Sustainable Development in West Africa: Beginning the Process

A Collaborative Study of
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and
Environnement et Développement du Tiers-Monde

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June 1999
Published by the Stockholm Environment Institute - Boston Center

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1. The Region and the Challenge

The challenge of sustainable development is to harmonize economic, social and environment objectives. For development to be sustainable, it must address the aims and aspirations of today while passing on robust and resilient environmental and socio-economic systems to future generations. The quest for sustainable development poses new challenges for science and policy. The concern for both socio-economic and biophysical aspects of development requires that we transcend a sectoral focus to adopt a holistic viewpoint of *socio-ecological* systems that is sensitive to the multiple linkages and interactions among environmental and societal issues. The concern for the future requires a long-range time horizon that considers the implications of today's conditions in trends over the coming decades — where are we going? It also puts on the collective agenda the question of vision — where do we want to go? — and action — how do we get there?

The transition to sustainable forms of development will be a long and complex process. The objective of this project is to help launch that process in West Africa. Specifically, it focuses on the countries in the UEMOA region, the Union Economique et Monetaire Ouest Africain. The study is the first to assess current patterns of development and resource use in the region, with a view to evaluating the sustainability of current practices into the future. After setting the context for the issue of sustainable development in the region in the first chapter, the second chapter provides a country-by-country profile of the historical trends and current state of a range of development indicators: social, economic, resource and environmental. The third chapter presents a Conventional Development scenario, a possible picture of the region in 2025 assuming current trends, typical assumptions about economic growth and demographic change, and no major new policies to address the challenge of sustainable development challenge. The final chapter discusses the strategic implications of this initial analysis, the need to consider alternative scenarios and policies, and the next steps in the process of advancing sustainable development in West Africa.

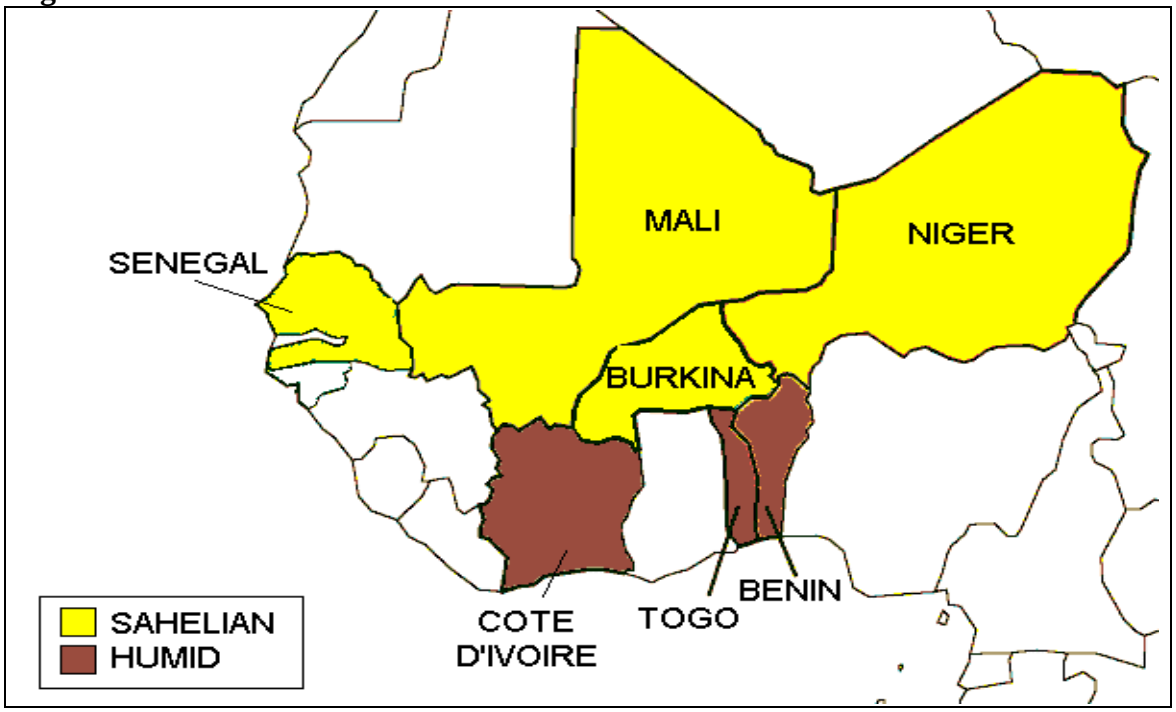
1.1 The UEMOA States: an Overview

The UEMOA is a regional governmental organization consisting of the Francophone West Africa states — Benin, Burkina Faso, Côte d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo[1]. These countries are situated in the north-western part of Sub-Saharan Africa (Figure 1-1). The UEMOA region covers a wide range of ecological zones, from the humid south to the arid north. The northern parts of Mali and Niger extend into the Sahara, while large areas in Burkina Faso, Mali, Niger and Senegal are in the Sahel — the transitional region between the desert to the north and the wetter areas to the south. Because of the special constraints imposed by the drier climate, it is useful to distinguish these four *Sahelian* countries from the wetter *humid* countries to the south — Benin, Côte d'Ivoire and Togo.

[1] Guinea-Bissau descended into civil war shortly after joining the UEMOA and is excluded from this study.

The Sahelian region is dominated by areas with erratic rainfall and fragile soils. Moving from the south to the north, the land becomes progressively less suitable for settled agriculture, and in the drier part of the countries, agricultural production is dominated by pastoralist livestock production. Three of the four Sahelian countries — Burkina Faso, Mali and Niger — are landlocked, while Senegal has access to the coast on its western border. For the landlocked countries the restricted access to international markets is a common constraint on development (Snrech, 1995). The lack of direct access to the coast is exacerbated by the decline of the road network in Togo. Prior to the 1990s, Togo had a well-developed system of roads that connected the Sahelian countries to the coast, but this has deteriorated as a result of political crisis. The humid region along the southern coast of West Africa is relatively favorable for agricultural production, although the soils are low in phosphorous (World Bank, 1996b).

Figure 1-1. The UEMOA Countries



The UEMOA countries are all at or near the bottom of most tables of global development indicators, with Niger, Mali and Burkina Faso experiencing some of the lowest per capita incomes in the world. West African has experienced considerable political turmoil, although the UEMOA countries have largely avoided the worst ravages of war experienced by such neighbors as Sierra Leone, Liberia, Sudan, and Algeria. Stability in some UEMOA countries is related to the long-term dominance of a single political group. Others, notably Mali and Burkina Faso, have recently experienced serious political unrest and are in a stage of consolidation. The long term prospects for stability in the region are difficult to predict.

The UEMOA region is rich in energy, mineral and natural resources, although current levels of exploitation are low and monetary benefits are often directed outside the region. The region's institutional and administrative capacity is weak as is its transport, communications and other infrastructure. To take a single example, there is less than one telephone line per one hundred people. Population in the region is expanding at an annual rate of about 3%. While growing in recent years, GDP has not kept pace with population growth. Standards of living in the region are falling as a result. West Africa is dependent largely on agricultural production for both domestic food needs and export revenue. However, the productivity of this sector is at risk from desertification. The industrial base, which is the primary focus of governmental development efforts, remains weak.

Underdevelopment and stagnation of the region are not inevitable. There is great scope for improving and accelerating the development process in a manner that is informed by a concern for the environment and for the conservation of resources. It is important that the region determine its own path for sustainable development and not allow the environmental issues of industrialized countries to dominate the agenda. For example, while regional energy consumption is the lowest in the world and air pollution levels are not high, they both will rise as the economy grows. The challenge is to fashion a region-specific strategy that avoids the environmental degradation and resource depletion that accompanied industrial development in the past.

This is an opportune moment for rethinking the developmental paradigm in the UEMOA states. The wave of democratization and economic liberalization in Africa in the 1990s, despite setbacks, could provide a context for building environmental considerations into economic growth and social development in the region. A major impetus for this has its roots in the Earth Summit of 1992 in Rio de Janeiro, which underscored the seriousness of environmental problems facing Africa in the near future, particularly desertification (UNCED, 1992). These issues have captured the attention of the global community. The challenge is to ensure that actions to address them will contribute to, rather than obstruct, local and regional development. Sustainability and development must be mutually reinforcing objectives in the African context and, in particular, in West Africa its poorest region.

1.2 Integrating the Region

A large and growing body of opinion holds that regional cooperation, with a view to eventual integration, is the optimal approach to sustainable development in West Africa. In a region of great geographical and social diversity, geopolitical boundaries only rarely correspond to cultural and ecological zones. The causes of environmental degradation tend to be common across West Africa's various shared ecosystems: extensive farming, a loss of fallow area, demographic pressure, water-management complications and farmer-herder conflicts. The nation-state has not yet succeeded in bringing either stability or coherent development in the region. Reconceptualization of development as a region-wide challenge reveals enormous potential for market expansion, infrastructure integration and resource exploitation.

Regionalism has a long history in West Africa. In pre-colonial times, the area was replete with trans-regional trading routes between the Sahel and the Coast, before often arbitrary frontiers solidified into linguistic and commercial barriers. The old trade routes persist to some extent in the informal economic sectors of West Africa, despite stringent border controls and exorbitant excise taxes. In contemporary West Africa, various regional formations have emerged. The Economic Community of West African States (ECOWAS), a comprehensive and ambitious effort at integration, rewrote its basic treaty in 1993. Hampered by the divergent economies and histories of the Anglophone and Francophone nations under its umbrella, ECOWAS' impact has so far been more visible on regional security issues. In the health sector, the Francophone OCCGE (Organisation de Coordination et de Cooperation pour le lutte contre les Grandes Endémies) and the Anglophone West African Health Community (WAHC) are soon to join forces. There are two organizations for managing the river basins of the Senegal and Gambia rivers: the OMVS (Organisation pour la Mise en Valeur du fleuve Sénégal) and the OMVG (Organisation pour la Mise en Valeur du fleuve Gambie). The CILSS (Comité permanent inter-état de lutte contre la sécheresse dans le Sahel) addresses drought issues, and, along with the Club du Sahel, has produced a number of significant texts examining the potential for sustainability across the region, particularly with a view to stemming the tide of desertification in the region.

The UEMOA was created in 1994 from the UMOA (Union Monetaire Ouest Africain) and the CEAO (Communauté Economique des Etats de l'Afrique de l'Ouest), uniting the countries of the CFA Franc monetary zone. The UEMOA exercises some regulatory authority in regional fiscal issues, and is expected eventually to assume greater regulatory powers akin to its counterpart in Europe, the European Union. The UEMOA is potentially the most significant entity for promoting trans-regional action for sustainable development, although the body does not focus explicitly on this goal at present. Its constitutional treaty of 1994 emphasizes the principle of subsidiarity, establishes a supranational commission modeled on that of the EU and outlines five major objectives:

- encourage competition in an open and competitive market within a reasoned juridical environment;
- achieve convergence between policy and macro-economic policy indicators;
- create a common market;
- coordinate sectoral policies;
- align budgetary policies.

In addition, a number of legislative mechanisms are stipulated including a prohibition on the introduction of new protectionist barriers between member states and measures for surveillance of the alignment of economic policy with a provision for sanctions.

UEMOA's concern with monetary and economic matters to date — an orientation which reflects the notion that economic integration is the key to regional integration — will support regional investment in industry, agriculture, transport, communications and energy infrastructure. In the future, it is critical that the principles of sustainability become

explicit in the UEMOA, just as it is essential that other regional bodies working in sustainable development align themselves with the UEMOA.

1.3 Planning Environmental Action

The emergence of environmental issues in the last twenty years has significantly influenced development ideas in the region. Before Rio there was a perception of conflict between development and environmental goals, since conventional economic expansion demanded exploitation of the environment. However, Agenda 21, drawing on the Brundtland report (WCED, 1987), noted that in order to satisfy current needs and preserve resources for the future, new modes of development were needed. With the breakdown of colonial models of wealth extraction and exploitation of the natural resource base, the principle of sustainability was strikingly appropriate to the African context where the environment is a vulnerable and crucial element of development. One result is that African states are actively engaged in the formulation and implementation of the UN Conventions on biodiversity, climate change and desertification. Although these efforts are conducted primarily at the national level at present, concerted regional action offers enormous potential.

Since Rio, all the UEMOA states have embarked on a process of elaborating National Environmental Action Plans (NEAPs). An important aspect of these plans is a National Action Plan (NAP) to combat desertification, as required by the UN Convention to Combat Desertification (CCD). A number of states have completed their NEAP and have gone on to the implementation phase. The NEAPs and NAPs constitute statements by these countries of their intent to pursue an ecologically balanced course in the future. While the general trend is towards an acceptance of sustainable development objectives, problems arise at the national administrative level. For example, responsibility for NEAPs and NAPs generally lies with the Ministries for the Environment rather than for Development, and coordination between the different departments is not always transparent.

The Convention to Combat Desertification encourages local participative action. Ideally, the implementing bodies will provide a framework for the coordination of local actions and the exchange of relevant information. Desertification is a major environmental issue in the UEMOA countries, four of which are Sahelian, and ultimately measures taken to combat it will alter the agricultural, land-use and energy-use systems of the area, which will in turn affect the systems of food production and wealth distribution. These long term development impacts should be monitored and integrated into the planning of any scenario for the future of the region.

Another major regional concern is global climate change. The greenhouse gas emissions of countries of the region are insignificant in global terms; the major sources of emissions that do exist are from land-use changes and deforestation. However, West Africa, and particularly the Sahel, is one of the areas most vulnerable to climate change due to its

propensity for drought and desertification, and its dependence on subsistence agriculture. The region is likely to experience increases in extreme events such as drought and desertification, along with increasing average rainfall in the humid regions, although it is not yet possible to predict these effects with high scientific confidence (IPCC, 1996; Hulme et al., 1995). Properly designed and implemented, the region could benefit from initiatives to mitigate climate change, particularly the Global Environmental Fund (GEF) and the Clean Development Mechanism (CDM). These are intended to contribute to sustainable development while mitigating greenhouse gas emissions. African countries are exploring how best to engage with the CDM, but the uncertainty surrounding its design and implementation prevent a definitive determination at this time of its potential contribution to regional development.

1.4 Bracing for the future

The importance of a coherent approach to development and the environment for the countries of the UEMOA region cannot be overstated. However, these twin aspects of sustainable development remain largely isolated from one another at present. Despite the apparent stasis in development since independence, West African society and culture thrives and features many traditional forms of sustainable production, which are merely invisible to the eyes of conventional developers. This study exposes some of the limits of conventional development thinking in the light of their long-term unsustainability. It will be for a future study to better approach the reality of the often hidden modes of living and producing which may provide the basis for a sustainable development path into the future.

A key to a sustainability transition in the region is to transcend the limits of the nation-state to consider opportunities for the region as a whole. A regional approach is an important means to achieve sustainable development in West Africa, since environmental, economic and social conditions are shared without reference to geopolitical boundaries. The challenges are great, but so are the opportunities for fashioning a form of development that is true to the West African heritage as well as the principles of sustainability. This study, we hope, will help lay the groundwork.

2. Current Patterns

The previous chapter surveyed the broad challenges facing West Africa as it seeks to meet the dual goals of social development and environmental protection. Now we look in more detail at the historical trends and current state of a range of social, economic, resource and environmental indicators.

2.1 Demography

Populations in the region have been growing rapidly over the past decades compared to the world average (Table 2-1). Between 1994 and 1995, in the region as a whole population grew at close to the average rate for Africa, around 3% per year, twice the average rate for the world as a whole. The growth rates in individual countries varied from 2.6% per year in Senegal to 3.4% per year in Niger. Over the thirty-year period from 1965 to 1995, population in the region more than doubled. A central concern today and in the future is how to meet the needs of the rapidly growing population while maintaining the natural resource base on which livelihoods in the region depend.

Table 2-1. Population and GDP

	Population (millions)			Population growth rate (ave. ann., %)	Urbanization (%)		GDP_{PPP} (billion IN$)	GDP_{PPP} per capita (IN$/cap)
	1965	1990	1995	1990-1995	1980	1995	1995	1995
Benin	2.3	4.7	5.4	2.9	25	31	10.0	1,842
Burkina Faso	4.5	9.1	10.5	2.9	8	27	8.0	759
Cote d'Ivoire	3.9	11.7	13.7	3.2	35	44	23.6	1,721
Mali	4.5	9.2	10.8	3.2	18	27	5.9	546
Niger	3.1	7.7	9.2	3.4	12	17	6.4	702
Senegal	3.3	7.3	8.3	2.6	36	42	14.2	1,708
Togo	1.5	3.5	4.1	3.0	23	31	4.6	1,128
UEMOA	23	53	62	3.1	23	32	73	1,173
Africa	289	629	719	2.7	-	34	1,165	1,619
World	3,086	5,282	5,687	1.5	40	46	33,416	5,876

Sources: Population from UN (1997), Urbanization from WRI (1996), GDP from World Bank (1998) and SESRTCIC (1997).

As the regional population has grown, it has also become more urbanized, from 23% of the regional population in 1980 to 32% in 1995, compared to just under 50% for the world overall (Table 2-1).

There has also been a general migration in the region from the north to the south, both within countries and within the region. The migration is driven in part by the greater economic opportunities in these countries, especially in the cities (Snrech, 1995), by population growth and also by the climatic conditions in the arid northern part of the region, which are prone to desertification and are less suitable for agriculture. Adding to

the pressure, over the past three decades the region has been drier than average, as rainfall in the Sahel has been lower than the long-term average (UNEP, 1997). These migration patterns are placing increasing stress on resources, ecosystems and human infrastructure, particularly in cities and coastal areas.

2.2 Economy

As shown in Table 2-1, average income varies considerably across the region, from around $550 per capita in Mali to over $1,800 per capita in Benin.[2] In every case, the average income is smaller than the average for Africa as a whole, and considerably below the world average. Accordingly, a large proportion of private consumption is devoted to basic necessities — in Benin, Côte d'Ivoire, Mali and Senegal, between 35% and 50% of private consumption expenditure is for food (World Bank, 1998), highlighting the vulnerability of the region's peoples to fluctuations in commodity prices. By comparison, in the wealthier industrialized countries, around 10% of private consumption expenditure is for food. Average incomes are noticeably lower in the landlocked Sahelian countries compared to the humid countries or Senegal. The average income for the humid countries is about $1,650, while that of the landlocked Sahelian countries is $670 and for Senegal is about $1,710, reflecting the geographical development constraints outlined in Section 1.1.

In recent decades, the economies of the region have stagnated, as average per capita income levels have been declining in real terms. Fiscal policies in the region have contributed to this situation. All seven of the UEMOA states share the same currency, the CFA franc, which is guaranteed by the French franc at a fixed rate of exchange, and administered by the BCEAO (Banque Centrale des Etats de l'Afrique de l'Ouest), the independent central bank of the UEMOA. While this arrangement protects it from the speculative pressures that can be wrought upon the currencies of small countries, it also makes the region's economies vulnerable to changes in the value of the franc. In the seventies and early eighties as the economies in the region slumped, the CFA rose in value alongside the strong franc. This led to capital flight, decreasing foreign investment and declining exports. Finally, in January 1994, the CFA was cut to half its former value by the BCEAO at the behest of the international monetary bodies. After the devaluation, real GDP throughout the zone has increased for the first time in over ten years, inflation has been checked and exports have become competitive and profitable, although the devaluation inflated national debts. Devaluation was only a first step in building an effective economic base for the development of the UEMOA states.

As shown in Table 2-2, agriculture plays an important role in the regional economies, reflecting the low level of development in the region. Between 60% and over 90% of the economically active population is engaged in agriculture, higher than the roughly 50% average for the world as a whole. The contribution of agriculture to GDP is also much

[2] Currencies are expressed in common units adjusted for purchasing power parity (PPP). The PPP approach, in which prices of a common "basket of goods" are compared across countries, gives a more realistic picture of relative incomes than the more commonly used market exchange rates (MER) (WRI, 1998).

higher than the world average, 31% compared to 11%, and is higher than the 21% for Africa as a whole. In contrast, industry contributes only about 20% to the total production from the region, compared to around 30% both for Africa and for the world as a whole. Much of the agricultural production is at a subsistence level, emphasizing the vulnerability of the population to land degradation and other environmental impacts.

Table 2-2. Structure of GDP and employment

	Industry as % of GDP 1995	Services as % of GDP 1995	Agriculture as % of GDP 1995	Population Employed in Industry (%) 1994	Population Employed in Services (%) 1994	Population Employed in Agriculture (%) 1994
Benin	12	54	34	8	28	63
Burkina Faso	27	39	34	2	6	92
Cote d'Ivoire	20	50	30	10	30	60
Mali	17	37	46	2	12	86
Niger	17	44	39	4	6	90
Senegal	18	62	20	7	16	77
Togo	21	41	38	10	25	66
UEMOA	19	50	31	5	16	79
Africa	31	47	21	10	26	64
World	33	56	11	30	20	50

Note: Employment as a percentage of economically active population; UEMOA averages weighted by GDP in PPP terms.

Sources: Distribution of GDP by country from WRI (1998), for Africa and World from Raskin et al. (1998); Employment from World Bank (1997, 1998).

In most of the countries agricultural products are the most important exports. In Benin, Burkina Faso and Mali, cotton is one of the principal exports; both Burkina Faso and Mali export livestock; Côte d'Ivoire exports cocoa and coffee; and in Senegal the main exports are fish and groundnuts. In Niger and Togo the most important exports are mineral ores — uranium and phosphates — while the second most important exports are agricultural products. This reliance on a limited range of food and basic commodity exports makes the UEMOA countries vulnerable to price fluctuations in international commodity markets.

The region's rich mineral endowment remains only minimally exploited. At current rates of extraction, the important mineral resources of Niger and Togo will last many decades. Estimated uranium resources in Niger (WEC, 1995) would last more than 100 years at current rates, and phosphorous resources in Togo (Mobbs, 1996) another 50 years.

The trade picture in the region is mixed. The value of aggregate exports exceeds imports, as shown by the negative resource gap for the region in Table 2-3. (The resource gap — net imports as a percentage of GDP — is a measure of the degree to which a country relies on imports rather than its own resources to meet domestic demand.) However, there is considerable variation between countries. In each of the Sahelian regions, imports exceed exports, by as much as 8% of GDP in Mali. Furthermore, a more complete picture of the economic situation in the region must also include the debt burden carried by the countries. Côte d'Ivoire, the largest exporter in the region, also has the highest level of external debt, accumulated during a boom period in the late 1970s (World Bank, 1996a; ENDA-TM, 1995). As shown in Table 2-3, the total debt for the region as whole

exceeds regional GDP, and service on the debt amounts to around 20% of export receipts. As a result, while there is net income from trade, it is currently used to service the region's debt payments, constraining investment in the region.

Table 2-3. Debt and trade

	Debt Service (% of Exports) 1996	Total Extern. Debt (% of GDP) 1996	Resource Gap (Net Imports as % of GDP) 1996	Net Exports Less Debt Service (as % of GDP) 1996
Benin	7	72	(3)	1
Burkina Faso	11	51	5	(6)
Cote d'Ivoire	26	184	(10)	(2)
Mali	18	114	8	(12)
Niger	17	78	7	(10)
Senegal	16	71	5	(9)
Togo	11	103	(3)	(0)
UEMOA	21	121	(2)	(7)

Note: Resource gap calculated as the difference of imports and exports of goods and services (from balance of payments) as a percentage of GDP.
Source: World Bank (1998)

2.3 Human Development

All countries in the region suffer from dire poverty and the inadequate provision of basic needs. This is reflected in the social indicators shown in Table 2-4. The table shows average life span, infant mortality rates, the percentage of the population with access to safe water, the literate percentage of the adult population, and the incidence of chronic undernutrition. Where available, historical values are also shown.

Table 2-4. Social indicators

	Life Expectancy (years)		Infant Mortality (per 1000 live births)		Safe Water (%)		Adult Literacy (%)		Hunger (%)		Hunger (millions)	
	1960	1995	1960	1996	1980	1995	1970	1995	1970	1995	1970	1995
Benin	37	54	179	84		50	10	37	36	18	1.0	1.0
Burkina Faso	36	46	186	82	35	78	8	19	66	37	3.6	3.8
Cote d'Ivoire	39	52	165	90	20	72	16	40	24	19	1.3	2.7
Mali	35	47	209	134		37	7	31	45	30	2.5	2.9
Niger	35	48	191	191		53	6	14	48	32	2.0	2.9
Senegal	37	50	172	74		50	15	33	24	30	1.0	2.5
Togo	39	50	182	78			23	52	30	27	0.6	1.1
UEMOA	37	49							41	28	12	17
Africa		55				51		55	35	34	128	247
Dev. Countries	46	62	149	65			48	70	35	20	940	873
World	50	63	129	60				78	25	16	940	898

Note: Hunger in 1970 for the world set to the value for developing countries.
Sources: Life expectancy, infant mortality and adult literacy from UNDP (1998); safe water from World Bank (1998); hunger FAO (1996b, 1997a); values for Africa and the world in 1995 from Raskin et al. (1998); except for hunger, values for developing countries from UNDP (1998); for hunger, value for developing countries in 1995 is from Raskin et al. (1998).

