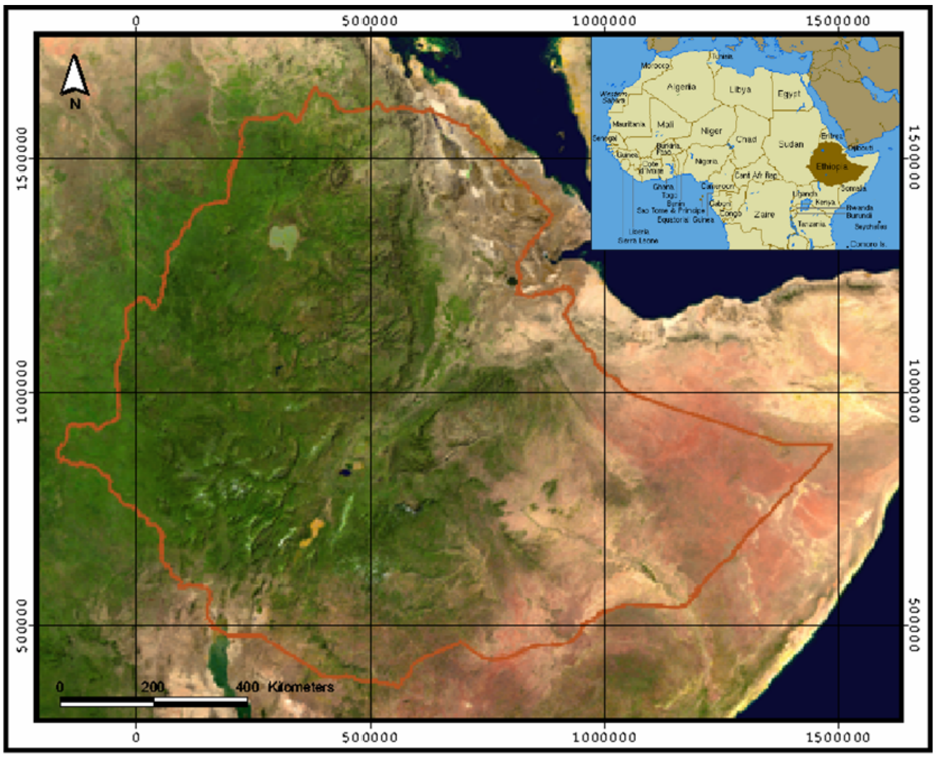
4 Country Profile

One major topic of this research is the inter-relationship between human dynamics and the landscape as well as processes of landscape change. Thus, the first part of this chapter provides a general overview of the development and genesis of the actual landscape as well as the spatial distribution of bedrock and tectonic activities. The general geographical conditions of Ethiopia are described in the second part including climate, geology, and soils. Lastly, population characteristics such as the distribution and growth of the population, land use systems, and economic situation are briefly outlined.

Ethiopia (fig. 1) is located at the Horn of Africa between 3° to 18° N latitude and 33° to 48° E longitude. The country extends over 1,127,127 km² including a water surface area of 7,444 km². The topography is characterised by an extreme range in altitude (fig. 2). The Danakil Depression is located at 125 m below sea level (b.s.l.), while the highest point is Ras Dajen, with 4.620 m above sea level (a.s.l.) (CIA, 2005). The northern and western parts of Ethiopia, with the exception of the Afar Triangle, are dominated by very rugged terrain with high plateaus (> 2200 m a.s.l.) and deeply incised valleys, such as the Nile drainage system.



Projection:
UTM Zone 37 N
Map Datum Adindan

Fig. 1: Ethiopia and the Horn of Africa (modified after http://www.geobserver.com/faq_de.php)

