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1. INTRODUCTION

Abbay Basin Authority was established to contribute in creating efficient and stable mechanisms for the implementation of Ethiopian Water Resources Management Policy through river basin plans and sustainable management by relevant stakeholders of the water resources of the basin.

Thus, Abbay Basin Authority is operating having the mission; to contribute for overall sustainable development in the basin by ensuring integrated, participatory, equitable and sustainable water resource management, by Creating favorable conditions for the better protection & conservation of the ecosystem, and through knowledge building & being the center of information. The Authority, also envisions to ensure the socio-economic welfare of the people as a result of the integrated development and sustainable management of the water, land and other related resources of the river basin.

It is obvious that among the powers and duties of Abbay Basin Authority granted by the regulation issued by the Council of Ministers Regulation No.151/2008 is to collect, compile, analyze and disseminate information for proper planning, administration and steering of water resources in the basin.

Compiling and producing a 'state of the basin' is believed to be one mechanism to put to effect the above mentioned duty of the authority. Thus, this document is compiled for the purpose of providing information about the entire feature of the river basin. It aims at presenting relevant information about the socio-economic aspects of the basin, the biophysical environment, the agro-ecology and topography of the basin.

2. PHYSIOGRAPHIC CHARACTERISTICS OF THE ABBAY BASIN

2.2. Geographical Location

Abbay Basin in Ethiopia is located in the northwestern region between 7^0 40' N and 12^0 51' N latitude, and 34^0 25' E and 39^0 49' E longitude. The basin is the second largest basin with an area of 199,812 sq.km. The river basin is deemed to be the most significant river basin in Ethiopia in terms of a wide range of criteria. It occupies 20% of the country's territory and it covers an area of 60% of Amhara, 40% of Oromiya and 95% of Benishangul-Gumuz regional states. It shares a boundary with the Tekeze basin to the north, the Awash basin to the east and south east, the Omo-Gibe basin to the south, and the Baro-Akobo basin to the south west. The country's largest freshwater lake, Lake Tana, is located to the north of the basin.

The basin is subdivided into 16 sub basins based on the major rivers in the basin, the Abbay River and its tributaries (See Fig.1 below).

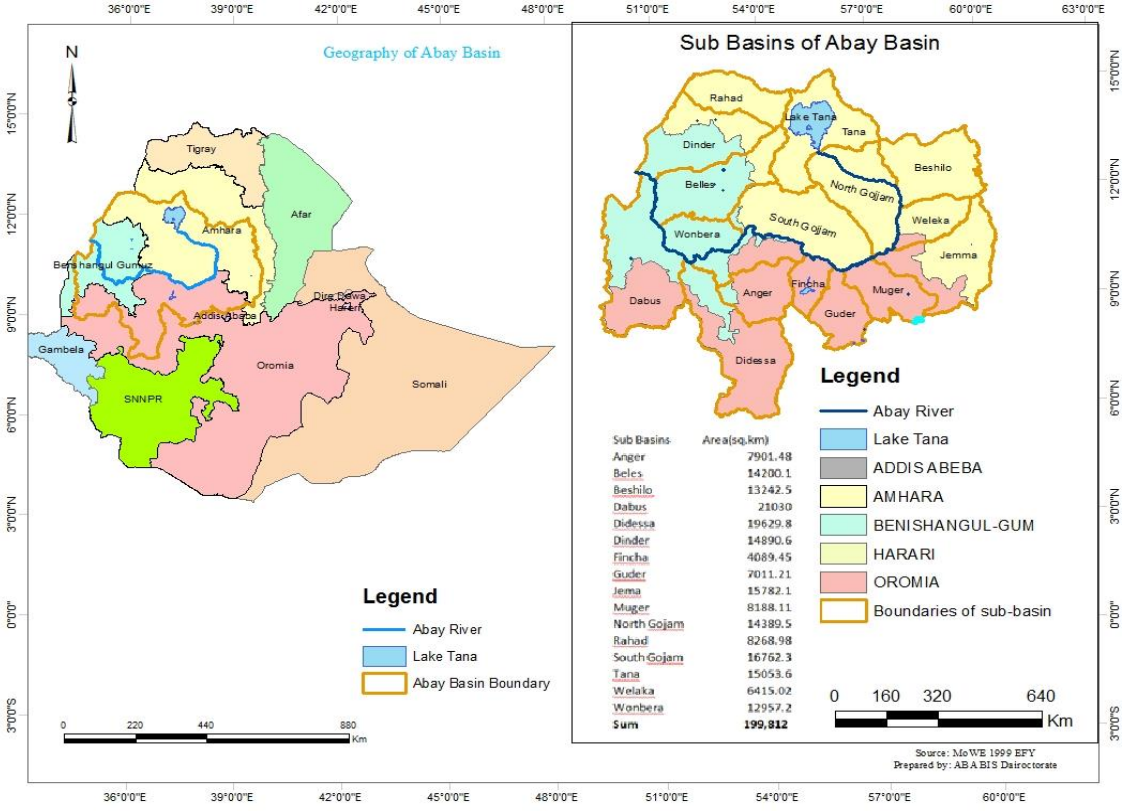


Figure 1:Geographical Location of Abbay Basin

2.2. Topography

The topography of the Abbay basin signifies two distinct features; the ***highlands***, ragged mountainous areas in the center and eastern part of the basin and the ***lowlands*** in the western part of the basin. The altitude in the basin ranges from 498 masl in the lowlands up to 4261 masl in the highlands. The slope of the basin can be grouped in to three as it indicated in the figure below. 85% of the basin areas have slope percentage of less than 30%, 15% of the basin area have steep slope having slope percentage greater than 30%.

The Abbay leaves the lake close to the city of Bahir Dar at the southeastern corner of the lake and cuts a deep gorge first south then westwards, through a series of cataracts. Approximately 40 km downstream it drops 50 m over the TissIssat Falls into the Blue Nile gorge.

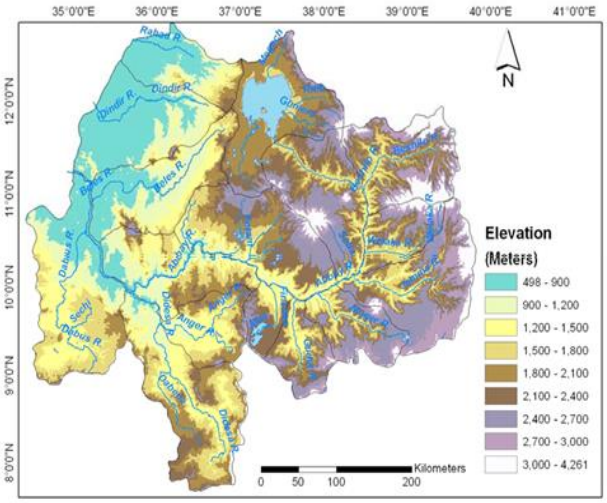


Figure 3:Elevation Map of the Abbay Basin

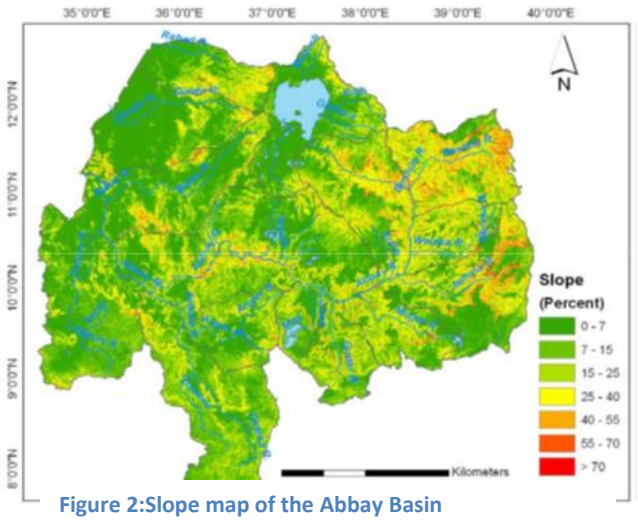


Figure 2:Slope map of the Abbay Basin

2.3. Climate

2.3.1. Rainfall

Within the basin, rainfall varies significantly with altitude and is, to a large extent, controlled by movement of air masses associated with the Inter-Tropical Convergence Zone (ITCZ). There is considerable inter-annual variability, it increases from about 1000 mm near the Sudan border to between 1400 and 1800 mm over parts of the upper basin, and exceeds 2200 mm in some places in the south with a mean of about 1,420mm yr^{-1} (Awulachew*et al.*, 2008).;This proportion generally increases with latitude. Locally the climatic seasons are

defined as; dry season (Bega) from October to the end of February; short rain period (Belg) from March to May the long rainy period(Kiremt) account for a large proportion of mean annual rainfall: roughly 70% occurs between June and September with the greatest rainfall occurring in July and August.

2.3.2. Temperature

The spatial distribution of temperature is strongly related to altitude. The altitude of the Abbay basin ranges from 475 m.a.s.l.at the Sudanese border to 4,257 m.a.s.l. at the summit of Mt. Guna. The highlands (i.e. altitude greater than 1500 m.a.s.l.) and the lowlands are the main landscape units observed in Abbay basin.

The highest temperature observed in the north western part of the basin, in parts of Rihad, Dinder, Beles and Dabus, the maximum temperature being 28^{o}C–38^{o}C and minimum temperature 15^{o}C–20^{o}C. Lower temperature observed in the highlands of Ethiopia in the central and eastern part of the basin the maximum and minimum temperature ranges from 12^{o}C – 20^{o}C and -1^{o}C – 8^{o}C respectively.

