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DRAFT ENVIRONMENTAL PROFILE ON THE GAMBIA

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ON

THE GAMBIA

PREPARED BY THE
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TUCSON, ARIZONA

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THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE
Department of State, IO/UCS



WASHINGTON, D. C. 20520

An Introductory Note on Draft Environmental Profiles:

The attached draft environmental report has been prepared under a contract between the U.S. Agency for International Development (A.I.D.), Office of Science and Technology (DS/ST) and the U.S. Man and the Biosphere (MAB) Program. It is a preliminary review of information available in the United States on the status of the environment and the natural resources of the identified country and is one of a series of similar studies now underway on countries which receive U.S. bilateral assistance.

This report is the first step in a process to develop better information for the A.I.D. Mission, for host country officials, and others on the environmental situation in specific countries and begins to identify the most critical areas of concern. A more comprehensive study may be undertaken in each country by Regional Bureaus and/or A.I.D. Missions. These would involve local scientists in a more detailed examination of the actual situations as well as a better definition of issues, problems and priorities. Such "Phase II" studies would provide substance for the Agency's Country Development Strategy Statements as well as justifications for program initiatives in the areas of environment and natural resources.

Comments on the attached draft report would be welcomed by USMAB and DS/ST and should be addressed to either:

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SUMMARY

The Gambia is a small, densely populated West African nation with an agrarian economy based on the rain-fed cultivation of groundnuts. Its dominant geographic feature is the Gambia River, a tidal estuary flanked with tall mangrove forests in the western half of the country. Saline waters extend far upriver during the dry season, preventing the use of river water for irrigation. Increasing pressure on The Gambia's limited land has accelerated the destruction of forest reserves and wildlife, and created competition between farmers and herders. Plans now under consideration call for the construction of a salinity barrage to increase production by irrigating double-cropped rice, but the environmental effects of the barrage remain to be determined.

Major environmental problems of The Gambia include:

1. Shortage of fuelwood. Clearing forests for cultivation, cutting for fuelwood, and a lack of managed forest plantations have contributed to a loss of wood reserves so severe that demand will soon outstrip supply unless remedial measures are quickly enacted.
2. Poor health. Nutritional levels are generally low and water-borne diseases, especially malaria and intestinal parasites, are common.
3. Increased demands on the land. With a rapidly growing population requiring more land under cultivation, fallow time has decreased, contributing to impoverishment of the soil. A large national cattle herd also requires extensive grazing land, and competition between farmers and herders, particularly for riverside grasslands, is becoming acute.

The Organization for the Development of The Gambia River Basin (OMVG) was formed in 1978 by The Gambia and Senegal for the purpose of coordinating basin development projects. The OMVG has just received a development proposal from the United Nations Development Program (UNDP), which includes a salinity barrage at Yelitenda to prevent salt-water intrusion in the dry season and thereby provide irrigation water for 24,000 ha of rice. Basic studies required to assess the environmental impact of the proposal have yet to be done, but potentially harmful consequences include the loss of estuarine fisheries and the destruction of mangrove forest above the barrage.

The Gambia is fortunate to have an environmentally enlightened administration and a body of progressive environmental legislation. Although lacking in trained staff to implement environmental programs, The Gambia is small enough and sufficiently homogeneous that its environmental problems are manageable.

Dr. James R. Silliman
Compiler

1.0 Introduction

This draft environmental report is the result of an eight week review of information available in the United States on the natural resources and environment of The Gambia. This is the first step in the process of developing an environmental profile for the use by the U.S. Agency for International Development and government officials of The Gambia. The next step in this process should be a field study to evaluate the information in this draft, obtain additional information, define issues, problems, and priorities, and provide direction for future efforts in the management, conservation and rehabilitation of environmental resources in The Gambia.

The information and interpretations presented in this report are preliminary and not intended to be sufficiently detailed or accurate for development planning. This study represents a cooperative effort by the entire staff of the Arid Lands Information Center, but the primary focus, research, and writing were done by James Silliman. The cooperation of personnel at AID and the National Park Service are gratefully acknowledged, especially James Hester, Bureau Environmental Officer, USAID, and James Corson, AID/MAB Project Coordinator. Ken Middleholtz generously provided a number of valuable documents from his personal library. Major sources of information for this report are Dunsmore et al. (1976), Republic of The Gambia (1979) and various reports of the UNDP multidisciplinary Multidonor Mission on Development of The Gambia River Basin (1977, 1980).

2.0 General Description

2.1 Geography and Climate^{1/}

2.1.1 Geographical Features

Located between 13° and 14° N. latitude, the Republic of The Gambia is a small, narrow West African nation enclosing the lower 470 km of the Gambia River from its mouth in the Atlantic Ocean. Ranging in width from 48 km at the coast to 24 km inland, The Gambia extends eastward 320 km into the interior and has an area of 10,367 sq. km. Except for 70 km of Atlantic coastline, it is entirely surrounded by Senegal. The country is divided into five administrative divisions: Western, North Bank, Lower River, MacCarthy Island, and Upper River. The capitol city of Banjul, located on the south bank of the river close to the mouth, is a distinct administrative subdivision.

The terrain of The Gambia is generally flat, consisting of the broad, shallow valleys of the Gambia River and its tributaries, and low plateaus, rarely higher than 50 meters in elevation (Figs. 1 & 2). The river bed is also flat, and the river as a consequence is tidal throughout the country. During the dry season, when freshwater flows down the river are reduced, tidal saltwater intrudes as far as 250 km upstream. Swamps with mangrove forests rising 30 meters tall fringe the river and its tributaries as far as 144 km inland, where they give way to short grass and tree clusters. Human settlement tends to avoid low riverside lands around the mangrove swamps due to problems with saltwater flooding of crops and insect pests. Villages are generally located on upland plateaus in this lower river region, but conditions farther upstream are favorable for riverside habitation.

2.1.2 Rainfall

The Gambia has a Sahelo-Sudanian climate with a single wet season from June to October, and a dry season for the remaining seven months. Peak rainfall is in August, as exemplified by the pattern at Yundum (Fig. 3). There is little east-west variation in rainfall except for a marked increase along the coastline (Table 1). Highest rainfall occurs at Gunjur in the southwest (1400 mm per year), and lowest in the region farthest north near Kau-ur (900 mm per year).

¹Sources: Dunsmore et al. 1976.
Europa Publications. 1980.
Johnson. 1978.
Republic of The Gambia. 1979.
UNSO. 1979.
U.S. Department of State. 1980.

Figure 1: Landform Transition from West to East Showing Ironpan Levels

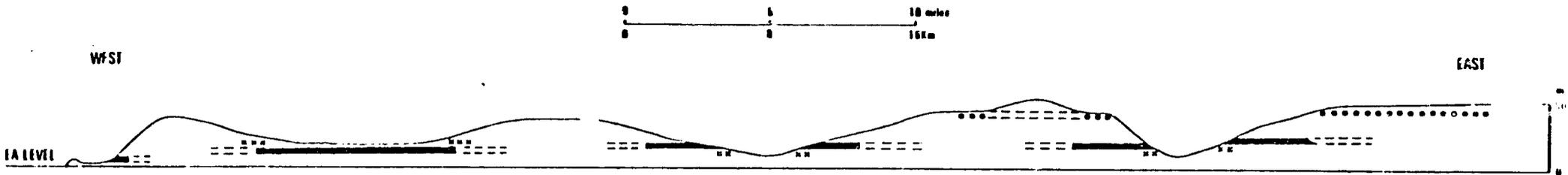
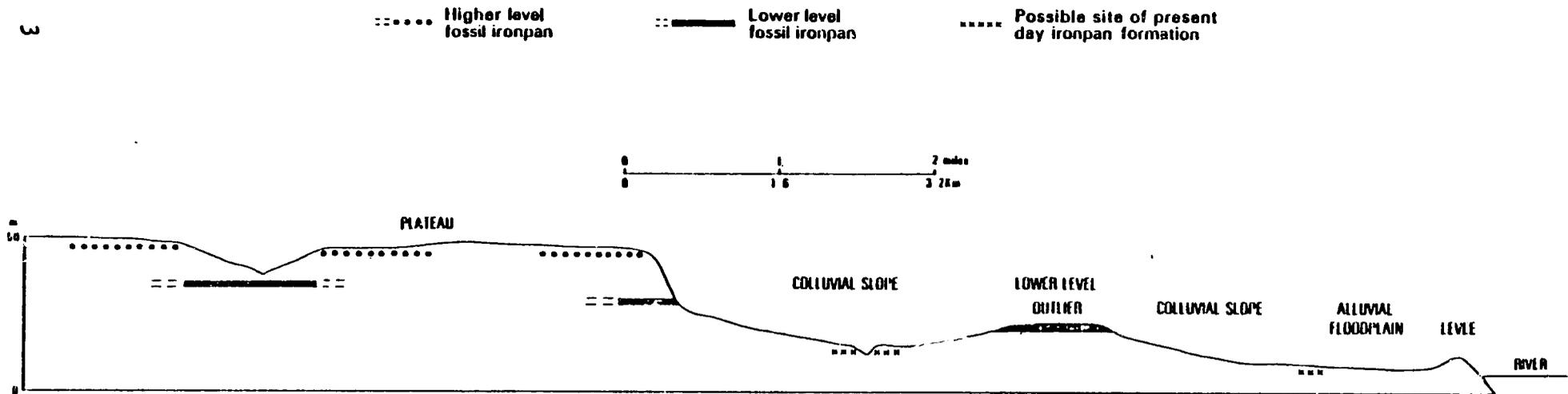


Figure 2: Idealised North-to-South Cross-section in Eastern Gambia Showing Ironpan Levels



Source: Dunsmore et al. 1976.