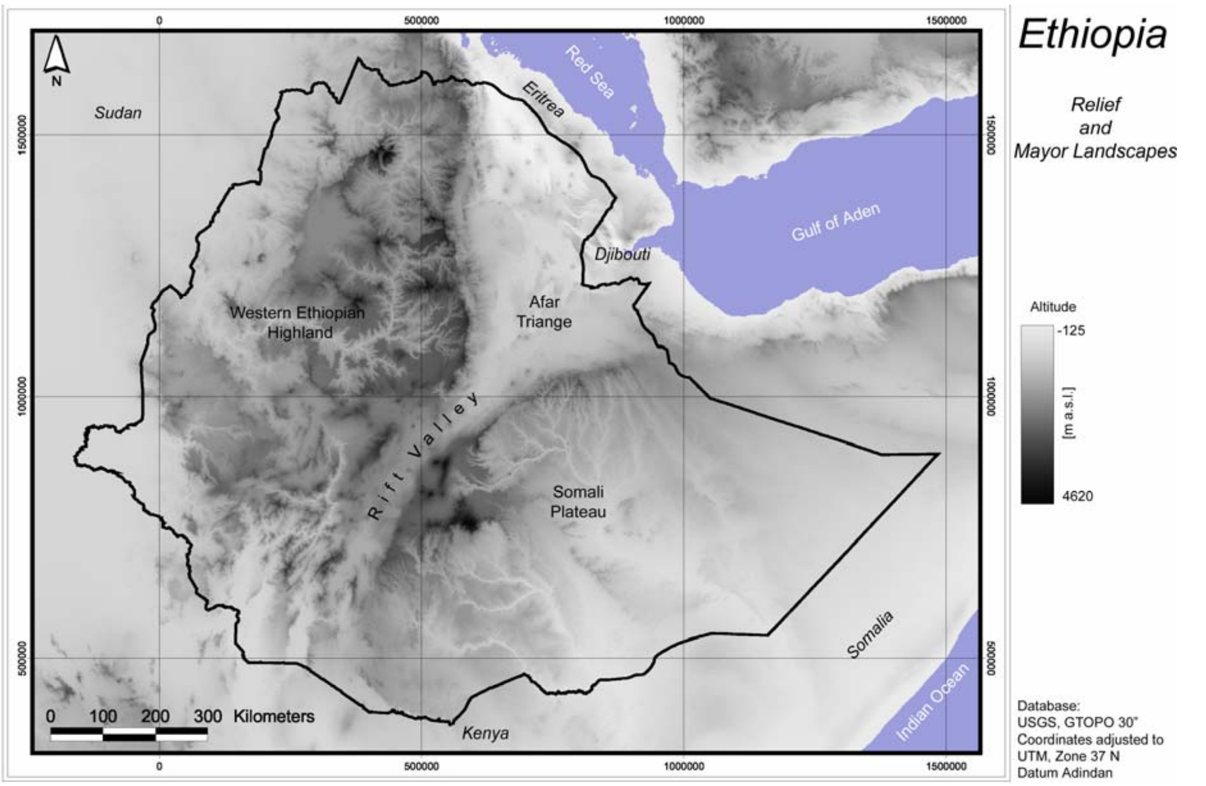


Fig. 2: Relief and Major Landscapes of Ethiopia (source: GTOPO 30)

4.1 Geographical Settings

4.1.1 Major Landscapes

The Western Ethiopian Highlands are separated into the Abyssinian Highlands, i.e. the area north of the capital Addis Ababa and the southern region of the Kaffa Highlands.

The Somali Plateau, located in the east and southeast of Ethiopia, is separated from the Western Highlands by the Ethiopian Rift Valley. The plateau is gently sloping down from an altitude of 4307 m a.s.l. (Batu Mountain of the Bale Massif) to the Indian Ocean.

The Ethiopian Rift Valley is ranging in elevation from 125 m b.s.l. in the Afar Triangle to approximately 1,800 m a.s.l. in the Rift Valley Lake Region. Further southward, elevation again decreases towards 1,000 m a.s.l. at Lake Chew Bahir.

4.1.2 Drainage System

The major drainage systems are of endogenous origin. They incised antecedent into the landscape during the uplift and formation of the relief. The drainage systems are of canyon shaped character in the northern Ethiopian Highlands (Abyssinia), whereas the drainage valleys in the southern Ethiopian Highlands (Kaffa) and the Somali Plateau are v-shaped.

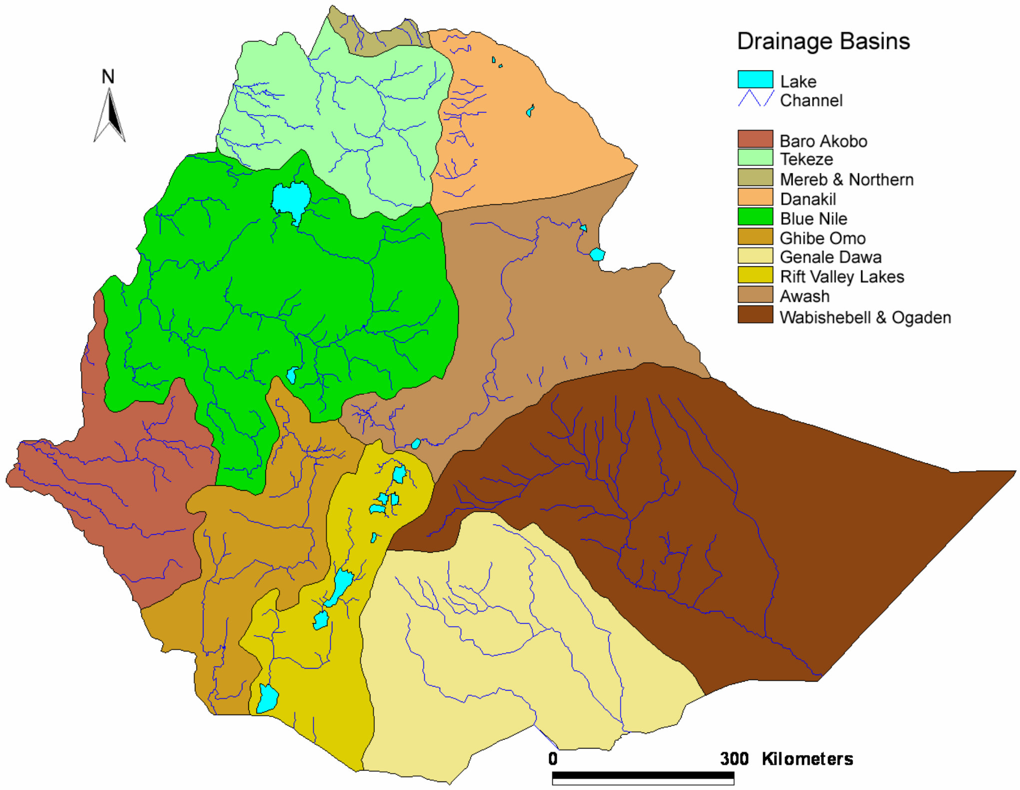


Fig. 3: Drainage Basins of Ethiopia (BEKELE, 2001)

BEKELE (2001) describes the water resources and the drainage basins of Ethiopia as follows (fig. 3):

Exoreic: eastern and western drainage systems (Nile Basin)

Endoreic: Main Ethiopian Rift drainage systems (Awash River, Lake Region, Abaya-Chamo Basin, Chew Bahir Basin and Omo River)

4.1.3 Soils

The development of soils depends primarily on geologic and climatic conditions. In Ethiopia, seventeen major soil units have been identified (EMA, 1988). The FAO Soil Map of Ethiopia (1998) classifies 19 soil units, which do not all coincide spatially with the EMA soil map. For this research, the FAO classification system has been selected and is used in the following descriptions and analyses (FAO, 1998). Figure four illustrates the distribution of the different soil types within Ethiopia. Various general clusters of similar soil types can be distinguished:

- Nitisols in the southern part of the Western Ethiopian Highlands;
- Luvisols and Leptosols, with isolated occurrences of Cambisols in the northern part of the Western Ethiopian Highlands;

- Gypsisols and Calcisols as well as Solonchaks and Solonetz in semi-arid to arid Somali Lowlands;
- Cambisols and embedded Luvisols in the transition zone between the Highlands and the Somali Lowlands;
- Fluvisols and Andosols in the Rift Valley, and in endorheic basins;
- Vertisols located across the country in small fragmented pattern.