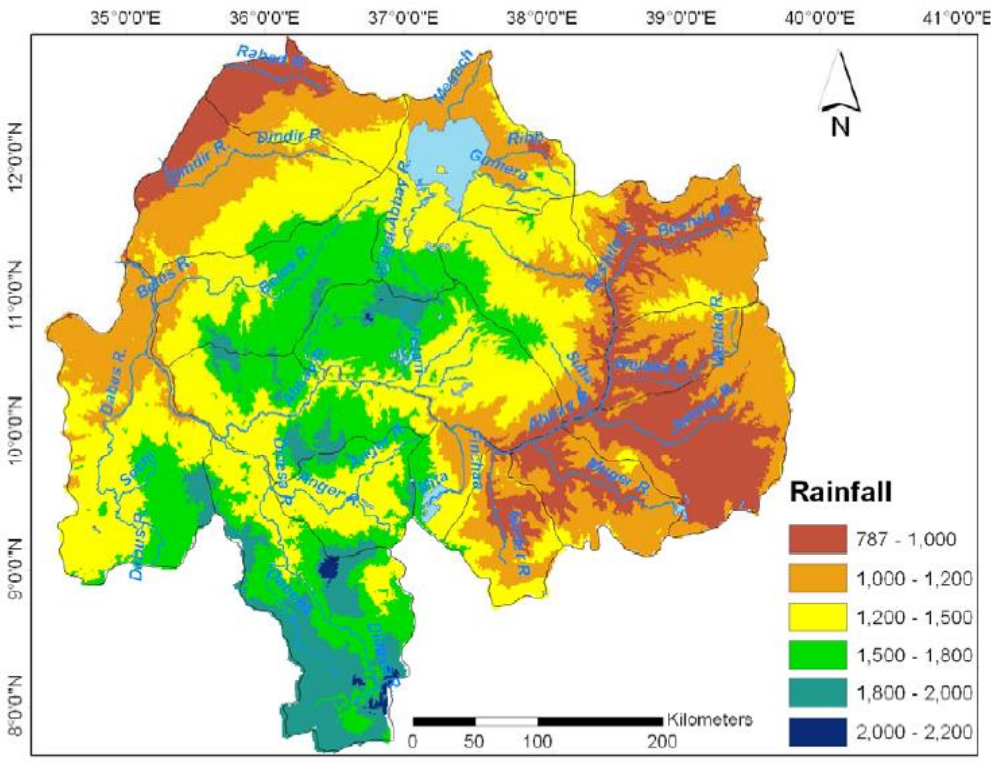
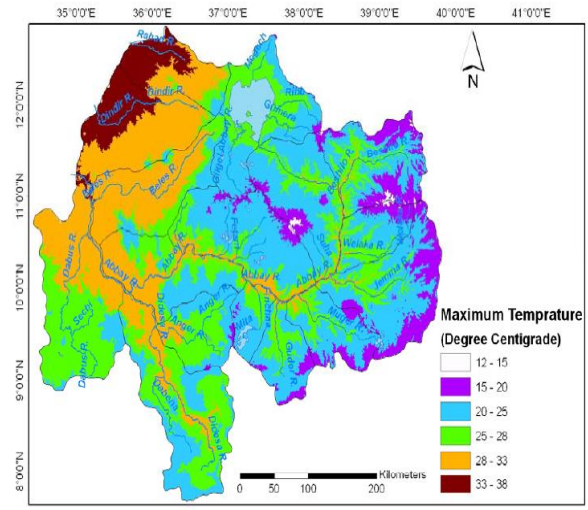


Figure 4:Rainfall distribution in the Basin



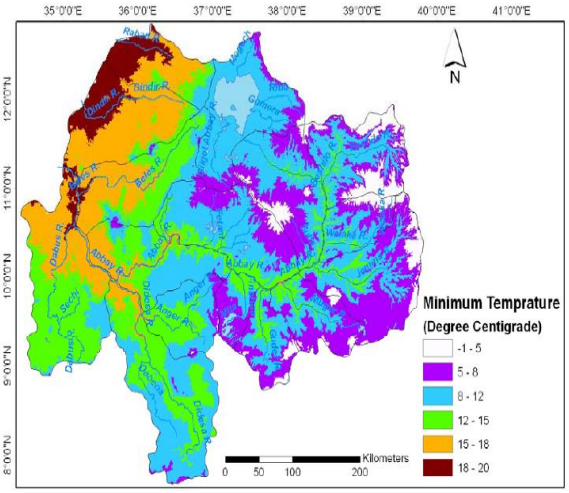


Figure 5.Maximum temperature distribution in the basin Figure.6.Minimum temperature distribution in the basin

2.3.3. Evapotranspiration

Due to its equatorial positioning, the Abbay River is ripe for evaporation in its channels and reservoirs, and evapotranspiration through irrigation practices. Potential Evapotranspiration (PET) in the basin ranges between 1056 mm and 2232 mm per year. High PET is observed between 1800 mm and 2232 mm per year in North Western parts of the basin, in Dinder, Rahad, and parts of Beles and Didessa sub basins. The Eastern and southern parts having lower PET ranging between 1200 and 1800 mm per year and the lowest PET below 1200 mm per year observed in the parts of the highlands (Abbay Basin atlas, 2015) and, in many places, is less than rainfall in the rainy season.

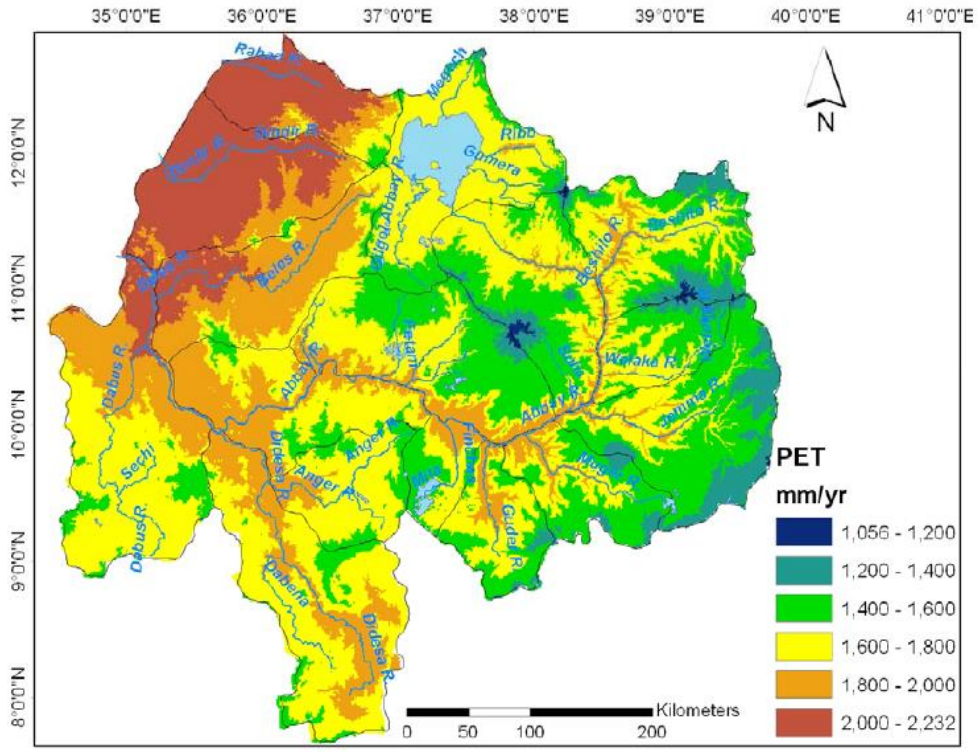


Figure 6: Potential Evapotranspiration of Abbay Basin

2.3.4. Climate Monitoring Stations

There are 349 identified meteorological stations of which 30 are class I or principal, 28 are Class II , 112 are class III and 176 are class IV. The climatic data network shows there is uneven scattering of the stations over the basin and insufficient coverage of low and high areas.

The Tana, Dedissa and Jemma sub basins have intense data coverage; both the eastern and the western parts of the basin have a very low station density. The catchments of Beshilo and Welaka, Rahad, Dinder and Beles, have a very poor coverage of meteorological stations (Fig. 8

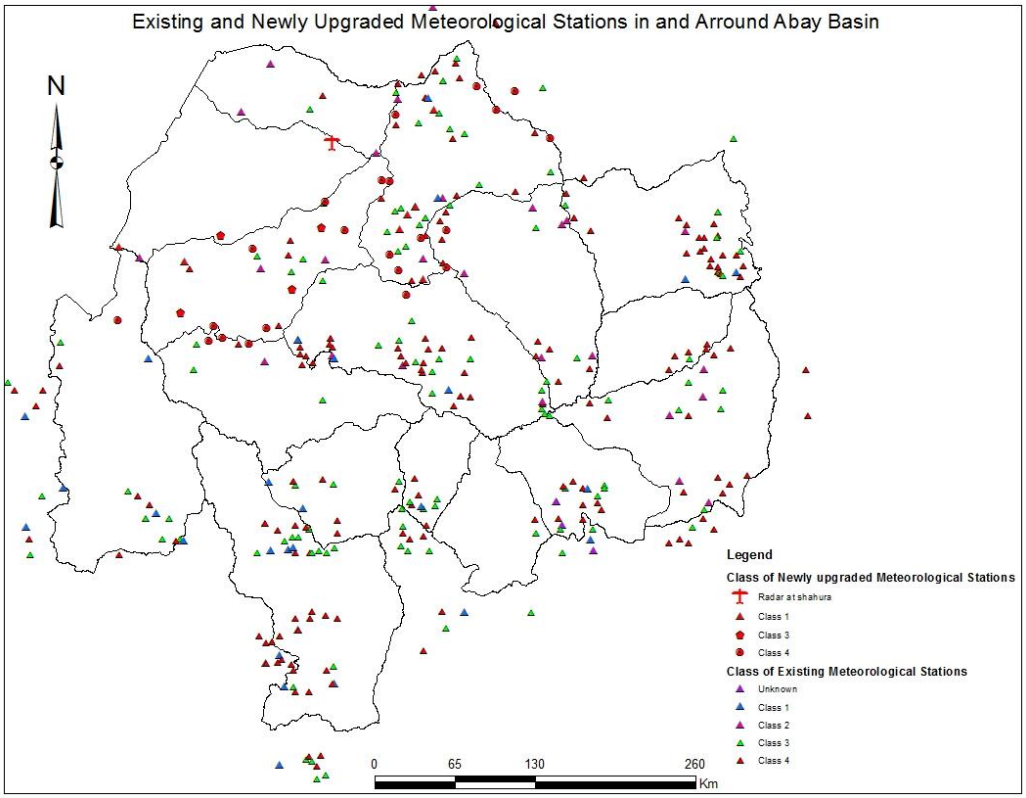


Figure 7: The Distribution of Meteorological Stations in AbbayBasin

Overall, Apart from this, 143 hydrological stations are found in the basin in which 43 of them are newly installed, avanced and upgraded HIS/BIS stations established through the HIS/BIS project. All data from the monitoring network is collected by the Hydrological Branch Offices of at regularly. The data collection activities are mainly engaged in surface water resources assessment which currently comprises collection of stream flow data, lake level, recording of suspended sediment sampling and water quality data.

