IN-DEPTH STUDIES FROM THE 1994 POPULATION AND HOUSING CENSUS IN ETHIOPIA

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POPULATION GROWTH AND ENVIRONMENT IN ETHIOPIA

by

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GENERAL BACKGROUND

1.1 Introduction

During the last few decades, Ethiopia has experienced massive environmental degradation due to natural factors, unwise use of its natural resources, unsound ecological practices and population pressure.

Among the harmful consequences of environmental degradation, land degradation is the most serious environmental problem in Ethiopia. Land degradation is one of the greatest threats which strikes at the basic resource of the population, particularly in countries like Ethiopia, where large proportions of the population depend on agriculture for their livelihood. Land degradation is one of subjugating main causes for increasing numbers of people to remain in poverty, suffer from shortage of food and deteriorating living conditions.

The population which is growing at a very rapid rate, of about 3 percent annually, has been clearing forests and vegetation to satisfy its increasing requirements of food and energy. The forest coverage of the country which was once 40 percent about a century ago is now reduced to only less than 4 percent, and the deforestation rate is estimated at 100,000 ha/year (EVDSA; 1990, 1991). The disappearance of the forest cover leads to lack of material for soil regeneration and increased soil erosion which results in the reduction of soil fertility and declining agricultural production.

As population grows, arable land per capita declines and the fragmentation and degradation of land through overuse increases. To accommodate the landless young generation, frequent redistribution of land occurs resulting in the possession of holdings which are too small for sufficient production and has an impact on food shortages and family income. According to the 1999/2000 agricultural sample survey conducted by the Central Statistical Authority (CSA), the average farm size for the total country is 0.97 hectare whereas 29 percent of the total farming households have half or less hectare of land (CSA, 2000). In the areas of

northern highlands of Ethiopia, the problem is more acute than in most other areas. In these areas the average cultivated area per household is slightly more than one half of a hectare (Markos, 1997).

In response to the increased population density and shortage of arable land, fallowing practices which were traditionally used by farmers to maintain land fertility have also been either abandoned or the periods shorten. The disappearance or decline of fallow periods leads to the reduction in soil fertility and land productivity. In many weredas in the northern highlands of Ethiopia, more than 90 percent of the land is used for agricultural purposes on a permanent basis and fallowing as a system of farming has completely disappeared indicating that there is serious land shortage (Markos, 1997).

Ethiopia, the second most populous country in Sub-Saharan Africa had a population size of 63.5 million in July 2000 and a growth rate of about 2.7 percent. Rural population constitutes about 85 percent of the total population and is mainly dependent on farming (OPHCC, 1999). So land is the most important source for food (agriculture), building materials and domestic energy (forests).

In addition to the repeated droughts which occurred in the country, the rapid growth of the population and the associated land degradation has resulted in a serious food deficit over the past three decades. Thus since the early 1960's the country has failed to meet the food requirements of its growing population. In view of this fact, a technical analysis conducted by the World Bank (1990) has shown that the population-resource balance for Ethiopia is 0.5, which implies that the country could support less than half of its present population, at internationally accepted levels of nutrition, on a continuous basis. These shortcomings of food production and hunger lead to malnutrition particularly among children. Malnutrition is highly associated with the level of morbidity and mortality. According to the 2000 Ethiopian Demographic and Health Survey, among children under age five in Ethiopia, 51 percent are undernourished and 26 percent are severely undernourished (CSA, 2001).

However, regional differences within the country exist depending on several soil and climatic conditions as well as variations in their population density, with some areas having a poor population-resource balance and others having much excess capacity. For example, in the

Southern Nations, Nationalities and Peoples' Region (SNNPR), where the population density is high in most weredas*, one wereda Wenago had 864 persons per square Kilometer in 1999, whereas the average population density for the country was about 56 persons per Km^2 (CSA, 1998a).

In light of the linkages observed between population variables and socio-economic and environmental trends, it becomes necessary to ascertain the possible relationships using empirical findings. In view of this, this paper attempts to investigate statistically the interrelationships of population and environmental variables at country level. However, since the nature and extent of the relationships vary by ecological regions, it becomes unrealistic to put all the regions and zones together in the analysis. Due to this the study will be conducted at zone levels where data is available for zones and where it becomes impossible it will be done by combining zones and also at regional level.

1.2 Objectives

The general objective of this research work is to examine the interrelationship between population factors and environmental conditions in Ethiopia taking into consideration differences at regional and zonal levels.

The specific objectives are:

(i) to examine the relationship between population variables and environmental conditions at zone level;

(ii) to identify areas (zones) which exhibit similar features in their characteristics with respect to the prevailing interrelationship between population variables and environmental conditions .

(iii) suggest possible recommendations giving attention particularly to priority areas for action to mitigate the adverse impacts of population factors on environmental conditions and vice versa;

* Ethiopia is divided into nine regions and two administrative councils. The regions are further divided into zones. Zones are again divided into *weredas, and the weredas into Kebeles*.

1.3 Data Sources and Limitations

The basic data to be used in this study was expected to be obtained from the 1994 Population and Housing Census of Ethiopia. Every effort has been put to utilize the 1994 census results. However, environmental statistics covers natural as well as the man-made environment including a wide range of human activities, natural events and environmental impacts, and comprises social, demographic and economic data. Due to this, in addition to the census figures, data from other sources are also included. Thus data for this paper is obtained from various independent data sets (see Appendix I). Moreover, due to the variation in the nature and extent of environmental problems by ecological regions, it becomes unrealistic to put all the regions and zones together in the analysis. For this reason most of the analysis will pertain to zones wherever data is available and if it becomes impossible to obtain data for each zone, analysis will be done by combining zones and also at regional level. In general the units of analysis for this study are both the zones and regions.

The data sets used in this study include:

a) Population size, literacy, mortality, school enrollment, fuel for cooking and lighting are compiled from the 1994 census (OPHCC, 1997).

b) Data related to crop production, livestock, land use and related variables are obtained mainly from the 1994/95 agricultural sample surveys (CSA, 1995)

c) Data on prevalence of illness is taken from the 1998 health and nutrition survey (CSA, 1999)

d) Climatic variables are obtained from the National Meteorological Services Agency and they represent the average values for the periods 1993, 1994, and 1995 (unpublished data).

e) Geographic coordinates are taken from Atlas of Ethiopia (EMA, 1988)

Data obtained from surveys and censuses in developing countries are usually subject to sampling and non-sampling errors plus content and coverage errors. Data utilized in this research analysis face these errors mentioned. The data used for Affar and Somalie regions have even more critical errors. The population data of these two regions are from the 1996 and 1997 censuses for Affar and Somalie respectively, which are part of the 1994 Population and Housing Census of the country.

Not only are the data from different sources but are also collected in different years. Despite these limitations, it is believed that available data are useful to suggest results that may contribute valuable information in this difficult and unexplored field "Population Growth and Environment".

1.4 Organization of the Study

The study is composed of five chapters. The first chapter deals with the general background of the study and constitutes the introduction, objectives of the research, data sources and limitations, the population profile and natural resources of the country. Chapter two focuses on the review of literature related to the topic. In chapter three the methodology employed is briefly described and chapter four is devoted to discussion of the main findings. Finally Summary and policy recommendations are presented in chapter five.

1.5 The Population Profile of Ethiopia

a) Size and Growth Rate

With very few exceptions, Sub-Saharan African countries are characterized by very high rates of population growth, largely as a result of high birth rates and declining mortality levels. The average annual rate of natural increase for the whole of Sub-Saharan Africa is around 2.8 percent (UN, 1988).

Ethiopia is the second most populous country in Sub-Saharan Africa with estimated total population size of 63.5 million in July 2000 and a growth rate of 2.73 percent between 2000-2005 (OPHCC, 1998). The first ever National Population and Housing Census of Ethiopia

was conducted in May 1984. Based on this census, the Central Statistical Authority has reconstructed the historical perspective of the population from 1900 to 1985 (CSA, 1985). According to this result shown in Table 1.1, the population of the country was estimated to be 11.8 million at the beginning of the 20th century and its growth rate was then only 0.2 percent per year. In 1950, the population size had increased to more than 19 million and its growth rate had reached 2.1 percent per year. The growth of the population followed a slow rate of increase until 1970 and accelerated thereafter. The rapid increase in the population size and growth rate is the result of a sharp decline in mortality which was brought about by the successful malaria and smallpox eradication programs of the 1950's and 1960's (Belay Tegene, 1995). In 1984, the total population of Ethiopia was 42.6 million out of which 88.6 percent were rural residents and 11.4 percent urban (OPHCC, 1991).

The 1994 Population and Housing Census showed that Ethiopia's population had reached 53.5 million, out of which 86 percent live in rural and 14 percent live in urban areas (OPHCC, 1998). According to the projection made using this data under the medium variant assumptions, the 1994 population will double within less than 27 years. The doubling time of the population is getting shorter as the growth rate of the population increased. It took 60 years for the population at the beginning of the 20th century to double itself but less than 27 years for the 1994 population to double itself.

b) Age Structure and Spatial Distribution

The population of Ethiopia is characterized by an extreme youthfulness. According to the projections made on the basis of the 1994 census data, the proportion of the population under the age of 15 in July 2000 is 43.8 percent, whereas the proportion of the population aged 65 and over is only 2.8 percent. The proportion of the population aged 15-64 accounts for 53.2 percent of the total population (OPHCC, 1998).

Since the population under age 15 represents the potential parents in the near future, the dominance of the young age shows the high growth potential of the population. Thus, it indicates the continuing rapid increase of the population size for the coming years even

Table 1.1 Population Size and Growth Rate1900-1984 and 1994-2035

	Reconstructed based on the 1984 census			Projected based on the 1994 census			
Period	Growth Rate (%)	Year	Population (thousands)	Period	Growth Rate (%)	Year	Population (thousands)
1900-1905	0.2	1900	11,754.3	1995-2000	2.92	1995	54,649
1905-1910	0.4	1905	11,871.8	2000-2005	2.73	2000	63,495
1910-1915	0.5	1910	12,121.1	2005-2010	2.62	2005	73,044
1915-1920	0.8	1915	12,424.1	2010-2015	2.44	2010	83,483
1920-1925	1.0	1920	12,933.5	2015-2020	2.26	2015	94,526
1925-1930	1.1	1925	13,606.0	2020-2025	2.05	2020	106,003
1930-1935	1.2	1930	14,367.9	’’	’’	2021	108,318
1935-1940	1.3	1935	15,258.7	’’	’’	2022	110,632
1940-1945	1.5	1940	16,281.0	’’	’’	2023	112,959
1945-1950	1.8	1945	17,534.6	’’	’’	2024	115,276
1950-1955	2.0	1950	19,182.9	2025-2030	1.85	2025	117,586
1955-1960	2.1	1955	21,197.1	’’	’’	2026	119,893
1960-1965	2.2	1960	23,550.0	’’	’’	2027	122,198
1965-1970	2.3	1965	26,281.8	’’	’’	2028	124,498
1970-1975	2.3	1970	29,488.2	’’	’’	2029	126,787
1975-1980	2.6	1975	33,085.8	’’	’’	2030	129,059
1980-1985	2.8	1980	37,684.7				
		1984	42,185.0				

Source: CSA, 1988 and OPHCC, 1999.

assuming some decline in fertility. In addition, the population under age 15 and those at ages 65 and over are economically dependent age groups that must be supported by the population in the working age group (15-64). The Ethiopian population age structure shows a high dependency burden, which is 88 dependents for every 100 persons of working age group. This implies that 100 persons in the working age group have to support themselves and additional 88 persons who depend on them. A youthful age structure also necessitates a disproportionate allocation of a nation’s resources to the provision of the nutritional, health,

and educational needs of the young population rather than as investments to generate or sustain economic growth (UN, 1988).

With a projected population size of 63.5 million in July 2000 and a land area of about 1.1 million square kilometer, the population density of Ethiopia is about 58 persons per square kilometer. This indicates that the overall population density is fairly low in Ethiopia. However, large disparity in the distribution of the population exists among the different parts of the country. Excluding large urban centers, average density among the regions varies from 8 persons per sq. km. in Gambella to 111 persons per sq. km. in (SNNPR).

Higher population concentrations are found in the highlands where the largest agricultural potential exist (rainfall is adequate and soil is fertile). These areas are suitable for crop cultivation and mixed farming and the population engaged in agricultural activities have traditionally settled here. Even among the highlands the spatial distribution of the population varies from about 100 in Arsi and North Shoa zones to more than 300 in KAT (Kembata, Alaba and Timbaro), Sidama and Gedeo zones. In the later areas, the unique Enset culture under which a very small plot of land is sufficient to support a family and can be stored from 6-7 years has most probably resulted in such high population concentration (EMA, 1988). In contrast, population settlement is discouraged in the lowland areas where the climate is relatively dry and endemic diseases such as malaria and tsetse fly infestation are wide spread.

c) Components of Population Growth

The size, growth rate and composition of the population is influenced by the three demographic phenomena, namely fertility (births), mortality (deaths) and migration. However, in Ethiopia the two basic factors in determining demographic changes are fertility and mortality, while the influence of international migration has been observed to be negligible (Kebede Tesfaye, 1994).

The level of fertility in Ethiopia has been constantly high between 1970 and 1990 and slightly declined thereafter (see Table 1.2). According to the Ethiopia 2000 Demographic and Health Survey, the crude birth rate for the country was 41 per 1000 population and the total fertility rate was about 6 children per woman. Though the level of fertility has declined by half a child

during the past decade, it still stands among the highest in the world. This is because people want to have large number of children, start child bearing at younger ages and make much less use of family planning to limit their childbearing. The desired number of children in Ethiopia averages more than five and the contraceptive prevalence rate stands at 8 percent (CSA, 2001).

The level of mortality as measured by the crude death rate, infant mortality rate or expectation of life at birth presented in Table 1.2 shows a decline over the past three decades. Infant mortality declined from 155 deaths per 1000 births in 1970 to 97 deaths per 1000 births in year 2000 (a decline by about 63 percent). The expectation of life at birth increased from 44 years in 1970 to nearly 50 years in 1994. Eventhough a substantial decline in mortality rates is recorded during the past three decades, it still remains well above those observed in other countries. In this regard, Assefa (1994) pointed out that the reasons for this sluggish decline in the mortality conditions of Ethiopia are the continuous war as well as the high state of food insecurity prevailed in the 1970s and 1980s, and the poor health service infrastructure.

Overall, the youthful age structure, the high level of fertility and the declining trend in the mortality conditions of the country indicate the tendency of the population to continue growing in the next few decades.

