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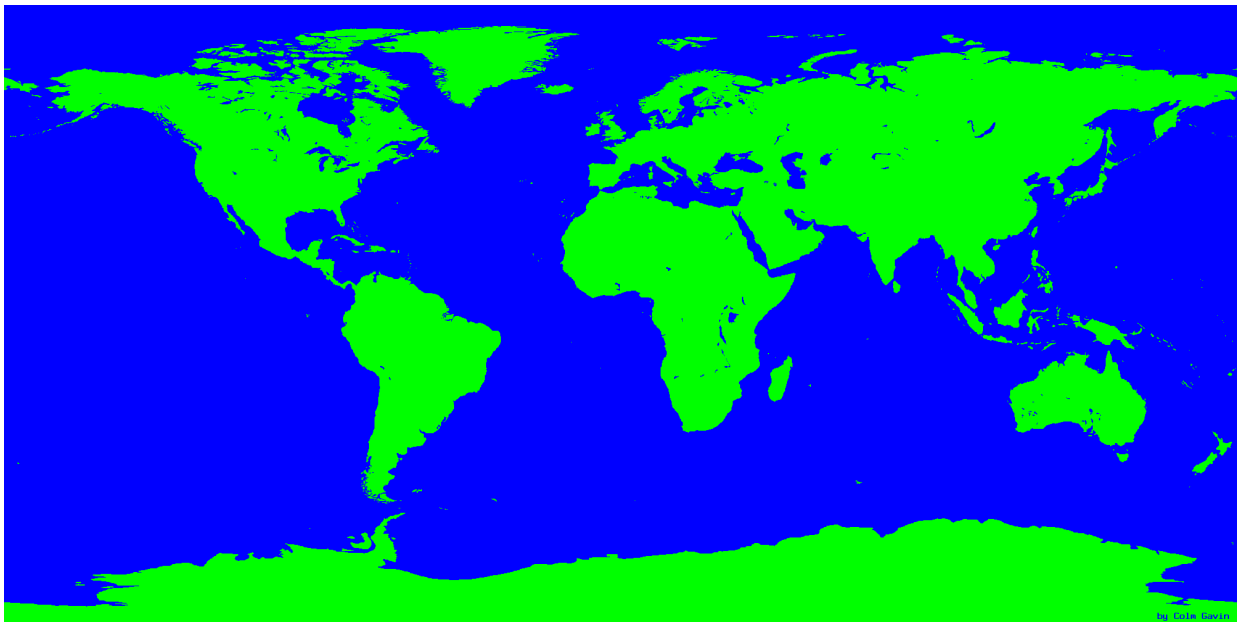
2.1. AFRICA, THE SECOND LARGEST CONTINENT OF THE WORLD



2.2. GENERAL VIEW TO THE PAST AND THE TRENDS IN AFRICA AND, SPECIFICALLY, SUB-SAHARAN AFRICA AGRICULTURE [B.1.]

In a recent article, in *The Daily Yomiuri* Tokyo, Friday 16 October 1998, by Prof. Amani, H.K.R., University of Dar es Salaam, wrote:

"Africa remains one of the least developed regions of the world. This is largely an outcome of a neglected agricultural sector. To understand the challenges of agricultural development in Africa in the 21st Century one must have a deep understanding of the past.

In Africa, the agricultural sector accounts for about 30 to 60 percent of GDP and provides employment to the range of 70 to 80 percent of Africa's labor force. In most African countries, smallholder and subsistence farmers account for about 50 percent of total agricultural output.

With the exception of the few oil exporters and South Africa, the agricultural sector in most African countries play four key roles in overall economic development and political stability.

The first role is to increase domestic food supplies in order to keep pace with the fast growing population. Africa's current average rate of population growth is close to 3 percent per year, the highest in the world. In the last twenty years or so average rate of food production growth was about 50 per cent of the 3 percent rate of population growth. The gap has been filled by commercial food imports and food aid.

The second role is to provide a growing market for domestic manufacturers in order to support import - substitution growth. The essence of import-substitution policy was to make domestic manufacturing profitable. A combination of exchange rate policy and tariff protection, to mention just the main instruments, has been used to effect import substitutions policies. However, these policies had adverse effects on the agricultural sector in two respects. The overvalued exchange rate penalized exporters of farm products while artificially higher prices of domestic manufacturers turned the domestic terms of trade against farmers and consequently reduced incentives for agricultural production.

The third role, namely, to provide foreign exchange through agricultural exports conflicted with the second role. Export duties and taxation of agricultural output have also negatively affected agricultural exports.

Apart from these domestic constraints, agricultural exports have also been limited by world demand for primary exports. This demand is now rising too slowly and at times unstable to provide an adequate rate of increase in foreign exchange available to Africa.

The forth-key role of agriculture is to contribute to domestic saving and capital accumulation.

Agricultural performance in Africa has been very disappointing during the last thirty years. It is important to examine why this has been the case.

First, high population growth rate has led to a rise in the man/land ratio. In a system of smallholder farming with low technology, the result has been large inputs of labor per unit of land and a decline in labor productivity. This trend is likely to continue well into the 21st century.

Second, African governments have generally neglected agriculture and food production in particular since independence in the early 1960's. The majority of African countries devoted less than 10 per cent of their public expenditures for all sectors to agriculture. At the same time most African governments taxed heavily the agricultural sector.

Third, massive climatic changes and soil erosion are taking place, causing drought and famine.

Fourth, technology based agriculture has not come to Africa on a significant scale. Productivity in "traditional" agriculture has depended largely on the kinds of inputs and other resources smallholder farmers have been able to gain control of over many years. However, these traditional methods have not been able to increase farm output rapidly enough to match either present population growth rates or increases in demand for agricultural products resulting from more rapid growth in per capita income.

Fifth, poverty and particularly rural poverty as manifested by increasing food insecurity are a major problem in Africa. The poverty situation has been made worse by Structural Adjustment programs that began in early 1980.

Sixth, women play a central role in Africa's agriculture. Most food producers are women. Women support children through subsistence farming and informal sector. But they are a neglected group of farmers. The land tenure system and agricultural credit in many African countries favors men. These and other factors have adversely affected women's' contribution in agricultural productivity.

Seventh, many African countries have invested very little in rural infrastructure which include physical infrastructure (roads, railways, communications, power, irrigation, etc) institutional infrastructure (property rights, agricultural research and extension, agricultural finance, information systems etc) and soft infrastructure (postage, registration of land, cooperative societies, education health, insurance companies, community based organizations etc.) Apart from little investment, African countries have made little attempt to integrate these infrastructures spatially. The list is long but these are the major factors."

Prof. Amani article points out a major challenge in Africa's predicament. With the decline in African agricultural productivity there has been a concomitant increase in external food aid to supply basic nutritional needs. Yet in this time of decline in absolute income and per capita food production there has been a remarkable increase in life expectancy. The increase in life expectancy at birth, which is due to the involvement of the "developing" countries, will be explained in chapter 5.

Development of African agriculture since early colonial days has pursued two objectives. Economic interests led European powers to develop an agricultural economy that maximized their investment and the colonies' earning capacity. The colonies essentially paid for their own administration and financed the industrial development of the colonial powers. **Both factors contributed to the over-emphasis on export agriculture and to the neglect of food production**. With independence this concept of a dualistic agricultural economy has been maintained and expanded. This continued economic dependence on the western industrialized powers has been perpetuated by the former colonies' need for foreign exchange and by their own industrial development.

Even where late colonial ventures were a financial success they left little profit for true African development. Gross domestic product may expand, even considerably sometimes; but that can still not mean development, i.e., in the HDI - Human Development Indicator- sense [B.6.3.].

Food production in Africa has been in steady decline since independence. At the same time, in the middle of the second half of this century, the production of export crops has been increasing exponentially. But also finally the total value of agricultural exports in current US $ fell by an average of 4.6% from 1980 to 1985 and by 1.1% per year from 1986 to 1992. Declining returns from exports have contributed to a rapid worsening of the region's external debt [B.6.8.].