While there is considerable spread across the region, all the UEMOA country indicators are below the world average, and in general below those for Africa and for the developing countries as a whole. This is reflected in the composite UNDP Human Development Indicator, where the UEMOA countries are ranked between 144 and 173 out of 174

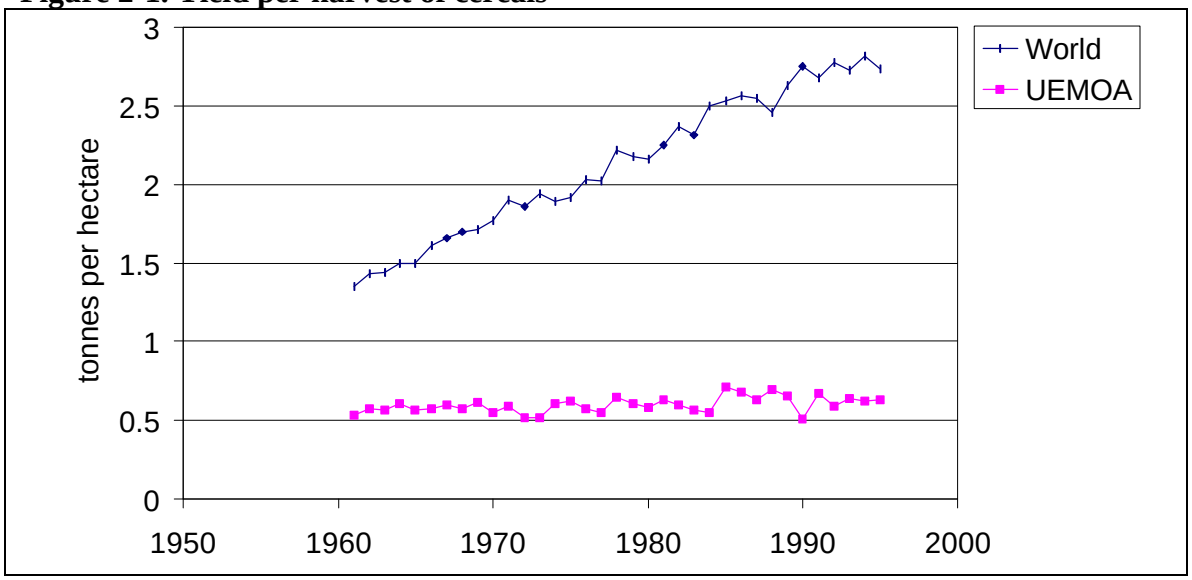
countries reported (UNDP, 1998). Nevertheless, as shown on Table 2-4, for nearly every indicator in nearly every country there has been improvement, often substantial over the last few decades. For example, in every country except Senegal, the incidence of hunger as a percentage of the population dropped between 1970 and 1995. However, the decline was not enough to offset the effects of population growth: so that while hunger decreased as a percentage of the population, it increased in absolute numbers by over 40%.

The low levels of development shown by the social indicators are consistent with the low average incomes shown earlier in Table 2-1. The average indicators are also affected by the distribution of income within countries. Data on income distribution for the region are scarce. Figures are only available for Côte d'Ivoire, Niger and Senegal, where the ratio of the average expenditure of the lowest-earning 20% of the population to that of the highest-earning 20% varies from around 0.05 to 0.15 (higher figures reflect more equitable distribution), compared to 0.13 for Africa as a whole and 0.11 for North America (Raskin et al., 1998) .

2.4 Food and Agriculture

Agriculture in West Africa remains a predominantly subsistence activity, although it is becoming progressively more market-oriented (Snrech, 1995). Due to a combination of economic, institutional and climatic factors, the rapid growth in crop production of the Green Revolution of the 1960s and 1970s was largely confined to South Asia and Latin America, while Sub-Saharan Africa saw little change (Conway, 1997). One factor contributing to the difference is that the most important food crops for the Sahelian countries — drought-tolerant cereals like sorghum and millet — were not an initial focus of Green Revolution research. Average cereal yields in the UEMOA countries have remained nearly constant between 1961 and 1995, compared to the rapid growth for the world as a whole (Figure 2-1). Although new varieties of sorghum and millet have been developed, adoption of the new plants has been slow. The vulnerability of effected populations and the risky nature of agricultural production in semi-arid areas makes farmers less willing to spend their limited resources on new approaches (FAO/ICRISAT, 1996). Production of millet is still mostly concentrated on traditional varieties and few farmers apply fertilizer (because of high costs and limited availability) or adopt practices to improve conservation of soil moisture. Allocation of resources is probably limited by the perceived higher benefits from investments in areas other than land conservation. As a result of the relatively constant yields, increases in agricultural production have come about by extension onto previously uncultivated land and through a shortening of fallow times, leading to potential conflicts over land use and increased land degradation.

Figure 2-1. Yield per harvest of cereals



Source: FAO (1996a).

One of the major changes that drove the world growth in cereal yields since 1960 was the expansion of irrigation. In the UEMOA region, crop production is almost entirely on rainfed land, and rainfall in the region is erratic. As shown on Sheet F-7 in the Annex, only a small percentage of current cropland is irrigated. Also shown on Sheet F-7 are historical changes in the area of irrigated cropland, which has grown substantially in some countries in the region. Combined with the current low levels of irrigation, this suggests that considerable potential may exist for further expansion. Realizing the potential, however, will require large investments in a region where capital is scarce, and could lead to conflicts over the use of scarce water resources, as discussed in Section 2.5.

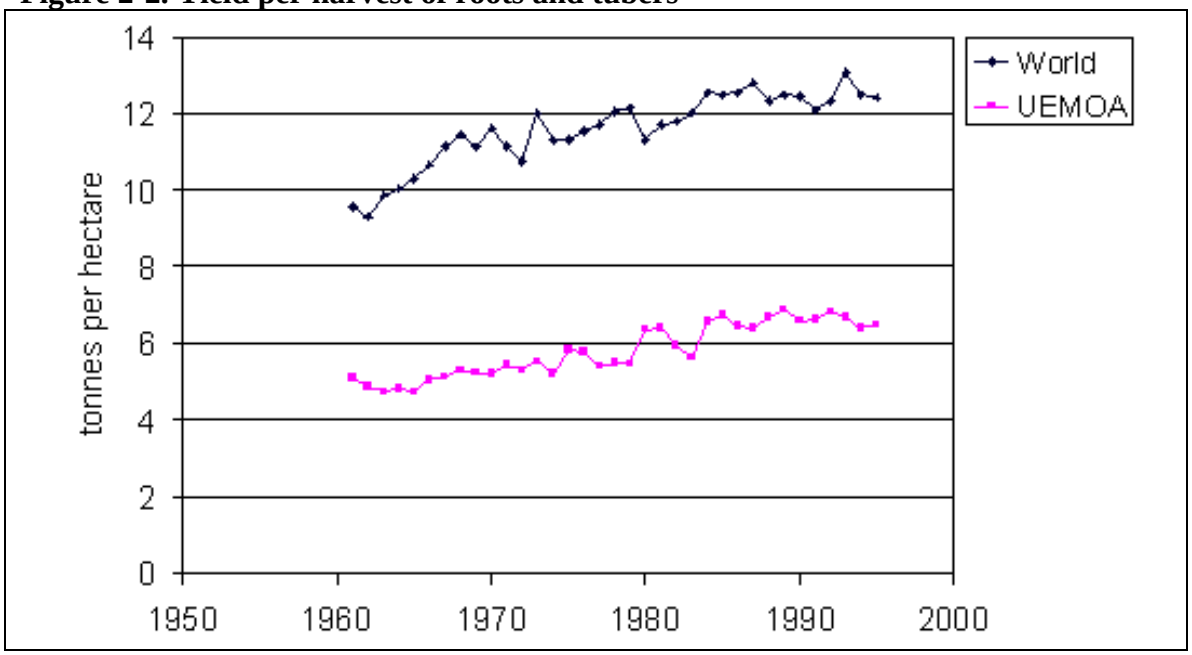
In the humid countries, roots and tubers contribute a comparable amount of calories to diets as cereals (Table 2-5). In contrast to the historical yield trends for cereals, the growth in yields of roots and tubers in the UEMOA region has been comparable to the world average, although regional yields remained well below global average yields (Figure 2-2). Also, cereal crops that have received more research attention, such as rice and maize, contribute more to total cereal production in the humid countries than in the Sahelian ones. In Côte d'Ivoire, where rice is an important component of diets, rice yields have increased by roughly a factor of 2 between 1961 and 1995, comparable to the increase in average cereal yields for the world.

Table 2-5. Average daily caloric intake in 1994

kcalories per capita per day	Cereals	Fish	Meat	Milk	Oil Crops	Other Crops	Roots & Tubers	Total
Benin	873	17	65	11	185	330	840	2,320
Burkina Faso	1,856	2	64	29	254	145	16	2,366
Cote d'Ivoire	913	24	58	10	126	514	652	2,296
Mali	1,500	12	91	85	212	187	8	2,094
Niger	1,530	1	58	48	57	373	77	2,144
Senegal	1,352	51	101	52	385	293	31	2,264
Togo	1,087	21	71	10	130	222	495	2,036

Source: FAO (1996a).

Figure 2-2. Yield per harvest of roots and tubers



Source: FAO (1996a).

As seen in Table 2-5, average daily caloric consumption ranges from around 2,000 to 2,300 kcalories per capita. The FAO estimates that if the populations in the regions are to have an adequate supply of food, average consumption must at least be between 2,700 and 2,860 kcalories per capita per day (FAO, 1996c). Average consumption is well below this minimum level, in keeping with the high levels of hunger shown in Table 2-4. As a result, to meet the basic food requirements of the region in the future, the amount of food available must increase faster than population, with implications for agricultural productivity, land and water use, and trade.

Animal products, such as meat and fish, contribute little to total diets in the region, but livestock production is important for sustenance and income in some parts. In the landlocked Sahelian countries, livestock contributes significantly to exports. Production is

livestock management has been associated in the past with land degradation and desertification, but recently it has become widely accepted that traditional pastoralist management practices are well adapted to conditions in the arid Sahel, and are effective at conserving land resources in these difficult environments (Behnke and Scoones, 1992; de Haan et al., 1997). However, the mobility that is essential to the traditional agricultural systems is being constrained by country boundaries and by rules of land tenure. Moreover, as population growth and increased pressure from reduced fallow periods places pressure on existing cropland, farmers are settling permanently on what was once wet-season grazing for pastoralist herders, leading to over-use of land, and conflicts between herders and farmers (de Haan et al., 1997). These pressures can lead to land degradation, which in turn increases the risks of drought, and causes increased poverty and migration (World Bank, 1996a).

Livestock production also takes place in the wetter parts of the region, but as the climate becomes more humid, disease is an increasingly important limiting factor. One of the most important animal diseases in Africa is trypanosomiasis, which is carried by the tsetse fly. Trypanosomiasis can be lethal for both livestock and people (when it is called "sleeping sickness"). Because of trypanosomiasis, it is estimated that cattle densities are up to 70% below their potential in humid regions of Africa, and around 37% below their potential in sub-humid areas. Trypano-tolerant breeds of cattle are found throughout the UEMOA region, but they are generally smaller and less valuable to farmers than the non-tolerant breeds, a factor which has limited their widespread adoption (FAO, 1998).

Trade in crops is shown in Table 2-6, and trade in livestock products is shown in Table 2-7. As seen in Table 2-6, most countries are close to self-sufficiency in the main components of diets — cereals, roots and tubers. However, Senegal imports a significant amount of cereals, and is a net importer of crop commodities. Senegal is also a net importer of livestock products, due to imports of milk products. The landlocked Sahelian countries are net importers of crop products (although Burkina Faso and Mali export some oil crops); they are all close to self-sufficiency in livestock products, and all export some meat.

Table 2-6. Self-sufficiency ratios for crop commodities in 1994

	Cereals	Oil Crops	Other Crops	Roots & Tubers	Total
Benin	0.84	2.05	0.35	1.00	0.85
Burkina Faso	0.95	1.04	0.96	0.99	0.96
Cote d'Ivoire	0.72	1.25	1.46	1.00	1.11
Mali	0.97	1.10	0.45	0.86	0.80
Niger	0.94	0.96	0.78	1.00	0.90
Senegal	0.63	1.06	0.70	0.87	0.71
Togo	0.89	1.19	0.69	1.00	0.90

Note: Self-sufficiency ratio is given by 1+(Net Exports)/Requirements. This may differ from the ratio Production/Requirements because of stock changes and statistical discrepancies.
Source: Based on FAO (1996a).

Table 2-7. Self-sufficiency ratios for livestock products in 1994

	Fish	Meat	Milk	Total
Benin	0.72	0.86	0.68	0.79
Burkina Faso	0.60	1.10	0.89	0.97
Cote d'Ivoire	0.40	0.99	0.26	0.62
Mali	0.97	1.13	0.92	0.99
Niger	0.71	1.09	0.96	1.00
Senegal	1.29	0.95	0.45	0.88
Togo	0.45	0.96	0.59	0.71

Note: Self-sufficiency ratio is given by 1+(Net Exports)/Requirements. This may differ from the ratio Production/Requirements because of stock changes and statistical discrepancies.
Source: Based on FAO (1996a).

Fish contribute little to dietary calories in the region, especially in the landlocked Sahelian countries, as shown in Table 2-5; however, in Senegal they are an important source of export earnings. Generally, fisheries in the UEMOA region are considered to be either fully or over-exploited, indicating that there is little possibility for expanding production from this source in the future (FAO, 1997c). Overfishing in the region may also lead to reduced catches in the future unless stocks are allowed to regenerate. However, there is potential for expanding aquaculture production, especially in Senegal and Togo (FAO, 1997b), although this has implications for water and land use and, unless carefully controlled, may have impacts on the sensitive ecology of coastal regions. Note however, that when carefully implemented, aquaculture can help alleviate pollution problems from certain agricultural land practices (FAO, 1997b).

2.5 Water

By some measures, renewable water resources in the region appear relatively abundant. One measure, the use-to-resource ratio (given by total water withdrawals divided by the available renewable resources), provides an overall gauge of the average pressure on available resources. A value as low as 0.10 for this measure may indicate the onset of stress (Raskin et al., 1997). As shown in Table 2-8, values for this measure range from 0.01 to 0.03 for the UEMOA countries, indicating no generalized stress for the region.

Table 2-8. Annual renewable water resources in 1995

	Internal Resources (km^3)			Cross-border flows (km^3)		Coefficient of Variation	Use / Resource	Use / Internal Resource
	Ground	Surface	Total	Total	Dependency	of Precip.		
Benin	2	9	10	16	0.60	0.06	0.01	0.01
Burkina Faso	10	8	18	0	0.00	0.06	0.02	0.02
Cote d'Ivoire	38	39	77	1	0.01	0.05	0.01	0.01
Mali	20	40	60	40	0.40	0.13	0.03	0.04
Niger	3	0	4	29	0.89	0.14	0.02	0.20
Senegal	8	19	26	13	0.33	0.12	0.03	0.05
Togo	6	6	12	1	0.04	0.07	0.01	0.01

Sources: Internal resources and cross-border flows (FAO, 1995); coefficient of variation (Raskin et al., 1997); use-to-resource ratios based on (FAO, 1995).

However, looking beyond the picture painted by this measure, the situation appears less favorable. As shown in Table 2-8, an important issue for some countries, especially Niger, is their dependency on outside water resources, as measured by the dependency ratio, the ratio of outside flows to total resources. In Niger, nearly all of the total renewable resources originate outside of the country. Most of the external resources are supplied by the Niger river (FAO, 1995), which crosses the extreme southwestern part of the country. This high degree of dependency makes Niger vulnerable to future reductions in cross-border flows should other countries increase their consumption, with implications for future conflicts over water resources. Such conflicts are already a familiar concern in other parts of the world such as North Africa, the Middle East and Central Asia.

In addition, the low values for the use-to-resource ratio shown in Table 2-8 may be more a reflection of low levels of access to water than of abundance, since withdrawals for domestic uses are small, between 4 and 17 cubic meters per capita, compared to the estimated minimal requirements for basic needs of 18 cubic meters per capita annually (Gleick, 1996). Furthermore, the use-to-resource ratio does not reflect the strong variation in the availability of water in the region, both in time and in space. Water supplies in both Mali and Niger are concentrated in the southwestern part of the country, limiting the availability of water in large parts of those countries. In the Sahelian countries most of the rivers are temporary, and rainfall is erratic and very localized (FAO, 1995). When the rains do come, they are hard and brief, which leads to an irregular supply of water for crops, and which can compact the soil surface and lead to soil loss from runoff. The tasks of using the available water efficiently, retaining the soil, and reducing the risk of crop failure from insufficient rainfall, are challenges faced annually by the region's farmers. There is strong inter-annual variation as well, as measured by the coefficient of variation of precipitation (Table 2-8). A value for this indicator above 0.06 may reveal a stress condition (Raskin et al., 1997). The values for all of the UEMOA countries except Côte d'Ivoire meet or exceed this threshold.

Finally, it is worth noting the likely effect of future increases in industrial and urban development and the expansion of irrigated agriculture. For example, irrigated agriculture currently accounts for 87% of water withdrawals in the region (Table 2-9), even though only about 2% of the cropland in the region is irrigated (Sheet F-7). This illustrates the potentially huge increases in withdrawals that may occur as irrigated agriculture expands. Without careful planning, the increased competition for scarce water resources caused by these effects will increase the level of water stress faced by subsistence households.

Table 2-9. Annual water withdrawals in 1995

	Contribution to Withdrawals (%)			Total
	Agricultural	Domestic	Industrial	(km3/year)
Benin	64	22	14	0.2
Burkina Faso	80	20	0	0.4
Cote d'Ivoire	67	24	9	0.9
Mali	98	1	1	2.5
Niger	84	14	1	0.7
Senegal	91	6	3	1.4
Togo	26	63	11	0.1
Total	87	10	3	6.1

Source: FAO (1995).

2.6 Energy and Air Pollution

The total final consumption and total primary supply of fuels in the region are summarized in Table 2-10. They clearly show the dominance of biomass, the dependency on oil imports, and the generally low levels of development of modern energy resources (natural gas, coal, crude oil and hydropower).

Table 2-10. Total final consumption and total primary supply of energy in 1995

	Total Final Consumption							
TJ	Crude Oil	Petroleum	Coal	Natural Gas	Electricity	Hydropower	Biomass	Total
Benin	-	3,647	-	-	872	-	65,845	70,364
Burkina Faso	-	4,914	-	-	708	-	68,940	74,562
Cote d'Ivoire	-	32,777	-	-	8,037	-	106,345	147,159
Mali	-	8,618	-	-	944	-	73,948	83,510
Niger	-	4,052	-	-	1,217	-	45,634	50,903
Senegal	-	25,983	-	1,883	2,708	-	56,057	86,631
Togo	-	9,706	-	-	1,373	-	26,837	37,916
Total	-	89,697	-	1,883	15,859	-	443,606	551,045
TJ	Total Primary Supply							
	Crude Oil	Petroleum	Coal	Natural Gas	Electricity	Hydropower	Biomass	Total
Benin	-	3,727	-	-	901	-	65,845	70,473
Burkina Faso	-	7,027	-	-	10	266	68,940	76,243
Cote d'Ivoire	90,275	(33,089)	-	-	169	3,506	106,345	167,206
Mali	-	9,710	-	-	-	803	73,948	84,461
Niger	-	4,775	1,765	-	665	-	45,634	52,839
Senegal	30,346	9,295	-	1,883	197	-	56,057	97,778
Togo	-	11,132	-	-	1,078	22	26,837	39,069
Total	120,621	12,577	1,765	1,883	3,020	4,597	443,606	588,069

Notes: Total primary supply = production + imports – exports; 1 TJ=10^{12} Joules.
Sources: Benin, Côte d'Ivoire and Senegal from IEA (1997). Others based on EIA (1998) and ENDA-TM (1995).

The low level of development of modern fuels is reflected in the relatively low levels of electricity consumption (Table 2-11). Electricity demand per capita ranges from around 20 kWh per capita in Burkina Faso to 160 kWh per capita in Côte d'Ivoire, compared to an average of 390 kWh per capita for Africa as a whole, and 1,884 kWh per capita on average for the world. In Côte d'Ivoire only around 20% of the population has access to electricity, while in Mali the figure is as low as 5% (World Bank, 1998). Most energy needs are met from biomass fuels, such as wood, charcoal and agricultural residues, which

contribute from around 65% to over 90% of total final demand, with biomass demand being dominated by the consumption of the household and informal sectors. The levels are generally higher than the 60% supplied by biomass for Africa as a whole, and much higher than the 13% worldwide. Petroleum products are the second largest category of energy consumption, reflecting their importance in the transport, industrial, household and electricity generation sectors. It is also worth noting the importance of both animal and human power in providing transportation services in the region.[3] In summary, the energy picture reflects the chronic poverty in the region.

Table 2-11. Electric power consumption and hydroelectric supply in 1995

	kWh/cap	Hydroelectric (%)
Benin	44	0
Burkina Faso	19	38
Cote d'Ivoire	160	44
Mali	27	85
Niger	38	0
Senegal	89	0
Togo	93	2
UEMOA	72	0
Africa	391	22
World	1884	24

Sources: Benin, Côte d'Ivoire and Senegal from IEA (1997). Others from EIA (1998).

Largely as a result of the widespread use of biomass as a fuel, emissions of greenhouse gases and other air and water pollutants arising from energy combustion from the region remain small — at most 0.1 tonnes of carbon per capita per year (Sheet P-4), compared to around 5 tonnes per capita per year in North America (Raskin et al., 1998). However, they are likely to grow substantially in the future. Indeed, even environmentally-sound economic development will inevitably require a large increase in the consumption and production of energy and other resources. Increases in emissions of these pollutants will, therefore, be necessary for meeting social development targets. Nevertheless, it will be important for the countries in the region to be well informed about climate issues, so as to be able to position themselves to take advantage of the technology transfer and other investment opportunities that may arise from the post-Kyoto negotiations on combating climate change.

Localized pollution problems are likely to be a more pressing concern in West Africa. One example is the adverse health effects associated with indoor air pollution from the burning of biomass fuels. The burning of these fuels on traditional stoves is associated with a range of serious health impacts, including respiratory infections in young children, low birth weights of babies, adverse pregnancy outcomes, lung and heart disease, and cancer (Smith, 1993). A transition to sustainable development in West Africa requires a move away from the traditional use of biomass fuels in households and towards electricity

[3] Trypanosomiasis limits the use of draft animals in the more humid parts of the region.

and cleaner-burning fuels including, where necessary, greater use of fossil fuels. Moreover, heavy reliance on biomass fuels is associated with land degradation and deforestation, and these pressures can be expected to increase with growing population.

The contribution to electricity production from hydroelectric plants is shown in Table 2-11. In Burkina Faso, Côte d'Ivoire, and especially in Mali, hydroelectric power contributes significantly to the total supply. There is currently no hydropower generation in Niger, but an estimated 2,000 GWh could be produced each year by damming the Niger river (ENDA-TM, 1995). However, so far the low cost of imported electricity from Nigeria has made the project uneconomical (ENDA-TM, 1995). If the price of electricity from Nigeria were to increase, however, the project may become more attractive, potentially leading to conflicts over the use of cross-border river flows. As an indigenous and renewable energy resource, hydropower offers the benefits of reducing fuel import dependency and air pollution relative to fossil fuel-fired generating options. The benefits of hydropower are conditional, however. Its renewability is only approximate since reservoir siltification gradually erodes the resource potential, and the construction of large-scale hydroelectric facilities can cause significant disruption to local communities and ecosystems. Potential impacts include disturbance of the spawning grounds of migratory fish; flooding of natural habitats and displacement of populations; alteration of local hydrological patterns; and risks of catastrophic flooding from dam failure (Raskin and Margolis, 1995).

Most of the remaining electrical consumption is met from imports or from oil-fired plants. Imports are especially important in Benin, where around 98% of electricity is imported; Niger, where around half the electricity consumed is imported, mostly from Nigeria; and Togo, where imports are around 80% of total final consumption.

Some of the UEMOA countries have reserves of crude oil and natural gas. Benin produces crude oil, all of which is exported. At current rates of extraction, and without additional discoveries, the estimated reserves would last for another 16 years. Both Côte d'Ivoire and Senegal are net importers of crude oil, which they process in domestic refineries. Current reserves within Côte d'Ivoire will last another 19 years at current extraction rates. Figures for oil reserves in Senegal and Niger are not available, although oil and gas exploration in the countries is continuing actively (ENDA-TM, 1995; MBendi Information Services, 1999). Côte d'Ivoire is a net exporter of refinery products, while Senegal imports about 37% of total final consumption. Both countries use a substantial amount of petroleum for transportation, amounting to around 14% of total final consumption in Côte d'Ivoire and 24% in Senegal. Both Côte d'Ivoire and Senegal also have natural gas reserves. In 1995, Côte d'Ivoire was not producing any gas; the most important gas field in the country, containing around 15 cubic kilometers, was yet to be developed (ENDA-TM, 1995). The plan was to use the gas primarily in a new gas-burning electric power plant, intended to go into service in 1996, and at least some gas-powered electric plants are now in service there (Africa Info, 1998).

2.7 Land

The distribution of land in each country is shown in Table 2-12. Land use is given for the area under the built environment, agricultural land (cropland, grazing land and forest), protected land and a residual category called "other land." In the region as a whole, population densities are low compared to other regions of the world. However, this aggregate figure is misleading since large tracts of land in the region are poorly suited to high population densities. The large land area in Mali and Niger under the Sahara is reflected in the high proportion of "other" land and the low amount of potentially cultivable land. In Niger, especially, the low percentage of land area that is potentially cultivable, just 5% of the total, is indicative of the current and potential pressures arising from the growing population.

Table 2-12. Land use and potentially cultivable land in 1994

Millions of ha	Built Environment	Cropland	Pasture and Grazing	Forest Unprotected	Forest Protected	Other Protected	Other	Total	Potentially Cultivable (% of total)
Benin	0.4	1.9	0.4	2.8	0.3	0.8	4.5	11.1	28
Burkina Faso	0.7	3.6	6.0	12.0	0.9	2.7	1.6	27.4	34
Cote d'Ivoire	0.9	3.7	13.0	9.3	0.8	2.0	2.1	31.8	35
Mali	0.6	2.5	30.0	11.7	0.1	4.0	73.0	122.0	11
Niger	0.6	3.6	10.4	2.5	0.0	8.4	101.1	126.7	5
Senegal	0.6	2.4	5.7	5.0	1.3	2.2	2.2	19.3	35
Togo	0.3	2.4	0.2	0.9	0.0	0.6	1.0	5.4	38
Total	4.0	20.1	65.8	44.2	3.4	20.7	185.4	343.6	15

Sources: Built environment (estimate, based on Heaps et al., 1998); cropland, pasture, total forest and total land area 1994 figures from FAO (1996a); total protected land and protected forest from WCMC (1998a, b); potentially cultivable land from Alexandratos (1995).

In Burkina Faso and Senegal, the most important land cover is forest, which accounts for around 20% of the land area in the countries. Forest is also significant in Côte d'Ivoire, where it covers 17% of the total area. However, Côte d'Ivoire has suffered rapid deforestation, largely as a result of logging, with much of the forest replaced by plantation crops (FAO, 1997d). It has lost, on average, 7.7% of the forest area each year between 1980 and 1990 (WRI, 1998).[4] Between 1990 and 1995 the rate appears to have slowed considerably, to just 0.6% per year on average. This may reflect a decline in the quality of the wood being produced, perhaps as a result of overexploitation of forest resources (Millington et al., 1994). Forest area has also been lost at high rates in Benin and Togo, where deforestation rates exceeded 1% per year on average between 1980 and 1990, and between 1990 and 1995.