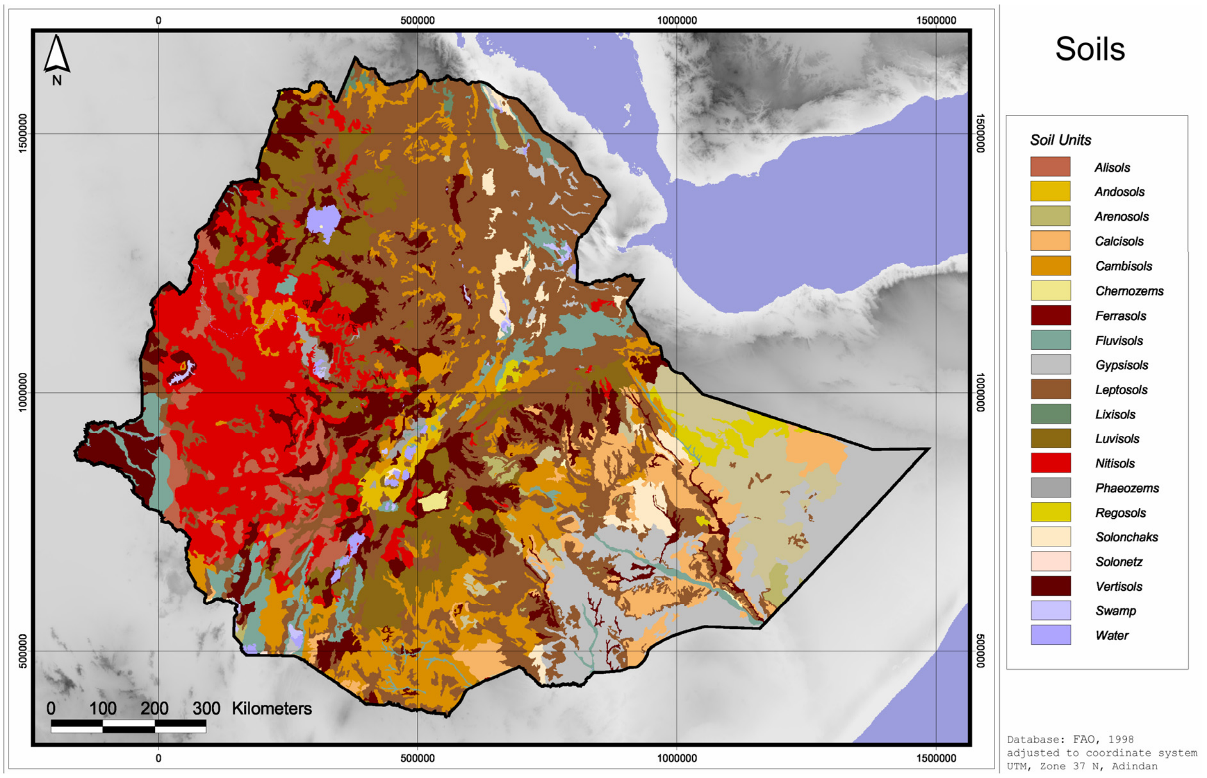


Fig. 4: Soils in Ethiopia (FAO, 1998)

4.1.4 Climate

The climate pattern of Ethiopia is mainly determined by the alternations of the inner tropical convergence zone (ITCZ) and the influence of the Indian Monsoon throughout the year (MORON, 1998). Two major air streams cause dry and rainy seasons: from late June to early September, when the ITCZ is northernmost, the equator dominant air stream direction is south-east in southern Ethiopia and south-west in central to northern Ethiopia. These warm and moist winds are the result of high evaporation and water vapour saturation of the air mass both above the Indian Ocean and the Atlantic Ocean and Congo Basin, respectively.

From October to May dry air streams from the north-east cause dominant dry weather conditions, which are interrupted in southern Ethiopia by a short rainy season from

April to May. During this time of the year the ITCZ shifts toward the south and the air streams follow the regular pattern of the Passat-Winds, with their source in the Arabic Peninsula (OSMAN, 2001).

The climate in Ethiopia (fig. 5) is intensified by thermal and dynamic effects that are determined by altitude. Precipitation and temperature gradients are strongly dependent on altitude; while precipitation increases, temperature decreases with increasing altitude. The three major climate classifications characterising Ethiopia are therefore very elevation dependent (KÖPPEN, 1931):

- Cwb-, Cfb-, Cwc-climates in the Ethiopian Highlands, which are of warm to cool mountainous semi-humid to humid characteristics.
- As-, Aw-, Am-climates in the lowlands, which are of semi-humid to semi-arid characteristics surrounding the highlands.
- BWh-, BSh- and BSk-climate in the Afar-Triangle and the Somali Region.