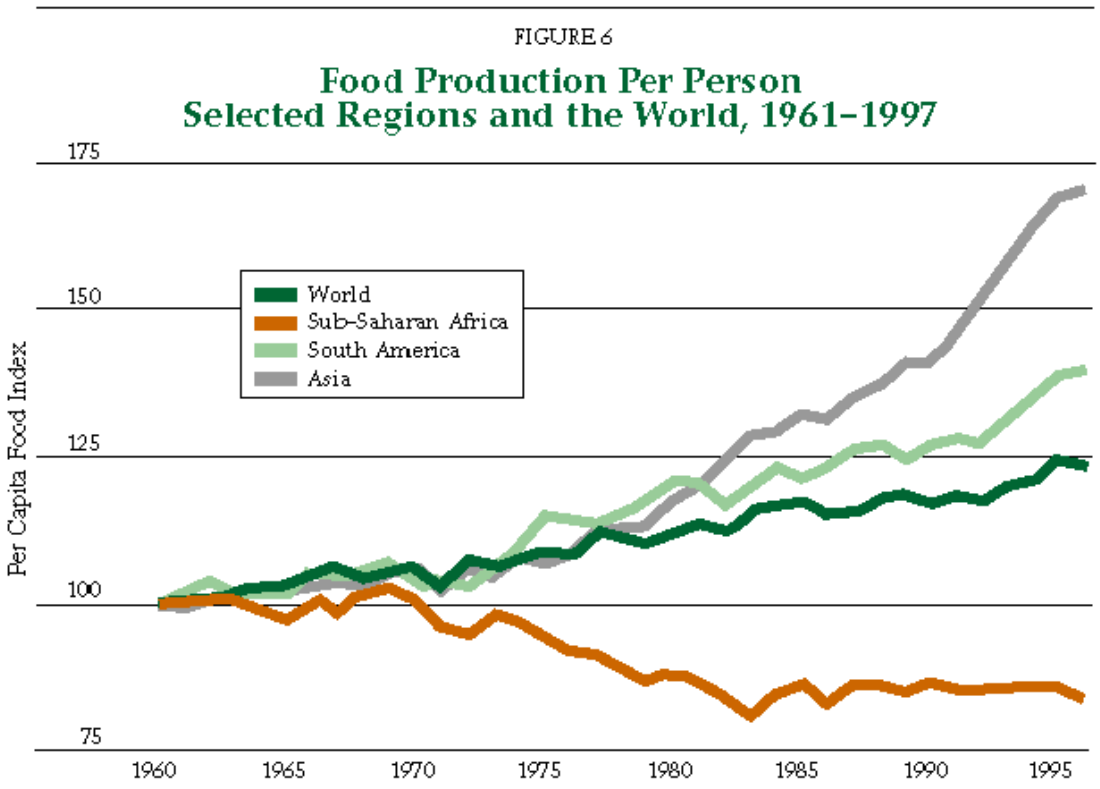
Per capita food production began to decline in the 1970s, and fell at a rate of 3.1% per year in 1980-84. The green revolution turned out not be ideally suited to existing conditions in most part of Africa. Africa does not have the means to employ the costly technological advancements garnered in the Green Revolution. Apart from the differences in soil, environment, and the general level of technical know-how that exist in most parts of Africa in contrast to the regions where the Green Revolution proved to be a success, the cost factor makes it prohibitive. A necessary condition for increasing food crops yields is the expansion of on-farm research conditions of areas where small farmers maintain successful farming operations. Traditional farming systems combine these elements to satisfy the food and nutritional needs of the operator's family. The farmer does not think in terms of efficiency and maximum yields, but basically of a sustained yield. To have sustained their people and productivity over centuries means that crop combinations are adapted to local environmental conditions and resistant to the vicissitudes of insect pests and plant pathogens. This achievement suggests a repository of useful knowledge in traditional systems.

An important general point in the debate about future prospects concerns the question of production trends over the past few decades and particularly the question of slowing growth in production. From 1961 to 1992, the growth of world agricultural production slowed, drooping from 3% annually in the 1960s to 2.3% per year in the 1970s and to 2% during the 1980-92 period [B.6.8.].

This general production trends are indeed most critical in those developing countries characterized by high economic dependence on agriculture (with more than one third of the economically active population engaged in agriculture), low levels of per capita food, and a limited ability to import more food. About 62 of 93 principal developing countries are in this category. Africa remains the continent most seriously affected by food shortages. Fifteen countries in the region are facing exceptional food emergencies. Of the 27 countries with household food security problems, 22 are in Sub-Saharan Africa.

But in Sub-Saharan Africa population is growing at high rates, which put agriculture under pressure to expand more quickly in order to feed the growing population. Population is growing at unprecedented rates and large proportions of the population depend on agriculture for their income. Unfortunately, agriculture growth in this region has been exceptionally slow, so that increasing numbers of people remain in poverty and in fact suffer from deteriorating living conditions. See Figure 2.1. from the reference [B.6.8.].

Figure 2.1.



But Africa continent's natural resources offer great promises. Only half of its arable land has ever been cultivated. Only 3% of its hydroelectric power have been harnessed.

Indeed, Sub-Saharan Africa stands out as the only region in the world where the expansion of cropland area contributed nearly as much as yield increases to the growth of cereal production during the 1961-90 period.

The hypothesis that population growth is causing declines in agricultural productivity in Sub-Saharan Africa despite the presence of large, untapped land resources is supported by two explanations. First, the distribution of population is not congruent with the distribution of natural resources. Second agriculture in much of the region has not progressed to higher levels of technology.

Concurred with references [B.3.7.] and [B.3.8.] that agricultural productivity in Sub-Saharan Africa contrasted sharply with what might be expected of a region

with large tracts of unused land and much potential. Africa is at or almost at the low level of technology; but even at low input levels, enough land is available to allow food self-sufficiency. Despite such large potential for the region as a whole, important intercountry differences exist in the population-resource balance.

Furthermore population growth generates changes in the agricultural ecology that could lead to declines in agricultural productivity. A number of factors other than population density affect progress toward the agricultural transition, the most important of which are the climatic and soil characteristics of the local area. The points at which yields start to decline could differ in different ecologies. Farmers have responded in different ways to declining soil fertility caused by more intensive use of land. Changes in technology, however, could fend off declines in productivity if technological change occurs quickly enough to offset the effects of increased population density. Evidence of declining yields, however, suggests that the necessary technological changes have not been occurring in countries of Sub-Saharan Africa.

Furthermore, Sub-Saharan Africa, which is the last region in the world to pass through the forest and bush fallow stages of the agricultural transition, faces an unprecedented population growth rate. At the time of the transition in the rest of the Old World, by comparison, population was growing at a much slower pace than it is growing in Sub-Saharan Africa today.

Sub-Saharan Africa is one of the two regions of the world (with South Asia) in which food security and undernutrition problems seem relatively intractable. In spite of this, many studies generally support the FAO forecast that production increases can meet effective demand and rising world population.

Like the reality itself, Lester Brown and the Worldwatch Institute and other authors are much more pessimistic about future food production. They argued that food production will be constrained by the shrinking backlog of unused agricultural technology, by the approaching limits to the biological productivity of fisheries and rangelands, by the increasing scarcity of water (see chapter 7) the effectiveness of additional fertilizer applications, and generally by social disintegration in many developing countries.

The question is not whether it is optimistic or pessimistic. The answer to the dilemma is not growing more cereals in more appropriated developed countries. To improve the sustainable food security of this group of countries, especially in Sub-Saharan Africa, ways must be found on how and how much more can they

grow their own food. And, at least, we should return here to the main assumptions of previous chapter.

Kenya tea field

Burundi women gathering coffee

2.3. THE PAST AND THE TRENDS IN AFRICA AND, SPECIFICALLY, SUB-SAHARAN AFRICA AGRICULTURE [B.1.]: CHALLENGES AND POTENTIALS

The following is the continuation of previous section's quotation:

"Going into the 21st century, Africa faces a number of challenges, which will have to be addressed before agricultural development, can occur.

First, because of low agricultural technology, agricultural development strategies in Africa in the 21st century must focus on scientific, institutional and human capital development. The main challenge is to create and manage the continuously shifting disequilibria in agriculture resulting from technological change, institutional change, investment in human capital and investment in research and extension. There should be no over-optimism about the potential for direct technological transfer. The experience of Asian countries, which benefited from the green revolution, tells us that the success was to a large extent, due to the indigenous research capability to follow up on the direct "material transfer". Indigenous research capability is normally a result of a long-term process of institution building. The problem is that Africa, which has the greatest need for sustained programs to support institution building for agriculture, has not been receiving significant levels of foreign aid. Unless efforts are made to attract donors in this endeavor, no foreign support will be forthcoming because aid policies have shifted away from institution building to other priorities. Furthermore limited experience with successful agricultural research programs make it more difficult to mobilize the needed political and financial support for strengthening research.

The Second challenge relates to the high rate of population growth. Serious efforts have to be made in order to control population growth rates. A kind of population policy is needed.

Thirdly, Africa faces the challenge of dealing with environmental degradation particularly deforestation. Generally, environmental problems reflect market failures. Markets for natural resources have not developed in a manner which induces individual decisions to be consistent economically and socially with desirable outcomes.

Fourthly, the challenge is that Africa needs to invest in rural infrastructure. This is quite costly and none of the African countries have the financial resources to

establish networks of physical, institutional and social infrastructures. Donor support will be needed.

Fifthly, the challenge for Africa is to foster the progressive modernization of smallholder farms which dominate the agrarian structure. This would require, among other things, accelerating the rate of output growth and expanding farm and non-farm employment opportunities. The biggest challenge perhaps is that Africa will require a good deal of patient waiting because the most important elements of the "new" strategy of agricultural development require a much longer time horizon. Since the poor do not live in the long-run, African countries also face the challenge between meeting the short-run welfare of the poor and the long-run economic development."

In the following subsections, we want to relate the main tendencies and potentials (trends and targets) that the international sources provide, specifically, for this general region, in a general context.

The main sources that we have used are: [B.1.3.], [B.2.] , [B.6.8.].

We will come back to this later, in chapter 8, more specifically.

Hutu (Rwanda) farmer

2.3.1. CONTROVERSY OVER SOURCES OF POTENTIALS IN FOOD PRODUCTION GROWTH

Numerous attempts have been made in recent years to grapple with the question of whether global food production can keep up with population growth and reduce undernutrition in the next few decades. Whether they are positive or negative in outlook, most studies agree that the key issues include the potential for expanding cropland area and irrigated cropland area, for increasing yields, and for improving efficiency. Other scholars emphasize the importance of resource conservation and alternative production models that are less environmentally damaging than the conventional high-input approach.

The Food and Agriculture Organization of the United Nations, FAO, has published a study on the food production outlook through the year 2010 [B.2.2.]. The World Bank, WB, has produced a similar study, although it does not represent the formal position of the Bank on these issues. In addition to the WB and FAO analyses, other studies have looked at food production potential over a longer time frame. The International Food Policy Research Institute, IFPRI, which is part of the Consultative Group on International Agricultural Research, CGIAR, recently published a study of food production potential through the year 2020 [B.3.9.]. Although acknowledging the many obstacles to future food production increases, these studies generally support the FAO forecast that production increases can accommodate effective demand and rising world population, although they are much less sanguine about reducing undernutrition. A proviso in most of the forecasts is that continuing substantial investments in agricultural research are essential.

The last FAO forecast and the following “opposite” vision have been mentioned before, but here we want to emphasize, to extent and to concrete them, taking some position in front of the controversial.