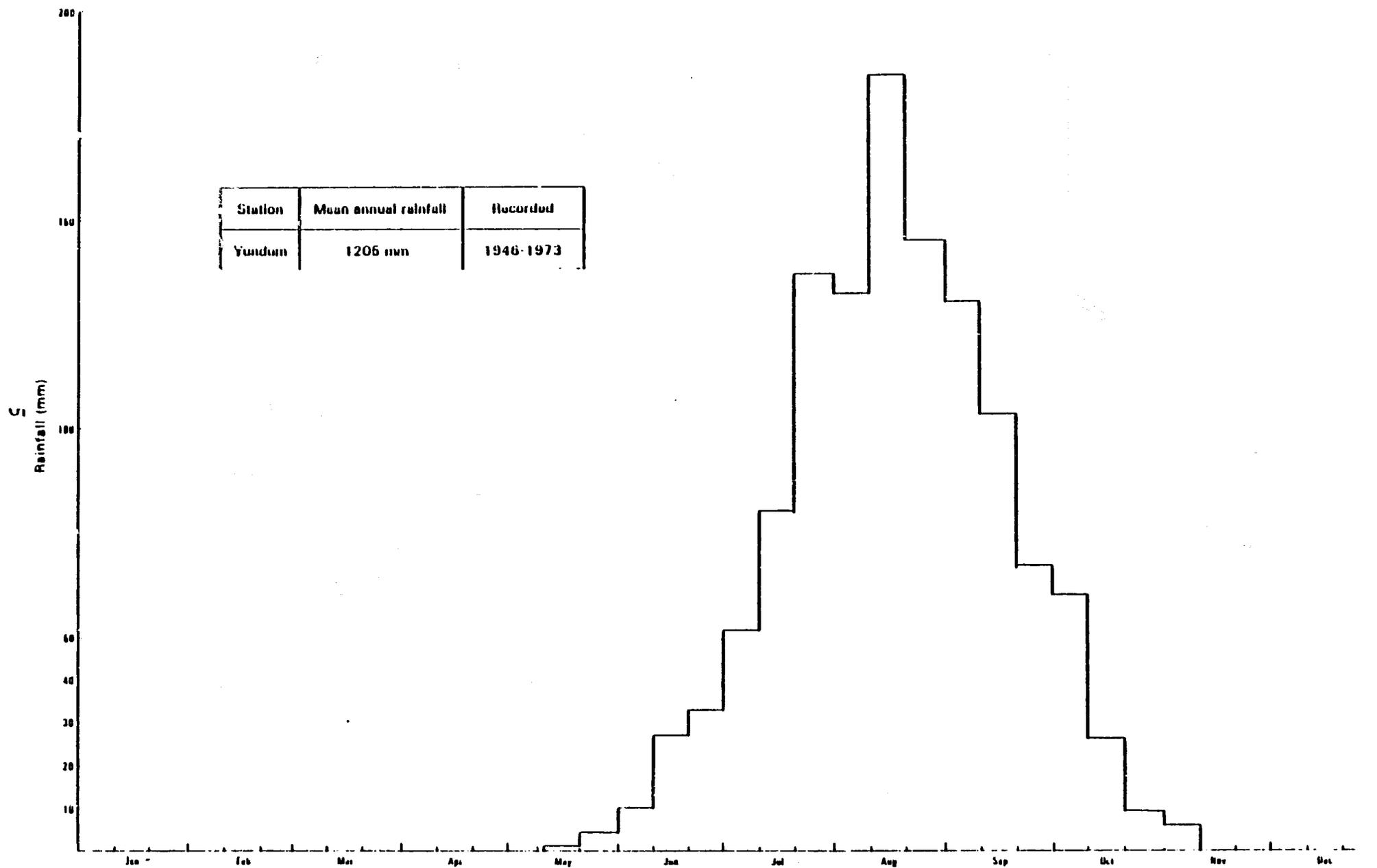
Table 1: Mean Monthly and Annual Rainfall Totals (in mm) from Gunjur in the West to Kristi Kunda in the East.

Station	Period	Years*	May	June	July	Aug.	Sept.	Oct.	Nov.	Annual
1. Gunjur	1951-61	8	3	63	404	449	370	146	15	1 447
2. Kanifing	1951-57	7	7	66	324	412	366	100	27	1 303
3. Cape St. Mary	1926-37 1951-59	20	3	87	295	520	306	83	16	1 311
4. Yundum Airport	1946-73	28	4	70	269	462	300	94	6	1 205
5. Abuko	1951-69	17	3	76	271	469	356	109	10	1 293
6. Brikama	1949-60	12	12	82	327	553	340	104	12	1 430
7. Banjul Marina	1886-1950	64	5	65	259	489	275	89	4	1 185
8. Banjul Half-die	1943-71	29	3	68	242	416	302	91	2	1 123
9. Bwiam	1945-63	18	4	84	260	375	297	102	4	1 126
10. Kerewan	1931-58	28	7	79	227	406	242	85	10	1 056
11. Massembe	1950-55	6	18	84	210	345	294	84	5	1 040
12. Mansa Konko	1951-67	16	7	27	236	327	299	93	4	992
13. Kaur	1950-63	8	9	66	107	336	211	110	6	926
14. Sapu	1956-62	7	4	124	203	319	204	81	1	935
15. Kuntaur	1949-66	18	12	102	228	335	225	86	2	990
16. Georgetown	1908-25 1949-73	43	11	115	203	305	246	84	4	967
17. Yoro-Beri Kunda	1951-61	11	10	106	232	292	273	100	7	1 021
18. Bansang	1951-72	22	14	125	212	349	259	117	5	1 031
19. Diabugu	1951-60	10	25	109	209	378	249	117	20	1 105
20. Basse Santa Su	1942-72	26	19	127	209	338	242	90	10	1 035
21. Wuli	1926-53	27	24	157	215	322	260	96	10	1 082
22. Kristi Kunda	1949-60	12	17	128	210	322	306	31	2	1 067

* Some data are missing and dubious data were omitted.

Source: Dunsmore, et al. 1976.

Figure 3: Mean Ten-day Totals of Rainfall at Yundum (1946-73), The Gambia



The rainy season is started by the northward movement of the Inter-Tropical Convergence Zone (ITCZ), a boundary interaction of high pressure regions. The amount of annual rainfall depends directly on the extent of northward movement of the ITCZ, being lowest when the ITCZ remains to the south. Rain generally falls along extensive atmospheric disturbance lines, but at the beginning and end of the season, rainfall occurs in very intense storms only a few km in diameter. These conditions cause abrupt local differences in seasonal rainfall totals.

Partial crop failures occur one year in five due to rainfall variability and erratic distribution. Although there is little evidence to support long-term cycles of wet and dry periods, there seems to be evidence of a recent downward trend in annual rainfall. The 1970-77 drought was the most severe and prolonged since record-keeping started in 1884, and a drought spell in August and September 1979 caused considerable agricultural losses.

2.1.3 Temperature, Humidity, Wind

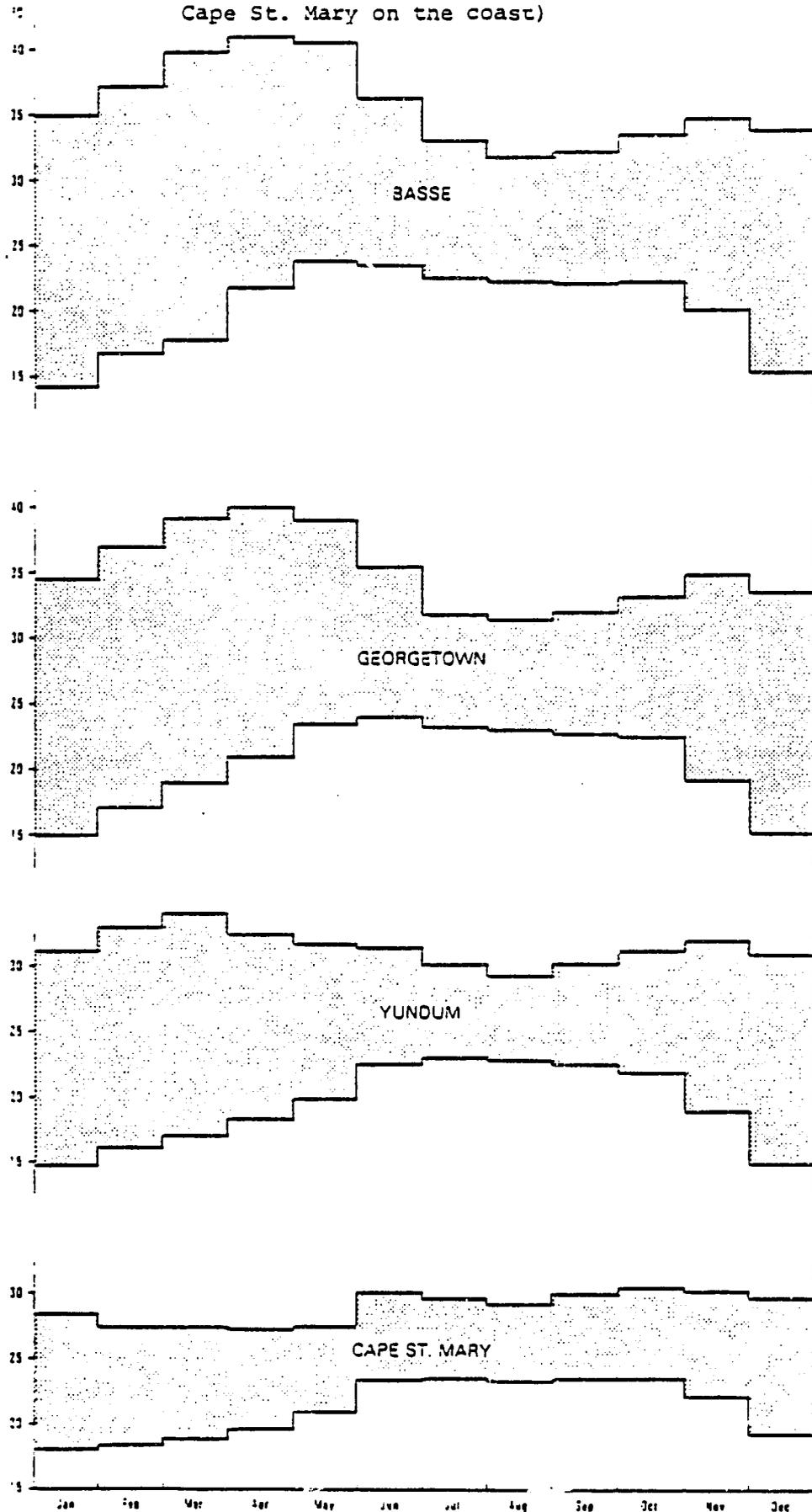
The Atlantic Ocean moderates temperatures along the coast, while temperature variations are greater eastwards in the interior (Fig. 4) where there is a distinct hot period from March to May. Mean temperatures range from 23°C (January) and 27°C (June) at the coast to 24°C (January) and 32°C (May) inland.