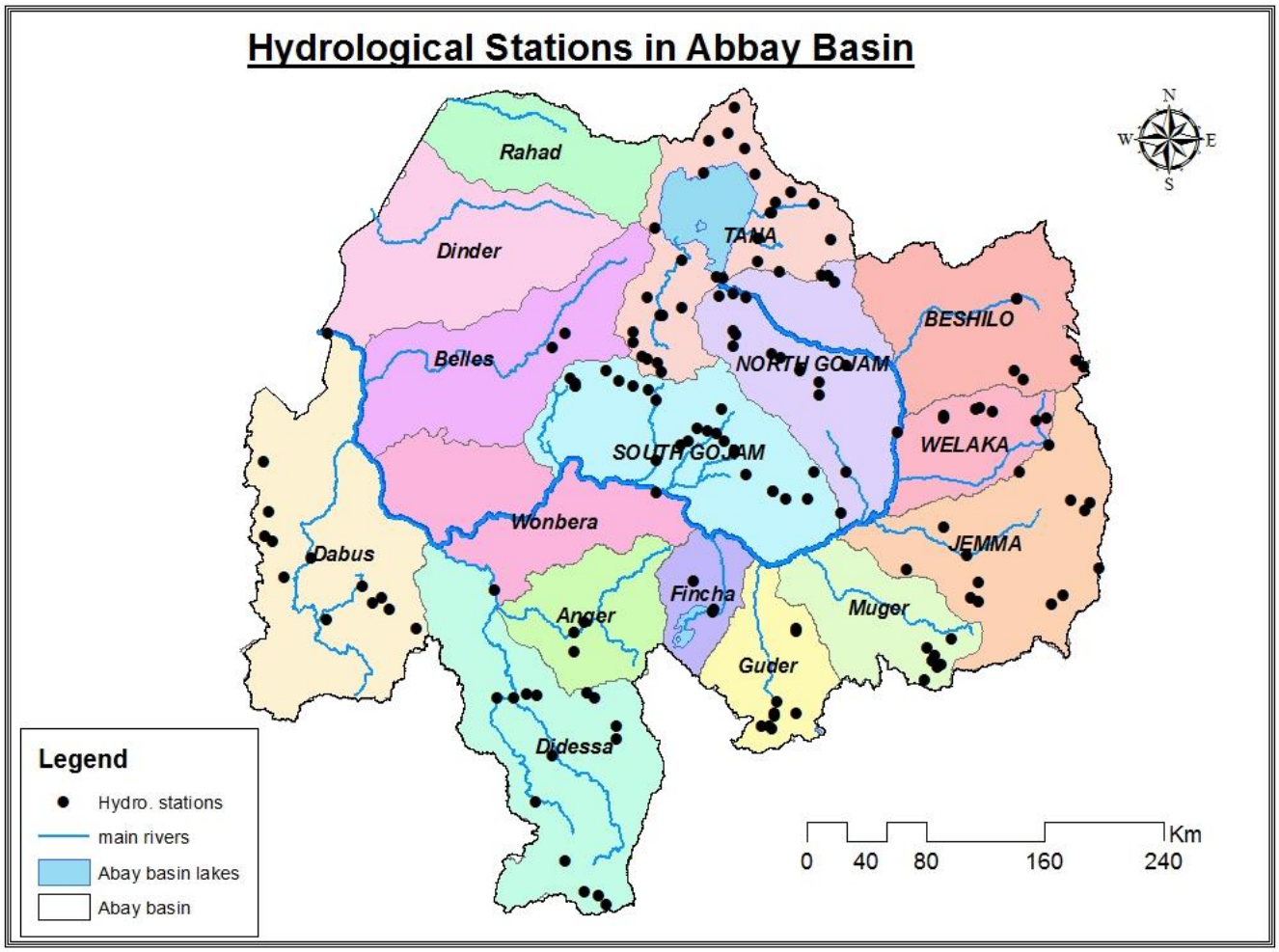


Figure 8 : Hydrological stations in Abbay river basin

2.4. Hydrology of Abbay Basin

The hydrology of the River Abbay is regulated by the interaction between climate and geography throughout the basin. The timing and volume of discharge in the main River Abbay depend on the flow patterns of its tributaries. In turn, water flow and balance within these tributaries and other water bodies within the basin depend on rainfall and temperature patterns; physical characteristics of river channels, lakes, and wetlands; vegetation; and human influences such as dams.

Table 1. Runnoff in each sub basin

Map Unit (no)	Unit Name	Area (KM2)	Runoff Depth in mm
1	Lake Tana	15 054	514
2	North Gojam RB	14 389	486
3	Beshilo LB	13 242	455
4	Welaka LB	6 415	410
5	Jemma LB	15 762	422
6	South Gojam RB	16 762	543
7	Mougr LB	8 188	423
8	Guder LB	7 011	537
9	Finchaa LB	4 089	450
10	Dedessa LB	19 630	651
11	Anger LB	7 901	527
12	Wombera RB	12 957	410
13	Dabus LB	21 032	466
14	Beles RB	14 200	378
15	Dinder	14 891	279
16	Rahad	8 269	339
	TOTAL	199 812	7290

2.4.1. Surface flow

The Abbay River Basin with an area of 199,812 Sq. km is the second largest basin in Ethiopia but has the largest quantity of runoff estimated to be 54.5BCM(Abbay Basin Atlas, 2015). The Abbay River basin drains to Sudan through three main outlets: (i) the main channel of the Abbay River with a mean annual discharge of 49.4BCM at the border. This contributes 94 percent of the basin flow from a drainage area of 172,254 Sq. km; and (ii) the channel of the Dinder and (iii) the channel of Rahad rivers which drain to Sudan to the north of the Abbay channel and join the Abbay. Both the Dinder and Rahad have a mean annual discharge of approximately 5.5 BCM and each contributes 7%of the Abbay River basin flow from a combined catchment area of about 23,160Sq. km. The remainder of the catchment is distributed within smaller water courses on both banks of the Abbay River. These include on the left bank in descending order of entry; the Beshilo, Welaka, Jemma, Muger, Finchaa and Didessa rivers. On the right bank the rivers arising from the Gojam area of the Ethiopian Highlands have smaller more limited catchments and these rivers include; Abeya, Suha,

Chemoga, Birr, Fettam and Dura. Two major tributaries join the Abbay in the lowlands and these include the Dabus on the left bank and the Beles on the right bank.

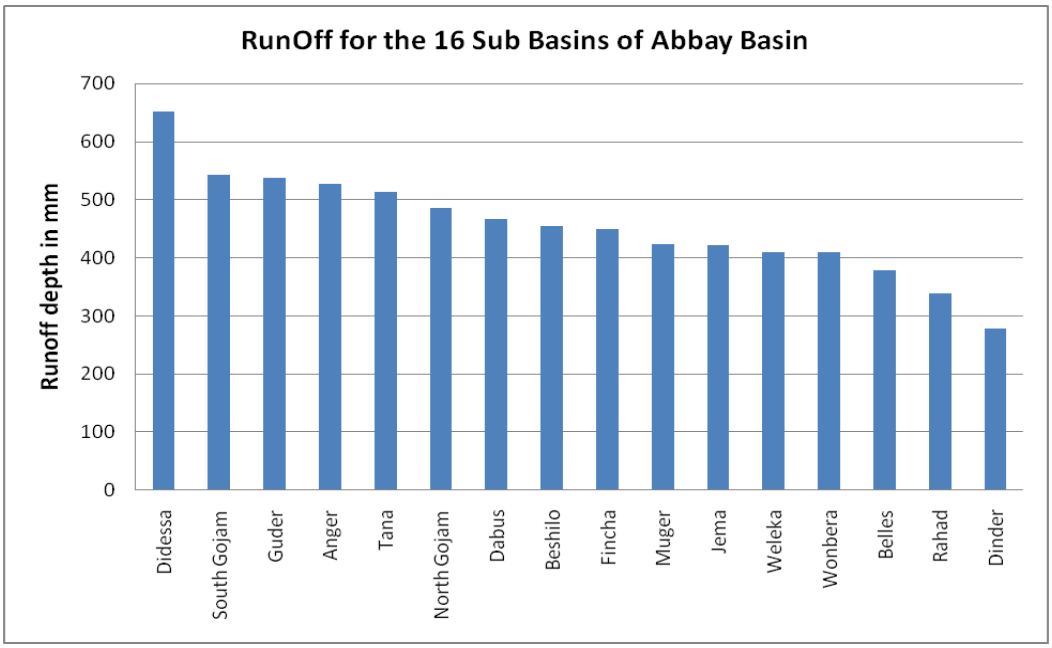


Figure 9 : Runoff depth of the 16 sub basins of Abbay

2.4.2. Ground Water resources

The groundwater resource is almost exclusively included in consolidated rocks: basalts, limestone and sandstone, and metamorphic basement. The retention capacity of these rocks is low. Thus water flow is linked to the presence of fractures. However, it is anticipated that the porosity of some geological formations may make a significant contribution to the groundwater storage (probably Amba Aradam and the Adigrat sandstones).

Most of the water accessible through 60 to 100 m deep boreholes is included in volcanic rocks. Although Adigrat sandstone outcrops in the southern part of the basin, most of this geological series as well as the other sedimentary formations such as Antalo limestone and Amba Aradam sandstones are generally overlain by thick basaltic rocks that impede infiltration. This hydrogeological background has the following consequences:

- Due to their extension and continuity and lithological characteristics, the sedimentary rocks (Adigrat sandstone, Antalo limestone and Amba Aradam sandstone) may provide a regional aquifer.

- Even though some of the volcanic rocks cover large areas, their incision by erosion, their own lithological heterogeneity, and their discontinuity make it difficult to consider them as regional hydrogeological units. Their behaviour can be assimilated to separate hydrogeological units, independent from each other in their relationships with the presence of poorly fissured areas and deep valley entrenchments.
- In most of the area where thick sedimentary rocks exist, the thickness of the overlying volcanic rocks make them inaccessible through water boreholes ranging from 60 to 100 m. Most of the water abstraction through boreholes will be confined to volcanic and metamorphic rocks.

The mean borehole discharge ranges between 3 and 4 l/s except for the Kombolcha area colluvium. In which, the mean discharge is 10 l/s.

Groundwater recharge results mainly from infiltration of rainfall. Rainfall infiltration coefficients per geological series have been derived from the groundwater contribution to surface water; they range between 3 % and 20%.

Recharge, expressed as average continuous flow, ranges between 250 and 300 m^3/s. The aquifers drain relatively freely to rivers as the storage capacity of the water bearing formations is low due to their lithological characteristics, while frequent and deep canyons provide numerous outlets. Even so, dry season flow of the Abbay is still largely dependent on groundwater. At the end of the dry season, the Abbay River at the Sudan border still flows at an average of 100 m^3/s.

However, in the valley escarpments or in the highlands, the storage capacity of the perched aquifers is generally not able to ensure a continuous flow to the springs. In the highland plateau areas most springs dry up during the dry season. The study showed that almost twice as many households (37%) on the Abbay valley escarpment reported groundwater shortages than those in lowland areas (23%), with the majority of shortages occurring from February to beginning of May. The least affected area was the plateau area which is remote to the groundwater drawdown area of the escarpments, while benefiting more from the recharge areas.

2.4.3. Drainage Networks

The whole area of the Basin is intersected by streams, many of which are perennial though highly seasonal in their flow. The primary tributaries of the Abbay Basin are the Beshilo, Derame, Jema, Muger, Finchaa, Didessa and Dabus from the east and south; and the Suha, Chemoga, Keshem, Dera and Beles from the north. From which the main tributaries of the Abbay,Dabus and Didessa Rivers accounts with 10% and 8.5% of the total flow at the border respectively.