Lester Brown and Hal Kane are much more pessimistic about future food production. They argue that food production will be constrained by the shrinking backlog of unused agricultural technology, by the approaching limits to the biological productivity’s of fisheries and rangelands, by the increasing scarcity of water and the declining effectiveness of additional fertilizer applications, and generally by social disintegration in many developing countries. Ian Carruthers [B.2.3.] argues that the fragile tropical and subtropical environments in many developing countries will be unable to sustain further food production increases, and that prospects for production increases are much better in temperate zone nations such as the United States, Australia, and Europe. Carruthers believes that

temperate zone countries will increasingly export food to developing countries in exchange for labor-intensive manufactured goods. Other scholars emphasize the significance of soil erosion as a major threat to the sustainability and productive capacity of agriculture.

As with many predictions about the future, there are wide differences in outlook. Many factors help explain these differences. Slight differences in population growth assumptions, for instance, can lead to substantial differences in outcomes. There is uncertainty about the extent to which past agricultural performance is a useful guide to future performance; if yields were *x* over the past two decades, does this mean they will continue to be *x* over the next two decades? New cereal varieties have played a big role in the success of the past few decades, but it is hard to say whether the pace of new innovations will continue unabated. Environmental degradation has clearly had a significant effect on agricultural production in many regions; will such degradation get worse under the pressures of population growth and further intensification of production? Finally, models cannot predict the future of the world economy with much confidence.

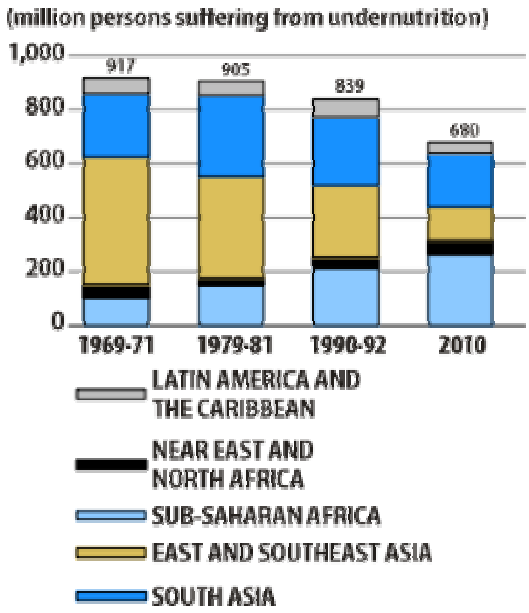
These caveats notwithstanding, most studies indicate that over the next few decades global food production can continue to increase to meet "effective" demand, that is, the level of demand that corresponds to purchasing power irrespective of food needs. This is not likely to be the case in Sub-Saharan Africa and South Asia, however. These regions are likely to experience regional production shortages, food distribution problems, and famines. In addition, given the millions of people who lack the money to buy all the food they need, it is even more doubtful that growth in purchasing power will be adequate to raise per capita food consumption to levels comparable to those needed to eliminate undernutrition.

Growing more cereals in the United States or in other developed countries will not meet the food needs of many of the poor in developing countries. To improve the food security of this group, ways must be found to help farmers grow more of their own food. Many of these nations remain primarily rural and heavily dependent on the agricultural economy. Boosting domestic food production would thus be doubly positive, increasing both food supplies and the incomes of many of the poor.

The World Bank projects that developing countries could be importing not more than about 15% of their grain consumption by 2010!

Chronic undernutrition is a more long-term, intractable food security problem (see Figure 2.2. from the reference [B.6.8.]. Sub-Saharan Africa is projected to have a per capita food supply of 2170 Kcal per capita and day -the lowest among all regions- by 2010.

Figure 2.2



So it is possibly true that the FAO forecast may be somewhat toward the optimistic end of the range of studies on future food production. While the optimistic position is concerned more with the potential (we often come back to this point in our work) and the study provides a consistent data set, the FAO numbers are the reference used in most of the following discussion.

There is a broad consensus that yield increases will continue to be the key component of future growth in food production. FAO estimates that increased yields will account for 66 percent of production growth through the year 2010 in developing countries, with arable land expansion accounting for an additional 21 percent and increased cropping intensity (fewer fallow periods or more than one crop per year on a field) providing 13 percent of the projected increase. (See table of Figure 2.3. from reference [B.6.8.].

Global gross agricultural production will continue to grow over the next two decades; however, it is projected to grow at a slower rate (1.8 percent per annum) than it did in the previous 20 years. According to FAO, the slowdown in the growth of production will be due in part to slowing rates of population growth

and an increasing saturation in demand for food, especially in developed countries. Inadequate income growth in countries with low levels of consumption will also be a factor.

Figure 2.3.

Table 10.3 Estimated Sources of Growth in Crop Production and Total Land Use, Developing Countries, Excluding China, 1988–90 to 2010

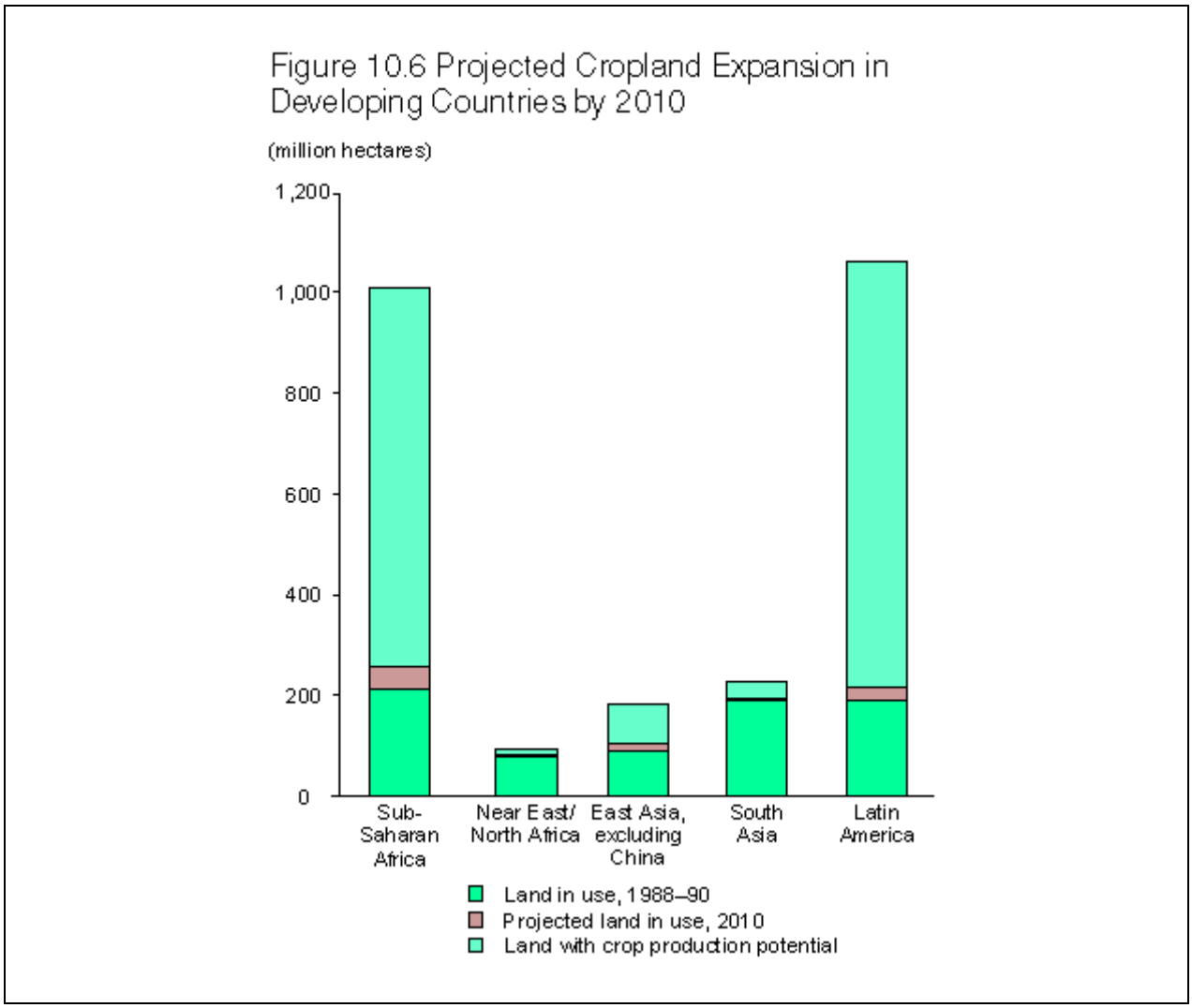
Region	Percent Contribution		
	Increased Yield	Arable Land	Cropping Intensity
Developing countries	66	21	13
Sub-Saharan Africa	53	30	17
Near East/North Africa	71	9	20
East Asia	61	32	7
South Asia	82	4	14
Latin America/ Caribbean	53	28	19

Source: Nikos Alexandratos, ed., *World Agriculture: Towards 2010, An FAO Study* (John Wiley and Sons, Chichester, U.K., and Food and Agriculture Organization of the United Nations, Rome, 1995), p. 170.

2.3.2. POTENTIAL FOR EXPANDING CROPLAND

FAO estimates that by the year 2010, the 760 million hectares of land currently in crop production in developing countries (excluding China) could increase by 12 percent to 850 million hectares. Of these 850 million hectares, 720 million hectares could be harvested in a given year -an increase of about 21 percent- because of greater cropping intensities. See the following Figure from reference [B.6.8.].

Figure 2.4.



Some experts are much less optimistic about the potential for further cropland expansion in the next few decades. They believe that the potential for further

expansion of cropland area is rapidly disappearing in most regions. The potential to expand cropland is limited by many factors, including environmental costs and the cost of developing the infrastructure in remote areas. Furthermore, undeveloped areas usually are not prime cropland, so yields will generally be less than average.

