a cable car during the station's early history (1960s). The samples giving rise to the estimate of 140 M tons (July 1970 to August 1994) are stated to be taken by hand at the water's edge. The relationship between sediment concentrations based on comprehensive sampling (as in the 1960s) and hand samples taken at the riverbank is unknown.
- El Deim sediment ratings include data from as early as 1970, and are therefore weighted in part to conditions more than 35 years ago; similarly, the most recent

samples used to establish ratings (in 1994), some 13 years ago, may be unrepresentative of current land use conditions.

- The Abbay Master Plan report estimated sediment transport annual yield of 168M tons at Border dam site, using a rating curve for Border gauging station based on sediment sampling in 1961 only – more than 45 years ago (See below).

All of the above points suggest that the estimate of 140 M tons total mean annual sediment load at El Deim is likely to seriously underestimate current sediment transport at Border dam site.

The Ethiopian Country Paper goes on to state that "the Tekezi Medium Hydro Study (1998) quoted a much higher figure of 273 M tons per annum as the mean annual suspended sediment load for Roseires".

The Country Paper presents summary data for 15 selected stations in the Abbay Basin, giving the source as Abbay Basin Master Plan Study. From our understanding of there being no comprehensive sediment monitoring at Border during at least the last 27 years, we are not aware of any sediment rating curve for Border which represents current land use conditions. We have therefore to conclude that the sediment load quoted (140 M tons/year) is based on a flow record period from 1980 to 1991 and not on a sediment rating curve developed from comprehensive sampling during these years.

In the Abbay Master Plan report itself, we note that sediment transport is presented for potential dam sites including Border. For Border dam site, sediment transport annual yield is given as 168 M tons. (Phase 2, Data Collection – Site Investigation Survey and Analysis. Section III, Volume 2: Dam Project Profiles). This estimate appears to be based on sediment samples at Border gauging station obtained in only a seven month period in one year (between March and September 1961), now more than 45 years ago (Phase 2, Data Collection – Site Investigation Survey and Analysis. Section II Sectoral Studies, Volume III – Water Resources, Appendix 6; BPFR, Section 4, pg. 4-26 to 4-30).

4.3.3. Suspended Sediment in the Blue Nile River System

- ***Sediment yields***: **Sudan**: Infrequent, unsystematic and incomplete suspended sediment data for the El Deim gauging station just across the border in Sudan is available. This has been analyzed by Group 1 of the NBCBN/River Morphology Research Cluster (Ahmed Musa Siyam et al., 2005). They estimate long-term mean suspended sediment at El Diem to be 123M tons, and the annual sediment yield for the Abbay Basin to be 700t square kilometre per year.
- ***Sediment delivery ratio***: **Sudan**: They also estimate the sediment delivery ratio to be 39 percent. This figure is similar to SDR's quoted by Walling (1983) for central and eastern USA. The estimate is lower than that for the Tekeze Sub-basin (between 800 t square kilometre per year and 65 percent respectively). The Tekeze Medium Hydro Study (1998) quotes a much higher figure of 273M tons per annum as the mean annual suspended sediment load for Roseires. However, the sediment monitoring programme of the Sudan Hydraulic Research Institute recorded a figure of 135.6M tons for 2000 for the same station. Thus, the annual mean of 140M tons is more consistent with the NBNBN study.
- ***Sediment yield and watershed area***: **Ethiopia**: The Ethiopian MWR has a number of intermittent sediment records for tributaries of the Abbay. Nearly all watersheds are less than 1,000 square kilometre in area. They have been analyzed and tabulated by three sources: (i) The Abbay Basin Master Plan Study, (ii) the Tekeze Medium Hydro Study, and (iii) a study undertaken by Rodeco for MWR (2002). There are a number of discrepancies between the data sets and some stations are included one data set and not the other, and vice versa. There is no clear relationship between sediment yield and watershed area indicating that a number of other factors have a much stronger influence. In the Study undertaken in Tekeze

Basin these were found to be variations in lithology, landuse, gully density and connectivity (Nigussie Haregeweyene et al., 2005) and given the similar conditions in the Abbay Basin the same factor are also likely to be responsible. The sediment yield estimates are generally lower than those recorded for small dam catchments in the Tekeze Basin.

- ***Sediment delivery ratios***: **Ethiopia**: In order to estimate the sediment delivery ratio the gauging stations were located by wereda and the mean soil erosion rate of the wereda used to generate an estimate of the total erosion within the catchment. Two catchments show SDR's of >100 percent. In these cases the amount of soil erosion within the catchment could have been under-estimated. Again there is no clear relationship between basin size and SDR and there is a slight but not statistically significant positive trend line in contrast to the generally published figures. The mean SDR is 49 percent but with a coefficient of variation of 100 percent. There is no significant difference between the sediment yields of small and large catchments, with the mean of the small catchments close to that of the large catchments. This would indicate that there is little or no storage of sediment within the Abbay River system, a factor normally attributed to declining sediment yields with increasing catchment areas. This is to be expected given the steep gradients in both tributary and main rivers. Given the relatively high sediment delivery ratios and very similar sediment yields it would appear that the Abbay River system is also relatively efficient in delivering and removing eroded sediment from the landscape.
- ***Average suspended sediment***: **Ethiopia**: From the data on suspended sediment discharge at three key stations on the main Abbay River, it appears that most of it comes from the tributaries located in the south and west parts of the basin. The average suspended sediment at Bahir Dar station, where Abbay leaves Lake Tana, is about 2.2 million tons per year, or about 143 t square kilometre per year; the average suspended sediment at Kessie station (on the bridge between Addis Ababa and Debre-Markos) is 49.4 million tons per year, or 751 t square kilometre per year, while the average suspended sediment measured at the El Diem station of the Sudanese border is 140 million tons per year, or 700 t square kilometre per year.

4.4. POTENTIAL WATER INFRASTRUCTURE

Dams and reservoirs: Four major reservoirs in the main stem of the Blue Nile (Karadobe, Mandel, Mandiade and the Border) are reservoirs envisaged largely for hydropower development. Quite a number of reservoirs in the highland tributaries of the Blue Nile sub basin in its upper course, including the Tana natural reservoir, are envisaged for the development of irrigated agriculture in the system although no reservoir development is envisaged in the lower course of the sub basin.

Irrigation: Despite problems of land degradation, the sub basin has considerable potential both for hydropower and irrigated agriculture developments.

- Ethiopia:The Tana-Beles together with the Birr & Koga valleys in the upper course and the Gezira intensifications in the lower course are some of the important potential sites for the development of irrigated agriculture in the sub basin. Irrigated agriculture potential in the u/s and d/s reaches are estimated to be more than 950,000 ha (Abbay Master Plan, Sept 1998) and 2.613 million ha (Sudan OSI Water component report, May 2006) respectively. The master plan study for Abbay River has developed a development plans based on two models/scenarios for 50-years planning horizon. The conservative and the accelerated development scenarios envisaged to implement

235,000 ha and 350,000 ha respectively in the planning horizon. The third scenario envisages the development of all identified/potential projects in the planning horizon.