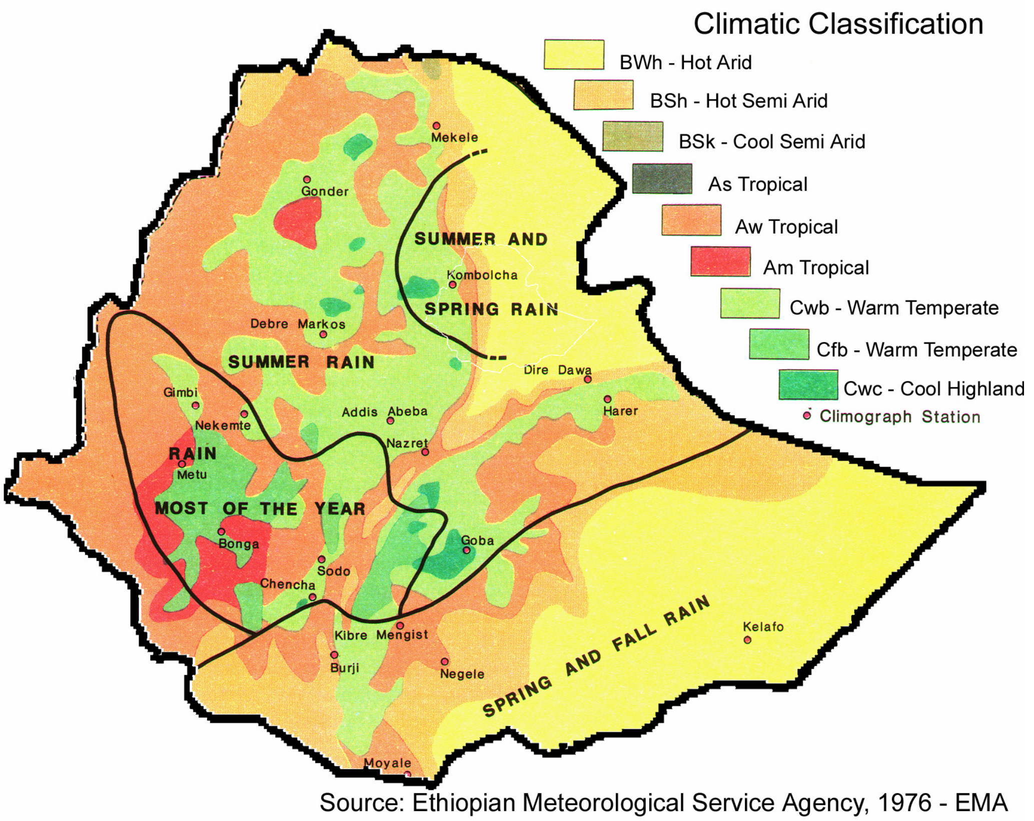


Fig. 5: Climatic Classification after Köppen & Geiger (modified source: Ethiopian Mapping Authority Services, 1988)

The average annual temperatures in Ethiopia range from less than 10° C (in the high elevations of the two massifs Ras Dejen and Batu) to more than 30° C in the Danakil

Depression and the Somali Region. While inter-annual temperature variations exist, the amplitude is relatively small. Temperature variations are caused by the amounts of incoming solar radiation that varies depending on cloud cover during the dry and rainy seasons. The influence of the sun's declination is minor. Daily temperatures ranges are characteristic for daytime climates of the tropics; they are more pronounced in the highlands than in the lowlands (CHENDO & MADUEKWE, 1994).

Precipitation across the country is characterised by high spatial and temporal variability (fig. 6). On a spatial scale, the distribution of annual rainfall ranges from less than 400 mm in the Somali Region and the Afar Triangle to more than 2,400 mm in the southwest of Ethiopia.

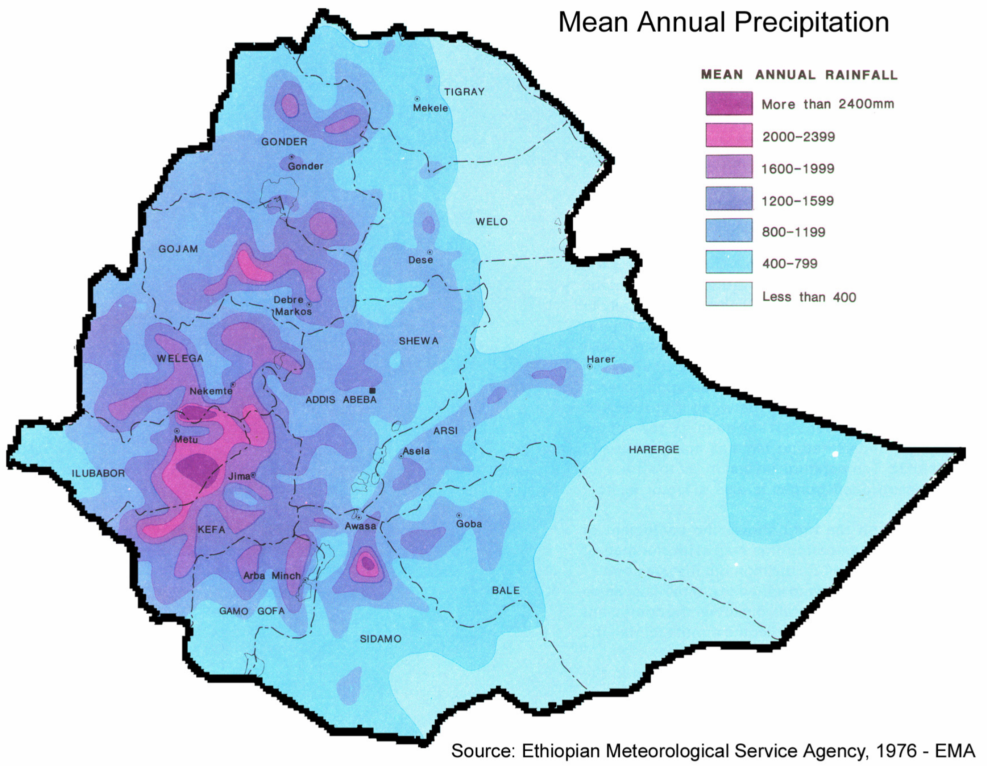


Fig. 6: Mean Annual Precipitation (modified source: Ethiopian Mapping Authority Services, 1988)

On inter-annual time scales, precipitation in Ethiopia is highly seasonal, with the time and length of the different seasons varying by location. While the southern-eastern parts of the country experience precipitation maxima in spring and autumn, central Ethiopia has its main precipitation volume in spring and summer. The north-western part has its maximum in summer. In some localized parts in the south of the country the maximum precipitation occurs in spring, winter and summer (fig. 7; DELLIQUADRI, 1958; WESTPHAL, 1975; EKLUNDH & PILESJÖ, 1990).