Relative humidity is generally moderate, becoming higher during the rainy season. At Yundum, near the coast, the mean monthly relative humidity ranges from 51 percent in February to 87 percent in August. Variations in humidity are slightly greater further inland. Mean rainfall exceeds potential evaporation in July, August and September by about 500 mm at Yundum and 400 mm at the inland town of Basse. This is the period of hot, damp, southwesterly winds bearing rain. In the dry season, humidity is lowered by the hot and dry harmattan wind from the northeast, which blows overland from the Sahara. Maritime northeast trade winds affect only the coastal area.

2.2 Population^{2/}

²Sources: Dunsmore et al. 1976.
Hubbard. 1977.
Mittelholtz and Mittelholtz. 1976.
Republic of the Gambia. 1979.
U.S. AID. 1980.
U.S. Department of State. 1980.

Figure 4: Comparison of Coastal and Inland Monthly Mean Diurnal Temperature Range (four stations, from Basse inland to Cape St. Mary on the coast)



Source: Dunsmore, et al. 1976.

2.2.1 Historical and Cultural Background

The origins and date of arrival of the first settlers along the banks of the Gambia River are unknown. Stone circles on the north bank are thought to be more than 1000 years old, but written and oral histories date back only to the 12th and 13th centuries, by which time small groups of Mandingos and possibly some Fulas had settled. The Jolas arrived later from the forests to the south and the Serahulis and Wollofs came from the north. The first unifying political influence was that of the Mali-based Manding Empire, which was dominant in the 13th and 14th centuries. Islam was introduced after the 15th century by way of trans-Saharan trade routes, but did not become widely accepted until the late 19th century.

Contact with Europeans began in the 15th century with the arrival of the Portuguese, and by the 16th century Portuguese slave traders and gold-seekers had settled in the lower river area. The navigability of the Gambia River made it uniquely important to European colonial powers, particularly for the Atlantic slave trade. The river and its environs were handed back and forth among Portuguese, French and British traders between the early 16th and early 19th centuries. In 1783 the Treaty of Versailles gave Great Britain possession of The Gambia, but the abolition of the slave trade by acts of the British Parliament beginning in 1807 reduced its importance to Britain except as a trading pawn with France. An 1889 agreement with France established the present boundaries and The Gambia became a British Crown Colony. British administration was generally benevolent, though little was invested in the economic development of the country. Local self-government emerged relatively painlessly and took on a non-violent, democratic character which remains to this day. The Gambia achieved independence on February 18, 1965, as a constitutional monarchy within the British Commonwealth, and became a Republic on April 24, 1970.

The people of The Gambia today are composed of five major ethnic groups, the largest of which are the Mandingos (38 percent), followed by the Fulas (16 percent), Wolófs (14 percent), Jolas (9 percent), and Serahulis (8 percent). Traditionally, Mandingos and Wolófs depend on farming, while Fulas are herdsmen. The spatial distribution of the groups varies over the country, with Mandingos predominating in Kombo St. Mary, Brikama, Mansakondo, and Kerewan; Fulas in Georgetown; Serahulis in Basse; and the Wolófs in Banjul and Kuntaur. Some 21 distinct languages have been recorded in The Gambia, and most Gambians speak the language of their group plus at least one other local tongue. Local languages are not written, and although English is the official literate language, the literacy rate is only about twelve percent. Islam is the principal religion, with Christians (at most 5 percent) concentrated in Banjul. Most Gambians (72 percent) are employed in agriculture, followed by industry, commerce and services (15 percent), and government (6 percent).

2.2.2 Population Size, Growth, and Distribution

The population of The Gambia is estimated at 602,000 for 1980, based on a 2.8 percent annual growth rate. The annual growth rate includes a natural rate of increase of 2 percent per annum and a 0.8 percent per annum immigration rate. The last census was taken in 1973, when the population totalled 493,200. A breakdown of the population at that time by sex and age groups is given in Table 2.

About 15 percent of the population lives in the Banjul/Kombo St. Mary and Brikama urban area, to which there has been a significant immigration in recent years from rural areas. Rural population densities for the five divisions based on the 1973 census are as follows:

	<u>pop/km²</u>
Western Division	40
Lower River Division	26
North Bank Division	38
MacCarthy Division	32
Upper River Division	41

2.2.3 Health and Nutrition

The state of health and nutrition in The Gambia is generally poor. Infant mortality to age five approaches fifty percent, due primarily to diarrheal diseases and malaria. The rural population has an average life expectancy of 35 years. Inadequate nutrition, exacerbated by intestinal parasites, is the most basic health problem in The Gambia, and contributes directly to lowered resistance to disease. A bulky, predominantly vegetarian diet inadequate to maintain growth, poor health care, and long and hard labor of parents compound the problems of infant survival. Nutritional and health problems are worst among rural women and infants because custom dictates that men and older boys have priority in the distribution of family food supplies.

Infant mortality and adult morbidity reach a peak in the rainy season, locally called the "hungry season". Food stocks and savings from the previous harvest are usually exhausted at this time, and energy expended by adults in field labor increases in preparation for the next crop. These stresses increase susceptibility to disease. Wet conditions also lead quickly to an increase in various water-borne diseases, including gastroenteritis, malaria, schistosomiasis and onchocerciasis. About 90 percent of adult Gambians carry malaria. Other diseases present in The Gambia include trypanosomiasis, leprosy, tuberculosis, venereal disease, measles, and yellow fever.

The waste disposal system currently used in Banjul, consisting of septic tanks, night pails, and open storm sewers, is not adequate for proper sanitation. Septic tanks are small and do not drain properly because of the high water table. The dump site for night pail waste may be subject to seepage, and storm sewers do not flush properly and overflow in heavy rains. Human waste disposal in rural villages is also inadequate and is recognized as an important contribution to the spread of disease.

Improvement of health conditions in The Gambia has been addressed by both national and international programs. The Gambian government plans a sanitary sewer system for the city of Banjul to serve 30 percent of the population by 1981, and 100 percent by 2000. Waste disposal will most likely be by open outfall. Current national objectives of the Ministry of Health include extension of primary health care to villages and improvement of village sanitation. International assistance sponsored by U.S. AID has helped establish national health statistics and disease surveillance programs, emergency food supplies, and family planning services. Control of the vectors of water borne diseases is not as easy to attain through government programs as are improved health care programs, because of the considerable logistic and ecological problems involved. These will be further discussed in section 4.1.3.

Table 2. Construction of the Population by Sex and Age.

Sex	Age group by years					Total
	0-4	5-14	15-49	50+	Not stated	
Male	41 454	61 324	116 922	30 559	905	251 704
Female	41 697	59 953	115 822	23 175	846	241 493
Both	83 191	121 777	232 744	53 734	1 751	493 197
Percentage	17	25	47	11		100

Source: Dunsmore, et al. 1976.

2.3 Land Use^{3/}

³Sources: Dunsmore et al. 1976.
 Europa Publications. 1980.
 Hubbard. 1977.
 Middleholtz and Middleholtz. 1976.
 Republic of The Gambia. 1979.
 UNDP. 1980.
 UNSO. 1979.

2.3.1 Crops

About 45 percent of the land in The Gambia is under cultivation (Table 3), which is predominantly rainfed cropping. As shown in Table 4, more than half of the cultivated area is planted in groundnuts (peanuts), 27 percent in millet/sorghum, and 15 percent in rice.

Table 4. Areas of Principal Rainfed Crops in The Gambia, 1976 (10³ ha)

	10 ³ ha	percent
Groundnuts	98.4	52
Millet/Sorghum	51.1	27
Rice	28.4	15
Maize	9.5	5
Cotton	1.5	1
Total	188.9	100

Source: UNDP. 1980.

Groundnuts are the major cash crop, principal source of foreign exchange, and basis for the country's major processing activity. About 40-60 percent of the crop is processed as oil for export. Soils are generally well-suited to groundnut production, and the crop is largely free of serious pest and disease problems during the growing season. A sample survey in 1973 and 1974 found that over 95 percent of all farmers in The Gambia grew groundnuts.

Millet and sorghum are the most widespread and important cereals in The Gambia, with millet dominant in the west and sorghum in the east. Maize is largely grown as a garden crop except in the Wuti district of the Upper River Division where it is planted on a larger scale. Rainfed rice cultivation is most developed in alluvial areas in the central part of the country, particularly the North Bank, Lower River, and MacCarthy Island Divisions.

Relative areas planted in groundnuts and subsistence cereals depend on the market price of groundnuts and the availability and price of cereals. There is no perennial crop of any major importance, so most crop production is confined to the rainy season (June-October) and the subsequent 1-2 months. Upland crops are produced on the plateau and colluvial soils, while alluvial soils with tolerable salinity levels are used for rice and dry-season cattle grazing.

Table 3. Land Use by Geographical Region in 1972. (areas in ha and % of regional total)

Land use category	Western*	Lower Bank	North Bank	MacCarthy Island (N)	MacCarthy Island (S)	Upper River (N)	Upper River (S)	Total
1. Cultivated	16,959 10%	7,563 5%	40,925 19%	18,347 12%	13,084 9%	6,423 7%	14,077 13%	117,008 11%
2. Fallow	56,650 32%	37,703 24%	90,116 41%	54,675 37%	49,246 35%	25,764 29%	37,222 35%	351,437 34%
3. Uncultivated	92,755 53%	104,146 68%	86,111 39%	72,328 49%	77,887 55%	55,704 62%	54,440 51%	543,563 52%
4. Non-agricultural	8,426 5%	4,685 3%	3,932 2%	2,444 2%	1,923 1%	1,825 2%	1,305 1%	24,459 2%
Total	174,790 100%	154,097 100%	221,085 100%	147,684 100%	142,141 100%	89,716 100%	107,045 100%	1,036,558 100%
% of total area of The Gambia	17%	15%	21%	14%	14%	9%	10%	100%

*Figures for Western Division exclude Banjul and Kombo St. Mary

Source: Dunsmore et al. 1976.