- Sudan: Master plan studies in Sudan indicate that current (2005) irrigated area in the Blue Nile sub basin is estimated at 1.295 million hectare. By the year 2015 this area is expanded to 2.109 million hectare and in 2025 it will be expanded to 2.177 million hectare (Figure 4.28).

4.5. HYDROPOWER AND TRANSMISSION

4.5.1. Installed Capacity

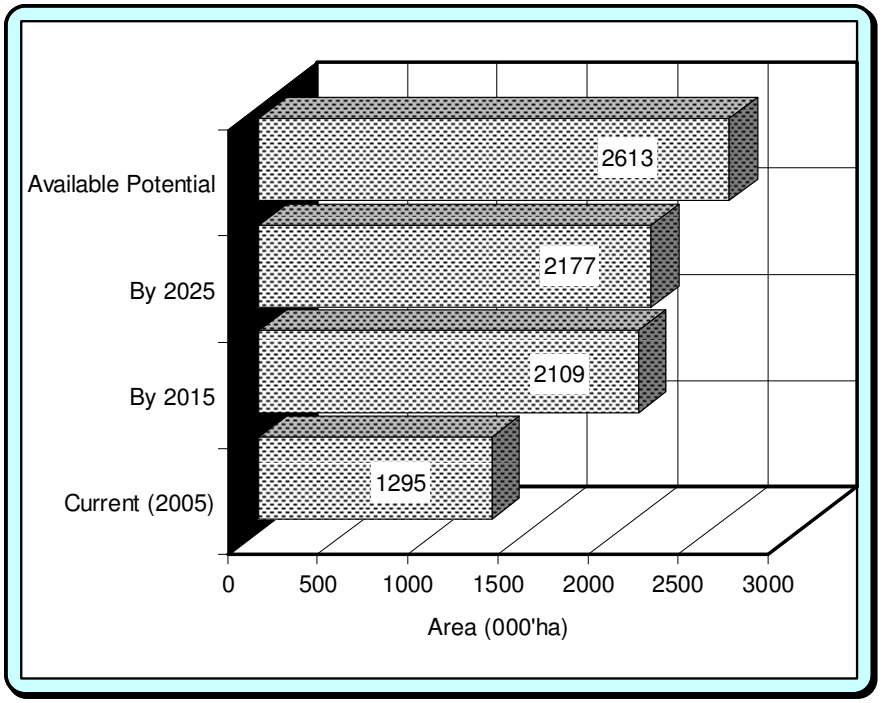
The four hydropower plants existing in the system are, the Tiss Abbay (I & II) and Fincha hydropower plants in Ethiopia and the Roseires & Sennar hydropower plants in Sudan. Tiss Abbay I&II altogether are with installed capacity of 72 MW and the Fincha is at 78 MW. The Roseires and the Sennar hydropower plants are at installed capacity of 280 MW and 15 MW respectively.

4.5.2. Proposed Interconnections and/or Transmission Lines

The high potential for hydropower, in the upper course of the sub basin, is largely derived from its topography. The upper course alone (Abbay in Ethiopia) has more than 70,000GWH/year hydropower potential and only about 1% has been tapped so far (Abbay Master Plan Study, Sept 1998). Due to storage site and head limitations, hydropower potential downstream of the Sudan border is limited.

Both the Tiss Abbay (I&II) and the Fincha hydropower plants are connected to the national grid system of Ethiopia, while the Roseires and Sennar hydropower plants are also connected in to the national grid of the Sudan. So far there is no power transmission connection between the two national grids.

Figure 4.28: Current Irrigation and Expansions in the Blue Nile (Sudan)



Source: Sudan OSI Report, water component, May 2006.

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Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain reported crude birth rate, general fertility rates, age specific fertility rates and cumulative as well as completed fertility at regional level for the year 1984. Also given in the report is estimated age specific fertility rates and total fertility rate at regional level. In addition, the report presents fertility differentials at regional level.

5.3.2 Mortality

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp 93-107.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for SNNP Region. Vol. I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain estimated infant and child mortality rates and life expectation at birth derived using the Trussell Method by sex at regional and zonal levels classifies by rural and urban place of residence for the year 1994. Also given are number of children ever born and surviving by sex age group of mothers classified by urban and rural place of residence at regional and zonal levels.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa, .

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Gambella Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for SNNP Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain children ever born and surviving, estimates of infant and childhood mortality levels along with implied life expectancy at birth by sex and urban and rural place of residence at regional and zonal levels for the year 1994. In addition, abridged life table for male and female population was also constructed at regional level.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

These reports contain number of deaths by sex and age group, crude death rates, age specific death rates by sex and urban and rural place of residence at regional level for the year 1984. Abridged life table, children dead and surviving, estimates of infant and childhood mortality levels along with implied life expectancy derived using different methods are also provided in the reports.

5.3.3 Population Size, Age and Sex Structure and Place of Residence

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part I. Statistical Report, Central Statistical Authority: Addis Ababa, pp 13-26.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa, pp 11-16.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain population size and distribution by age and sex at regional, zonal, wereda and kebelel levels classifies by rural and urban place of residence for the year 1994. The reports indicate actual and projected population size on the basis of the census enumeration. These reports also contain sex ratios by five year age groups and place of residence at regional level for the year 1999.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain population size and percentage distribution by age and sex at regional and zonal levels classifies by rural and urban place of residence for the year 1994. The reports also provide projected population size for each of the years during 1995 to 2030 for total population classified by sex and place of residence. Projected population by five year age group is also provided for 1995 to 2000 every year, but every five years then after.

CSO (1976 to 1984) and CSA (1985 to 2004). Statistical Abstract - Ethiopia. Central Statistical Authority: Addis Ababa.

The statistical abstracts that are issued every year by the Central Statistical Office/Authority provide total population size by sex for each of the weredas, zones and regions in the country. They also provide population density for each wereda, zone and region on the basis of projection made using the most recent census.

CSA (2000). Analytical Report on: The 1999 National Labor Force Survey, Central Statistical Authority: Addis Ababa.

CSA (2002). Ethiopia Child Labor Survey Report, Central Statistical Authority: Addis Ababa.

These reports contain sex ratios by urban and rural place of residence at regional level for the year 2000.

CSA (2004). Report on Urban Bi-Annual Employment Unemployment Survey October 2003 1st Year Round 1, Central Statistical Authority: Addis Ababa.

CSA (2004). Report on Urban Bi-Annual Employment Unemployment Survey October 2003 1st Year Round 2, Central Statistical Authority: Addis Ababa.

These reports contain sex rations for urban parts at regional level for the year 2000.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

These reports contain population size and distribution by age and sex at regional levels classified by rural and urban place of residence for the year 1984. Total Population of urban rural areas of Awrajas, weredas and kebele or Peasant Associations (PAs) are also provided in the report. The reports, moreover, indicate actual and projected distribution of population size by age, sex and place of residence. These reports also contain sex ratios by five year age groups for urban and rural areas at regional level for the year 1984. Sex ratios for different religions groups are also given.

5.3.4 Ethnic and Religious Composition

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp170-246, 327-369.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain the ethnic distribution population by sex and place of residence at regional and zonal levels. The report also present religious distribution of population by age group, sex, place of residence at regional level. Religious distribution by sex and place of residence is also given at zonal and wereda levels.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain percentage distribution of population by major ethnic groups (500 or more) and religions classified by sex and place of residence at regional level. Also presented in the report is percentage distribution of population by major ethnic groups and religious affiliation at zonal levels.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain numerical and percentage distribution of major ethnic groups (10,000 population or more) and religion affiliations by place of residence at regional level and some of the towns with large population size.

