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**Geography, European Colonization, and
Past Population Dynamics in Africa**

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GEOGRAPHY, EUROPEAN COLONIZATION, AND PAST POPULATION
DYNAMICS IN AFRICA

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ABSTRACT

Past population dynamics in Africa have remained largely elusive due to the lack of demographic data. Researchers are understandably deterred from trying to explain what is not known and African historical population estimates suffer from this lack of interest. In this paper I explain present day African population densities using mostly ecological factors as explanatory variables. I find evidence supporting the view that ecological factors deeply affected pre-colonial patterns of human settlement in Sub-Saharan Africa. Human populations grew relatively large in the presence of lakes, highlands, or when situated in the wet, coastal regions of Western Africa. Other environmental suites were thinly populated with overall population sizes stagnant at low or very low steady states. Subsequent developments show that dramatic increases in the agricultural productivity of peripheral, semiarid areas were possible once colonial innovations were on hand. Thus, European colonization had likely asymmetric effects on the population dynamics of different regions of Africa.

1. INTRODUCTION

Population densities and factor endowments are intimately related to income levels in the African mainland. Resource-poor countries tend to have comparatively low income per head, while well-endowed countries have low GDP per capita if they boast large populations (e. g. Nigeria) or relatively high income per capita if they sustain smaller populations (for ex. Namibia, Botswana). This situation is not unique in the World and presents some similarities with the situation in the Middle East: only countries that combine oil wealth with small populations are prosperous. Thus, past population trends have direct implications in present wealth disparities among African nations.

This reality conceals the importance of past income levels, or at least past agricultural productivity, for explaining population dynamics: at one point higher population densities in the present must be a sign of past prosperity reflected in higher wages or higher agricultural yields. In order to fully comprehend why some parts of Africa are poorer than others, it is therefore crucial to understand which forces allowed their populations to grow so much in the past.

Any enquiry into African historical demographics is necessarily ambitious for a number of reasons: there are a multitude of different and often contradictory forces at play, the literature on the subject is relatively narrow, and data is in most cases not available. The last two concerns are linked, as researchers are understandably wary of trying to explain population trends that are not known and perhaps will never be. The usefulness of this task is further put in question by the impossibility of substantiating any expressed view with population data. Accordingly, in this paper consideration will be given mostly to ecological factors that are time invariant and might plausibly have influenced demographic trends in Africa. The dependent variable is approximate population density in 1850 using estimates from McEvedy and Jones (1978).

The aim is to obtain a picture of population densities in Africa, at a moment that precedes colonial occupation of Africa by European powers but is sufficiently close to early colonial population estimates in order to minimize measurement error in the population variable. It is implicit that population density is regarded as a stock variable, being the cumulative outcome of the ecological factors that affected demographic trends in previous centuries.

The lack of material for calculating African populations is unfortunately the most common situation until well into the 20th century. This prolonged non-existence of statistical data is unique to Africa and is attributable to the lack of stratified classes with distinct subcultures that were elsewhere the norm in the 19th century. Iliffe (1987) argues that this absence of stratified societies results itself from the lack of the plough, intensive agriculture, literacy, and world religions. The only noteworthy exceptions are Ethiopia and perhaps the Islamic societies in the Central Sudan, although these societies never produced reliable population estimates.

The plan of this paper proceeds as follows. Section 2 presents an historical overview of population trends in Sub-Saharan Africa (SSA). Section 3 presents regression results, while section 4 discusses the impact of European colonization on population trends in Africa. Section 5 concludes.

2. PRE-1885 POPULATION DYNAMICS

Very low levels of population density are characteristic of hunting and gathering societies. Higher population densities normally require genuine agriculture, which made a first appearance on the continent around 1000BC in Western Africa. Subsequently, the agricultural (Bantu) revolution spread

eastwards into the Cameroons, reaching the East Coast around 500AD¹. These Bantu farmers possessed Iron Age technology and a productive agriculture, allowing them to displace the original Pygmy populations in Central Africa and the Bushmen further east and south. It is likely that West Africa had access to iron-working techniques from the Maghreb via the trans-Saharan networks established by the Berbers².

This Bantu expansion coincided temporarily with the Nilo-Saharan pastoralist expansion, which succeeded best in East Africa where the terrain naturally favours the pastoralist style. The result of these overlapping expansions is still visible in the present day ethnic mix of some of the countries in this region (for ex. Hutus and Tutsis). The lower population densities characteristic of pastoralist societies contributes to the differences between East and West Africa: lower population density, more pastoral peoples, lack of economic specialization, and lack of indigenous towns.

Central Africa is more like East Africa but more reliant on agriculture and consequently less dependent on cattle. In the more tropical parts the crops (finger millet and cassava) are not of high value and cropping rapidly exhausts the soils.

Southern Africa presents a more complex picture due to the different climate zones existing in a relatively small area. The Bantu expansion was overwhelming up to the Drakensberg Mountains in the east of South Africa. This mountain range catches sufficient rainfall to change a naturally arid climate into one favourable to agriculture. The western half of Southern Africa was left as a last refuge to the Bushmen and the Hottentots, who were an intermediate group constituted by Bushmen who had learnt how to herd cattle. Hailey (1957) refers to the Bushmen as being a group of people who didn't possess cattle and didn't know the use of iron when first encountered by

¹ Chronological estimates from **McEvedy and Jones** (1978).

² The trans-Saharan trade routes from the Mediterranean to Timbuktu and Lake Chad are known to the Europeans at least since the 13th century.

Europeans in the late 15th century. Economic specialization was much less developed in this region than in Western Africa, with little trade and exchange.

Early European presence in Africa

Prior to the partition of Africa in 1885 the colonization of Africa by European powers had been nearly impossible. With the exception of Capeland, this European presence was confined to coastal bases or narrow coastal strips. One common denominator of the early European institutions in these coastal bases is that they were generally concerned in avoiding being overwhelmed by African poor. The first permanent European settlement in SSA was established in Elmina on the Gold coast in 1482. The first hospital was founded in Mozambique in 1507, but this hospital was mostly destined for European troops and sailors *en route* to the Indian Ocean. The same is true for the military hospital in Luanda (1576): although giving care indistinctly to whites, blacks, and coloureds, most inmates were soldiers. The only known exceptions to this deliberate distancing are the *Misericordias* (a medieval Portuguese institution which cares for the poor and the sick) in the Portuguese towns in Angola, although these sometimes had no hospital, as their constitution required, when the Europeans living in the town were too few. Francisco Paccionio published the first book in a Bantu language in Angola in 1642 but dissemination of literacy to native populations remained very limited (and to Europeans likewise).

European institutions in Capeland also functioned as an alien body avoiding most involvement with African populations. Sick slaves were not admitted to the hospital after 1685 and poor relief paid to free blacks was reduced in the 18th century (other free blacks had to care for impoverished free blacks).

These coastal bases witnessed the first censuses in SSA. Yearly censuses reach as far back as the 17th century in Capeland and the 18th century in Angola

(1770). However, these first population counts are of limited interest for this work, as population dynamics in the small African colonies cannot be extrapolated to their hinterland or other regions beyond European control. Altogether, the picture that emerges is one of very limited contact between the few European residents and native populations. Positive influences seem for the most part absent from the balance sheet of early European presence in Africa.

Perhaps the only positive impact on African living standards results from the introduction of new crops brought from the Americas. These included the introduction of manioc and maize in the 16th century, certainly leading to higher agricultural productivity (maize is a particularly versatile crop and is easy to cultivate). Dias (1981) maintains that the introduction of new, drought-resistant crops (e.g. manioc) helped reducing the risk of total crop failure and increased overall food production (although it should be noted that manioc has low food value). The availability of a wider choice of crops allowed for rotation, thereby regenerating the soils, and plantation in new areas (the case of wheat in mountainous parts of Southern Africa, where it is more suited than sorghum or maize).

Ballard (1986) shows the far-reaching consequences of the introduction of a new crop. Portuguese traders from nearby Lourenço Marques (Maputo) first introduced maize in Eastern South Africa around 1700. At first, with little effect due to the low rainfall in the first half of the 18th century, which inhibited the expansion of maize production in the area. However, increased precipitation levels in the following decades permitted a substantial increase in grain production leading to an increase in the number of cattle and the correspondingly enhanced milk and meat output. This region recorded a rapid population growth at the end of the 18th century. Decline in rainfall in the early 19th century placed local populations (Nguni) in a vulnerable situation, as maize combines higher yields with lower drought resistance.

Early European presence in Africa is also relevant for the hindsight that it gives us into contemporaneous African standards of living. Of particular importance is information gathered by Christian missionaries as these frequently both outnumbered and preceded colonial officials. Where these sources are available, they seem to confirm that patterns of human settlement are strongly related to the environmental suite. Vincent (1982), referring to the Teso region in present day Uganda, records pre-colonial population densities that varied between 56 per square mile in semidesert northern Teso and 242 per square mile in the overpopulated, overstocked, and overcultivated south. She further refers to the prevalence of famines during the 19th century in a region where agricultural surpluses were either used for exchange and/or as a hedge against bad seasons. These periodic famines and the intermittent food shortages were alleviated through patronage, then a very common strategy for famine prevention. In this pre-colonial world the use of currency had only localized distribution, as most trade was exchange and barter.

The people of pre-colonial Zimbabwe seem to have effectively minimized the risk of drought and famine by exploiting ecological diversity and by locating themselves in relatively favoured environments (Vaughan, 1991). Iliffe (1990) points to the lack of evidence for high famine mortality in pre-colonial Zimbabwe. He concludes that deaths directly due to famine were relatively uncommon owing to indigenous survival techniques. Droughts and scarcity were certainly common but deaths surged mostly when natural catastrophes were combined with violence. He only finds evidence for widespread famine mortality in Zimbabwe for the 1790-1836 period, a time when extensive violence interrupted indigenous survival procedures. The absence of purely pastoral people in Zimbabwe contributed to scarcity rarely degenerating into severe mortality.

However, it should be noted that not everywhere in Africa was famine mortality so successfully prevented. Iliffe (1990) refers heavy mortality during the drought of the early 1860's in Southern Malawi. Miller (1982) concludes

that famine and disease had indeed been the chief constraints on population growth in an environment similar to Zimbabwe's.

The earliest accounts result from missionary activity in the Kongo Kingdom (Northern Angola) during the 16th and 17th centuries. The missionaries were impressed by the extreme poverty, the lack of storable wealth, the decadal droughts and the great famines averaging one in each man's lifetime (Iliffe, 1987). The effects of drought were intensified by primitive farming techniques and lack of irrigation, seriously restricting the amount of cultivable land (da Silva Correia, 1782). Dias (1981) argues that the size and distribution of population in Angola by the early 1800's probably owed more to long-term climatic influences than to more recent events like the overseas slave trade. There were relatively few fertile and healthy areas capable of supporting dense populations, given African techniques of land use, throughout Angola. Even in more favoured areas, demographic growth would have been periodically checked by drought or epidemic³. These early records show that the droughts were regularly preceded or accompanied by locust invasions and by plagues of other crop-destroying pests (rats, frogs, ants). Dias (1981) lists the following strategies for avoiding starvation among native populations in Angola: ancient techniques of gathering fruits and roots, trade between African societies, servitude to other Africans⁴, and working for Europeans as porters or the colonial government in road building programs (at least from 1850's onwards). It is noteworthy that trade is particularly effective for famine prevention when established with more distant regions, as trade across environmental frontiers might provide access to food reserves during periods of localized drought or crop failure (Giblin, 1986). This last pattern of trade often led to the production of exchange goods (tobacco, honey, livestock) as a famine avoidance strategy.