Table 1.2 Trends in Fertility and Mortality conditions of Ethiopia (1970-2000)

Year	Crude birth rate	Total Fertility Rate	Crude death rate	Infant mortality rate	Life expectancy
1970	44.7	6.2	19.8	155	43.8
1981	46.9	6.9	18.4	144	46
1984	46.4	7.5	8.7	110	52.0
1990	-	7.7	-	105	-
1994	44.4	6.7	-	116	50.7
2000	41	5.9	-	97	-

Source: CSO, 1974 and 1985; OPHCC, 1991; CSA, 1993; OPHCC, 1999; CSA, 2000

1.6 The Natural Resources of Ethiopia

a) Location and size

Ethiopia is situated in the Horn of Africa comprising an area of about 1.1 million sq. Kms. This landlocked country is bounded by five countries. Eritrea is on the North, Djibouti and Somalia on the East, Kenya on the South and the Sudan on the West. The altitude of the country ranges from a depression of 110 meters below sea level in the Affar Depression to 4550 meters above sea level at Ras Dashen in North Gondar. The geographic location of Ethiopia is between 3^{o} N and 15^{o} N Latitudes and 33^{o} E and 48^{o} E Longitudes and has land area of about 113,000,000 hectares.

b) Climate

The effect of climatic conditions both on human and environment of a country is tremendous, particularly in a developing country like ours. Three main climatic regions are identified in Ethiopia, namely:

- Dry climate
- Tropical rainy climate
- Temperate rainy climate

The dry climate is sub-divided into hot arid climate having mean annual temperature higher than 27^{o}C and mean annual rainfall less than 450 mm, hot semi-arid climate with mean annual temperature 18^{o}C-27^{o}C and mean annual rainfall 410-820 mm and cool semi - arid climate mean annual temperature below 18^{o}C and mean annual rainfall 410 - 820 with reduced evapotranspiration due to lower temperature.

The Tropical Rainy Climate has three sub-divisions mainly-depending on the mean annual rainfall. Tropical Climate I has mean annual rainfall 680-1200 mm, Tropical Climate II has mean annual rainfall 680-2000 mm and Tropical Climate III's mean annual rainfall is 1200 - 2800 mm. The temperature in all three being above 18^{o}C in the coldest months.

The Temperate Rainy Climate has also three sub-divisions and covers the highland areas of the country with cool climate (i.e., 10^{o}-18^{o}C) and mean annual rainfall 800-2000 mm. (Conservation Strategy of Ethiopia; 1996).

c) Land Resources

The land area of Ethiopia is estimated to be about 113,000,000 hectares. The volcanic soils are relatively fertile and deep, and the highlands are suitable for the growth of a wide range of tropical, subtropical and temperate crops. The lowland arid and semi-arid areas are pasture areas (Conservation Strategy of Ethiopia, 1996). About 56 percent of the total land area of the country is said to be suitable for agriculture (MOA, 1995). Ethiopia is an agrarian country and agriculture employs about 80 percent of the population. The poor peasant farmers utilize rudimentary agricultural implements. Land utilization of the private peasant holdings of the settled population in 1997/1998 was as shown in Table 1.3.

Table 1.3 Land area by use

Land use	Area	
	('000 hectare)	percent
Temporary crop	7008.7	77.3
Permanent crop	558.2	6.2
Grazing	599.7	6.6
Fallow	504.0	5.6
Wood	33.3	0.4
Other use	356.7	3.9
Total	**9060.6**	**100.0**

Source: CSA, Agricultural Sample Survey 1997/1998 Land Utilization, Vol. IV, Summary Table B, Page,14.

The table mainly shows land utilization of peasant holders of the settled highland population, though this table includes small proportion of the lowland settled population, the arid and semi-arid areas inhabited by nomads and semi-nomads are not included here.

d) National Forest Resources

About a century ago, forest cover of Ethiopia was estimated to be about 40 percent of the country. However, now-a-days the estimate is between 2-3 percent. Deforestation for agricultural use is the main factor for the loss in forest cover. Extensive agricultural activities plus demand for firewood due to population increase are the major causes for deforestation. It is to be noted that it is the highland part with better rainfall which had forest cover. The lowland areas had bushes and shrubs covers, which are also decreasing fast (Conservation Strategy of Ethiopia, 1996).

Wars have devastating effects on the environment. Large size of the population will be displaced, internally and externally, which will lead to clearing large forest areas for settlement. Forests will be cleared for fire-wood for cooking for a large army, bombardment of forest land and placement of land mines besides big trees are cut for fortification. Ethiopia was ravaged by external and internal wars for many successive decades particularly on its northern part. Hence, man-made destruction has also played severe role in devastating the environment.

e) Water Resources

Ethiopia is called the "Water Tower of Northeastern Africa" (Conservation Strategy of Ethiopia, 1996). The country is source of six transboundary rivers, of which the Blue Nile is the main one. The annual runoff of the major rivers is about 111 billion meter cube. Despite this huge water resources, the country is prone to famine due to concurrent drought. The potential gross irrigable area is about 3.5 million hectares, however, the net area under irrigation is about 0.16 million hectares or 4.6 Percent of the irrigable land. Likewise the hydroelectric generation potential of the country is tremendous, yet utilized hydroelectric power is 1.25 percent. Hydroelectric generation potential (Gwh/year) is 135,311 while the utilized part is 1,698 (Conservation Strategy of Ethiopia, 1996).

f) Livestock Resources

Ethiopia has a Livestock Population which is the largest in Africa and the tenth largest in the world (Conservation Strategy of Ethiopia, 1996). According to the survey result conducted by the Central Statistical Authority, the Livestock population and pack animals in 1997/1998 was estimated at 64,408,180 (CSA , 1998b).

Livestock population of the private holders of the highland settled population by type of livestock in 1997/1998 is shown below in Table 1.4.

Table 1.4 Livestock Population by Type

Type of Animal	Number
Cattle	35,371,770
Sheep	13,428,480
Goat	10,460,390
Horse	1,230,730
Ass	3,169,340
Mule	263,110
Camel	470,360
Total	**64,408,180**

Source: CSA, Bulletin 193, Table 2, Page, 13

g) The Flora and Fauna Resources

The topography of the country has wide variation ranging from below sea level to more than 4,550 meters above sea level. This has caused ecological diversity which in turn has created diverse flora and fauna in Ethiopia. The country is home for various flora species, the estimated figure is 6500 - 7000, of which 12 percent are endemic. Ethiopia has the fifth largest flora in tropical Africa (Conservation Strategy of Ethiopia, 1996).

Likewise Ethiopia has wide diversity of fauna depending on climate, vegetation and terrain. At present 240 species of mammals and 845 species of birds are identified in the country. Twenty-two species of mammals and 24 species of birds are endemic which makes the country the richest in avifauna in mainland Africa (Conservation Strategy of Ethiopia, 1996).

h) Soil

Fertility and type of soil varies considerably in Ethiopia (MOA, 1995). However, the most critical problem is the erosion of fertile soil by rain and wind. “Ethiopia is one of the three countries in the world, which is endangered by soil erosion. Ethiopia loses 2 billion tons of soil annually”. Ethiopian Herald Vol. LVII No.93, 28/12/2000.

The soil erosion is very high in the heavily deforested Northern regions. For example, “ The Amhara State Agriculture Bureau said 1.1 billion of fertile soil is annually washed away by wind and rainwater in the state”. Ethiopian Herald Vol. LVII N0.91. Likewise wind erosion in Affar regional state has devastating effect, “some 36 million tons of soil was exposed to wind erosion annually in the Affar State”. Ethiopian Herald Vol. LVII No. 86.

CHAPTER II

THE POPULATION-ENVIRONMENT NEXUS

2.1 Theoretical and conceptual Framework

The United Nations two Conferences, respectively: on Environment and Development, held in Rio De Janeiro in 1992 and on: Population and Development, held in Cairo, 1994, motivated researchers to begin to explore systematically the linkages between population and environment through data collection. The statements and the exhortations coming from these important planetary meetings stress a revolutionary change in thinking about the world development. For the first time in history, the consciousness is taking place that almost all of the world's people are bound together in a global system. In this direction many scientific and socio-economic works have been witnessed: first of all the quantic physics, second the wide-spreading longevity, third the speed of communication facilities, forth the market globalisation.

The discovery of the quantic universe plays the analogous revolutionary change that the Copernican revolution had. Especially in the matter of climate and environment, it is possible to verify easily the existence of a systemic reaction to every pressure acted in everywhere in the planet, far away of heavier and longer-term impact than those perceived using the cause-effect Newtonian point of reference.

Longevity makes it possible for every person, born in a rich country, to experiment the long-term effects of global development during its own every-day life.

The possibility of immediate world-wide communication immensely amplify, and sometimes also deform the massive information about changing natural environmental conditions, generating a spread of sensitivity about environmental concern acting processes.

The process of market “Globalisation” has considered the attitude towards making more similar the previous vast differences in economic performances depending on the past market structural and political differences across regions of the world. The most desired result of this process, is that large part of the developing world will narrow the income gap between themselves and richer nations. Market differences are the simplest to be quantified, but they are not the only one existing between developed and underdeveloped regions style of life: a great importance must be assigned to other factors, as demographic behaviour, cultural references, religious believes, ethnic identity, education, environmental context, just to quote the most emergent and, relatively easy to be identified. Often they constitute a web of endemic brakes indirectly opposite against the developing way outlined by people living in rich countries for people living in underdeveloped regions. However, often they constitute important qualification of mankind-diversity, a heritage worthy to be respected not less than the bio-diversity, basic to the planet survival.

Theoretical and conceptual framework of current researches concerning population-environment relationships are various, but they can be grouped in two distinctive categories (UN-DESIPA, 1994): The Malthusian ("limits to growth") and the Boserupian ("cornucopian") perspectives: these imply the existence of direct relationships between population and environment, or between population, technological change and the environment. The Malthusian point of view suggests that limited natural resources place a restriction to population growth: environmental crisis must be interpreted, there on as the natural mechanisms of compensation, limiting the population growth pressure. Boserup explicitly takes into account technological change, which Malthus did not. Population growth and the resulting increased population density might induce technological changes necessary to allow food production to keep pace with population increase.

The Multiplicative Perspectives: population and its characteristics (size, growth, density and distribution) interacts in a multiplicative way with other factors, such as levels of consumption and technology, to have impact on environment. One of the most frequently used multiplier approaches, is equation: I = PAT. Impacts on environment result as the product of: Population size, Affluence (or per capita consumption), and the level of Technology.

The Mediating Perspectives. These emphasise that social, cultural and institutional factors play a mediating role in determining population-environment relationships. The influence of those factors is viewed as multi-level so that layers of mediating variables at the household, community, national and international levels must be considered.

However, the importance of problems related to environment-population nexus is identified, till the times of the starting capitalistic age: many geographical characteristics have been considered more or less favourable for economic and social development. For example, Adam Smith: "…So is upon the sea-coast, and along the banks of navigable rivers, that industry…..naturally begins to subdivide and improve itself, and it is frequently not till a long time after that those improvements extend themselves to the inland part of the country…….All the inland parts of Africa and all that part of Asia which lies in a considerable way north of the Euxine and Caspian seas …..seem in all ages of the world to have been in the same barbarous and uncivilised state in which we find them at present."

Over the past 200 years, this interplay of economy and geography has produced inequalities of income greater than any seen before in history. Europe and North America had the most productive economic system reinforced and partly caused by their very favourable geographic conditions. In contrast, the ancient empires near the tropics and great land-based weakened their economic institutions and, as a rule, exhausted their poorer geographical endowments .

In this century the sense of interactions between geography and policy nature-nurture in socio-economical development has continued to be more and more steadily linked. In recent studies on global pattern of growth during 1965-90, these were shown to depend on four factors:

a) initial conditions;
b) physical geography;
c) government policy;
d) population change.

For common people living in Sub-Saharan Africa, the problem of lack of economic and social development assume a very concrete aspect: the points quoted above can simply be

summarised in few words: food is not sufficient for large portion of the population, an hostile environment, menacing survival, health, welfare.

In conclusion, what was once a universal threat to human life is now found primarily in Sub-Saharan Africa, and at present time, the Malthusian perspective seems to be prevalent, as it concerns environmental demographic interplay in this region.

Experts in development studies continue to forecast that Sub-Saharan Africa is likely to be the only continent to experience a persistent high level of mortality due to food deficiency related problems, as well as an increase in absolute poverty. If death due to absolute hunger or famine is controlled, it will be replaced by death due to malnutrition. Food deficit is still the major killer in this Sub-Saharan continent.

Presently, mass starvation in Sub-Saharan Africa due to natural and man-made disasters is becoming less surprising. For most, the human miseries that are frequently displayed on western television screens may seem occurring during famine periods only. But the reality is that poverty and destitution are becoming almost permanent features of most of the rural areas of the sub-continent. While famine episodes induced from drought and ecological degradation are almost eradicated from most of our present day world, the frequency of their occurrence in Africa is increasing from time to time.

Population growth may be but only one of many factors which are impeding development in Africa, but its role seems to be overemphasised by many writers. Many writers have alleged that Sub-Saharan Africa is being pressed backward into greater poverty and hunger, by the weight of an excessively rapid population growth.

It is believed that population is growing at about 3 percent per year, while no region in the sub-continent has a record of agricultural output increasing at 3 percent. Such trends of disharmony between population and food production may indicate that population can be a problem, but they do not warrant that it is the root cause of the region’s problems of poverty. At present time the questions of concern are the means urgently identifiable to make an alternative process start (Boserupian, or Multiplicative) within the population-environment relationship, different from the actually acting Malthusian one.

In this perspective, African population do not need massive quantity of food coming from charity of rich developed countries. The urgent need is the constant transfer of technology as well as development of its human resources so that people could develop mechanisms by which they can manage to live on their own natural resources and cope up with situation of ecological degradation and drought which are becoming permanent features of the continent.

If for each person in a large population it would be invested in order to make it a resource, a faster growing population could necessarily become a faster growing human capital. Indeed, considering population growth merely as an oversized reproduction of present pressure of poverty, it's quite normal to forecast a potential crisis. The forest and the woodland, capital source of food, fuelwood, medicine…etc, are seriously menaced by the rapidly increasing human and animal population. The pressure exerted on environmental resources is causing the decline in food production.

Local people attitude and practice on their environment is indeed decisive to sustainability of resources. For many years people took for granted the environment in which they lived or depended. They thought that the environment is in-exhaustible can go for ever as it is. That such attitude is short-sighted became widely apparent when the extent of land degradation and desertification related human suffering was exhibited by the widespread droughts that tragically affected the Sub-Saharan Africa between the late 1960s and now. Since then both public and decision makers have become increasingly concerned with changes in environmental quality resulting from human activities.

These subjects are deeply and largely discussed in the recent literature concerning the population-environment nexus in Africa. Many researchers are exploring the possibility of starting a Boserupian process. The results, coming from national or case studies, carried out in the continent, pointed out the themes of ecological degradation, food insecurity, demographic response as the basic concepts of this field of studies.