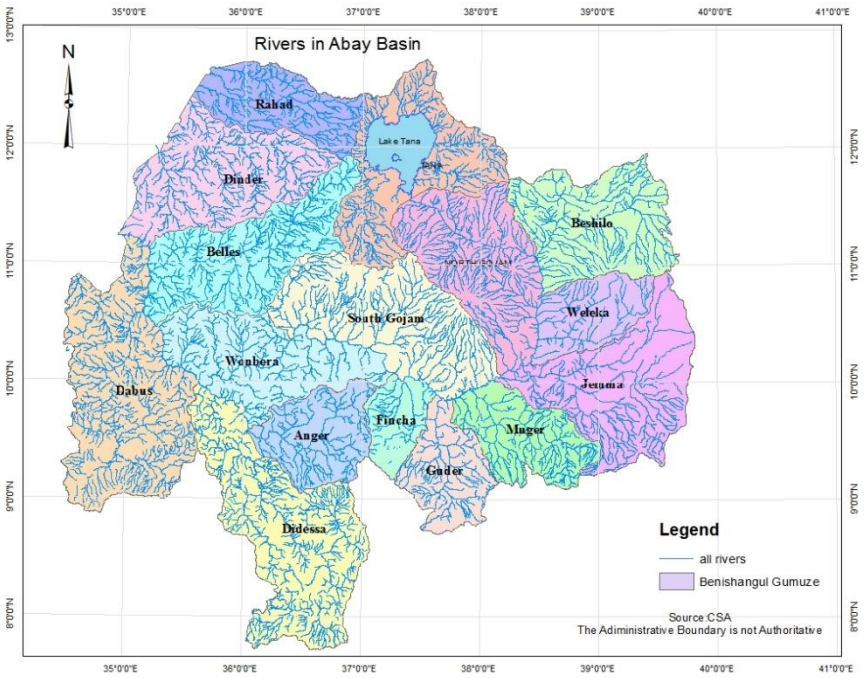


Figure 10: Drainage networks of Abbay Basin.

Table 2. **Sub basin hydro-climatic characteristics in Abbay basin**

Summary statistics for the major sub-basins of the Abbay Basin.						
Sub-basin	Catchment area (km^2)	Mean annual rainfall (mm)	Mean annual evapotranspiration (mm)	Mean annual runoff (mm)	Mean annual flow (Mm^3)	coefficient of runoff
Guder	7,011	910	1,307	312	2,187	0.34
Dabus	21,030	2276	1,112	297	6,246	0.13
Finchaa	4,089	1766	1,290	438	1,719	0.25
South Gojam	16,762	1633	1,183	299	5,012	0.18
Anger	7,901	1813	1,318	298	2,355	0.16
Beles	14,200	1655	1,274	306	4,345	0.18
Didessa	19,630	1816	1,308	289	5,673	0.16
Muger	8,188	1347	1,210	298	2,440	0.22
North Gojam	14,389	1336	1,242	305	4,389	0.23
Jemma	15,782	1105	1,059	304	4,798	0.28
Tana	15,054	1313	1,136	253	3,809	0.19
Welaka	6,415	1072	1,263	323	2,072	0.3
Beshilo	13,242	982	1,140	296	3,920	0.3
Wombera	12,957	1660	N/A	299	3,874	0.18
Dinder*	14,891	N/A	N/A	188	2,797	N/A
Rihad*	8,269	N/A	N/A	133	1,102	N/A

Source: Modified from Gupta and Van der Zaag, 2007N/A -not available,* Joins Nile in Sudan

2.5. Agro Ecological Zones of Abbay Basin

The agro-ecology of the basin is divided into three major climatic zones, cold to very cold, tepid to cold, and hot to warm, and further divided into moist, sub moist, humid and sub humid. The agro-climatic zones of the basin are considered based on the topographic nature that ranging from about 475 masl to the highest elevation about 4261 masl. There are five traditional agro ecological zones as described in the table below.

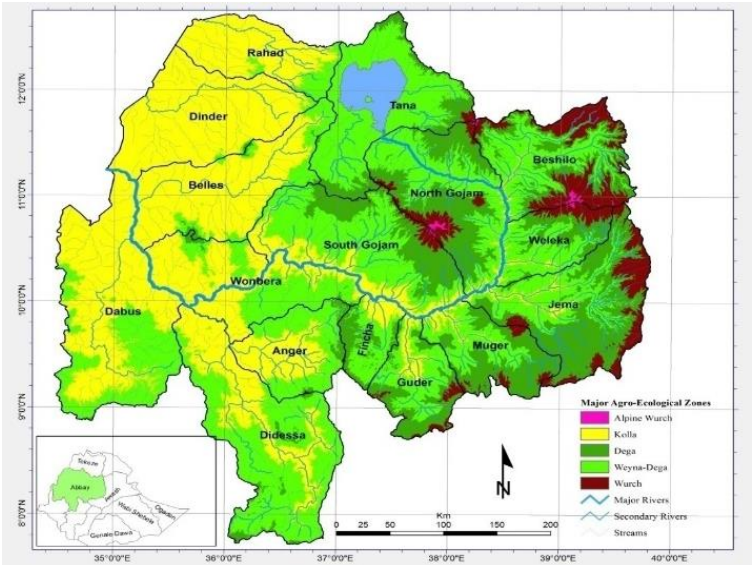


Figure 11: Traditional agro-ecological zone in the Abbay Basin

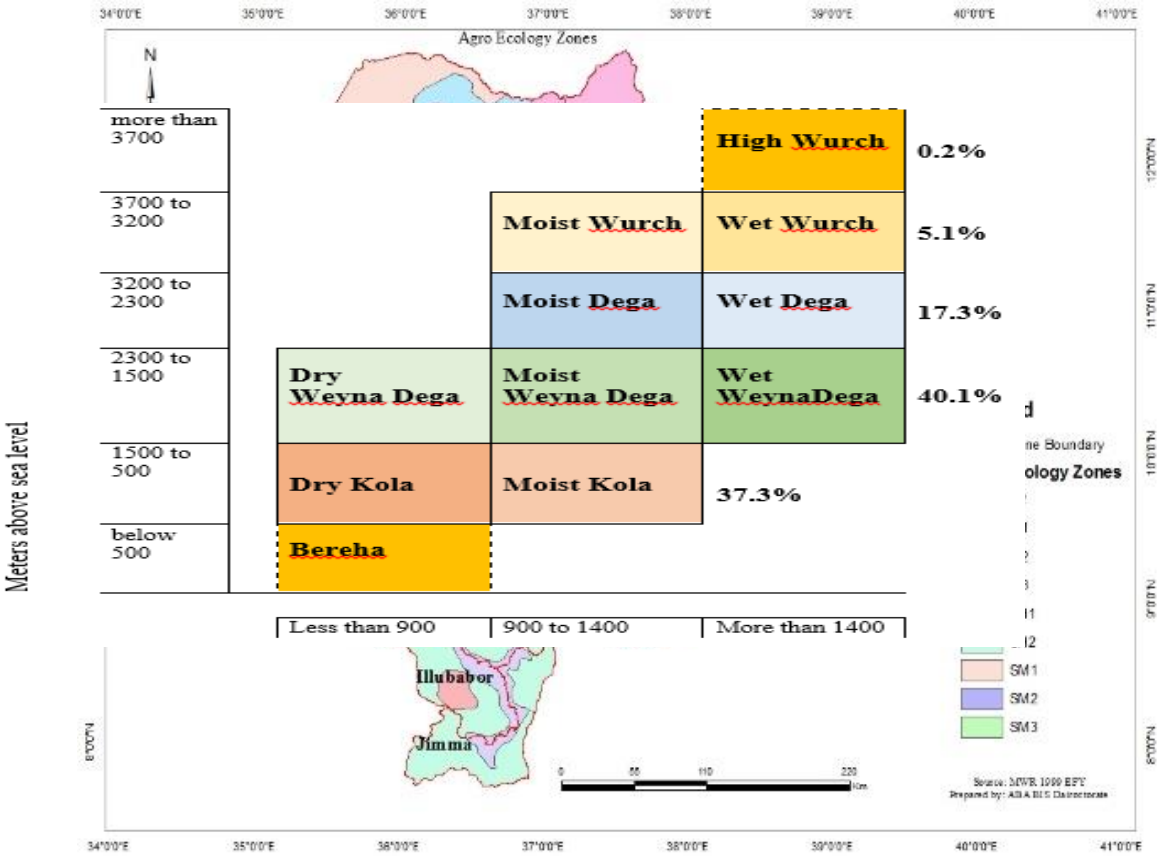


Figure 12: Tabular representation of Traditional agro-ecological zone in the Abbay Basin

Figure 13: Major agro-ecological zone in the Abbay Basin

H2: Tepid to cool humid mid to high altitude

M1: Hot to worm moist low lands and high lands

M2: Tepid to cool moist mid to high altitude

M3: Cold to Very cold moist sub-afro alpine to afro alpine

SH1: Hot to worm Sub humid low land to the mid altitude

SH2: Tepid to cool Sub-humid low to high altitude

SM1: Hot to Worm sub moist lowlands and plateau ruminants

SM2: Tepid to cool Sub moist low to high altitude.

SM3: Cold to very cold Sub moist sub afro alpine to afro alpine

2.6. Land use/land cover

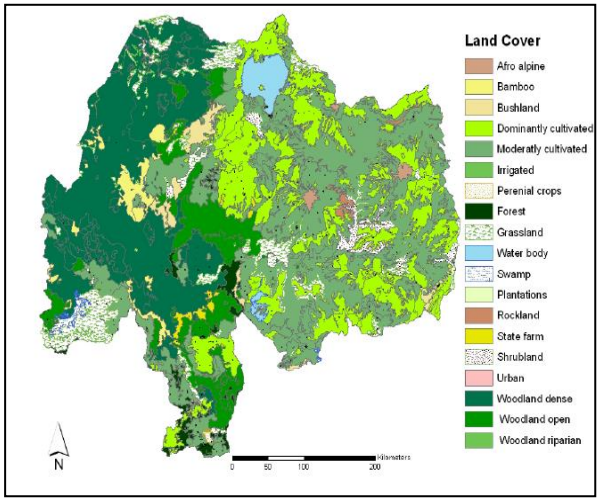
The land cover for the basin is mainly characterized by dominantly cultivated, in the eastern part, and grass land, wood lands, and forest to the western part according to the master plan land cover classification.