Different types of soil degradation have occurred in each of the UEMOA countries to different degrees. Deforestation in Côte d'Ivoire was mentioned above. In the Sahelian countries, where livestock production plays an important role in agriculture, land has been degraded as a result of overgrazing. Over one million hectares in Burkina Faso has been overgrazed to the point where it is no longer productive, and an additional million

[4] The area under forest given by WRI (1998) is 5.5 million hectares, about one-half the 11 million hectares recorded here. This illustrates the great uncertainty and range of definition of forest area. The definition used for this study includes area from which forest cover has been removed, but which is expected to be reforested in the near future (FAO, 1997).

hectares, nearly 20% of the grazing area, has been degraded to some degree, although it can still be used for livestock production.[5] In Mali, the area of overgrazed land, nearly all of which is still estimated to be productive, is half the total grazing area, while in Niger the overgrazed area is almost equal to the reported area of grazing land. In Senegal, around 3 million hectares of cropland, more than the current total cropland area, has been degraded through loss of nutrients to the point where it is no longer productive, and an additional area, between one-half and one million hectares, while still productive, is affected by salinization. The degradation has been the result of processes that are not only still continuing — extensive agricultural expansion, loss of fallow area, intensified use of grazing lands and fuelwood collection — but can be expected to increase in the future as populations grow. The result is not inevitable, but avoiding it will require concerted action. As mentioned in Chapter 1, several countries in the region have now produced plans for action — national environmental action plans (NEAPs) and national action plans (NAPs) to combat desertification. Measures being considered for the plan in Senegal, for example, include a review of the tenurial system and programs for soil conservation, improved farming practices, afforestation and agro-forestry (UNEP, 1997).

[5] Soil degradation estimates are based on the digital version (GRID/UNEP, 1991) of the GLASOD soil degradation map (Oldeman et al., 1991).

3. A Conventional Development Scenario

Beyond considering current environment and development problems, the concept of sustainable development asks that we look well into the future to evaluate the impacts of current practices and policies on the lives of coming generations. It asks also that we consider the competing needs of different sectors of society for available resources. To examine the requirements for a transition to sustainable development we need to take the long view and adopt an integrated systems perspective. While the future cannot be predicted with any certainty, scenarios can be constructed that illustrate the possible paths the region may follow and provide guidance in the formulation of policies and actions for a transition to sustainable development.

3.1 Scenario Methods

The long-range future is inherently unpredictable. Scenario analysis helps to clarify the possibilities and to identify strategies for sustainability. Development scenarios are plausible stories about how society and the environment might unfold over the coming decades. A broad range of alternative futures for the 21st Century are possible, all consistent with current conditions and trends (Gallopin et al., 1997). The trajectory of regional development will depend on a complex set of external economic and political factors. But it will also depend on critical policies, actions and choices of people in the region and in the international community as they respond to changing global, technological and institutional conditions.

The analysis in this study was developed with the assistance of the PoleStar system, a software tool to aid the generation and evaluation of alternative development scenarios.[6] PoleStar is both a comprehensive, flexible and easy-to-use accounting framework for mounting economic, resource and environmental information, as well as being a scenario-building tool for examining alternative development scenarios.

PoleStar is applicable at national, regional and global scales. The user customizes data structures, modeling relationships, time horizons, and spatial boundaries — all of which can be expanded or altered easily in the course of an analysis. The system accepts information generated from formal models, from existing studies, or any other sources the user wishes to draw upon.

An application generally begins with the current accounts, a snapshot of the current state of affairs. Current accounts and scenarios are developed through a series of linked modules. In the Pop, GDP, Income module, demographic and economic data and assumptions are entered. The module can also be used to examine income distribution and poverty issues. These macroeconomic variables set the scale of activity within the sectoral

[6] The PoleStar System was developed by SEI-Boston. More information is available on the internet at http://www.seib.org/polestar.html where the software can be downloaded.

modules. Then, scenarios are developed to explore alternative futures. Finally, environmental and resource pressures are computed and can be compared to user-defined sustainability criteria.

3.2 A Conventional Development Scenario for West Africa

In forging a regional development paradigm for transition to sustainability, a full range of alternative visions and scenarios will need to be articulated, analyzed and widely discussed. Such a comprehensive exploration is beyond the scope of this study. Instead, as a first step, we offer a Conventional Development Scenario (CDS) in the hopes of providing a baseline for beginning such a process. The scenario suggests where current trends and development policies may be leading, and the problems and risks of a "business-as-usual" future (Raskin et al., 1996). The CDS illustrates the problem of *unsustainability*. It is a point of departure for beginning a discussion of alternative scenarios for achieving sustainability goals and a baseline for policy discussions. The scenario is not a prediction. Indeed, the utility of the scenario approach is that it helps us to understand uncertainty and to formulate policies that can influence future patterns of development.

The time period of the CDS is 30 years, from 1995 to 2025. At the global level, the conventional development story is characterized by continuity, globalization and convergence. That is, it envisions a future in which institutions and technology evolve without major surprises, the world's economy and society become progressively more integrated and standards of living rise everywhere. The industrial regions evolve without major change in institutions and values, and developing regions gradually approach this market-driven model. Consumerism, structural adjustment, and liberal democracy eventually dominate, spurred by the continued development and global diffusion of information technology in an increasingly integrated world economic system.

The scenario is by no means simply an extrapolation of past trends. Indeed, for Africa the scenario is an optimistic story of economic take-off for the region as stagnation is overcome, and an era of "modernization" and growth emerges. For example, economic growth rates in the region are assumed to be higher than in the past, and agricultural yields rise faster than before. These changes are associated in the scenario with a growing industrial base, a gradual shift from subsistence to commercial agriculture and the evolution of effective governance systems. Despite these changes, and to some extent because of them, pressures on resources grow and inequity within West African nations persists. A key feature of this market-led scenario is the absence of a comprehensive and coordinated policy effort to address social and environmental issues.

It is useful to consider a specific quantitative illustration of the CDS. To do so, we draw on mid-range projections and long-range assumptions from international organizations and major studies. In particular, the CDS relies on the Reference scenario developed for Africa by the recent work of the Global Scenario Group, an international and interdisciplinary body engaged in the exploration of alternative futures and their policy implications (Raskin et al., 1998; Heaps et al., 1998). The illustrative CDS for the

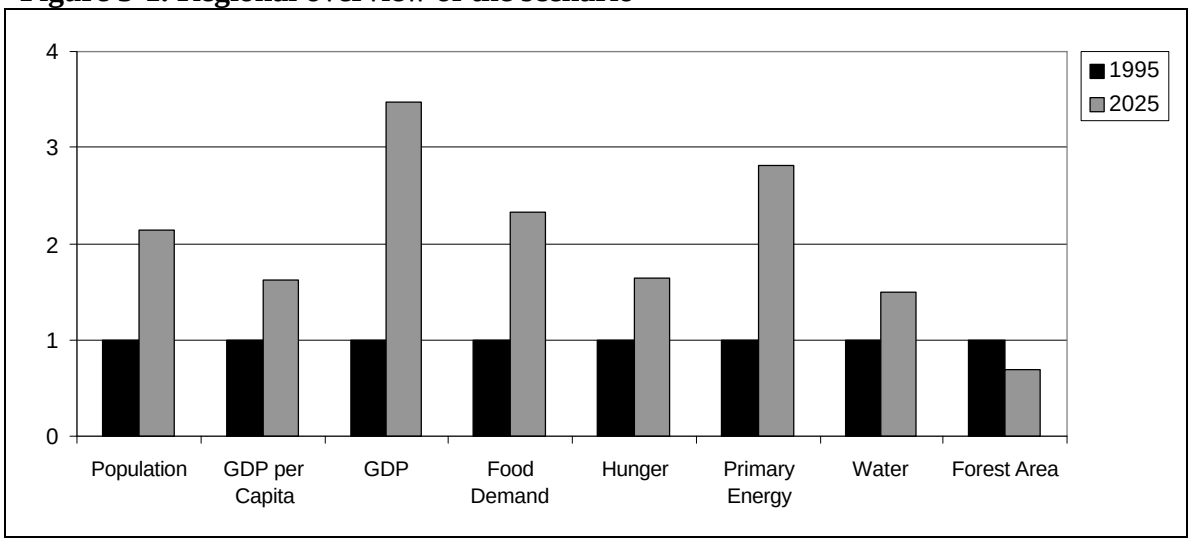
UEMOA region is described and discussed below. The results are collected in a series of tables and graphs in the Annex.

3.3 Summary of the Scenario

An overview of the scenario for the UEMOA region as a whole is presented in Figure 3-1. Relative to 1995 values, population more than doubles between 1995 and 2025. Income, expressed as GDP per capita, increases by about 1.5 times, a departure from recent decades of economic stagnation in the region. In combination with the large increase in population, this implies a considerable expansion of total economic output, by a factor of more than three over the course of the scenario. These increases in population, income and total economic output lead to increasing environmental pressures. As incomes and populations increase, the demand for food also increases, by a slightly higher factor than population alone, reflecting an increase in food consumption per capita. The incidence of hunger as a percentage of the population decreases, but due to the rapid increase in population, in absolute numbers the hungry population increases over the scenario, by more than 1.5 times.

The growth in economic output and population, combined with rising incomes, leads to a sharp increase in primary energy requirements. However, energy needs grow less rapidly than GDP, so that aggregate energy intensity drops over the course of the scenario. Water withdrawals grow significantly, but by far less than GDP, largely due to structural shifts in which industry accounts for a progressively greater share of water use while the growth in irrigated cropland slows. Since water intensity per dollar of economic output is lower for industrial withdrawals than for agriculture, the aggregate intensity decreases. As a result of expanding population and agricultural production, land devoted to settled areas (the "built environment"), cropland and rangeland increase over the course of the scenario. These increases are, in part, at the expense of forests, whose areas decrease sharply over the scenario (Figure 3-1). These issues are explored in more detail below.

Figure 3-1. Regional overview of the scenario



3.4 Demography

In the scenario, population in the region more than doubles between 1995 and 2025 following mid-range projections of the UN (1997). As shown on Sheet D-1, the population growth rate for the region over the scenario time-frame, at an average annual rate of 2.6%, is slightly higher than for Africa as a whole, and considerably higher than the average growth rate for the developing countries of 1.4%. There is considerable variation among the countries of the region, ranging from 1.9% per year in Côte d'Ivoire to 3.0% per year in Niger over the course of the scenario.

All else equal, the growing population will require more services and resources, with proportionate pressure on the environment. However, environmental and resource stress is compounded by the growth in per capita incomes. While partially offset by the penetration of more efficient and cleaner technologies in the course of economic development, the net effect is progressively greater pollution and pressures on land and water resources, as we shall see below.

As populations grow in the region, they also become more urbanized, as rural people are drawn to the economic opportunities in the cities (Snrech, 1995). Urbanization trends in the scenario (Sheet D-2) are taken from UN projections (WRI, 1996). In the region as a whole, urbanization continues to increase rapidly, from 32% of the population in 1995 to 55% in 2025, compared to an increase from 15% to 32% over the previous thirty years. By comparison, 76% of OECD populations currently reside in urban areas. Urbanization increases are greatest in the landlocked countries, where the degree of urbanization is the lowest today.

Combining the urbanization trends with the population growth in the scenario, urban populations increase by a factor of 3.7 by 2025 for the region as a whole, and by as much as 4.5 in Niger. This level of expansion of cities implies an immense challenge for the provision of urban infrastructure and services. In the past, the rising urban population in coastal countries has expanded into the surrounding forest land, leading to deforestation and other kinds of land degradation. This trend can be seen especially in Benin and Togo World Bank, 1996b). In the absence of policies designed to mitigate these impacts, degradation can be expected to continue and accelerate.

3.5 Economy

Economic trends in the scenario are based on those for Africa in the mid-range scenario of the IPCC (1992) which in turn is based on World Bank projections. Growth in GDP, shown in Sheet E-1, is between 4% and 5% per year on average, higher than the average for all developing countries, and higher than the world average. In the scenario, economic growth takes off as the region experiences high growth rates that are sustained over several decades.[7] However, since populations are also growing, income — defined here

[7] A more recent World Bank baseline economic growth scenario for Sub-Saharan Africa has GDP increasing at a little over 4% per year on average between 1992 and 2020, within the range of rates assumed here (World Bank, 1997). The assumptions are also comparable to medium-term economic

as GDP per capita — grows less rapidly, at an average annual rate of under 2% (Sheet E-3). These rates are significantly lower than in developing regions generally and for the world as a whole, and average incomes in the region remain well below the current developing country average. However, the income growth rates assumed in the scenario are higher than those of past decades for the region, which were discussed in Section 2.1.

As economies grow over the course of the scenario, their structure shifts, consistent with the conventional development assumptions of the scenario (Sheet E-2). The countries in the region gradually converge toward the pattern seen in the industrialized nations as average income increases. The share of GDP contributed by agriculture declines over the course of the scenario, from 32% in 1995 to 21% in 2025 for the region as a whole. However, agricultural value added increases in absolute terms, more than doubling between 1995 and 2025. The service sector is an important component of GDP in several of the countries in the base year, exceeding the agricultural contribution to GDP in all the countries except Mali. In the scenario the share from services grows, from 50% in 1995 to 60% in 2025 (the OECD figure is 65% today). The share of industry remains roughly constant, though in absolute terms industrial output increases significantly, at the same rate of growth as GDP, leading to a more than three-fold increase by 2025.

The rising share of industry and services in total GDP relative to agriculture reflects an assumed shift in production and export activities in the scenario. The current emphasis on agricultural products and primary goods in trade changes gradually toward an increasing contribution of manufactured goods and services. As discussed in later sections, this trend is reflected in the scenario in changing trade patterns for agricultural products, and for some primary products.

3.6 Human Development

There are many measures of human development and poverty, each drawing attention to different basic needs. Several were presented in Table 2-4: access to clean water, infant mortality, average life expectancy, adult literacy and hunger. In the scenario, the incidence of hunger is used as a representative indicator of a nexus of poverty issues.

Several factors influence the level of poverty in a scenario. All else equal, as population increases, the population in poverty also increases. Countering this, as average income increases, poverty decreases. But it is not sufficient to consider changes in population and average income alone. The distribution of income must also be taken into account. For given assumptions on population and average income, if income distribution becomes more equal, poverty decreases. On the other hand, if income distribution becomes less equal, poverty increases.

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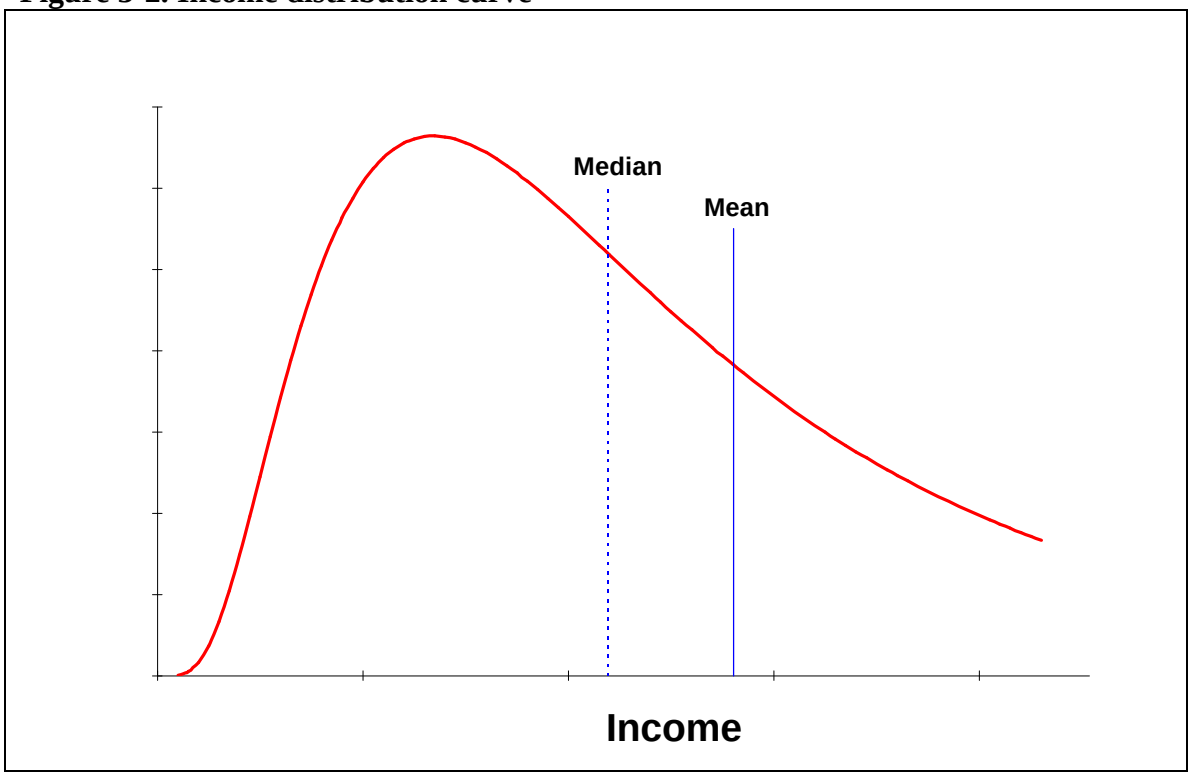
projections, in which GDP growth for the individual countries in the region varies from over 4% per year to more than 6% per year (World Bank, 1996a).

National income distributions are typically concentrated at low incomes with the characteristic shape shown in Figure 3-2. Income distribution curves in the scenario are specified by average income, population and a measure of income inequality representing how skewed the curves are. One such measure that we shall refer to is the ratio of the average income of the lowest-earning 20% of the population to that of the highest-earning 20%.

Figure 3-2. Income distribution curve

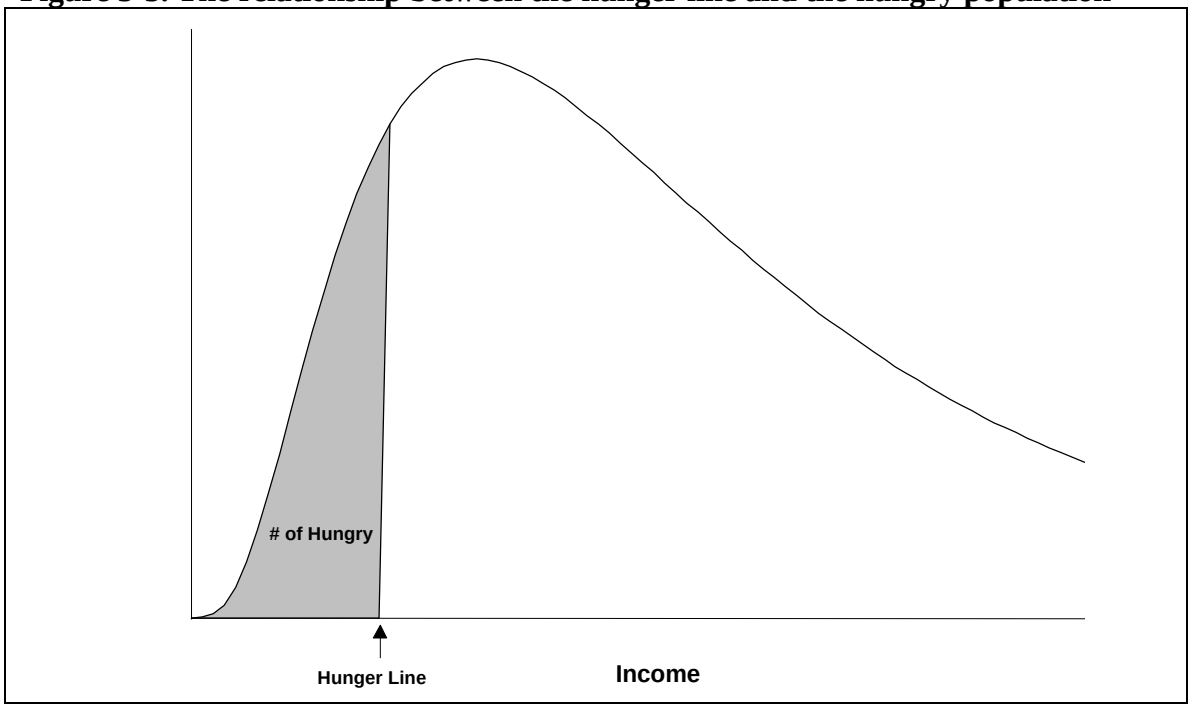


In the scenario, in keeping with conventional development assumptions, income inequality is assumed to follow the trends seen in industrialized countries, where in recent decades income distributions have become more unequal (WRI, 1998). In the United States, there has been a trend of steadily increasing income disparity since the 1960s (USBC, 1997), and in the scenario income inequality in the region converges gradually toward the U.S. pattern (Sheet S-1). Under these assumptions, the ratio of the average income of the lowest-earning 20% of the population to that of the highest-earning 20% decreases from 0.12 to 0.09 on average for the region, compared to the decrease from 0.09 to 0.07 for the U.S.

In order to translate income distributions into the number of people suffering from hunger, we introduce a "hunger line," as illustrated in Figure 3-3. The hunger line represents a minimum income level at which a person is barely able to meet minimum dietary requirements. This is analogous to the concept of the poverty line, a minimum income or expenditure level at which a person is barely able to meet his or her basic needs. National poverty lines are adopted in many countries, including some in the UEMOA region. For

developing countries the World Bank poverty line of $1 per day is commonly used. National poverty lines tend to increase with increasing average income (Ravallion et al., 1991). The same is true for the hunger lines in the scenario, with the rate of increase based on observed patterns for a large set of developing countries (Heaps et al., 1998). The increase in hunger lines may be due to decreased access to informal sources of food, and the erosion of traditional sources of material support in the process of modernization. Both of these processes are consistent with the conventional development story of the scenario.

Figure 3-3. The relationship between the hunger line and the hungry population



In the scenario, the net result of growing average incomes coupled with increases in income inequality is that the incidence of hunger as a percentage of the population drops in every country, with the regional figure declining from 28% to 21% between 1995 and 2025 (Sheet S-2). However, because of population growth, the absolute number of the hungry population increases over the scenario period by 65%, from 17 million to 28 million.[8]

3.7 Agriculture

Requirements

In the scenario, agricultural production is driven by changing food requirements and agricultural trade patterns. As a result of population growth and changes in diets driven

[8] If income inequality is left at 1995 levels, rather than increasing, as assumed in the scenario, then the hungry population would still rise, but at a slower rate, from 17 million in 1995 to 22 million in 2025.

by growing average incomes, requirements for agricultural commodities grow faster than the population. In the scenario, the demand is met either through domestic production or through trade. In some countries, the level of net imports increase, reflecting environmental constraints that are likely to limit the expansion of agriculture in areas where land and water resources are scarce.

Changing dietary patterns in the scenario are shown on Sheet F-1. They follow a general pattern seen throughout the world, that as incomes increase, people consume more, and at the same time consume more animal products (Leach, 1995; Bender, 1997). As a result, average caloric intake increases from 2,231 to 2,422 kcalories per day (Sheet F-1). However, in every country of the region average consumption in 2025 still falls below the average for Africa as a whole, and below the estimated minimum levels, ranging from 2,700 and 2,860 kcalories per day, which are required for food security (FAO, 1996c). These figures are consistent with the persistent hunger in the scenario.

The growth in average caloric intake and the shift toward greater meat consumption leads to considerable increases in the demand for animal products over the course of the scenario. By 2025, total demand for meat and milk products increases to over three times current values (Sheet F-2). Requirements for fish also increase over the course of the scenario (Sheet F-3). However, local fisheries are already stressed in the base year, and additional requirements are assumed to be met largely through increased trade and through increased aquaculture production. Pressures on fisheries are assumed to moderate the growth in the demand for fish, which increase at a slower rate than for meat and milk products, by a factor of 2.5 between 1995 and 2025. Crop requirements also increase more rapidly than population. As will be discussed below, in the scenario an increasing proportion of livestock is fed from feedlots, which leads to a rising demand for crops for feed. Combined with the demand for food crops, total crop requirements increase by 2.4 times over current levels.

Trade

Requirements for agricultural products can be met either through domestic production or through trade. The countries in the region are currently close to self-sufficiency in the most important components of their diets, but do import some agricultural products. Historically, farmers have been able to increase production to keep pace with rapid increases in food demand. In the scenario, this general pattern continues in the UEMOA region. For each crop, the degree of self-sufficiency — the ratio of production to requirements — of importing countries gradually increases over time. Net exporters either maintain or increase their level of exports, although at a slower rate than domestic demand. However, it is not possible to maintain these assumptions for Niger and Togo, where increasing production leads to unsupportable pressures on land resources, despite the increases in agricultural productivity described below. The implications for overall trade balances are reflected in the aggregate self-sufficiency ratios — total crop requirements over total production — reported in Sheet F-4.

Livestock Seafood Production

Traditional livestock production systems gradually give way to more commercial operations over the course of the scenario. In the scenario there is a shift toward stall feeding in the humid countries and in the wetter areas of the Sahelian countries. Historically, such a shift has been seen across the world as rising incomes make relatively labor-intensive herding systems uneconomic (Leach, 1995). In the scenario, this transition is also assumed to occur in response to increasing pressures on grazing land. The trend toward stall feeding is reflected in the increasing fraction of meat production from feedlots as shown on Sheet F-2.

At the same time, the amount of meat or milk produced per hectare of grazing land increases by around 2.8% per year on average between 1995 and 2025. This aggregate figure is affected by several factors. First, improvements in the quality of herds and changes in herding practices will increase production per hectare. Second, decreases in the tsetse population are expected as a result of land-clearance for expanding settlements (Crosson and Anderson, 1992), allowing an increase in the herd density on grazing lands in the humid and sub-humid parts of the region. Third, increased use of crop residues and fodder relative to grazing land are reflected in increased meat production per hectare. Evidence for such a trend is given by a study of five Sub-Saharan African countries, including Mali and Niger, which suggests a trend for livestock systems to become less dependent on grazing land and more reliant on crop-derived feed resources (Alexandratos, 1995). Despite the increase in productivity and the shift toward feedlots, grazing land expands by 20% in the region over the course of the scenario to meet the sharp increase in the demand for livestock products (Sheet F-2).

In the coastal countries, especially Senegal, seafood remains an important commodity. In the scenario, production increases from around 600 ktonnes per year in 1995 to over 1,100 ktonnes in 2025 (Sheet F-3). This is slower than the growth in domestic requirements, since ocean fisheries are already over-fished to some degree in 1995. As a result, all countries see a decline in self-sufficiency in seafood and fish. Nevertheless, total fish and seafood production almost doubles over the scenario, an increase of around 2.2% per year on average. This is slightly higher than the rate of increase over the past few decades (2.0%). Given the existing pressure on the region's ocean fisheries, much of the increase in production is assumed to be met through aquaculture.