But over the past three decades, the expansion of cropland area has been significant in two regions: Sub- Saharan Africa and Latin America. Indeed, sub-Saharan Africa stands out as the only region in the world where the expansion of cropland area contributed nearly as much as yield increases to the growth of cereal production during the 1961-90 period.

Most of the expansion of cropland area projected by FAO will be in maize and other coarse grains, which are more prominent crops in these regions.

According to FAO forecast, in Sub-Saharan Africa the increase in harvested land could contribute about 30% to the increase in crop production (47% including greater cropping intensity). But at least 45% of the potential cropland in Sub-Saharan Africa is under forest or is in protected areas; about 72% suffer from soil and terrain constraints.

2.3.3. POTENTIAL FOR EXPANDING IRRIGATED LAND

Irrigated land accounted for more than 50 percent of the increase in global food production from the mid-1960s to the mid-1980s and currently accounts for about one third of total production. Irrigation results in higher crop yields and also allows multiple cropping, which dramatically increases production. Africa has, only, 5 percent of the world's total irrigated land.

FAO predicts that irrigated land in developing countries (excluding China) will expand at a rate of 0.8 percent annually (The Worldwatch Institute is more optimistic on this point: 2.7%), which is much slower than the 2.2 percent annual increase experienced during the 1970s and the 1.9 percent annual increase in the 1980s. About two thirds of the expansion will be in Asia. Even with this slower growth rate, more than half of the increment in crop production between now and 2010 will come from irrigated land, according to the FAO forecasting.

The rate at which cropland is brought under irrigation is declining, mainly because of the increasing cost of irrigation (for development and maintenance), the growing competition for water uses, and the decline in both agricultural and food prices. Irrigation's environmental and health impacts also may inhibit further expansion. Salinization and waterlogging problems from improper irrigation techniques reduce crop yields, constraining future gains in production. Furthermore, it is increasingly costly to avoid or reverse the accretion of silt in dams and reservoirs and of the salt in already irrigated soil.

To be specific, all sources agree that irrigated arable land in Sub-Saharan Africa, in the 90’s, is around 3,5 M He, with additional 18,5 M He of potential irrigated arable land.

2.3.4. POTENTIAL FOR INCREASING YIELDS

Yields of maize, rice, and wheat doubled between 1961 and 1991 in developing countries as a whole. The most extraordinary gains occurred in Asia, where wheat yields rose from 0.7 to 2.6 metric tons per hectare. In Africa, maize, rice, and wheat yields have been poor, especially compared with those in Asia and Latin America. Between 1961 and 1991, maize yields in Asia rose from 1.2 to 3.4 metric tons per hectare, whereas maize yields in Africa rose from about 0.8 to 1.2 metric tons per hectare.

From 1990 to 2010, cereal yields in developing countries (excluding China) are projected to increase by about 1.4 percent per year, according to FAO. (This does not include increases due to greater cropping intensity). FAO's forecast assumes a substantial slowdown in the rate of yield increases for all of the major cereals: the average yearly growth in wheat yields, for example, is forecast to fall from 2.8 percent in 1970 to 1990 to 1.6 percent from 1990 to 2010; similarly, annual growth in rice yields is expected to drop from 2.3 percent to 1.5 percent. See the table in Figure 2.5. from reference [B.6.8.].

Figure 2.5.

Table 10.4 Production, Yield, and Area by Major Cereal Crop, Developing Countries, Excluding China, 1969/71 to 2010

Crop Type	1969/71	1988/90	2010	1970/90	1988/90 to 2010
	Production (million metric tons)			Growth (percent)	
Wheat	67	132	205	3.8	2.1
Rice (paddy)	177	303	459	3.0	2.0
Maize	70	112	196	2.7	2.7
Other cereals	67	84	135	1.3	2.3
Total	**381**	**631**	**995**	**2.8**	**2.2**
	Yields (kilograms per hectare)				
Wheat	1,150	1,900	2,660	2.8	1.6
Rice (paddy)	1,855	2,775	3,810	2.3	1.5
Maize	1,300	1,790	2,470	1.8	1.5
Other cereals	730	940	1,210	1.3	1.2
Total	**1,270**	**1,910**	**2,560**	**2.2**	**1.4**
	Harvested Area (million hectares)				
Wheat	58	70	77	0.9	0.5
Rice (paddy)	95	109	120	0.8	0.5
Maize	54	63	80	0.9	1.2
Other cereals	92	89	112	0.0	1.0
Total	**299**	**331**	**389**	**0.6**	**0.8**

Source: Nikos Alexandratos, ed., *World Agriculture: Towards 2010, An FAO Study* (John Wiley and Sons, Chichester, U.K., and Food and Agriculture Organization of the United Nations, Rome, 1995), p. 169.

Note: Other cereals include barley, millet, sorghum, rye, oats, buckwheat, quinoa, triticale, and canary seed.

Part of FAO's cautious optimism about continuing yield increases is based on the existing wide disparities in yields among countries. For example, rice yields on irrigated land vary from 1 to 10 tons per hectare; today's average yield of 3.7 metric tons per hectare is well below the 6.7 metric tons per hectare achieved by the best-performing countries. Similarly, average yields of wheat and maize on irrigated land are only about half the yields achieved by the best-performing countries. Thus, there is considerable room for further improvement by farmers currently achieving less-than-peak yields, according to the FAO forecast.

Although FAO predicts that, on average, increased yields will contribute about 66 percent to future crop production growth, they project that yield increases will make the strongest contribution in South Asia (82 percent) and much smaller contributions in Latin America and Africa (53 percent).

Brown and others argue that the dramatic gains in yields achieved over the past three decades are not likely to be repeated, since more and more of the world's farmers are already using varieties with the highest genetic yield potential. Furthermore, they note that rice yields at experiment stations in Asia have been stagnant for many years.

2.3.4.1. TRENDS IN YIELDS

The causes of production gains in developing countries in the past few decades - often subsumed under the term "Green Revolution"- include the introduction of modern varieties of rice, wheat, and maize in combination with the more intensive use of inputs such as fertilizers, water, and pesticides.

There are large regional differences in the adoption of modern varieties. China's rice and maize crops, for example, are almost entirely planted to modern varieties. On the other hand, modern varieties have not been widely adopted in areas prone to drought or in rice crop areas with poor water control. Diffusion also is slower in areas with poor infrastructure or market access, as is the case with many regions in Sub-Saharan Africa or the hillside systems of Latin America and Asia.

Although some exceptions exist, most of the growth in production in developing countries is a result of the higher yields generated by the Green Revolution. As shown in the table of Figure 2.6.from reference [B.6.8.], increases in the yields of the major cereals in developing countries have been substantial,

Figure 2.6.

Table 10.1 Trends in Yields in 93 Developing Countries

	Yield (kilograms per hectare)			
Crop Type	**1961–63**	**1969–71**	**1979–81**	**1990–92**
All cereals	1,171	1,461	1,894	2,466
Excluding China	1,116	1,271	1,557	1,951
China	1,336	2,070	3,017	4,329
Wheat	868	1,153	1,637	2,364
Excluding China	964	1,146	1,460	1,997
China	673	1,169	2,046	3,208
Rice	1,818	2,218	2,653	3,459
Excluding China	1,650	1,855	2,145	2,790
China	2,355	3,281	4,236	5,722
Maize	1,157	1,456	1,958	2,531
Excluding China	1,122	1,291	1,572	1,837
China	1,265	2,005	3,038	4,545

Source: Nikos Alexandratos, Chief of Global Perspective Studies Unit, Economic and Social Department, Food and Agriculture Organization of the United Nations, Rome, 1995 (personal communication, based on data from *FAOSTAT-Mainframe*).

Because so much of the recent success is due to increases in yields, a vital question for the future is whether such increases will continue and at what rates. Next table of Figure 2.7. from reference [B.6.8.], shows the growth rates in the yields of the major cereals over the past few decades.

Figure 2.7.

Table 10.2 Trends in Growth Rates in Yields of Wheat, Rice, and Maize in 93 Developing Countries, 1961–92

	Growth (percent)		
Crop Type	1961–70	1970–80	1980–92
All cereals	2.8	2.6	2.1
Excluding China	1.5	2.1	1.9
China	6.0	3.7	2.9
Wheat	3.7	3.5	3.2
Excluding China	2.0	2.5	2.8
China	7.8	5.4	3.7
Rice	2.5	1.7	2.1
Excluding China	1.3	1.5	2.2
China	4.9	2.5	2.3
Maize	3.0	2.9	2.2
Excluding China	1.7	1.6	1.3
China	6.2	4.2	3.3

Source: Nikos Alexandratos, Chief of Global Perspective Studies Unit, Economic and Social Department, Food and Agriculture Organization of the United Nations, Rome, 1995 (personal communication, based on data from *FAOSTAT-Mainframe*).

The table confirms that although total yields have increased, yield growth rates in developing countries have slowed for all cereals. The results tend to be skewed by China's performance, however, especially its dramatic yield increases during the 1960s. For all other countries, growth rates in the yields of rice and wheat have climbed steadily over the past three decades, whereas growth rates in the yields of maize have declined.

In this direction we ought to come back finally to the key table of Figure 2.5., and we need to insist again that furthermore, the table of the last Figure 2.8. of this section, shows us the great disparity between yields around the world.

Figure 2.8.

World Average, Highest, and Lowest Yields of Cereal Crops
1990-96 Mean Value (Kg per hectare):

World Average Yield	**2700**
Highest Yields (Netherlands)	**8800**
Lowest Yield (Botswana)	**350**

Source: Food and Agriculture Organization of the United Nations (FAO), *FAOSTAT Statistical Database* (FAO, Rome, 1997).

2.4. THE CASE STUDY REGION

In Africa, the second largest continent of the world, there are, obviously, many Africa's.

North Africa is clearly a region of its own, separated by Sahara.

The country South Africa and its surroundings have its particular history and is also a separate region like the north.