The use of irrigation for rice production and to a limited extent for vegetables is largely in the east of the country above the salinity limit of the river. Irrigated rice production, begun in 1966 in the MacCarthy Island Division, has recently expanded to the Upper River Division and totals about 2000 hectares. The Gambia is not yet self-sufficient in rice, however, and imports about 30,000 tons per year.

Cotton has received special attention since 1975 as an additional cash crop in the Upper River Division, where it is grown on a small scale. Oil palm kernels, gathered from wild palms near the coast, have been exported for many years, but yields are low and climatic conditions are unsuitable for economic production. In addition to the major field crops, vegetables and fruits for local consumption are grown in small garden plots around village compounds.

Crop production is by individual farm families rather than large estates, land settlement schemes or cooperatives. Average holding size is approximately 4.8 ha for farmers not owning implements and 9.4 ha for those holding implements. Farm land is generally within close proximity of the village, with upland fields as far as 4 or 5 km away. Fields are dispersed and fragmentation is considerable. Areas close to the village are often essentially under annual cultivation while those more distant are cropped on a bush-fallow system, the resting period being tumbledown fallow. Crops are commonly grown as pure stands close to villages, while intercropping and sometimes mixed cropping are practiced further away.

Cultivation methods are predominantly traditional, with the hand-hoe as the basic tool, although ox-drawn equipment is used on a limited basis. About 10-15 percent of all villages now use oxen and this percentage is expected to increase. The remaining area of upland crops and much of the rainfed rice is cultivated by hand and practically all weeding and harvesting is done by hand. Tractor plowing is confined to the MacCarthy Island Division, where it is used for rainfed rice on alluvial soils. The total area cultivated by tractor amounts to about 2000 hectares.

Under the traditional system of shifting cultivation with bush-fallow (also called slash-and-burn) agriculture, lengthy fallow periods helped maintain natural soil fertility. In recent years, increased population size and oxenization have caused greater pressure on the land and a resultant decrease in fallow periods. To sustain fertility, inorganic fertilizers or manure must be used.

Gambians use household and livestock manure on rice fields, and tether cattle during the dry season to manure fields intended for crop production. However, manure is not worked into the soil, so that nutrients are lost by oxidation, and it is often heaped and burned prior to planting in the belief that weeds will be reduced. Still, some advantage is gained. Only a small minority of farmers use artificial fertilizers, principally those participating in government programs.

2.3.2 Livestock

The major species of livestock in The Gambia are cattle, sheep and goats (Table 5), with cattle by far the most numerous. Some small scale poultry production is carried on, particularly near Banjul. Sheep and goats are not widely herded with cattle but rather are kept near the village and brought into the owner's compound at night. During the wet season, they are taken out and tethered on roadsides and fallow land or herded by children around the village.

The number of cattle has increased rapidly in recent years from 40,000 in 1936 to 122,500 in 1951 and 290,000 in 1977. Cattle ownership has become increasingly widespread in Gambian rural society, and most owners regard their stock primarily as a form of savings. As a result of this custom, most of the country's fodder resources are used for herd maintenance rather than commercial production. The animals are found in all districts of the country, but some 55 percent are located in the two easternmost divisions, MacCarthy Island and Upper River.

Table 5. 1977 Livestock Populations (10^3 head)

Cattle	290
Sheep	95
Goats	92
Pigs	9
Asses	4
Poultry	260

Source: Europa Publications. 1980.

The main cattle feed resource is natural pastures, which are abundant during and after the rainy season, from June to October. By the beginning of November the grasslands are no longer adequate, and the herd depends on crop residues, floodplain and swamp grazing, and browse. Herdsmen climb and lop certain tree species for browse, particularly Pterocarpus erinaceus and Acacia albida, with the result that in some areas trees are mutilated or destroyed. Estimates of total dry season fodder resources, including crop residues, floodplain grazing, and early fallows, show enough to support a herd of 177,500 adult animals. The difference between this carrying capacity and the actual herd size (290,000) must be made up by browse, by moving animals out of the country to feed, or by malnutrition of the animals. Increasing disputes between farmers and herders for access to land, deterioration of natural grasslands, and a decrease in the natural herd by 20,000 head from 1976 to 1977 are indications that cattle numbers are at or near the critical dry season carrying capacity.

2.3.3 Forest Exploitation

Natural forests in The Gambia consist of savannah woodland with shrub and grass understory in upland areas, and tall mangrove forests fringing the river from Banjul to a point about 10 km upstream from Kau-ur. In the west coast region, where rainfall is highest and the woodlands are relatively undisturbed, trees are taller and denser, while the drier central and eastern woodlands have smaller trees and a more open canopy. Most of The Gambia's forests have been modified by fire, grazing, or cultivation, although the mangrove swamps are relatively untouched. Recent data on the extent and condition of Gambian forests are not available, but a 1968 aerial survey estimated forest coverage as 45 percent of the total land, distributed as follows: closed forest, 7,200 ha; woodland, 115,280 ha; wooded savannah and bush fallow, 201,495 ha; and mangrove, 66,770 ha.

Gambian forests are used as a source of fuel, poles and timber as well as for browse. Total consumption of local wood resources was estimated at 877,900 cubic meters in 1973, of which about 90 percent was used for fuel. Rhun palm (Borassus aethiopum) and bamboo (Oxytenanthera abyssinica) are used extensively for rural house construction. In the past, mahogany (Khaya senegalensis) and rosewood (Pterocarpus erinaceus) were harvested for export, but today the trees are too few and too scattered to support an export industry. Rhun palm rafters and charcoal were also exported previously, but these exports have been suppressed to protect the diminishing natural supply. Mangroves are used for rural house construction, poles and fuelwood; the extent of their use is unknown, but is surely increasing. The Gambia currently imports 38 percent of its needs for sawn timber.

Destruction of The Gambia's forest reserves is proceeding at a rapid pace. Between 1958 and 1973 the area of woodland fell by approximately 30 percent, and 11 percent of the 34,000 ha of national forest parks set aside for protection in the 1950's had been totally cleared by 1972. A considerable amount of wood is destructively wasted in the process of clearing land for farming or reclaiming land from lengthy fallow. Man-made fires used to clear the land are allowed to burn without containment, and trees are felled so as to leave a large stump, thereby wasting as much as 5 percent of the total volume. Without better management and a program to increase forest plantations, The Gambia could face a deficit of 1.7×10^6 cubic meters of wood for fuel and construction in the year 2000.

3.0 Environmental Resources

3.1 Geology and Mineral Deposits^{4/}

3.1.1 Composition of Dominant Landforms

The central feature of the Gambian landscape is the river itself and the alluvial flats through which it flows. Flanking the river flats is a transitional zone of sandstone bluffs and colluvial slopes leading up to a somewhat higher interior plateau. The river with its bordering swamps and tributaries accounts for 8 percent of the surface area, the river flats 24 percent, the transitional zone 41 percent and the interior plateau 27 percent.

Most of the land is developed from a sandstone deposit of the late Tertiary era known as the Continental Terminal and composed predominantly of quartz and kaolinite, with a small percentage of other resistant materials. Its structure includes layers of sandstone mixed with beds of quartz gravel, sand and clay, and hardened iron-rich layers called ironpan (or cuirasse) which developed in the sandstone by the accumulation of leached iron oxides at old water-table levels (Figs. 1 and 2). Past episodes of marine flooding at times of higher sea level contributed to the composition of alluvial deposits in the river flats.

3.1.2 The Interior Plateau and Transitional Zone

In the east of The Gambia the Continental Terminal is a broad plateau dissected by rather narrow drainages. Extensive exposures of the highest level of ironpan are found at 40-50 meters elevation, and a second layer is exposed in places by erosion. The eroded border of the plateau is marked by scarp slopes capped with ironpan. Below the scarp, colluvial deposits on very gentle slopes merge with alluvial deposits surrounding the drainage network. As the plateau slopes gently to the west, it becomes progressively more dissected, and the division between plateau and colluvial slope eventually disappears. In most of the Western and North Bank Divisions, there are only low, rolling sandhills, separated by broad, shallow valleys. Along the coast are low dunes of marine and blown sands, resting on the tertiary sandstone at an average depth of about 3 meters.

⁴Sources: Dunsmore et al. 1976.
Jarret. 1949.
U.S. Bureau of Mines. 1975.

3.1.3 The River Flats

A complex pattern of alluvial deposits is found throughout the past and present floodplain of the Gambia River and its tributaries. Among these are fragments of sandy terraces with Arca senilis shells found downstream from Kudang, and elevated levees bordering present and past river courses in the east. Both of these deposits are the result of past marine transgressions and regressions. Recent fluvio-marine sediments are normally colonized by mangroves and are most extensive towards the mouth of the river. Samples of alluvial materials from a number of sites within The Gambia were composed essentially of sedimentary kaolin clays mixed with varying proportions of quartz sand.

3.1.4 Mineral Deposits

Mineral production is not important in The Gambia, amounting to less than 1 percent of the gross domestic product (GDP). Some sand and gravel is currently taken for local use. Many years ago, ilmenite (titanium ore) was mined along the Atlantic Coast in the Western Division. The UNDP (United Nations Development Programme) has been conducting feasibility studies on kaolin and ilmenite deposits in The Gambia. Deposits of ilmenite in the Western District are estimated at 5 million tons, and extend into Senegal. Kaolin deposits near Basse have been evaluated as suitable for low grade ceramics and bricks, but neither ilmenite nor kaolin appears to be economically exploitable at present. Preliminary testing for petroleum and natural gas along the coast is indecisive but there is little indication of substantial deposits.

3.2 Soils^{5/}

The only complete soil survey of The Gambia was published as 1:125,000 maps in Dunsmore et al. (1976), where previous work is also summarized. Mapping was based on landscape forms identified on 1:25,000 aerial photos flown in 1972, combined with field reconnaissance to establish characteristic soil associations for each formation. Twenty-four different soil associations based on morphological and utilitarian characteristics were described. This classification was uniquely developed for The Gambia, although an attempt was made to relate it to existing systems in the report. Efforts to match mapping lines between The Gambia and Senegal proved to be of little value because Senegal was mapped by the French classification system. However, an understanding of the 24 associations described in Dunsmore et al. is important because vegetation formations and land use suitability are referred to this system. The following discussion of Gambian soils is therefore based on the soil survey of Dunsmore et al., where more detailed information is available.