Crop Production

Due to increases in agricultural productivity, the requirements for cropland grow more slowly than those for crop products, by a factor of 1.3 versus a factor of 2.4 between 1995 and 2025 (Sheet F-6). Productivity increases come from increasing yields per harvest, and also from a slight increase in the degree of multiple cropping. As discussed in Section 2.4, cereal yields in the region have been almost constant over the past 30 years, while the average yield for the world doubled. In the scenario, cereal yields in the region finally begin to increase in the context of overall commercialization and modernization. Yields double between 1995 and 2025 (Sheet F-5), approaching the current world average. Yield improvements are due to greater use of new crop varieties, increases in inputs, such

as irrigation water and fertilizer, and other changes, such as improved soil and water conservation methods.

The changing agricultural practices are correlated to the spread of commercial agricultural production in the scenario. Over time, a larger proportion of farmers are able to risk planting the higher-yielding varieties of crops and paying for higher levels of inputs, such as irrigation water and fertilizer. In addition, fallow times are shortened somewhat and the level of multiple cropping increased. These changes lead to increased cropping intensity, the ratio of the area of land harvested each year to the total area of cropland.

Over the course of the scenario, irrigated areas increase in all countries (Sheet F-7). However, with the exception of Niger and Togo, the increase is less than for total cropland, as rainfed farmland expands more rapidly than irrigated areas. Increases in irrigated area in the CDS take historical trends into account. Between 1961 and 1990, irrigated area grew considerably in Côte d'Ivoire, but the growth has recently shown signs of slowing. In the scenario, growth resumes, but at a slower rate than in previous decades. In Benin and Burkina Faso, irrigated areas continue to grow at close to the historical rates. In Niger and Togo, the severe limits on the expansion of arable land are assumed to lead to slightly higher rates of expansion than would be indicated by recent trends.

In the scenario, the increases in agricultural production have both social and environmental impacts. On the social side, they have implications for income distribution. The benefits of the improved crop varieties are likely to initially accrue to the larger farmers, while most subsistence farmers will be unable to take the risks of introducing new varieties, or paying for the higher inputs required. However, use of the new varieties can be expected to gradually spread, a pattern seen in other countries during the Green Revolution (Conway, 1997). In terms of environmental issues, the expansion of irrigated agriculture, and the intensification of the crop and livestock production systems can be expected to lead to increased land degradation and greater pressure on water resources.

3.8 Water

Withdrawals

The expected expansion of industrial, agricultural and urban areas, discussed earlier, have implications for water consumption. In the scenario, total water withdrawals for the region increase by 50% (Sheets P-1 and P-2). The largest increase is in industrial water withdrawals, which grow by nearly four times between 1995 and 2025. The drivers of water demand increases are population for domestic use, value added for the industrial sector, and the area of irrigated cropland for agriculture. Demand grows faster than these drivers since water-use intensities — the amount of water per capita, per dollar value added and per hectare of harvested irrigated land — also increase.

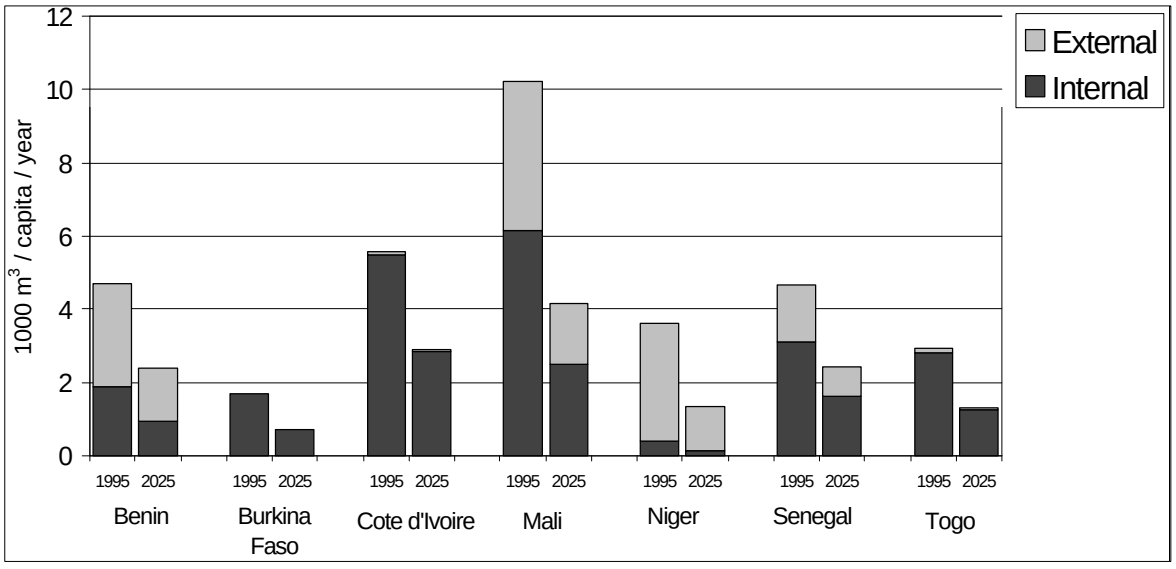
The increase in intensity is a result of the assumption that the countries of the region gradually converge toward the technological and managerial practices of industrialized regions in the course of development. In households and the service sector, as incomes

and levels of material consumption increase, withdrawals also increase per capita. This is assumed to occur both because of increased access to clean water for domestic use, and as a result of greater penetration of water-consuming devices. Nevertheless, domestic withdrawals per capita remain low: in Mali, for example, average withdrawals for households and the service sector are only around 5 cubic meters per capita, compared to the estimated 18 cubic meters per capita required for basic needs (Gleick, 1996), indicating a persistent lack of access for much of the population. In the industrial sector, as production patterns shift gradually toward those of the industrialized countries, water withdrawals per dollar of output increase slightly. Finally, as yields rise on irrigated land, so does the water intensity of agricultural withdrawals.

Water Stress

Despite increasing water demand, withdrawals remain small compared to the renewable resources, which are assumed to remain at their 1995 levels throughout the scenario. As shown in Sheet P-3, the average use-to-resource ratio for the region increases only from 0.02 to 0.03. The level in all countries remains well below the level of 0.1 that may indicate the onset of water stress (Raskin et al., 1997). However, this seeming abundance in fact reflects the persistent lack of access for much of the population and the continuing low level of development of the regional economies in the scenario. Ultimately, water resources are likely to hamper conventional patterns of development. To see this, note that a figure of 1,700 cubic meters per capita per year has been suggested as a "barrier" to development (Falkenmark et al., 1989). That is, when values fall below this level, water scarcity becomes a constraint. Three of the eight countries — Burkina Faso, Niger and Togo — are below that figure in 2025 (Figure 3-4).

Figure 3-4. Water resources per capita in the scenario



It is important to note that the scenario assumption that useable water supplies remain at their 1995 levels may be questionable. In particular, this assumption implies that no major changes occur that might restrict flows from neighboring countries. Were this assumption

to be violated, Benin, Mali, Niger and Senegal could see their supplies considerably reduced, and may experience water stress. Furthermore, both the increasing industrial water consumption and the greater use of chemical fertilizer on irrigated land could lead to increased water contamination. These effects are not explicitly considered in the scenario, but could potentially restrict the available supplies in the country. Similarly, the likely regional impact on water resources of long-term global climate change are poorly understood and have yet to be quantified.

3.9 Energy and Air Pollution

Demand

Energy demand in the scenario grows by a factor of 2.7 between 1995 and 2025, as both the populations and economies of the region grow (Sheet En-2). As a result, import dependence on refined petroleum products and electricity increase (Sheet En-1). However, patterns of energy consumption remain far from those of the industrialized countries. In per capita terms, annual energy consumption in the region reaches only 11 GJ by 2025, compared to nearly 140 GJ for the industrialized countries in 1995. Biomass use continues to dominate energy demand, and even increases in absolute terms, as populations and incomes rise, implying greater pressures on land resources and increasing levels of air pollution.

Following patterns in other parts of the world, household and service sector energy use rises with income. This effect is tempered by a shift away from inefficient traditional biomass fuels to more efficient fuels such as petroleum products, natural gas and electricity. The net effect is a slight increase in energy consumption per capita. Considering industrial consumption, as the industrial sector grows and diversifies, the scenario reflects a general shift toward more capital-intensive and energy-intensive industries, and away from labor-intensive ones. As a result, industrial energy intensities also rise. In agriculture, as well, energy intensities rise as mechanization gradually replaces human and draft power on farms.

The changing patterns of energy consumption in transportation are more complex. Freight intensities, expressed as energy consumed per tonne-km of freight hauled, decline slightly over the course of the scenario. This occurs as freight transport practices (vehicles, infrastructure, vintages, etc.) increase towards the level of efficiency seen in industrialized countries. Over the scenario time-frame, tonne-km per dollar of GDP also falls, following a general pattern seen around the world, perhaps reflecting the increasing share of economic value added deriving from services that require little transportation. Conversely, passenger transport energy intensities, expressed as energy used per passenger-km traveled, increase over the course of the scenario. The increase is due mainly to the rise in automobile use relative to buses as incomes increase, but also to a declining number of passengers per automobile (the load factor). Along with increasing passenger intensities, passenger-km per capita also increases as incomes rise.

With both passenger and freight transport requirements increasing by a factor of more than three over the scenario, the growth in the transport sector will require large

investments to improve road, air and other transport infrastructures. At the same time, the transport sector will be a cause of increasing levels of pollution, particularly in congested urban areas. Nevertheless, in global terms, the region's transport sector remains small: by 2025 per capita transport requirements are still only approximately 5% of current per capita transport requirements in North America.

The net result of the individual sectoral changes is that aggregate intensity — energy consumption per dollar of GDP — declines in every country (Sheet En-2), with domestic energy consumption continuing to dominate total final demand.

Production and Trade

Currently, all of the countries produce some electricity, although most are net importers. Only Mali is entirely self-sufficient, although Burkina Faso, Côte d'Ivoire and Senegal are close to self-sufficiency. In the scenario, these patterns persist. However, in Côte d'Ivoire, which imported only 2% of its electricity in the base year, it is assumed that the natural gas fields that were being developed for electricity production in 1995 are developed and running by 2025, allowing the country to be self-sufficient in electricity generation. As a result of these trade patterns, combined with rising demand, electricity imports increase in the scenario, as shown in Sheet En-1.

Demand for refined petroleum products rises in the scenario as a result of rising sectoral demand and requirements for oil-fired electricity generation. Most of the countries in the region are now entirely dependent on imports, a pattern that continues in the scenario. Only one country in the region, Côte d'Ivoire has active refining capacity, which is used to process both imported and domestically produced crude oil.[9] In the scenario, Côte d'Ivoire maintains the same level of trade relative to production as in 1995. Net petroleum imports are shown on Sheet En-1.

Biomass production increases in absolute terms in every country, despite decreasing as a share in total final demand. Overall, biomass consumption increases by a factor of 2.5 for the region between 1995 and 2025. Thus, in spite of a gradual transition to modern fuels, the CDS tells a story of continued reliance on biomass for the majority of households with all of the adverse social and environmental impacts that implies, such as exposure to harmful indoor air pollutants, the burden on women and children of collecting increasingly scarce firewood and increasing pressures on wood resources.

[9] In 1995 Senegal also produced some refined petroleum products. However, the refinery has since been converted to a terminal, and now all petroleum products are imported (MBendi Information Systems, 1999).

Reserves

There is considerable uncertainty about the potential for oil production in the UEMOA in the future. Two countries — Benin and Côte d'Ivoire — have been producing crude oil since the late 1970s and early 1980s, and subsequent exploration in Côte d'Ivoire has identified further oil and gas reserves (ENDA-TM, 1995; MBendi Information Services, 1999). Some oil fields have been discovered in Senegal, and exploration is continuing, but currently production is small, amounting to less than one percent of imports. None of the other four countries produce crude oil, and in Burkina Faso, Mali and Togo there are no known reserves. However, recent exploration in Niger has identified potential oil fields. The amount available is unknown, and exploration is continuing (MBendi Information Services, 1999). Given the uncertainties for future production, in the CDS oil reserves are held at their 1995 levels. With this assumption, crude oil production in the region is expected to slow or stop between 1995 and 2025, and the countries are assumed to exhaust their reserves by 2025, as shown in Table 3-1. Over the scenario period, all of countries in the region remain dependent on oil and are likely to becoming increasingly vulnerable to fluctuations in world prices, as global supplies of crude oil become increasingly scarce (see for example, Raskin et al., 1998). Benin, which is an exporter of crude oil in the base year, loses export income from sales of crude oil.

Table 3-1. Energy reserves in the scenario

		Reserves		
Country	Fuel	1995	2025	Unit
Benin	Crude Oil	3.7	0.0	Mtonnes
Cote d'Ivoire	Crude Oil	6.8	0.0	Mtonnes
	Natural Gas	14.0	3.5	billion m^3
Niger	Coal	70	55	Mtonnes
	Uranium	343	256	ktonnes
Senegal	Crude Oil	Unknown		n/a
	Natural Gas	5.6	1.7	billion m^3

In 1995, both Côte d'Ivoire and Senegal had some natural gas reserves. Senegal is self-sufficient in natural gas production in 1995, and continues to be self-sufficient throughout the scenario. In the scenario Côte d'Ivoire develops its natural gas reserves for electricity production.

Niger is the only country in the region producing coal and uranium in the base year. The reserves of each are ample, and in the scenario Niger continues to meet all of its demand for coal from its domestic reserves, and to export uranium at the same rate as in the base year.

Air Pollution

The shift toward conventional fuels leads to higher emissions of greenhouse gases (Sheet P-4). However, they remain well below those of the industrialized countries, with regional emissions per capita in 2025 of just 0.3 tonnes of CO_2, compared to 11 tonnes of CO_2 for the industrialized countries in 1995. Non-greenhouse gas emissions are a more pressing concern. Local and indoor air pollution increases in line with increasing biomass use, in

spite of the gradual shift toward modern non-biomass fuels. Emissions from the transport sector increase in line with the large growth in that sector, a situation that, if unaddressed, is likely to create increasing urban air quality concerns.

3.10 Land

Nearly all of the topics discussed in earlier sections have implications for land use, and generally they point to greater pressure on land resources. Population growth alone, in the absence of other factors, would lead to greater pressure. Compounding this, growing urbanization and an expanding infrastructure leads to expansion of the built environment and increased land degradation close to cities, while population growth in the coastal regions increases the pressures on coastal environments. In addition, despite the increasing urbanization and the growing role played by industry in the region, the livelihood of much of the population remains tightly bound to the land. The increases in agricultural production, both from expansion into new land and intensified use of existing land, lead to land pressure and degradation. Other factors are likely to accelerate degradation processes. These include the competition for scarce land resources between different agricultural producers — herders, subsistence farmers and commercial farmers — and increasing degradation from the increase in the population in poverty, arising from uncertain land tenure and the necessary focus on immediate needs. Finally, increased exploitation of wood resources places additional pressure on land resources.

In the scenario, built environment increases as incomes and populations rise, more than doubling in area over the course of the scenario (Sheet P-5). The area of built environment required per capita is assumed to increase gradually, by about 10% over the course of the scenario. The increase comes in part from the expansion of human habitats, but also from increases in the area of other kinds of built land, such as paved roads and industrial sites.

The expanding built environment encroaches on existing cropland, forest and grazing land, as well as “other” land not in one of the explicit categories. In addition, cropland continues to be lost through degradation, amounting to 2.6 million hectares, or 13% of the original cropland area, by 2025. At the same time that agricultural land is being lost through these processes, in most countries requirements for cropland and grazing land are increasing. The area that is lost, as well as the additional area, must be converted from other existing land uses, such as forest and “other” land. In the past, the most important cause of deforestation in the region has been expanding cropland. To reflect this in the scenario, new cropland is converted from forest. Grazing land also expands into forested areas, and to some extent into “other” land.

As a consequence of these changes, the area under forests continues to seriously diminish in the region. As shown on Sheet P-5, forest area drops by 30% between 1995 and 2025, or about 1.2% per year on average for the region. In some countries the rate of decrease even exceeds the historical rate (Sheet P-7), reflecting the higher pressures placed by urban and agricultural expansion, and a rapidly growing population. Particularly striking is the accelerating rate of deforestation in Burkina Faso and Senegal, due to the

considerable expansion in agricultural land. The loss of forest area has both social and environmental consequences. On the social side, the loss of forest resources impacts people at low income levels who rely on forest products for subsistence or for some of their income. It also impacts the sustainability of traditional shifting cultivation practices, which need to leave areas of forest fallow for as much as a decade, to replenish nutrients in the soil. It also leads to serious loss of biodiversity and the depletion of biomass resources.

4. Toward Sustainable Development in West Africa

4.1 Indicators and Sustainability

The Conventional Development Scenario paints a picture of regional patterns over the next several decades under "conventional" development assumptions. In many ways, it tells an optimistic story of rapid growth and modernization of the economies of the region. In the context of increasing economic globalization, regional consumption and production patterns gradually move toward the standards of industrialized countries, while the scenario also assumes that institutions of governance become progressively more effective and the region enjoys an era of relative peace and security.

Nevertheless, in addition to these optimistic development assumptions, the scenario bears a disquieting message, as well. Certain environmental and social conditions that were already problematic in 1995 persist or worsen — dire poverty, inefficient energy use, inadequate water services and land pressure. Moreover, the story of "convergence" in the scenario should not be read as an assumption of fast approaching parity between the region and industrialized countries. Even if the optimistic rate of income growth assumed in the CDS are sustained, it will take around 200 years before average incomes in the region reach the present day average seen in North America. Important trends in the scenario are summarized in Table 4-1.

Table 4-1. Summary of conventional development scenario indicators

Indicator	1995	2025	Unit or Quantity	Trend
Population	62	133	Million	Near doubling (2.6%/year)
GDP per capita	1,173	1,904	$ PPP/capita	Significant growth (1.6%/year)
Hunger	17 (28%)	28 (21%)	Million	Increasing absolute hunger, decreasing as percentage
Deforestation	304	499	kha/yr	Accelerating deforestation
Cropland degradation	227	87	kha/yr	Slowing but serious
Biomass Reliance	81	73	% of final demand	Gradually decreasing
Biomass Energy Use	444	1,121	PJ	Increasing pressure on resources
Oil Dependency	80%	87%	Imports as % of non-biomass primary energy	Increasing dependency
CO_2 Emissions	10	40	Mtonnes/yr	Increasing, but very low
Water Stress	0.02	0.03	Use-to-resource ratio	Low, but lack of access continues

See Annex for notes on figures.

In spite of the scenario's relatively optimistic vision of growing economies and average household incomes, it remains in many ways a bleak vision of the development prospects in the region. While poverty decreases as a fraction of the population, the absolute number of people in hunger increases more rapidly in the thirty years of the scenario than in the twenty-five years between 1970 and 1995. At the same time, the environment is

progressively degraded through loss of forests and other ecosystems, degradation of arable land and local pollution around burgeoning cities.

In the energy sector, growing demand for biomass energy aggravates pressure on forest resources. Petroleum demand grows almost four-fold, deepening the region's dependency on oil imports. Nevertheless, even under the robust economic assumptions of the CDS, West Africa does not emerge as a significant contributor of greenhouse gases, as energy consumption per capita remains relatively low.

The persistence of absolute poverty, rapid population growth and increasing resource scarcity in the scenario could lead to social friction and conflict over increasingly scarce resources. In fact, such conflict could undermine the assumption of steady economic growth. In other words, long-range social, economic and environmental sustainability is highly uncertain under conventional development premises.

4.2 Policy Implications

The survey of indicators indicates that the CDS is not a development pathway compatible with sustainability. The scenario assumes "policy-as-usual", that is, an absence of integrated and coordinated efforts to meet sustainability goals. It provides a baseline reference for exploring the actions required for a transition to an alternative sustainable development scenario in the future.

Policy-making for the long term is not straightforward in Africa, even among the relatively stable UEMOA states. One of the CDS assumptions is the evolution of effective governance. This is not only a precondition of sustainable development, it is also a *sine qua non* for sustained effective long-term policy making. Even if stability is assumed, there is a sense of “emergency” to much planning in the area in the face of demographic change, economic vulnerability, security concerns and the threat of drought. Policy inevitably tends to concentrate on survival in the short term rather than development in the long term. Under these conditions, and given the unpredictability of many of the factors involved, finding the breathing space to construct credible and viable long-term policy strategies is indeed a challenge. Our purpose here is simply to raise questions that may be of use for those policy-makers who assume that challenge.

4.2.1 Priority Areas for Policy-Makers

Among the areas deserving of special attention are the high incidence of hunger, the continuing reliance on inefficient energy resources (particularly biomass), the continuing under-development of water resources, and the potential for resource conflict. Although the CDS brings these areas into focus, it should be borne in mind that they are likely to figure in virtually any conceivable scenario for this thirty year period. Indeed, in a more pessimistic, historic-trend scenario they would appear even more pressing.

Hunger

The increase in absolute poverty in the region is perhaps the most unsettling feature of the scenario. The decrease in the fraction of population in hunger does not disguise a situation of increasing poverty. Although the distributional inequality in UEMOA states remains below US levels, the exceedingly low average income levels and the lack of even the rudimentary redistribution net that exists in the industrialized countries together magnify the extent of the crisis. In West Africa the problem is not so much the size of the gap between rich and poor, as the extent of the poverty affecting a majority on the bottom.

A clear policy goal should be the radical alteration of the existing agricultural production systems that, as the scenario shows, are not efficient enough or improving sufficiently quickly to meet the needs of the rising population. Considerable and speedy evolution towards intensification must be targeted, but such an overhaul is not attainable without an appreciable boost in external support.

Eventually, some form of effective social security system will need to be introduced to alleviate poverty. Such an initiative is both practically and politically difficult however, and ultimately dependent on political will at the national level. Furthermore, public spending on social welfare in Africa is currently subject to the international climate which is not presently supportive of such measures. Other steps may be taken, however, to ensure that the resilient informal networks of distribution and food supply that currently keep many of the poorest in West Africa from starving do not succumb to modernizing pressures. Taxation, social welfare, education and health care policy can all profit from a close examination of the existing "informal" networks by which West African societies have internalized various forms of social security. The question is how to make these systems compatible with the new demands of "modern" social structures in order to reinforce, rather than criminalize or uproot these systems.

Energy

Another troubling aspect of the scenario is the projected increase in biomass use, by a factor of 2.5 for the region between 1995 and 2025 in the CDS. This absolute increase occurs in spite of the decreasing share of biomass in the regional energy balance. The continued reliance on increasingly scarce biomass fuels will have undesirable impacts both on human development and the environment. The major factor in forest depletion today is changes in land-use, but fuel requirements already are a significant factor, and the two combined in the future may be explosive. In the meantime, the international conventions on desertification, climate change and biodiversity all indicate growing international pressure to further protect and extend forests. Such conflicting demands on this resource can have a directly negative impact on the populations closest to them, as has already been seen in Mali in the 1980s (Ribot, 1998).

Two policy approaches come into play here: energy system modernization and forest management. Energy requirements grow by a factor of 2.7 for the region between 1995 and 2025 in the CDS. To improve the quality and efficiency of energy available to the

average West African user, the provision of electricity and modern fuels would have to increase to meet this demand and displace the predicted 73% met by biomass. At the same time, prices will have to decrease for the user, presumably as economies of scale come into play. A diversification of energy sources would allow a demand-driven increase in alternative sources of energy. Renewable energy sources are a possibility that have already been explored with some success throughout the UEMOA region. The Sahel countries in particular have exceedingly high insolation rates, ideal for large-scale introduction of solar power. Pro-active policy measures in East Africa, in particular Zimbabwe, have met with a certain success in disseminating this energy resource and these could be emulated and extended in the UEMOA states. Finally, with wise energy policies, the region can avoid replicating the energy inefficient path of conventional Northern development by promoting end-use efficiency and demand management.

In terms of large-scale generation, hydroelectric power is a possibility although its exploitation in the region has to date been limited. Given the interactive nature of the water systems in the region, a regional approach to construction and distribution of hydropower would be the most rational. The issue is fraught with complications however, not least of which is concern about water constraints in the future. Any attempt to improve large-scale electricity generation in the region would require a diversified but highly coordinated policy, regional in nature, and taking account of the trade conditions (in petroleum and other fossil fuels) between the UEMOA states and their neighbors. It is worth noting that one of the UEMOA states' neighbors has considerable water resources (Guinea) while others have large crude oil deposits (Nigeria and Gabon). The current trading conditions make the proximity of these major resources all but irrelevant to the region. Another consideration requiring research is the viability of increasing the number of regional refineries.

Forest-management policy has advanced in recent years, with forest protection, management and renewal schemes emerging throughout the region. At present, however, there is tension between the international drive to maintain forests and the local need to exploit them. Research is needed to determine how the increasing need for cleared land, for both settlement and agriculture, can be aligned with the continued high demand for fuelwood on the one hand and plans to preserve and renew forest land on the other. Without clear and coordinated policy in this area, conflict is likely.

Water

Water withdrawals in the CDS are small relative to water resources in the UEMOA states, but this reflects inadequate access for much of the population and underdevelopment rather than an *a priori* abundance of freshwater sources. The indications are that, in order both to grant access to water to the population at large and to feed the increasing demands of irrigation, industry and power generation, a strategic long-term policy for water use and infrastructure must be devised. The current under-exploitation of water resources has the advantage of allowing such a policy to be conceived and executed in a timely manner, rather than being imposed upon an already unsustainable system.

Water exploitation is emerging as a major potential source of conflict for the next century. Africa has some experience of the dangers of confrontation over the use of shared resources in the Congo basin, and the continuing tension between Ethiopia and Eritrea over control of the upper Nile (Okidi 1994). West Africa has not yet experienced such conflicts, but there too the resource is not shared equally by all countries. A regional approach to water exploitation would allow maximal efficiency and head off potential conflict. The UEMOA provides an important regional forum for water development. It provides a structure for water allocation between states, resource development and ecosystem protection, which could help West Africa avoid water conflicts that may deepen in the years to come. Water sharing should become a priority for negotiation in the near future, if it is to become a strong foundation for regional development.