So when we speak about Africa we usually speak about Sub-Saharan Africa except the south. In this case, general views on past, trends, challenges and potentials of Africa are identified, in fact, with Sub-Saharan Africa.

However in Sub-Saharan Africa there are, also, a lot of "Africa's". First of all, for example, we have the west, the central and the east. Inside the east, furthermore, we can talk about the horn of Africa (Sudan, Ethiopia, Eritrea, Somalia).

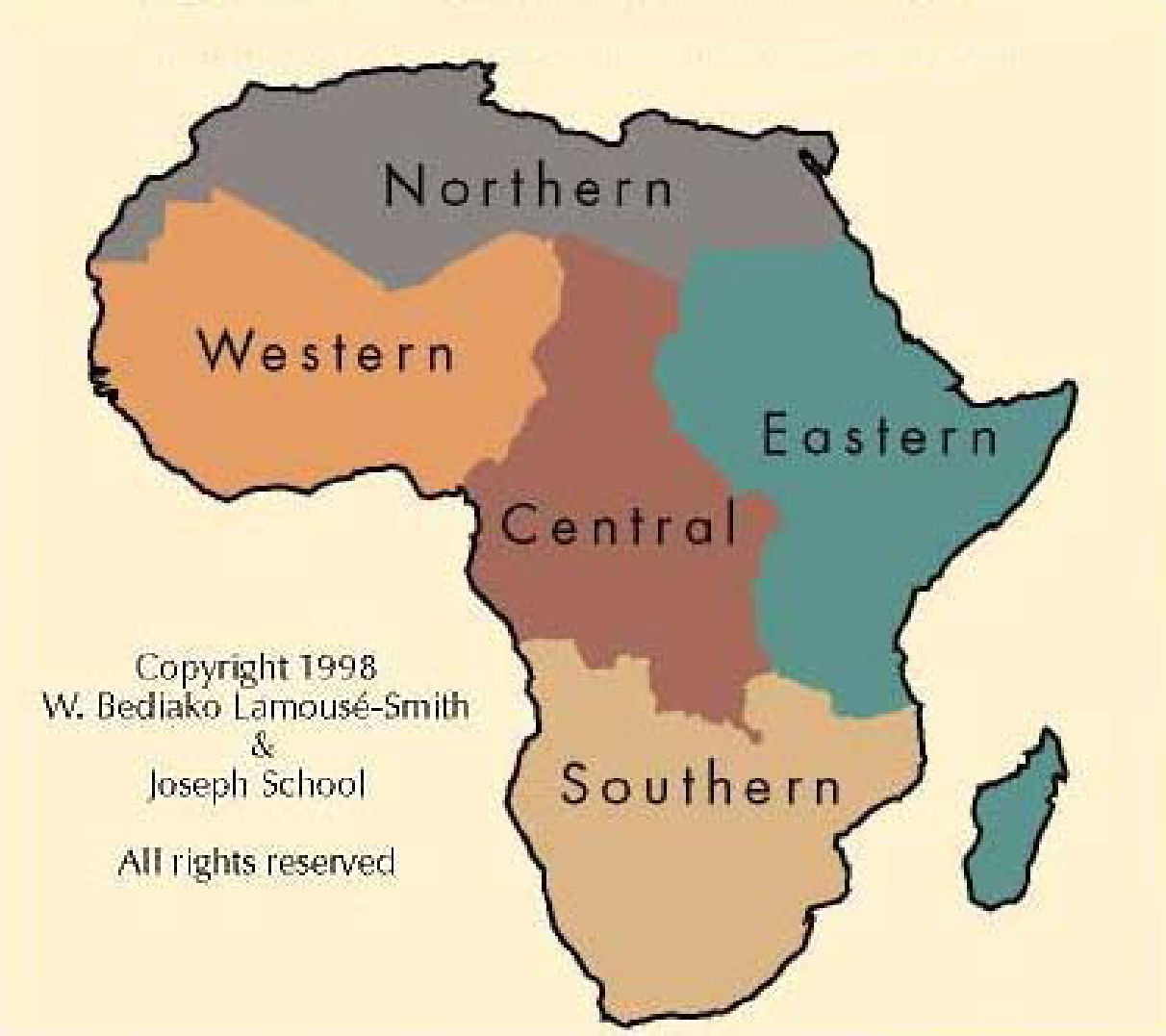
Our Case Study region is the region with the following countries: Ethiopia, Somalia, Kenya, Uganda, Rwanda and Burundi. It is clearly a very significant part of East Africa. All this countries, except Somalia, are Nile riparian.

The region of our concern includes practically all the horn of Africa except Sudan. The reason is that there are many Sudan's, and not all of these Sudan's are geographically, religiously, etc. part of the region that we want to study. And also because it is so big that can distort the reality of the other parts of the region, we decided to leave it outside of our study.

It is not, again, all east Africa because Tanzania is not included. Tanzania is like Sudan although in the south of our region. It is the south border of our region and, particularly because from the point of view of the combination of climate, vegetation and land use aspects, we think that it can break the continuity of the study; parallel considerations with Sudan are appropriated here.

But finally, all these considerations can be made clearer in the light of the following maps, Figures 2.3., from several sources ([B.6.2.], Internet public access). We can see that the case study region that we have chosen is one of the most evident intersections of all of them.

Figure 2.9.


Northern
Western
Eastern
Central
Southern
Copyright 1998
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&
Joseph School
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Figure 2.10. (Satellite)

Figure 2.11.


50 AFRICA—Physical
ALGERIA
LIBYA
EGYPT
MAURITANIA
MALI
NIGER
CHAD
SUDAN
ETHIOPIA
KENYA
ZAIRE
TANZANIA
ANGOLA
ZAMBIA
NAMIBIA
BOTSWANA
SOUTH AFRICA
ATLANTIC OCEAN
INDIAN OCEAN
WALVIS RIDGE
CAPE

Figure 2.12.

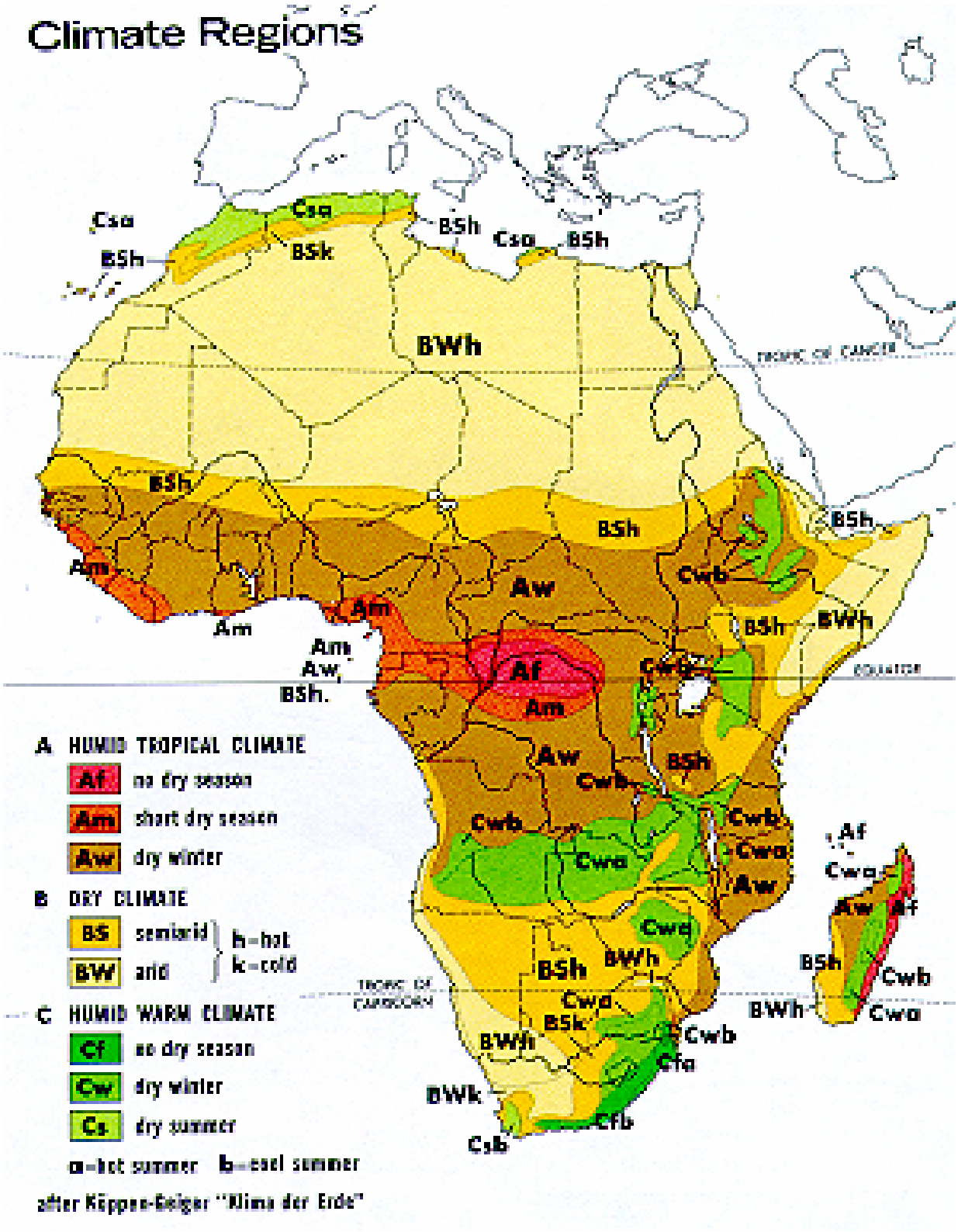

Climate Regions
Csa
BSk
BSh
BWh
Am
Aw
Af
Cwb
Cwa
Cfa
Cfb
BWk
Csb
TROPIC OF CANCER
EQUATOR
TROPIC OF CAPRICORN
A HUMID TROPICAL CLIMATE
Af no dry season
Am short dry season
Aw dry winter
B DRY CLIMATE
BS semiarid
BW arid
h=hot
k=cold
C HUMID WARM CLIMATE
Cf no dry season
Cw dry winter
Cs dry summer
a=hot summer
b=cool summer
after Köppen-Geiger "Klima der Erde"

Figure 2.13.