Ecological degradation

This term is used to describe the process of deterioration and reduction in the quality of life of humans and the living environment. Ecological degradation is a process that unfolds

gradually and is apparently manifested by serious land degradation and deforestation. Usually, degradation of the ecology is seen under land degradation, water resource degradation, loss of biodiversity, deforestation and an expanding process of desertification.

Food insecurity

Food insecurity is defined as a complete lack or decline in access to productive resources, in particular land; deterioration of the household asset position overtime and declining resource productivity as a result of environmental degradation

The environmental impact of a possible intensification of traditional agricultural practice.

Many researchers are exploring the possibility of starting a Boserupian process by the intensification of agricultural practice, in some countries of Sub-Saharan Africa, where contemporary acting exist: declines in per capita food production, high rate of population growth, deteriorating land resources, the conclusion is often that intensification of agriculture could accelerate land degradation.

From a descriptive analysis based upon data concerning 38 sub-Saharan African countries Cleaver and Schreiber (1992) observed that traditional production system in Africa seems completely indifferent in front of rapid population growth. The absence of sufficient technological change in agricultural practice plays in the sense of worsening land degradation process: increased population growth and subsequent heavier density have been accompanied by intensification of land use. It means essentially a forced increase in the frequency of cropping rather than the traditional fallowing system. Using data from population and national agricultural censuses in six African countries, Lele and Stone (1989) found that a "policy-led intensification", rather than "autonomous intensification" is preliminary to start the Boserupian process. The first allows shifts to crops of higher value production, the second increases the frequency of cropping, favouring land degradation and merely involving, as additional input, the exploitation of increasingly marginal lands.

More favourable effects of the "autonomous" style in agriculture management has been found by Hyden, Kates and Turner (1993) and Tiffen, Mortimer and Gichuki, in different countries of Africa (Kenya, Nigeria, Rwanda, Uganda and Tanzania) and in a particular zone (the Machakos District of Kenya).

Another important consequence of land degradation, often studied in the context of traditional African agriculture practice, is the desertification. This has been defined as the expansion of desert like landscapes into the arid and semi-arid environment and rangelands used for livestock grazing. The issue of desertification in Africa is frequently discussed in the context of population-environment relationships. The studies on desertification found that the growth of nomadic and subsistence farmer population, combined with increased livestock density, led to increased fuel demand, deforestation and the extension of agricultural and grazing activity into forests and semi-arid marginal lands; all these factors result associated with increased desertification.

Population response to environmental stress

The literature concerning this aspect of the country takes into account weredas and zones after punctual ecological disasters. The emerging results, mainly obtained by field surveys seem to suggest the existence of a Malthusian-kind of population response in many cases. The effects of exceptional drought, famine and other stressing events have been of severe demographic impact, in many regions of Sub-Saharan Africa: increase in infant mortality and mortality in general, decrease in nuptiality and natality have been, at some extent, registered and pointed out.

2.2 Population Growth and Environmental Degradation

There is growing concern that much of Sub-Saharan Africa's natural resource base and ecological environment are deteriorating mainly due to high loss of vegetative cover resulting from deforestation and conversion of savanna to cropland (UNECA, 1993). Among the contributory factors in the deterioration of the environmental conditions in the African continent, the recurring natural disasters such as drought and political instability are worth mentioning. Africa's Population growth combined with unsustainable consumption patterns has a critical influence on the life-supporting capacity of the region. In view of these interrelationships, the 1992 International Conference on Environment and Development held in Rio de Janeiro, Brazil known as the Earth Summit produced a report (UN, 1993) in which it identified demographic processes and population pressures as one of environmental priorities and warranted states to reduce and eliminate unsustainable patterns of production

and consumption and promote appropriate demographic policies. The conference further elaborated to carry out the objectives and activities according to the different situations and priorities of countries and regions in the light of changing needs and circumstances giving special priority to the least developed and those environmentally vulnerable.

In developing countries, land degradation is one of the greatest threats which strikes at the basic resource of the population. The degradation process is so acute in Africa that millions of people have fallen into poverty and have suffered famine and death. The situation in Ethiopia is not different. In Ethiopia, massive environmental degradation has occurred during the last few decades due to natural factors, unwise use of its natural resources, unsound ecological practices and population pressure. The major factor accelerating the environmental degradation rate is man's abusive actions such as the removal of the natural vegetation cover through deforestation, over-grazing and inappropriate agricultural practices. The population which is growing at a very rapid rate of about 3 percent annually has been clearing forests and vegetation at an alarming rate in order to meet its increasing requirements of food, fiber and energy.

The forest cover which constituted 40 percent of the land some 100 years ago has gone down to less than 4 percent at present (EVDSA,1990). Widespread deforestation in the highlands started around 2500 BC (Ethiopia-UNCED National Report, 1992). The Ethiopian highlands consisting of around 45 percent of the total area of the country, contain four-fifths of the human and two-thirds of the livestock populations. The area receives more than 90 percent of the total rainfall which makes it favorable for rainfed agriculture and has thus been settled for more than 5000 years (Ethiopia-UNCED National Report, 1992). Large increase in the number of human and livestock population resulted in scarcity of land and expansion of agriculture into traditional grazing areas and marginal lands. In many weredas of the northern highlands of Ethiopia, more than 90 percent of the land is used for agricultural purposes on a permanent basis and fallowing as a system of farming has completely disappeared indicating that there is serious land shortage (Markos Ezra, 1997). According to this study, in most areas, the average cultivated area per household is slightly more than one half of a hectare. Marginal lands are less able to retain water and are subject to wind and water erosion. Land degradation problem is affecting considerable parts of Ethiopia, especially the highlands, mainly due to water erosion. Soil erosion is the main feature of land resource depletion leading to desertification which leads to reduced agricultural production and shortage of food. Overall, the effect of population pressure and resulting environmental degradation have

driven the country into widespread food insecurity, drought and famine for the last three decades.

The main activities that are responsible for environmental degradation in Ethiopia include the removal of vegetation cover and over cultivation as a result of the rapidly increasing population requirements for crop production and fuel wood. In addition, overgrazing and high livestock density resulted in the deterioration of rangeland resources.

2.3 Population Growth and Food Production

Since the beginning of the 1970s, in many countries of Sub-Saharan Africa land degradation and highest rates of population growth have undermined all efforts to provide the population of the region with necessary goods and services including food. During this period average food production per capita has been falling by about one percent per annum and the capacity of the region to feed itself has been and is declining (WCED, 1987).

The situation of food in Ethiopia during the last successive three decades is largely dominated by decline in domestic food production. Ethiopian agriculture is dominated by small holder peasant farming which contributes about 95% of the annual food production of the country. This sector is dependent mainly on traditional and subsistent farming methods (with a very limited use of modern technologies) and rainfall. Despite the irrigation potential of the country which is around 3.5 million hectares, nearly 5 percent has been utilized up to now. The high dependency of the peasant farmers on rainfall associated with the shortfall and erratic nature of the rainfall during the last three decades have resulted in widespread drought and famine. Moreover, the rising population pressure and clearing of forests to satisfy its basic demands such as food and energy made the soil susceptible to wind and water erosion. In this respect, a study carried out by Ministry of Agriculture (1995) has indicated that,

> "Out of agriculturally productive lands of the country, 14 million hectares rendered unproductive (seriously eroded) and about 2 million hectares of land have reached the point of no return. An annual loss of about 1,900 million tons of soil from the highlands through erosion which is equivalent to a loss of 100 tons/ha (8mm depth of soil) per year. The problems were serious in Wollo, Gondar and in parts of Tigray, Shewa and Gojam regions."

The majority of the regions cited above are located in the northern highlands of the country and are known for their population pressure and vulnerability for shortcomings of food production and hunger. The sustained deterioration in the per capita food production and hunger has resulted in a widespread malnutrition, particularly among children, which will lead to physical and mental impairment over the next successive decades. According to the result of the 2000 Demographic and Health Survey carried out by the CSA, malnutrition is observed to be highly prevalent over all the country. The result indicated that, in Ethiopia, among children under five years of age 51 percent are under-nourished and 26 percent are severely under nourished (CSA, 2001). Malnourished children are more prone to be inflicted by infections diseases compared to well-nourished children. It is well known that nutritional status is closely related to the level of morbidity and mortality of children.

Due to the country's limitations to overcome some basic economic and environmental problems, an abundant portion of the land which is suitable for crop production is unused. A study conducted by Land use Planning and Regulatory Department of the Ministry of Agriculture indicated that 56 percent of the country's total land area of about 112.3 million hectares is regarded to be suitable for agriculture out of which, only 14.8 percent of the total land area is used for the production of annual and perennial crops (MOA, 1995).

Despite the presence of such large untapped land resources for the country as a whole, important inter-regional differences exist in the population resource balances. On one hand, the majority of Ethiopia's population (80 percent) is located in the high altitude zone of the country. The concentration and expansion of the population and their animals in these areas for many years and the associated removal of woodlands and ground vegetation cover to satisfy their basic requirements resulted in accelerated soil erosion and reduced soil fertility. On the other hand, most of the untapped land resources are concentrated in the lowlands which are drier than the highlands and suffer from inadequate amount of rainfall have low level of population density. Some of these areas are suitable for irrigation. But irrigation can cause soil salinization and creates ground for the spread of diseases such as malaria. The moister wooded lowlands have also tse-tse flies which are causing sleeping sickness (Tewolde, 1996). Belay Tegegne (1995) also points out that "most of the potential arable land is marginal and the economic or ecological cost of bringing it under cultivation is extremely high. Such marginal areas can be brought under reliable and sustainable development only

when a huge investment on modern technologies, irrigation and conservation are possible". Expansion into these new lands may not occur easily with increasing population size. It needs government efforts to provide large investments in infrastructure including transportation and health services.

2.4 Population Growth and Fuelwood consumption

Fuelwood has become increasingly difficult to obtain in both rural and urban areas in many Sub-Saharan African countries with rapidly growing populations using much more fuelwood than in the past (World Bank, 1990). On the subcontinent, the fuelwood shortages in many regions have three primary causes; an increase in fuelwood consumption; expansion of agriculture into forests or woodlands which reduces available tree stocks; and overgrazing caused by an increase in the cattle population which often parallels human population growth. Fuelwood is the main source of household energy in Sub-Saharan Africa, with 90 percent of households using them for cooking. An increase in population translates directly into an increase in demand for fuelwood. As a result, in some parts of Africa the demand for both fuelwood and agricultural land has led to deforestation and desertification (World Bank, 1990).

According to the report prepared by the woody Biomass Inventory and Strategic Planing Project, (WBISPP 1995), in Ethiopia, household activities take the largest share of the energy consumption, accounting for 89.4 percent of the overall energy consumption, and industry and transport are distant second and third with 6.8 and 3.2 percent of the total energy consumption, respectively. In Ethiopia where more than 80 percent of the people live in rural areas, traditional fuels contributed a high percentage of the energy consumption, with fuelwood being the most important source, followed by dung, crop residues and of charcoal. Within the households, traditional fuels contribute 99.6 percent of the total household energy consumed, with fuel wood (81 percent), dung (9 percent), crop residues (8 percent) and the remainder contributed by modern fuels. Due to the relative importance of cottage industries, the contribution of the traditional fuel for industry sector is the highest, 85 percent (WBISPP, 1995).

Though fuelwood is the most important source of energy in Ethiopia, its supply is steadily collapsing in most parts of the country, because it is being collected faster than it can regrow. Increased forest clearance to create farmland, wood for construction purposes and forage has

led to shortage of fuelwood, deforestation, and environmental degradation. In areas where shortage of fuelwood is prevailing, large portion of the population, particularly, rural households are unable to satisfy their energy requirements with alternative energy sources (such as kerosine, electricity and gas) for reasons of inaccessibility and unaffordable prices. Due to this, they will switch to agricultural wastes and dung. The detrimental effects of the substitution of agricultural wastes and dung includes deterioration of soil fertility and eventual loss of topsoil. It is indicated by World Bank (1990) that the avoided costs of environmental deterioration and declining yields in Ethiopia can be substantial if trees are grown to replace dung. It has been also estimated that for each additional one million people, the resulting demand for the dung and agricultural waste that would replace wood fuels would cost the economy of Ethiopia approximately 102-150 thousand tons of grain production (World Bank, 1990).

CHAPTER III
METHODOLOGY

The aim of this study is to build some scenarios of reference for different kind of relationships existing between population and environment in the country.

Table 3.1 List of Selected Variables and Labels

Labels	Rate	Year
Popu14	% of population under 14 years	1994
Popo64	% of population over 64 years	1994
Density	Inhabitants per square kilo meter	1994
Iln	Prevalence of Illness	1998
U5MR	Child mortality rate	1994
Lit	Literacy rate	1994
Woodhc	% of households using wood for cooking	1994
Elechl	% of households using electricity for lighting	1994
Kerohl	% of households using kerosine for lighting	1994
Liv	Pressure of the livestock	1994
Cereals	Quantity of cereals per hectare	1994
Pulses	Quantity of pulses per hectare	1994
Temp	Area of land employed for temporary crops	1994
Perm	Area of land employed for permanent crops	1994
Graz	Area of land employed for grazing	1994
Wood	Area of land reserved for forest	1994
Rain	Annual average rainfall	1994
Maxtemp	Annual average maximum temperature	1994
Mintemp	Annual average minimum temperature	1994

Two preliminary choices have been done: the first concerning the administrative zones as geographical point of reference. This choice has been forced by the lack of more detailed information. The second choice concerning the nature of figures to employ: they are all of a

quantitative nature and concern both the population and the environment. They refer mainly to the 1994 date.

The first step done to treat the data has been the calculation of bivariate and multivariate correlations. This process allows to extract from the original set of about 45 variables, the final employed one, of 19 variables. The choice also depends from precious information, emerging during the discussion between Ethiopian and Italian experts (see Table 3.1).

The sources of the data are mainly the 1994 Population and Housing Census and the 1994 Sample Surveys of agriculture and livestock. All critical observations concerning the expressive extent of each variable are also expressed in this section.

These variables have been treated by the method of Principal Component Analysis. A new "artificial" variable has been built, as a linear combination of the original variables, maintaining, however, a relevant informative value. This process allows to study the subject employing fewer variables and also reveals relationships which were not originally suspected and allows interpretations which would not ordinarily result.

The results are expressed in the first five principal components, which all together explain 70 percent of the variability (see Figure 3.1). The figure shows the contribution of each component to variability. The first component only explains 30 percent of the variability while the contribution of the second one is of 12 percent more; the final cumulative 70 percent consists of the contribution of each principal component which subsequently decreases as one goes from the first component to the second, third, fourth and fifth components, respectively.

The results of the Principal Component Analysis are shown in Table 3.1 and Appendix II. In the first column of Table 3.1 the number of considered eigen values is specified; in the second column the quote of variability explained by each of them is presented. In the remaining columns the values of enginevectors for each variable is illustrated. The results presented in Appendix II show the values of eigen vectors comparing a couple of eigen vectors each time.