Land	Amhara	Oromia	Beni-Gumuz	Total km^2	Total %
Use Category					
Cultivated	42,736	22,349	2,805	67,890	34%
Tree Crops	-	260	-	260	0.13%
Plantation	301	228	8	537	0.27%
Afro-alpine	927	174	2	1,103	1%
Disturbed forest	65	2,128	83	2,276	1%
Bamboo	918	872	5,536	7,326	4%
Wood land, bush land & shrub land	20,598	16,549	23,291	60,438	30%
Grassland	17,797	15,387	12,959	46,143	23%
Wetland	1,110	1,274	-	2,384	1%
Water body	3,045	370	-	3,415	2%
Rock	5,085	2,833	14	7,932	4%
Urban areas	58	50	-	108	0.054%
Total	92,640	62,474	44,698	199,812	100%

Table 4. Land use type of Abbay Basin

Land Use type	**Use in Hectare**
Agricultural(A)	3987834.06
Agro-past(AP)	5561400.55
Agro-sylvic(AS)	1559728.84
State Farm(SF)	96832.99
Pastoral(P)	1458909.63
Sylvo-past.(SP)	1741791.59
Sylvi-cultural(S)	729763.19
Traditional(T)	4349205.46
Water(W)	46119.38
Marsh(M)	64829.28
Un useable(N)	70083.48
Urban(U)	10410.57
Lake tana	304162.64
Total	**19,981,071.66**

Figure 14: Land Cover of Abbay Basin



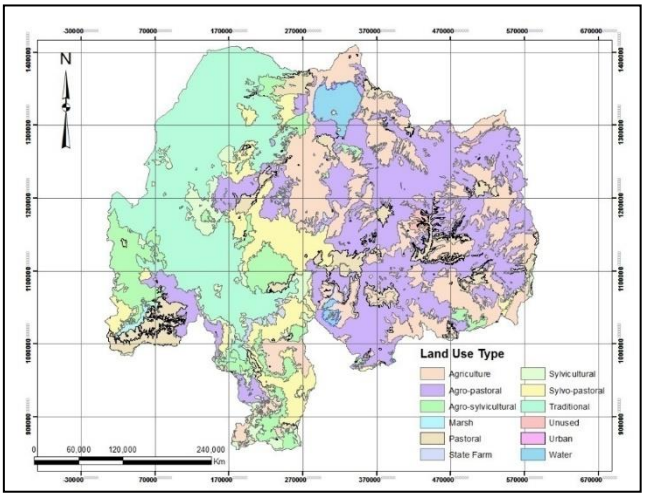


Figure 15: Land Use type of Abbay Basin

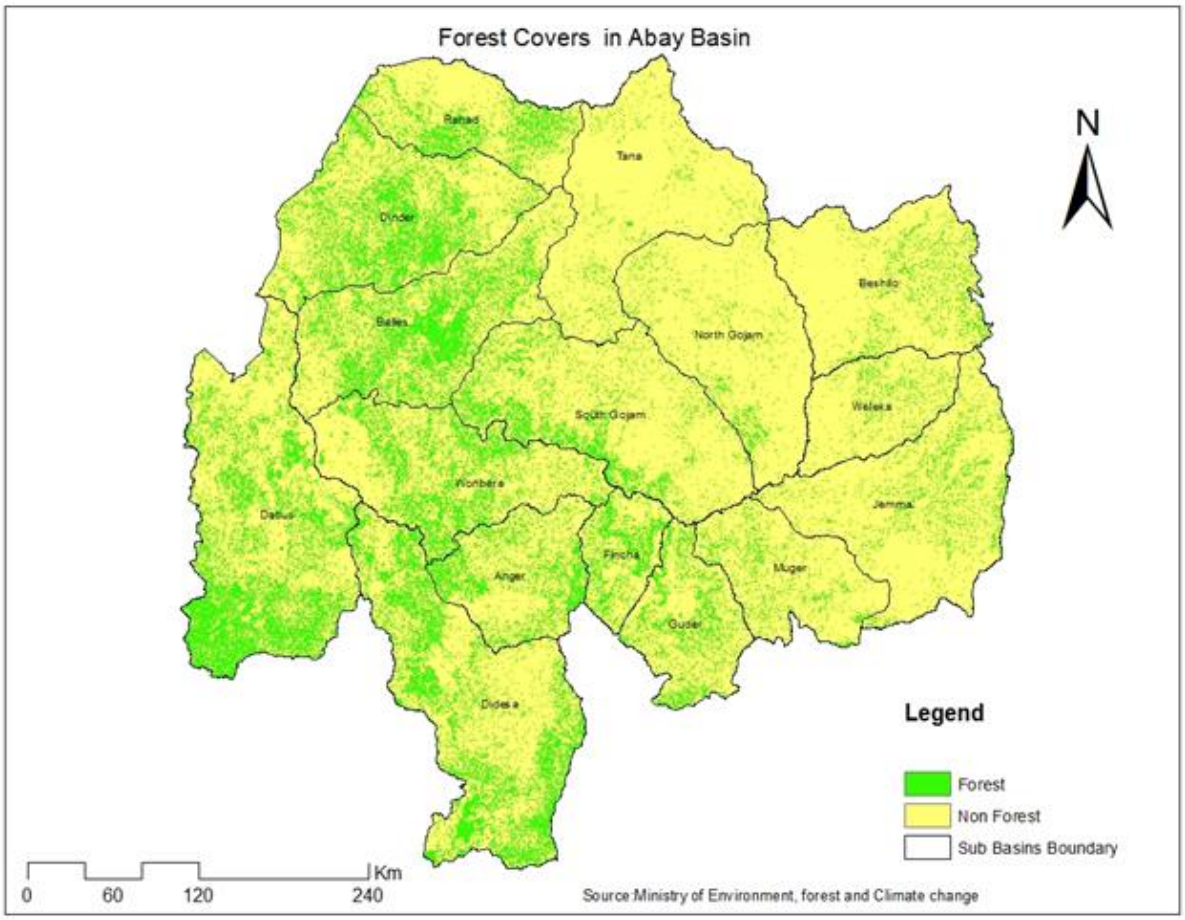


Figure 16: Forest cover in the Abay basin

2.6.1. Different Land use/cover types in brief

***Cultivation*:**67,890 Sq. km; 34% of basin; 46 % of Amhara Region; 36% of Oromiya Region and 6% of Benishangul-Gumuz Region.

***Tree Crops*:** (260Sq. km; < 1% of basin). Coffee production in Jimma, Illubabor and some parts of Welega in Oromiya; Mango tree in Benshangul -Gumuze region is the only occurrence of this land use classification.

Plantations (537 Sq. km; <1% of the basin): This mainly includes *Eucalyptus* spp. together with *Cupressuslusitanica*which have been planted for wood and fuel wood. ***Afro-alpine vegetation*** (1,103 Sq. km; 1 % of the basin; Amhara 1 %). This includes areas above 3,200 masl such as Mt Guna and Mt Choke. These areas are characteristically almost devoid of any forest and this is replaced by moist moorland. At its lower extremity the afro-alpine vegetation consists of shrubs, sedges, short woody bushes and occasional trees. Cultivation may now extend up to 3,000 masl on many of these areas, which is now posing a threat to the stability of these extremely fragile areas. Other areas of afro-alpine vegetation occur in limited areas in Oromiya, while 2 km^2 has been reported for Benishangul- Gumuz Region.

DisturbedForest(2,276 Sq. km; 1 % of basin). No areas of undisturbed forest remains anywhere within the Abbay basin. The original forest remains in a few places but the overall effect is one of a seriously disturbed environment. The greatest conversion has occurred in the Amhara and then in the Oromiya Region where areas of forest have been cleared for coffee planting. Disturbed forest areas remain at; Gera, Setema, Jimma, Komto, Chato and Guangua. All of these areas have been classified as National Priority Forest Areas (NPFA's).

Bamboo (7,326Sq. km; 4 % of basin; 1 % of Amhara and Oromiya areas; 12 % of Benishangul-Gumuz Region). Extensive stands of *Oxytenantheraabyssinica* and occasionally *O. borzii,* occur in the lower areas of the western part of the basin.

Woodland, Bush land and Shrub land (60,438Sq. km; 30 % of basin; 22 % Amhara; 26 % Oromiya and 52 % of the Benishangul-Gumuz Regions). These areas occur mainly in the lower western slopes of the basin and are normally always associated with a grass understory or grassed areas between areas of low woody vegetation. These areas support pastoralism,

while a major traditional economic activity has been the collection of *Gumarabic* and *frankincense*. Both Guba and Asosa are noted centers for the supply of aromatic gums to wider markets within Ethiopia and elsewhere. *Gumarabic* is also collected within the basin from; Mankush, Bambudi, Almahal, Gizen, Kurmuk, AmuruGarte, Delias and Ginde Beret.

The Grasslands (46,143Sq. km^2; 23 % of basin; 19 % of Amhara; 25 % of Oromiya and 29 % of Benishangul-Gumuz Regions). Two types of grassland occur within the basin; lowland tall grasslands and highland temperate grasslands.

Lowland Tall Grasslands:occur in low rainfall areas and are dominantly grassland interspersed with a few trees, shrubs, and other woody vegetation. The main grasses that occur within these areas are *Hyparrhenia*spp. *Digitaria spp*. and *Panicumspp* often in association with *Acacia* shrub lands. These grasses often occur together with gourds, wild squashes and *Acanathaceae* and *Convolvulacea*. Grasslands mainly occupy the lower humid valleys of the Beles, Anger and Didessa valleys where they are maintained as a fire deflected succession by repeated burning.

Highland Temperate Grasslands: occur above 2,000 masl and include palatable grass species such as *Pennisetum, Andropogon, Eragrostis* and *Cynadon.* Better areas may be interspersed with clovers such as *Trifolium*spp. (low grazing pressure) while herbs consisting of *Haplocarphaschimperi,* chickweed (*Cerastium*s pp.) and sedges (*Cupressus*spp.) occur in wetter areas. Due to an increasing shortage of grazing areas, especially in the Amhara Region many of these areas are intensively grazed, by cattle, sheep and goats. Consequently many of these areas are now suffering from overgrazing, loss of fertility from gathering of cattle dung for fuel. These areas are now actively degrading.

Wetlandareas (2,384 Sq. km; 1 % of basin; 1 % Amhara; 2 % Oromia). These areas can be either permanent swamps such as the Dabus swamp or, else they may seasonally recede as around Lake Tana. This gives rise to recessional agricultural use during the dry season where plantings follow the water level down as the lake level drops.

WaterBodies (3,415Sq. km, 2 % of basin; 3 % of Amhara; 1 % Oromia); these areas include inland lakes and waterways. Lake Tana at 3,042 km^2 is the largest inland lake in Ethiopia and is an important regulating feature for the Abbay River. It is also an important fishery resource and wildlife area with regard to its aquatic and wetland habitats. Other important water

bodies are the Dabus, Finchaa and Chomen swamps. These areas are much shallower and have greater affinity as swamp and wetland areas rather than lacustrine environments. Other small lakes occur throughout the basin as crater lakes within extinct volcanoes, e.g. Lakes Zengena and Dendi.