³ A drought was first recorded on the coastal district around Luanda in 1587-8.

⁴ Voluntary slavery was observed in some parts of Angola in times of famines.

Trade and transport systems are also important in explaining food crises: Eldredge (1987) argues that starvation depends not only on food supply but also on “distribution”. She observes that severe drought occasionally caused an absolute shortage of food in Lesotho because the interior of Southern Africa was isolated in the early 19th century and there were no trade systems to distribute food across the region. While the famine of 1802-03 in Lesotho was caused by an absolute shortage of food in the absence of trade with the coastal areas, subsequent famines in the colonial period were the result of food not reaching areas of drought for political and socio-economic reasons (Eldredge, 1987).

Slavery and epidemics (human and cattle) are also often cited constraints to pre-colonial population growth in Africa. These topics are discussed separately considering the vast attention they received in literature on African demographics.

Slavery

It was not the Europeans who introduced slavery in Africa but West Africa’s integration into the Atlantic mercantile system certainly brought African slave trading to new heights. Hailey (1957) refers to an estimate of 15 million slaves exported to overseas markets between the 15th and the 19th centuries. McEvedy and Jones (1978) present the following estimates for the slave trade in the period 1500-1810: 5.75 million from West Africa, 3.75m from Central West Africa, 0.3m from the Niger/Chad area, 0.6m from the Sudan/Ethiopia area, 0.3m from East Africa, and 0.5m from Mozambique. These authors agree with the now common opinion that slave trade does not seem to be of any lasting quantitative significance to African population size or composition.

Nevertheless, slave trade was temporarily significant for population trends in some parts of Africa. In West Africa slave trade seems to have significantly slowed down population growth during the 18th century. At its peak (around 1785) the slave trade was responsible for an annual levy of 45000 West Africans, or 0.25% of total population, against an estimated population growth rate of around 0.35% yearly. This substantial demographic toll was aggravated by the prevalent gender bias of slave exports: slave traders took three males for each female causing widespread polygamy in West Africa.

As for East Africa, slaves became much more important in the East African mercantile system after the 1770's when France established sugar and tobacco plantations in the Indian Ocean islands (Bourbon and Mauritius)⁵. Slave exports to the plantations in Zanzibar and Pemba were also numerically significant. Giblin (1986) presents evidence that Swahili traders (interested in Ivory and slaves) fostered the emergence of effective new middlemen in Uzigua (North-eastern Tanzania) supplying them with firearms, cloth, and other imports. These developments resulted by the 1840's and 1850's in intensive slave hunting and escalating violence. The plantation production in Pemba increased further in the 1870's and early 1880's causing more demand for and dealing in slaves. Early European presence in the region proved ineffective in abolishing the slave trade: local slave traders got around the treaty of 1876 between the British and the Omani government in Zanzibar prohibiting the entry of slave caravans into coastal towns by breaking up the caravans into smaller parties to avoid detection. According to McEvedy and Jones (1978), Arab (Zanzibar) slave trade in East Africa was demographically only significant in the 1850-1870 period. They estimate slave exports from the region at around 20000 a year (perhaps 40000 including loss of life), a quantity that was probably enough to stunt momentarily local population growth. Slave trade was abolished in Mozambique in 1810 but abolition was only in 1860 made effective. In this

⁵ See Vincent (1982).

half-century around 0.5m slaves (0.4% to 0.5% yearly of total population) were exported⁶.

Often overlooked is voluntary slavery as a strategy to secure the provision of subsistence (to avoid hunger and starvation or else for protection and defence) in exchange for temporary or lifelong slavery. Voluntary slavery might make economic sense when perceived benefits more than offset perceived costs (Engerman). Voluntary slavery was not unique to Africa as it was used by different societies as a solution to a perceived problem of overpopulation. Mendelsohn (1949) suggests that the bulk of Babylonian and Assyrian slaves were voluntary (the Hammurabi code allowed individuals to sell themselves or family members into slavery, although only for a limited number of years). In more recent times voluntary slavery was reported in Muscovy (where it was legalized in the late 16th century) and in 19th century India (parents sold their children in times of famine). Voluntary slavery is less well known in Western Europe partly because self-sale was probably not legally accepted under Roman law. Enslavement of other Europeans ended in Western Europe in the 14th century. Here, excess birth frequently meant either abandonment, giving children to the church, or infanticide.

Elsewhere, voluntary slavery declined when incomes rose, and when more successful relief and welfare institutions were devised (Engerman). However, the very low levels of income in many parts of Africa resulted in the sale of children and adults to the wealthy to be often seen as the only way for individuals to survive. Giblin (1986) provides some evidence for large-scale slave exports from Tanganyika to Somalia (around 1800) and to Zanzibar (1820's). He argues that this sale of dependents is the corresponding effort to obtain subsistence during serious periods of scarcity. Dias (1981) reports the sale of relatives in times of hunger in Angola to the agents of licensed labour recruiters. A record 512 people were embarked in a single shipload for São

⁶ Estimates from **McEvedy and Jones** (1978).

Tomé by the *Banco Nacional Ultramarino's* recruiters in October 1877 (the usual shipload was between 50 and 200). The increased demand for slaves in this West African island was due to the expansion of cocoa plantations.

Epidemics

It has become in last years rather fashionable to discount famines as major regulators of population growth (Dyson and Ó Gráda, 2002). However, famines can affect demography through a multitude of channels and more often than not, literal starvation is not the main cause of death. One of the main causes of excess mortality is infectious disease, itself the result of endemic malnutrition and the social disruption that often accompanies famine. Where infectious diseases are endemic in non-crisis time, they bulk large when crisis strikes (Dyson and Ó Gráda, 2002). This interplay of explanatory factors leading to epidemic levels of disease is well documented for 19th century Lesotho. Eldredge (1987) argues that in this region too drought was important as a catalytic, if not ultimate, cause of famine. Droughts more commonly prompted famines indirectly by inducing migrations, which intensified territorial disputes and provoked open conflicts in the context of ongoing struggles for land. In Lesotho, migrations and conflicts caused by droughts were the channels of causality that promoted pestilential trauma.

Records from the Luanda Military Hospital allow for a perception of the most common infectious diseases in the 19th century. Dias (1981) reports that out of 3955 people receiving treatment in this hospital during 1865/66 1298 were treated for malarial fevers, 351 for dysentery, diarrhoea, etc., 342 for syphilis, and 252 for respiratory disease⁷. Yellow fever was probably endemic on the Angolan coast by the 19th century, but Angola is generally believed to be

⁷ It is important to note that African treatments were often preferred to European medical aid, even by so-called *civilizados* (Africans of inland centres of Portuguese power and trade, assimilating some European culture to varying degrees).

exempt from terrible epidemics of this disease. The most feared disease among the infectious/contagious diseases in Angola was smallpox. Outbreaks of this disease often coincided with Portuguese troop movements and on one occasion (late 1620's) many thousand Africans were reported to have died in one outbreak.

Another supplementary reason for epidemics was the crowding together of slaves in unhygienic conditions. Governor-General Daun expressed hope in 1836 that the abolition of overseas slave trade would make such epidemics a thing of the past, but that proved sadly premature (Dias, 1981).

On the other hand, the periodic recurrence of famines and epidemic crises here described for 19th century Angola was not more unusual than those that had long afflicted different parts of Europe. Additionally, it is worth highlighting that smallpox caused relatively few cases or fatalities among European populations in this region.

The importance of smallpox for explaining high African mortality rates is well documented for other regions as well. Iliffe (1990) attributes the relatively low famine mortality in Zimbabwe, compared to neighbouring Mozambique, to the low incidence of smallpox in the former ("Smallpox was the great killer elsewhere in Africa").

Particularly relevant for Equatorial Africa was the combined effect of sleeping sickness (Trypanosomiasis) and venereal diseases. According to Iliffe (1987), the impact of these diseases was so widespread in the region that equatorial populations only recovered from the 1950's on⁸. Sleeping sickness eventually reached the more tropical parts of Angola in the 1870's. This spreading out seems to be related to changes in the Equatorial African disease environment through forest clearance or the shooting out of game (Dias, 1981). Further East, similar developments were taking place: Weiss (1998) argues that in late 19th

⁸ Many of the slaves imported into Martinique from the Congo region in 1869 were infected with sleeping sickness.

century Eastern Africa a combination of different cattle diseases, famine, and population decline all contributed to the breakdown of vegetation control and the enlargement of tsetse-belts⁹.

3. REGRESSION ANALYSIS

3.1 The data and descriptive statistics

Appendix A contains the data on the variables used in this paper. Table A1 presents the list of variables used, together with their respective definitions and sources, while the descriptive statistics for the same variables can be seen in table A2. Tables A3 and A4 present new data specifically constructed for this chapter.

Table A3 presents population estimates for African countries at four different moments (1850, 1900, 1925, 1950), together with the respective population growth rates for the periods in between. As already discussed, the year 1850 was chosen in order to obtain a picture of population densities in Africa, at a moment that precedes colonial occupation of Africa by European powers but is sufficiently close to early colonial population estimates in order to minimize measurement error in the population variable. The three subsequent years (from 1900 to 1950) serve the purpose of allowing introspection into population dynamics during the colonial period. The subjacent intention is to assess the widespread belief that African population decreased during the early colonial period and only recovered from the 1920's or 1930's. Hailey (1957) informs that most official estimates and independent opinion concurred in believing that the African population was diminishing until 1923. This perception was most acute for Equatorial and Eastern Africa, and independent of the colonizer. Depopulation during early colonial period was rarely questioned in the Belgian Congo; only the causes were subject to debate. Several hypotheses were then

⁹ Thibon (2002), and Giblin (1986) also refer to this ecological crisis in Eastern Africa.

advanced: i) the exploitation during the regime of the Free State, ii) the introduction of disease by Europeans, iii) “la pénétration européenne, telle quelle, par elle-même” (Hailey, 1957).