5.3.5 Migration

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp 10-73.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain migration status (i.e. level of migration) and length of residence at place of enumeration by sex, age group and place of residence at regional level for the year 1994.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain percentage distribution of migrants and years of last arrivals of migrants by sex and place of residence at regional and zonal levels for the year 1994. Also given are in- migration rates by age group; forms of migration and area of previous residence by length of residence at regional level .In addition, the reports provided socio-economic and demographic characteristics of migrants and non-migrants (e.g. age, sex, marital status, education and economic participation) at regional level for the year 1994.

CSA (1999). Statistical Report on 'The 1999 National Labour Force Survey', Central Statistical Authority: Addis Ababa.

This report contains migration status and duration of residence by sex and place of residence at regional and zonal levels for Tigray, Amhara, Oromiya and SNNP regions for the year 1999. Also given are the size of recent migrants by current and previous region of residence classified by sex and place of residence; reasons for migration by sex and place of residence at region level and zonal levels for some of the selected regions (Tigray, Amhara, Oromiya and SNNP regions). The reports also indicate actual number and percentage distribution of respondent by migration status.

CSA (2000). Analytical Report on The 1999 National Labour Force Survey, Central Statistical Authority: Addis Ababa.

This report contains volume and level of all migration and recent migrants by sex, urban and rural place of residence at regional level for the year 1999. It also contains number of recent in- and out- migrants by sex, as well as form and type of migration at regional level. Percentage distribution of recent migrants' reason for move is also given by sex for each of the regions included in the study.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain the level of migration by sex and place of residence; stream of in- and out- migration rates by place of residence and sex. It also presents forms

of migration by sex and place of origin for the year 1984. Information, however, is available at the then administrative region level.

5.3.6 Urban centers by population and primacy

CSO (1976 to 1984) and CSA (1985 to 2004). Statistical Abstract - Ethiopia. Central Statistical Authority: Addis Ababa.

The statistical abstracts that are issued every year by the Central Statistical Office/ Authority provide total population size by sex for each of the towns in the country.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain the population size of all urban centers by sex, and major towns by age and sex.

5.4 LIVELIHOOD PROFILE/EMPLOYMENT CHARACTERISTICS

5.4.1 Abbay Basin: Ethiopia

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp 279-299.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for SNNP Region. Vol. I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain major occupational and industrial distribution of the economically active population including skilled and unskilled labor in agriculture, livestock, hunting and fishing, as well as jobs taken as primary activity by sex, age group and place of residence at regional level for the year1994. The reports also contain minor occupational and industrial distribution of the economically active population by sex and place of residence at regional level.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain major occupational distribution and major industrial distribution of the economically active population by sex and place of residence at regional and zonal levels for the year 1994.

CSA (1999). Statistical Report on: The 1999 National Labor Force Survey, Central Statistical Authority: Addis Ababa.

These reports contain major occupational distribution and major industrial distribution of the economically active population including skilled and unskilled labor in agriculture, livestock, hunting and fishing, as well as jobs taken as primary activity by sex, age group and place of residence at regional and zonal level for Tigray, Amhara, Oromia and SNNP regions for the year 1999. The reports also contain minor occupational and industrial distribution of the economically active population by sex and place of residence at regional level.

CSA (2000). Analytical Report on: The 1999 National Labor Force Survey, Central Statistical Authority: Addis Ababa.

These reports contain major occupational and industrial distribution of the economically active population including skilled and unskilled labor in agriculture, livestock, hunting and fishing as well as jobs taken as primary activity by sex, age group and place of residence at for the year 1994. The reports also contain minor occupational and industrial distribution of the economically active population by sex and place of residence at regional level.

CSA(2003) Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Benishangul-Gumuz Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household, Land Use, Area and Production of Crops, Part I. Central Statistical Office, Addis Ababa.

CSA(2003) Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Gambella Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household, Land Use, Area and Production of Crops, Farm Management Practice, Livestock and Farm Implement. Central Statistical Office, Addis Ababa.

CSA(2003) Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Oromia Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household. Central Statistical Office, Addis Ababa.

CSA(2003) Ethiopian Agricultural Sample Enumeration, 2001/02 Result for SNNP Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household. Central Statistical Office, Addis Ababa.

These reports contain the type of holding (mixed, crop only and livestock only) of agricultural holders by sex and place of residence at regional, zonal and wereda level for the year 2001/01. The reports also show working status and reasons for not working among the population in the agricultural households by sex and place of residence. They also show employment status and type of working by sex and place of residence at regional, zonal and wereda level.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Authority: Addis Ababa.

These reports contain the distribution of working age population by economic participation status and activity rates, unemployed population and unemployment rates by age group and sex at regional level and major urban centers. The reports also present numerical and percentage distribution of employed and unemployed persons and reasons for not engaging in the labor force by sex and place of residence at regional levels and some of the major urban towns for the year 1984. The reports also contain employment status, occupation and industrial characteristics of the employed people by educational level; and the age as well sex characteristics of the unemployed population.

5.4.2 Blue Nile Basin: Sudan

Hayat Abdullah Bakhiet El Imam (2005). The Incidence of Rural Poverty and sustainable Human Development Polices in Sudan: A case study of El Zeiab Rural Area., Ph.D. Dissertation, University of Khartoum.

The main objective of the study is to explain the causes and effect of rural poverty in Sudan, and to show its impact on population, so as to suggest policy options that would be helpful for reducing rural poverty and facilitating sustainable human development in the rural areas of Sudan. The study argues that in the last ten years (1992-2002) Sudan has witnessed an accelerating spread of poverty, in such a way that individuals and households are becoming unable to satisfy their basic needs. This study has been of particular relevance for the reason that the increasing rate of rural poverty is already reaching unacceptable levels. Indeed, poverty is contradictory to human dignity and rights. And it bears negative effect on human development and individual achievements. It also increases social inequality and political instability, and therefore leads to the displacement of people. The study adopted the following hypothesis:

(1) There is a relationship between development policies and the spread of poverty in rural areas.

(2) Development policies in Sudan have mostly favored the centre. These essential (top-down) policies have been principal literature of poverty in rural Sudan.

(3) The rural poor are not integrated into the development process, and do not participate in the making of decisions that affect their own lives.

(4) The national political, social and economic policies have concentrated on investment, finance and social services in urban areas, leading to greater unbalanced development, and increasing migration from rural to urban areas.

Different methods of data collection are used. The UNDP Human Development indicators of poverty, such as low income and deterioration in primary health care and basic education were used to show the incidence of rural poverty on population.

The study concluded that in all successive government of Sudan, before and after independence 1956, has failed to inst sufficiently in the rural areas. They concentrated on investment (financial and social services, such as primary health care and basic education) in urban areas, neglecting rural areas. This situation has led to greater imbalance in development, has pushed the rural population to migrate to urban areas, searching or better opportunities of employment and welfare live. It also argues that top –bottom development policies in Sudan have not been successful for a number of institutional and structural reasons. These policies have been an important reason for poverty. A truly sustainable human development policy for rural areas implies the need for (bottom- up) approach so as to enable the rural poor to analyze their own poverty and design heir own agenda for fighting poverty. Poor people in rural areas have-not participate in decision-making, and they have not been integrated in the development process.