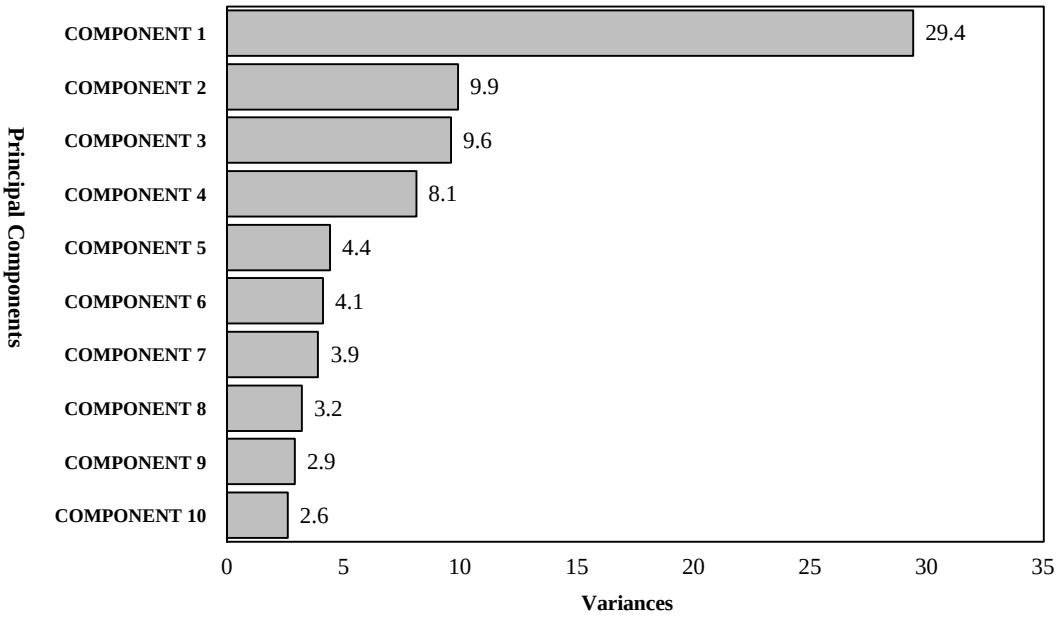


Figure 3.1 Principal components with explained variances

Table 3.2 Values of Eigen vectors for the first Five Components

Eigen Values	Explained Variance (cumulative %)	1° Eigen vector	Variables	2° Eigen vector	Variables
1°	0.294	0.29	Mintem	0.32	Rain
2°	0.426	0.28	Kerohl	0.32	U5MR
3°	0.525	0.27	Iln	0.31	Pulses
4°	0.621	0.26	Maxtem	0.29	Woodhc
5°	0.702	0.22	Woodhc	0.29	Cereals
		0.19	Popu14	0.28	Popu14
		0.00	U5MR	0.25	Perm
		-0.33	Livest.	0.24	wood
		-0.30	Temp	0.22	Kerohl
		-0.30	Elechl	0.18	grazing
		-0.28	Literacy	0.17	Livest.
		-0.27	grazing	0.01	Iln
		-0.25	Density	0.00	Temp
		-0.19	Rain	-0.28	Density
		-0.15	Perm	-0.23	Literacy
		-0.13	Pulses	-0.21	Elechl
		-0.12	Cereals	-0.16	Mintem
		-0.12	wood	-0.11	Popo64
		-0.07	Popo64	-0.09	Maxtem

Table 3.2 (Cont'd)

3° Eigen vector	Variables	4° Eigen vector	Variables	5° Eigen vector	Variables
0.39	Cereals	0.36	Pulses	0.37	Kerohl
0.32	Maxtem	0.35	Popo64	0.34	Density
0.29	Pulses	0.22	U5MR	0.20	Literacy
0.27	Mintem	0.22	Rain	0.17	Pulses
0.25	Literacy	0.13	Cereals	0.15	Perm
0.22	Elechl	0.11	Kerohl	0.09	Cereals
0.22	U5MR	0.11	Iln	0.08	Rain
0.21	Woodhc	0.05	Temp	0.07	Popu14
0.19	Density	-0.43	Perm	0.05	Woodhc
0.19	Rain	-0.33	Wood	-0.46	U5MR
0.01	Iln	-0.27	Woodhc	-0.38	Iln
-0.32	Popo64	-0.24	Mintem	-0.34	Elechl
-0.24	Kerohl	-0.23	Livest.	-0.23	Wood
-0.23	Grazing	-0.19	Maxtem	-0.18	Temp
-0.21	Popu14	-0.18	Popu14	-0.18	Popo64
-0.19	Livest.	-0.18	grazing	-0.14	Livest.
-0.16	Temp	-0.13	Elechl	-0.12	Maxtem
-0.04	Wood	-0.11	Literacy	-0.11	Mintem
-0.02	Perm	-0.02	Density	-0.03	Grazing

CHAPTER IV
FINDINGS

The first and strongest component describing the relationship between population and environment constitutes two contrasting environmental-demographic variable groups. As it regards the environmental variables, two of them which are highly linked to the climate (the maximum and minimum temperature) seem to be exclusive, dominant and, at some extent, antagonistic to any possible interrelationship with the human stable settlement. The disposable energy sources, employed by the inhabitants are firewood for cooking and kerosene for lighting. Almost all zones (except the four zones group between Gambella and Omo) around the external belt of the country are the most typical examples of this situation.

The opposite group of environmental variables are: the rainfall which is linked to the climate, cultivation of temporary crops (such as cereals and pulses) and permanent crops, availability of grazing areas and existence of forests (wood land) are revealed. Here the source of energy for lighting is electricity. The central zones, and Harari Region are categorized in this group.

Population behaviour is not strongly different from a strictly demographic point of view in the two scenarios, however, the life styles seem to be very different. In the first group of zones, a relatively higher level of fertility (high proportion of population under 14 years of age) and also a spread of illness have emerged. In the second group of zones, a more permanent agricultural or pre-urban type of settlement (the case of Addis Ababa is not included in the data matrix of course) is suggested by the coexistence of density of inhabitants and a high level of literacy. A significant part of the remaining zones represents an intermediate situation between the two described scenarios: the western ones are nearer to the first, the central ones are nearer to the second also geographically, the zones belonging to the second scenario are all grouped around the heart of the country.

The second component constitutes two contrasting environmental contexts in which nature and agriculture linked aspects coexist in the first group, and a certain degree of urbanisation appears as a dominant aspect in the second group. In the first context, the rainfall, availability of forests, cultivation of permanent and temporary crops, traditional sources of energy (wood for cooking and kerosine for lighting) correspond to the compact group of zones at north west

of Omo river. The most noteworthy is the compact one from the north-east to the central part of the country, depending on a settlement pattern based on both small villages and relatively big towns (M. Ezra 1997). In the remaining groups of zones the settlement pattern is more oriented toward few big towns, in the case of the two groups of zones: North Gondar and West Gojam at north-west; Dirashe and Gambella at west, as well as the case of Dire Dawa, Harar and Somali at south-east. The population in the two scenarios present different characteristics as it concerns both the demographic behavior and the life style aspects. In the first group of zones, fertility is relatively higher and people are poorer (Proportion of population under 14 years of age and child mortality seem to be higher) whereas in the second group of zones, the level of literacy appears to be better. The remaining zones represent intermediate situations, oscillating at different extent between the two opposite scenarios. It is possible to distinguish a west-east direction of the population-environment rural pattern and a north- south direction of the population- environment urban pattern.

The third component consists of two opposing contexts in which the first one shows environmental aspects linked either to the agricultural practice (cultivation of cereals and pulses) or to the natural climate (maximum and minimum temperature and, rainfall is less important). In this group, energy sources belong to either the traditional (wood for cooking) or the modern one (electricity for lighting). The second group presents a context in which the environmental aspects are linked to the most traditional agricultural practice (availability of grazing areas and temporary crops are less important) and, the only source of energy for lighting is kerosene. The first scenario corresponds both to the noteworthy group of zones at west: Gambela, Sheka, Bench, Maji, Kefa, Jima and Benishangul and to the more limited group at east: W. Harerghe, E. Harerghe, Dire Dawa and Harari. The second scenario corresponds to zones, irregularly plotting the north-east and the south-west band of the country: E. Tigray, N. Gondar, N.Wello, N.Shoa, KAT, Konso, Agewawi. The population in the first group of zones is particular more as it concerns the life-style than the demographic behaviours: signs of modernity appear as relatively higher level of literacy and use of electricity for lighting coexist with signs of traditional poverty, as relatively higher level of child mortality. The population in the two zones of the second group presents a particular age structure within which the contemporary presence of children and ageing people is noteworthy. This is presumably an area of an important emigrants stream. The remaining

zones represent intermediate situations, partly close to the first and partly close to the second scenario. These constitute the largest part of the country.

The fourth component contrasts two opposing contexts. In the first scenario, environmental characteristics are linked in part to the natural climate (rainfall) and to agricultural practices such as production of pulses. In the second scenario, the environmental aspects are linked to the climate (minimum and maximum temperature) coexist with availability of livestock and land use under forests (wood land), grazing areas and permanent crops. The prevalent source of energy for lighting in the first scenario is kerosene (with marginal importance) whereas in the second context, wood is used for cooking and electricity (less important) is used for lighting. Two compact groups of zones are identifiable as belonging to the first scenario: Illubabor, Jima, Sheka, Kefa, Maji, Oromiya and Bench, in the west-central part of the country; S.Gondar, N. Wello, S. Wello, E.Gojam, N. Shoa, in the east-central part of the country. More spread appear to be the characteristics belonging to the second scenario: Gambella and Dirashe at west, Gurage, Hadiya, N. Omo Sidama, Gedio, Amaro, Konso, in the west-central part of the country; the four zones of Afar and Somali, respectively at north and south-east. The remaining parts of zones share themselves in scenarios either close to the first or to the second. The population characteristics do not seem to differ significantly as it concerns both the structural aspects and life-style conditions. The presence of ageing people and a high incidence of child mortality are more evident whereas the presence of illness is less important in the first, and the level of literacy is slightly higher in the second.

The fifth component consists of two contrasting contexts. In the first group, population density and level of literacy are relatively higher. The most widely used source of energy for lighting is kerosene and agricultural activities such as production of pulses and permanent crops prevail in these areas. Here, the level of literacy is also high. The second group is identified by severe health conditions such as prevalence of illness and high level of child mortality, availability of forests and a natural climatic condition linked to the minimum and maximum temperature coexist with a widespread use of electricity for lighting. The zones belonging to the first scenario are few in number: Gambella, Sheka, Kefa, Amaro, Yem, Burji, Borena. The zones belonging to the second group are numerous and more widespread in the country: Central and South Tigray, South Wello, North Omo, Gurage, East Shoa, Arsi,

West Harerghe and Dire Dawa. Within the first scenario, the life-style of population seems to indicate a traditional rural settlement where low levels of modernisation appear. Within the second scenario, however, the life style of the population expresses a more traditional rural characteristic, based on livestock and temporary cropping (ageing people, temporary crops). At a lower extent two compact group of zones are identified by the prevalence of the first scenario: West Gojam, West and East Wellega, Illubabor, at west; Maji, KAT, Sidama, Gedio, Bale, Somali, at south; three more distant zones with each other: Wag Hemra, N. Shoa, Agew Awi. At a lower extent are identified all the remaining zones by the prevalence of the second scenario: C. and S. Tigray, S. Wello, in the central-east part of the country; N. Omo, E. Shoa, Oromia, Arsi, W. Harerghe, in the south.

Particular suggestions concerning differential demographic behaviours are not evident, but it would be necessary to introduce more demographic indicators in order to deepen this aspect. However, the existence of a Malthusian-kind of response to environmental stress could be a fact in the zones where the rural life is more linked to the most traditional life-style. But it is impossible to distinguish if it depends on the changing fertility and mortality or, more probably on the intensifying emigration stream.

CHAPTER V
SUMMARY AND RECOMMENDATIONS

a) Summary

This Paper is a modest attempt to explore the population-environment nexus. The principal component analysis method was applied to examine the relationship between the two. Originally 45 variables were employed. However, after calculating bivariate and multivariate correlation, variables that are observed to be highly correlated and redundant were eliminated, and only 19 variables were utilised in the analysis of principal components. For the purpose of describing the interrelationship between population factors and environmental conditions, the first five principal components were retained in the analysis. In fact the first principal component explains 30 percent of the variation while the other four components explain the remaining 40 percent.

The findings obtained from the analysis suggest that living conditions of the Ethiopian population differ depending on varying ecological regions, i.e., life is better in some zones and worse in the others. This can be easily argued watching the maps (Map I-Map V). According to the result, climatic factors are found to be dominant and sometimes antagonistic to any possible relationship with population. Two types of settlement scenarios are distinguished. That is a west-east direction of the population-environment rural pattern and a north-south direction of the population-environment urban pattern.

Map I illustrates the distribution of zones with regard to the first principal component and is the most important from the statistical as well as the general point of view. This component constitutes two contrasting environmental-demographic group of variables which prevail in different zones of the country. In the first group of zones it is revealed that the climatic condition which is indicated by the average annual maximum and minimum temperature is observed to be antagonistic to the general welfare of the people residing in these areas. In these areas prevalence of illness is observed to be high and also fertility is comparatively higher. In addition, kerosene for lighting and fire wood for cooking are the available sources of energy (see areas with green colour in map I). In the second group of zones, environmental conditions such as the amount of rainfall, the availability of forests (wood land) and different

agricultural practices, i.e., cultivation of permanent and temporary crops, availability of grazing areas and livestock (which can be summarised by mixed farming), coexist with high density of inhabitants. In these areas, literacy level is relatively higher and the most prevalent source of energy for lighting is electricity (see areas with orange colour in Map I). The remaining zones represent an intermediate situation between the two described scenarios. The western zones are nearer to the first (areas coloured blue) and the central zones are nearer to the second (areas coloured yellow). This component summarises that the central parts of the country which constitute most of the highland areas are relatively convenient for human settlement and, in contrast, peripheral areas of the country are observed to be antagonistic to human health and socio-economic development.

Overall, the effect of climatic condition both on the human and the natural environment is found to be tremendous. The central highlands are areas with mild temperature, fertile soil and adequate rainfall for crop cultivation and are also relatively free from tropical diseases. Due to this, people prefer to settle in these areas. This is indicated by high density of population and low prevalence of illness in the outcome of the analysis. The other factor which is also associated with the climatic condition of the area is the relatively better socio-economic development and urbanisation of these central parts of the country. This is indicated by the relatively higher level of literacy and higher proportion of households using electricity for lighting. In contrast, the peripheral zones of the country, which are hot and dry are infested by tropical diseases such as malaria and sleeping sickness and thus human settlement is discouraged in these areas. The analysis has shown that the amount of average temperature is associated with high prevalence of illness in these areas. In addition, the most prevalent source of energy in these areas is kerosene for lighting and fuel wood for cooking. This shows the relatively low level of urbanisation and socio-economic development in this part of the country.