These estimates show that the average increase in population was 30% for the second half of the 19th century (the median increase is 22%). According to this data, the smallest increases are recorded for Djibouti (no variation over the 50 year period), Somalia (3%), Namibia (5%), Botswana and Uganda (9%). With the exception of Uganda (suffering from a prolonged period of revolutions and civil war that helped British annexation following the 1897-9 war), these countries consist mostly of desert or near desert regions, providing at best rather poor pasture. Accordingly, the modest population growth rates reflect the low human population densities that these environmental suites could support prior to the innovations brought by the European colonizers. By far the highest population growth rates are obtained for South Africa, Lesotho, and Swaziland. Immigration is major factor in explaining the rapid population growth in South Africa in this period. The native population also seems to have increased significantly during this half century. Iliffe (1987) maintains that there was no demographic decline in Southern Africa, unlike elsewhere in early colonial Africa. Lesotho and Swaziland, without any significant immigration movements, also seem to have benefited from incorporation into the regional economy, which had become European and international in orientation.

The first quarter records acceleration in the population growth rate, with an average growth of 33% over a 25 year stage (median growth is 27%). The smallest increase is now obtained for French West Africa (Mauritania, Mali, Niger, Chad) and the Belgian Congo. It is noteworthy that the West African states, being situated in the Sahel region, combine a desert or at least arid climate with relatively late colonial penetration. The highest population growth rates are now recorded in an area then known as Southern Rhodesia and Federation, comprising present-day Zimbabwe, Zambia, and Malawi. This

situation confirms the findings in Iliffe (1990). The author sustains that the population in Zimbabwe grew rapidly between 1900 and 1925, unlike in the rest of East and Central Africa. This outcome is attributed to relatively early control of famine mortality made possible by more intensive government than in other colonies (better trade and transport systems).

The second quarter of the 20th century witnesses faster population growth rates than ever before in SSA. The average growth rate is now 40% and the median growth rate also accelerated to 33%. The smallest increases are estimated for Guinea (10%), Sierra Leone (15%), French Equatorial Africa (Congo, Gabon, Central African Republic), and Angola (just under 20%). These rather modest increases might be a result of the widespread impact that sleeping sickness and venereal diseases had in Equatorial Africa¹⁰. The highest growth rates are again obtained for Zimbabwe, followed by its Southern African neighbours (Botswana, Swaziland, Lesotho, and South Africa).

Finally, table A4 presents in column (4) the estimates for population densities in 1850. By far the most populated countries in mainland Africa were Rwanda (42.5) and Burundi. This finding is hardly surprising, as the Rift Valley has long been known for particularly high population densities. High population densities are also encountered in adjacent areas (Uganda) and coastal West Africa (Sierra Leone, Nigeria, Gambia). The most depopulated areas in 1850 correspond to present-day Botswana, Namibia, and Mauritania. All these three countries have 96%/97% of their landmass in the climate zones CZ20 (desert) or CZ19 (Dry subtropical steppe).

Column (5) presents a different measure of population density. Total land surface is now replaced in the denominator by the total land area considered suitable for agriculture (according to FAO). The agriculturally suitable land area is reported in column (2) and the new measure of population density is shown in column (5). This new variable might provide a useful indication of

¹⁰ Iliffe (1987) concurs in believing that Equatorial populations only recovered from the 1950's on.

agricultural productivity in sense that it shows just how large were the human populations supported by agricultural land in different parts of Africa. The largest estimates are still obtained for the Rift Valley (Rwanda, Uganda, no data available for Burundi), but the distance to West African countries (Sierra Leone, Benin, Equatorial Guinea) is now somewhat mitigated. The lowest population densities are obtained for the same countries as in column (4). It seems that desert areas were not their only problem: the poor pasture that was intrinsic to the non-desert parts of their countries supported much smaller human populations than greener parts of Africa.

The last two columns show new African rainfall variables constructed with data from Barrios et al. (2003). Column (6) presents the expected total annual rainfall using the average calculated for the period 1900-1998. Data for rainfall in previous centuries is not available so this data is used as a proxy. Although rainfall is often characterized by its unpredictability, this series seems long enough to accommodate for temporary oscillations thereby constituting the best possible effort with existing data at predicting rainfall levels in Africa. According to this new data, average annual rainfall is particularly high in West Africa (Sierra Leone, Liberia, and Equatorial Guinea, all have more than 2000mm of rainfall per year). As expected, the Sahel Belt, Southwest Africa, and the Horn of Africa are the driest regions. By far the smallest amount of rainfall is recorded for Mauritania (102mm on average per year), followed by Niger (164mm), Djibouti (243mm), Somalia (252mm), and Namibia (276mm). The median country is Mozambique with 1010mm of average yearly rainfall.

A different way to look at the importance of rainfall for agriculture is to measure its predictability. Absent rainfall, or rainfall out of the season, results all too often in crop failure and the associated hardship for agriculturalists and pastoralists alike. For that purpose, it was decided to construct an additional variable, which is the result of dividing the standard deviation by the average rainfall. Djibouti is credited with the highest yearly variation in rainfall (36.7), followed by Namibia (29.2), Swaziland (25.7), and Somalia (25.3). On the

other hand, pattern of rainfall seem to be particularly predictable in the Gulf of Guinea and adjacent territories. The lowest yearly variations were recorded for the Belgian Congo (5.7), the Cameroons (6.9), Oubangui-Chari (now the Central African Republic with 8.2), Nigeria (8.2), and Sierra Leone (9.2). These findings suggest that there good *a priori* reasons for including the rainfall variables as determinants of early agricultural expansion and associated large human populations in West Africa.

3.2 Econometric analysis

Table B1 presents ordinary least squares regression results with our two measures of early population density as dependent variables. Total population density is the dependent variable in columns (1) and (2), while population density in agriculturally suitable land is the dependent variable in the last two columns. Disease environment was examined as an additional regressor to the rainfall variables previously discussed. Considering that in some parts of the world (e.g. Central America) very high incidence of tropical diseases was a deterrent to human occupation, and knowing that the incidence of malaria and yellow fever was (and is) indeed very high in Equatorial Africa, it might be of interest to examine whether population densities were affected by the local disease ecology.

There is little evidence that tropical diseases restrained higher population densities. Although the estimated coefficient on diseases is statistically significant (at the 5% significance level), it has the “wrong” sign, i.e. the incidence of tropical diseases is positively correlated to larger human concentrations even after controlling for rainfall. This result suggests that the same ecological background that contributed for the Bantu agricultural expansion (high rain and high temperature throughout the year) also caused higher incidence of malaria and yellow fever. As for the rainfall variables, total

rainfall is significant (at the 5% level) and variation in rainfall is not individually significant even though it has the “correct” sign.

Column (2) repeats the same specification with the exclusion of the disease variable. This last regressor was excluded because there is little evidence for a negative impact it might have on population density, and it is difficult to find good *a priori* considerations on how it could affect human population densities positively. This exclusion magnifies the coefficients of the rainfall variables. Total rainfall is now significant at the 1% level, while variation in rainfall continues to be not statistically significant.

Columns (3) and (4) show the same overall trends, with the difference that the estimated impact of total rainfall results somewhat smaller (0.63 versus 0.71). This last result could be anticipated bearing in mind that population density in agriculturally suitable land already excludes desert areas, thereby reducing partially the importance of total rainfall. The opposite ensues with variation in rainfall: excluding desert areas increases the estimated coefficient, although this variable continues individually insignificant (and still has the “correct” sign). However, this variable was not excluded from the baseline specification due to the ambiguity of the results. On one hand this variable is not individually significant in the multiple regression model and the F test for joint explanatory power is marginally insignificant (F test value of 2.48 versus critical value of 2.85), on the other hand this variable is individually significant in the simple regression model and its exclusion from the multiple regression model causes a drop in the adjusted R-squared (from 0.32 to 0.3). It is possible that the variation in rainfall variable suffers from the relatively small sample. Ultimately, conclusive results depend on conducting similar research with larger samples.

The estimated impact of total annual rainfall on population densities is large: a 10% increase in precipitation levels increases human populations by 6.3%. Increasing Mauritania’s annual rainfall to the level of the second driest country in Africa (from 102mm annually to Niger’s 164mm) would increase its

population by 38%. An increase in precipitation to the level of its southern neighbour Senegal (764mm) could multiply its population by five.

Total annual rainfall might not be the entire story when it comes to explain historical populations. Lower variation in rainfall might also have positive effects on the size of human populations even if total annual rainfall is left unaltered. Increasing the predictability of rainfall in a country where precipitation is notoriously unreliable (for ex. Namibia) to the African average could more than double its human population (population density in agriculturally suitable land would increase from 0.5 to 1.2 per square kilometre).

Panel B2 shows regression estimates with all climate zones that exist in Africa as determinants of population density. The inclusion of all climate zones in column (1) results in estimates that turn out to be unreliable and downright strange. It seems to be a problem of too many predictors in a relatively small sample that reduces the true predictive quality of the regression model. Thus, it was decided to employ a stepwise procedure by removing the statistically insignificant variables from our specification. The dropping method with backward elimination was favoured since at this moment it is not clear which, if any, of these variables are significant. The backward sequence of F tests is visible from column (2) through column (9), where for the first time the F test rejects the exclusion of climate zone 1 (Water). Accordingly, column (8) is our baseline specification with four independent variables and an R-squared of 0.5. The largest (positive) coefficients are estimated for CZ7 (Highland) and CZ1 (Water). Highland location is important for Rwanda (63%), Burundi (47%), Ethiopia and Eritrea (30%), and to a lesser extent to Uganda (7%), Kenya (4%), DR Congo (2%), and Tanzania (0.2%). According to these estimates, Highland location is almost exclusively (96%) responsible for the very high population density recorded for Rwanda.

A climate that is strongly influenced by the coastline is much more important for West Africa than for Eastern Africa. The countries where CZ1 is most pervasive are Guinea-Bissau (32%), Equatorial Guinea (22%), Sierra Leone (14%), Gambia (13%), and Liberia (11%). This variable seems to be responsible for the high population densities recorded in coastal West Africa. Smaller coefficients are obtained for CZ21 (Tropical savannah), which is the most common climate zone in SSA (38% of the total landmass) and CZ9 (Temperate marine west coast), which only exists in Swaziland, Lesotho, South Africa and Mozambique. All other climate variables are statistically insignificant for explaining population densities in SSA.

Panel B3 is similar to panel B2 with the exception that climate zones are now replaced with biome classes. The problems involved with the use of too many variables are again apparent, leading to the stepwise exclusion of individually and jointly insignificant variables. This elimination process is visible between columns (2) and (5). The exclusion of the biome class BC13 (Deserts and xeric shrubland) was rejected at the 10% significance level in column (5). Also, this desert variable is individually significant at the 5% significance level. Therefore, our baseline specification is visible in column (4) with six predictors and an R-squared of 0.4.

As expected, the lowest coefficient is found for BC13 (Desert). The highest impacts are obtained for BC98 (Lake) and BC14 (Mangroves). Lake environments are important for the Great Lakes region, particularly Malawi (18%), Uganda (13%), Burundi (5%), Tanzania (5%), and Kenya (2%). Consequently, this variable helps explain the high population density of Malawi, something that had been impossible with the climate zone variables¹¹. The Mangrove variable (BC14) is important for Guinea-Bissau (26% of the total surface), Gambia (9%), Sierra Leone (9%), and Equatorial Guinea (3%).