Al Hadi Ibrahim Osman (1999). Some Aspects of Small Farmers Credit Question: The Case of Singa. Msc. Thesis, University of Khartoum.

The main goal of the thesis is to study the credit system in rural areas, and the relationship between Shail lenders, the Agricultural bank, and the small farmers. The study also seeks to investigate the practice of shail system and its effects on rural production process and to evaluate the performance of the ABS concerning credit provision and other services.

The study holds the hypothesis that the flourishing and the persistence of Shail relations in rural Sudan and the lending behavior of the ABS are reflection of the capitalist system and the inherent urban biased planning that serve the interest of the dominant socio-economic groups at the expense of the rural masses.

The study proved that traditional farming is no longer subsistent, as it has been thought of, and small farmers have become more responsive to the market demands under the policy of free market and liberalization adopted by the government. Farmers no longer borrow to meet consumption needs or paying for social and ceremonial obligation as before. Most of the credit directed to investment in agriculture. Shail lenders are dominant in rural financing markets. The ABS is biased for urban merchants vis-à-vis rural farmers and thus did not replace the traditional Shail system.

The study recommended the full democratization of economic and social life, the provision of basic infrastructures and social services.

5.5 SOCIAL AND PHYSICAL INFRASTRUCTURE

5.5.1 Literacy and Education

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp 10-158.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain status of school attendance and level of schooling by age group, sex and place of residence at regional level; and status of school attendance and level of schooling by sex and place of residence at zone level for the year 1994.They also contain gross and net enrolment ratios in primary and secondary schools by sex and place of residence at regional, zonal and wereda levels. The reports, moreover, provide the distribution of population by literacy status and highest grade completed by sex and place of residence at regional, zonal, wereda levels.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain status of school attendance status distribution, gross and net enrolment rates by sex and place of residence at regional and zonal levels for the year 1994. The reports also contain the distribution of those currently attending school by age, sex, grade and place of residence and also show school progression at regional level by sex and place of residence. Age-sex specific enrolment rates as well as gross and net enrolment rates are also given by place of residence at regional level for the year 1984. The reports also show percentage distribution of population by literacy status, and highest grade completed across sex and place of residence at regional and zonal levels.

CSA (2000) Ethiopia Demographic and Health Survey 2000, Central Statistical Authority: Addis Ababa.

This report contains literacy status and highest level of schooling at region level all persons age five and above living in sampled households for the year 2000.

CSA (1999). Statistical Report on 'The 1999 National Labor Force Survey', Central Statistical Authority: Addis Ababa.

CSA (2000). Analytical Report on the 1999 National Labor Force Survey, Central Statistical Authority: Addis Ababa.

These reports contain literacy status and highest grade completed of literate population by sex at region and zonal level for Tigray, Oromia, Amhara and SNNP regions in 1999.

CSA (2003). Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Benishangul-Gumuz Region, Statistical Report on Socio-Economic Characteristics of the

Population in Agricultural Household, Land Use, Area and Production of Crops, Part I. Central Statistical Office, Addis Ababa.

CSA (2003) Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Amhara Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household, Land Use, Area and Production of Crops, Farm Management Practice, Livestock and Farm Implement. Central Statistical Office, Addis Ababa.

CSA (2003). Ethiopian Agricultural Sample Enumeration, 2001/02 Result for Oromia Region, Statistical Report on Socio-Economic Characteristics of the Population in Agricultural Household. Central Statistical Office, Addis Ababa.

These reports contain literacy status and level of education of agricultural household population by sex, place of residence and holding status at regional level for the year 2001/02. The reports also contain proportion literate by sex and place of residence at regional, zonal and wereda levels.

CSA (1996) Report on the Year 1996 Welfare Monitoring Survey, Volume I. Statistical Bulletin 205, Central Statistical Authority, Addis Ababa, pp 51-73.

This report contains literacy rate, gross and net enrollment ratios, and school drop-outs by sex, distance to the nearest primary/secondary school of households in rural areas at regional level and some selected urban centers for the year 1996

CSA (1998) Report on the 1998 Welfare Monitoring Survey, Statistical Bulletin 224, Central Statistical Authority, Addis Ababa, pp 91-122.

This report contains literacy rates, gross and net enrollment ratios, level of schooling and distance to the nearest primary school by sex and for rural areas at regional and zonal level and for some selected urban centers for the year 1998

CSA (2000). Report on the 2000 Welfare Monitoring Survey, Statistical Bulletin 259, Central Statistical Authority, Addis Ababa. pp 201-247

This report contains literacy rates, gross and net enrollment ratios, level of schooling and distance to the nearest primary school by sex at regional and zonal levels, as well as selected urban centers for the year 2000.

CSA (2004). Welfare Monitoring Survey, Statistical Report on Basic Population Characteristics: Education, Health, Nutritional Status and Child Care. Statistical Bulletin 339-B, Central Statistical Authority, Addis Ababa.

This report contains literacy rates, highest grade completed, gross and net enrollment ratios, and type of school by sex and place of residence by sex and place of residence at regional level for the year 2004

CSA (2003-2004) Report on Urban Bi-Annual Employment Unemployment Survey Round 1 (2003) and Round 2(2004), Central Statistical Authority: Addis Ababa.

These reports also contain literacy status and highest grade completed by sex for urban areas at regional level.

CSO (1985) Rural Labor Force Survey, 1981-1982, Statistical Bulletin 51, Central Statistical Office, Addis Ababa

CSO (1992) Rural Labor Force Survey, 1987/88, Statistical Bulletin 108, Central Statistical Office, Addis Ababa

These reports contain literacy status and level of education of population by sex at regional levels for the year 1981 and 1992, respectively.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain age-sex specific enrolment rates gross and net enrolment rates by place of residence at regional level for the year 1984. The reports also contain numerical and percentage distribution of population by school attendance status and sex for major urban centers with population size of 10,000 and above.

5.5.2 Occupation

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol I: Part III. Statistical Report, Central Statistical Authority: Addis Ababa, pp 279-289.

CSA (1995). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

CSA (1996). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. I. Statistical Report, Central Statistical Authority: Addis Ababa.

These reports contain major occupational distribution by sex, age group and place of residence at regional level and minor occupational distribution by sex and place of residence at regional level for the year 1994.

CSA (1998). The 1994 Population and Housing Census of Ethiopia. Results for Oromia Region. Vol . II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Amhara Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

CSA (1999). The 1994 Population and Housing Census of Ethiopia. Results for Benishangul-Gumuz Region. Vol. II. Analytical Report, Central Statistical Authority: Addis Ababa.

These reports contain major occupational distribution by sex and place of residence at regional and zonal levels for the year1994.

CSA (1999). Statistical Report on: The 1999 National Labour Force Survey, Central Statistical Authority: Addis Ababa.

This report contains major occupational distribution by sex and place of residence at regional and zonal levels for the year 1999.