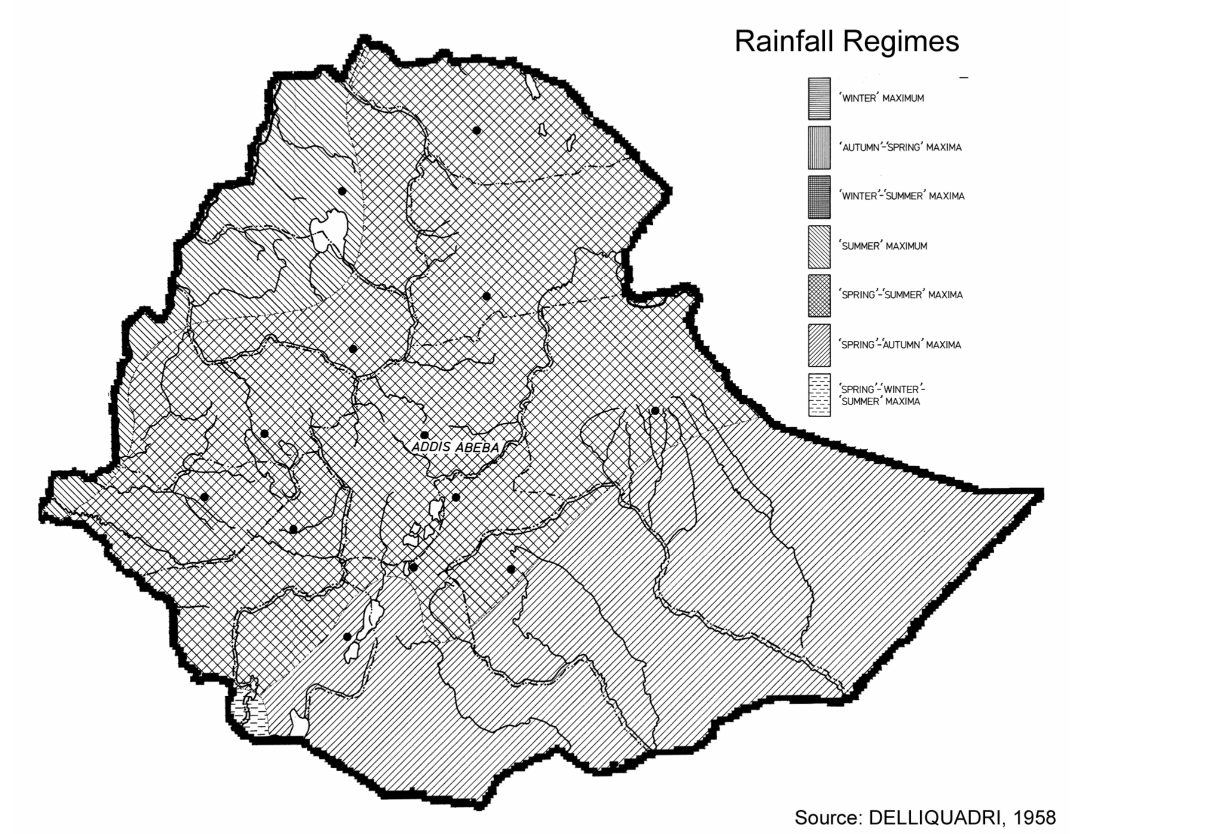


Fig. 7: Rainfall Regimes (modified source: Ethiopian Mapping Authority Services, 1988

The prevailing rainfall regimes are also a good indicator of the distribution of potential natural vegetation. In the area of the spring-summer-maxima rainfall regime coniferous forests, broadleaf forests as well as woodland and savannah are dominating. The rainfall regime area of spring and autumn maxima is preferred by grasslands, whereas the rainfall regime area of summer maxima creates desert and semi-desert vegetation (EMA, 1988).

The sections above provide only a brief overview over climatic patterns in Ethiopia; more detailed information about the climate of Ethiopia is provided by SUZUKI (1967), GOEBEL & ODENYO (1984) and KRAUER (1988).

4.2 Geology and Paleogeography

The current geologic and tectonic situation of Ethiopia (fig. 8) is strongly linked to the development of the East African Rift System and of the Ethiopian magma dome. This dome can be differentiated into three major geological settings: Precambrian complexes occur in the north and the west that are strongly folded and where granites or granitoides outcrop. The actual dome originates from the ballooning of a magma chamber and as a consequence volcanic activities, such as fissure eruptions and developed multiple basalt layers

(BOCCALETTI ET AL., 1998). These Mesozoic to Tertiary layers cover most parts of the Ethiopian Highlands and the Somali Plateau. The Somali Plateau and the Ethiopian Highlands are not significantly folded. However, the Lake Tana region and the Graben shoulders of the Rift Valley constitute an exception where Precambrian Rocks outcrop.