¹¹ According to **Hailey** (1957) the population density in Nyasaland (Malawi) in the 1950's was double that of any territory in Eastern or Central Africa.

The geographical distribution of this variable coincides with the highly populated “wet” coastline in West Africa. An intermediate group, conducive to more moderate population densities is formed by BC1 (Tropical and subtropical moist broadleaf forests), BC7 (Tropical and subtropical grasslands and savannas), and BC10 (Montane grasslands).

Table B4 brings all this together as all determinants previously found to possess significant individual or joint explanatory power are included. As before, the backward elimination is again monitored through individual significance, F test, and impact on the R-squared and adjusted R-squared. Although the adjusted R-squared starts to drop from equation (6) onwards, we decide to proceed considering that the excluded variable has low t test and low F test values. The opposite succeeds in equation (8), leading us to adopt equation (7) as our baseline specification for explaining pre-colonial patterns of population density in SSA. These results confirm the findings of previous panels: the natural environments that are conducive to higher population densities are: Lakes (BC98), Water (CZ1), and Highlands (CZ7). The temperate regions of Southern Africa (CZ9) also have a significant, positive coefficient (though of much lower magnitude). Tropical Savannah (CZ21), due to its widespread prevalence in Africa and its low coefficient, seems to be mostly a control variable. Perhaps the most interesting result is the large drop in the coefficient on lakes to a more credible 0.07. Nevertheless, it remains the largest estimated coefficient and thus the natural habitat best suited for supporting large populations. The estimated population densities for 1850, together with the predicted densities using the regression equations (1) and (7) from table B4 are shown in table B5.

On the whole, these results suggest that geospatial factors influenced human settlement patterns through the relevant human-environment interactions. Three African natural environments seem to be particularly benign to human settlement: Lakes, Highlands, and Coastlines (though the latter only for West

Africa). The combination of great lakes with highlands in the Rift Valley results in particularly high human population densities.

4. THE COLONIZATION PERIOD

We saw in the previous section that environmental factors are largely responsible for pre-1885 population trends and these population dynamics determined to a great extent present-day population densities in Africa. West Africa and the Great Lakes region still exhibit relatively high population densities, while the arid regions in the Sahel belt and Southern Africa remain sparsely populated. This does not mean that the colonization period is entirely irrelevant for explaining contemporary population distribution in SSA. Perhaps the most obvious feature of this period is the dissemination of fast population growth to regions previously characterised by stagnation or very low growth at best. On occasion, European colonization had dramatic effects on the local demography and completely changed the prevalent pattern of population growth. The most cited example is the case of colonial Southern Rhodesia. According to McEvedy and Jones (1978), population growth in South-Central Africa (including Zimbabwe) remained astonishingly slow until 1900 for an agricultural people in a virgin and not inhospitable land. Iliffe (1990) is equally intrigued with Zimbabwe's very small population at the beginning of the 20th century. However, European innovations permitted the multiplication of Zimbabwe's population by factor four or five in only 50 years and one of Africa's most thinly populated countries became one of its most densely populated.

In this section we review the channels of causality through which European colonization impacted population dynamics in SSA. For that purpose, it is important to bear in mind that European power projection was not the only force at play during this period in Africa. The 1880's initiated nearly half a century of natural disasters. This period of erratic precipitation and famine

anticipated in one decade any substantial European invasion (Iliffe, 1987). Accordingly, we start by reviewing the natural disasters of this early colonial period and then turn to the impact of European colonial policies on African population dynamics.

Natural Disasters

Tropical African rainfall as a whole was low and exceptionally erratic during the first half of the colonial period but began to increase in the 1920's (Iliffe, 1987). Phoofolo (2003) notes a cycle of disasters that ricocheted off one another in unrelenting succession throughout the entire continent in the last two decades of the 19th century. The causes and the consequences of this period of adversity receive considerable attention in the literature. Hailey (1957) refers to decreasing population in British East Africa between 1895 and 1920 and attributes this decline to famines and epidemic disease that more than offset the beneficial effects of the abolition of inter-tribal warfare.

Vincent (1982) also refers to depopulation and advances some rare data for the Teso region in Uganda: where comparable figures are accurate (the Serere district for ex.), the loss of population is of devastating proportions. The population in this district fell from 56170 in 1911 to 36454 in 1921. She admits that the explanations remain elusive but advances epidemics, famines, sexual diseases, and sterility as possible causes (food shortages, drought, rinderpest, and epidemics were reported in Teso in 1917). The pan-African rinderpest of the 1890's also reached the Teso region. She cites some estimates that put the proportion of cattle that died in the drought of 1894-6 and the ensuing rinderpest plague at two out of three for Teso.

This crisis was also felt in Zimbabwe. Iliffe (1990) attributes the 1896-7 famine to drought, locusts, rinderpest, and the consequences of the European invasion in 1893. Thibon (2002) describes for Burundi what he calls a "multidimensional demographic depression over the longer run" as a direct

consequence of the famines in the late 19th century. These famines result from the conjunction of natural calamities (climatic accidents, microbial shocks) and foreign intervention. He situates the apogee in the 1890-1920 period. Subsequently, the 1920's are characterised by regional famines (subsistence crises intensified by epidemics) and the 1930's by short-lived famines (subsistence crises of a seasonal kind and the last, more circumstantial, epidemic outbreaks).

Eldredge (1987) emphasizes the consequences of the extremely long and severe drought of the early 1860's in Southern Africa. While the incidence of drought in Southern Africa was high throughout the 19th century, this one in particular caused for the first time the transport system between the Cape Colony and the Orange Free State to cease entirely. This situation was possible because of the inexistence of navigable rivers into the interior of Southern Africa and the absence of railroads (until the 1880's). The only means of transportation were draught oxen and wagons, though these could not survive the lengthy journey to the Cape during the drought of the early 1860's. The consequent isolation of the interior of Southern Africa led to famines among both the BaSotho and the Boers. They were entirely cut off from food supplies from the south. The sequence of droughts, famines, and diseases in this region between 1858 and 1866 resulted in the Boers making the final push to expropriate BaSotho land. In 1868 the desperate BaSotho sought protection from the British Crown (granted in the same year) but by then they had already lost more than half of their arable land.

The rinderpest of the 1890's receives very detailed treatment in Phoofolo (2003). He argues that the rinderpest cattle panzootic, which killed 95% of African herds throughout Southern Africa in 1896-8, arrived amidst an unrelenting cycle of other climatic, ecological and pestilential disasters. The rinderpest threatened to wipe out the only capital of the BaSotho and to restrict future capital accumulation. The drought combined with the lack of animal traction (due to rinderpest) caused wheat exports to decline and finally in 1899

to collapse. Another side effect of the rinderpest was a dramatic rise in transport costs, which led the price of every commodity to escalate. The combination of all these disasters brought an outbreak of human disease, most commonly related to hunger and starvation (diarrhoea, dysentery, measles, meningitis, pneumonia, scurvy, smallpox, and typhoid). In some African communities more than 60% of the people were reported to have died of starvation, although the rinderpest had worse effects in other parts of Southern Africa (widespread starvation in Bechuanaland and Transvaal)¹². The Rinderpest crisis was followed by progressive ecological deterioration, the 1920 depression, and the catastrophic drought of 1932-3. In the case of Lesotho, a recovery was only possible from the 1930's on.

The best sources on this rinderpest come from Southern Africa where European or colonial administrations were already present (including trained veterinarians). Some information on the catastrophic consequences of this disaster also exists for Eastern Africa due to European travellers and emerging colonial administrations. Nonetheless, Weiss (1998) makes an effort at summarizing the impact of cattle epizootics in the Central Sudan during the 19th century. Although outbreaks of cattle diseases in this region were relatively common in the second half of the 19th century, these were less destructive than in Eastern Africa because the majority of the population in the Central Sudan were neither cattle owners nor cattle breeders. It was mostly the local pastoral societies and cattle keepers that descended into total misery. As a result, some pastoralist societies had to turn to agriculture, which led to an expansion of permanent cultivation. Other livestock keepers migrated to the towns reinforcing an incipient urbanization. The cattle keepers who decided to rebuild their herds had three different options at their disposal: i) own reproduction (takes relatively long time); ii) buying animals (which demands resources for transactions); or iii) raiding. The last option was the easy solution for the ruling

¹² Native women were reported to have picked up the grains of maize that fell from the mouth of post mules.

classes but had the inconvenience of passing on the effect of the epizootic to hitherto unaffected localities and people.

The coincidence of European conquests in Africa with a period of ecological and epidemiological disaster was also observed in Angola. Dias (1981) argues that the 1864 smallpox epidemic was the first to seriously threaten the rising prosperity of the colonial economy based on “legitimate” commerce (cotton, sugar, coffee plantations). The mortality and panic caused by the ensuing smallpox epidemic (1872-3) led the king of Kongo to request Portuguese help in combating it. Throughout this crisis the death toll was mostly confined to densely populated centres (food continued to be cheap and abundant in the surrounding areas during the peak of the crisis in July 1873). These new pockets of population density surged in the 1850’s as populations fled areas affected by drought and Brazil outlawed the importation of slaves in 1850.

These epidemics could lead to the paralisation of the colonial economy, as kings in the interior temporarily refused to trade with (European) coastal towns. The combined effects of starvation, due to rain failure and disease, normally resulted in less opposition to European expansion¹³. However, sporadically ecological crises actually impeded European expansion: severe drought, locusts, and cattle disease led to the temporary evacuation of the forts built in the Angola-Namibia border region in the 1850’s. This situation was only reversed in the 1880’s. A positive side effect of the epidemics is that they contributed to the rise of a free labour force and resulted in higher wages for the healthy.

Sleeping sickness, so important elsewhere in Central Africa, reached the tropical (northern) parts of Angola in the 1870’s. The geographical location of this country facilitated the spread of rinderpest in the temperate south and of malaria and sleeping sickness in the north. According to Dias (1981), this last disease, combined with migrations caused by famines, were responsible for the

¹³ A medical officer in Luanda commented in 1876 that the majority of the inhabitants of this land are mummies rather than human beings.

significant fall in the population of Portuguese *concelhos* between 1876 and 1898 (recovery only from the 1920's)¹⁴. She sustains that Trypanosomiasis caused an enormous increase in the rural death rate in Africa in the early 1900's (deaths attributable to sleeping sickness varied from 1.5% in Luanda to 33% further inland).

These ecological and epidemiological disasters, and the resulting depopulation of this colony created an acute shortage of labour for the European plantations. The prolonged crisis in the plantations lasted from the early 1900's until the 1940's.

Giblin (1986) establishes a similar pattern of prolonged ecological and subsistence crisis for North-eastern Tanzania between 1880 and 1940. This period of disasters is particularly striking, as he finds no evidence for a comparable subsistence crisis prior to 1880. The earliest European information (1811) actually reports a prosperous population owning many cattle and exporting to the coast. This does not mean that there were no famines in this part of Africa, yet widespread famines only seemed to occur in rare, exceptional circumstances. Cattle disease had devastating effects in this part of Tanzania: the rinderpest of 1891-2 crippled famine insurance as it hit both Masai (pastoralists) and Zigua (cultivators), thereby ruining the basis of reciprocal exchanges across environmental frontiers.