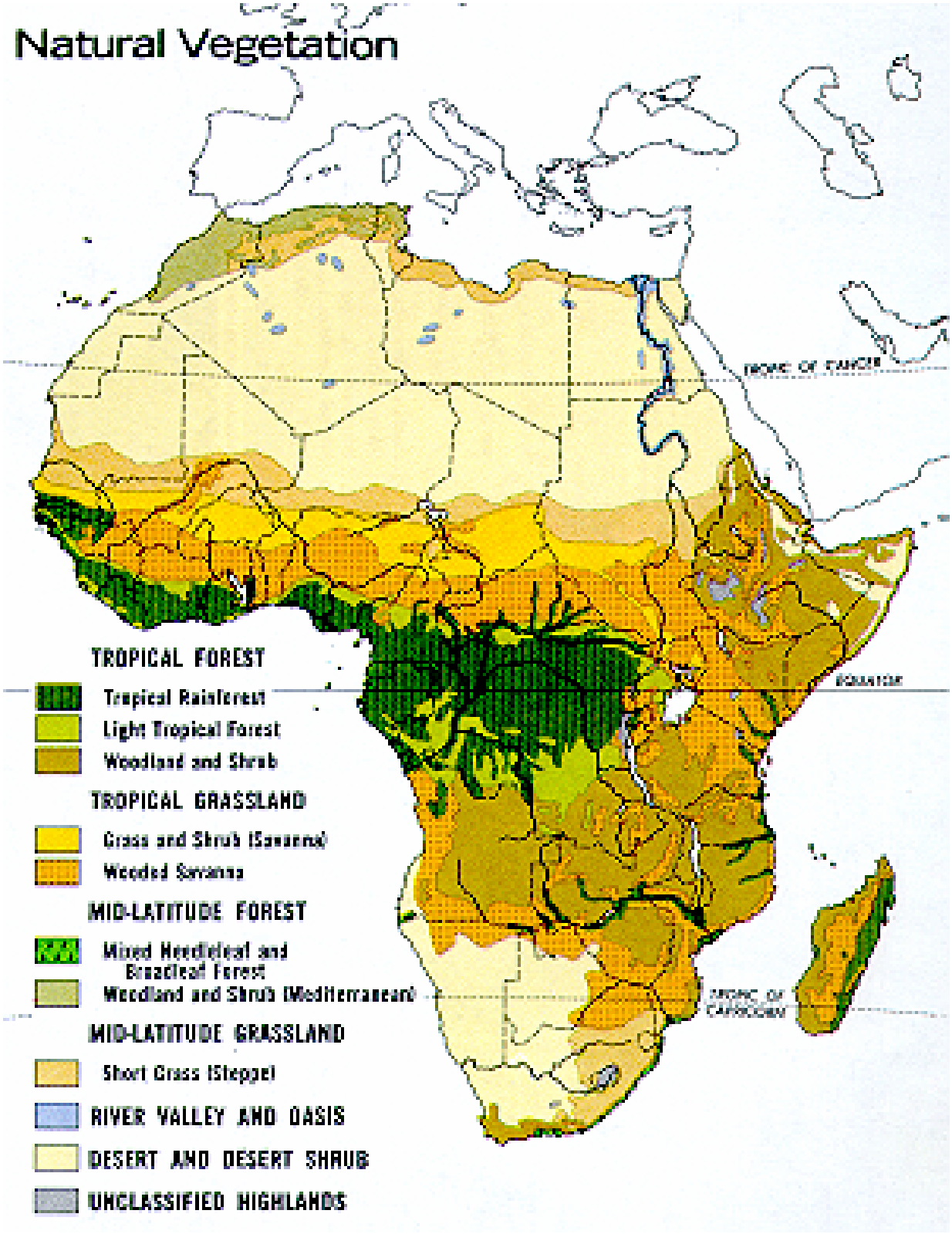

Natural Vegetation
TROPIC OF CANCER
EQUATOR
TROPIC OF CAPRICORN
TROPICAL FOREST
Tropical Rainforest
Light Tropical Forest
Woodland and Shrub
TROPICAL GRASSLAND
Grass and Shrub (Savanna)
Wooded Savanna
MID-LATITUDE FOREST
Mixed Needleleaf and Broadleaf Forest
Woodland and Shrub (Mediterranean)
MID-LATITUDE GRASSLAND
Short Grass (Steppe)
RIVER VALLEY AND OASIS
DESERT AND DESERT SHRUB
UNCLASSIFIED HIGHLANDS

Figure 2.14.

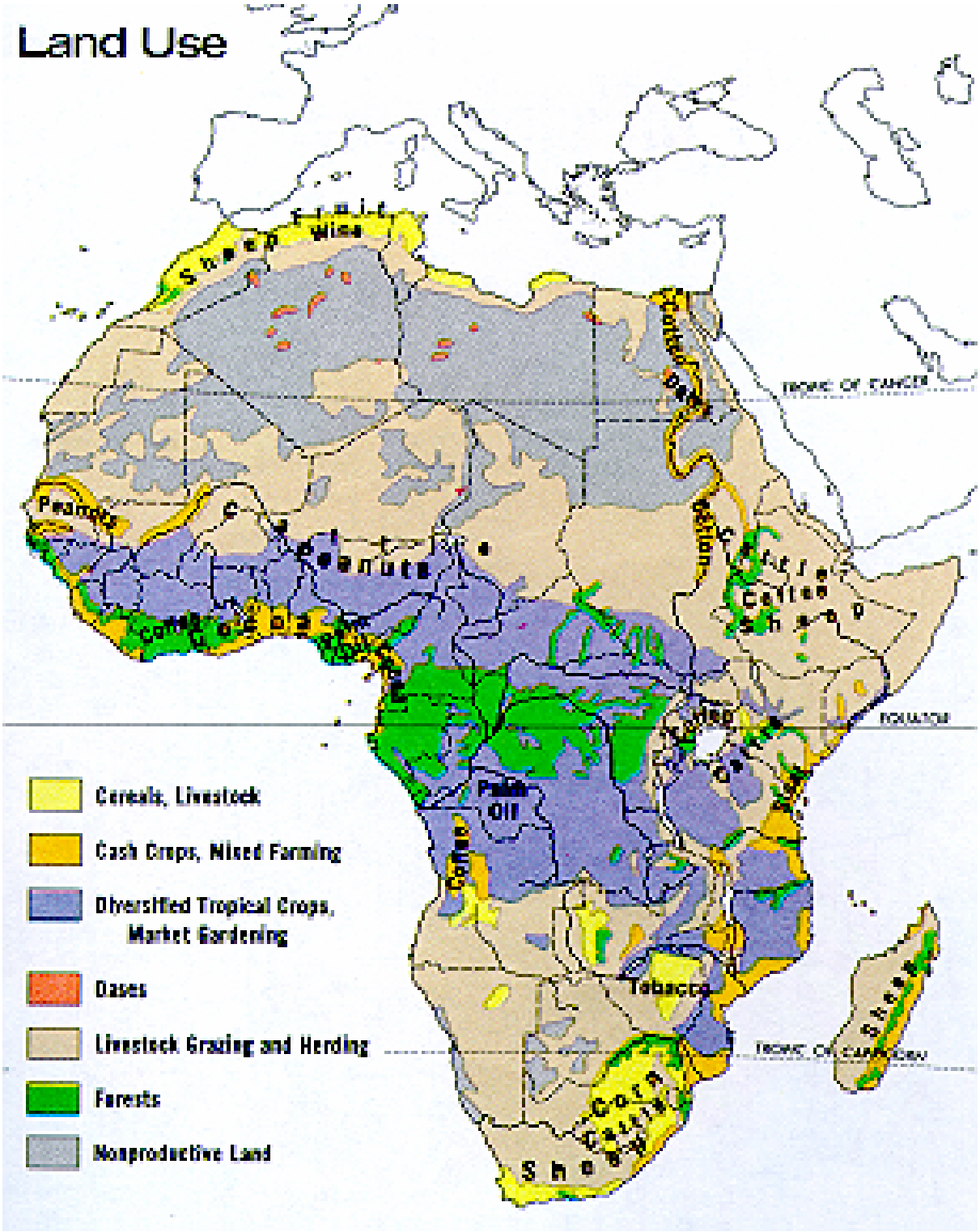

Land Use
Cereals, Livestock
Cash Crops, Mixed Farming
Diversified Tropical Crops, Market Gardening
Oases
Livestock Grazing and Herding
Forests
Nonproductive Land
Tobacco
EQUATOR

Figure 2.15.:
FAO photo 1990; Number of rainfall days map for Africa covering period of 1-10 September 1990, providing information on the distribution of rainfall over time within a ten-day period