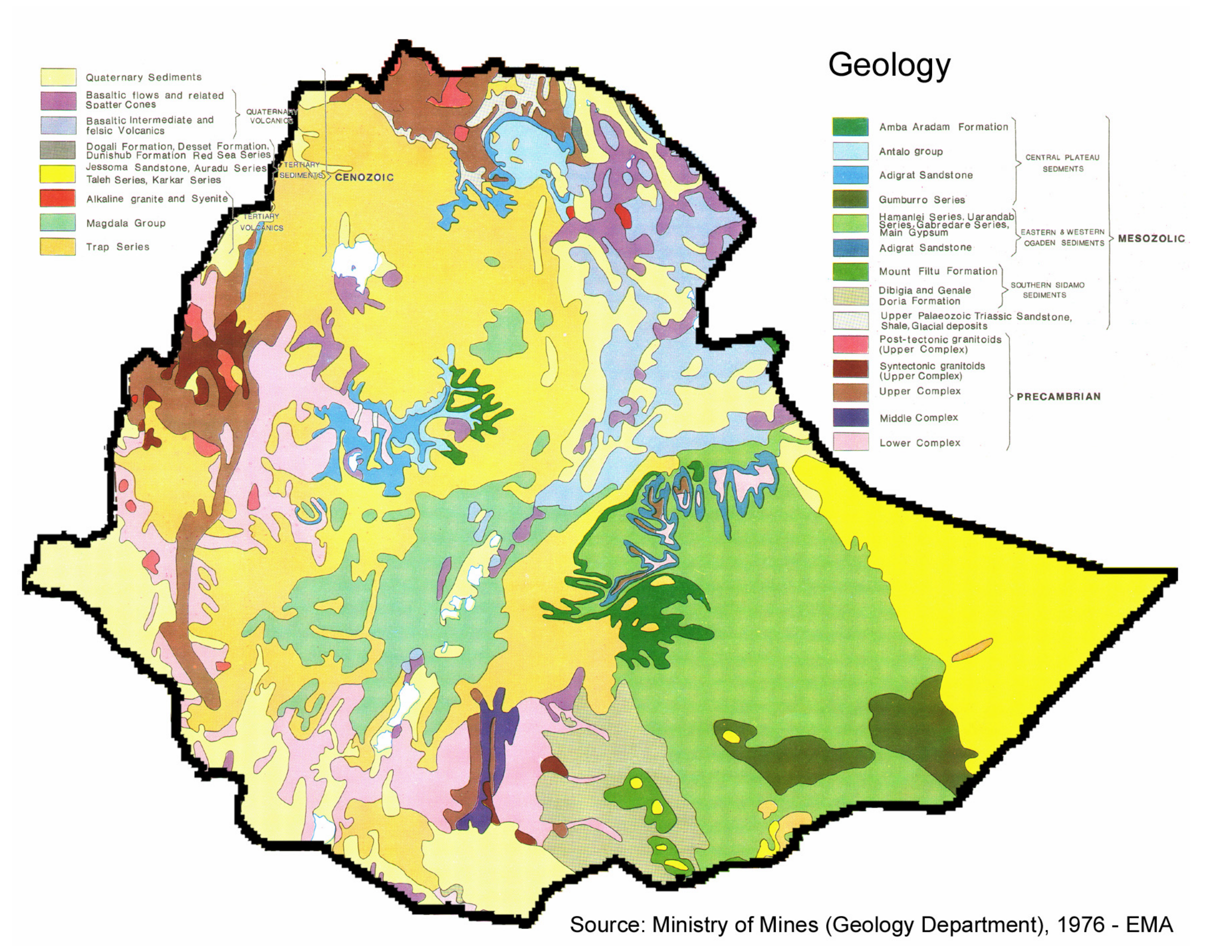


Fig. 8: Geology of Ethiopia (modified source: Ethiopian Mapping Authority Services, 1988

The Graben shoulder is characterised by several echelon faults and tectonic escarpments, which continue in the Rift Valley. Here, Cenozoic basalts and Quaternary sediments, which are often fissured, form the dominant rock types. Embedded in the main landscape of the Rift Valley and the Ethiopian Highlands are huge volcanoes (MOHR, 1962; MEYER, 1987; SUMMERFIELD, 1996).

The formation of the Ethiopian landscape is directly associated with the geological development of the Horn of Africa and the East African Rift System (MOHR, 1962). The present geological setting has predominantly developed since the late Palaeozoic.

During the Precambrian era various grades and types of schist and gneiss, as well as sedimentary rocks were formed, which were separated into strong and weak metamorphosed groups. These undifferentiated groups are called the Crystalline Basement of Ethiopia. They are exposed only at the margins of the country and underlay all other younger rocks in the centre of Ethiopia (MOHR, 1962).

The Palaeozoic period in Ethiopia was a very stable period of almost no active deposition processes. A stable landmass has formed over at last 500 million years, where denudation developed peneplains of the ancient pre-Cambrian orogenic mountain ranges. These peneplains were almost perfectly planar, with the exception of some outstanding islands, where the magnitude of the relief surface was more than 50 m (MOHR, 1962).

Throughout the Mesozoic period, three major lithologic categories of sediment rocks developed. In the early Mesozoic period a huge transgression took place concurrently with the epirogenetic sinking of the Arabo-Ethiopia shield (MOHR, 1962). During this transgression, which started in the Trias, the Adigrat Sandstone, Antalo Limestone and the Upper Sandstone formation were deposited. The transgression reached its maximum in the Jurassic period; and at the end of the Mesozoic period epirogenetic uplift caused a regression until almost the entire Horn of Africa raised above sea level (BAKER ET AL., 1972; MOHR, 1962). The sedimentary rocks from this period are rarely exposed in the Ethiopian Highlands, but are visible where drainage systems incise deeply into the younger Cainozoic rocks, and in the Somali Plateau Mesozoic sediments often outcrop (MOHR, 1962).

While the uplift in the Mesozoic was a consequence of epirogenetic processes, the uplift during in the Tertiary was caused by huge magma chambers with a diameter of approximately 1,000 km. Multiple fracture zones and faults across the Main Ethiopian Rift were formed by intense tectonic and volcanic activities during the uplift (GROVE, 1986). Tertiary volcanism was dominantly effusive and created huge basalt plateaus with hundreds of metres of thickness which characterise today's landscape. In addition, eruptive volcanism formed various stratovolcanoes of different sizes, which rise above the surrounding landscape surface.

The Main Ethiopian Rift continues towards the north through the Afar Triangle into the Red Sea and towards the south into Kenya. It separates into two rift systems, both part of the East African Rift System (EBINGER ET AL., 1993).

The Precambrian crystalline complex and the Mesozoic sediments in the centre of Ethiopia are predominantly covered by tertiary volcanoes from the Trap series and the Magdala group. Intermittently, quaternary basaltic and intermediate volcanoes are exposed. Quaternary sediments fill accumulation areas in the Main Ethiopian Rift Valley and the Afar Triangle, as well as towards the southern border of Ethiopia. Today, only little tectonic activity is measured in the Main Ethiopian Rift and volcanic activity is limited to hot springs. The exceptions are some parts in the northern Afar triangle where a number of volcanoes are active and newly tectonic activities were reported in popular scientific papers. MOHR (1962 and 1971), BAKER ET AL. (1972) and SCHICHO (2005) provide detailed accounts of landscape evolution for Ethiopia and the Horn of Africa.

4.3 Human Dynamics

4.3.1 Demography

Ethiopia is one of the oldest civilizations in Africa and looks back to a long history of human settlement.