Other Issues

Two further critical areas of policy concern are the rapid urbanization rate and population-driven land pressures. The latter has long been recognized as a major cause for concern by African policy-makers, but reform has been hampered in the past by the complications of traditional land ownership arrangements, inherited colonial structures and the demands of a modernizing economy. It will become increasingly urgent to overcome these difficulties, as vying pressures for land use contribute to land degradation and settlement tensions. Likewise, the rapid growth of cities will require coherent urban planning, which today is minimal. At the same time, efforts can be made to improve economic conditions in rural zones to lessen rural-urban migration.

4.2.2 Further Indications from the Conventional Development Scenario

The CDS suggest numerous other areas where policy-makers can move early to anticipate and influence the trajectory of the region's development. These include building on existing industrial potential (identifying and supporting nascent viable industries); increasing efficiency in the agricultural sector (irrigation, commercial agriculture, increasing crop yields and intensity, etc.); shifting the export base from primary materials to manufactured goods and services; and investing in an infrastructure with the capacity to support increasing demands in industry, agriculture, transport and communication.

In the case of transport it is worth noting the increased passenger transport energy intensity projected by the conventional development scenario, due to increasing automobile use and falling load factors. Integrated transport planning can head off this potential problem early on. Regarding communications and information technology, Senegal, which enjoys the highest rate of main telephone lines per capita and the lowest fault rate in sub-Saharan Africa (with the exception of South Africa), offers a promising model. The important role of communication and information technology in modern development suggests that pro-active policy to develop this area will be important to building a thriving private sector.

Consideration should also be given to oil and mineral reserves policy. Outside the UEMOA countries, West Africa is rich in reserves and further exploration may well prove fruitful. The negotiation of favorable trade agreements in petroleum and minerals from

neighboring producers is an important policy objective. Forging favorable oil and mineral arrangements will not be easy considering the history of foreign influence over oil exploration and exploitation, but the development of regional capacity for exploiting and refining regional oil and mineral wealth would take considerable pressure off the huge import bill that these energy sources run up now and, according to the CDS, in the future.

In the CDS, the level of international economic integration and trade increases. There is, however, a great difference between predominantly *intra-regional* trade (where each country trades with the others according to the principal of comparative advantage) and *inter-regional*, in which case the countries within the region tend to be in competition with each other. While currently limited, increased intra-regional would help shield the UEMOA countries from international price changes and currency fluctuations. The use of a shared currency allows the UEMOA zone to operate essentially as a large domestic market. A common, or at least integrated, trading policy would also lay the groundwork for more coherent and coordinated policy on water and mineral resources.

The fate of the informal economy under conventional development scenarios is another important policy matter. Currently, the informal sector thrives throughout West Africa and contributes to about a third of the GDP. The workings of this sector need to be thoroughly studied and understood so that its pivotal role in the livelihoods of so many in the region can be successfully nurtured.

4.2.3 Policy Implications for the International Community

The scenario's bleak vision of increasing hunger and worsening environmental problems in the region, in spite of optimistic economic growth assumptions, highlights the fact that the policy implications of the scenario apply not just to decision makers in the region, but to the international community as a whole. While policy makers in West Africa can do much to address the issues highlighted above, ultimately a new development paradigm will be required in which industrialized nations commit to alleviating poverty and promoting development in West Africa on an unprecedented scale. While this is not the place to discuss the implementation of such a program, it might include debt forgiveness, improved terms of trade and new forms of technology transfer. All such efforts will need to go beyond the limited aid and trade arrangements of recent decades.

4.3 Next Steps

The Conventional Development Scenario is based on the convergence of the region's development trajectory toward that of the industrialized world. The three basic assumptions for West Africa are of a growing industrial base; a gradual shift from subsistence to commercial agriculture; and the evolution of effective governance systems. None of these conditions are guaranteed, and in fact the recent history of the region does not give good grounds for faith in any of them. However, as the preceding discussion made clear, the vision of the future presented by the CDS is not a prediction of an inevitable future for the region. Rather, it is provided as a baseline scenario to guide future decision-making. By focusing attention on a concrete set of issues, we hope it will

help to place sustainability issues on the agenda of relevant international, regional and national organizations and other stakeholders. By looking decades into the future, it brings potential problems to bear on policy discussions today, providing a starting point for building a regional vision of sustainable development. In this role, the CDS can benefit from further refinement through the addition of better information and data, and more thorough analysis of key issues. It can also provide a starting point for constructing alternative normative scenarios for the region, to help examine the prospects for innovative development strategies for moving toward sustainable patterns of development.

4.3.1 Refining the CDS

The Conventional Development Scenario developed for this study is intended as a first order analysis with the aim of catalyzing further sustainability assessment and policy discussion in the region. Ideally, the assessment and discussion processes will be mutually reinforcing as the range of issues covered by the scenario is both expanded and refined, and as better sources of data are brought to light. Two areas needing elaboration in the CDS were mentioned in the policy discussion above — intra-regional trade (both between the UEMOA countries and more generally within West Africa) and the role of the informal economy. Incorporating these explicitly in future scenarios would facilitate an exploration of different development paths, in which trade patterns and the relative importance of the formal and informal economies appear as scenario variables.

Other issues could benefit from further analysis. Some of the most pressing concern land use, whether for the provision of biomass fuel, urban expansion or agricultural production. Land-use dynamics in the region are complex, affected by the wide range of agro-ecological zones that are present, as well as both traditional and formal rules for land management that exist in the region. Elaboration of these issues is a priority for future scenario enhancement. Also, the energy analysis, while benefiting from sectoral-level information, was treated at an aggregate level in this report, due to the limitations of energy sector statistics for the region. In particular, accurate and up-to-date data describing biomass consumption and production patterns in the region are scarce. Improving energy statistics in the region is no small matter and will require investment in energy surveys, capacity-building within government ministries and other initiatives.

4.3.2 Alternative Visions

The Conventional Development Scenario presents one vision of a possible future for the region. Ultimately, however, there is no development scenario for these countries that can be called “conventional”. The region will have to innovate and forge its own style of development based on the sustainable use of its resources and existing systems of production and trade networks. In terms of policy, the great challenge facing these countries is to identify which of its existing structures, productive systems and industries, trading relations, legal infrastructures and regulations to keep and reinforce, and which to jettison.

In making these decisions, development need not be equated to the "Westernization" of society. In the West African context there are surely other models awaiting definition. Indeed, many of the basic conditions driving development historically in industrial countries are no longer applicable. On the one hand, developing societies today are subject to constraints — environmental and commercial — that were unknown in the past. On the other hand, certain opportunities exist to developing societies today that were unavailable a century or two ago. For example, the spectacular improvements in information technologies and the accessibility of information imply that centralization of policies and decision-making processes are no longer necessary to development, and indeed may prove a hindrance. The CDS illustrates the problems of applying conventional development models for West Africa. What remains is to find desirable and feasible alternatives.

The magnitude of the task of constructing alternative scenarios should not be underestimated. The *problematique* of sustainable development in the UEMOA countries is quite different and considerably more challenging than in other more developed parts of the world. In the UEMOA countries, almost all of which figure among the world's "least developed countries", the primary concern is not to curb or alter "development" but to generate and direct it — the creation of systems of production and distribution which will meet the needs of burgeoning populations, and lift the majority out of their current conditions of poverty and privation. This is an already many-faceted task involving the political and legal spheres as much as the economic. However, as these social goals are met, environmental issues — which are of secondary importance today — will increase in importance and urgency. If social development is to continue, the environmental base on which it rests must be protected in the long-term.

The challenge is to set long-term achievable objectives, at a time when pressing short-term problems demand immediate attention, and to develop workable policies that will allow a productive economy to grow and flourish sustainably. Alternative scenarios, reflecting a brighter future for the region, may very well require fundamental transitions in the development process. Vision and determination will be necessary to find ways around the daunting problems that face the region to at least improve the prospects for the majority of inhabitants, for whom, to judge by the relatively optimistic scenario presented here, the future does not yet look bright enough.

4.4 Conclusions

This report, with its first cut analysis of a Conventional Development Scenario and preliminary scan of policy priorities, is but a first step on the long road to creating a vision of sustainable development for West Africa. If there is to be a transition to a more prosperous and environmentally resilient mode of development in the region, sustained initiatives will be required at national and regional levels. These must include a commitment to building the institutional and human capacity for integrated sustainable development assessment and policy analysis.

An inclusive process of dialogue, debate and discussion is key to mobilizing popular support and the political will necessary for a sustainable path of development. The trade-offs between competing objectives and the balance between alternative social visions will need to be considered by a spectrum of affected stakeholders in an open and democratic decision-making process. As a first step, a policy dialogue should be launched to promote awareness of the critical issues raised by this report and to consider follow-up actions. An outcome of a policy dialogue could be the examination of scenarios that go well beyond the scope of the CDS. Since West Africa faces many issues that require coordinated international action, it would make good sense for a policy dialogue to take place at the regional level.

To advance down the road of sustainable development, significant effort will be required to build the human, institutional and scientific capacity in the region to support discussions and decision-making with analysis, information and solutions. Ultimately, it is clear that fundamental changes will be required in policy making, both within the region and the international community. Only then can the concept of sustainable development begin to move from rhetoric to a practical basis for action. Although the challenge is substantial, the reward is no less than a better future for the region's peoples.

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Annex: Scenario Highlights

DEMOGRAPHY

Sheet D-1. Population
Sheet D-2. Urbanization

ECONOMY

Sheet E-1. GDP
Sheet E-2. Structure of GDP
Sheet E-3. Income

SOCIETY

Sheet S-1. Income Distribution
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ENERGY

Sheet En-1. Primary Energy Requirements
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FOOD AND AGRICULTURE

Sheet F-1. Diets
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ENVIRONMENTAL PRESSURE

Sheet P-1. Water Withdrawals by Country
Sheet P-2. Water Withdrawals by Sector
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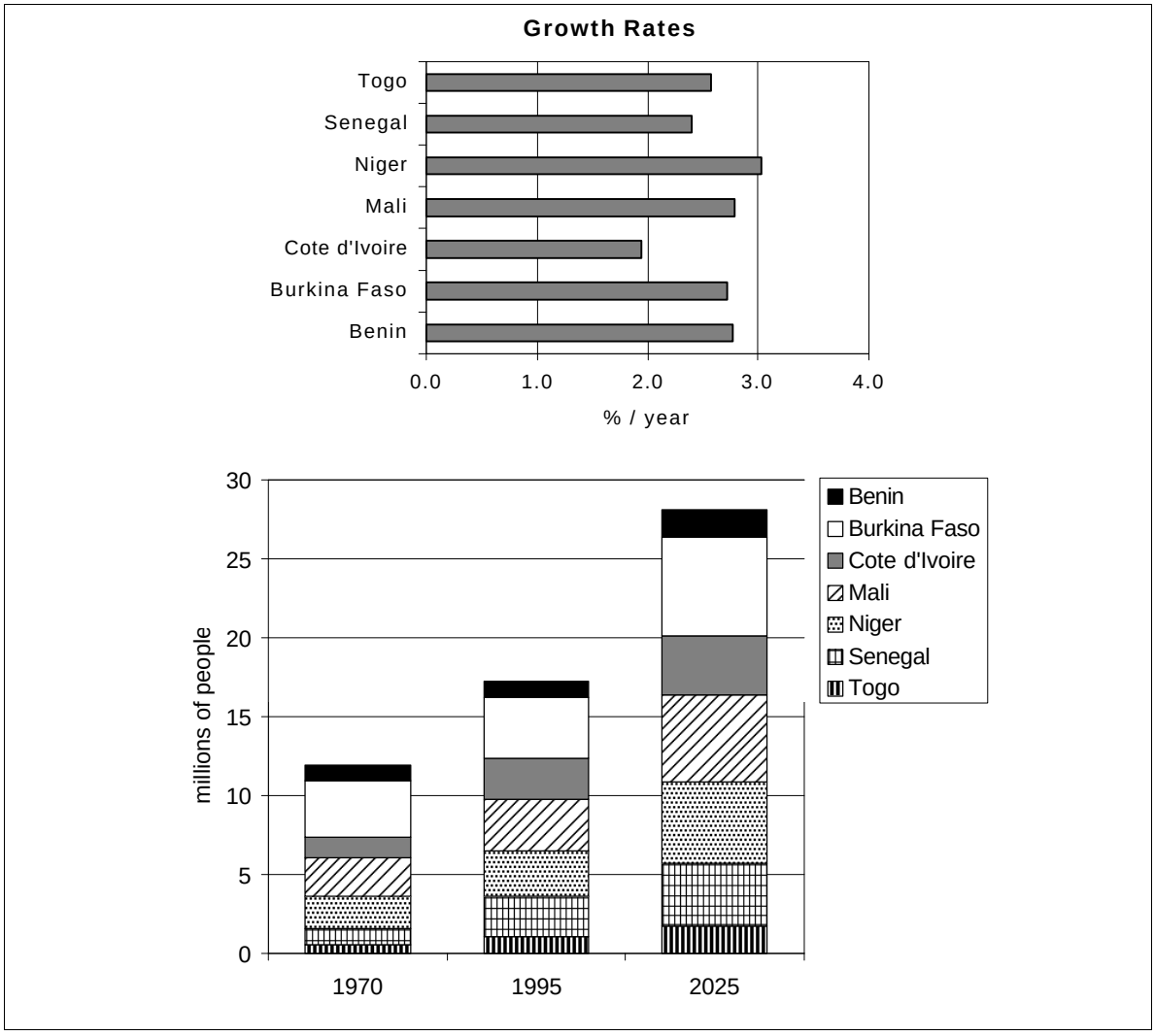
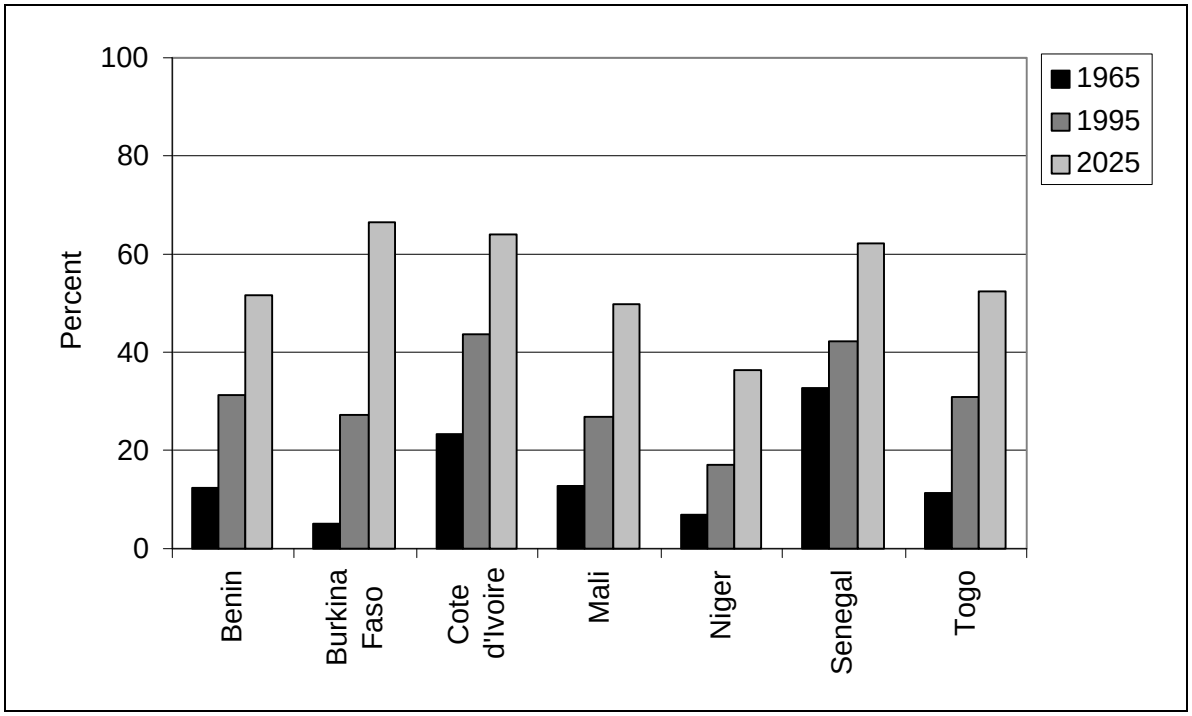
Sheet P-4. Carbon Emissions
Sheet P-5. Land Use by Land Type
Sheet P-6. Land Use by Region
Sheet P-7. Deforestation
Sheet P-8. Fertilizer Consumption

Sheet D-1. Population



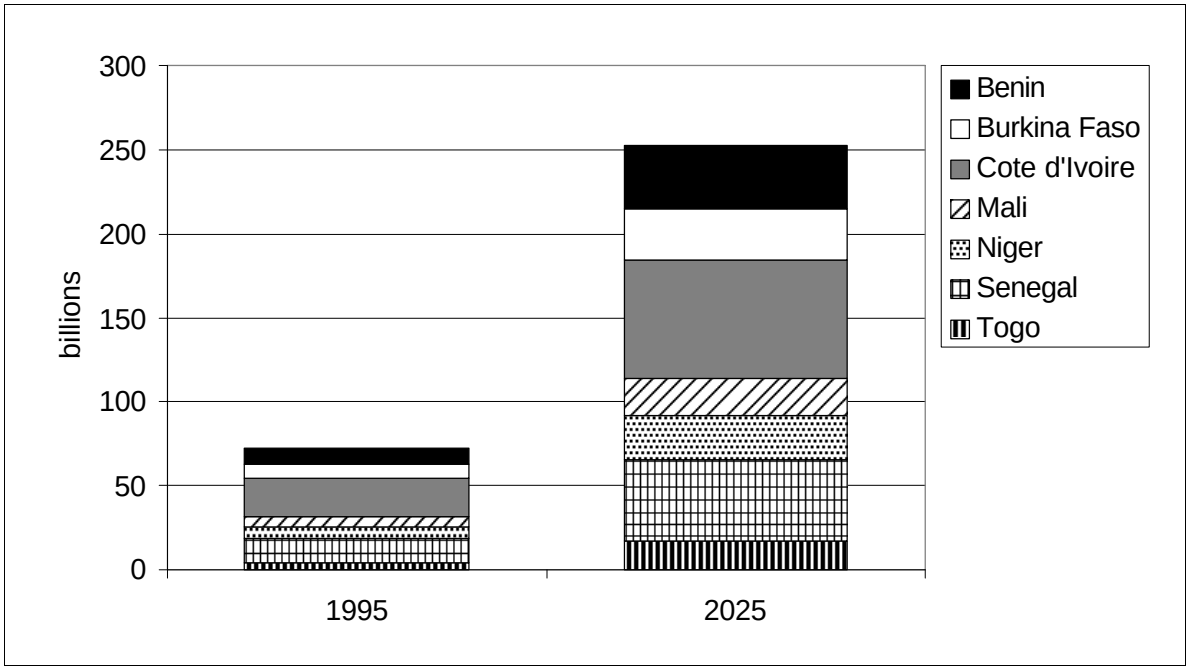
Country	Population (millions) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Benin	5.4	12.3	2.8	2.3
Burkina Faso	10.5	23.5	2.7	2.2
Cote d'Ivoire	13.7	24.4	1.9	1.8
Mali	10.8	24.6	2.8	2.3
Niger	9.2	22.4	3.0	2.4
Senegal	8.3	16.9	2.4	2.0
Togo	4.1	8.8	2.6	2.1
UEMOA	62	133	2.6	2.1
Africa	719	1,454	2.4	2.0
Developing	4,382	6,630	1.4	1.5
OECD	913	1,015	0.4	1.1
World	5,687	8,039	1.2	1.4

Sheet D-2. Urbanization



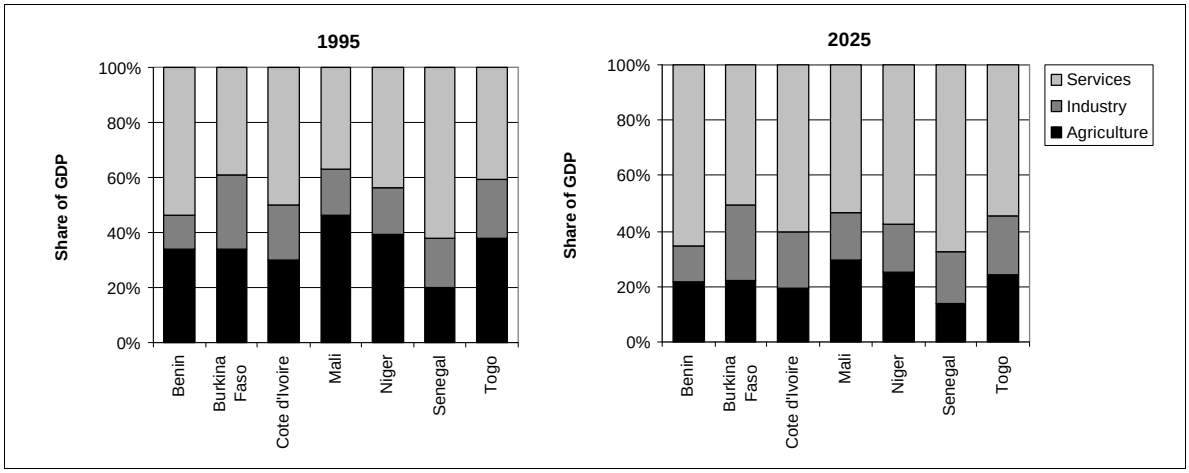
	Urbanization (%)		
Country	1965	1995	2025
Benin	12	31	52
Burkina Faso	5	27	66
Cote d'Ivoire	23	44	64
Mali	13	27	50
Niger	7	17	36
Senegal	33	42	62
Togo	11	31	52
UEMOA	15	32	55
Africa	21	34	54
Developing	n/a	37	56
OECD	n/a	76	84
World	36	45	61

Sheet E-1. GDP



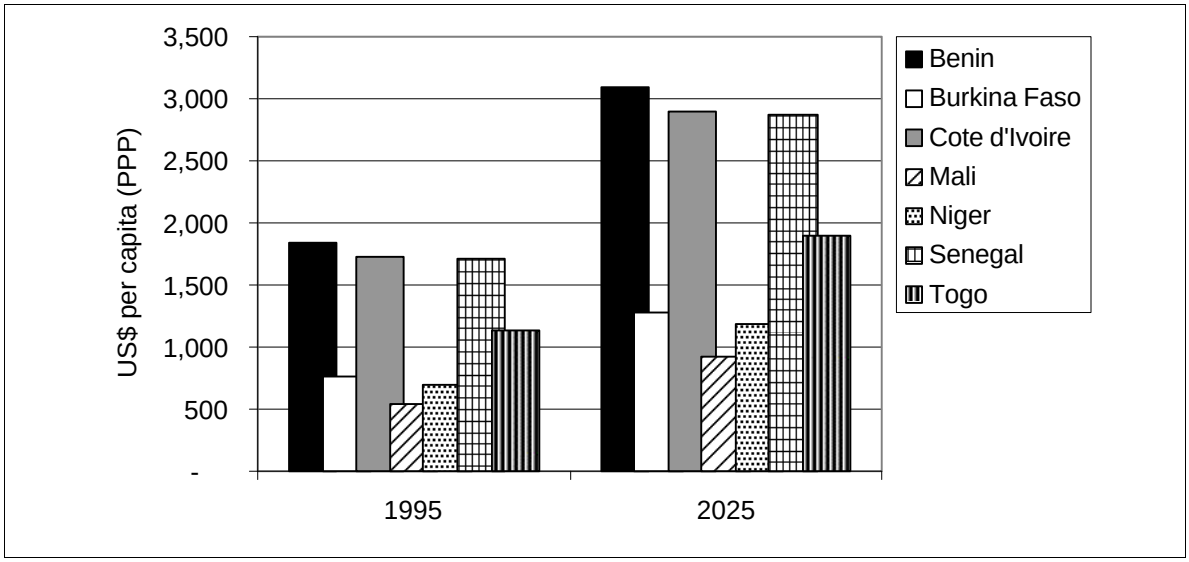
GDP (billion US$)				Growth Rate (%/yr)	Index (1995=1)
	MER	PPP			
Country	1995	1995	2025	95-25	2025
Benin	2.1	10.0	38.0	4.6	3.8
Burkina Faso	2.3	8.0	30.0	4.5	3.8
Cote d'Ivoire	9.9	23.6	70.6	3.7	3.0
Mali	2.7	5.9	22.5	4.6	3.8
Niger	1.9	6.4	26.5	4.8	4.1
Senegal	4.8	14.2	48.5	4.2	3.4
Togo	1.3	4.6	16.6	4.4	3.6
UEMOA	25	73	253	4.2	3.5
Africa	475	1,165	3,958	4.2	3.4
Developing	5,310	13,129	40,825	3.9	3.1
OECD	22,094	18,493	39,056	2.5	2.1
World	28,205	33,416	83,117	3.1	2.5

Sheet E-2. Structure of GDP



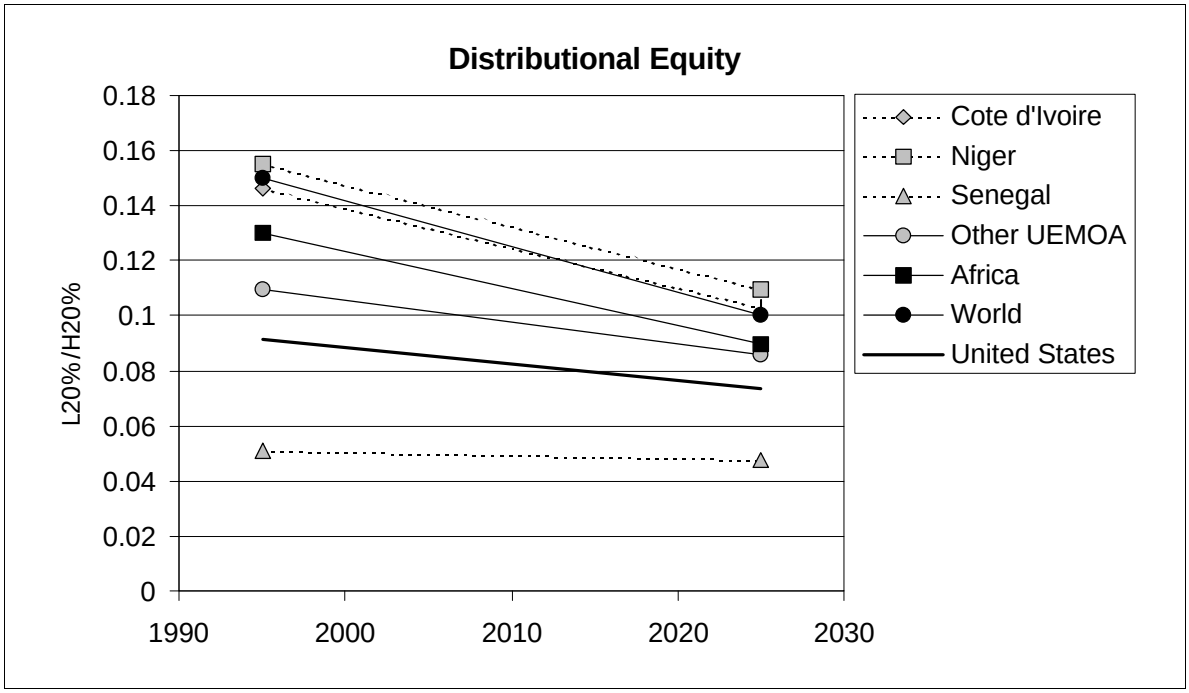
Share of GDP (%)	1995			2025		
Country	Agriculture	Industry	Services	Agriculture	Industry	Services
Benin	34	12	54	22	13	66
Burkina Faso	34	27	39	22	27	51
Cote d'Ivoire	30	20	50	19	20	60
Mali	46	17	37	29	17	54
Niger	39	17	44	25	17	58
Senegal	20	18	62	14	19	68
Togo	38	21	41	24	21	55
UEMOA	32	19	50	21	19	60
Africa	21	31	47	15	31	54
Developing	18	37	44	11	35	55
OECD	6	29	65	3	26	71
World	11	33	56	7	31	63