European presence had been established in coastal Southern Africa before the scramble for Africa (1880's), but here too it often coincided with periods of disaster caused by climatic stress. Ballard (1986) sustains that the climatic regime over much of Southern Africa in the early 19th century was characterized by a higher frequency of drought and lower precipitation. The situation was so serious that from being a revictualing station on the way to India, Cape Town and its outlying agricultural communities had to import food from Britain during the drought years. The economic and political implications

¹⁴ The drain of manpower to São Tomé, 3000 to 4000 people per year, is probably less responsible for this depopulation.

of the radical rainfall variations for Nguni cattle-keeping cultivators (in Natal/Zululand) could be serious when drought and a deterioration of pasturage coincided with a rising human and livestock population. Droughts between 1800 and 1824 produced famine of such magnitude that it led to a serious breakdown of social, political, and economic institutions among the Nguni (starvation, increased migration, cannibalism, raiding, etc.). These events reinforce the view expressed in Appleby (1980) that the threat of a serious famine due to poor weather is particularly acute in a closed economy where a “long, sustained increase in population had reduced the per capita agricultural output to the subsistence level, even in good years”. The Nguni were not entirely cut off from the outside world as they traded with the Portuguese from Delagoa Bay (Maputo) but they remained dependent on the local harvest for subsistence (neither had the technology nor the economic system to overcome famine on a massive scale). Ultimately, the Nguni refugee population was in no political or economic position to offer resistance to the handful of British traders who, in turn, quickly assumed mastery over a defeated and malnourished population (Ballard, 1986). More likely, they were willing to submit to anyone who offered food and security.

Negative impacts of European colonization

War is the most obvious cause for the demographic distress that often coincided with the arrival of the colonial state. In addition to the usual, unhelpful consequences of any war, early colonial wars in Africa overlapped with a period of natural calamities. Thus, opposition to British colonial rule in Uganda was crushed in the 1897-9 war, precisely when the local population was exposed to the aftermath of the 1894-6 drought and rinderpest. Following the war, sanctions were required to maintain the production of cotton (cotton growing conflicted with food crop cultivation). Forced labour adds to this already grim picture: Vincent (1982) documents that some officials expressed

concern over the depopulation of the protectorate, which they attributed to forced labour conditions. She sustains that forced labour was “a great deal more onerous during this early period than poll tax imposed by the colonial state”¹⁵.

In Zimbabwe, European invasion (1893) also coincided with the famine of 1896-7, originally caused by drought, locusts, and rinderpest. Iliffe (1990) argues that preventing natives from harvesting was a vital military objective of the Europeans. Hence, a difficult situation originated in natural disasters was further aggravated by land alienation, taxes, and most of all the violence of the rebellion and its suppression.

Although the colonial period witnessed the abolition of slavery in most parts of Africa, enslavement was quickly replaced by forced labour. The abolition of slavery in the Cape Province (1807) was followed by the arrest of all Hottentots found travelling without a pass. They were sent to prison until assigned to an employer (Iliffe, 1987). Compulsory labour in the early colonial period ceased in most colonies during the 1920's¹⁶.

Thibon (2002), writing on the case of Burundi, emphasizes the vulnerability of an economy made unstable by colonial development, which the least climatic or other shock dramatically accentuated. He refers to the local famines of the 1920's as being “classic” colonial famines, climatic and epidemiological upsets in peripheral regions accentuating the economic disequilibria that followed colonial development.

The undermining of native strategies for coping with ecological and pestilential trauma by the colonial state receives considerable attention in the literature. Phoofolo (2003) argues that a combination of Cape colonial rule and integration into a wider capitalist economy had gradually weakened pre-colonial ideological and institutional strategies designed for managing resources in times of crises in Lesotho. This weakening of native institutions

¹⁵ Forced labour was imposed in Uganda between 1909 and 1922.

¹⁶ One exception is Mozambique, where the shibalo system of conscription at very low wages lasted for another 40 years (Iliffe, 1987).

added to the commercial and productive insecurity and disruption caused by the South African war (1899-1902). The difficult situation created could not be alleviated through colonial relief schemes, as these did not match the demand and excluded able-bodied (this exclusion was due to the belief that relief for the able-bodied members of African communities only encouraged indolence). Taxes also contributed to the difficulties: in the peak of the humanitarian crisis (1898), the colonial revenue, mostly comprising a hut-tax, exceeded that of any previous year. The tax was doubled in the middle of the crisis (Phoofolo, 2003).

Sometimes well-intentioned colonial policies had unforeseen consequences that damaged the colonial economy. Dias (1981) supports the view that the gradual substitution of overseas slave trade by commerce in raw materials and cash crops led to far-reaching changes in European and African structures in Angola, thus worsening famine and epidemic crises in the end of the 19th century. These developments caused commercial instability and depopulation, which contributed to the difficulties experienced by the Portuguese in developing viable economic alternatives to the overseas slave trade before the 20th century. This causality worked through different channels, one of them being the replacement of subsistence crops with cash crops. African populations that previously produced large surpluses of manioc, beans, and maize switched to peanuts and coffee production for export, thus relying on food supplies from coastal towns¹⁷. It is precisely these regions that suffered increasingly from crises during the latter half of the 19th century.

Diseases spread quickly around Angola due to the increased mobility of native populations in the 19th century. A commercial boom in rubber and coffee from the 1870's onwards led to an expansion of European trade and agriculture and to new pockets of white settlement and farmland in the interior. The resulting fever of gathering and marketing these products among African populations,

¹⁷ African populations found cash crops more remunerative than production of food supplies for the growing population of Luanda (Dias, 1981).

combined with increased threat from starvation (more export economy and less subsistence) is responsible for the high mobility of populations to work in plantations or colonial enterprises (railway construction in Angola from the 1880's).

The European commercial expansion, which started in Angola in the 1830's, not only helped spread disease and reduced the cultivation of subsistence crops but also caused land alienation. The struggle for land between Portuguese and Boer settlers on one hand, and African populations on the other, resulted in the latter being driven off from much of the best land by the mid-1880's. The redistribution of land from African to European settlers and smallholdings to large-scale plantations in the 1870's and 1880's was aided by bankruptcies of small African producers and flight from disease and famine (Dias, 1981). European presence also contributed to increased alcohol consumption everywhere in Angola. This sad development coincided with a decline in meat consumption due to rinderpest and enforced colonial laws against hunting (after 1910).

Struggle for land and ill-conceived policies were equally important in 19th century Lesotho. Eldredge (1987) argues that the growth in the economies of both BaSotho and European societies produced an ongoing competition for land, and overt conflicts were occasionally stimulated by droughts. In this case, it is the landlessness for many Boers that increased the impetus for Boers competition for BaSotho land. The BaSotho had increasingly less resistance to famines during the 19th century as war deprived them of arable land, cattle and crops. This situation was further aggravated by the disappearance of wild game and increased commercialisation of their agriculture and the consequent dependency on a volatile market. The overall result was chronic hunger later in the century. Eldredge (1987) is very critical of early colonial policies: The early colonial administration is reported to have made no attempt either to alleviate famine through food distribution or to control epidemic disease through

quarantine and the improvement of sanitation. She concludes that the colonial system drained the economy of whatever surpluses were generated and made economic diversification impossible. At the end of the 19th century it became the explicit policy of white governments in South Africa systematically to deprive African populations of the resources for self-support, so as to mobilize labour for their industry¹⁸.

Giblin (1986) admits that that North-eastern Tanzania was in this period characterized by low rainfall and frequent locust plagues. However, he adds that these misfortunes do not appear to have possessed the unparalleled degree of severity, length, or geographical scope, which might qualify them to be considered as the sole causes of the disasters in this period. Again, the expansion of export commerce is pointed out as one of the main culprits: more trade caravans and increased population in coastal towns led to increased demand for food, thereby enhancing the opportunities for the profitable sale of foodstuffs. From the mid-1870's on, chieftains started to sell food stocks for imported goods, thus eroding subsistence security and causing serious food shortages. The most affected were individuals who previously dependent on patronage in times of crises. They had to rely on self-sale or the sale of dependents.

German conquest destroyed the pre-colonial order. The German suppression of slave raiding, trading, and holding had the side effect of contributing to the loss of political authority and wealth by the chieftains. Local chiefs were, thus, incapable of maintaining redistributive relationships during the famine of 1894-6 while imports of food had now to be provided by the local government or private merchants and operated through markets. It is the collapse of patronage that caused the famine of 1894-6 to be worse than the predecessor (the famine of 1884-5), causing widespread emigration and starvation. The aftermaths of food crises in colonial era involved indebtedness (with rapid repayments), and

¹⁸ Migrations supplying mines and farms in the Cape Colony, Orange Free State, and Transvaal was no longer an option but a necessity. When agricultural production failed, earned wages constituted often the only source of income (Eldredge, 1987).

crop sales, where previously with patronage no immediate payment was demanded. Chieftains delayed repayment demands until the next harvest and often accepted work for debt cancellation. This degenerative cycle was further exacerbated by colonial obligations of taxation and compulsory cultivation (Giblin, 1986).

Positive impacts of European colonization

European reports from the 1950's emphasize the cessation of tribal wars following European conquest as instrumental for population increase in Africa, though it is important to note that most of these had not heavy casualties as the chief objective of the tribal wars was plunder of cattle or grain¹⁹. More recently, Iliffe (1987) explains faster population growth from the 1920's on with more efficient transport and government, wider markets, improved medicine, and better opportunities to earn wages. Perhaps, this enumeration should also include the introduction of new crops, livestock, and farming techniques. Writing on Uganda, Vincent (1982) refers to the introduction of peanuts and sweet potatoes in the 1890's, as well as the construction of railways to the East African coast (replacing caravans and the waterways on the Nile). She also noted the importance of the development of small towns in the early 20th century Uganda. They were an intrinsic component of the official policy and had the aims of inculcating "law and order", participating in the development of agriculture, marketing cotton, and creating a home market.

European administration in Southern Rhodesia was more deep-rooted than in Uganda. Here, famine mortality was controlled through railway transport, wider markets, mobile labour markets, increase in wealth, improved medical conditions, and especially more efficient government (Iliffe, 1990). The author notes that while many people died in early colonial famines, famine mortality declined rapidly during the early 20th century and ceased almost completely

¹⁹ See for example **Hailey** (1957).

after 1922. The famine of 1922 convinced the Southern Rhodesian authorities for the first time to turn their minds from the relief of famine to its prevention. African populations were now required to cultivate drought-resistant crops, especially cassava, already widely grown in neighbouring Mozambique but not in Southern Rhodesia.

At this point it is important to note that although famine mortality disappeared from Zimbabwe in the colonial period non-fatal scarcity remained as common as before. Iliffe (1987) argues that famines were replaced by growing endemic poverty: now few die but poor are condemned to indigence even in good years (a pattern that resembles that of late 18th century Europe). These developments were particularly felt in areas of European settlement where mortality rates decreased but malnutrition was endemic.