Patterns of human settlement and human activities across Ethiopia are strongly influenced by the prevailing climatic conditions but also by the political regimes that governed Ethiopia during past and current millennia. Changing political regimes have recurrently forced people to obey changing policies. The repeated changes in land policy, including the misappropriation of land, resettlement schemes and high taxes are often made responsible for reduced agricultural production, the prevention of harvest surpluses or the generation of more income. Consequently, poverty, mismanagement, food insecurity and poor education are prevailing.

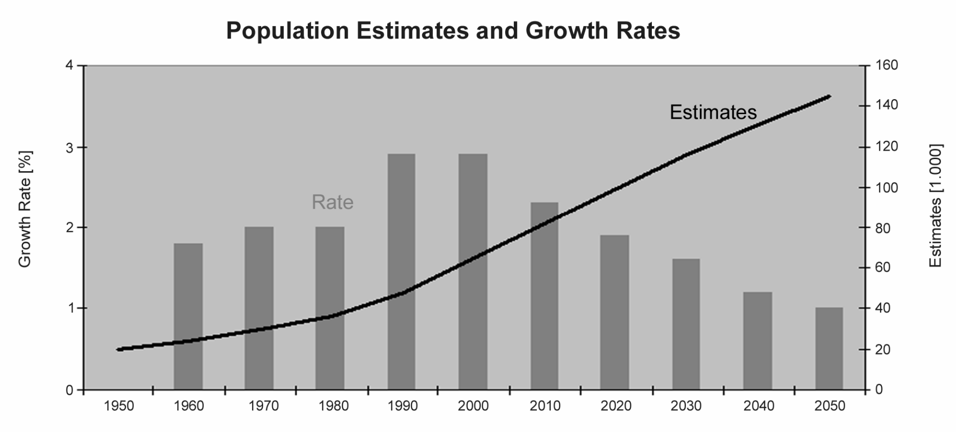


Fig. 9: Midyear Population Estimates and Average Annual Period Growth Rates (source: U.S. Census Bureau, 2005)

Moreover, population growth rates in Ethiopia are amongst the highest in Sub-Saharan Africa, which reinforce the above mentioned problems (CIA, 2005). At the time of this study, the population growth rate was about 2.36% (CIA, 2005) and the population is estimated to be 73 million (fig. 9). Due to the high growth rate, the distribution of the age structure is changing rapidly as well (fig. 10): 44% of the population is below 14 years old, and the life expectancy is 49 years (male: 47.6; female 50; CIA, 2005). The pressure on natural resources is strongly increasing as result of this high population growth rate. In addition, low education levels and a weakly developed private sector intensify the pressure on land use (DEJENE, 2003), as subsistence farming continues to be a main survival strategy. The resulting pressure on scarcity of natural resources therefore becomes a crucial factor in the future soco-economic development of the country (GREPPERUD, 1996).

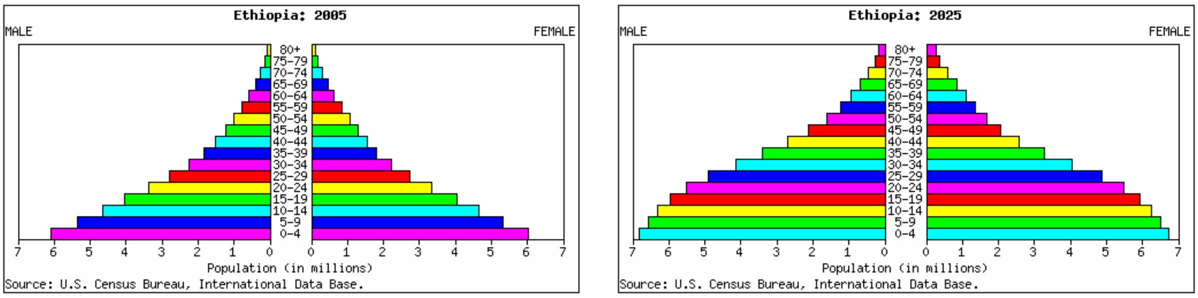


Fig. 10: Midyear Population 2005 and 2025 (source: U.S. Census Bureau, 2005)

4.3.2 Land Use

Ethiopia is characterised by great diversity in terms of natural resource endowments. In principle, favourable environmental conditions, i.e. fertile soils, good climatic conditions, and a high diversity of fauna and flora, are capable of supporting large numbers of humans and livestock. However, most of these resources are dwindling due to high population growth, the increasing pressure on natural resources, and the lack of adequate resource management policies and their enforcement.

The current land cover significantly departs from the potential vegetation, mainly due to anthropogenic influences that dramatically change land use across the country (VOIGT, 1992). Natural forest cover has decreased to 2.4% of its original size (TEDLA & LEMMA, 1998), while woodlands and savannahs are either utilized as pastures or have been converted into agricultural lands. In addition, grasslands are in general highly degraded due to overgrazing or ploughing wherever climatic conditions permit cultivation (WEDINEH, 1999; ENDLICHER, 2000). In the Western Ethiopian Highlands 95% of the land is cultivated, whereas the average for Ethiopia is only 45%. This is caused by the large extent of land that is unsuitable for cultivation, such as the *Afar Triangle* or *Somaliland* (SHIFERAW & HOLDEN, 1999). These areas are generally utilized by nomadic pastoralists. The majority of the population is therefore concentrated in the Ethiopian Highlands and the fertile south-western regions where environmental conditions favour cultivation (fig. 11).