⁵Sources: Dunsmore et al. 1976.
Kewitt. 1977.
Republic of The Gambia. 1979.
U.S. AID. 1979.

3.2.1 Characteristics and Distribution

Soils of The Gambia are generally divided into upland soils, alluvial soils, and a transitional strip of colluvial-alluvial soil between these two types. Upland soils are developed on the Continental Terminal (see 3.1.1) and have many similar features associated with their common parent rock. Referred to as Continental Terminal soils, they are divided into 12 associations, numbered 1-12. Alluvial soils are those deposited by the Gambia River and its tributaries and show a wide range of variability; a major division is between saline and non-saline types. Alluvial soils are divided into 10 associations, numbered 14-23. The transitional strip of colluvial-alluvial soil is referred to as association 13, and a narrow coastal strip of sandy littoral soil is known as association 24. The areas and general distribution of the 24 associations are given in Table 6, and the typical topographic distribution of most associations is shown in Fig. 5.

Soils of the Continental Terminal (associations 1-12) are usually sands or loamy sands, and less commonly sandy loams. Most can be classed as ferruginous tropical soils, while some of the better drained redder soils are ferrallitic. They are generally of high density causing poor root penetration and low permeability. They are low in organic content and chemical fertility, have low salinity levels and are somewhat acid (topsoil pH 6.0-6.5, subsoil pH 5.0-6.0). In the identification of associations, a major distinction is made between soils of the western region with its low hills and broad valleys (associations 1-5), and the eastern region of higher, dissected plateaus (associations 6-12). Further distinctions are based on topography and soil depth, as for example soils of the plateau surface (nos. 10 and 11), shallow soils of plateau edge with ironpan or ironpan derivatives close to the surface (nos. 8 and 9), and deeper, well-drained soils of low hilltops and colluvial slopes (nos. 1, 6, 7).

Most of the alluvial soils (associations 14-23) are hydromorphic and fine textured, generally containing more than 80 percent silt plus clay. They are deeper than Continental Terminal soils but root penetration may nevertheless be limited by the high water table. Surface soils are rich in organic matter, but are generally poorly drained. Saline soils of the lower river often have acid sulfate layering and are particularly acid when dry (pH less than 4.0). Associations 14-16 are saline, and extend eastward to Kau-ur, associations 17-20 are in MacCarthy Island Division, and 21-23 are in Upper River Division. Associations 14-16 are subject to tidal flooding most of the year, while 17, 18, and 21 are seasonally flooded, and 19, 20, 22 and 23 are rarely or never flooded.

Table 6. Extent of Soil Associations in Western and Eastern Gambia (ha)^{a/}

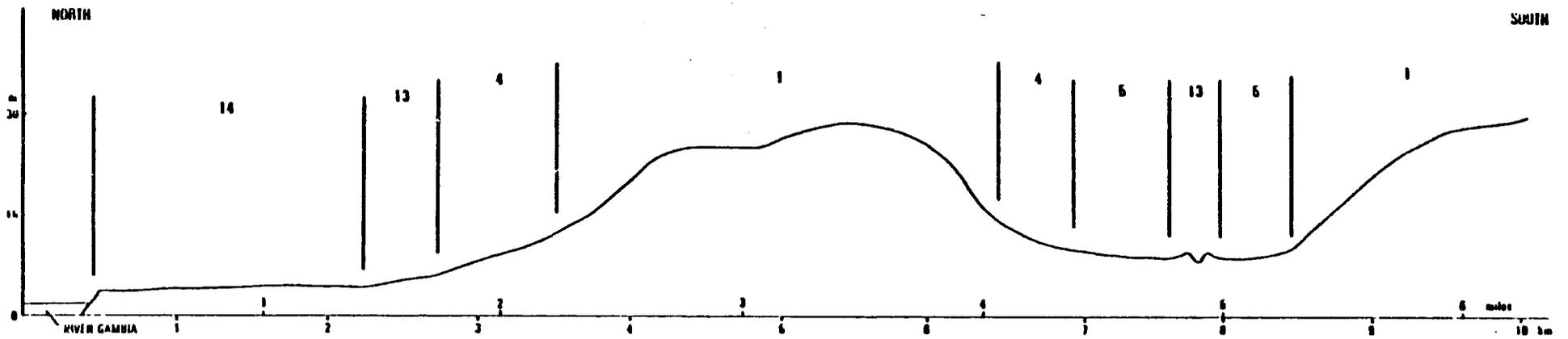
Soil Assoc.	Western	Eastern	Soil Assoc.	Western	Eastern
1	76,871	--	13	40,979	29,012
2	48,278	140	14	97,926	1,571
3	21,042	177	15	29,320	4,843
4	24,788	--	16	14,061	13,466
5	20,678	--	17	--	14,518
6	36,814	74,711	18	--	10,383
7	3,117	16,836	19	--	3,860
8	51,186	140,851	20	--	14,719
9	1,171	2,078	21	--	21,754
10	33,278	67,449	22	--	3,919
11	22,407	25,176	23	--	10,186
12	23,646	30,722	24	4,262	--
			Total	547,893	486,371

^{a/} Western Gambia - Western, Lower River, and North Bank Divisions
 Eastern Gambia - MacCarthy Island and Upper River Divisions

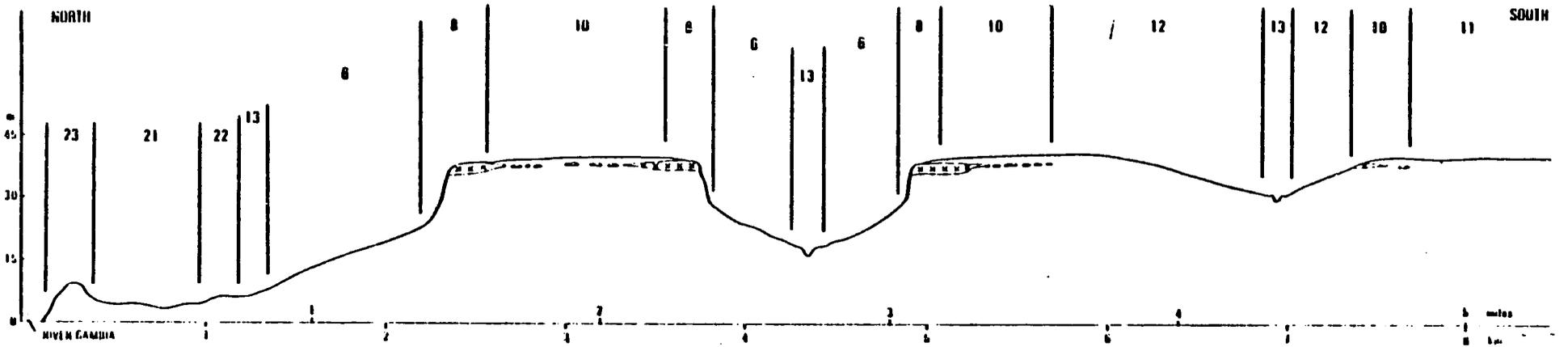
Source: Hewitt. 1977.

Figure 5. Idealised Sections Showing the Relationship between Landform and Soil Mapping Associations:

(a) Western area



(b) Eastern area



Source: Dunsmore et al. 1976.

3.2.2 Agricultural Suitability of Soils

Dunsmore et al (op. cit.) group the 24 soil associations into 5 groups based on their suitability for crop production:

Group 1: Unsuitable (Associations 8, 9, 14, 15, 16)
This group includes shallow soils at the edge of plateaus (8 and 9), and lower river alluvial soils affected by salinity (14, 15, 16).

Group 2: Marginal (Associations 3, 10, 24)
These include the coastal strip (24), shallow soils of outer plateau (10), and mixed depth soils on eroded hills (3).

Group 3: Suitable with Qualifications (Associations 4, 5, 11, 12)
These are fine textured soils which are difficult to work and have poor infiltration or drainage.

Group 4: Suitable (Associations 1, 2, 6, 7, 13)
Soils of colluvial slopes in the three eastern divisions (6, 7) mid- to upper slopes of hills in the west (1, 3), and colluvial-alluvial transition soils (13).

Group 5: Suitable and Irrigable (Associations 17-23)
These include all alluvial soils not affected by salinity, and are found upriver of Kau-ur.

Table 7 gives the area and percent coverage of the five suitability groups broken down by geographical regions and for the country as a whole. Including groups 3, 4 and 5 together as suitable for agriculture, the lower River Division has the lowest proportion of suitable land (36 percent), while the Western Division has the highest proportion (67 percent). The only appreciable area of soils suitable and irrigable are in the MacCarthy Island and Upper River Divisions, although small pockets of irrigated cultivation do exist on association 13 in the west.

3.2.3 Actual Use of Soils

Table 8 shows the uses to which the five soil suitability groups were actually put throughout the country at the time of the survey by Dunsmore et al. In general, the more suitable the soil, the lower is the ratio of area in fallow to area under cultivation, indicating shorter fallow time. The small proportion of suitable and irrigable soils (Group 5) actually under cultivation (7 percent) is noteworthy, and is probably caused by their fine texture making them difficult to work, and the limited availability of irrigation water in the dry season.

The proportion of unsuitable land under cultivation (2 percent) includes rainfed rice grown on a few areas of saline alluvial soil in the west (association 16). This is possible only in the second half of the wet season, after flushing of salt, and is always a risky land use practice.