Sheet E-3. Income



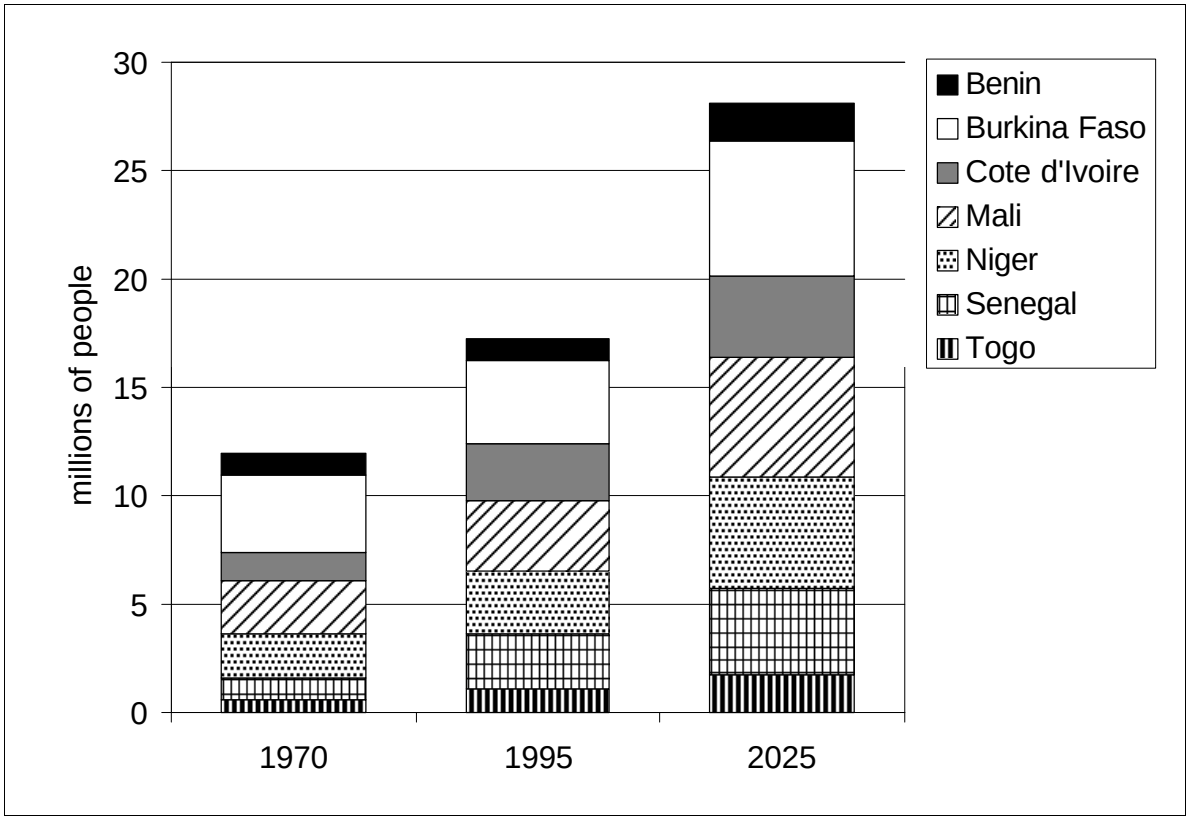
Country	GDP per capita (1995 US$ PPP) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Benin	1,842	3,098	1.7	1.7
Burkina Faso	759	1,278	1.8	1.7
Cote d'Ivoire	1,721	2,893	1.7	1.7
Mali	546	917	1.7	1.7
Niger	702	1,183	1.8	1.7
Senegal	1,708	2,872	1.7	1.7
Togo	1,128	1,895	1.7	1.7
UEMOA	1,173	1,904	1.6	1.6
Africa	1,619	2,722	1.7	1.7
Developing	2,996	6,157	2.4	2.1
OECD	20,249	38,472	2.2	1.9
World	5,876	10,339	1.9	1.8

Sheet S-1. Income Distribution



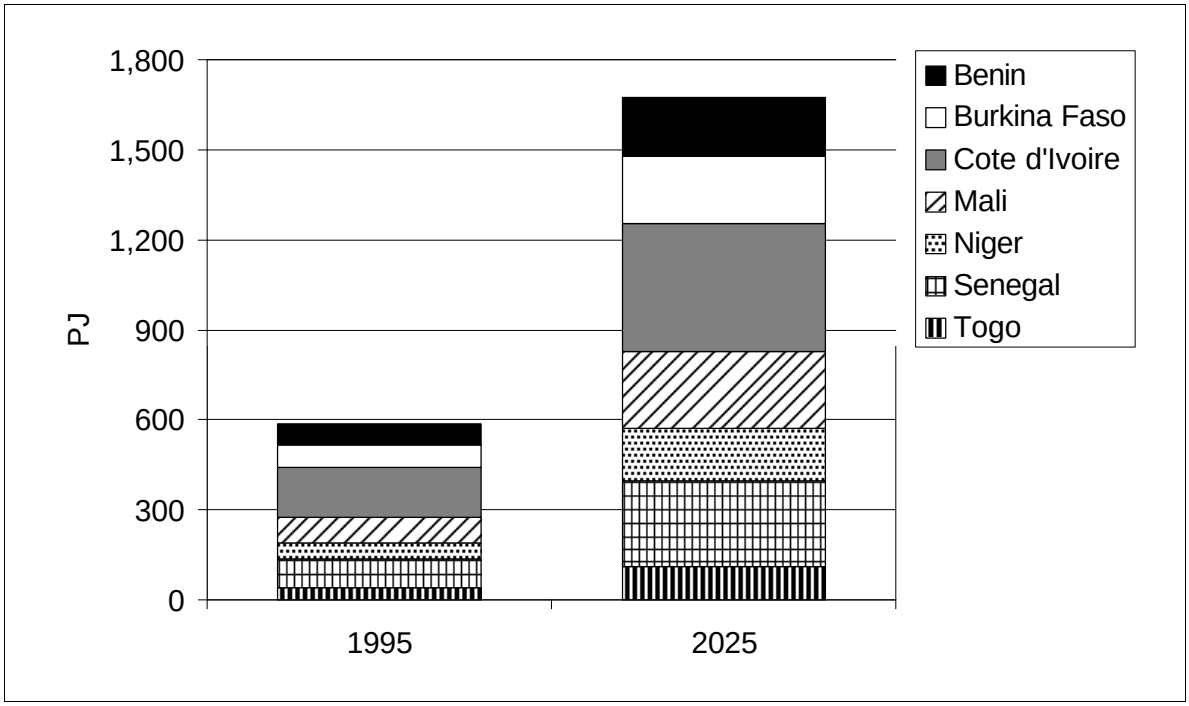
Country	Distributional Equity (L20%/H20%) 1995	2025	Gini Coefficient 1995	2025
Benin	0.11	0.09	0.42	0.46
Burkina Faso	0.11	0.09	0.42	0.46
Cote d'Ivoire	0.15	0.10	0.37	0.43
Mali	0.11	0.09	0.42	0.46
Niger	0.16	0.11	0.36	0.42
Senegal	0.05	0.05	0.54	0.55
Togo	0.11	0.09	0.42	0.46
UEMOA (pop. weighted)	0.12	0.09	0.42	0.46
Africa (pop. weighted)	0.13	0.09	0.42	0.46
United States	0.09	0.07	0.45	0.48
World (pop. weighted)	0.15	0.10		

Sheet S-2. Hunger



Country	Incidence (% of population) 1970	1995	2025	Incidence (millions) 1970	1995	2025	Index (1995=1) 1970	2025
Benin	36	18	15	1.0	1.0	1.8	1.0	1.8
Burkina Faso	66	37	27	3.6	3.9	6.2	0.9	1.6
Cote d'Ivoire	24	19	15	1.3	2.6	3.7	0.5	1.4
Mali	45	30	22	2.5	3.2	5.5	0.8	1.7
Niger	48	32	23	2.0	2.9	5.1	0.7	1.8
Senegal	24	30	24	1.0	2.5	4.0	0.4	1.6
Togo	30	27	20	0.6	1.1	1.8	0.5	1.6
UEMOA	41	28	21	11.9	17.2	28.1	0.7	1.6
Africa	35	34	25	128	247	361	0.5	1.5
Developing	35	20	13	940	873	893	1.1	1.0
OECD	n/a	1	1	n/a	12	8	n/a	0.7
World	25	16	11	940	898	917	1.0	1.0

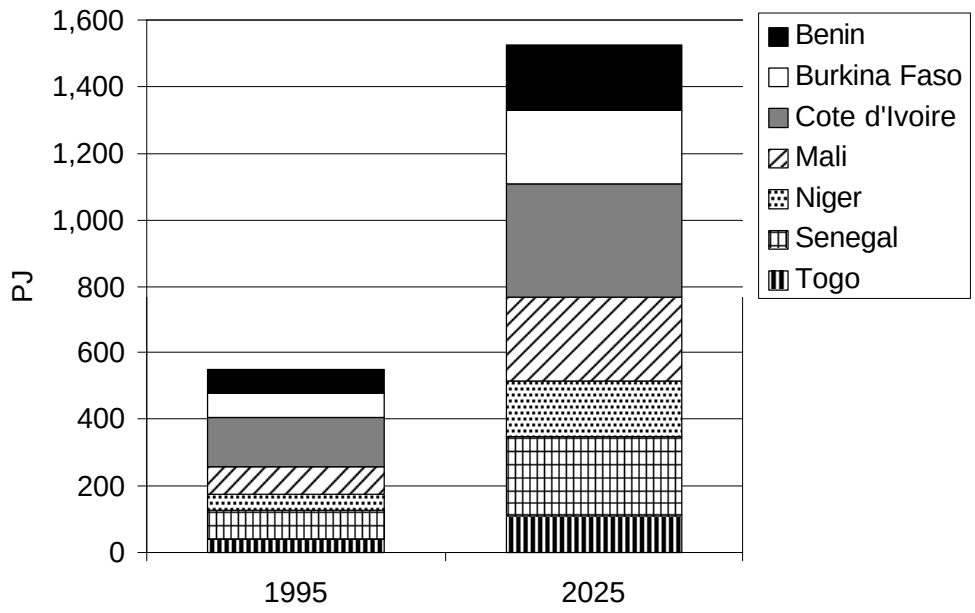
Sheet En-1. Primary Energy Requirements



1995	Total (PJ)	Intensity (MJ/$PPP)	Crude Oil	Coal	Natural Gas	Hydropower	Biomass	Petroleum	Electricity
Benin	70	7.1	-	-	-	-	65.8	3.7	0.9
Burkina Faso	76	9.6	-	-	-	0.3	68.9	7.0	0.0
Cote d'Ivoire	167	7.1	90.3	-	-	3.5	106.3	(33.1)	0.2
Mali	84	14.3	-	-	-	0.8	73.9	9.7	-
Niger	53	8.2	-	1.8	-	-	45.6	4.8	0.7
Senegal	98	6.9	30.3	-	1.9	-	56.1	9.3	0.2
Togo	39	8.5	-	-	-	0.0	26.8	11.1	1.1
UEMOA	588	8.1	121	2	2	5	444	13	3

2025	Total (PJ)	Intensity (MJ/$PPP)	Crude Oil	Coal	Natural Gas	Hydropower	Biomass	Petroleum	Electricity
Benin	197	5.2	-	-	-	-	177.4	15.0	4.9
Burkina Faso	228	7.6	-	-	-	1.2	196.2	30.8	0.0
Cote d'Ivoire	424	6.0	285.6	-	24.5	11.5	206.5	(104.3)	-
Mali	255	11.3	-	-	-	3.6	208.7	43.2	-
Niger	174	6.6	-	8.4	-	-	139.6	22.8	3.2
Senegal	286	5.9	-	-	7.1	-	131.5	146.1	1.0
Togo	112	6.8	-	-	-	0.1	61.0	46.7	4.5
UEMOA	1,677	6.6	286	8	32	16	1,121	200	14

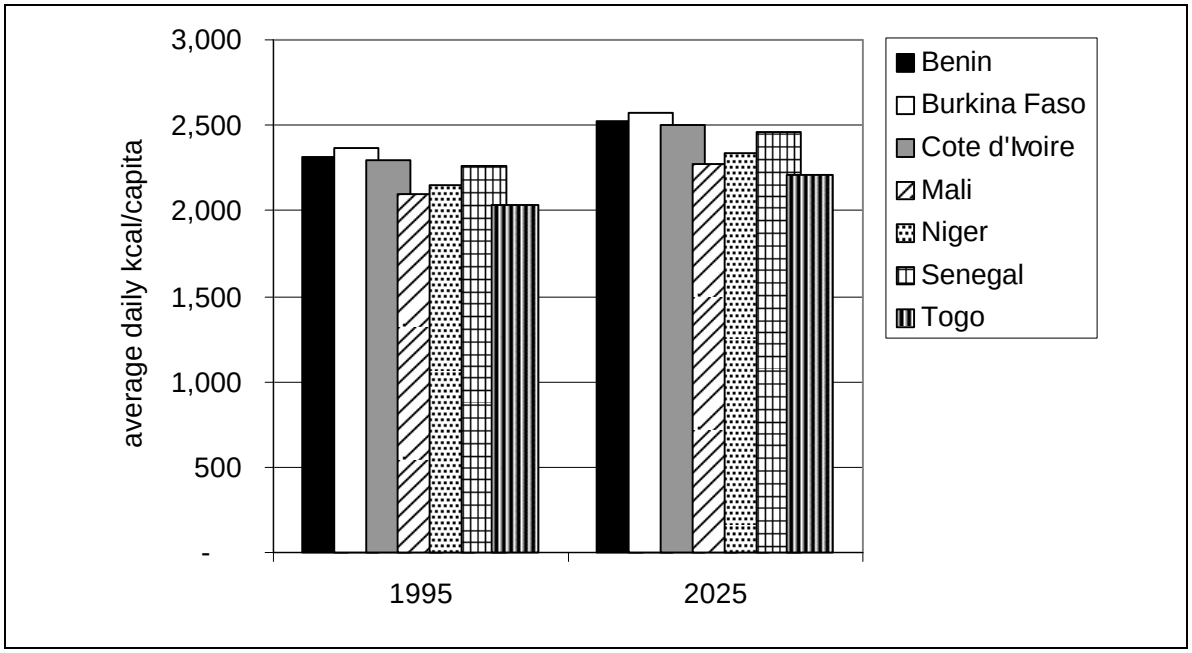
Sheet En-2. Final Fuel Demand



1995			Percent of Total			
	Total (PJ)	Intensity (MJ/$PPP)	Petroleum	Electricity	Natural Gas	Biomass
Benin	70	7.1	5	1	-	94
Burkina Faso	75	9.4	7	1	-	92
Cote d'Ivoire	147	6.2	22	5	-	72
Mali	84	14.2	10	1	-	89
Niger	51	7.9	8	2	-	90
Senegal	87	6.1	30	3	2	65
Togo	38	8.2	26	4	-	71
UEMOA	551	7.6	16	3	0	81

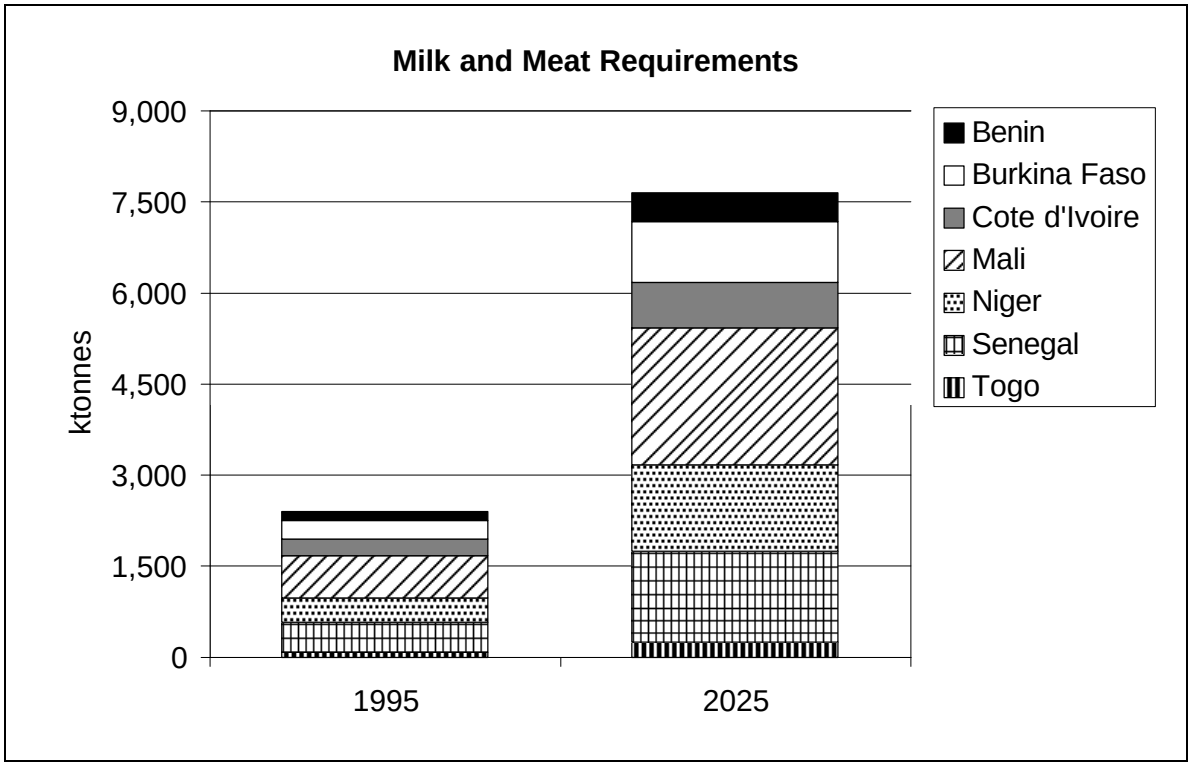
2025			Percent of Total			
	Total (PJ)	Intensity (MJ/$PPP)	Petroleum	Electricity	Natural Gas	Biomass
Benin	197	5.2	7	2	-	90
Burkina Faso	221	7.4	10	1	-	89
Cote d'Ivoire	342	4.8	30	10	-	60
Mali	251	11.1	15	2	-	83
Niger	165	6.2	12	4	-	85
Senegal	242	5.0	38	5	3	54
Togo	107	6.5	38	5	-	57
UEMOA	1,525	6.0	22	4	0	73

Sheet F-1. Diets



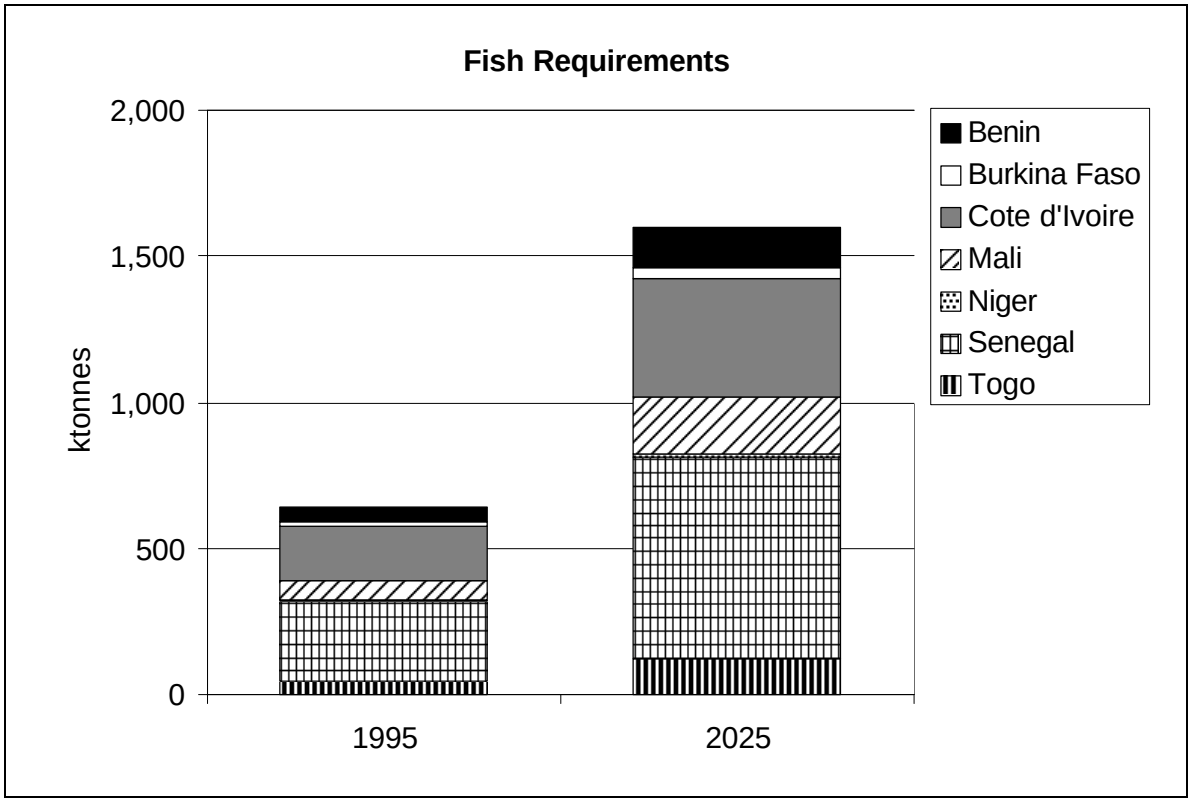
Country	Avg. Daily Consumption (kcal/capita) 1995	2025	Share from Animal Products (% cal) 1995	2025
Benin	2,320	2,524	4	5
Burkina Faso	2,366	2,574	4	5
Cote d'Ivoire	2,296	2,498	4	5
Mali	2,094	2,278	9	12
Niger	2,144	2,332	5	7
Senegal	2,264	2,463	9	12
Togo	2,036	2,215	5	7
UEMOA	2,231	2,422	6	8
Africa	2,322	2,526	7	10
Developing	2,534	2,748	12	14
OECD	3,327	3,397	29	29
World	2,683	2,850	16	17

Sheet F-2. Meat and Milk Requirements and Production



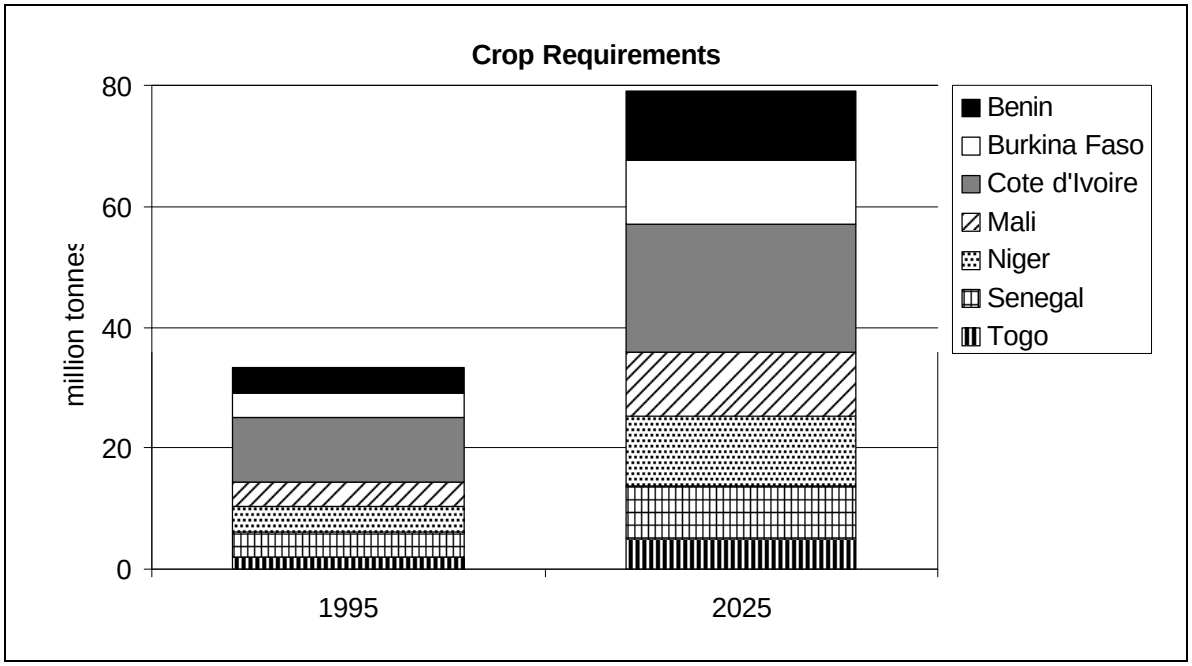
Country	Requirements (ktonnes) 1995	2025	Production (ktonnes) 1995	2025	Self-Sufficiency Ratio 1995	2025	Fraction of Meat from Feedlots (%) 1995	2025
Benin	143	488	108	424	0.76	0.87	45	49
Burkina Faso	313	993	297	970	0.95	0.98	0	25
Cote d'Ivoire	282	758	179	600	0.63	0.79	20	33
Mali	681	2,235	666	2215	0.98	0.99	0	16
Niger	410	1,425	429	1425	1.05	1.00	15	36
Senegal	501	1,512	329	1224	0.66	0.81	3	9
Togo	75	242	56	147	0.75	0.61	4	37
UEMOA	2,404	7,653	2,064	7,004	0.86	0.92	n/a	n/a