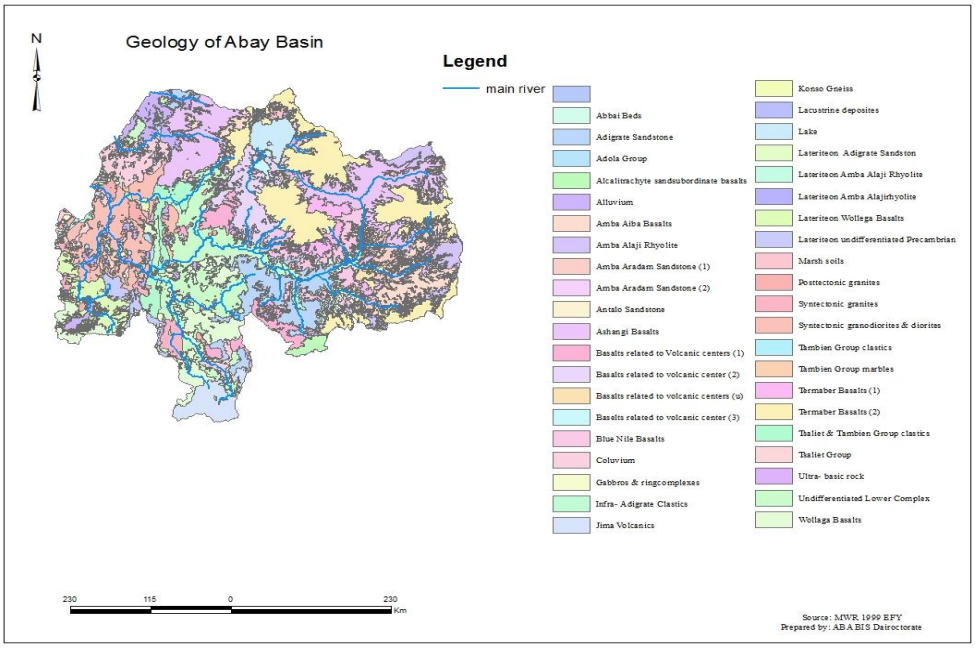
Rock (7,932 Sq. km; 4 % of basin; 5 % of Amhara; 5 % of Oromia); this is mostly accounted for by large areas of exposed rock on ridges, escarpment sides and valley bottoms e.g. the Abbaygorge. Other areas occur as exposed rocky ridges in hilly areas to the west of Gondar. There is very little of this unit in Benishangul-Gumuz as the area is mainly composed of lowlands with few steep rocky areas.

UrbanAreas (108Sq. km; < 1 % of basin). This is accounted for by land take required for towns e.g. Gondar, Bahir Dar, Nekemte, etc.

2.7. Geology

The geology of the basin signifies different formations such as Basalt, Alluvium, Lacustrine deposit, sand stone, granite and marbles. The dominant rock is Basalt (Tarmaber basalt, followed by Ashange basalt, and Amba Aiba basalt).

The Highlands of the 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 lime stones and then sandstones before the Basement Complex is reached.



: Figure 17 Geological map of Abbay Basin

2.8. Soils

The major soils of the basin are Leptosols, Alisols, Nitisols, Vertisols, Cambisols, and Luvisols, in orderof decreasing areal coverage (BCEOM, 1998b). Leptosols (22%) represent the mostwidely occurring soils within the basin, mostly along the course of the BlueNile/Abbay River and its main tributaries. They are shallow soils with limited profiledevelopment and are usually prone to drought. Alisols (21%) are the second mostimportant soils in terms of area coverage. These soils are reddish brown in colour andhave deep profiles (>100 cm). Alisols are mainly derived from basalts, granites andgranodiorites and possess favourable drainage, structure and workability. Nitisols(16%) are the third most important soil group within the basin in terms of area.Nitisols are derived from basalts/tuffs and granites/associated felsic materials. On the flat plateaus in the Ethiopian Highlands are extensive areas of Vertisols (15%). Thesesoils are reddish brown in colour, clay to clay loam in texture, well drained and verydeep (>200 cm).

Table 3: Major Soils Located in the Abbay Basin

Major Soil Type	Percent of Area
Leptosols	21.46
Alisols	20.71
Nitisols	15.9
Vertisols	15.18
Cambisols	9.46
Luvisols	9.05
Acrisols	4.46
Regosols	0.71
Arenosols	0.66
Fluvisols	0.31
Phaeozems	0.05
Total	97.95
Miscellaneous Units	
Marshes	0.39
Urban Areas	0.03
Water Body	1.62
Total	2.04
Grand Total	99.99

Corresponding to the variation in landscape and other soil forming factors such as climate and vegetation, the soils of the basin are also highly variable. However, only four soil types, Leptosols (22%), Alisols(21%), Nitisols (16%) and Vertisols(15%). cover over 74% of the area.

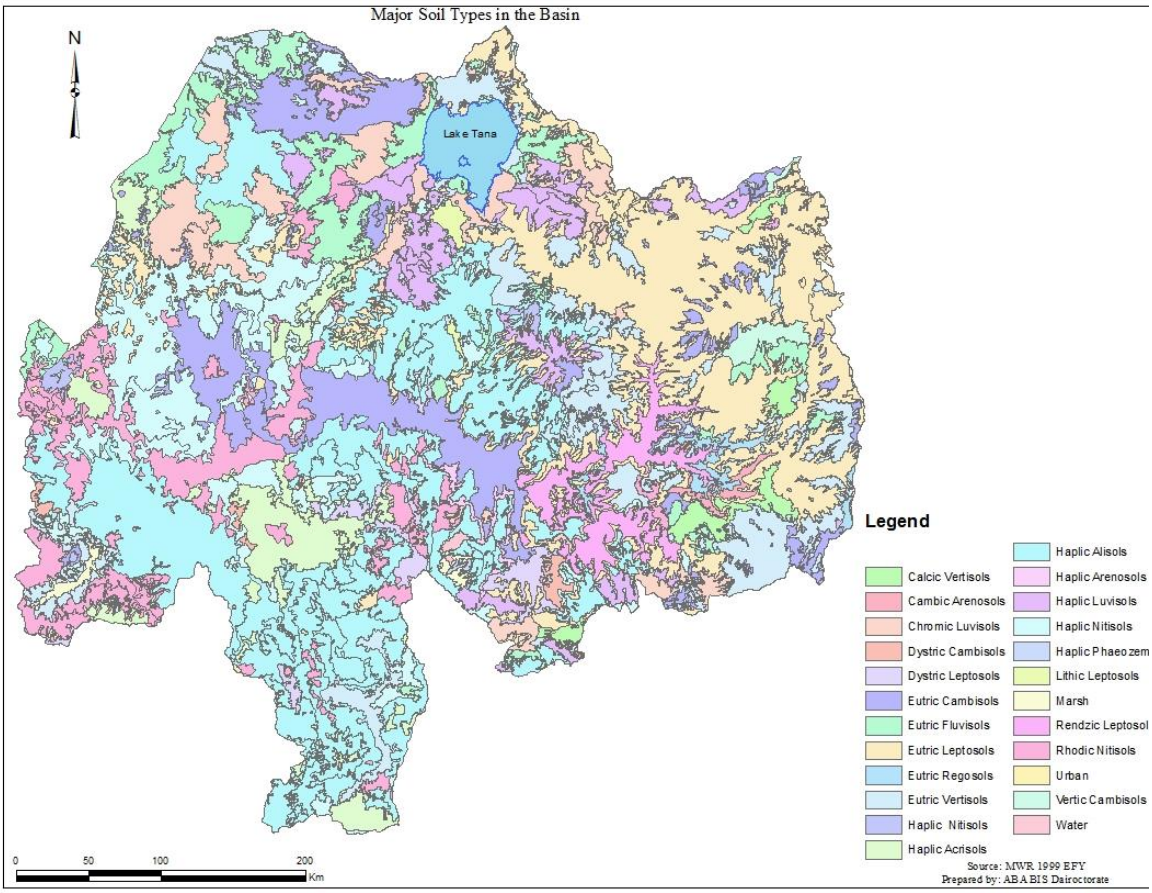


Figure 18: Major Soil Types in the Abbay Basin

3. SOCIO ECONOMIC ASPECT OF THE BASIN

3.1. Administrative structure of the basin

According to the current regional structure, the basin covers three regional states namely Amhara regional state, Oromia regional state, and Benishangul-Gumus regional state.

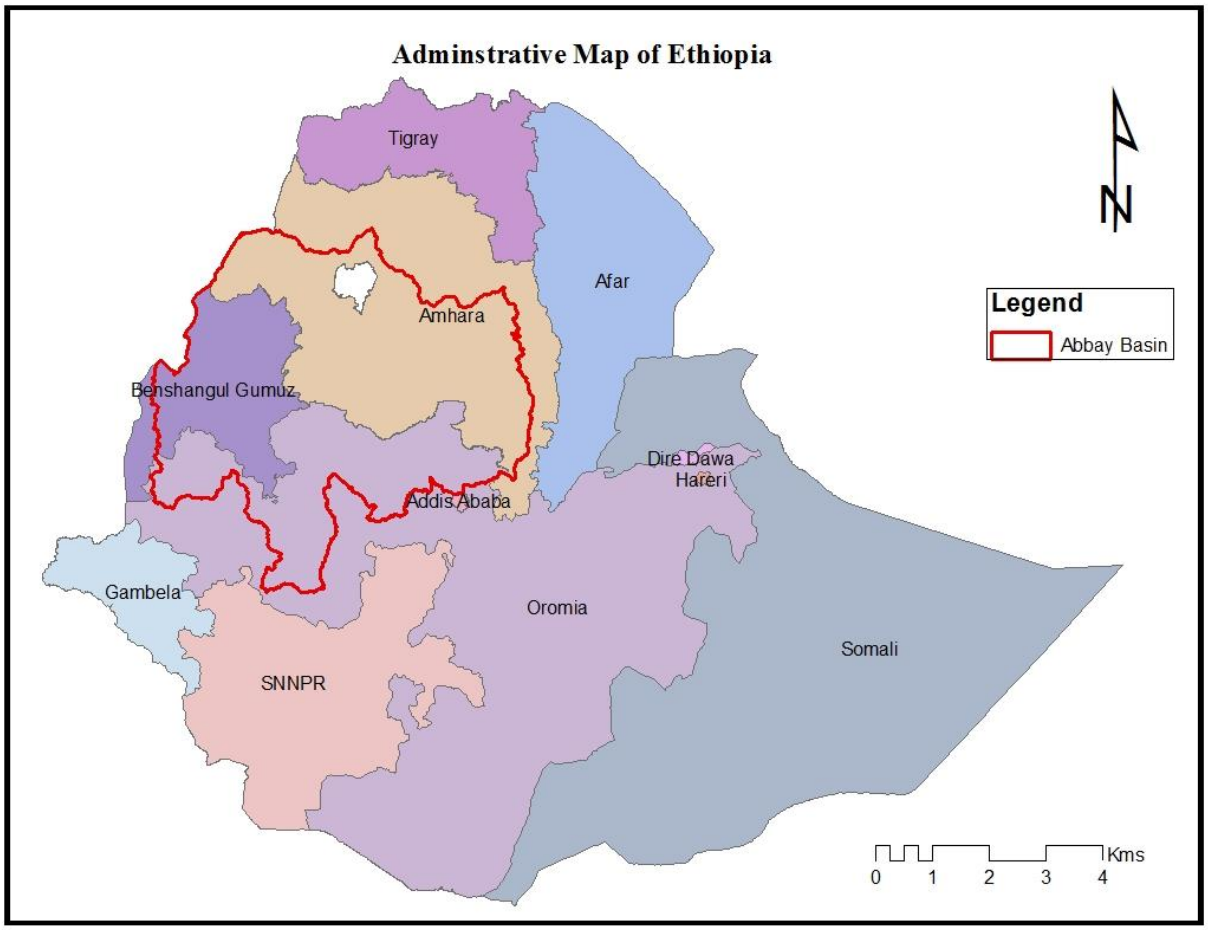


Figure 19: Administrative structure of Abbay Basin

3.2. Population

3.2. 1. Population size

According to CSA and ANRS BoFED, in 2014 the total population of the basin was about 28,590,000, (Abbay basin atlas, 2015) and in 2030, the population will be expected to increase 40,300,989. This number is expected to share about 32 percent of the total population of the country. From the total population of the basin Amhara region has the population of 60%, Oromia region 36% and Benishangul-Gumuz has the population share of

4 % in the basin. From the total basin population on average 80% of inhabitants live in rural areas of the basin while the rest 20 % populations dwell in urban areas.