To a certain extent, Southern Africa anticipated (about one generation in advance) the demographic dynamics and patterns of famine of the rest of the continent. Whereas deaths from famine were common in tropical Africa until the 1920's, they were rare in South Africa after the 1890's. More competent administrations elsewhere in Africa from the 1920's on were increasingly able to prevent or alleviate famines. This worked for example through vaccination (no smallpox epidemics in Mozambique after 1900; cholera absent from much of Africa between 1923 and 1970) or the introduction of motor vehicles (much more effective than human porters).

Thibon's (2002) findings for Burundi seem to confirm this trend: famines on national scale came to an end in 1943-4; crises of inter-tribal or socio-political character have resurged since 1972, and no famines occurred in between. He emphasizes the campaigns aimed at popularising anti-famine plants (from the 1920's on) and the great improvements achieved by the Belgian authorities in public relief policies (from the 1930's). Important was also the decline in end-year (September-December) mortality attained since the 1950's. This was accomplished with modifications to food and cultural regimes, a third growing

season, the growing importance of perennial crops (which has reduced the protein-hungry months January-February).

Often overlooked is the importance of veterinary medicine for explaining increased agricultural productivity in Africa. Nevertheless, veterinary medicine played a crucial role considering the importance of pastoralism for many parts of the continent²⁰. One good example is provided by the impact of the 1896-8 rinderpest in Southern Africa: Phoofolo (2003) observes that while this cattle panzootic killed 95% of the African herds in Southern Africa, in white farms the cattle mortality was much lower (around 35% in the Cape). He attributes the higher infection rate in African farms to the practice of communal pasturing and to less receptivity among African farmers to inoculation (African farmers suspected that colonial officials wanted to kill their cattle to force them to seek work in the labour centres). The surprising exception was Basutoland, very successful in pioneering the implementation of Koch's bile inoculation method (it proved so successful that it was a few years later copied in the Cape). The BaSotho popularly embraced immunisation after initial suspicions had abated. Phoofolo (2003) estimates that probably more than 50% of BaSotho's cattle survived (including around 70% of the inoculated animals). Further famine prevention strategies adopted by the BaSotho included the cultivation of maize and sorghum (more resistant to drought and locusts), emigration (in spite of colonial restrictions on movement), and labour tenancy and sharecropping in Boer farms in the Free State.

At the same time, similar developments took place in Angola. Whenever land was taken over for plantation Africans were allowed to continue farming part of the land in a system of sharecropping or labour services, although they were normally excluded from the most fertile patches of land (Dias, 1981). Inoculation was first introduced in Angola in 1803 and became increasingly

²⁰ Iliffe (1987) notes that the importance of pastoralism in breeding poor people was a distinctive feature of poverty in Africa when compared with many other regions. This occurred because, unlike land, livestock was a scarce resource in pre-colonial Africa.

successful from the 1820's. Contrary to the temperate parts of Southern Africa, the tropical parts of Angola still suffered from the devastating consequences of sleeping sickness. The causes of Trypanosomiasis were finally found in 1904 and corrective measures became effective from the 1920's on. By 1930, sleeping sickness and smallpox had been brought under control, though tuberculosis remained widespread and malaria remained acute in form and incidence until 1944.

Marked improvements were also felt in Tanzania. According to Giblin (1986), the cycle of severe recursive famines in Tanzania's Handeni District was broken by increased food imports after World War II.

Ballard (1986) puts more emphasis on the importance of order and stability. He argues that it was precisely the order and stability imposed by Shaka's government that allowed the Zulu to cultivate their crops of maize, sorghum, and vegetables with regularity (following two decades of social, political, and economic breakdown). The chaos, killing, and misery that then characterized the Nguni society (Natal/Zululand) came in Natal to an abrupt end with British penetration in the region. Within a decade of white settlement in Natal, a minor agricultural miracle had taken place among a large section of the Nguni refugee population. Starving and drought-stricken people had obtained a modicum of security under the protection of white farmers and had, once again, taken up agriculture as their main occupation (Ballard, 1986). By 1835 Natal was exporting corn to Mauritius.

5. CONCLUSION

In this chapter we saw that ecological factors deeply affected pre-colonial patterns of human settlement in SSA. Human populations grew relatively large in the presence of lakes, highlands, or when situated in the wet, coastal regions of Western Africa. This does not necessarily mean that these regions were the only ones able to sustain large human populations, but, more likely, were the

regions best suited to the limited set of crops, livestock, and farming techniques at the disposal of early African cultivators. Subsequent developments show that dramatic increases in the agricultural productivity of peripheral, semiarid areas were possible once colonial innovations were on hand. Contrary to earlier European overseas expansions (e.g. the Spanish in Latin America), most European settlers preferred to stay in these peripheral regions, characterized as they were by a relatively temperate climate and low human occupation. Considering their agricultural success, they sometimes revealed perplexity on the minuscule size of native populations there encountered.

Iliffe (1987) reflects well this puzzlement on the small population of Zimbabwe upon the arrival of the British administration in the territory. He advances the hypothesis that it was famine (often accompanied by epidemic disease) that held down population before 1900. The obvious corollary is that it was the ending of famine mortality soon after the European invasion that permitted rapid population growth. However, he fails to find any substantial evidence for significant famine mortality in pre-colonial Zimbabwe. Accordingly, he concludes that famine mortality was probably not responsible for the very low pre-colonial population density in the region (although he admits that colonial innovations explain largely the rapid population growth in the 20th century).

The findings of this chapter might provide the answer for his question: human population in Zimbabwe were so small because the ecological factors were less favourable than he believed them to be (especially for African farmers). Total annual rainfall is low for African standards (700mm versus African average of 1041mm) and its distribution is particularly unpredictable (20.2 versus African average of 15.4). Furthermore, Zimbabwe lacks the lakes, the highlands, and (obviously) the wet coastal climate conducive to larger populations. The regression models predict population densities between 1 and 1.5 inhabitants per square kilometre, very close to the actual estimated population density of 0.9 (please refer to table B5). Indeed, there is very little to suggest higher population densities than the ones encountered by the Europeans.

At one point, Iliffe (1987) seems to point in the right direction when he concedes that “in Zimbabwe, as in the Sahel, cultivation without irrigation was possible but never assured”. However, he fails to draw the necessary conclusion and presents the problem of Zimbabwe’s population history as remaining largely unsolved.

Nonetheless, ecological factors might not tell the whole story. A closer look at table B5 raises the suspicion that forces, other than environmental, were at play. The regression models systematically underestimate the high population densities in the Rift Valley and coastal West Africa (particularly notorious for Nigeria). On the other hand, the regression models coincide in overestimating population densities in arid and semiarid Southern Africa (Botswana, Namibia, Zimbabwe, Angola, Zambia). Surprisingly, this systematic overestimation is not repeated for the countries situated in the dry Sahel-belt. The residuals do not appear to be random, suggesting a stochastic component along regional lines. The explanation might be provided by existing literature: Iliffe (1990) asserts that in Rwanda, the densely peopled, closely governed central regions had long been less liable to famine than the newly settled borderlands. Thibon (2002) also noticed that high population density, on itself, was no reason for famines. He observed that famines occurred mostly in peripheral spaces, depopulated or unsettled by international migrations. Density of population and economic specialization led to an incipient urbanization (particularly noticeable in the Yoruba region in Western Nigeria) and the formation of larger political systems developing beyond the kinship group. The closely governed societies had well-developed economic and social relationships which granted insurance from scarcity (mostly patronage). It is these political organisations, together with exchange relations beyond environmental frontiers, which the peripheral populations of Southern Africa lacked. The result was much lower resistance to prolonged ecological and subsistence crises. One important difference to the arid and semiarid regions in the Sahel-belt is that these had much more long-

range trade with the Mediterranean and the fertile plains of coastal West Africa. Symptomatically, only for Mauritania, Oubangui-Chari (now the Central African Republic), and Ethiopia are population densities overestimated in the regression models. These territories were for different reasons isolated from trade systems in their region.

Recurrent famines and endemic malnutrition, associated with peripheral regions, does not translate automatically into Malthusian crises, where famines are nature's "ultimate response" to population outstripping food supply. More likely, nature and the limited tools at the disposal of local farmers affected population growth ex-ante. The risk of fast demographic growth outstripping food production was improbable for these regions, as elsewhere in other arid, isolated parts of the world (e.g. Aborigines in Australia). What remain largely unexplained are the proximate causes through which the natural habitat depressed population growth. One hypothesis here advanced is fertility reduction caused by insufficient or inappropriate food supply. Saito (2002) shows that famines were a major factor governing the rate of population growth (more important than epidemics) in Tokugawa Japan (1603-1868). This effect of famines on demography ran through the reduction of fertility. He argues that this effect was especially pronounced simply because the usual level of marital fertility was only moderate in Japan. Indeed, it was the elimination of famines after the 1840's that laid the basis for sustained population growth in Japan. Dyson and Ó Gráda (2002) add that in historical conditions moderate, rather than high fertility seems often to have been the norm and populations grew slowly, if at all. They argue that fertility reduction is probably an even more common feature of famines than is mortality increase. These conclusions help explain why Iliffe (1990) found plenty of evidence for non-fatal scarcity but little or no indication for the big "famines that kill" in pre-colonial Zimbabwe. Its population was simply too thin and dispersed to allow for a large Malthusian-type of cataclysm. Such extreme catastrophes could be possible in the densely

populated regions of the Great Lakes, and Thibon (2002), writing on the succeeding crises of late 19th century Burundi, advances that “agriculture, having supported exceptional demographic growth, no longer offered much margin for further growth.

Colonial innovations unarguably lifted population growth everywhere in SSA, regardless of climate zone. Eventual depopulation in Equatorial Africa during the early colonial period, and its extent, will probably remain an inscrutability considering the scarcity of sources for this period. McEvedy and Jones (1978) do not take account of any population decline in their estimates. On the other hand, where partial population counts exist (Uganda, Angola), the loss of population until the 1920's is notorious. Unfortunately, these samples are too small to allow for a convincing extrapolation into the wider Equatorial African environment. In the second half of the colonization period, the positive impacts of European presence gradually started to outweigh the negative consequences of colonization on African demography. Iliffe (1987) explained these events with more efficient transport and government, wider markets, improved medicine, and better opportunities to earn wages. More efficient governments were increasingly able to impose order and stability, thereby creating incentives for bigger agricultural output. They effectively monopolized violence within the colonial administration. Iliffe (1987) makes the point that everywhere in Africa, and perhaps also in early medieval Europe, insecurity was more important than land pressure as a cause of poverty. African poor were thus bred by “natural disasters or the recurrent physical insecurity of a turbulent and violent society”. Repeated depredations by (often private) armies discouraged agriculture or the accumulation of famine reserves while inducing the African poor to join these armies. Very often they ended up stealing instead of producing due to expected higher gains. Other economic incentives contributed to constantly expanding output in this period. According to Childe (1952), simple agricultural productive systems are transcended when cultivators are

“persuaded or compelled to wring from the soil a surplus above their own domestic requirements”. Vincent (1982) provides the corollary: trade entails incentives for higher agricultural productivity. Prior to the introduction of motor vehicles and railway transport, long-range communication had been mostly confined to adjacent areas of waterways (the well-established caravan system across the Sahara being the outstanding exception). Thus, the network of lakes in the Great Lakes region helps explain its unusually high agricultural productivity and population density.