CSA (2000). Analytical Report on: The 1999 National Labour Force Survey, Central Statistical Authority: Addis Ababa.

This report contains major occupational distribution by sex and place of residence at regional level for the year 1999.

CSA(2003-2004) Report on Urban Bi-Annual Employment Unemployment Survey Round 1(2003) and Round 2(2004), Central Statistical Authority: Addis Ababa.

This report contains major occupational distribution by sex for urban areas at regional level for the year 2004.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Illubabor Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Keffa Region Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wellega Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Wello Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gojjam Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Gonder Region, Central Statistical Authority: Addis Ababa.

Office of the Population and Housing Census Commission (1990). Population and Housing Census 1984. Analytical Report on Shewa Region, Central Statistical Authority: Addis Ababa.

These reports contain distribution of economically active population by major occupation and industry, sex and place of residence at regional levels for the year 1984

5.5.3 Health Facilities

CSO (1976 to 1984) and CSA (1985 to 2004). Statistical Abstract - Ethiopia. Central Statistical Authority: Addis Ababa.

The statistical abstracts that are issued every year by the Central Statistical Office/ Authority also provide the total number of hospitals, health centers, and clinics; as well as total number of medical personnel at regional level.

CSA (1996). Report on the Year 1996 Welfare Monitoring Survey, Volume I. Statistical Bulletin 205, Central Statistical Authority, Addis Ababa, pp 32-38.

This report contains distribution of households according to type of health facility consulted, distance to the nearest health facilities, use of health facilities in rural areas at regional level and some selected urban centers for the year 1996

CSA (1998). Report on the 1998 Welfare Monitoring Survey, Statistical Bulletin 224, Central Statistical Authority, Addis Ababa, pp 48-70.

This report contains distribution of households according to incidence of health consultation, personnel consulted, distance to the nearest health facilities, and use of health facilities in rural areas at regional and zonal levels as well as in some selected urban centre for the year 1996.

CSA (2000). Report on the Year 2000 Welfare Monitoring Survey, Volume I. Statistical Bulletin 259, Central Statistical Authority, Addis Ababa. pp 255-274

This report contains distribution of households according to incidence of health consultation, frequency of visits, distance to the nearest health facilities, use of health facilities at regional and zonal level as well as some selected urban centers for the year 2000

CSA (2004). Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 21-120.

This report contains distribution of households according to distance to the nearest health facilities (health post, clinic, health center, hospital and pre/post natal care), use of health facilities and reason for not using health facilities by place of residence at regional level for the year 2004.

5.5.4 Access to Water and Sanitation

CSA (1996). Report on the 1996 Welfare Monitoring Survey. Statistical Bulletin 205, Central Statistical Authority, Addis Ababa, pp 110-129

This report contains distribution of households according to source of drinking water, toilet facility and method of waste disposal in rural areas at regional level and some selected urban centers for the year 1996.

CSA (1998). Report on the 1998 Welfare Monitoring Survey, Statistical Bulletin 224. Central Statistical Authority, Addis Ababa, pp 170-188

This report contains distribution of households according to source of drinking water, and toilet facility in rural areas at regional and zonal levels and some selected urban centers for the year 1998.

CSA (2000). Report on the 2000 Welfare Monitoring Survey, Volume II Statistical Bulletin 259, Central Statistical Authority, Addis Ababa, pp 209-210, 221-228

This report contains distribution of households according to source of drinking water, toilet facility and method of waste disposal at regional and zonal levels, and some selected towns for the year 2000.

CSA (2004) Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 123-131, 150-161

This report contains distribution of households according to distance to the nearest drinking water during dry and rainy seasons, use of facilities and reasons for not using facilities by place of residence at regional level for the year 2004. The report

also shows the distribution of households by source of drinking water, and type of toilet facilities by place of residence at regional level.

5.5.5 Access to all weather roads

CSA (2004). Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 21-120.

This report contains distribution of households according to distance to the nearest all weather and dry weather roads, use of facilities and reasons for not using facilities by place of residence at regional level for the year 2004.

5.5.6 Access to markets

CSA(2004)Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 21-120.

This report contains distribution of households according to distance to the nearest food market, use of facilities and reasons for not using the facilities by place of residence at regional level for the year 2004.

5.5.7 Access to Credit, Extension and Veterinary Services

CSA (2004). Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 21-120.

This report contains distribution of households according to distance to the nearest credit and extension service provision centers, use of the facilities and reasons for not using the facilities by place of residence at regional level for the year 2004.

5.5.8 Gender Indicators

CSA (2000). Ethiopia Demographic and Health Survey 2000, Central Statistical Authority: Addis Ababa.

This report contains literacy status and highest level of schooling; median age at first marriage; proportion of women who suffered night blindness, nutritional status; knowledge, ever use and current use of contraceptives; Tetanus toxoid coverage among women with recent birth and vaccination coverage among children aged 12-23 months; distribution of immunized children and vitamin A administration at regional level the year 2000.

CSA (2004). Welfare Monitoring Survey, Statistical Report. Indicators on Living Standards, Accessibility, Household Assets, Food Security and HIV/AIDS. Statistical Bulletin 339-C, Central Statistical Authority, Addis Ababa, pp 170-188.

5.5.9 Vulnerability and Poverty Situation

Abdussamad H. Ahmed (1987). Peasant Condition in Gojjam During the Great famine (1888-1892). Journal of Ethiopia Studies, Vol xx, p.1-18. .
The study focuses on the great famine of 1888-1892, that cursed major economic and social upheavals which life hard the population of Gojjam.

Abdussamed H. Ahmed (2003a). Poverty and Agricultural Evolution. In Dessalegn Rahmato (eds). Some Aspects of Poverty in Ethiopia. The selected paper of FSS studies in poverty No1 (FSS Library)

The article state that Ethiopia agricultural process is declining for four decades and confined unabated and some of the structurally elements of this deeming have been examine where agriculture has virtually exhausted its potential x is in capable of in its present from serving as engine of growth and development.

Abraham Molla (2004). Factors Affecting Reproductive Right of Women in Enebssie Sarr Midir District, Amhara Region. MA Thesis in Demography. AAU.

Aklilu Amsalu (2000). A Study on Soil Erosion, Land Degradation and Conservation in the Hulet Wenz Catchment, Andit Tid Area, North Shoa. MA-Thesis in Geography, AAU. .

The study investigates the relationships existing among landforms the process of socio soil erosion and degradation and to evaluate the existing conservation.

Alemante Amera (2005). Early Marriage and Reproduction Health Problems in East Gojjam: The Case of Machakel Wereda, Sostu Debir Shelel PA. MA Thesis in Social Anthropology, AAU

Ali Hassen (2000). Female Headed Households Vulnerability and their Participation in Employment Generation Skills: A Case Study of Two Peasant Association in Mekdela Woreda, South Wello. MA-Thesis in Regional and Local Development Studies, AAU - IES Library.

The study attempts to explain the socio-economic situation of female headed households in South Wello.

Amanuel Abraham (2002). Demographic and Social Factors that Influence Educational Participation of Girls in Primary School in Assosa, Town, Benishangul Gumuz. MA Thesis in Demography AAU.

Ambachew Legesse (1998). Demographic Response to Household Food Insecurity in North Wollo. MA the submitted to AAU in Demography.