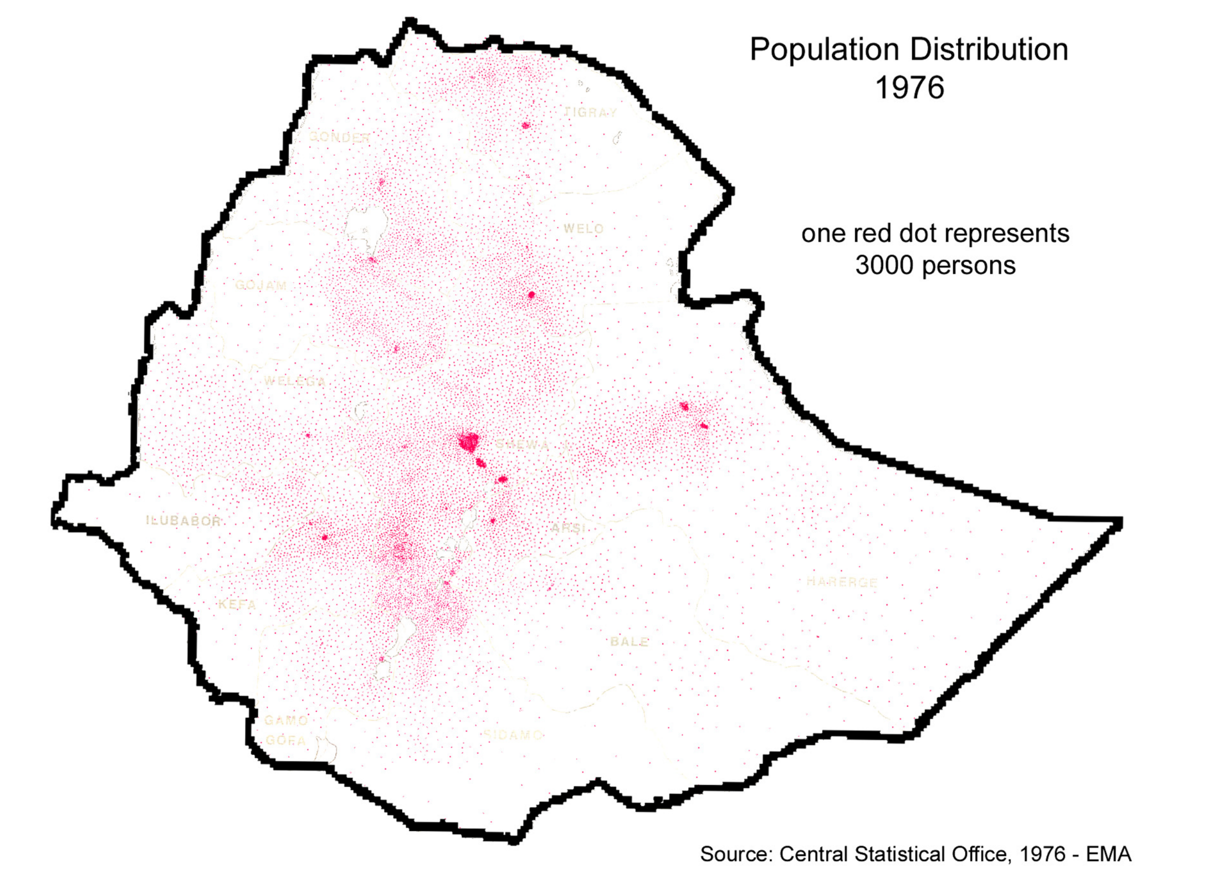


Fig. 11: Population Distribution (1976; modified after Ethiopian Mapping Authority Services, 1988)

HURNI (1986) established a land classification system for Ethiopia that is representing agro-climatic zones according to altitude, temperature and rainfall. It also characterises the agricultural potential of each agro-climatic zone (fig. 22). In the fertilize highlands commonly planted cereals are teff, wheat, barley, maize, sorghum, and millet. The seeds from teff are grinded and used for making *ingera*, the traditional bread (FRANKE, 1992). Barley is a major subsistence crop used as food and for the production of local beer. Pulses form the second important part of the national diet and are the principle protein source. The lowlands (the south and southeast as well as the northeast) are dominated by pastoralism due to arid to semi-arid climatic conditions, thus planted cereals are of minor appearance (HURNI, 1986).

The majority of the rural population is engaged in mixed crop-livestock systems where animals form an important component, as oxen provide the only form of draft power available to crop production. The greatest concentration of livestock is found in the highlands. However, these livestock resources are currently under-utilised and of extremely low productivity (GEBREGZIABHER ET AL., 2005).

A high unemployment rate, particularly in urban areas, parallels the high population growth rate and contributes towards the reliance on small-scale subsistence farming, particularly in the highlands. The improvement of living standards and the economy in general is strongly constrained by these factors (BOGALE ET AL., 2002). Moreover, natural resources are highly endangered by erosion and soil erosion. Erosion becomes a major problem in Ethiopia, especially in the highlands, when land is cleared from forest cover to provide land for agriculture, or wood resources for construction and firewood. Erosion and soil erosion has a long history in Ethiopia, as it closely relates to cultivation. The environmental degradation and loss of arable land negatively impacts development and food security (SHIFERAW & HOLDEN, 1999). Average rates of soil loss from cultivated land in the highlands are more than one hundred metric tons/hectare/year, which decrease available soil nutrients, organic matter and reduce the soil water holding capacity and rooting depth (WOLDE-AREGAY & HOLDINGE, 1996). In 1998 the agricultural area affected by erosion and soil erosion was:

- lost to degradation: 4%
- severely degraded: 27%
- moderately degraded: 25%
- not affected: 44% (TEDLA & LEMMA, 1998)

4.3.3 Economy

Ethiopia currently has a Gross Domestic Product (GDP) of less than US$ 100 per capita. During the last three decades a constant decrease of the GDP has been observed (BESHAH, 2003); in 1975 it was US$ 117 per capita. 60% of the country is classified as suitable for cultivation as well as irrigation, however, less than 5% are irrigated. The contribution of agriculture to the GDP is roughly 50% providing 83.7% of population's livelihood (GEBREGZIABHER ET AL., 2005). The service sector produces 43.3% of GDP followed by manufacturing sector with 6.7% (United Nations Development Programme - UNDP, 2000).

Today the official GDP for Ethiopia is roughly US$ 8.854 million, whereas the contribution is:

- 40.1% from agriculture
- 12.7% from industry
- 47.2% from services (CIA, 2005)