In the present analysis it is observed that the central parts of the country are densely populated with high population pressure on the agricultural sector which may result in severe arable land degradation. On the other hand, the peripheral zones of the country which are known for their high potential of arable land and carrying capacities are not exploited by the population due to the prevailing high temperature and high prevalence of diseases. This calls

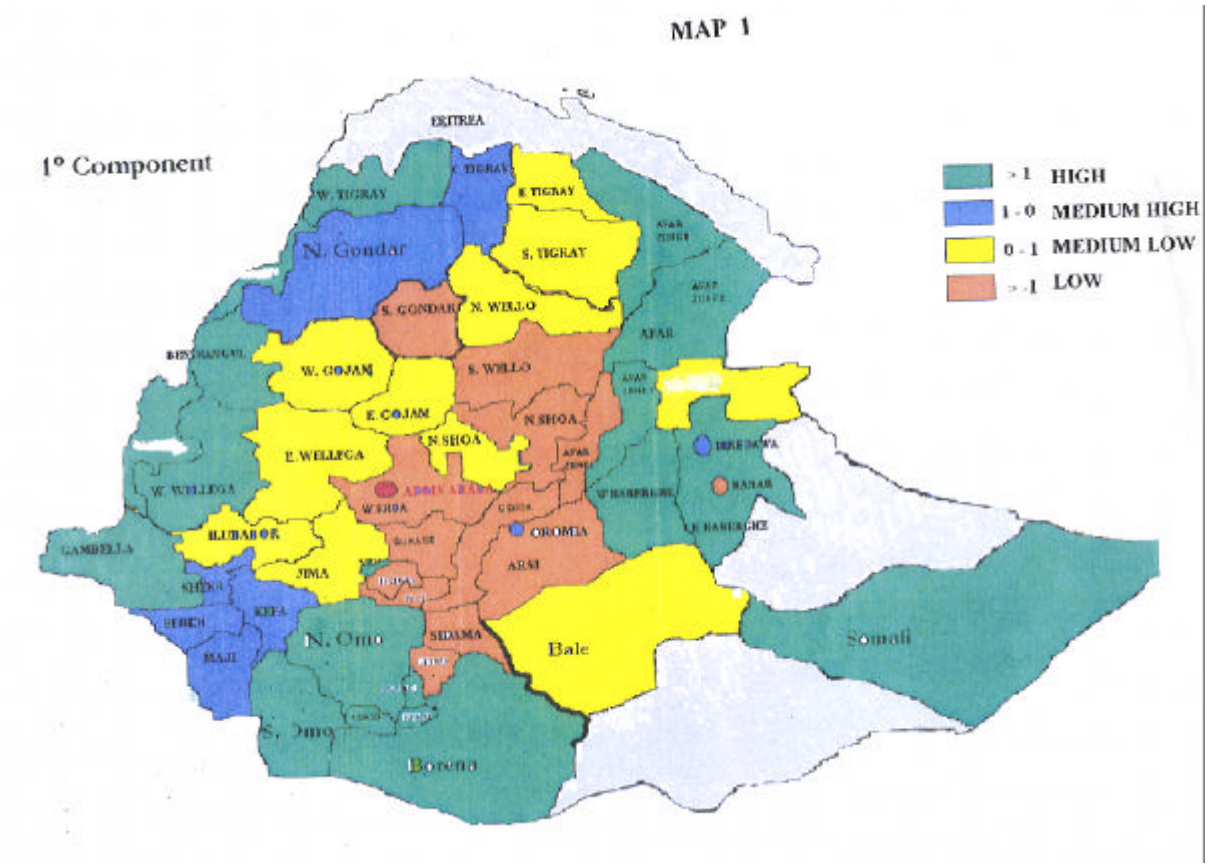
for a need to balance the relation between the population and its supporting natural environment:

b) Recommendations

Based on the literature review and our findings we are inclined to recommend the following:

i. create awareness among the population about the dynamics of population growth, population movements, and their effects on the natural environment.
ii. decrease the population rate of increase by adopting effective strategies to provide and promote effective family planning services
iii. increase the rate of urbanisation by promoting the industrial and service sector of the economy
iv. design appropriate policies to facilitate population movements that occur spontaneously rather than transplanting large group of people in a new area
v. efforts should be made to eradicate or decrease tropical diseases to make such areas (with high potential arable land but infested by tropical diseases) conducive for settlement of large enough populations

MAP 1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1 - 0 MEDIUM HIGH
0 - 1 MEDIUM LOW
< -1 LOW
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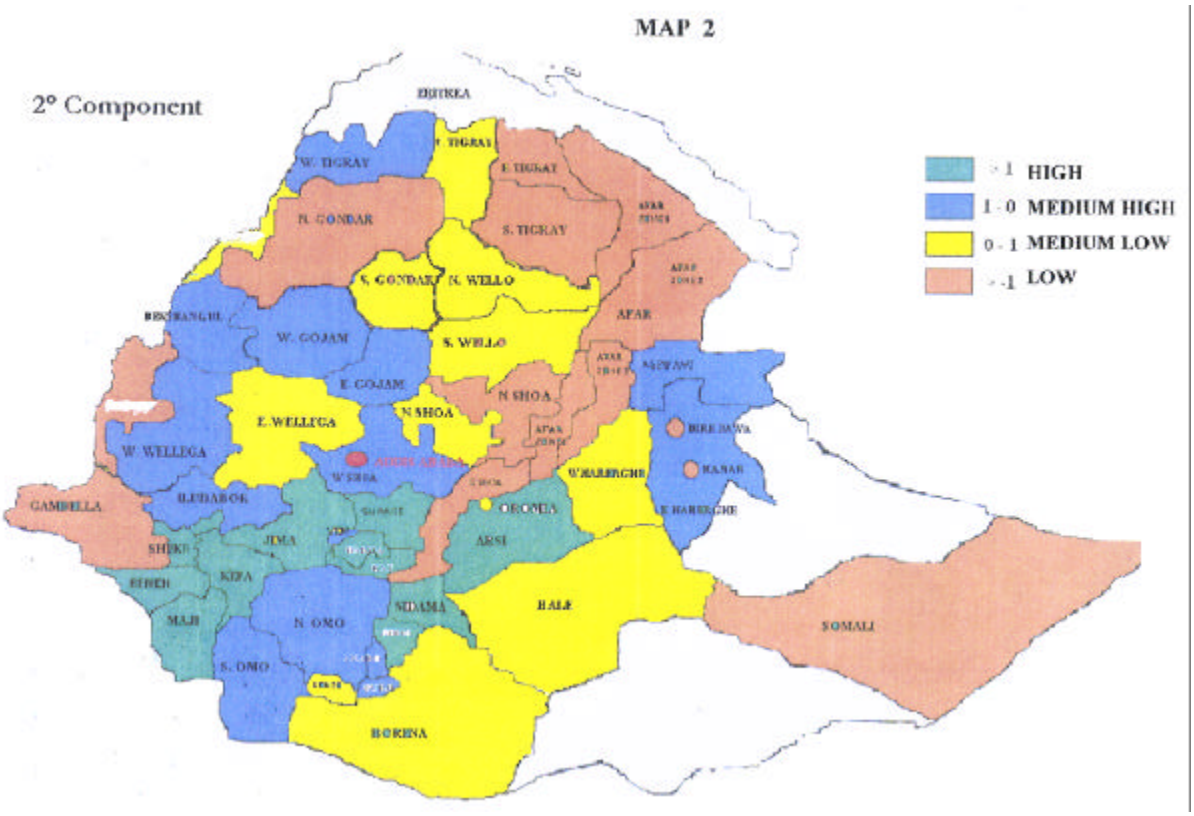
E. TIGRAY
N. Gondar
S. TIGRAY
S. GONDAR
N. WELLO
AFAR
W. GOJAM
S. WELLO
E. GOJAM
N SHOA
E.WELLEGA
W. WELLEGA
W SHOA
ILUBABOR
JIMA
GAMBELLA
KEFA
N. Omo
SIDAMA
Bale
Somali
Borena
OROMIA
ARSI
HARARI

MAP 2


2° Component
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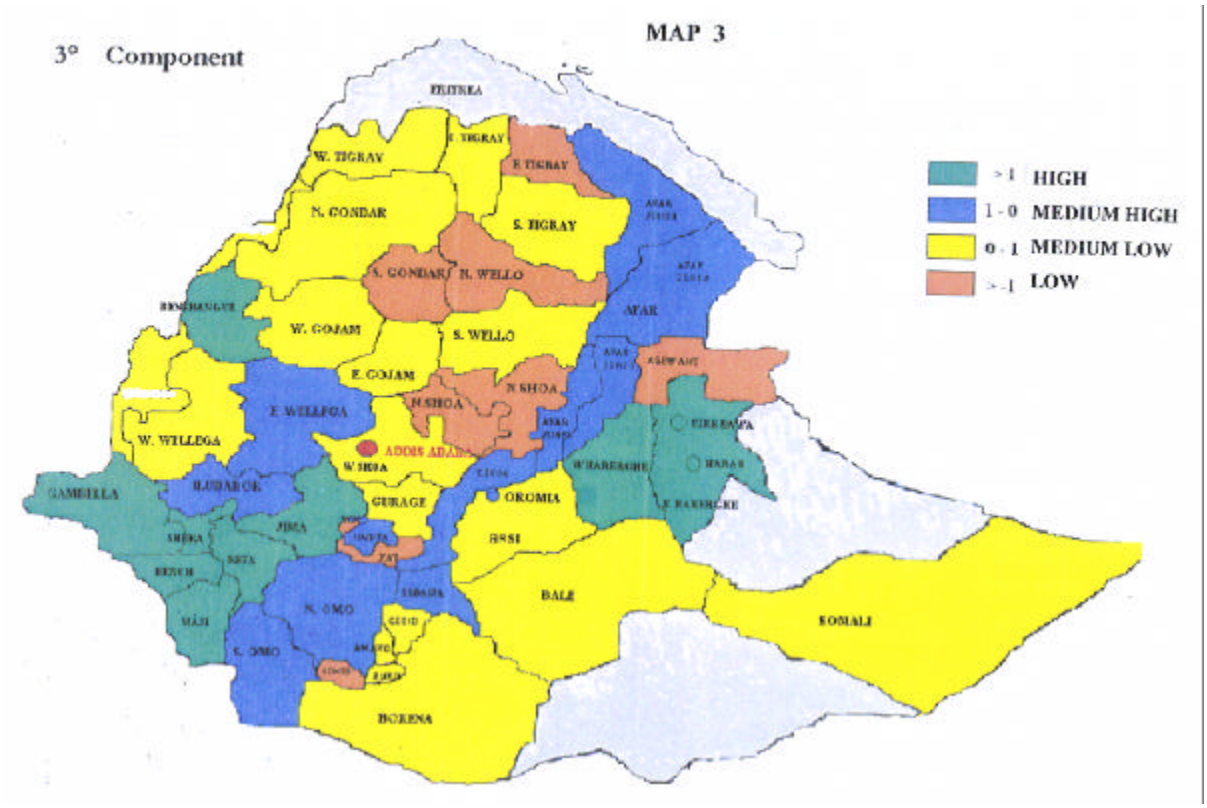
E. TIGRAY
N. GONDAR
S. TIGRAY
S. GONDAR
N. WELLO
AFAR
W. GOJAM
S. WELLO
E. GOJAM
N SHOA
E. WELLEGA
W. WELLEGA
W SHOA
GAMBELLA
ILUBABOR
JIMA
SHEKI
KEFA
BENCH
MAJI
N. OMO
S. OMO
SIDAMA
ARSI
BALE
SOMALI
BORENA
1 HIGH
1 - 0 MEDIUM HIGH
0 - 1 MEDIUM LOW
-1 LOW


3° Component
MAP 3
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1-0 MEDIUM HIGH
0-1 MEDIUM LOW
<-1 LOW
ERITREA
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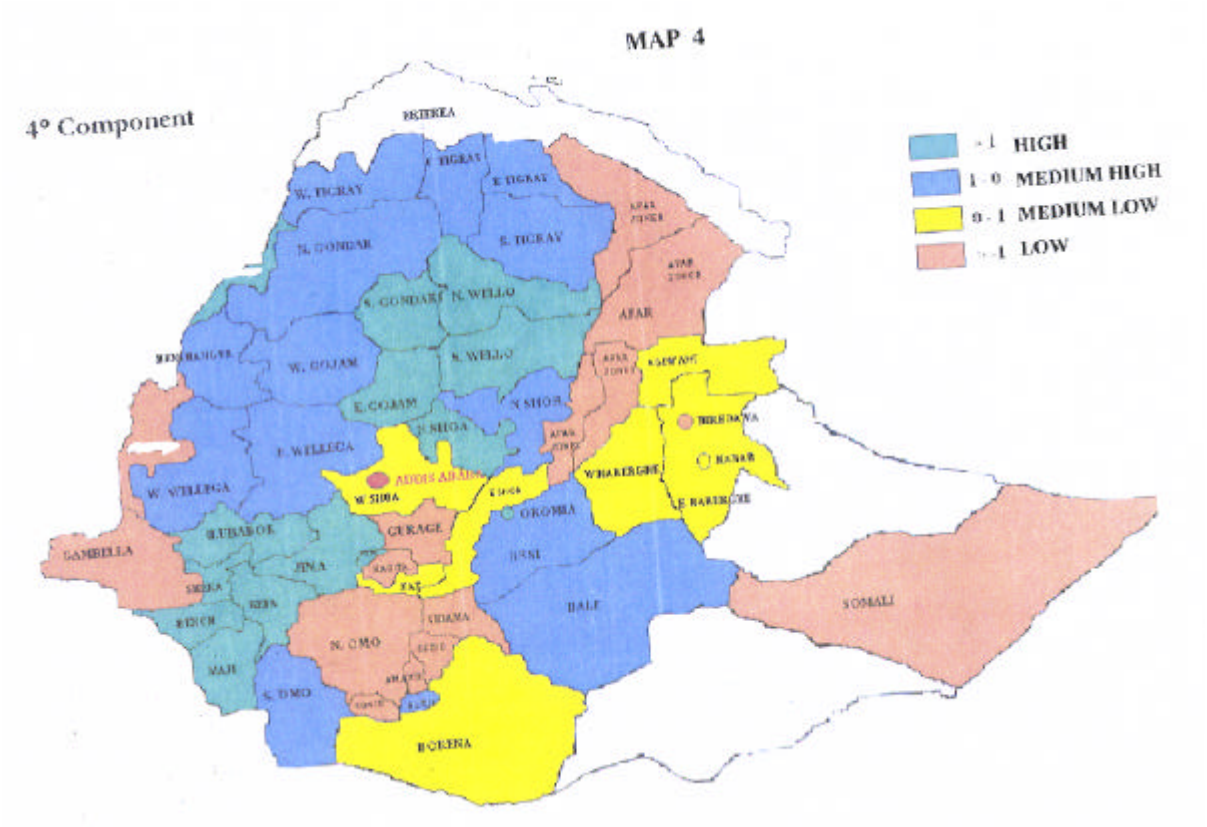
E TIGRAY
N. GONDAR
S. TIGRAY
S. GONDAR
N. WELLO
AFAR
W. GOJAM
S. WELLO
E. GOJAM
N SHOA
E WELLEGA
W. WELLEGA
ADDIS ABABA
W HIYA
GAMBELLA
ILUBABOR
GURAGE
OROMIA
JIMA
SHEKA
BENCH
SIDAMA
BALE
SOMALI
N. OMO
S. OMO
BORENA