The study looks at coping strategies in the case of food insecurity among the community and Northern Wollo.

Amsalu Abushe (2001). Effects of School-Parental Attitudes on Psycho Social Adjustment of High School Adolescents with Visual Disabilities: A Case of Some Selected Western Shoa High School. (M.A Thesis in Special Needs Education).

The study examines the impact of school parental attitudes on blind adolescents psychosocial adjustment status.

Aschalew Gemechu (2000). Determinants of the Nutritional Status of Children in Amhara Region: The Case of Misrak Gojjam and Semen Wello Zones. M.A Thesis in Demography, AAU. .

The study estimates the levels of child malnutrition and identifies the different factors associated with the chronic malnutrition among children.

Bankoff, Greg, George Frerks and Dorothea Hilhorst. Mapping Vulnerability. Sterling: Earthscan.

Baulch, B. 1987. Entitlements and the Wollo Famine of 1982-1985. Disasters 11 (3): 195-204.

Berhanu Ayechew (1998). Pre-marital Sexual Behavior: Pregnancy Incidence and Its Resolution in Bahir Dar Town. MA Thesis in Demography. AAU

Bendz, M. and P.A. Molin (1988). Trees Grow in Wollo. Ethiopian Red Cross Society Mission Report, Rural Development consultants Ab, Vaxjo, Sulldu.

Daniel Tesfaye (2002). Household Livelihood Strategies in South Wollo: The Case of Dankakel PA, Ambasel Wereda. MA Thesis in Social Anthropology, AAU.

Delil Hassen (2001). The Determinants of Off-farm Employment and Its Role in Rural Poverty Alleviation: The Case of Oromia Regional State. M.A in Economic Policy Analysis, AAU. .

The study explains that agricultural sector alone cannot ensure sufficient employment or income for the rural population.

Dessalegn Rahmato 1987. Famine and Survival Strategies: A Case Study from Northeastern Ethiopia. Addis Ababa: Addis Ababa University (Food and Famine Monograph, No.1), 306p. .

Donal Crummey (1997). Deforestation in Wollo: Process or Illusion. IDR Proceeding No. 17,1997.

Eshetu Bekele (2000). The Underlying Cause of Household Food Insecurity and Copying Strategies: The Case of Legambo Woreda, South Wollo Zone, Amhara Region. M.A in Regional and Local Development Studies, AAU. .

The study reports both theoretical and empirical findings on the underlying cause of food insecurity and household coping strategies in Legambo worda.

Fantaye Amsalu (2000). The Role of Married Women in Household Food Security: The Case of Kersa Kondaltiti Woreda, West Shewa. MA in Regional and Local Development Studies, AAU. .

The study investigates the role of the local people in managing biological diversity through agricultural activities.

Fisheha Begashaw (1987). Environmental Degradation Hazards: The Expereince of North Western Planning Region. In Proceedings of Third Social Science Seminar held in Nathareth Oct, 27-29,1978. Report No.7. 1987

Hirut Bekele (2000). Natural Resource Degradation and the Predicament of Rural Woman: The case of Bugna Wereda, North Wollo. MA. Thesis in Regional and Local Development Studies, AAU. .

The study examines the on going Natural Resource degradation and its implication in rural Gelesot (lowland) and Telfetit (highland) kebeles in Bugna Wereda.

Jira Mekonen (2005). The HIV/AIDS Epidemic and its Devastating Consequences on the Lives of Women in Neqemte. MA Thesis is Social Anthropology, AAU.

Keremenz Agoneafir (1997). Socio-economic and Demographic Status and Differentials of Female Headed Household: The Case of Debre Berhan Zuria Wereda. MA Thesis in Demography, AAU.

The study examines the socio-economic and demographic situation and female-headed household bate in urban and rural in comparative way.

Louise Pilote, George Olwit, G/Sillassie Okubagzi and Charles Carson (1991). Community Based Nutritional Survey: Garuke Jimnte peasants' Association (Illubabor Jimma Zone) Southern Ethiopia. Ethiopian Journal of Health Research 5 (1): 25-28

Mekasha Belete (2000). Some Factors Affecting Female Pupils' Participation and Academic Performance in Primary Education in Amhara. MA in Curriculum and Instruction, AAU. .

The thesis dealt with factors that influence the participation and academic performance of primary school girls in Amhara Region.

Mengistu Gonsamo (1998). Effects of Environmental Factors on Distribution of Vegetation on the Eastern Stops of South Wollo Highland, MA Thesis in Geography, AAU.

The study identifies and classifies the vegetation in Southern Wollo and relates distribution and occurrence of visitation with different environmental factors.

Meron Zeleke (2005). The Socio-economic Role and Status and Gumuz Women. MA Thesis in Social Anthropology, AAU.

Mesay Mulugeta (2000). The Study on Rural Household's Food Security Status: The Case of Kuyu Woreda Oromia Regional State. MA Thesis in Geography, AAU. .

The study is on rural households food security status in Kuyu Wereda

Moges Logaw (2000). Some Factors that Influence Attitude Toward Sex Education Among High Schhol Female Students in South Wollo. MA Thesis in Educational Psychology, AAU.

Mulualem Tesema (1998). Gender Bias Analysis of Primary School Text Book of Amhara Region. MA in Curriculum and Instruction, AAU. .

The study tries to investigate the contact of Newly developed primary school text book of Amhara Region Which have gender bias message.

Poluha, E, (1990). Risks, Trees and Security: A Baseline Study of Beddedo, A Peasant Association in Wollo, Ethiopia working paper 111, revised, Swedish University of Agricultural Science, International Rural Development Center-IDRC-UPPSALA.

Seid Mohammed and Binyam G/Egziaber (1993). A cross-sectional study of Anthropometric Measurements of Women in Reproductive Age Group Attending Family Planning Clinics in Jimma Town. Ethiopian Journal of Health Development 7(2): 120.

The study shows that women have a good nutritional status in general, with a promising possibility of having children with better birth weight. There is also a need for researches on total population on women nutritional status in Jimma town.

Selome Bekele (2004). Livelihood Changes Among the Population of Rural North Wollo. MA Thesis in Demography. AAU

Shewandagne Belete, et al, (1977). Famine in Ethiopia. A Study of Shelter Population in the Wollo Region. Journal of Tropical pediatric and Environmental Child Health 23 (1): 15-22 [IES-Library].

Shewandagne Belete, et al, (1977). Famine in Ethiopia. A Study of Shelter Population in the Wollo Region. Journal of Tropical pediatric and Environmental Child Health 23 (1): 15-22.

Solomon Tekalign (1998). Soil and Soil Management Practices in Tullube Catchments of Illubabor Highlands. MA Thesis in Geography, AAU. .

The study assesses the characterization and Classification of soil and the identification of Soil management practices and their implication to soil degradation to full be catchments.

Tesfaye Shiferaw (1992). Maternal Mortality in rural communities of (Illu Aba Bora), South Western Ethiopia. 1992 6(2):54

The finding indicates a life time risk of maternal mortality ratio of 560/100,000 live births which the community experience high that is compounded by high fertility as reflected by total fertility rate of 7.6 (information gap and lack of support planning).