The asymmetric importance that different colonial innovation had across SSA has, so far, received insufficient attention. Introduction of modern veterinary medicine, and the consequent interruption of a long series of recurring cattle epizootics, must have been crucial for the pastoral people of East Africa. European presence in West Africa was more superficial. Iliffe (1987) suggests that the forest region of West Africa may have experienced continuous demographic increase. If this was the case, it is almost certainly due to less disruptive colonial presence and lower incidence of natural disasters in the region. However, the fastest population growth during the colonial period was recorded for Southern Africa. It seems safe to say that European technology (transport systems, new crops and livestock, etc.) was most suited for the non-tropical parts of Africa. This assumption is well exemplified with the introduction of sheep in Southern Africa. Boers quickly moved from cattle herding to sheep herding as wool was more profitable than beef, easier to store and transport than butter, and sheep were more suited to the arid conditions in the Orange Free State (Eldredge, 1987). This increased suitability to the environment, combined with absence of sleeping sickness, explains largely the early and very impressive acceleration of colonial era demographic growth in Southern Africa.

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Appendix A: Data

Table A1 Definitions and Sources of Country Level Variables

Variable	Definition and Source
Log Tdens	Natural logarithm of estimated population density in 1850. See table A4.
Log Densagri	Natural logarithm of estimated population density in 1850 in land by FAO considered suitable for agricultural use. See table A4.
Population of European descent	See table A7 for data construction and sources.
Disease	This variable reflects data on incidence rates for the tropical diseases malaria and yellow fever. For all three diseases shown, the numbers correspond to the fraction of the population living in areas with the respective disease in 1950. Source: Vaz Silva (2004).
Log TotRain	Natural logarithm of the average annual rainfall in the period 1900-1998. Rainfall data from Barrios et al. (2003).
VarRain	Standard deviation as a percentage of average annual rainfall in the period 1900-1998. Rainfall data from Barrios et al. (2003).
Climatic Zones	The estimates correspond to the fraction of land area that is situated within a particular type of the Koeppen-Geiger climate zones. Source: Center for International Earth Science Information Network (CIESIN), Columbia University (2002).
Biome Classes	The estimates correspond to the fraction of land area that is situated within a particular biome class. Source: Center for International Earth Science Information Network (CIESIN), Columbia University (2002).

Appendix A: Data

Table A2 Descriptive Statistics

Variable	Observations	Mean	Std Deviation	Median	Minimum	Maximum
Tdens	41	5.7	8.71	2.9	0.19	42.47
Densagri	36	14.9	14.88	11.2	0.42	71.76
Disease	41	0.79	0.29	0.98	0	1.06
TotRain	41	1041	614	1010	102	2654
VarRain	41	15.43	6.47	13.6	5.7	36.7
CZ1 Water (W).	41	3.15	6.58	0.28	0	32.1
CZ7 Dry, highland (H).	41	3.73	12.83	0	0	63.17
CZ9 Temperate, marine west coast - mild with no dry season, warm summer (Cfb).	41	5.01	20	0	0	99.38
CZ13 Temperate, Mediterranean - with dry warm summer (Csb).	41	0.08	0.49	0	0	3.11
CZ18 Temperate, humid subtropical - mild with dry winter, hot summer (Cwa).	41	6.58	20.53	0	0	94.51
CZ19 Dry, subtropical steppe (BSh).	41	19.97	26.12	8.96	0	96.47
CZ20 Dry, subtropical desert (BWh).	41	13.4	26.02	0	0	84.14
CZ21 Tropical savanna (Aw).	41	37.84	34.38	36.83	0	96.63
CZ22 Tropical, monsoonal (Am).	41	9.2	20.34	0	0	78.42
CZ23 Tropical wet (Af).	41	0.34	1.61	0	0	9.47
CZ24 Temperate, humid subtropical - mild with dry winter, warm summer (Cwb).	41	0.72	3.33	0	0	18.77
BC1 Tropical & subtropical moist broadleaf forests.	41	19.79	27.97	9.82	0	98.47
BC2 Tropical & subtropical dry broadleaf forests.	41	0.12	0.72	0	0	4.61
BC7 Tropical & subtropical grasslands, savannas & shrublands.	41	57.81	29.58	61.18	0	100
BC9 Flooded grasslands & savannas.	41	1.09	2.46	0	0	10.8
BC10 Montane grasslands & shrublands.	41	5.5	17.38	0	0	100
BC12 Mediterranean forests, woodlands & scrub.	41	0.19	1.22	0	0	7.83
BC13 Deserts & xeric shrublands.	41	12.91	24.14	0	0	100
BC14 Mangroves.	41	1.43	4.48	0	0	26.41
BC98 Lake.	41	1.15	3.56	0	0	18.16

Appendix A: Data
Table A3 Population Estimates for Sub-Saharan Africa

Country	Total Population							Revisions
	1850	1900	1925	1950	1900/1850	1925/1900	1950/1925	
Equatorial Guinea	0.11	0.13	0.16	0.2	1.18	1.23	1.25	1950: from 0.19 to 0.2
South Africa	1.88	4.82	7.54	12.38	2.56	1.56	1.64	1900: from 5.16 to 4.82; 1925: from 7.51 to 7.54; 1950: from 12.4 to 12.38
Botswana	0.11	0.12	0.18	0.31	1.09	1.50	1.72	
Gabon	0.17	0.21	0.26	0.31	1.24	1.24	1.19	
Namibia	0.19	0.2	0.25	0.41	1.05	1.25	1.64	1950: from 0.4 to 0.41
Swaziland	0.03	0.08	0.12	0.2	2.67	1.5	1.67	
Lesotho	0.09	0.25	0.37	0.61	2.78	1.48	1.65	
Zimbabwe	0.37	0.5	1.1	2.1	1.35	2.20	1.91	1925: from 1.3 to 1.1; 1950: from 2.5 to 2.1
Angola	2.4	3	3.5	4.15	1.25	1.17	1.19	1950: from 4.1 to 4.15
Ghana	1.56	1.93	2.84	4.65	1.24	1.47	1.64	1925: from 2.5 to 2.84; 1950: from 4.5 to 4.65
Cameroon	2.17	2.64	3.33	3.98	1.22	1.26	1.20	
Guinea	1.25	1.54	2	2.2	1.23	1.30	1.1	
Djibouti	0.05	0.05	0.06	0.08	1.00	1.2	1.33	
Sudan	5.4	6	7	9	1.11	1.17	1.29	
Gambia	0.12	0.15	0.19	0.29	1.25	1.27	1.5	1925: from 0.2 to 0.19; 1950: from 0.3 to 0.29
Mauritania	0.53	0.6	0.65	0.85	1.13	1.08	1.31	
Togo	0.5	0.62	0.8	1	1.24	1.29	1.25	
Senegal	1	1.23	1.6	2	1.23	1.30	1.25	
Côte d'Ivoire	1.25	1.54	2	3	1.23	1.30	1.5	
Uganda	2.75	3	3.5	5.1	1.09	1.17	1.46	1950: from 5 to 5.1
Rwanda	1.08	1.28	1.53	2.04	1.19	1.20	1.33	
Chad	1.48	1.68	1.82	2.38	1.14	1.08	1.31	
Burkina Faso	1.56	1.93	2.5	3.1	1.24	1.30	1.24	
Mozambique	2.25	3	3.75	5.73	1.33	1.25	1.53	1950: from 5.75 to 5.73
Benin	0.63	0.77	1	1.5	1.22	1.3	1.5	
Central African Republic	0.51	0.62	0.79	0.94	1.22	1.27	1.19	
Nigeria	12.17	15.02	19.5	29.57	1.23	1.3	1.52	1950: from 30 to 29.57
Kenya	3	3.5	4.25	5.61	1.17	1.21	1.32	1950: from 5.75 to 5.61
Mali	1.96	2.22	2.41	3.15	1.13	1.09	1.31	
Congo	0.31	0.38	0.48	0.57	1.23	1.26	1.19	
Zambia	0.62	0.75	1.3	1.82	1.21	1.73	1.40	1950: from 2 to 1.82
Niger	1.59	1.79	1.95	2.57	1.13	1.09	1.32	
Guinea-Bissau	0.25	0.31	0.4	0.51	1.24	1.29	1.28	1950: from 0.5 to 0.51
Dem. Rep. Congo	6.36	8	9	11.43	1.26	1.13	1.27	1950: from 12 to 11.43
Burundi	1.05	1.22	1.47	1.96	1.16	1.20	1.33	
Tanzania	3.5	4	5	7.9	1.14	1.25	1.58	1950: from 8 to 7.9
Malawi	0.62	0.75	1.4	2.25	1.21	1.87	1.61	
Sierra Leone	1.07	1.31	1.7	1.95	1.22	1.3	1.15	1950: from 1.9 to 1.95
Eritrea and Ethiopia	3.7	5	8	12	1.35	1.6	1.5	
Liberia	0.44	0.54	0.7	1	1.23	1.3	1.43	
Somalia	0.92	0.95	1.34	1.92	1.03	1.41	1.43	
Average					1.3	1.33	1.4	
Median					1.22	1.27	1.33	

Notes: Population estimates shown in million. Surface in thousand square kilometres. Most data from McEvedy and Jones (1978), except when census data or official estimates led to revision as shown in last column. When McEvedy and Jones present only regional estimates, data for individual countries is obtained using 1925 or 1950 specific weight of this country within the region.