Table 7. Regional and Total Areas (ha) and Percent Coverage of Soil Suitability Groups

Soil Suitability Group	Western	Lower River	North Bank	MacCarthy Island (N)	MacCarthy Island (S)	Upper River (N)	Upper River (S)	Entire Country
1. Unsuitable	31,981 18%	79,795 52%	81,811 37%	52,485 35%	39,389 28%	34,679 39%	36,197 34%	358,115 34%
2. Marginal	25,348 15%	18,225 12%	14,790 7%	30,638 21%	16,312 11%	13,409 15%	7,234 7%	126,127 12%
3. Suitable with qualifications	39,117 22%	21,693 14%	30,731 14%	8,681 6%	23,661 17%	11,253 12%	12,278 11%	147,781 14%
4. Suitable	78,340 45%	34,085 22%	93,676 42%	40,740 28%	33,860 24%	15,476 17%	30,780 29%	326,344 32%
5. Suitable and irrigable	0	0	0	15,065 10%	28,917 20%	14,809 17%	20,592 19%	81,116 8%
Total	174,790 100%	154,097 100%	221,085 100%	147,684 100%	142,141 100%	89,716 100%	107,045 100%	1,036,558 100%

Source: Dunsmore et al. 1976.

Table 8. National Land Use of Soil Suitability Groups by Area (ha) and Percent

Soil suitability Group	Cultivated	Fallow	Un-cultivated	Non-agricultural	Total
1. Unsuitable	6,655 2%	59,212 17%	279,027 78%	10,221 3%	355,115 100%
2. Marginal	5,684 4%	38,913 31%	80,383 64%	1,147 1%	126,127 100%
3. Suitable with qualifications	27,018 18%	68,789 47%	48,531 33%	3,335 2%	147,781 100%
4. Suitable	71,877 22%	172,796 53%	72,956 22%	8,715 3%	326,344 100%
5. Suitable and irrigable	5,791 7%	11,727 15%	62,665 77%	933 1%	81,116 100%

Source: Dunsmore et al. 1976.

3.3 Water Resources^{6/}

A major hydrological study of the entire Gambia River basin was carried out in 1972-74 by Howard Humphreys & Sons as part of a United Nations Development Programme Special Fund Project (UNDP 1974a). The same firm also completed a subsidiary study of the groundwater potential of The Gambia (UNDP 1974b). These studies are the major sources for summaries in Dunsmore et al. (1976), Hewitt (1977), and Republic of The Gambia (1979). Further information on the river is included in a Coode & Partners (1977) report on a proposal to construct a salinity barrage at Yelitenda, and is summarized in Johnson (1978).

3.3.1 Groundwater

Groundwater levels in The Gambia are not closely related to river levels, because wells frequently extend far below river level before reaching water. Groundwater reserves thus contribute little to river flow. Well water levels vary annually by 1-3 meters, from a peak in the middle of the wet season through a steady decline in the dry season. There are two major aquifers in The Gambia, an upper level one called the Continental Terminal aquifer, and a deeper one called the Maestrichien aquifer.

The Continental Terminal aquifer is recharged by rainfall during the wet season and appears to be continuous beneath The Gambia. Water table depth increases from south to north and from west to east. Salinity concentrations are higher in the west (2000 ppm) than in the east (500 ppm). Yields are from 550 to 1100 cubic meters per day near the coast to over 2200 cubic meters in the central and eastern region. Effects of continuous pumping on the aquifer are not known, but any significant drop in the water level would be critical to rural people who rely on hand-dug wells.

The Maestrichien aquifer is an artesian aquifer found under most of the Gambia River basin. Water quality from this aquifer appears to be marginal for irrigation use west of Georgetown. Yields are estimated at 1500 to 6000 cubic meters per day, but recharge sources and rates are unknown for lack of adequate testing.

⁶Sources: Dunsmore et al. 1976.
Hewitt. 1977.
Johnson. 1978.
Republic of The Gambia. 1979.

3.3.2 Surface Water

Surface water runoff in the wet season is generally high (about 50 percent), and probably contributes to flooding of alluvial soils along the river. Infiltration rates are slower on plateau soils than colluvial soils, but vegetation has a larger influence on infiltration than soil type. Infiltration is faster under trees than bush, and worst under annual crops. Improved infiltration under trees and bush is caused by termites, which open passageways in the soil. Termites are not found with annual crops, which present them with little food.

The Gambia River and its tributaries are the major sources of surface water in The Gambia. From its headwaters in the mountains of northern Guinea (1538 meters elevation), the river flows northwestward through Senegal to The Gambia, where its bed is essentially flat (Fig. 6). While Guinea includes only 9 percent of the 77,800 sq km basin, it contributes the majority of the wet season flow. Senegal (77 percent of the basin) makes a considerable addition, but little or no inflow originates in The Gambia.

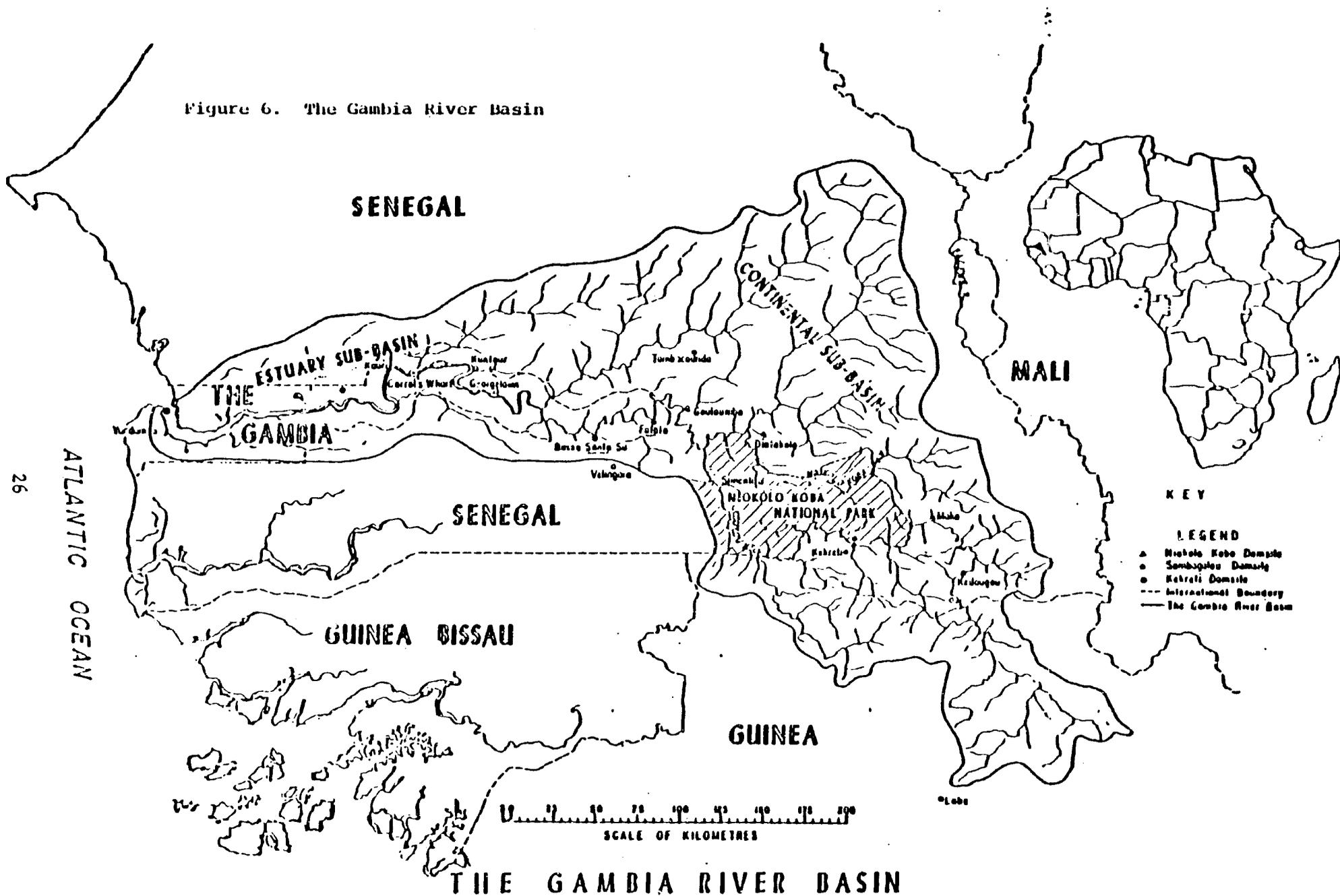
The average annual flow as the river enters The Gambia, based on data from 1953 to 1975, amounts to 9100 million cubic meters. This figure must be treated with caution, however, as the range varies from about 14,000 to 3,000 million cubic meters, and has been falling. Seasonal flow rates are directly related to seasonal precipitation, with highest flows from July to November (Table 9). The maximum monthly flow was recorded in September 1955, when the mean flow rate was 1930 cubic meters per second. Flows during the dry season have fallen to less than 3 cubic meters per second during especially dry years.

River water quality is good except where affected by seawater intrusion. The distance that salinity intrusion moves upstream varies depending on the volume of freshwater flow. During the peak of the wet season, seawater extends approximately 70 km upriver from Banjul. As flows decrease in the dry season, the mixing zone moves upstream at a rate of 15 to 20 km per month. The maximum recorded upstream extension is at Muntaur, about 247 km upriver from Banjul. The length of the dry season is a more important cause of saline intrusion in soils than the extent of wet season flushing.

3.3.3 Water Use

Despite its prominence as a source of surface water, the Gambia River is little used for agricultural, domestic, or industrial purposes. Probably less than 29 million cubic meters of water are taken annually for agriculture, a minor amount is taken for domestic use, and almost none for industrial use. At present virtually no groundwater is used for irrigation, although groundwater is used for almost all domestic water supplies and rural cattle water.

Figure 6. The Gambia River Basin



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Source: Hewitt. 1977.

Table 9. Monthly Average Flows of Gambia River as it Enters The Gambia at Gouloumbo, Senegal (m³/s)

<u>Month</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
January	13	21	23
February	7.5	13	13
March	5.0	7.8	8.4
April	2.5	5.9	3.7
May	2.2	3.7	
June	18	6.2	
July	264	138	
August	832	313	
September	1,142	1,098	
October	757	831	
November	160	144	
December	60	51	

Source: Hewitt. 1977.

A major problem of using river water in the lower river is its salinity, particularly during the dry season. Diverting upstream water raises further problems by causing the saline mixing zone to move upstream at a rate dependent on the amount diverted. Continuous pumping of 1 cubic meter per second moves the saline zone upstream at a rate of approximately 1 km per month. Damming of tributary bolons (creeks) to prevent saline intrusion and to use them for freshwater irrigation is not practical because they are surrounded by poorly drained acid soils and have an irregular water supply. These problems have contributed to the current interest in constructing a salinity barrage at Yelitenda, to be discussed further in section 4.2.4.