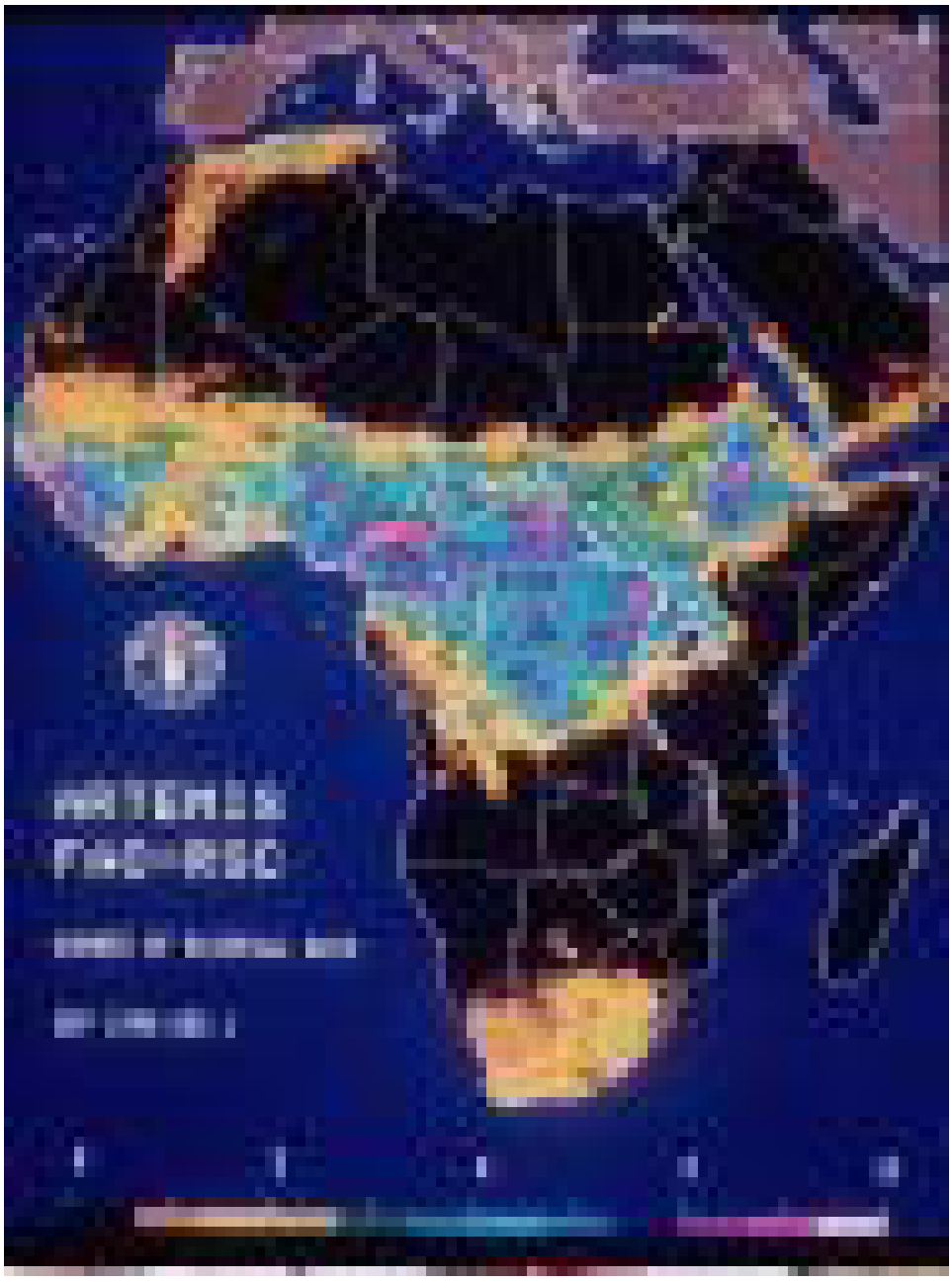


Figure 2.16.:
Desertification

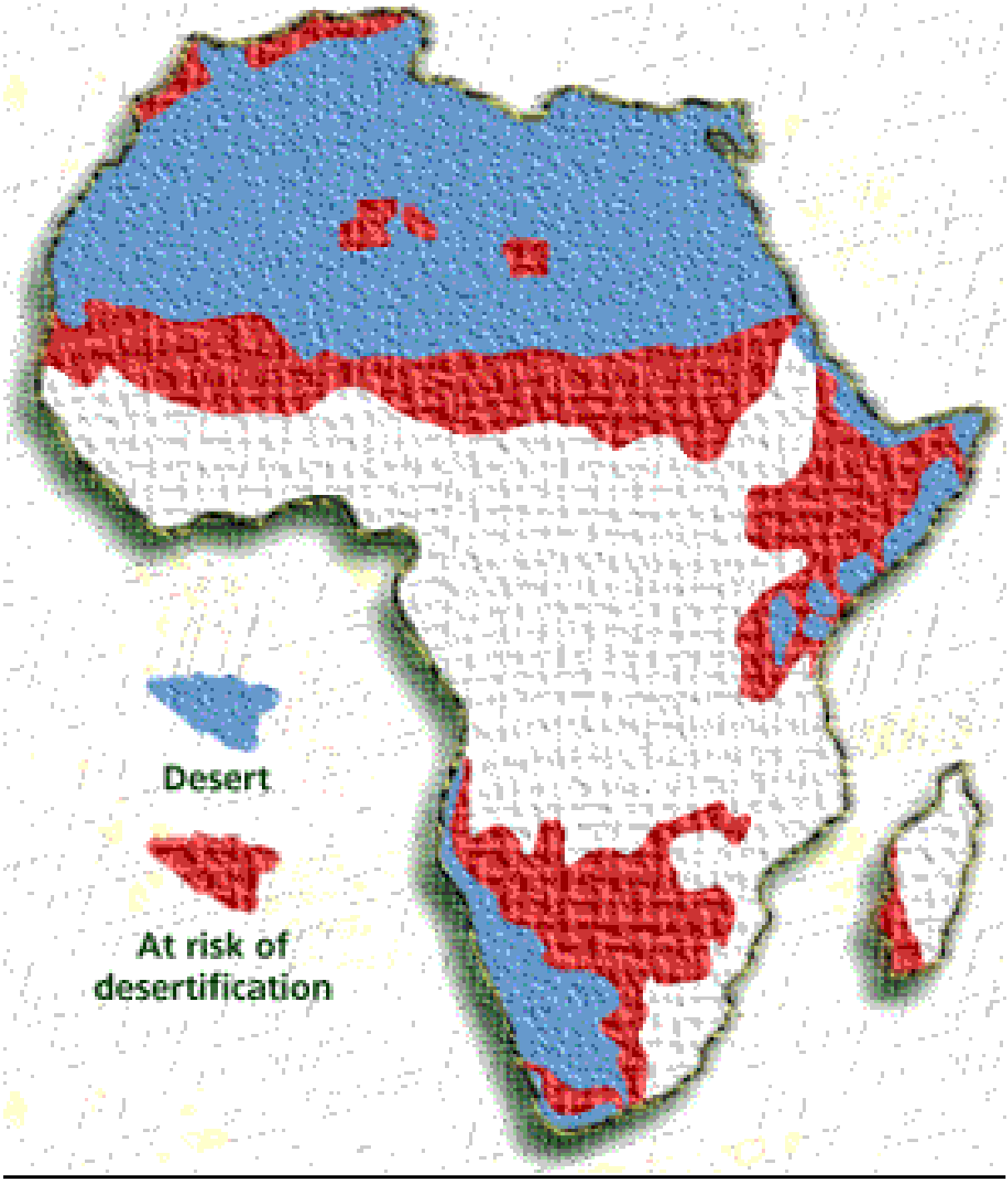
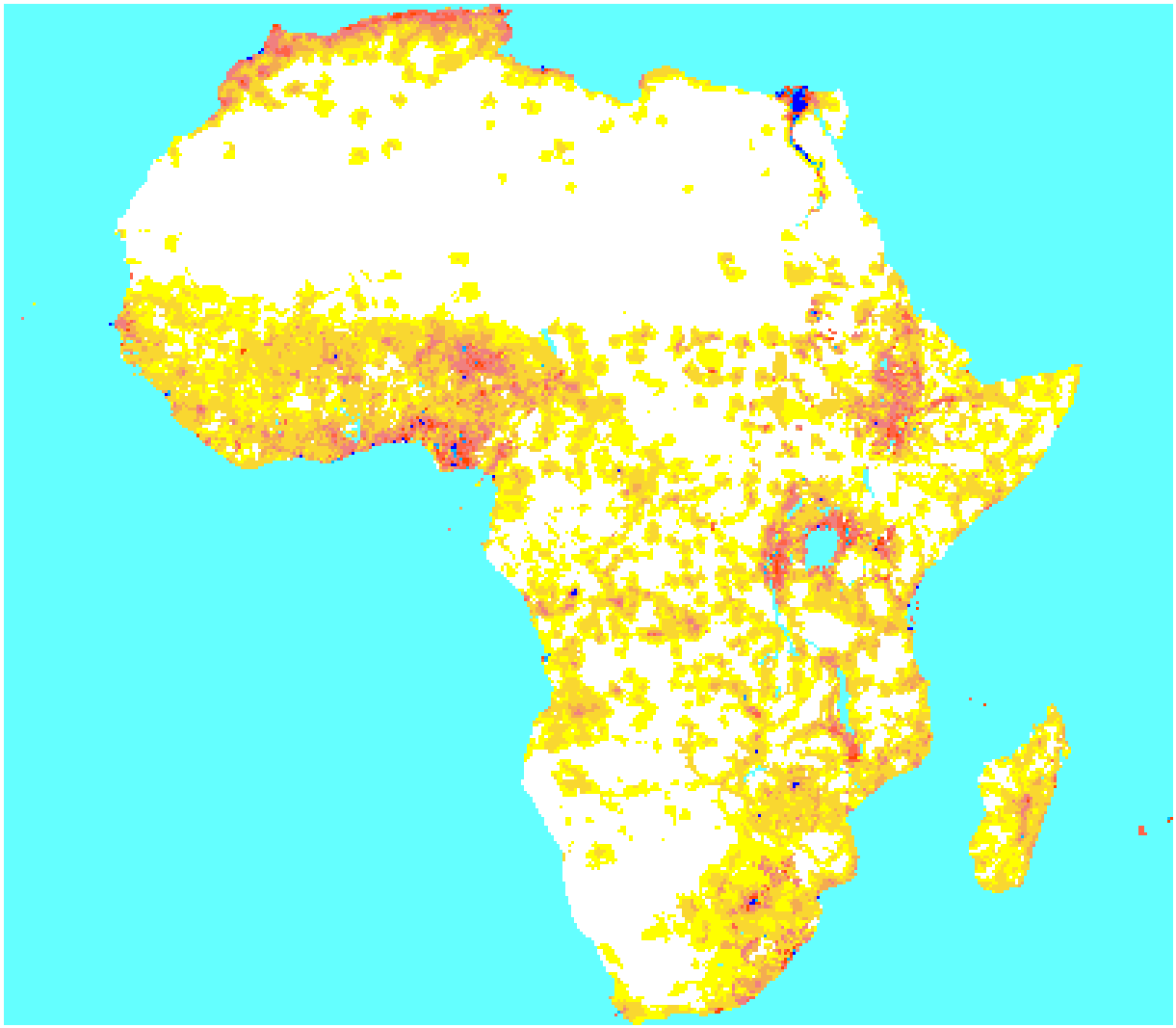