3.2. 2. Population growth trend (2014-2030)

Table 4: Population growth trend in the Basin

Year	*Growth rate*	*Male*	*Female*	*Total*	*Urban*	*Rural*
2014		14,369,276	14,220,724	28,590,000	5,432,100	23,157,900
2015	0.0251	14,729,945	14,573,398	29,303,343	5,568,446	23,734,897
2016	0.0248	15,095,247	14,934,818	30,030,066	5,706,543	24,323,523
2017	0.0245	15,465,081	15,300,721	30,765,802	5,846,353	24,919,449
2018	0.0226	15,814,592	15,646,518	31,461,109	5,978,481	25,482,628
2019	0.0226	16,172,002	16,000,129	32,172,130	6,113,595	26,058,536
2020	0.0226	16,537,489	16,361,732	32,899,221	6,251,762	26,647,459
2021	0.0205	16,876,507	16,697,147	33,573,655	6,379,923	27,193,732
2022	0.0205	17,222,476	17,039,439	34,261,915	6,510,712	27,751,203
2022	0.0205	17,575,537	17,388,747	34,964,284	6,644,181	28,320,103
2024	0.0205	17,935,835	17,745,217	35,681,052	6,780,387	28,900,665
2025	0.0205	18,303,520	18,108,994	36,412,513	6,919,385	29,493,128
2026	0.0205	18,678,742	18,480,228	37,158,970	7,061,232	30,097,738
2027	0.0205	19,061,656	18,859,073	37,920,729	7,205,987	30,714,741
2028	0.0205	19,452,420	19,245,684	38,698,104	7,353,710	31,344,393
2029	0.0205	19,851,195	19,640,220	39,491,415	7,504,461	31,986,953
2030	0.0205	20,258,144	20,042,845	40,300,989	7,658,303	32,642,686

Source; Abbay basin atlas ,2015 and CSA projection,2014-2030

The table shows how many people have been living in the basin from 2014 to 2030. There are several discernable changes in the proportion of people in urban and rural areas . As can be seen apparently the basin population has swelled considerably from 28.59 million to 40.3 million from 2014 -2030.. This shows that, fertility manifests itself for the increment of the basin's population.

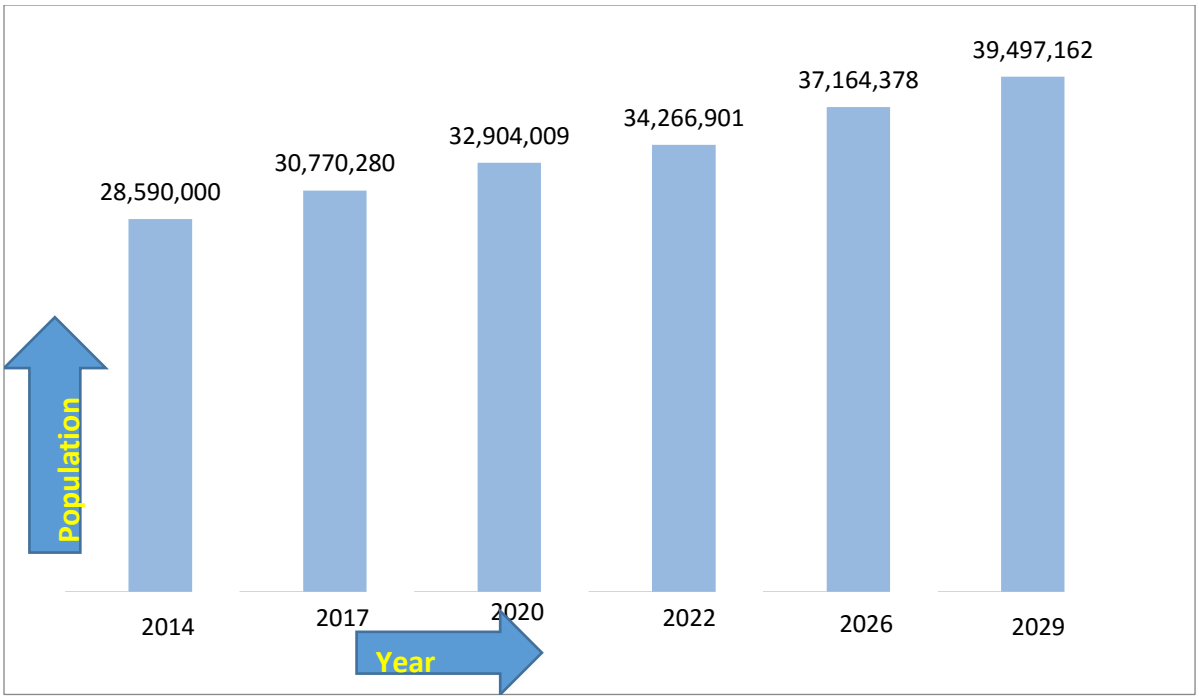


Figure 20 : Graphical Representation

The graph shows the basin population is increasingly growing from 2014 to 2029 generally.

3.2. 3. Population distribution

According to CSA, 2007 highly populated areas of the basin include, the northern part of Lake Tana ,the central part of the basin and the southern ends of Didessa sub-basin but there may be variation among the rural and urban areas. The distribution of basin population as shown in the figure below depicts that, the northern, central and some southern end of the area (Tana , South & North gojjam and Didessa sub-basins) are densely populated areas.

Moderately populated area of the basin, covers majority of the central parts and Eastern parts of the basin, (Jemma, Woleka, Beshilo, Anger, Muger, Guder,and Fincha), on the other hand, most of the Weastern parts of the basin (Belese, Dinder, Rahad, Dabus and Wonbera) are characterized by sparsely populated area.

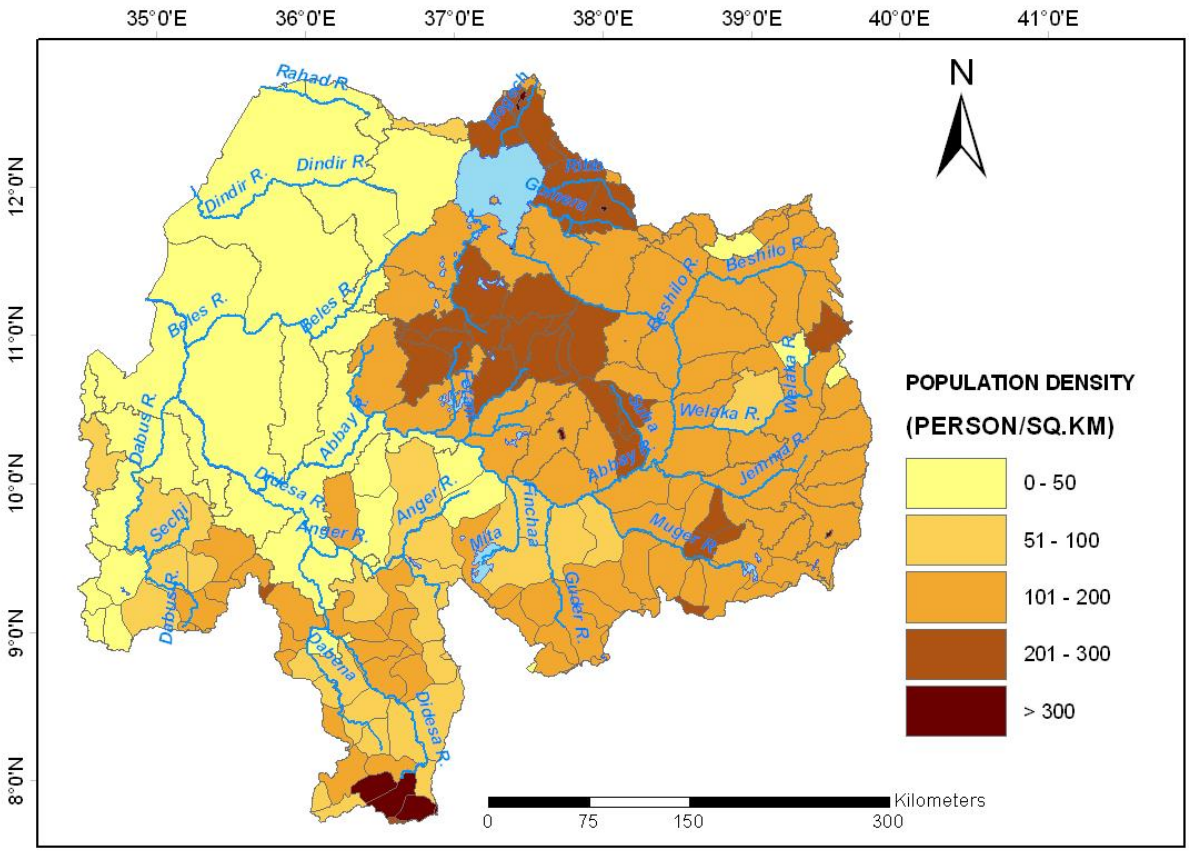


Figure 21: population distribution of the basin

3.2. 4. Sex structure and its trend in the Basin (2014-2017)

Sex structure is the most important demographic characteristics that are captured by a census of a population. It attributes that largely influence an individual's role in society. The following table shows the sex composition of the population of Abbay basin using data obtained from CSA, 2014-2030 and other relevant literatures.