MAP 4
4° Component
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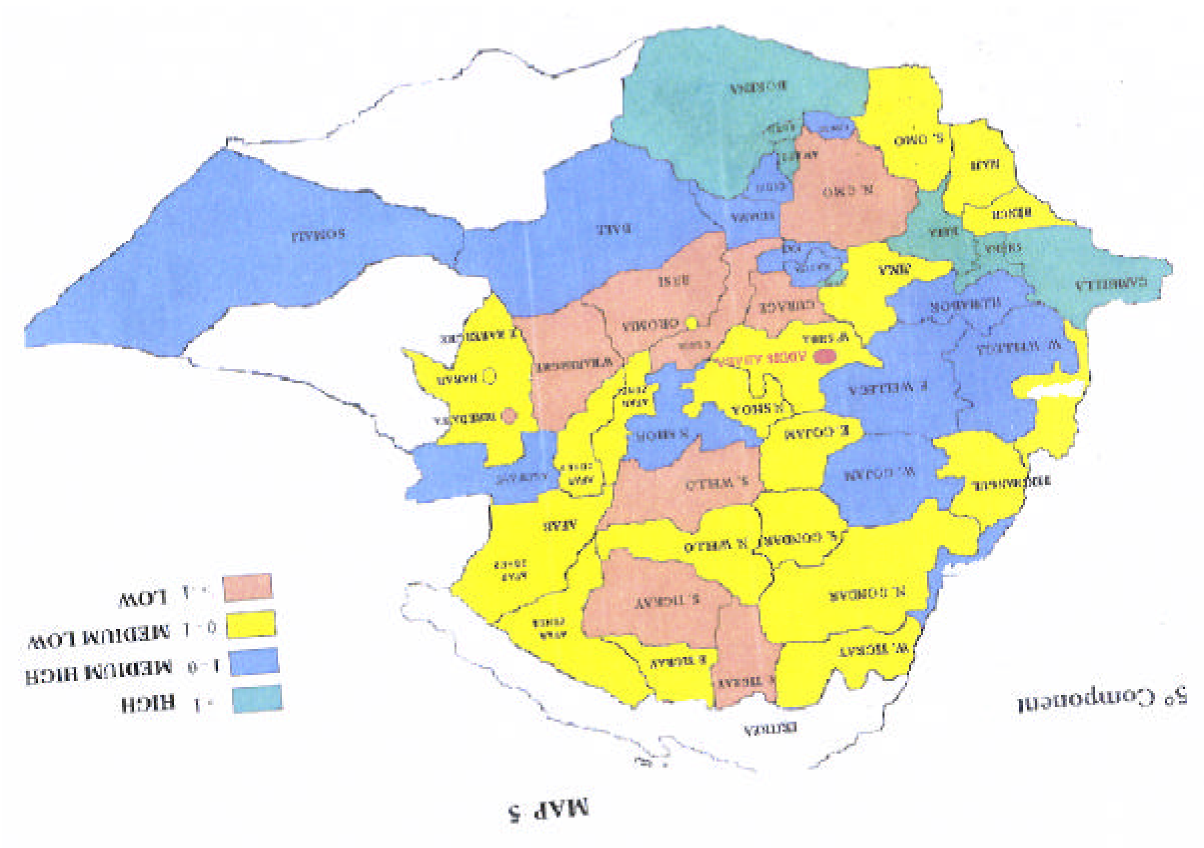
E. TIGRAY
N. GONDAR
S. GONDAR
N. WELLO
S. WELLO
W. GOJAM
E. GOJAM
N. SHOA
E. WELLEGA
W. WELLEGA
W. SHOA
ADDIS ABABA
GURAGE
HARARGHE
E. HARARGHE
OROMIA
BALE
SOMALI
ILUBABOR
JIMA
KEFA
GAMBELLA
N. OMO
S. OMO
BORENA
AFAR
1 - 0 MEDIUM HIGH
0 - 1 MEDIUM LOW
- 1 LOW


MAP 5
5° Component
HIGH
MEDIUM HIGH
MEDIUM LOW
LOW
SOMALI
BALE
SIDAMO
BORENA
N. OMO
S. OMO
ARSI
OROMIA
GURAGE
JIMA
ILLUBABOR
GAMBELLA
W. WELLEGA
E. WELLEGA
ADDIS ABABA
N. SHOA
E. GOJAM
W. GOJAM
S. WELLO
N. WELLO
S. GONDAR
N. GONDAR
S. TIGRAY
E. TIGRAY
W. TIGRAY
AFAR
HARAR
DIRE DAWA
ERITREA

Appendix I

List of Variables

SR. No.	List of Zones	Population Census 1994	Area	Density 1994	Population by Broad Age Group (1994) Population Age 0-14	Population Age 15-64	Population Age 65 +	Prevalence of Illness / '000 Year (1998)
1	West Tigray	733962	24708,84	29,7	335788	377550	20624	358,4
2	Central Tigray	943850	10353,5	91,2	422939	483629	37282	279,5
3	East Tigray	584946	5705,34	102,5	263928	291069	29949	220,8
4	South Tigray	873509	9310,96	93,8	381811	454923	36775	221,9
5	Affar	1060573	110000	9,6	541982	485811	32780	214
6	South Gondar	1768732	14337,53	123,4	770637	937959	60136	241,3
7	North Gondar	2088684	48204,39	43,3	961212	1068362	59110	271,9
8	North Wello	1260317	16400,98	76,8	513201	681958	65158	224,6
9	South Wello	2123803	16956,06	125,3	880316	1124554	118933	174,1
10	North Shoa	1560916	16070,23	97,1	660580	821822	78514	188,6
11	East Gojam	1700331	14103,62	120,6	786573	857987	55771	135
12	West Gojam	1875863	13972,36	134,3	888059	940777	47027	175,1
13	Wag Hemra	275615	8329,7	33,1	109585	156825	9205	244,5
14	Agew Awi	717085	6364,26	112,7	344344	353523	19218	161,3
15	Oromiya	462951	4434,53	104,4	192634	249207	21110	211,8
16	East Wellega	1547075	21863,82	70,8	572818	639250	41364	185,5
17	West Wellega	1253432	23788,13	52,7	679939	802158	64978	240,2
18	Illubabor	847048	16555,36	51,2	377529	430046	39473	209,5
19	Jimma	1961262	18412,54	106,5	867270	1032801	61191	204,3
20	West Shoa	2329699	21551,98	108,1	1077486	1152036	100177	153,5
21	North Shoa	1157978	11376,32	101,8	528154	577484	52340	135,4
22	East Shoa	1668184	13624,09	122,4	749515	873628	45041	114,2
23	Arsi	2217245	23724,44	93,5	1090441	1054965	71839	261,4
24	West Hararghe	1271894	17552,23	72,5	598172	640017	33705	291,7
25	East Hararghe	1830631	24900,21	73,5	858383	932157	40091	217,2
26	Bale	1217864	63917,46	19,1	606862	567525	43477	171
27	Borena	1430213	95740,23	14,9	717252	663333	49628	174,3
28	Somale	3198514	248000	12,9	1625307	1522309	50898	214,2
29	Benishangul-Gumuz	460459	49289,48	9,3	208334	234818	17307	197,6
30	Gurage	1556964	7992,22	194,8	699077	815849	42038	196,1
31	Hadiya	1050151	3978,14	264,0	500922	529276	19953	152,4
32	K.A.T.	727340	2433,93	298,8	333122	381126	13092	187
33	Sidama	2044836	6832,85	299,3	1001970	995835	47031	166,3
34	Gedeo	564073	1329,39	424,3	269627	277524	16922	115,2
35	North Omo	2605435	23911,03	109,0	1195895	1347010	62530	202,7
36	South Omo	327867	22360,79	14,7	147540	173442	6885	310,4
37	Kefa-Sheka	725086	12739,25	56,9	334265	365443	25378	169,7
38	Bench Maji	325878	23442,76	13,9	146971	174345	4562	265,5
39	Yem	64852	666,25	97,3	28859	33010	2983	168,8
40	Amaro	98315	1534,07	64,1	48863	47683	1769	143,2
41	Burji	38746	1319,85	29,4	20845	16545	1356	221,8
42	Konso	157585	2276,25	69,2	78635	74695	4255	252,3
43	Dirashe	89900	1526,41	58,9	41983	45400	2517	315,7
44	Gambella	181862	25802,01	7,0	75970	103427,0	2465	171,3
45	Harari	131139	311,25	421,3	49438	77275,0	4426	164,6
46	Dire Dawa	251864	1213,2	207,6	95289	150168,0	6407	277,9
47	Addis Ababa	2112737	530,14	3985,2	669813	1386903,0	56021	78,5
	Total	53477265	1109748,38	48,188639 84	24350135	27403439	1723691	196,1

Note: 1. For Tigray Region estimates of agricultural statistics data by zone were not available for the year 1994/95 and hence to get these information by zone estimates for the year 1997/98 are taken.

2. For Somali Region estimates of agricultural statistics data were not available for the year 1994/95 and hence estimates for the year 1995/96 are taken except for land use estimates which is taken from the 1997/98 survey.

Table 1.1 (Cont'd.)

SR. No.	List of Zones	Mortality Rate per 1000 Year 1994 IMR	Mortality Rate per 1000 Year 1994 U5MR	Literacy Rate(1994) (%)	Net School Enrollment Rate(1994) Primary (7-12)	Junior (13-14)	Senior (15-18)	# of Livestock Year(1994/95)	CEREALS (1994/95) Area Cult. (000' Ha)	Crop Prod. (000' QT)	Yield (QT/Ha)
1	West Tigray	120	177	13,20	11,34	0,65	0,51	1300,78	173,84	1975,82	11,37
2	Central Tigray	123	181	20,75	15,95	1,71	2,11	919,65	133,09	1135,40	8,53
3	East Tigray	112	163	25,45	27,06	2,70	3,53	553,40	51,90	410,27	7,91
4	South Tigray	132	196	22,93	23,34	4,70	5,08	576,57	109,53	762,85	6,96
5	Affar	118	174	7,28	3,20	1,58	1,30	368,98	16,51	146,35	8,86
6	South Gondar	114	167	16,52	6,00	1,59	1,53	1375,28	326,52	2724,63	8,34
7	North Gondar	105	153	14,59	9,89	3,88	4,01	2650,22	337,01	2814,64	8,35
8	North Wello	113	165	13,34	6,53	1,56	1,19	912,76	147,47	1735,45	11,77
9	South Wello	128	189	23,64	12,04	6,29	5,08	1647,45	177,21	1976,18	11.15
10	North Shoa	101	145	20,95	9,55	3,25	3,37	1159,05	227,14	2117,85	9,32
11	East Gojam	142	211	18,77	7,67	3,74	3,68	1328,01	335,46	3181,79	9,48
12	West Gojam	111	161	15,65	6,24	2,76	2,52	1268,71	306,61	3347,09	10,92
13	Wag Hemra	114	167	5,07	2,66	0,15	0,35	276,57	44,29	549,61	12,41
14	Agew Awi	106	154	18,19	7,03	3,40	4,61	615,88	115,14	961.61	8,35
15	Oromiya	132	195	10,27	6,09	2,38	1,48	234,32	38,99	503,22	12,91
16	East Wellega	108	157	26,47	14,70	5,58	4,84	1059,45	208,84	1707,62	8,18
17	West Wellega	119	175	23,03	11,30	2,23	2,54	998,65	214,71	2407,96	11,21
18	Illubabor	120	176	26,19	17,11	6,68	4,62	734,95	140,61	1884,93	13,41
19	Jimma	147	219	18,38	9,34	4,36	3,49	1217,09	204,72	2199,86	10,75
20	West Shoa	111	161	22,79	9,89	3,69	4,10	2352,99	415,23	4782,60	11,52
21	North Shoa	106	154	14,65	5,84	2,81	2,53	1174,14	193,72	1708,56	8,82
22	East Shoa	128	190	36,04	18,70	9,55	10,46	1377,00	325,81	4254,98	13,06
23	Arsi	128	190	28,89	11,75	5,38	4,68	2951,91	424,76	6534,31	15,38
24	West Hararghe	131	194	14,75	6,01	1,98	1,70	743,70	13.40	1798,57	13,69
25	East Hararghe	116	170	12,17	6,78	1,24	1,38	929,08	148,19	1824,42	12,31
26	Bale	116	169	25,90	12,40	5,98	5,92	1473,32	151,92	1751,22	11,53
27	Borena	73	101	16,06	7,48	2,71	2,46	1543,92	54,36	657,37	12,09
28	Somale	96	137	8,12	2,45	0,43	0,45	160,29	59,31	423,32	7,14
29	Benishangul-Gumuz	139	206	17,74	3,20	1,58	1,30	142,04	53,15	612,16	11,52
30	Gurage	145	218	20,62	10.95	2,11	2.08	1051,27	76,61	870,76	11,37
31	Hadiya	113	165	33,01	13,62	3,20	3,63	706,86	101,35	1492,76	14,73
32	K.A.T.	130	192	33,37	15,78	4,39	3,90	515,65	65,57	1022,67	15,60
33	Sidama	88	124	24,91	11,99	3,87	3,87	1219,45	33,61	552,15	16,43
34	Gedeo	127	187	29,92	12,86	5,00	4,49	203,94	15,05	168,26	11,18
35	North Omo	154	231	23,27	13,26	3,53	3,03	1608,82	109,60	880,88	8,04
36	South Omo	118	173	9,52	5,42	2,76	2,33	107,86	17,95	161,83	9,02
37	Kefa-Sheka	153	229	23,17	15,92	6,03	3,51	402,87	47,48	556,41	22,59
38	Bench Maji	190	285	18,71	12,35	5,04	2,58	187,49	21,82	220,08	21,36
39	Yem	129	190	29,08	8,13	2,33	1,84	22,09	3,82	35,18	9,20
40	Amaro	74	102	22,76	10,54	1,32	0,84	104,34	3,90	47,06	12,07
41	Burji	99	142	24,19	14,48	1,62	1,01	27,44	1,13	10,74	9,50
42	Konso	111	161	8,14	3,79	1,45	0,94	51,24	5,95	25,41	4,27
43	Dirashe	119	175	17,49	9,69	3,20	3,48	46,93	12,71	61,43	4,83
44	Gambella	99	142	29,33	21,28	4,59	2,86	17,83	6,14	78,39	12,77
45	Harari	113	166	54,54	37,96	20,82	26,56	25,37	5,04	58,91	11,69
46	Dire Dawa	115	168	51,53	35,93	15,81	17,95	100,68	9,52	134,03	14,08
47	Addis Ababa	78	108,7	82,52	72,68	34,58	35,53	31,94	7,66	85,29	11,13
	Total	116	171	23,35	12,24	5,01	5,13	38478,23	5680,95	62391,27	

Note: 1. For Tigray Region estimates of agricultural statistics data by zone were not available for the year 1994/95 and hence to get these information by zone estimates for the year 1997/98 are taken.