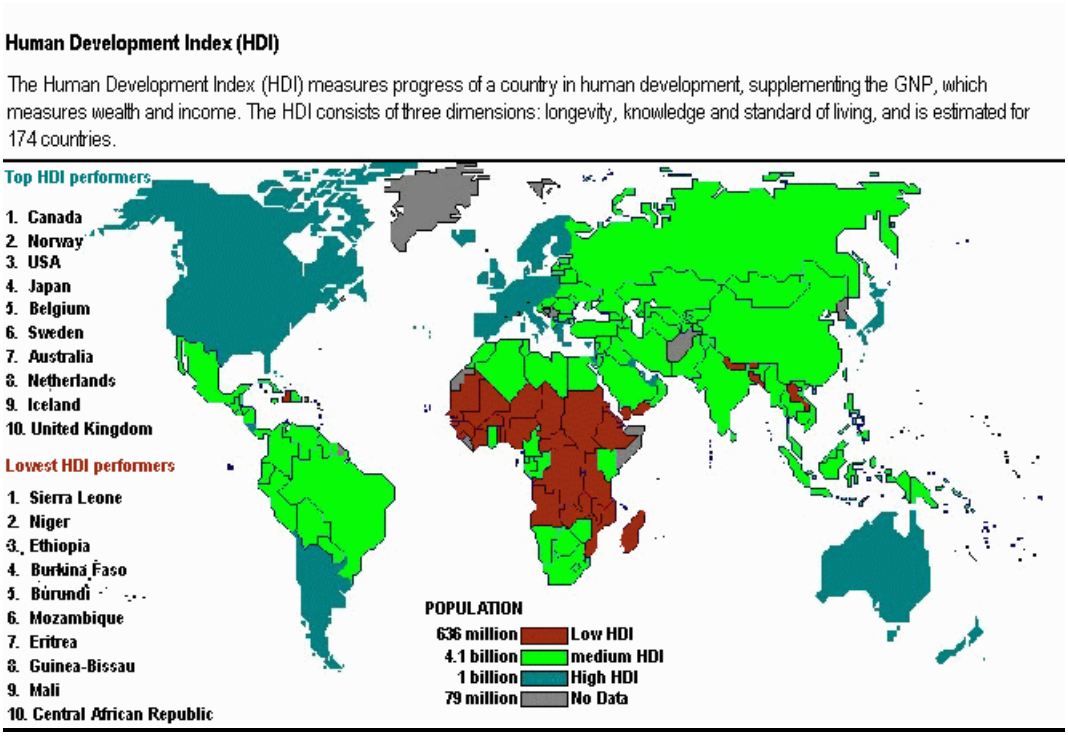
Figure 2.17.:
Population density (blue areas-points)



2.5. THE CASE STUDY REGION, UNDER THE LIGHT OF SOME OF THE PRINCIPAL INTERNATIONAL INDICATORS

HDI (Human Development Index) shown in Figure 2.18 from reference [B.6.3.], emphasizes that from 174 countries in the world, all the countries of the Case Study Region are from 136 (Kenya -in the bottom of the medium human development-) to the bottom. There aren't data about Somalia. And Ethiopia is the third from the bottom.

Figure 2.18.



From the point of view of undernutritional problems, in agreement of FAO reference [B.2.13.], we find all those countries in practically the same bottom position (the best is in the last 34 position). Somalia is the worst country in the world.

In agreement with all the references that we have consulted ([B.1.] and [B.6.]), we can affirm, clearly, that the case study region contains the most problematic aggregate group of countries in the world, with a lot of pressure in the basic issues: water scarcity (see chapter 7), food security (see the next two mapamundis

in Figure 2.19. in which the color countries are them that have and have had some food security important problem), food supplies per capita (see chapter 8), etc..

Figure 2.19

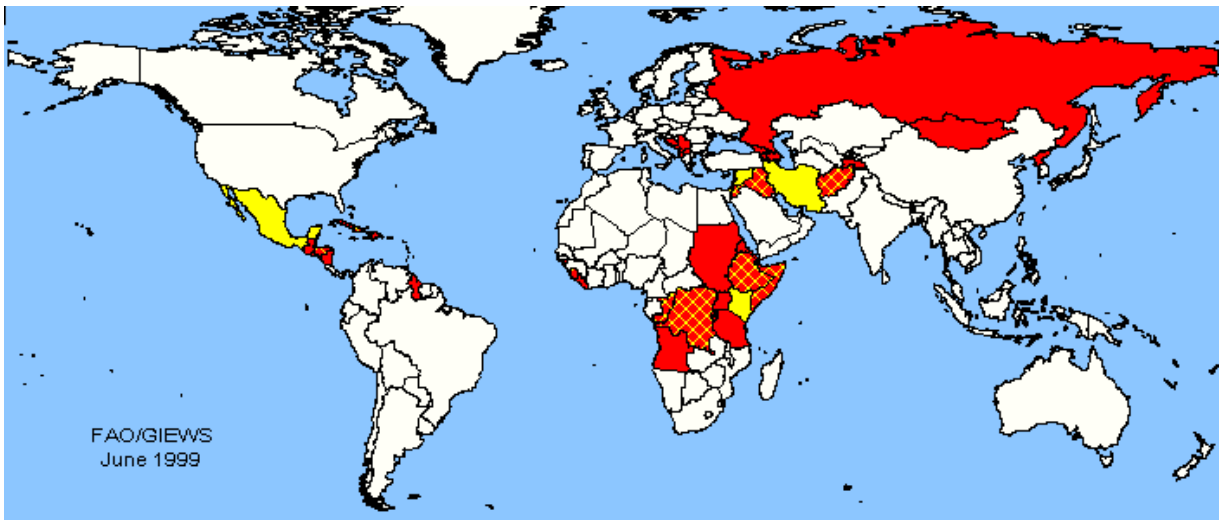
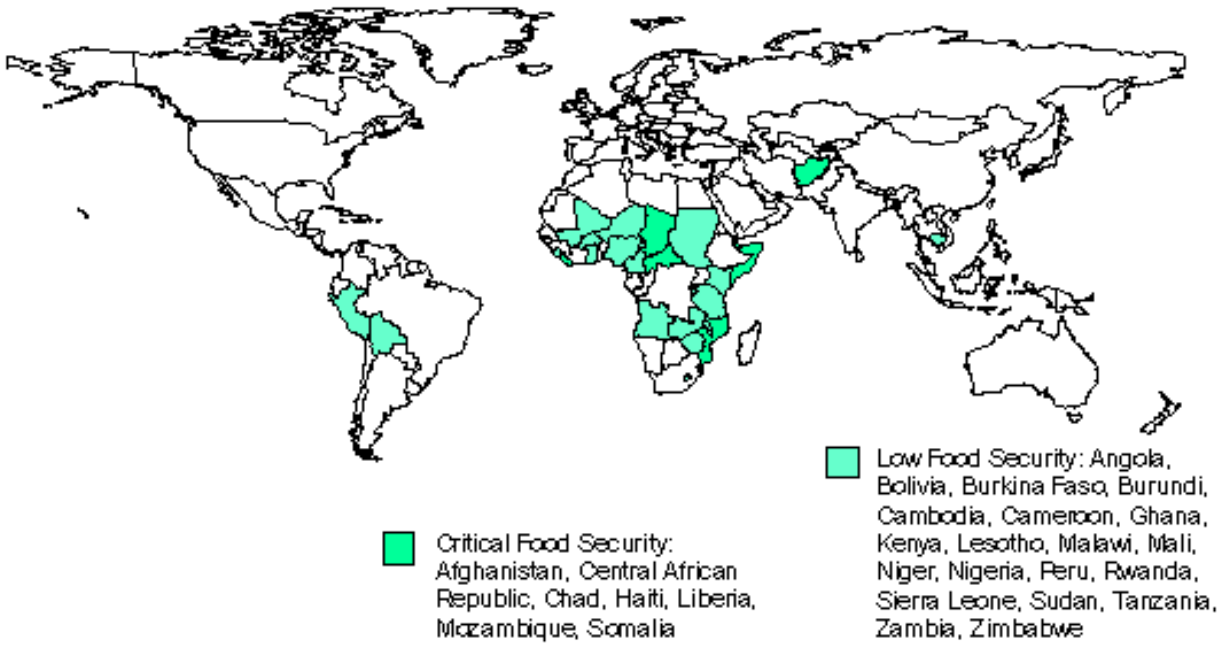


Figure 10.5 Developing Countries with Low or Critical Food Security Indexes, 1990–92



2.6. THE CASE STUDY REGION COUNTRY TO COUNTRY

Our study will not be plausible if we don't have some general vision of the region, on country-to-country basis. International data is available at this level, with some usual (but different depending on the source) aggregations. Finally, our multilevel integrated assessment will be done to this level.

Taken into account that this is not the subject and neither the goal of our work we only add to this study an "A.1. Country to country General Information Appendix" with this kind of background, from two basic sources available in the Internet WEB pages of WB and CIA [B.5.2.].