Table 5: sex structure

Year	*Total population*	*Male*	*% of Male*	*Female*	*% of female*
2014	28,590,000	14,369,276	50.25979713	14,220,724	49.74020287
2015	29,303,343	14,729,945	50.26711457	14,573,398	49.73288543
2016	30,030,066	15,095,247	50.26711563	14,934,818	49.73288437
2017	30,765,802	15,465,081	50.26711477	15,300,721	49.73288523
2018	31,461,109	15,814,592	50.26711233	15,646,518	49.73288767
2019	32,172,130	16,172,002	50.26711318	16,000,129	49.73288682
2020	32,899,221	16,537,489	50.26711423	16,361,732	49.73288577
2021	33,573,655	16,876,507	50.26711569	16,697,147	49.73288431
2022	34,261,915	17,222,476	50.26711437	17,039,439	49.73288563
2022	34,964,284	17,575,537	50.26711544	17,388,747	49.73288456
2024	35,681,052	17,935,835	50.26711376	17,745,217	49.73288624
2025	36,412,513	18,303,520	50.26711285	18,108,994	49.73288715
2026	37,158,970	18,678,742	50.26711451	18,480,228	49.73288549
2027	37,920,729	19,061,656	50.26711380	18,859,073	49.7328862
2028	38,698,104	19,452,420	50.26711386	19,245,684	49.73288614
2029	39,491,415	19,851,195	50.26711502	19,640,220	49.73288498
2030	40,300,989	20,258,144	50.26711379	20,042,845	49.73288621

Source; Abbay basin atlas, 2015 and CSA projection, 2014-2017

As shown in the above table, the basin female population constitute 14,220,724 in 2014 which was 49.74 percent of the total population of the basin while males constitute 14,369,276and covers 50.26 percent of the total population of the basin, and In 2030 the size of female population is projected to be 20,042,845 (49.73%) while males is expected to be 20,258,144 which accounting for 50.27 percent. In each consecutive year (2014-2030), the basin has almost proportional distribution of population in sex, is an important social factor for different governmental, non-governmental and community based organizational intervention to bring equity between males and females in the basin.

3.2. 5. **Age Structure**

Age structure indicates the number of people in different age group within a given population at a time. It is one of the most basic characteristics of population of a given territory. Below are the age characteristics of the basin population by the major age categories 0-14, 15-24, 25-54, 55-64, and 65+. The data and discussions are presented based up on the projected population of 2017 CSA data and CIA world factbook, 2016.

Table 6: Age structure of the basin population

No.	Age Structure	Number of population	Coverage in %
1	0-14 years	13,449,567	43.71%
2	15-24 years	6,166,308	20.04%
3	25-54 years	9,061,765	29.45%
4	55-64 years	1,196,953	3.89%
5	65+ years	895,407	2.91%.

Source; CIA world fact book, 2016

3.2. 6. Dependence ratio

Age dependency ratio is the ratio of persons in the ages defined as dependent (under 15 and over 64 years) to persons in the ages defined as economically productive (15-64 years) in a population. It shows the proportion of the basin's population not in the work-force who are 'dependent' on those of working-age. According CIA world factbook,2016 data realizes that, economically active population of the basin consists of 16,425,026 (accounting for 53.38 percent of the total basin population) in 2017, while economically inactive population accounts for 14,344,974 (46.62%). The basin has a dominant working age structure that indicates the basin is endowed with potential labor resources for socio-economic development.

3.2. 7. **Ethnic, Language and religion composition**

The population of Abay River basin consists of Amhara, Oromo, Gumuz, Agew, Berta, Shinasha, Mao,Koma and other ethnic groups. The major spoken language in the basin also includes Amharic, Afanoromo, Agew, Gumuz, etc. Orthodox, Protestant, Catholic, Islam, traditional beliefs and others are the most common religions found in the basin respectively (ABMP, 1998).

3.3. **Educational Institutions**

Table 7: number of school (Governmental and Non-Governmental)

No	Types of educational institution	Number of institutions	Enrolment
1	Primary school (1-8)	11981	6,324,102
2	Secondary school (9-12)	935	722,408
4	Universities	15	NA

Source; (Ministry of Education 2017)

As shown from the tables there are 11981 primary schools, 935 secondary schools and 15 universities found in the Basin. As well as 6,324,102 and 722, 408 students are enrolled primary and secondary school respectively.

3.4. Health Institutions

According to the data collected from ABA sub -basins' socio - economic assessment 2011 - 2017,there are about 47 hospitals, 1125 health centers and 5145 health posts with in the basin which provides necessary health services to the people of the basin .

Common Prevalent disease in the Basin

According to the data collected from different woredas of the basin among the most common prevalent diseases that affect human are: Malaria , Typhoid Fever, Lower respiratory tract infection, ARTI (Acute Respiratory Tract Infection), Helmentitis , Dyspepsia, Diarrhea, Tuber clauses, And Intestinal Parasite, Acute febrile illness /AFI, Trachoma, Intestinal parasite, Acute febrile illness /AFI/, thypoid, skin infection and urinary tract infection, acute feberile illness, tuberculosis /TB, , trauma, dyspepsia, rheunmantus, anemia, gasterate and etc.

3.5. Major Economic Activity in the Basin

According to CSA, 2015 the basin's economy comprises:- Agriculture, Industry & Manufacturing, , Tourism, Energy, Mining and Minerals, Transport and Other.

3.5.1. Agriculture-

Like other parts of Ethiopia, agriculture in the basin is the sector where the economy and livelihood of the majority of the people mainly depends on, it is obvious that agriculture includes both the rearing of animals and the cultivation of crops based on the data collected in woreda agricultural offices of the sub basins. Major agricultural practices in the Basin include;

i. Crop Production -The Basin has diversified agro- ecology (dega, woyna dega and kola) which is suited for the production of different annual as well as perennial crops. These include;

Grain Crops :-Refers to the major crop category that includes cereals, pulses and oilseeds which not only constituted the major food crops for the majority of the basin's population .

Cereals:- are the major food crops both in terms of the area they are planted and volume of production obtained. They are produced in larger volume compared with other crops because

they are the principal staple crops (Teff, Barley, Wheat, Maize, Sorghum, Finger-millet, Oats/'Aja') and Rice .

Pluses:- are also among the various crops produced in all areas of the basin after cereals (Faba beans, Field peas, White Haricot beans , Red Haricot beans, Chick-peas, Lentils, Grass, peas, Soya beans, Fenugreek., Mung bean and /"Masho", Gibto.)

Oilseeds:- refer to crops which are also classified within grain crops category**,** nonetheless**.** oilseeds are grown to flavor the food consumed at home and earn some cash for peasant holders in the area (Neug, Linseed, Groundnuts, Sunflower, Sesame, Rapeseed)

Vegetables-Holders living near to urban centers largely practice vegetable farming. Most vegetables are not commonly practiced by the rural private peasant holders. (Lettuce, Head Cabbage, Ethiopian Cabbage, Tomatoes, Green peppers, Red peppers, and Swiss chard)

Root Crops -Some root crops like onion and garlic are indispensable to improve the taste and scent of the food we eat. others like potatoes, sweet potatoes and taro/ godere are among the list of major food crops that are consumed across the basin. These and other economic importance prompt the peasant holders to grow many of the root crops (beetroot, carrot, onion, potatoes, yam/'boye', garlic, taro/'godere', and sweet potatoes).

Fruit Crops -Fruit crops grown by the private peasant holders cover only a small token area and production in the basin. the number of holders practicing fruit farming is much less than that of grains or cereals (avocados, bananas, guavas, lemons, mangoes, oranges, papayas, and pineapples)

Stimulant crops -Farmers engaged in growing and producing stimulant crops such as coffee and Chat are greater in number than those growing fruits. In agricultural products coffee is the largest export production which earns the majority of the export income.

II. **Irrigation-** Although, different irrigation potentials are not exhaustively identified, according to different sources, the basin has large irrigation potential;

- 523,000Ha, (FAO, information system on water and agriculture),
- 815,581Ha, (Master plan studies, water resource and development in Ethiopa (Sileshi Bekele, et al, 1998).
- 1,001,000Ha, (WAPCOS, water and power consultancy services India limited, Sileshi Bekele) and, but out of this economic irrigation potential only 3% is Under cultivation. The

basin water resources are used for traditional irrigation which result in low productivity and irrigation practices in the basin is not exploited its maximum potential cultivation and seems more traditional. . According to the basin socio economic study document important irrigated production include; grain, fruit and root crops are wheat, barley, banana, papaya, tomato. Mango, avocado, potato, onion and garlic.

III**. Livestock**

According CSA, 2015 the population of animals found in the basin, are about (71.48 million heads) from which cattle 29 million, sheep 10million, goat 8million, horse more than half million, mule 0.15million, donkey 2.5million, poultry 19million and beehive 2.33million.

3.5.2. Industry

The basin hosts a number of industries as cement factory, beverage industries, milling industries, textile and a number of micro industries found in the basin, these industries create employment opportunities, generate tax revenue, employment, income tax and sales tax revenue. They also have a foreign exchange saving effect to the country by substituting the current imports.

1. Agro- Processing Industries - Ambo Mineral Water S.C.(Ambo)
2. Pulp and Paper:-, D.M.S.K General Trading (Burayu), Huang Shang Cement Plc (Oromia), Main Project) (Derba), Mugher Cement Enterprise(existing) (Muge), Jema Cement Plc (Muketure), Industry Plc.(Holeta), Habesha Cement Sh.Co.(Holeta), Dangote Industrial Plc. (Muger, Ada berga), East Cement Plc. (North Shewa, Feche), C.H Clinker Manufcturing Plc. (Gerba Gurache)
3. Textile Factories, Bahirdar Textile S.C (Bahir Dar)
4. Tanning Industries, Abay Tannery (Bahir Dar), Bahir Dar Tannery (Davimpex) Enterprise, P.l.c Bahir Dar, DebreBerhan Tannery DebreBerhan, Dessie Tannery, P.l.c (Dessie)
5. Agro-Processing Industries, Ashraf Agricultural and industrial plc (Bahir Dar)
6. Pharmaceuticals, ElieLaboratoire P.L. (Gondar)
7. Cement , Dejen Project) (Dejen)

3.5.3. Tourism Development

The tourism industry in the Basin contributes a lot for the country economy. According to ABMP, the specific attractions of the basin divided in to four major tourist destination areas.

I. **The Northern part**; this scenery includes Bahirdar, Lake Tana, Gonder and their surroundings.

II. **The Abay Gorge Area and the central part of the basin- These include** Abay Gorge, the crossing of the Blue, Muger Sub Basin**,** this circuit is blessed with an abundance of material, non-material cultural resources and historical sites and Debre Libanos Monastery

III. Eastern Edge of Abay Basin; the most promising tourist destination area around this circuit includes Dessie, Debre Birhan and their surroundings.

IV. **The Southern part of Abay Basin / the coffee producing areas/.**This scenery, known by its coffee production and wealth of wild life and forest, So that it is found to be the prominent tourism circuits.Nekemte, Wollega museum and Kumsa Moreda palace.

3.5.4. Mining, Minerals and Energy

Mining-The contribution of the mining sector to export income in the Basin is limited to being generated from gold and gemstone exports with potash exports expected to come on line in the next few years.

Minerals- Production of industrial minerals is limited to domestic consumptions (MoM), the current mineral production is small, which in turn explains a low level of existing linkages with the rest of the economy as cement production and construction. According to ABMP The most important metallic minerals found in the basin are; Gold, Platinum, Copper, Nickel, Iron and Molybdenum on the other hand most abundant non-metallic minerals are marble deposits, limestone, construction stones, Gypsum, sandstone, Clay and lignite deposits are also found in the Abbay Basin.

Energy -Apart from the water power and forests, the Basin is not well endowed with energy sources. The Basin is deriving its electricity needs from hydropower thus explaining that electricity generation along with agriculture is dependent on abundant rainfall. The Basin rely on forests for nearly all of its energy and construction needs, the result has been deforestation of much of the areas.

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