2. For Somali Region estimates of agricultural statistics data were not available for the year 1994/95 and hence estimates for the year 1995/96 are taken except for land use estimates which is taken from the 1997/98 survey.

Table 1.1 (Cont'd.)

SR. No.	List of Zones	PULSES (1994/95)			OTHERS (1994/95)			ALL CROP (1994/95)			Improved Total Crop Area (1994/95)
		Area Cult. (000' Ha)	Crop Prod. (000' QT)	Yield (QT/Ha)	Area Cult. (000' Ha)	Crop Prod. (000' QT)	Yield (QT/Ha)	Area Cult. (000' Ha)	Crop Prod. (000' QT)	Yield (QT/Ha)	
1	West Tigray	3,84	20,45	5,33	6,77	35,86	5,30	184,45	2032,13	11,02	66,84
2	Central Tigray	9,20	71,63	7,79	5,12	22,21	4,34	147,41	1229,24	8,34	48,53
3	East Tigray	9,41	77,65	8,25	1,52	7,60	5,00	62,84	495,52	7,89	26,69
4	South Tigray	7,91	76,53	9,68	1,57	3,55	2,26	119,02	842,93	7,08	24,56
5	Affar	0,04	0,20	5.00	0,00	0,00	0,00	16,55	146,55	8,85	4,31
6	South Gondar	81,92	708,98	8,65	26,78	48,18	1.80	435,22	3481,79	8.00	53,45
7	North Gondar	48.30	334,04	6,92	29,86	93,31	3,12	415,17	3241,99	7,81	57,56
8	North Wello	37,74	289,72	7,68	2,12	7,75	3,54	187,40	2032,92	10,85	18,20
9	South Wello	51,85	542,86	10,47	4,35	13,62	3,13	233,41	2532,66	10,85	5,04
10	North Shoa	58,37	343.10	5,88	3,86	9,73	2,52	289,37	2470,68	8,54	77,55
11	East Gojam	63,93	735.70	11,51	29,04	62,48	2,15	428,43	3979,97	9,29	171,08
12	West Gojam	45.90	425,72	9,27	37.70	107..85	2,86	390,21	3880,66	9,94	188,25
13	Wag Hemra	10,45	97..05	9,29	0,04	0,05	1,25	54,78	646,71	11,81	5,01
14	Agew Awi	9,48	68,46	7,22	9,06	30,36	3,35	133,68	1060,43	7,93	54,03
15	Oromiya	1,66	15.10	9.10	0,00	0,00	0,00	40,65	518,32	12,75	3,72
16	East Wellega	21,91	222,78	10,17	34,24	51.90	1,52	264,99	1982,30	7,48	111,85
17	West Wellega	21,94	217,31	9.90	6,25	10,33	1,65	242,90	2635,60	10,85	44,88
18	Illubabor	22,88	214,26	9,36	1,32	2,87	2,17	164,81	2102,06	12,75	23,77
19	Jimma	15,08	168,40	11,17	2,98	4,11	1,38	222,78	2372,37	10,65	105,40
20	West Shoa	82,46	748,54	9,08	53,46	214,12	4,01	551,15	5745,26	10,42	314,74
21	North Shoa	42,72	369,08	8,64	15,04	37,95	2,52	251,48	2115,59	8,41	70,50
22	East Shoa	50,90	324,39	6,37	1,12	1,91	1,71	377,83	4581,28	12,13	261,22
23	Arsi	45,74	580,02	12,68	48,14	249,21	5,18	518,64	7363,54	14.20	435,30
24	West Hararghe	4,27	48,63	11,39	0,75	9,29	12,39	136,42	1856,49	13,61	12,06
25	East Hararghe	6,18	84,07	13.60	0,59	1,79	3,03	154,96	1910,28	12,33	49,37
26	Bale	22.50	164.90	7,33	18,34	156,77	8,55	192,76	2072,89	10,75	72,13
27	Borena	5,18	41,48	8,01	0,00	0,00	0,00	59,54	698,85	11,74	1,03
28	Somale	0,32	1,45	4,53	0,11	0,06	0,55	59,73	424,83	7,11	17,34
29	Benishangul-Gumuz	2,66	17,80	6,69	4,61	11,36	2,46	60,42	641,32	10,61	8,85
30	Gurage	13,06	114,22	8,75	0,04	0,26	6,50	89,71	985,24	10,98	39,93
31	Hadiya	9,40	99,12	10,54	0,03	0,13	4,33	110,78	1592,01	14,37	140,86
32	K.A.T.	1,86	16,98	9,13	1,08	4,46	4,13	68,51	1044,11	15,24	55,43
33	Sidama	3,40	35,13	10,33	0,00	0,00	0,00	37,01	587,28	15,87	15,32
34	Gedeo	4,61	43,76	9,49	0,00	0,00	0,00	19,66	212,02	10,78	1,07
35	North Omo	21,75	149,31	6,86	0,00	0,00	0,00	131,35	1030,19	7,84	38,06
36	South Omo	2,25	21,36	9,49	0,00	0,04	10,00	20,20	183,23	9,07	0,22
37	Kefa-Sheka	16,92	249,43	22,48	0,00	0,00	0,00	14,40	805,84	9,99	1,65
38	Bench Maji	3,00	41,17	25,51	0,00	0,00	0,00	24,82	261,25	21,98	0,57
39	Yem	0,58	4,30	7,41	0,00	0,00	0,00	4,40	39,48	8,97	1,21
40	Amaro	2,85	31,69	11,12	0,00	0,00	0,00	6,75	78,75	11,67	0,26
41	Burji	0,15	1,48	9,87	0,00	0,00	0,00	1,28	12,22	9,55	0,00
42	Konso	0,95	0,79	0,83	0,00	0,00	0,00	6,90	26,20	3,80	0,37
43	Dirashe	0,74	0,05	0,07	0,00	0,00	0,00	13,45	61,48	4,57	2,51
44	Gambella	0,00	0,37	3,70	0,00	0,00	0,00	6,24	78,76	12,62	0,34
45	Harari	0,25	1,92	7,68	0,00	0,00	0,00	5,29	60,83	11,50	1,78
46	Dire Dawa	0,00	0,00	0,00	0,00	0,00	0,00	9,52	134,03	14,08	1,40
47	Addis Ababa	2,54	33,54	13,20	0,11	0.40	3,54	10,31	119,23	11,56	9,15
	Total	752,35	6499,07		308,304	1039,36		6977,58	72407,31		2643,39

Note: 1. For Tigray Region estimates of agricultural statistics data by zone were not available for the year 1994/95 and hence to get these information by zone estimates for the year 1997/98 are taken.

2. For Somali Region estimates of agricultural statistics data were not available for the year 1994/95 and hence estimates for the year 1995/96 are taken except for land use estimates which is taken from the 1997/98 survey.

Table 1.1 (Cont'd.)

SR. No.	List of Zones	Land use estimates for the year 1994/95 by zone ('000 Ha)								
		Temporary crop	permanent crop	grazing land	fallow land	wood land	other land	Climatic Variables (Avg. 1993, 94, 95)		
								Min.Temp	Max.Temp	Avr. Rainfall
1	West Tigray	184,74	0,63	0,63	11,36	0,00	4,39	13,91	27,00	1013,47
2	Central Tigray	147,66	0,40	0,38	9,13	0,00	6,02	12,90	28,25	877,83
3	East Tigray	62,99	0,12	5,26	3,68	0,25	6,06	8,28	25,43	629,60
4	South Tigray	120,23	0,12	0,39	5,77	0,13	9,55	16,41	19,09	781,54
5	Affar	16.60	0,47	0.00	0.70	0.00	1,06	18,83	34,93	539,97
6	South Gondar	452,16	2,08	14.90	18,38	0,14	13.60	9,95	22,28	1101,77
7	North Gondar	424,91	7,36	10.50	24,66	0,19	11,94	12,25	27,99	984,04
8	North Wello	190,23	1,21	6,28	14,69	0,15	9,82	10,56	22,17	957,70
9	South Wello	234.80	2,17	26,71	32,14	0.30	22,47	10,76	24,09	1098,07
10	North Shoa	292,74	2,27	12,83	21,55	0,32	15,22	14,00	23,20	987,86
11	East Gojam	437,57	1.70	4.10	17.70	0,42	9.00	12,95	26,84	1261,97
12	West Gojam	402,04	2,19	7,57	8,71	0,51	6,84	10,19	24,05	1127,08
13	Wag Hemra	55,99	0.00	0.00	1,77	0.00	2,23	10,56	22,17	520,00
14	Agew Awi	138,19	0.90	8,47	7.30	0,13	4,91	8,00	25,17	1404,40
15	Oromiya	40,81	1,13	1,62	1,39	0.00	2,88	13,04	28,16	1031,00
16	East Wellega	268,64	7,02	10,53	48,62	0,01	10.20	12,50	23,56	1872,83
17	West Wellega	248,93	44,66	3,24	53,06	0,02	13,03	13,44	25,92	1213,58
18	Illubabor	166,17	25,49	6,65	18,69	0.00	6,96	12,62	23,08	1757,20
19	Jimma	227,02	36.90	16,24	23,34	0.00	14,23	11,87	27,53	1755,28
20	West Shoa	553.40	9,25	108,69	50,26	0,65	31,29	12,16	20,43	1279,33
21	North Shoa	253,52	0,36	85,75	26,93	0,18	18,16	8,64	20,40	1025,27
22	East Shoa	393,68	0,24	22,32	13,79	0,05	20,77	14,22	27,35	767,94
23	Arsi	525,96	8,05	154,24	61,46	3,02	33.60	10,82	23,76	939,03
24	West Hararghe	139,15	23,61	1,62	1,39	0.00	5,53	18,87	29,86	600,00
25	East Hararghe	169,14	20,36	4,83	8,11	0,03	11,97	17,00	27,35	767,94
26	Bale	193,68	14,42	23,45	60,33	0,12	16,29	9,60	22,69	881,04
27	Borena	60,28	58,22	4,87	38,92	0,87	11,75	16,09	26,92	793,70
28	Somale	51,59	3,70	15,49	5,56	0,00	5,16	18,87	29,86	443,62
29	Benishangul-Gumuz	60,97	0,81	0.00	2,56	0.00	2,32	15,63	28,52	1222,60
30	Gurage	97,46	38,69	32,83	8,22	6,85	14,56	10,52	26,58	1266,73
31	Hadiya	117,02	13,93	11,02	5,05	0,71	14,93	8,80	27,60	1515,80
32	K.A.T.	79,84	10,04	5,08	1,62	0,38	7,66	8,25	13,30	1285,11
33	Sidama	39,13	83,24	14,35	4,82	0,45	14,13	11,71	22,79	934,76
34	Gedeo	21,79	30.70	8,41	0,74	0,26	2,27	12,41	22,36	1564,78
35	North Omo	162.90	59,41	22,72	72,18	8,58	14,72	16,79	30,60	923,05
36	South Omo	21,61	2,62	0.00	4.10	0.20	1,41	15,78	27,63	1097,28
37	Kefa-Sheka	65,09	12,66	4,33	6,69	0,01	4,63	13,21	27,86	1624,08
38	Bench Maji	26,81	5,23	0,07	1,16	0,02	1,69	13,21	27,86	1982,40
39	Yem	4,39	0,72	0,78	0,21	0.00	0,06	10,80	21,95	667,65
40	Amaro	7.10	7,54	2.40	2,21	0.10	0,99	14,04	28,04	850,00
41	Burji	1,36	0,81	0.00	4,23	0.00	0,12	14,04	28,04	850,00
42	Konso	6.90	0,53	0.10	2,93	0.00	0,42	17,65	27,60	667,65
43	Dirashe	13,45	0,08	0.00	0,11	0.00	0,87	17,95	29,82	631,97
44	Gambella	6,47	0,67	0.00	0,41	0.00	0,56	18,36	31,45	724,78
45	Harari	6,63	0,66	0.00	0,27	0.00	0.20	14,22	27,35	831,00
46	Dire Dawa	9,51	0,66	0,19	0,19	0.00	0,43	18,97	31,93	656,90
47	Addis Ababa	10,58	0.00	0,89	0,08	0,01	0,51	10,51	23,37	1231,43
	Total	6230,13	473,83	628,73	677,37	24,46	340,81			

Note: 1. For Tigray Region estimates of agricultural statistics data by zone were not available for the year 1994/95
and hence to get these information by zone estimates for the year 1997/98 are taken.

2. For Somali Region estimates of agricultural statistics data were not available for the year 1994/95 and hence
estimates for the year 1995/96 are taken except for land use estimates which is taken from the 1997/98 survey.

Table 1.1 (Cont'd.)