Tilaye Kassahun (1997). Gender Specific Investigation into the Problems of High School Dropouts in the Amhara Region. MA Thesis submitted to AAU

The problem of high school dropouts was attributed to multitudes of school related and socio economic factors.

Tilaye Negawo (1994) The Effect of Selected Proximate Determinates and Socio-Economic Factors on Fertility Rate of Rural Women in North Shewa. MA in Demography. AAU.

The study looks at selected proximate determinants and socio-economic factors and their effects on fertility in rural Setting.

Yared Amare (2002). Rural poverty in Ethiopia: Household Case Studies from North Shewa. FSS Discussion Paper No 9. Forum for Social Studies, Addis Ababa.

The paper has discussed the relationship between poverty and adductive assets which in contrast to measurements of in one, are more realistic portrayal of the current and sustained economic status of peasant households including as a source of food, animal feed, surplus for investment in assets, base of household independence, access to markets, social legitimacy and entitlement to various institutions by state.

Yohannes Dibaba (2003). Sexual Violence against Female Adolescent in Jimma Town. MA Thesis in Demography AAU.

Zewde Shetaie (1999*)*. The Study on Agricultural Production, Environmental Degradation and Carrying Capacity in Debay Tilqtgin Wereda, East Gojjam. MA in Regional and Local Development, AAU. .

The study tries to show the direct consequence of population pressure on resource, especially on issue related to sustainability of environment and food production.

5.5.10 Social Organization

Bartels, Lambort (1970). Studies of the (Oromo) in Wolloga: Thier Own views of the Past. Journal of Ethiopia Studies, Vol. VIII. No. 1 pp.135-160. .

It is an anthropological/ethnographic study of the Oromo of Wollega.

Demeke Eshete (1998) Rural-urban Linkages in East and North Showa Zones. MA in Geography, AAU.

The study examines the nature and determinants of rural-urban linkages between small towns and their hinterland.

Fekadu Begna (1990). Land and the Peasantry in Northern Wollo 1941-1974. Yajju, Rayya and Qobbo Awraja. MA Thesis in History, AAU.

The study is about socio-economic and political development in Yajju, Rayya and Qobbo.

Fekadu Gedamu. (1988). Socio-economic System of the Shanqilla and the New Resettlement Program in Metekel: Conflict and/or Co-operation. In Proceedings of the Workshop on Famine Experience and Settlement in Ethiopia held at Addis Ababa, 29-30 December, 1988. Edited by Tegegne Teka. Addis Ababa: IDR Proceedings No 10.

The paper raises the possible conflict and (or cooperation in the process of interaction and indigenous people and the new settler, taking the “Shanqilla" socio-economic background into account.

Mesfin Woldesellassie (1995). The Role of Ten Small Market Towns in Integrating the Rural-urban Economy: A Case Study in Western Shoa Zone, Especially in Ambo, Chelca and Bako-Tibe Woredes. MA Thesis in Geography, AAU

The study examines the role of ten small market town in integrating the rural-urban economy in Western Shewa Zone.

5.6 CONFLICT AND CONFLICT MANAGEMENT

Abdurouf Abdurahman (2005). Resettlement and the Dynamic of Social Integration in Chewake Resettlement in IlU Aba Bora Zone. MA Thesis in Social Anthropology, AAU.

Alula Pankurest (2002). Surviving in Wellega: The Qetu Experience. In Remapping of Ethiopia: Socialism and After.

The study explores the different way in which the settler have responded to change in production and exchange since the time and their arrival from Wollo to Wellega. It also identifies how the situation changed notably with the respect to the second generation and to the current language policy.

Assefa Tolera (1995). Interethnic Integration and Conflict: The Case of Indigenous Oromo and Amhara Settler in Aoroo Alem, Kiramu Area, North Eastern Wallega. MA Thesis in Social Anthropology, AAU.

The study deals with the Inter-ethnic relation and identifies the factors leading to self initiated migration and settlement and assesses the area of nitration in b/n the Oromo and the Amhara.

Berihun Mebrate (1996). Spontaneous settlement and inter ethnic relation in Matakal, North-West Ethiopia. MA Thesis in Social Anthropology, AAU- [SOSA Library].

The study underlines the nature and the process of population movement and the impact they have on the receiving society focusing on the spontaneous settler of Metekel from Wollo, Gondor and Gojjam.

Demeke Argaw (2005). Co-operation and Conflict management Mechanism among Peoples of Kalu, North East of Ethiopia. MA Thesis Social Anthropology, AAU.

Demissie Guddissa (2005). Social Network, Conflict and Indigenous Conflict Resolution. The case of the Derba Oromo of North Shewa. MA Thesis in Social Anthropology, AAU.

Dessalegh Rahmato (1988). Resettlement and Indigenous People: The Case of Metekel. In Proceedings of the Workshop on Famine Experience and Settlmeent in Ethiopia held at Addis Ababa, 29-30 December, 1988. Edited by Tegegne Teka. Addis Ababa: IDR Proceedings No 10. (IDR Library).

The paper examines the resettlement program in Metekel and its likely consequences on indigenous "Shanqella" population.

Mengistu Wube (1995). Resource Use and Conflict along the Blue Nile River Basin: The Need for New Conservation Sustainability Measures, Uppsala University, Sweden.

The study, by taking the three major countries of the Blue Nile: Ethiopia, Egypt and Sudan in to account, suggests about the need of water resource development project to be implemented in Ethiopia through conservation based sustainability measures. Moreover, the author suggested that political stability, understanding and environmental rehabilitation measures taken by an countries of the Nile Valley are urgently needed if water resource are to be utilized on sustainable basis by Nile Regime countries.

Schwab, P. (1970). Rebellion in Gojjam Province, Ethiopia. Canadian Journal of African Studies 4 (2): 249-25.

Tesemma Ta'a (1984). The Basis for Political Contradictions in Wollega: The Par Land Apportionment Act of 1910 and Its Consequences. Northeast African Studies 6 (1-2): 179-197.

Triulzi, Alessandro. Center Periphery Relations in Ethiopian Studies: Reflections on Ten Years of Research on Wellega History, 7th International Conference. P.359-363

The study revealed to Anthropological and historical researches to focus on the periphery areas of the country with detailed and exhibiting way by the multi disciplinary research method integration in western part of the country.

W/Sillassie Abbute (2002). Gumuz and Highland Resetters: Differing Strategies of Livelihood and Ethnic Relations in Metekel, North-Western Ethiopia. PhD Dissertation, University of Gottingen (Germany)

Yohannes Berhanu (2001). Conflict and Conflict Resolution among the Chihera (Micro-Level Studies from Six Village in North Gondor). MA Thesis in Social Anthropology, AAU. .

The study reveals the major institution that deals with conflict resolution. If also argues that conflict resolution in based on public opinion and cultural consensuses.

5.7 DEVELOPMENT PROJECTS

Abdurouf Abdurahman (2005). Resettlement and the Dynamic of Social Integration in Chewake Resetlement in IlU Aba Bora Zone. MA Thesis in Social Anthropology, AAU.

Adane Mekonnen (1989). Health in Resettled and Indigenous Population in Kelem Awraja, Wollaga region, MPH in Public Health, AAU.

The study assesses the health condition of the study area.