Sheet F-3. Fish Requirements and Production



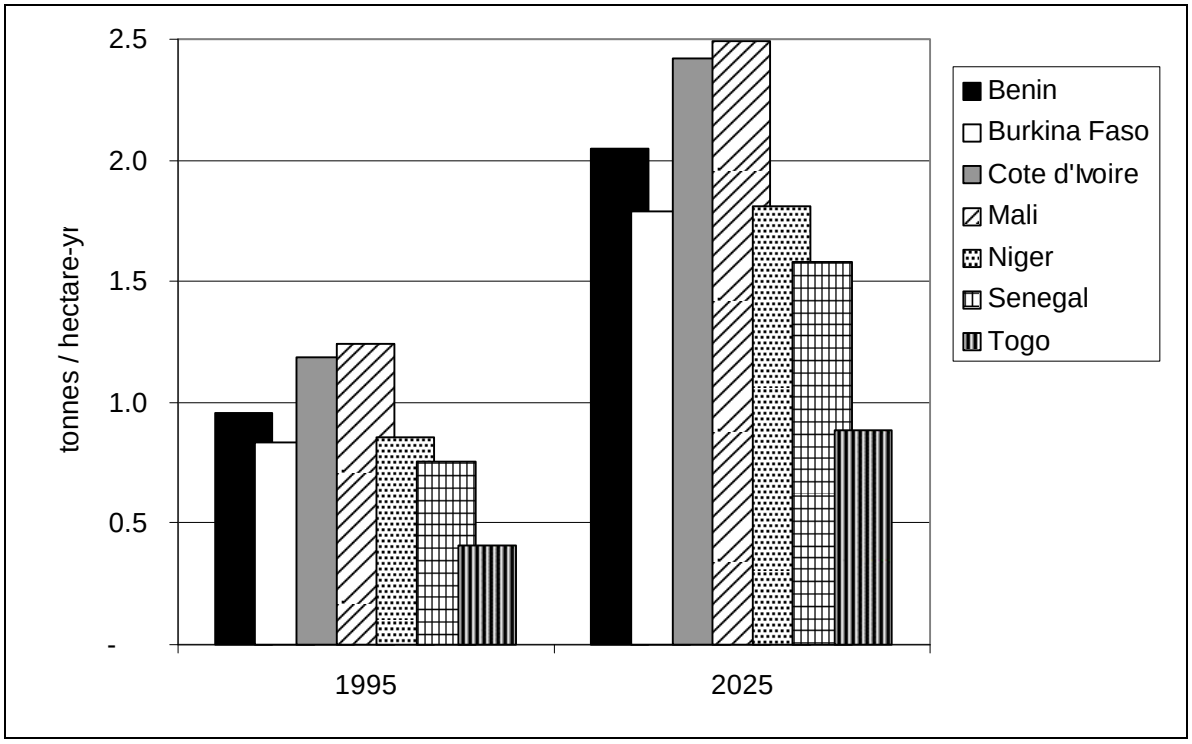
	Requirements (ktonnes)		Production (ktonnes)		Self-Sufficiency Ratio	
Country	1995	2025	1995	2025	1995	2025
Benin	50	139	39	97	0.8	0.7
Burkina Faso	13	35	7	15	0.6	0.4
Cote d'Ivoire	186	408	71	96	0.4	0.2
Mali	68	193	65	179	1.0	0.9
Niger	4	11	2	5	0.6	0.4
Senegal	275	691	378	691	1.4	1.0
Togo	46	121	16	25	0.4	0.2
UEMOA	640	1,599	578	1,108	0.9	0.7

Sheet F-4. Crop Requirements and Production



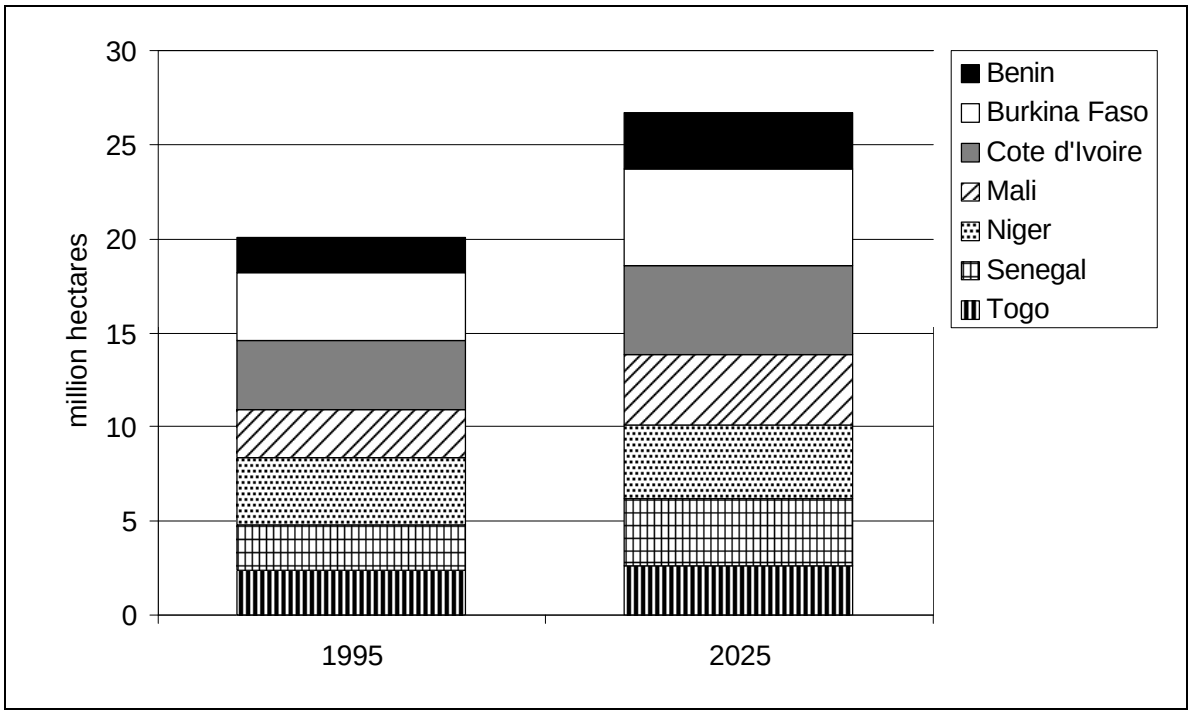
	Requirements (million tonnes)		Production (million tonnes)		Self-Sufficiency Ratio	
Country	1995	2025	1995	2025	1995	2025
Benin	4.4	11.6	4.0	10.7	0.9	0.9
Burkina Faso	4.1	10.4	3.7	9.9	0.9	1.0
Cote d'Ivoire	10.6	21.3	12.0	23.2	1.1	1.1
Mali	4.1	10.5	3.4	9.4	0.8	0.9
Niger	4.2	11.6	3.4	7.1	0.8	0.6
Senegal	4.0	8.9	2.7	7.2	0.7	0.8
Togo	2.0	4.8	1.7	2.8	0.8	0.6
UEMOA	33	79	31	70	0.9	0.9

Sheet F-5. Cereal Yields



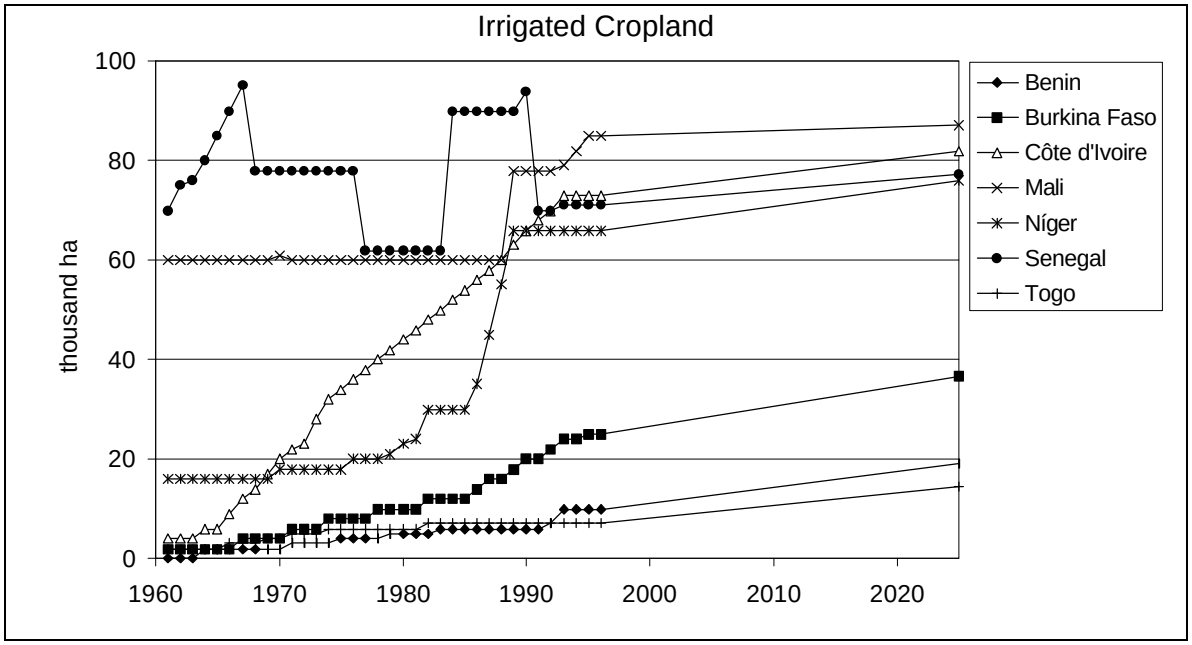
Country	Harvest Yield (tonnes per ha) 1995	2025	Cropping Intensity (harvests/yr) 1995	2025	Annual yield (tonnes/ha-yr) 1995	2025	Index (95=1) 2025
Benin	1.0	2.1	1.0	1.0	1.0	2.0	2.2
Burkina Faso	0.8	1.7	1.0	1.0	0.8	1.8	2.2
Cote d'Ivoire	1.1	2.1	1.1	1.1	1.2	2.4	2.0
Mali	0.8	1.6	1.5	1.5	1.2	2.5	2.0
Niger	0.3	0.7	2.8	2.8	0.9	1.8	2.1
Senegal	0.8	1.6	1.0	1.0	0.8	1.6	2.1
Togo	0.7	1.5	0.6	0.6	0.4	0.9	2.2
UEMOA	0.6	1.4	1.5	1.4	0.9	1.9	2.1
Africa	1.2	2.3	0.9	0.9	1.0	2.0	1.9
Developing	2.5	3.7	1.0	1.0	2.5	3.7	1.5
OECD	4.3	5.7	0.6	0.6	2.5	3.3	1.3
World	2.8	4.1	0.8	0.8	2.2	3.3	1.5

Sheet F-6. Cropland



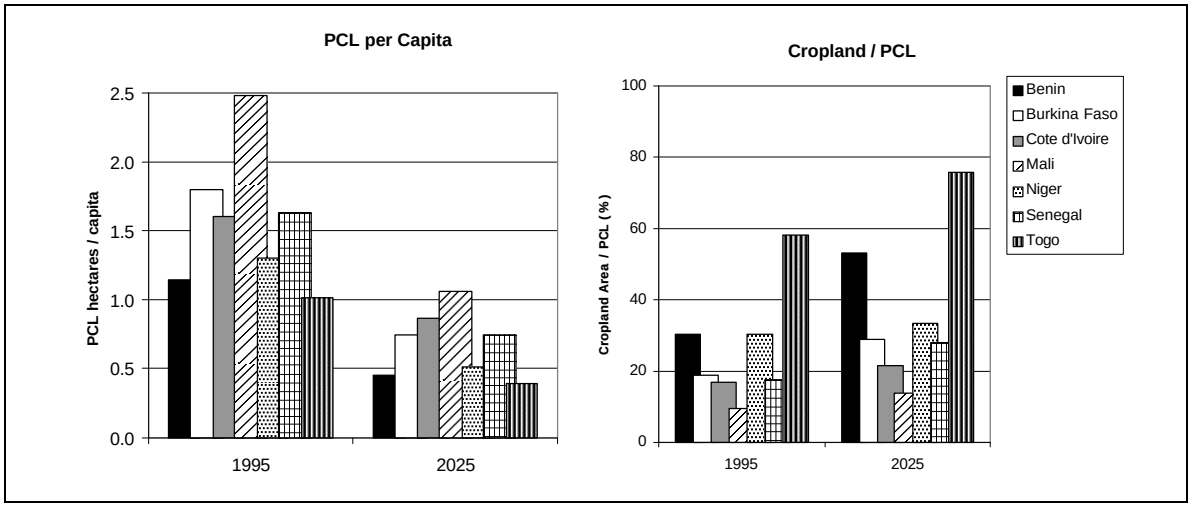
Country	Total Cropland (million ha) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Benin	1.9	3.0	1.6	1.6
Burkina Faso	3.6	5.1	1.2	1.4
Cote d'Ivoire	3.7	4.8	0.8	1.3
Mali	2.5	3.7	1.3	1.5
Niger	3.6	3.9	0.2	1.1
Senegal	2.3	3.6	1.4	1.5
Togo	2.4	2.7	0.3	1.1
UEMOA	20	27	1.0	1.3
Africa	186	255	1.1	1.4
Developing	770	867	0.4	1.1
OECD	412	410	0.0	1.0
World	1,450	1,534	0.2	1.1

Sheet F-7. Irrigation



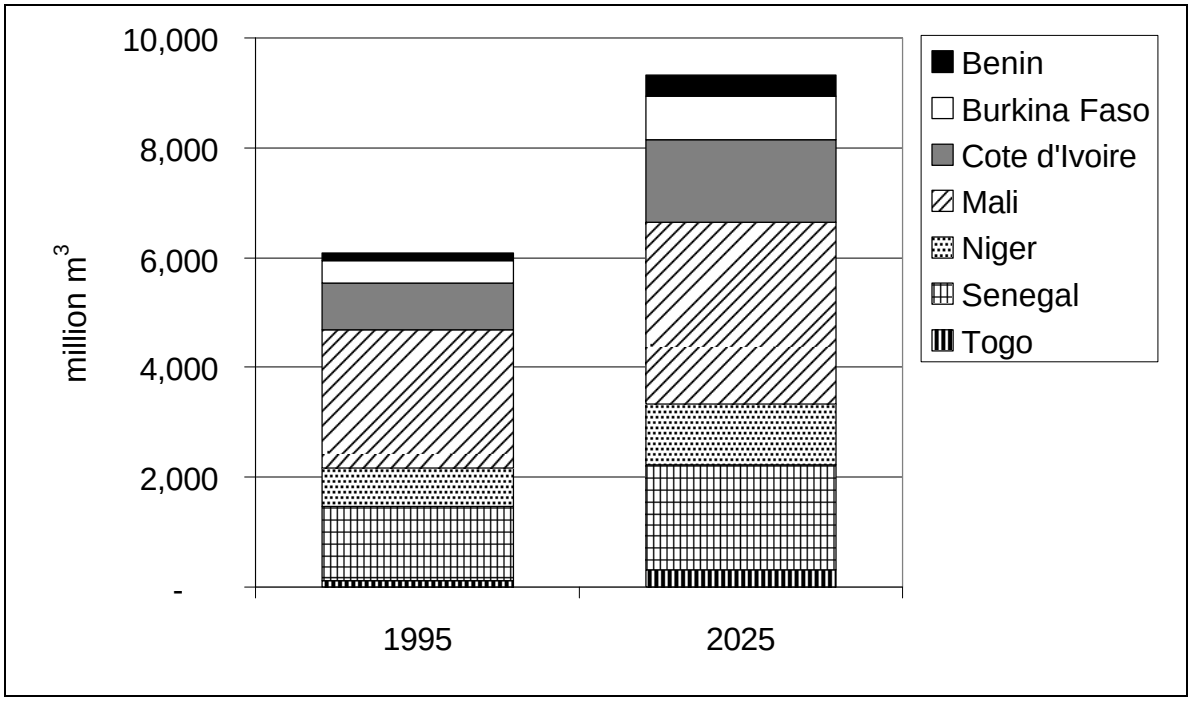
Country	Irrigated Cropland (thousand ha) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025	Fraction of Cropland Irrigated (%) 1995	2025
Benin	10	19	2.1	1.9	0.5	0.6
Burkina Faso	24	37	1.4	1.5	0.7	0.7
Cote d'Ivoire	73	82	0.4	1.1	2.0	1.7
Mali	79	87	0.3	1.1	3.2	2.4
Niger	66	76	0.5	1.1	1.8	2.0
Senegal	71	77	0.3	1.1	3.0	2.2
Togo	7	14	2.5	2.1	0.3	0.5
UEMOA	330	393	0.6	1.2	1.6	1.5

Sheet F-8. Potential Cultivable Land



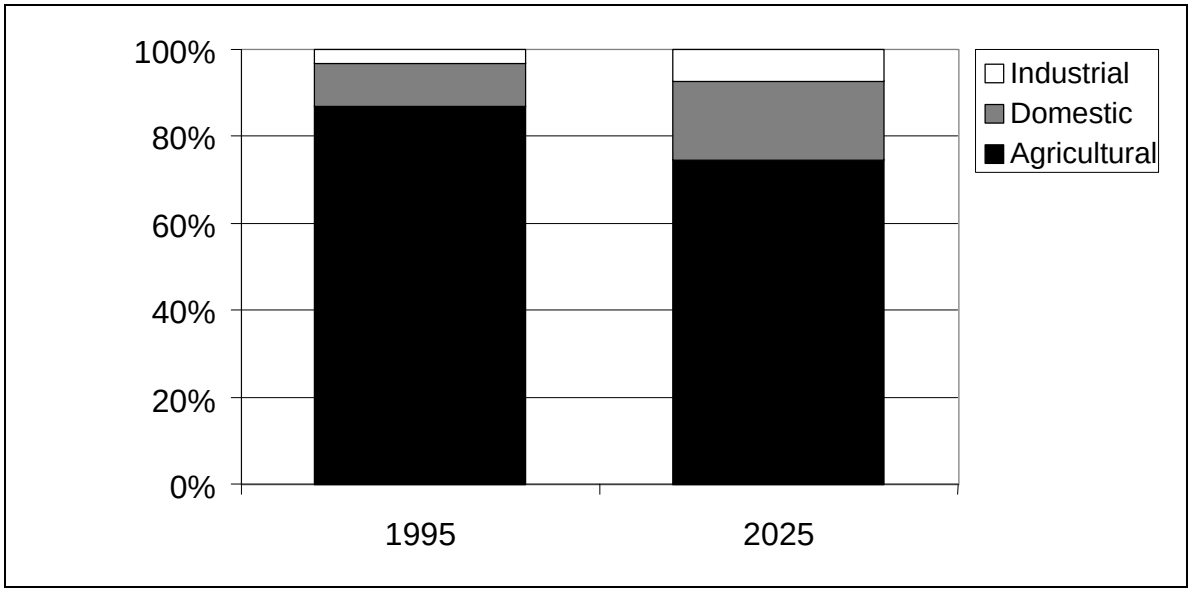
Country	PCL (million hectares) 1995	PCL (million hectares) 2025	PCL per capita (ha/cap) 1995	PCL per capita (ha/cap) 2025	Cropland/PCL (%) 1995	Cropland/PCL (%) 2025
Benin	6.2	5.6	1.1	0.5	30	54
Burkina Faso	18.9	17.5	1.8	0.7	19	29
Cote d'Ivoire	22.0	21.3	1.6	0.9	17	22
Mali	26.8	26.2	2.5	1.1	9	14
Niger	11.9	11.5	1.3	0.5	30	34
Senegal	13.5	12.7	1.6	0.7	17	28
Togo	4.2	3.5	1.0	0.4	58	76
UEMOA	104	98	1.7	0.7	19	27
Africa	1,077	1,024	1.5	0.7	17	25
Developing	2,772	2,626	0.6	0.4	28	33
OECD	1,267	1,254	1.4	1.2	33	33
World	4,812	4,649	0.8	0.6	30	33

Sheet P-1. Water Withdrawals by Country



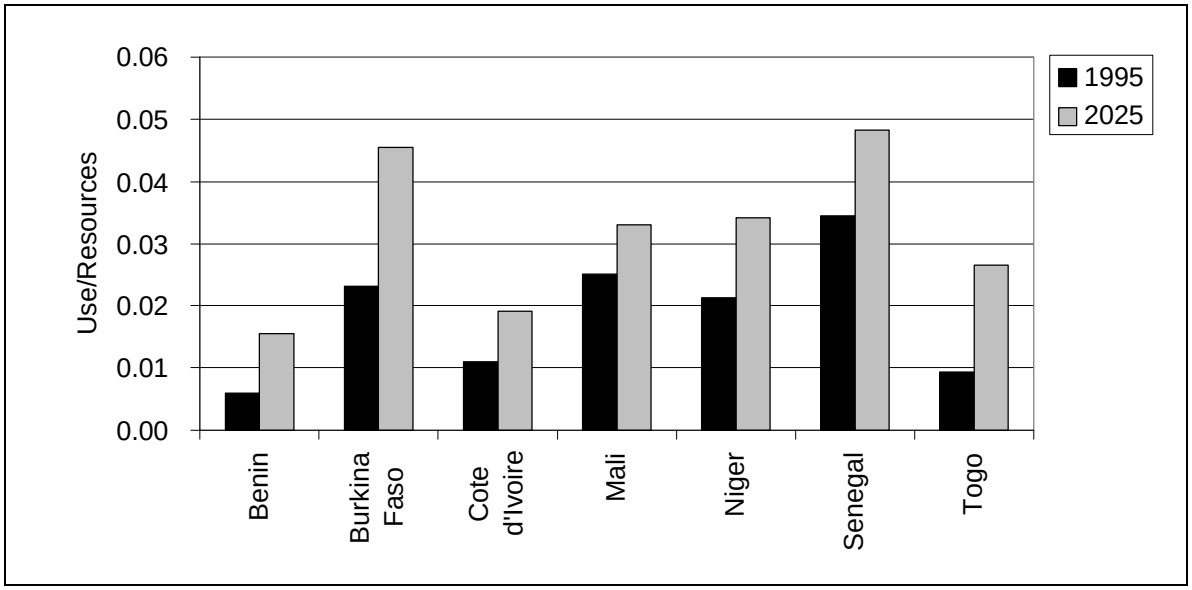
Country	Withdrawals (million m^3) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Benin	152	400	3.3	2.6
Burkina Faso	405	796	2.3	2.0
Cote d'Ivoire	855	1,488	1.9	1.7
Mali	2,522	3,307	0.9	1.3
Niger	692	1,108	1.6	1.6
Senegal	1,358	1,907	1.1	1.4
Togo	113	320	3.5	2.8
UEMOA	6,096	9,326	1.4	1.5
billion m^3				
Africa	167	255	1.4	1.5
Developing	2,319	3,375	1.3	1.5
OECD	936	1,059	0.4	1.1
World	3,699	5,044	1.0	1.4

Sheet P-2. Water Withdrawals by Sector



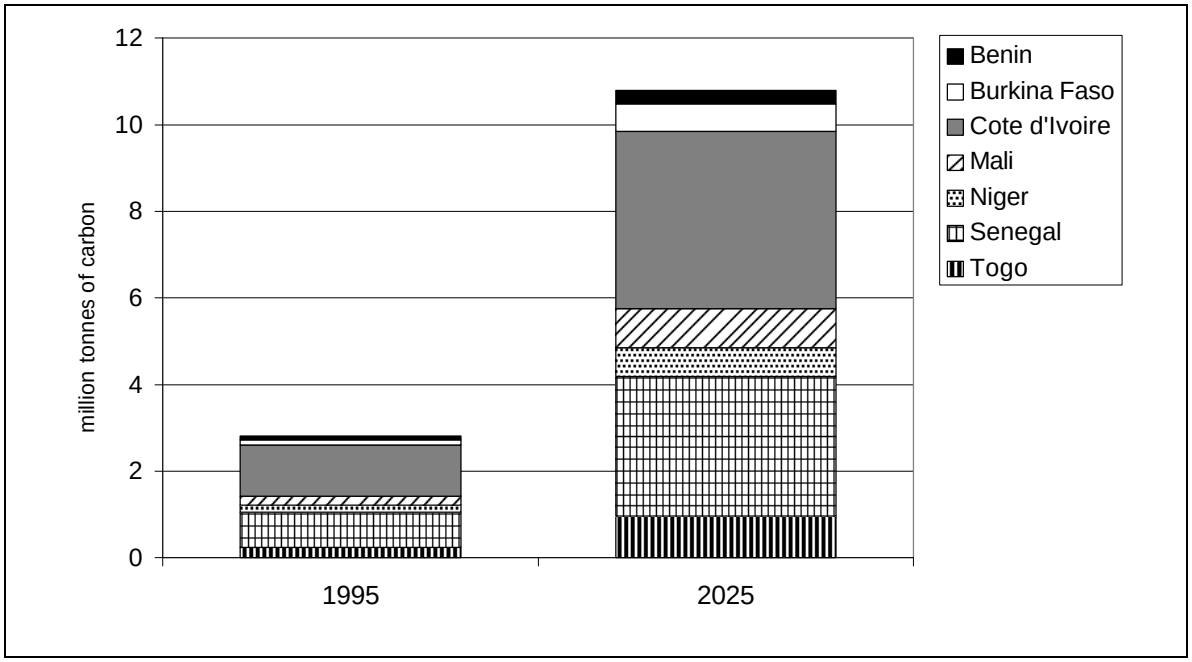
Sector	Withdrawals (million m^3) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Agricultural	5,308	6,964	0.9	1.3
Domestic	607	1,691	3.5	2.8
Industrial	181	671	4.5	3.7
Total	6,096	9,326	1.4	1.5