The number and quality of existing groundwater wells are not sufficient to meet rural demands for livestock and agriculture. Rural wells are wide-bore and hand-dug, and many collapse or become contaminated by silt. The urban water supply for Banjul comes from aquifers in the Yundum area and is of good quality, but demand is increasing to the point that increased pumping and delivery capacity needs to be developed. Potential problems include salt water intrusion if wells are overpumped and the danger of contamination by seepage. Further study to determine recharge sites, aquifer size and monitor water quality is necessary.

3.4 Vegetation^{7/}

⁷ Sources: Dunsmore et al. 1976.
 Huygen. 1978.
 Jarrett. 1949.
 Johnson. 1978.
 Mittleholtz and Mittleholtz. 1976.

3.4.1 Vegetative Associations

Dunsmore et al (1976) provides a good general classification of the current major vegetation types in The Gambia based on soil association (c. f. section 3.2.1); it is the major source used here. Johnson (1978) gives detailed information on the mangrove forest, together with predictions of the effect of a salinity barrage on mangrove survival. Further citations dealing with the vegetation of The Gambia are found in Gamble (1979), and are reproduced in the bibliography of this report.

Topography, land use, and general condition of the vegetation on each of the 24 soil associations are given in Table 10. The area and distribution of these associations are found in Table 6. Soil associations are grouped together in vegetation categories as shown in Table 11. Ten distinct categories are recognized:

1. Parkland or woodland savanna (Associations 1, 2, 6, 7)
Generally farmland with scattered medium to tall trees, no shrubs, and ground cover of weeds or annual grasses. Trees include Parkia biglobosa, Bombax buonopozense, and Khaya senegalensis. Where rainfall is higher in the west, Daniellia oliveri woodland reaches the northern limit of its range. To the east, D. oliveri does not occur, and K. senegalensis is usually restricted to moister sites.
2. Woodland and riparian woodland (Associations 4 and 5)
More like forest than woodland due to its continuous canopy with some emergents, this community is more diverse than 1. It is, however, very disturbed by large human and cattle populations. Dominant trees, including Detarium senegalese, Parkia biglobosa, Parinari excelsa, Dialium guineense, Erthythrophleum guineense and the oil palm (Elaeis guineensis) have 8-9 meters of clean stem. Acacia spp. and Combretum spp. are common shrubs.
3. Disturbed woodland with shrub understory (Associations 3, 8, 9, 10, 11, 12)
Disturbed by fire or cultivation, these areas are dominated by species of Combretaceae and Leguminosae, including Combretum micranthum, Terminalia albida and T. macroptera. Cordyla pinnata, Cassia sieberiana, Swartzia madagascariensis, Prosopis africana, and Acacia spp. are common and widespread. The herbaceous cover has few species and is often sparse due to fire and selective grazing.
4. Vegetation of association 13
Riparian thickets and woodlands are composed of dense entangled shrubs and a few tall trees, except those extensively cultivated in the Western Division. Elaeis guineensis is confined to stream lines in the west and the finest surviving specimens of Khaya senegalensis are found along washes throughout. In a number of areas, including North Bank Division, there are narrow belts of tall woodland just above the floodplain, with Parinari excelsa, Khaya senegalensis and Detarium senegalensis. A savanna with scattered low trees, mainly Mitragyna inermis and Acacia seyal, also occurs on this association.

Table 10. Environmental Characteristics of Soil Associations

Soil association	Environmental characteristics	Soil association	Environmental characteristics
1	Crests and mid to upper slopes of interfluvies mainly in Western and North Bank Divisions, intensively cultivated, scattered medium to tall trees, some forest parks and plantations in Western Division and Klang West (Lower River Division)	13	Tributary valleys and edge of Gamble River floodplain; vegetation varies including (a) riparian thicket, (b) swamp woodland and (c) <i>Mitragyna</i> and/or <i>Acacia</i> scattered tree savanna; cultivation in some districts
2	Crests and mid to upper slopes of some interfluvies, and sometimes forming distinctive north-south orientated slightly elevated ridges, in North Bank Division; intensively cultivated, scattered medium to tall trees	14	Low-lying river floodplain subject to inundation through tidal fluctuations in water level; vegetation is mangrove but includes barren areas associated with this
3	Eroded interfluvies commonly promontories projecting into the floodplain of the River Gamble; disturbed woodland, shrub understorey, varies from woody fallow to open woodland	15	Low-lying river floodplain subject to wet-season inundation; herbaceous floodplain of variable cover, woody species sometimes present
4	Lower slopes of interfluvies in Western and North Bank Divisions; woodland, including narrow areas of riparian woodland	16	Low-lying river floodplain subject to wet-season inundation; medium tall grassland
5	Broad, gently sloping depressions in Western and North Bank Divisions; woodland, including narrow areas of riparian woodland	17	Mostly low-lying river floodplain in MacCarthy Island Division; medium height grassland, <i>Mitragyna</i> sometimes present
6	Colluvial slopes; intensively cultivated, scattered medium to tall trees	18	Low-lying river floodplain in MacCarthy Island Division; medium-height grassland, <i>Mitragyna</i> sometimes present
7	Colluvial slopes; intensively cultivated, scattered medium to tall trees	19	Slightly elevated terraces or levees of the prior floodplain in MacCarthy Island Division; woodland
8	Edge of plateau, scarp slope and plateau outliers; disturbed woodland, shrub understorey, varies from woody fallow to open woodland	20	Elevated terraces or levees of the prior floodplain in MacCarthy Island Division; woodland
9	Strongly dissected valleys; disturbed woodland, shrub understorey, varies from woody fallow to open woodland	21	Back swamps or sloughs in Upper River Division; medium-height grassland
10	Outer zones of plateau; disturbed woodland, shrub understorey, varies from woody fallow to open woodland	22	Slightly elevated terraces of the prior floodplain in Upper River Division; medium-height grassland
11	Inner zones of plateau; disturbed woodland, shrub understorey, varies from woody fallows to open woodland	23	Elevated levees of the prior floodplain in Upper River Division
12	Lower plateau or plateau disclips, and valley heads; disturbed woodland, shrub understorey, varies from woody fallow to open woodland	24	Coastal strip

Source: Dunsmore et al. 1976.

Table 11. Vegetation Categories and Soil Associations

Soil Association	Vegetation category
1,2	Parkland or woodland savanna: medium to tall trees scattered in frequently cultivated areas (forest parks and plantations occur on these units in Western Division and in Kiang West, Lower River Division)
3	Disturbed woodland/shrub understorey: varies from woody fallows to open woodland
4,5	Woodland: includes riparian woodland when this is not mapped under 13(a)
6,7	Parkland: see 1 and 2
8-12	Disturbed woodland: see 3
13	<ul style="list-style-type: none"> a. Riparian thickets b. Fringing woodland c. <i>Mitragyna</i> and/or <i>Acacia</i> scattered-tree savanna (cultivation on this unit in some Districts)
14	<ul style="list-style-type: none"> a. Mangrove b. Barren flats
15	Herbaceous floodplain: cover variable, woody species sometimes present
16	Medium-tall flooded grassland
17,18	Medium height grassland: <i>Mitragyna</i> sometimes present
19,20	Wooded levies and alluvial areas
21,22	Medium height grassland (see 17,18)
23	Wooded levies and alluvial areas (see 19,20)
24	Coastal vegetation <ul style="list-style-type: none"> a. <i>Parinari-Loudezia</i> b. <i>Borassus</i> c. Dunes with stunted <i>Adansonia</i> d. Low tree - tall grass

Source: Dunsmore et al. 1976.

5. Mangroves and barren flats (Association 14)
Saline watercourses are bordered by mangrove forests arranged in two zones. A gallery of 20-30 meter tall red mangroves (Rhizophora racemosa) occurs from water's edge to the limit of daily tidal flooding, behind which shorter black mangroves (Avicenna africana) occur to the limit of mean spring tide. Rhizophora harrisonii and R. mangle occur at the boundary between these two zones. In time, as the accumulation of alluvium and leaf litter increases the soil depth around the roots of Rhizophora, Avicenna replaces Rhizophora. When soil levels are further raised they are too acid to support vegetation during the dry season and become barren flats with a high salt content. Such flats, most extensive in North Bank Division, support the succulent Sesuvium portulacastrum in more extreme conditions. Sporobolus spicatus and the stiff, hard grasses Paspalum vaginatum and Diplachne fusca occur in more favorable areas.
6. Herbaceous floodplain (Association 15)
This type consists of tightly-grazed grassland of the stiff, hard grasses Paspalum vaginatum and Diplachne fusca, and scattered oil palms (Elaeis guineensis).
7. Medium-tall flooded grassland (Association 16)
This community of tall Phragmites karka and Echinochloa pyramidalis grasses includes no woody plants and is common behind mangrove in Lower Bank Division.
8. Medium grassland (Associations 17, 18, 21, 22)
The middle and eastern end of the country have extensive floodplains dominated by one of a small number of grasses of medium height. These include Anadelphia arrecta, Eragrostis atrovirens, Panicum anabaptistum, and Vetivera nigritana. Mostly treeless, these plains do include scattered low Mitragyna in the middle river areas.
9. Alluvial woodland (Associations 19, 20, 23)
The vegetation of the levees and alluvial areas close to the river in central and eastern parts of the country consists typically of woodland on better-drained levees and Mitragyna shrub on swamp fringes and mounds within swamps. Levee woodland includes Pterocarpus erinaceus, Terminalia spp., Acacia spp., large Ficus spp. and Khaya senegalensis. The rhun palm (Borassus aethiopicum) is typical but much reduced by cutting.
10. Coastal vegetation (Association 24)
The sandy coastal soils support four different communities. Southeast of Kartung (Western Division) there is a distinctive community of Parinari macrophylla trees about 4.5 meters tall in a grassland dominated by Loudetia simplex. North and south of Gunjur are stands of the rhun palm (Borassus aethiopicum), but

the area is heavily farmed and immature palms are often damaged by man and animals. West of Kartung the dunes have a sparse cover of grasses with stunted baobab trees (Andansonia digitata). Finally, there is a low tree-tall grass community near the coast between Brufut and Tujering which includes the tree Parinaria macrophylla and the grasses Heteropogon melanocarpa and Loudetia kagerensis.