Ahmed Mohammed (2005). The Impact of Resettlement on Demographic and Socio-Economic Variables: The Case Study of Haro Tatessa Resettlement Site (Bedele Woreda in Oromia Region). MA in Demography, AAU.

Alebachew Tiruneh (1997). Preliminary Study on the Development and Expansion of Non-formal Education in Benishangul-Gumuz Region. Research Report. (IER Library). Benishangul Gumuz.

Relevant information for plan of action in the attempt to establish/expand non-formal education is made available.

Alula Abate, Tegegn Teka, Bayu Chane, Admasu Gebeyehu, Kassa Kinde (1988). Evolution of the Impacts of UNICEF Assisted Water Supply Projects in Bale. Haraghe, Shewa and Wollo, Ethiopia Program Cycle 1980-1983. IDR Research Report No. 30. Addis Ababa. Unpublished Memo.

The study attempts to help define the intended effect of rural water supplies and evaluate the socio-economic impacts of UNICEF assisted rural water supplies in and administrative region.

Asmerom Kidane and Assefa Haile Mariam (1988). Some Demographic Characteristics of Settler Population in Metekel and Gambella. In Proceedings of the Workshop on Famine Experience and Settlement in Ethiopia held at Addis Ababa, 29-30 December, 1988. Edited by Tegegne Teka. Addis Ababa: IDR Proceedings No 10. (IDR Library).

The paper examines certain demographic characteristics of settler population at Metekel and Gamballa by making use of the data generated through survey conducted in 1985.

Daniel Ayana (1988). Some Notes on the Role of Village Schools in Grafting Protestantism in Wollega: 1898-1935. In: CV 50, Vol. 1, pp. 329-336. .

This study is about strengthening of the Orthodox monarchies to assist the conquest of Menelik II via missionaries' assistances in the Region to weaken Protestantism.

Dessalegn Rahmato (1997). Environmentation and Conservation in Wollo before the Revolution. IDR Proc No 17.

Desselegh Rahmato (1999). Water resource Development in Ethiopia: Issues of Sustainability and Participation. FSS Discussion Paper No. 1.

The paper emphasizes on water schemes for agricultural purpose (irrigation): large, medium and small-scale whereby the small and uses based pluralist and integrated effort to water development is encouraged. Such schemes are less costly, more sustainable environment friendly and do not involve human displacement which provide beneficiaries the option to manage directly and increase social benefit.

Dessalegn Rahimato (2003). Resettlement in Ethiopia: The Tragedy of Population Relocation in the 1980s. FSS Discussion Paper No 11.

Resettlement is a complex and costly and taking, and without careful planning, a sound assessment of land and other resource avails for resettlement, and the clown involvement of beneficial sis in both endeavors, the chances of success minimum. Resettlement under the Derg was meant to promote food security to relieve population pressure of vulnerable areas and to bring environmental rehabilitation. But none of them succeed in 1980.

ECA and Beneshangul-Gumuz (1997). A Survey of Education program in Benishangul-Gumuz Region.

Schools are scarce and in poor condition. Internal conflict among Gumuz- families affect school enrollment.

Fantahun Ayele (1994) NGOs Relief Operation in Wollo 1973-1986 MA Thesis in History, AAU.

The study advocates the necessity of NGOs involvement in combating famine.

Fanta Moges (2001). An Assessment of the Management Capacity of World Education Offices in the Amhara Region. M.A Thesis in Educational Planning and Management, AAU. .

The study assesses the management capacity of world education offices and identify the major problems of management in the Amhara Region.

Fassil G.Kiros (1979). A Critical Evaluation of Family Planning Prescription for Rural Wollo and Tigray. Ethiopian Journal of Development Research Vol 3. No.1. (IDR Library).

The study underlines the possible recurrence of drought in the region. To avert such occurrence of drought, the study recommends the urgent need for the implementation of family planning measures.

Fekede Tsegaye (1990). Technical and Managerial Aspect of Environmental and Health Impact Assessment of Water Resource Projects. The Ethiopian experience Ethiopian Journal of Health Research 4(1): 65-68. (Special article).

Fifth Nile 2002 Conference Proceedings: Comprehensive Water Resources Development of the Nile Basin for cooperation. Feb 24 –28 1997 (IDR Library)

The Western part of Ethiopia has five water basins, which can produce 80% of the total water volume annually, and only one third of the country's population live within this basins.

Getachew Mekuria and Lulseged Mengistie (PHRDP) (1996). The Role of NGOs and the Private Sector in Social Service Delivery (in Benishangul-Gumuz), Survey Research Report.

NGOs have had a very small impact, about 3% on making towards achieving the give of education for all in the region.

Getachew Olana (1993). Some Factors Influencing Peasant Response to Agricultural Technologies in Ethiopia: The case of Coffee Growers in Ghimbi, Ethiopia. Ethiopian Journal of Development Research Vol. 15 No. 2.

Getahun Hailemariam (1998). Prototype Community Health Information Retrieval System for Jimma Zone: A Case Study of Jimma Institute of Community Health. MA Thesis in Information Science, AAU. .

The study analysis the existing system and propose the design and development of appropriate commuter base information system.

Getu Ambay (2003). Displacement - Induced Resettlement in Pawi, Beles Valley of North West of Ethiopia. MA Thesis in Social Anthropology, AAU.

Hasselblat, G. (1973). The Wollo Settlement Plan A/ Basheer 2(3): 143-154.

Haultin, J, (1977). Mana and Land in Wollega, Ethiopia Gothenbury: University of Gothenbury, Department of Social Anthropology, 88 Pp.

Kassahun Kebede (2001). Relocation and Dislocation of the Communities by Development Projects: The case of Gilgel Gibe Dam (1962-2000) in Jimma Zone, South West Ethiopia. MA in Social Anthropology, AAU, .

The study examines the impact of the project on the local community.

Kinfe Abraham (2004). Nile Dilemmas: Hydro Politics and Potential Conflict Flashpoints. The Ethiopian International Institute for Peace and Development and Horn of Africa. Democracy and Development International Lobby.

The work reflects on the prospects of Nile basin sharing hydro politics and the potential of confects among these countries.

Lelissa Chalchissa (1998). The Determinant of Adoption Intensity and Profitability of Fertilizer Use: the Case of Ejere District West Shewa. MA in Economic Policy Analysis, AAU.

The study attempts to address the determinants associated with fertilizer adoption, intensity and profitability of its use in Ejere District West Shewa.

McCann, J. 1981. Ethio-British Negotiation for the Lake Tana Dam, 1922-1935. International Journal of African Historical Studies 14(4): 667-699.

Misganaw Fantahun, Abubeker Kedir, Assefa Mulu, Dinsa Adugna, Daniel Meressa, Estifanos Muna (2000). Assessment of Antenatal Care Services in Rural Training Health Center in Western Ethiopia. Ethiopian Journal of Health Development. 14(2), 155-160.

The study indicates that the antenatal care at Debark health center though established very few high-risk mothers were using it. The existing ANC clinics need to be improved to effectively screen women with high risk factors and deal with them appropriately.

Ministry of Education (1990). Basic Education in Ethiopia: Challenges and Prospects We Want to Learn, MOE. AA. Policy Related (Library Study), UNESCO.

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