Sheet P-3. Water Stress



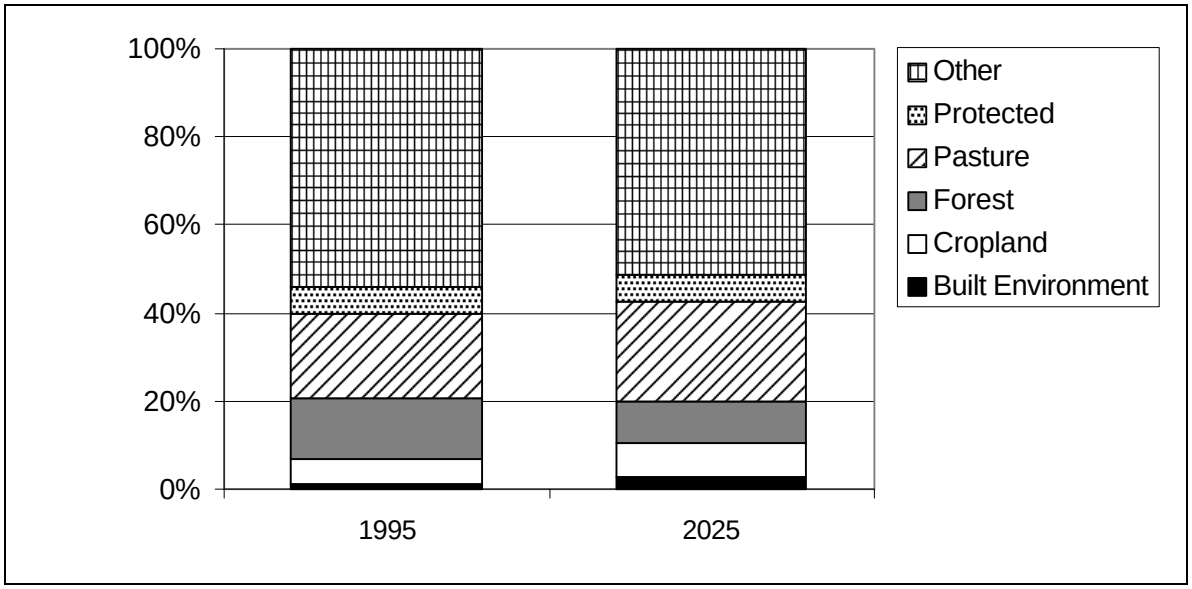
Country	Use / Resources 1995	Use / Resources 2025	Import Dep. (%)	Use / Internal Res. 1995	Use / Internal Res. 2025	COV of Precip.
Benin	0.01	0.02	60	0.01	0.04	0.06
Burkina Faso	0.02	0.05	0	0.02	0.05	0.06
Cote d'Ivoire	0.01	0.02	1	0.01	0.02	0.05
Mali	0.03	0.03	40	0.04	0.06	0.13
Niger	0.02	0.03	89	0.20	0.32	0.14
Senegal	0.03	0.05	33	0.05	0.07	0.12
Togo	0.01	0.03	4	0.01	0.03	0.07
UEMOA	0.02	0.03	n/a	0.03	0.07	n/a

Sheet P-4. Carbon Emissions



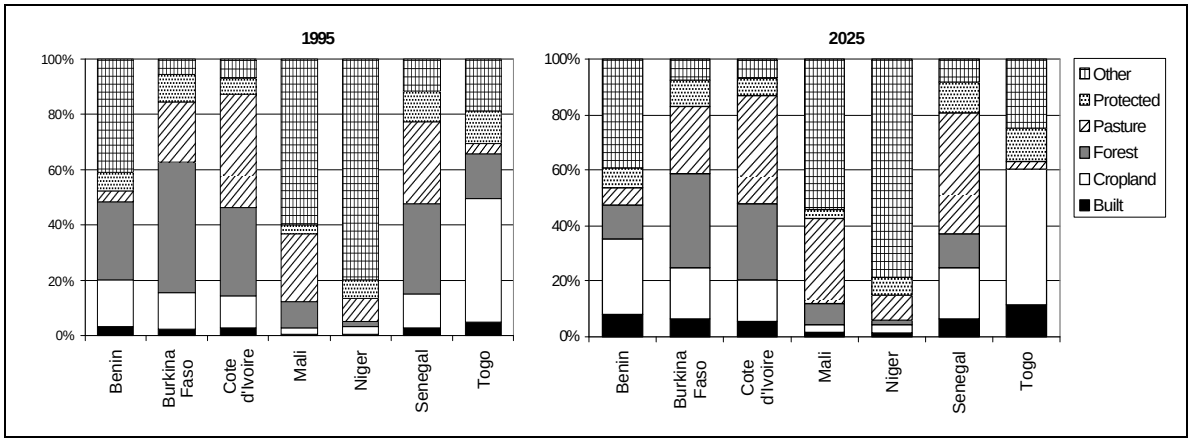
Country	Mtonnes of Carbon from fossil combustion 1995	2025	Annual per capita (t) 1995	2025	Annual per Dollar GDP_{PPP} (kg) 1995	2025
Benin	0.1	0.3	0.01	0.02	0.01	0.01
Burkina Faso	0.1	0.6	0.01	0.03	0.02	0.02
Cote d'Ivoire	1.2	4.1	0.09	0.17	0.05	0.06
Mali	0.2	0.9	0.02	0.04	0.03	0.04
Niger	0.1	0.7	0.02	0.03	0.02	0.03
Senegal	0.8	3.2	0.10	0.19	0.06	0.07
Togo	0.2	1.0	0.06	0.11	0.05	0.06
UEMOA	2.8	10.8	0.05	0.08	0.04	0.04

Sheet P-5. Land Use by Land Type



Land Type	Land area (million ha) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Built Environment	4.0	9.6	2.9	2.4
Cropland	20.1	26.7	1.0	1.3
Forest	47.7	32.7	-1.2	0.7
Pasture	65.8	77.3	0.5	1.2
Protected	20.7	20.7	0.0	1.0
Other	185.4	176.6	-0.2	1.0
Total	343.6	343.6	0.0	1.0

Sheet P-6. Land Use by Region



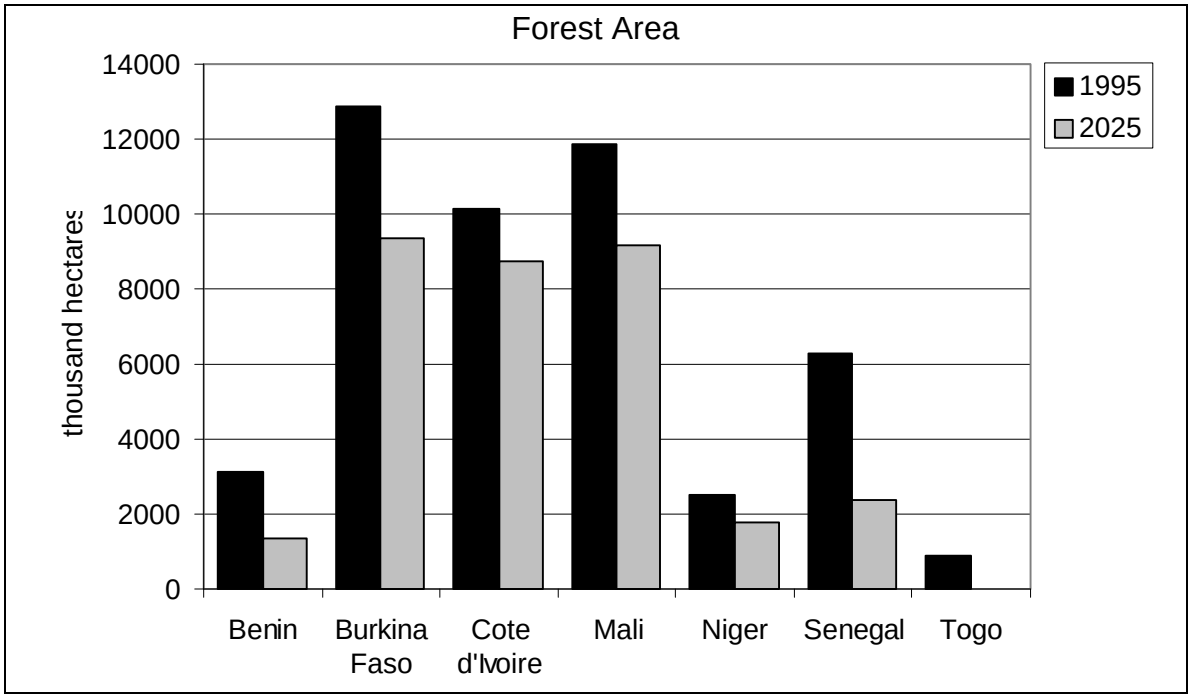
1995

Country	Built	Cropland	Forest	Pasture	Protected	Other	Total Area (million ha)
Benin	3	17	28	4	7	41	11.1
Burkina Faso	2	13	47	22	10	6	27.4
Cote d'Ivoire	3	12	32	41	6	7	31.8
Mali	1	2	10	25	3	60	122.0
Niger	0	3	2	8	7	80	126.7
Senegal	3	12	33	30	11	11	19.3
Togo	5	45	16	4	12	19	5.4
UEMOA	1	6	14	19	6	54	343.6

2025

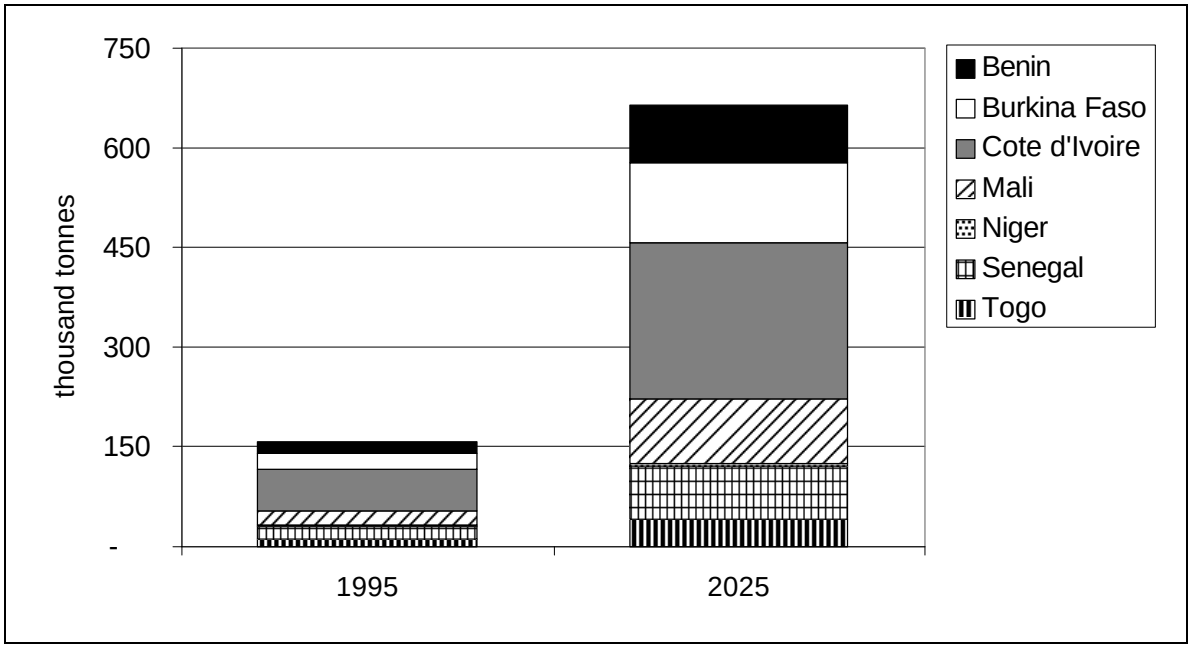
Country	Built	Cropland	Forest	Pasture	Protected	Other
Benin	8	27	12	7	7	39
Burkina Faso	6	19	34	24	10	7
Cote d'Ivoire	6	15	27	39	6	7
Mali	1	3	8	31	3	54
Niger	1	3	1	9	7	78
Senegal	6	19	12	43	11	8
Togo	12	49	0	3	12	25
UEMOA	3	8	10	23	6	51

Sheet P-7. Deforestation



Country	Average Annual Rate 1980-1990	1990-1995	1995-2025	Area Lost (kha) 1995-2025	Area Lost (% of 1995 forest area) 1995-2025
Benin	-73	-60	-59	1773	57
Burkina Faso	-31	-32	-119	3568	28
Cote d'Ivoire	-651	-31	-46	1392	14
Mali	-105	-114	-90	2704	23
Niger	1	0	-24	707	28
Senegal	-44	-50	-131	3939	63
Togo	-24	-19	-29	884	100
UEMOA	-927	-304	-499	14967	31

Sheet P-8. Fertilizer Consumption



Country	Consumption (thousand tonnes) 1995	2025	Growth Rate (%/yr) 95-25	Index (1995=1) 2025
Benin	17	86	5.5	5.0
Burkina Faso	23	119	5.6	5.1
Cote d'Ivoire	63	236	4.5	3.7
Mali	21	98	5.3	4.7
Niger	1	4	4.3	3.5
Senegal	20	79	4.7	4.0
Togo	11	40	4.4	3.6
UEMOA	157	663	4.9	4.2

Annex Notes

Sheet D-1. Population: 1995 and scenario populations are from the mid-range 1996 revision of the UN population projections (UN, 1997).

Sheet D-2. Urbanization: Urbanization in 1995 and in the scenario from the 1995 revision of the UN projections for urban and rural areas (WRI, 1996).

Sheet E-1. GDP: GDP calculated from population and GDP per capita.

Sheet E-2. Structure of GDP: 1995 figures for all countries except Côte d'Ivoire are from SESRTCIC (1997), Côte d'Ivoire from World Bank (1997). In the scenario, agricultural GDP per capita approaches the base-year average for the industrialized countries as average incomes approach the base-year average for the industrialized countries, following an approach described in Heaps et al. (1998). Degree of convergence is small, since average incomes remain small compared to the industrial country average throughout the scenario. Similarly, industry share approaches that of the industrialized countries in 2025 as average income approaches the industrial country average in 1995. Service sector calculated as balance.

Sheet E-3. Income: GDP per capita at market exchange rates (MER) in 1995 are taken from World Bank (1997) for all countries except Benin. For Benin, the MER value is taken from SESRTCIC (1997). Ratios of PPP to MER in the base year are estimated from World Bank GNP data (1997). GDP figures are given in US dollars adjusted for purchasing power parity (PPP). Scenario assumptions are described in the text and based on IPCC growth rates (IPCC, 1992). The IPCC growth rates are based on market exchange rates (MER). Examining patterns across countries, the PPP conversion factors tend to approach the MER values as GDP per capita approaches that of the industrialized countries. This trend is captured in the scenario through an algorithm that relates growth rates in PPP terms to growth rates in MER terms (Heaps et al., 1998).

Sheet S-1. Income Distribution: 1995 values for income inequality are available for only three countries — Côte d'Ivoire, Niger and Senegal (World Bank, 1998). The other four countries are assigned the average value of the Gini coefficient for Africa in the base year (Raskin et al., 1998). National income distributions are assumed to be lognormal, based on a cross-sectional analysis described in Heaps et al. (1998). In the scenario, changes in income inequality follow trends seen in industrialized countries.

Sheet S-2. Hunger: 1995 figures are based on FAO estimates of the incidence of chronic undernutrition. (FAO, 1997a). The FAO figures are from a 1990-92 survey of developing countries. They are brought forward to 1995 by assuming the absolute number of hungry is constant between 1991 and 1995 in all countries except Senegal. This has the effect of reducing the percentage of the population hungry in 1995 relative to 1991. In Senegal, where the percentage has increased historically, the percentage of the population hungry in 1995 is set equal to the FAO value, so in absolute size the hungry population in 1995 is larger than in 1991. Scenario figures follow from the scenario assumptions for population, GDP per capita and income inequality, as outlined in the text. Figures for 1970 for the UEMOA countries are taken from FAO (1997a).

Sheets En-1. Primary Energy Requirements: 1995 data are based on figures from ENDA-TM (1995), IEA (1997), EIA (1998) and a regional report for five West African countries as part of the Review of Policies in the Traditional Energy Sector (RPTES, 1995). IEA balances are available for three countries: Benin, Côte d'Ivoire and Senegal. For the four countries with no IEA balances, electric generation and trade are from EIA. Scenario values determined by final fuel demand (Sheet En-2), trade and fuel mix. Self-sufficiency in electricity generation is kept at 1995 levels in all countries except Côte d'Ivoire (see text). The electrical generation mix is kept at 1995 levels in the scenario in all countries except Côte d'Ivoire, where the natural gas share increases from 0% to 21%. Based on figures from ENDA-TM (1995), natural gas production in Côte d'Ivoire is assumed to be 700 million cubic meters per year by 2025.

Sheet En-2. Final Fuel Demand: 1995 data based on the sources listed for Sheet En-1. Note that in Senegal there is a substantial amount of biomass use (15 PJ, 36% of biomass TFC) recorded for "transformation, non-specified" in the IEA tables. This consumption is assigned to industry in the analysis. For Burkina Faso, Mali and Niger, biomass estimates are from RPTES. 1992 values brought forward to 1995 assuming constant consumption per capita. For Togo, per capita biomass use in 1995 was set to the average value for the other countries. Petroleum consumption for the countries without IEA balances is based on figures from ENDA-TM, with values brought forward to 1995 assuming constant intensities per dollar GNP. For transportation energy demand in 1995 in Benin, Côte d'Ivoire and Senegal, IEA totals are split between passenger and freight transport based on the relative values for Africa for the study described in Raskin et al. (1998), which were based on data from WRI (1992) and IRF (1992). Mode shares (e.g., road, rail, air) for both passenger and freight transport were based on the same source.

The scenario trends for energy demand are based on assumptions about changing sectoral consumption, although sectoral-level detail in the base year is available for only three countries — Benin, Côte d'Ivoire and Senegal. For these three countries, the scenario analysis is carried out for domestic uses (households and the service sector combined), industry and transportation. The small amount of energy consumption by agriculture was included with industry. For the other four countries, changing energy consumption patterns are estimated from an aggregate energy intensity, given by total energy consumption for the country per dollar of GDP. Trends in the aggregate intensity, and changes in fuel mix, are based on a sector-level analysis carried out for Africa as a whole (Raskin et al., 1998; Heaps et al., 1998). The sectoral trends assumed here for Benin, Côte d'Ivoire and Senegal (described in Section 3.9) are also based on that study. In the three countries where sectoral data are available, the mix of fuels used to meet industrial and transportation energy demand is held at 1995 levels in the scenario. In the domestic sector, the share of biomass declines over the course of the scenario as average incomes rise — reflecting an income-based transition to modern fuels. In the four countries with no sectoral-level data, the share of biomass in total final consumption drops between 1995 and 2025.

Sheet F-1. Diets: 1995 values are based on 1994 figures from FAO (1996a). Daily consumption is the amount available for consumption, not necessarily the amount actually consumed. In the scenario, consumption per capita increases with income, using an

elasticity of 0.16. The elasticity is based on an analysis for Africa as a whole described in Raskin et al. (1998), where consumption per capita increased with income following a logistic (s-shaped) curve. This leads to a 2% increase in every country between 1995 and 2025. Shares of different crops in total crop-derived calories are kept at base-year levels. Shares of meat and milk increase relative to fish in total animal-derived calories, as explained in the text.

Sheets F-2…4. Agricultural Requirements and Production: 1995 values are from FAO (1996a). A full set of food balances and land-use accounts for 1995 is unavailable, so 1994 figures are used. The self-sufficiency ratio is calculated as production divided by requirements. The difference between production and requirements in the base year is the total of net exports plus net additions to stocks. Meat includes eggs; milk includes all products derived from milk. Fraction from feedlots is the fraction of total production in caloric terms. Fish includes all seafood. Scenario assumptions are outlined in the text.

Sheet F-5. Cereal Yields: 1995 values are 1994 figures from FAO (1996a), as described for Sheets F-2…4. Annual yield defined as total annual production per unit area of cropland. Harvest yield is production per unit area per harvest. Cropping intensity, a measure of multiple cropping, is given by:

$$\text{cropping intensity} = \text{annual yield} / \text{harvest yield} .$$

The index shown in Sheet F-5 is for annual yield. Cereal yields roughly double in the scenario between 1995 and 2025. Some of the increases in yields and cropping intensities come from a shift to irrigated land. Depending on the crop, harvest yields on irrigated land in the base year are between 2.0 and 4.4 times those on rainfed land, with yield ratios based on data for Africa from Fischer (1993). Based on the same source, cropping intensities on irrigated land are 1.5 times those on rainfed land. Scenario assumptions for yield increases are based on Leach (1995).

Sheet F-6. Cropland: 1995 values are 1994 figures from FAO (1996a), as described for Sheets F-2…4. Changes in the scenario are the result of scenario values for agricultural demand and trade, and productivity changes for individual crop commodities, as reported in Sheet F-5, and aggregate demand and trade figures reported in Sheet F-4.

Sheet F-7. Irrigation: 1995 values are 1994 figures from FAO (1996a), as described for Sheets F-2…4. Historical values, 1961-1996, are from FAO (1996a) Note that fluctuations in the historical data may reflect changes in classification of irrigated areas, as much as actual changes in area. Scenario values are based in part on historical trends. The values for Niger and Togo were adjusted in combination with agricultural self-sufficiency ratios and feedlot fractions to mitigate land-use change impacts.

Note that estimates of irrigation potential can vary considerably from source to source, posing difficulties for assessing the reasonableness of the irrigated area expansion in the scenario. The irrigated areas in 2025 are all well below the potential area recorded in the FAO's *Irrigation in Africa in Figures* (FAO, 1995). However, this may be optimistic: the growth in irrigated areas for the region as a whole — by 20% over 1995 values —

exceeds the potential increase of 11% for Africa as a whole estimated by Leach (1995) based on potential irrigated area increases from Fischer (1993).

Sheet F-8. Potential Cultivable Land: Potential cropland (PCL) is the area of cropland plus the area of potential arable land currently under other land cover. Total potential cropland area for each country is from Alexandratos (1995), and is assigned to forest and grazing land in proportion to their areas in the base year. PCL is lost in the scenario from degradation and conversion to other land uses. Cropland degradation rates are estimated using land areas calculated from a 0.2°×0.2° gridded data set. The data set is based on the digital version of the GLASOD soil degradation map (Oldeman et al., 1991) produced by GRID/UNEP (1991). The GLASOD study covered roughly the 45 years following the Second World War, so the rates are estimated by dividing the total degraded area by 45 years. Values range from 3 kha/year in Côte d'Ivoire to over 70 kha/year in Burkina Faso. However, the estimated rates for Burkina Faso and Senegal lead to a large loss of cropland compared to the total cropland area (60% and 40%, respectively). For these two countries it is assumed that the high historical loss rate will be moderated as land-use pressures grow, so the fraction of cropland area lost through degradation was set at 17%, the average rate for Africa in Raskin et al. (1998). Loss of cropland compared to total cropland area in other countries ranges from 2% in Côte d'Ivoire to 17% in Mali.

Sheets P-1, 2. Water Withdrawals: 1995 values based on FAO (1995). Sectoral withdrawals calculated as the product of drivers and intensities, where the intensity is water withdrawals per unit change in the driver. Values prior to 1995 brought forward to 1995 assuming constant intensities. For domestic withdrawals the driver is population (Sheet D-1); for agricultural withdrawals it is harvested irrigated area (Sheets F-5,7); for industrial withdrawals it is industrial value added (Sheet E-1, 2). Scenario intensities are based on trends for Africa in Raskin et al. (1998), where intensities approached the future industrialized countries' average as average income approached the 1995 industrialized countries' average.

Sheet P-3. Water Stress: Resources are from FAO (1995). Water stress indicators are taken from Raskin et al. (1997). The *use/resource ratio* is total freshwater requirements divided by renewable freshwater resources, including river flows from adjacent countries, with a level of 0.1 indicating a possible onset of stress. *Import dependence* is the ratio of water from external flows to total renewable resources, with a level of 15% indicating stress. The *coefficient of variation of precipitation* is a measure of the inter-annual variation in precipitation, with a level of 0.06 indicating stress.

Sheet P-4. Carbon Emissions: Emissions computed from fossil fuel consumption and emission factors based on IPCC (1995). Emission factors kept at 1995 levels in the scenario. Land-use emissions are not included due to their uncertainty.

Sheets P-5, 6. Land Use: 1995 figures for cropland, pasture, forest and total area are 1994 figures from FAO (1996a) as described for Sheets F-2…4. Built environment is estimated based on an average built environment per capita for Africa from Fischer (1993). Total protected area and protected forest area is from WCMC (1998a,b). Protected forest land is included with protected land. "Other" is calculated as a balance.

There is little detailed information on land-use dynamics in the region. In the scenario it is assumed that no single land-use type, such as forest land, was lost at a disproportionately rapid rate relative to other land uses as a result of expanding built environment and grazing land. In the scenario, built environment is assumed to expand into cropland, grazing land and forest in proportion to the area of each of these land-use types in the base year. Historically, forest land in the region is generally lost to agricultural land: historical patterns of forest change in Africa are consistent with the forest being lost to expanding subsistence farming (FAO, 1997d); data for Côte d'Ivoire also indicate that forests have been converted to the production of commercial crops (FAO, 1997d). In the scenario, cropland is assumed to expand only into forest, consistent with these historical patterns. Grazing land expands into forest and "other" land in proportion to the available area under these two land-use types. Degraded cropland (see notes to Sheet F-8) is converted to "other" land.

Sheet P-7. Deforestation: Average annual rates from 1980-1990 and 1990-1995 are based on forest area figures from WRI (1998). Estimates of forest area from different sources can vary greatly, depending on the definition of forested land and the methodology used to arrive at the estimate. Both the definition and the methodology behind the WRI figures differ from those used for the 1995 forest areas in this study (Sheets P-5, 6), and the 1995 forest areas from the two sources also differ. The FAOSTAT land-use data are used for this study because they provide a complete account of land area in a given year. However, the WRI data, which are based on data compiled by the FAO's Forestry Programme, are intended to be comparable between years, while the FAOSTAT land-use data may vary from year to year due to changing land classification (WRI, 1998). For this reason, the WRI figures are used to estimate historical deforestation rates.

Sheet P-8. Fertilizer Consumption: The amount of fertilizer is the total domestic consumption of manufactured fertilizer (i.e., chemical-based fertilizer, as opposed to dung, crop residues etc.). 1995 values are from FAO (1996a). Scenario intensities (application per harvested hectare) are based on trends for Africa as a whole (Raskin et al., 1998). In that report, trends in intensities were estimated based on changes in yields. Yield increases are associated in part with higher fertilizer inputs, and a cross-sectional regression of yields versus fertilizer intensity reflected the increase. The regression curve was used to estimate fertilizer intensities in Raskin et al. (1998).