Appendix A: Data
Table A4 Estimates on population densities and rainfall in Africa

Country	Total Surface (1)	Agricultural Area (2)	Population in 1850 (3)	(3)/(1) (4)	(3)/(2) (5)	Total Rain (6)	Variation Rain (7)
Equatorial Guinea	28380	3340	0.11	3.9	32.9	2207	13.6
South Africa	1233687	955500	1.88	1.5	2.0	491	14.9
Botswana	580951	260020	0.11	0.2	0.4	410	23.3
Gabon	269503	51350	0.17	0.6	3.3	1842	13.8
Namibia	831623	386530	0.19	0.2	0.5	276	29.2
Swaziland	17433		0.03	1.7		783	25.7
Lesotho	30589		0.09	2.9		835	17.5
Zimbabwe	392433	196150	0.37	0.9	1.9	700	20.2
Angola	1259772	574000	2.4	1.9	4.2	963	15.1
Ghana	242075	117000	1.56	6.4	13.3	1189	12.1
Cameroon	470600	81600	2.17	4.6	26.6	1635	6.9
Guinea	248007	118150	1.25	5.0	10.6	1753	10.8
Djibouti	22833		0.05	2.2		243	36.7
Sudan	2520822	1100480	5.4	2.1	4.9	434	11.9
Gambia	11613	5430	0.12	10.3	22.1	934	23.2
Mauritania	1048340	394800	0.53	0.5	1.3	102	23.9
Togo	57515	28800	0.5	8.7	17.4	1166	12.1
Senegal	199961	80500	1	5.0	12.4	764	19.2
Côte d'Ivoire	325319	164400	1.25	3.8	7.6	1388	13.0
Uganda	243275	69800	2.75	11.3	39.4	1164	10.2
Rwanda	25432	15050	1.08	42.5	71.8	1157	14.2
Chad	1277230	479100	1.48	1.2	3.1	337	15.5
Burkina Faso	276452	83730	1.56	5.6	18.6	789	11.8
Mozambique	801880	470800	2.25	2.8	4.8	1010	12.6
Benin	116507	18270	0.63	5.4	34.5	1057	11.6
Central African Republic	624277	48600	0.51	0.8	10.5	1346	8.2
Nigeria	910200	699000	12.17	13.4	17.4	1187	8.2
Kenya	588777	252600	3	5.1	11.9	656	18.9
Mali	1257380	317500	1.96	1.6	6.2	310	14.8
Congo	344524	101540	0.31	0.9	3.1	1635	10.4
Zambia	755718	349850	0.62	0.8	1.8	992	10.6
Niger	1197560	125140	1.59	1.3	12.7	164	22.2
Guinea-Bissau	38685	13600	0.25	6.5	18.4	1713	16.8
Dem. Rep. Congo	2343440	224000	6.36	2.7	28.4	1503	5.7
Burundi	27170		1.05	38.6		1153	12.5
Tanzania	944409	380500	3.5	3.7	9.2	1029	12.2
Malawi	127838	32000	0.62	4.8	19.4	1122	14.3
Sierra Leone	75074	26640	1.07	14.3	40.2	2654	9.2
Eritrea and Ethiopia	1263245	594800	3.7	2.9	6.2	835	11.2
Liberia	98414	25710	0.44	4.5	17.1	2489	13.0
Somalia	646790		0.92	1.4		252	25.3
Average				5.7	14.9	1041	15.4
Median				2.9	11.2	1010	13.6

Notes: Population estimates shown in million. Surface in thousand square kilometres.

Appendix B: OLS regression results

Table B1 Rainfall and disease ecology variables

	(1)	(2)	(3)	(4)
Dependent variable is:				
	Log total population density		Log densagri	
Disease	1.47**		2.73*	
	(0.65)		(0.78)	
Log total rainfall	0.44**	0.71*	0.03	0.63**
	(0.21)	(0.2)	(0.32)	(0.3)
Variation in rainfall	-0.006	-0.02	-0.05	-0.06
	(0.03)	(0.03)	(0.04)	(0.05)
R-squared	0.34	0.26	0.55	0.36
Number of observations	41	41	36	36

Note: heteroskedastic-consistent standard errors are in parentheses. Significance at the 1%, 5%, and 10% levels are denoted respectively by "**", "** **", and "** ** **".

Appendix B: OLS regression results

Table B2 Climate zone variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable is Log total population density									
Panel A									
cz1	37	0.1	0.07**	0.06**	0.04	0.04	0.05***	0.04***	
	(27.18)	(0.11)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	
cz7	37.02	0.12	0.08*	0.07*	0.05*	0.05*	0.05*	0.05*	0.04*
	(27.18)	(0.12)	(0.03)	(0.02)	(0.01)	(0.007)	(0.007)	(0.006)	(0.007)
cz9	36.98	0.08	0.04	0.03	0.008	0.009**	0.009**	0.008**	0.006
	(27.18)	(0.12)	(0.03)	(0.02)	(0.009)	(0.004)	(0.004)	(0.004)	(0.004)
cz13	36.93	0.15	0.15						
	(27.1)	(0.16)	(0.14)						
cz18	36.97	0.07	0.04	0.03	0.004	0.005	0.005		
	(27.18)	(0.12)	(0.03)	(0.02)	(0.01)	(0.009)	(0.009)		
cz19	36.97	0.07	0.03	0.02					
	(27.18)	(0.12)	(0.03)	(0.02)					
cz20	36.97	0.07	0.03	0.02	-0.002				
	(27.18)	(0.12)	(0.03)	(0.02)	(0.01)				
cz21	36.98	0.09	0.05***	0.04**	0.02***	0.02*	0.02*	0.02*	0.02*
	(27.18)	(0.12)	(0.03)	(0.02)	(0.009)	(0.005)	(0.005)	(0.004)	(0.005)
cz22	36.97	0.07	0.04	0.02	0.002	0.003			
	(27.18)	(0.12)	(0.03)	(0.02)	(0.01)	(0.01)			
cz23	36.86								
	(27.16)								
cz24	36.95	0.05							
	(27.18)	(0.12)							
F-test for excluded variables		1.67	0.18	0.17	0.23	0.06	0.16	0.4	3.78
R-squared	0.54	0.52	0.52	0.51	0.51	0.51	0.51	0.5	0.45
Number of observations	41	41	41	41	41	41	41	41	41

Note: heteroskedastic-consistent standard errors are in parentheses. Significance at the 1%, 5%, and 10% levels are denoted respectively by "**", "** **", and "** ** **".

Appendix B: OLS regression results

Table B3 **Biome class variables**

	(1)	(2)	(3)	(4)	(5)
Panel A	Dependent variable is Log total population density				
bc1	36.3 (26.43)	0.17 (0.1)	0.13* (0.04)	0.11* (0.04)	0.02 (0.01)
bc2	36.24 (26.43)	0.19 (0.36)			
bc7	36.3 (26.43)	0.17*** (0.1)	0.13* (0.05)	0.11* (0.04)	0.02 (0.01)
bc9	36.13 (26.44)				
bc10	36.29 (26.43)	0.16 (0.1)	0.13* (0.04)	0.11* (0.04)	0.02 (0.01)
bc12	36.31 (26.44)	0.19*** (0.1)	0.16** (0.07)		
bc13	36.28 (26.43)	0.15 (0.1)	0.11** (0.05)	0.09** (0.04)	
bc14	36.33 (26.43)	0.21*** (0.11)	0.17* (0.06)	0.15* (0.06)	0.07 (0.04)
bc98	36.39 (26.44)	0.25** (0.12)	0.21* (0.06)	0.19* (0.06)	0.09 (0.05)
F-test for excluded variables		1.28	0.28	1.15	3
R-squared	0.45	0.42	0.42	0.4	0.35
Number of observations	41	41	41	41	41

Note: heteroskedastic-consistent standard errors are in parentheses. Significance at the 1%, 5%, and 10% levels are denoted respectively by ***, **, and *.

Appendix B: OLS regression results

Table B4 All significant predictors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Dependent variable is Log total population density							
Log total rainfall	0.16 (0.71)	0.15 (0.39)	0.18 (0.32)	0.2 (0.32)	0.32 (0.26)	0.29 (0.24)		
Variation in rainfall	-0.02 (0.05)	-0.02 (0.05)	-0.02 (0.05)	-0.02 (0.05)				
cz1	0.06 (0.06)	0.06 (0.06)	0.05 (0.04)	0.05 (0.04)	0.04 (0.03)	0.04 (0.02)	0.05*** (0.02)	
cz7	0.05* (0.01)	0.05* (0.01)	0.05* (0.01)	0.05* (0.01)	0.04* (0.01)	0.04* (0.01)	0.05* (0.01)	0.04* (0.01)
cz9	0.02 (0.02)	0.02 (0.02)	0.01 (0.02)	0.01 (0.01)	0.01 (0.01)	0.01 (0.004)	0.01** (0.004)	0.01*** (0.004)
cz21	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01** (0.005)	0.02* (0.004)	0.02* (0.005)
bc1	-0.001 (0.02)							
bc7	0.01 (0.02)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)			
bc10	-0.01 (0.03)	-0.01 (0.02)	-0.01 (0.02)					
bc14	-0.02 (0.1)	-0.02 (0.1)						
bc98	0.07** (0.03)	0.07* (0.02)	0.07* (0.02)	0.06* (0.02)	0.06* (0.02)	0.06* (0.02)	0.07* (0.02)	0.06* (0.02)
F-test for excluded variables		0.001	0.05	0.07	0.27	1.56	1.3	5.14
R-squared	0.58	0.58	0.58	0.58	0.58	0.56	0.54	0.48
Adjusted R-squared	0.43	0.45	0.46	0.48	0.49	0.48	0.48	0.42
Number of observations	41	41	41	41	41	41	41	41

Note: heteroskedastic-consistent standard errors are in parentheses. Significance at the 1%, 5%, and 10% levels are denoted respectively by "***", "**", and "*".

Appendix B: OLS regression results**Table B5 Fitted values versus actual observations**

Country	Total Population Density in 1850	Predicted in inclusive model	Predicted in restricted model
Equatorial Guinea	3.9	3.6	2.9
South Africa	1.5	1.2	1.4
Botswana	0.2	1.0	1.0
Gabon	0.6	2.4	2.8
Namibia	0.2	0.9	1.3
Swaziland	1.7	2.6	2.2
Lesotho	2.9	2.3	2.6
Zimbabwe	0.9	1.5	1.0
Angola	1.9	3.0	2.6
Ghana	6.4	3.4	3.8
Cameroon	4.6	3.4	3.4
Guinea	5.0	4.8	4.3
Djibouti	2.2	0.5	1.2
Sudan	2.1	1.6	1.5
Gambia	10.3	5.9	7.2
Mauritania	0.5	0.7	1.1
Togo	8.7	3.8	3.5
Senegal	5.0	3.2	2.4
Côte d'Ivoire	3.8	3.6	4.7
Uganda	11.3	13.3	14.7
Rwanda	42.5	34.3	33.1
Chad	1.2	1.3	1.3
Burkina Faso	5.6	2.0	1.2
Mozambique	2.8	3.3	3.3
Benin	5.4	3.2	2.3
Central African Republic	0.8	4.9	4.4
Nigeria	13.4	3.8	3.2
Kenya	5.1	2.6	3.0
Mali	1.6	1.1	1.1
Congo	0.9	2.1	2.2
Zambia	0.8	1.9	1.1
Niger	1.3	0.8	1.0
Guinea-Bissau	6.5	13.5	13.0
Dem. Rep. Congo	2.7	3.0	2.7
Burundi	38.6	31.7	29.5
Tanzania	3.7	5.2	5.8
Malawi	4.8	4.6	4.1
Sierra Leone	14.3	3.5	2.9
Eritrea and Ethiopia	2.9	6.3	6.7
Liberia	4.5	2.6	2.9
Somalia	1.4	1.1	1.1
Equation		(1) in table B4	(7) in table B4
Average	5.7	4.8	4.7
Median	2.9	3.0	2.8