SR. No.	List of Zones	Geographic Coordinates		Proportion of HHs by type of fuel for cooking '94				Proportion of HHs by type of fuel for lighting '94		
		Latitude	Longitude	wood	Dung/Manure	Kerosine	Others	Electricity	Kerosine	Others
1	West Tigray	14,00	37,00	93,20	5,80	0,10	0,30	25,70	72,90	1,60
2	Central Tigray	14,20	38,80	79,60	19,60	0,10	0,20	48,60	49,50	2,00
3	East Tigray	14,20	39,60	63,00	36,10	0,10	0,40	48,60	49,50	2,00
4	South Tigray	13,00	39,50	66,70	32,10	0,10	0,60	58,50	7,50	4,50
5	Affar	12,60	41,10	98,62	0,71	0,03	0,45	52,95	39,93	7,12
6	South Gondar	12,20	38,20	66,36	33,05	0,05	0,24	52,10	47,20	0,70
7	North Gondar	12,60	36,80	63,13	35,78	0,07	0,51	54,50	44,10	1,40
8	North Wello	11,80	37,00	65,08	34,04	0,05	0,48	34,50	64,20	1,20
9	South Wello	10,70	37,20	65,92	36,25	0,12	0,29	68,80	30,10	1,00
10	North Shoa	9,70	39,50	65,92	33,53	0,08	0,26	55,30	42,40	2,40
11	East Gojam	10,40	37,30	65,32	32,92	0,11	1,43	42,30	56,80	0,92
12	West Gojam	11,00	36,80	95,39	4,28	0,08	0,09	53,50	46,00	0,41
13	Wag Hemra	12,70	39,00	86,40	11,88	0,08	0,90	23,00	72,30	4,70
14	Agew Awi	11,00	36,50	97,27	2,43	0,08	0,09	54,30	45,20	0,50
15	Oromiya	11,40	40,40	90,85	8,79	0,03	0,12	46,30	53,00	0,70
16	East Wellega	9,60	36,40	98,31	1,34	0,09	0,08	46,60	51,99	1,41
17	West Wellega	9,50	35,00	97,86	1,70	0,13	0,05	37,71	60,70	1,59
18	Illubabor	8,40	35,50	97,23	1,87	0,05	0,64	41,41	55,68	2,91
19	Jimma	7,50	36,80	98,21	1,34	0,07	0,09	57,14	41,47	1,38
20	West Shoa	9,00	37,80	87,01	12,38	0,15	0,14	69,84	28,94	1,21
21	North Shoa	9,60	38,80	42,67	56,92	0,06	0,17	42,72	55,97	1,31
22	East Shoa	8,70	39,30	77,22	21,39	0,19	0,84	87,24	11,72	1,04
23	Arsi	7,70	39,50	65,87	33,15	0,27	0,53	55,78	43,21	1,00
24	West Hararghe	8,80	41,00	97,52	1,82	0,17	0,17	58,42	39,98	1,60
25	East Hararghe	8,50	41,80	95,02	4,21	0,14	0,22	56,42	42,26	1,32
26	Bale	7,30	40,30	86,81	12,35	0,13	0,54	63,97	34,23	1,81
27	Borena	4,70	38,70	97,21	1,96	0,10	0,27	47,63	46,10	6,27
28	Somale	6,70	43,40	91,05	0,75	1,70	6,70	20,20	71,00	8,80
29	Benishangul-Gumuz	10,75	36,60	96,78	1,76	0,09	0,91	38,83	57,90	3,27
30	Gurage	8,40	38,30	97,30	2,29	0,11	0,03	56,93	40,60	2,47
31	Hadiya	7,70	37,70	97,64	1,92	0,12	0,09	43,11	55,47	1,43
32	K.A.T.	7,50	38,00	97,93	1,70	0,10	0,05	36,03	62,41	1,57
33	Sidama	6,70	38,40	97,94	1,58	0,14	0,07	81,25	17,95	0,80
34	Gedeo	6,30	38,30	97,31	2,30	0,08	0,12	60,27	38,54	1,20
35	North Omo	6,50	37,30	98,26	1,39	0,05	0,07	38,88	58,80	2,32
36	South Omo	5,30	36,50	98,63	1,11	0,14	0,04	33,44	64,12	2,43
37	Kefa-Sheka	5,20	36,20	97,94	1,64	0,06	0,29	22,42	74,06	3,52
38	Bench Maji	6,50	35,30	98,33	1,04	0,03	0,27	39,65	49,63	10,72
39	Yem	7,30	37,20	98,50	1,21	0,18	0,11	1,92	98,09	0,00
40	Amaro	5,50	37,50	98,74	1,13	0,07	0,00	4,29	95,71	0,00
41	Burji	5,30	37,30	97,47	2,47	0,06	0,00	1,46	98,54	0,00
42	Konso	5,40	37,40	97,87	1,82	0,02	0,04	3,14	94,80	2,06
43	Dirashe	5,70	37,40	97,64	1,92	0,10	0,09	18,23	80,62	1,16
44	Gambella	8,00	34,00	96,81	1,73	0,14	0,65	26,17	64,55	9,29
45	Harari	9,20	42,20	95,70	2,80	0,20	0,40	95,30	3,40	1,30
46	Dire Dawa	9,60	41,80	96,60	1,10	0,40	0,30	87,90	10,40	1,70
47	Addis Ababa	8,90	38,80	35,61	60,63	1,90	1,49	95,54	3,31	1,17
	Total									

Note: 1. For Tigray Region estimates of agricultural statistics data by zone were not available for the year 1994/95 and hence to get these information by zone estimates for the year 1997/98 are taken.

2. For Somali Region estimates of agricultural statistics data were not available for the year 1994/95 and hence estimates for the year 1995/96 are taken except for land use estimates which is taken from the 1997/98 survey.

Appendix II

Table 3.3 Comparitive Components Scheme

Eigen Values	Explained Variance (cumulative %)	1° Eigen vector	Variables	2° Eigen vector	Variables
1°	0.294	0.29	Mintem	0.32	Rain
2°	0.426	0.28	Kerohl	0.32	U5MR
3°	0.525	0.27	Iln	0.31	Pulses
4°	0.621	0.26	Maxtem	0.29	Woodhc
5°	0.702	0.22	Woodhc	0.29	Cereals
		0.19	Popu14	0.28	Popu14
		0.00	U5MR	0.25	Perm
		-0.33	Livest.	0.24	wood
		-0.30	Temp	0.22	Kerohl
		-0.30	Elechl	0.18	grazing
		-0.28	Literacy	0.17	Livest.
		-0.27	Grazing	0.01	Iln
		-0.25	Density	0.00	Temp
		-0.19	Rain	-0.28	Density
		-0.15	Perm	-0.23	Literacy
		-0.13	Pulses	-0.21	Elechl
		-0.12	Cereals	-0.16	Mintem
		-0.12	wood	-0.11	Popo64
		-0.07	Popo64	-0.09	Maxtem

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	1° Eigen vector	Variables	3° Eigen vector	Variables
1°	0.294	0.29	Mintemp	0.39	Cereals
2°	0.426	0.28	Kerohl	0.32	Maxtem
3°	0.525	0.27	Illness	0.29	Pulses
4°	0.621	0.26	Maxtemp	0.27	Mintem
5°	0.702	0.22	Woodhc	0.25	Lit
		0.19	Pop14	0.22	Elechl
		0.00	U5MR	0.22	U5MR
		-0.33	Livestock	0.21	Woodhc
		-0.30	Temp	0.19	Density
		-0.30	Elechl	0.19	Rain
		-0.28	Literacy	0.01	Iln
		-0.27	Grazing	-0.32	Popo64
		-0.25	Density	-0.24	Kerohl
		-0.19	Rain	-0.23	graz
		-0.15	Permanent	-0.21	Popu14
		-0.13	Pulses	-0.19	Liv
		-0.12	Cereals	-0.16	Temp
		-0.12	Wood	-0.04	wood
		-0.07	Popo64	-0.02	Perm

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	1° Eigen vector	Variables	4° Eigen vector	Variables
1°	0.294	0.29	Mintemp	0.36	Pulses
2°	0.426	0.28	Kerohl	0.35	Popo64
3°	0.525	0.27	Ilness	0.22	U5MR
4°	0.621	0.26	Maxtemp	0.22	Rain
5°	0.702	0.22	Woodhc	0.13	Cereals
		0.19	Population14	0.11	Kerohl
		0.00	U5MR	0.11	Iln
		-0.33	Livestock	-0.43	Temp
		-0.30	Temp	-0.33	Perm
		-0.30	Elechl	-0.27	wood
		-0.28	Literacy	-0.24	Woodhc
		-0.27	Grazing	-0.23	Mintem
		-0.25	Density	-0.19	Liv
		-0.19	Rain	-0.18	Maxtem
		-0.15	Permanent	-0.18	Popu14
		-0.13	Pulses	-0.13	graz
		-0.12	Cereals	-0.11	Elechl
		-0.12	wood	-0.02	Lit
		-0.07	Population64	0.05	Density

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	1° Eigen vector	Variables	5° Eigen vector	Variables
1°	0.294	0.29	Mintemp	0.37	Kerohl
2°	0.426	0.28	Kerohl	0.34	Density
3°	0.525	0.27	Ilness	0.20	Lit
4°	0.621	0.26	Maxtemp	0.17	Pulses
5°	0.702	0.22	Woodhc	0.15	Perm
		0.19	Population14	0.09	Cereals
		0.00	U5MR	0.08	Rain
		-0.33	Livestock	0.07	Popu14
		-0.30	Temp	0.05	Woodhc
		-0.30	Elechl	-0.46	U5MR
		-0.28	Literacy	-0.38	Iln
		-0.27	Grazing	-0.34	Elechl
		-0.25	Density	-0.23	wood
		-0.19	Rain	-0.18	Temp
		-0.15	Permanent	-0.18	Popo64
		-0.13	Pulses	-0.14	Liv
		-0.12	Cereals	-0.12	Maxtem
		-0.12	Wood	-0.11	Mintem
		-0.07	Population64	-0.03	graz

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	2° Eigen vector	Variables	3° Eigen vector	Variables
1°	0.294	0.32	Rain	0.39	Cereals
2°	0.426	0.32	U5MR	0.32	Maxtem
3°	0.525	0.31	Pulses	0.29	Pulses
4°	0.621	0.29	Woodhc	0.27	Mintem
5°	0.702	0.29	Cereals	0.25	Lit
		0.28	Population14	0.22	Elechl
		0.25	Perm	0.22	U5MR
		0.24	Wood	0.21	Woodhc
		0.22	Kerohl	0.19	Density
		0.18	Grazing	0.19	Rain
		0.17	Livestock	0.01	Iln
		0.01	Ilness	-0.32	Popo64
		0.00	Temp	-0.24	Kerohl
		-0.28	Density	-0.23	graz
		-0.23	Literacy	-0.21	Popu14
		-0.21	Elechl	-0.19	Liv
		-0.16	Mintemp	-0.16	Temp
		-0.11	Population64	-0.04	wood
		-0.09	Maxtemp	-0.02	Perm

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	2° Eigen vector	Variables	4° Eigen vector	Variables
1°	0.294	0.32	Rain	0.36	Pulses
2°	0.426	0.32	U5MR	0.35	Popo64
3°	0.525	0.31	Pulses	0.22	U5MR
4°	0.621	0.29	Woodhc	0.22	Rain
5°	0.702	0.29	Cereals	0.13	Cereals
		0.28	Population14	0.11	Kerohl
		0.25	Perm	0.11	Iln
		0.24	Wood	-0.43	Temp
		0.22	Kerohl	-0.33	Perm
		0.18	Grazing	-0.27	wood
		0.17	Livestock	-0.24	Woodhc
		0.01	Ilness	-0.23	Mintem
		0.00	Temp	-0.19	Liv
		-0.28	Density	-0.18	Maxtem
		-0.23	Literacy	-0.18	Popu14
		-0.21	Elechl	-0.13	graz
		-0.16	Mintemp	-0.11	Elechl
		-0.11	Popolation64	-0.02	Lit
		-0.09	Maxtemp	0.05	Density

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	2° Eigen vector	Variables	5° Eigen vector	Variables
1°	0.294	0.32	Rain	0.37	Kerohl
2°	0.426	0.32	U5MR	0.34	Density
3°	0.525	0.31	Pulses	0.20	Lit
4°	0.621	0.29	Woodhc	0.17	Pulses
5°	0.702	0.29	Cereals	0.15	Perm
		0.28	Population14	0.09	Cereals
		0.25	Perm	0.08	Rain
		0.24	Wood	0.07	Popu14
		0.22	Kerohl	0.05	Woodhc
		0.18	Grazing	-0.46	U5MR
		0.17	Livestock	-0.38	Iln
		0.01	Ilness	-0.34	Elechl
		0.00	Temp	-0.23	wood
		-0.28	Density	-0.18	Temp
		-0.23	Literacy	-0.18	Popo64
		-0.21	Elechl	-0.14	Liv
		-0.16	Mintemp	-0.12	Maxtem
		-0.11	Popolation64	-0.11	Mintem
		-0.09	Maxtemp	-0.03	graz

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	3° Eigen vector	Variables	4° Eigen vector	Variables
1°	0.294	0.39	Cereals	0.36	Pulses
2°	0.426	0.32	Maxtem	0.35	Popo64
3°	0.525	0.29	Pulses	0.22	U5MR
4°	0.621	0.27	Mintem	0.22	Rain
5°	0.702	0.25	Lit	0.13	Cereals
		0.22	Elechl	0.11	Kerohl
		0.22	U5MR	0.11	Iln
		0.21	Woodhc	0.05	Temp
		0.19	Density	-0.43	Perm
		0.19	Rain	-0.33	wood
		0.01	Iln	-0.27	Woodhc
		-0.32	Popo64	-0.24	Mintem
		-0.24	Kerohl	-0.23	Liv
		-0.23	Graz	-0.19	Maxtem
		-0.21	Popu14	-0.18	Popu14
		-0.19	Liv	-0.18	graz
		-0.16	Temp	-0.13	Elechl
		-0.04	Wood	-0.11	Lit
		-0.02	Perm	-0.02	Density

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	3° Eigen vector	Variables	5° Eigen vector	Variables
1°	0.294	0.39	Cereals	0.37	Kerohl
2°	0.426	0.32	Maxtem	0.34	Density
3°	0.525	0.29	Pulses	0.20	Lit
4°	0.621	0.27	Mintem	0.17	Pulses
5°	0.702	0.25	Lit	0.15	Perm
		0.22	Elechl	0.09	Cereals
		0.22	U5MR	0.08	Rain
		0.21	Woodhc	0.07	Popu14
		0.19	Density	0.05	Woodhc
		0.19	Rain	-0.46	U5MR
		0.01	Iln	-0.38	Iln
		-0.32	Popo64	-0.34	Elechl
		-0.24	Kerohl	-0.23	wood
		-0.23	Graz	-0.18	Temp
		-0.21	Popu14	-0.18	Popo64
		-0.19	Liv	-0.14	Liv
		-0.16	Temp	-0.12	Maxtem
		-0.04	Wood	-0.11	Mintem
		-0.02	Perm	-0.03	graz

Table 3.3 (Cont'd.)

Eigen Values	Explained Variance (cumulative %)	4° Eigen vector	Variables	5° Eigen vector	Variables
1°	0.294	0.36	Pulses	0.37	Kerohl
2°	0.426	0.35	Popo64	0.34	Density
3°	0.525	0.22	U5MR	0.20	Lit
4°	0.621	0.22	Rain	0.17	Pulses
5°	0.702	0.13	Cereals	0.15	Perm
		0.11	Kerohl	0.09	Cereals
		0.11	Iln	0.08	Rain
		0.05	Temp	0.07	Popu14
		-0.43	Perm	0.05	Woodhc
		-0.33	Wood	-0.46	U5MR
		-0.27	Woodhc	-0.38	Iln
		-0.24	Mintem	-0.34	Elechl
		-0.23	Liv	-0.23	wood
		-0.19	Maxtem	-0.18	Temp
		-0.18	Popu14	-0.18	Popo64
		-0.18	Graz	-0.14	Liv
		-0.13	Elechl	-0.12	Maxtem
		-0.11	Lit	-0.11	Mintem
		-0.02	Density	-0.03	graz

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