3.4.2 Forest Reserves and Plantations

A small Forestry Division was established in 1950 to manage the forests of The Gambia. In its early years, the Division set aside 66 forest parks ranging in size from 4 to 2667 ha, as follows:

12	rhun palm forests	618 ha
14	timber forests	4,104 ha
6	bamboo forests	7,068 ha
34	protection forests	22,239 ha
	Total	34,029 ha

Over half of the total area of reserves was located in MacCarthy Island Division.

The parks were to be protected from burning and cutting except with a permit, and considerable effort was initially put into their protection by the Forestry Division. However, this function was subsequently turned over to the Area Councils, during which time considerable encroachment for farming and wood cutting occurred. Eleven percent of the total estate was completely cleared by 1972, together with an undetermined amount of felling of individual trees. Recently the parks were returned to the control of the Division of Forestry.

A plantation program begun in 1959 in the Western Division planted some 890 ha of Queensland beech (Gmelina arborea) and a small area of teak (Tectona grandis). Gmelina appears to have grown satisfactorily, but may be limited in usefulness to the Western Division, where rainfall is higher. Planting trial experiments at Yundum have shown encouraging results for Chlorophora regia, Gmelina arborea, Tectona grandis, Azadriachtha indica and particularly Terminalia superba, whose performance out-classes all others.

3.5 Fauna and Fisheries^{3/}

³ Sources: Aubray. 1978.
 Cawkell and Moreau. 1963.
 Dunsmore et al. 1976.
 Dupuy and Verschuren. 1977.
 Hubbard. 1977.
 King. 1979.
 Mittleholtz and Mittleholtz. 1976.
 Robins. 1970.
 Thomson. 1970.

3.5.1 Native Terrestrial Fauna

There is no current survey of the native fauna of The Gambia, and most of the work done is now out of date (see the bibliography for references), especially considering the recent rapid changes in habitat due to increased population pressure. The latest general treatment is that of Parker (1973), summarized in Dunsmore et al. (1976).

Although many large African mammals previously roamed The Gambia, they are now almost all gone. The elephant, once the national emblem of The Gambia, hasn't been recorded since 1913. Of 67 species of mammals either known or of probable occurrence in The Gambia during this century, ten no longer occur:

Bubal hartebeest	(<u>Alcelaphus bucephalus</u>)
Buffalo	(<u>Syncerus nanus</u>)
Buffon's Kob	(<u>Kobus kob</u>)
Chimpanzee	(<u>Pan trogladytes</u>)
Elephant	(<u>Loxodonta africana</u>)
Giant eland	(<u>Taurotragus derbianus</u>)
Giraffe	(<u>Giraffa camelopardis</u>)
Wild dog	(<u>Lycaon pictus</u>)
Tiang	(<u>Damaliscus korrigum</u>)
Lion	(<u>Panthera leo</u>)

Four additional species are probably gone:

Pied colubus	(<u>Colobus polykomos</u>)
Roan antelope	(<u>Hippotragus equinus</u>)
Waterbuck	(<u>Kobus defassa</u>)
Yellow-backed duiker	(<u>Cephalochus sylvicultor</u>)

About 550 species of birds have been recorded from The Gambia, including some 150 species of palearctic migrants. This is an exceptional number for such a small area, and constitutes a potential attraction for tourism. Again, the present status of bird populations in the country is unknown, although Cawkell and Moreau (1963) commented that many species had apparently declined in numbers since the turn of the century, primarily because of habitat destruction.

3.5.2 Conservation of Fauna

The major cause of wildlife loss has been habitat destruction, the extent of which is indicated by the review of vegetation communities in section 3.4.1. Only the mangrove swamps and barren flats around them have remained substantially unaltered due to their uselessness for agriculture. Fortunately, most of the mammals now eliminated for The Gambia (see list in section 3.5.1 above) are currently protected in Senegal's nearby Niokola-Koba National Park, which encompasses 900,000 ha of grassland and savanna woodland along the upper Gambia River (see map, Fig. 6). In addition, The Gambia has a small reserve, Abuko Nature Reserve, which includes 73 ha of riverine gallery forest.

and tall grass savanna. Located near Yurdum and protected since 1916 as a water supply reserve for Banjul, Abuko is enclosed and serves as an education and tourist center, drawing 10,000 to 11,000 visitors per year. Among the numerous mammals either occurring naturally or introduced to the reserve are:

Chimpanzee	(<u>Pan troglodytes</u>)
Red colobus	(<u>Colobus badius</u>)
Green vervet	(<u>Cercopithecus aethiops</u>)
Red patas	(<u>Erythrocoebus patas</u>)
Gambian sun squirrel	(<u>Heliosciurus gambianus</u>)
Crested porcupine	(<u>Hystrix cristata</u>)
West African civet	(<u>Civettictis civetta</u>)
Gambian dwarf mongoose	(<u>Helogale parvula</u>)
Genet	(<u>Genetta spp.</u>)
Serval	(<u>Felis serval</u>)
Leopard	(<u>Panthera pardus</u>)
Caracal	(<u>Lynx caracal</u>)
Bushbuck	(<u>Tragelaphus scriptus</u>)
Duiker	(<u>Cephalophus maxwelli</u>)
Harnassed antelope	(<u>Boocercus eurycercus</u>)
Sitatunga	(<u>Tragelaphus spekis</u>)

In addition, about 170 species of birds have been recorded, and reptiles include crocodiles, cobras, royal and African pythons, and the green mamba.

Although Abuko Nature Reserve serves a valuable function as an educational resource and tourist attraction, its small size limits its ability to maintain viable populations of any but the smaller animals. Niokola-koba National Park in Senegal relieves the pressure on many species, but some increase of protected areas in The Gambia is desirable. Several alternatives have been proposed:

1. Enlargement of Abuko Nature Reserve by 72-144 additional ha
Building around the present nucleus of the park seems reasonable and desirable.
2. Kiang West National Park
The Kiang West district is an 1800 ha area south of Jali Point, including Nganingkoi Bolon and containing a rich variety of unspoiled habitats. With a population in 1973 of 10,074, Kiang West has a population density of 14 per sq km, the lowest in the country. However, human pressure on the land is rapidly increasing and enforcement of conservation is likely to be difficult.
3. Gambia River National Park
Creation of a national park from the Baboon Island complex with N'jassang and Kaolong Forest Parks (5,000 ha in MacCarthy Island Division) could provide a last refuge for hippopotamus and crocodiles, currently endangered in The Gambia.

4. Gambia Sine Saloum International Park

A northwest coastal area would border the Sengelase national park of Sine Saloum and increase the total area under protection.

A special consideration in the planning of wildlife conservation should be the protection of mangrove swamps bordering the river, because these areas are relatively undisturbed, they have little agricultural value, they are unique within The Gambia River basin, and they provide refuge for endangered aquatic animals, including the sitatunga, African manatee, hippopotamus, and crocodile.

Specific legislation designed to protect wildlife in The Gambia is covered in Appendix 1.

3.5.3 Fisheries

Although The Gambia has a limited coast, it is located in one of the richest fisheries zones of West Africa. Most of the production comes from fishing grounds off the Atlantic coast, but fishing is also conducted in the estuary and along the river in swamps and tributaries. The annual catch is worth about U.S. \$1 million, or about 8 percent of the gross domestic product. The fisheries potential of The Gambia still remains largely unrealized, due to marketing problems and lack of efficient equipment. Most fishing is artisanal in nature and based on bonga or African shad (Ethmalosa fimbriata). The potential effect on the fishery of the proposed salinity barrage is a matter of concern, particularly since bonga is an anadromous fish which uses the river estuary to reproduce.

The catch for the 1975-76 season was about 23,000 tons, consisting of over 95 percent marine or estuarine species (Table 12), especially bonga, sardines, and demersal fish. Potential production has been estimated at about 5 times this amount (Table 12). About 9200 tons of the 1975-76 catch were exported, and the remainder was sold fresh or cured for local consumption. Annual per capita consumption of seafood in The Gambia is about 25 kg, up from about 20 kg per capita in 1960. An increase to 30 kg per capita is expected by 1990. Currently, consumption is much higher at Banjul and along the coast (over 45 kg) than in the interior (15 kg), due to marketing and distribution patterns.

Estimates of the number of fishermen in The Gambia range from 1500 to 5000, and are apparently complicated by the practice of seasonal fishing by Gambians as well as migrant Senegalese. A 1978 survey found 582 canoes in operation, of which 248 were coastal, 175 were along the lower river, and the remaining 159 along the upper river. Nearly all coastal canoes are motorized, but river canoes generally are not. In addition, 1978 records showed 23 commercial vessels registered to fish in Gambian waters, including 11 purse seiners and 12 stern trawlers.

Table 12. Observed Catch and Estimated Potential Annual Production of Major Fisheries Resources of The Gambia

	<u>Catch, 1975-76</u>	<u>Estimated potential</u>
Bonga	13,000 t	35,000 to 50,000 t
Sardines	4,000 t	35,000 to 70,000 t
Demersal Fish	3,500 t	10,000 to 12,000 t
Shark	400 t	
Lobster	70 t	60 to 70 t
Shrimp	300 t	300 to 500 t
Cockle/Oyster	670 t	
Other marine	230 t	
Upriver fisheries	800 t	
<hr/>		
Total	22,970 t	80,000 to 130,000 t

Source: Aubray. 1978.

About 80 percent of the coastal catch is bonga, captured from Nov.-April with encircling driftnets, and about half of the bonga catch is smoked for export. Canoes not specialized for bonga fishing catch mainly demersal species with handnets and gillnets. Lobsters are caught in shallow coastal waters by canoe fishermen, most of whom are Senegalese. Sardines are fished by a local company with its own purse seiners, but the fishery is limited to a 3 month period (Jan-March) due to the seasonal migration of sardines.

Among the estuarine fishing resources exploited are shrimp, oysters and cockles. Trawling for shrimp off the coast has proved unprofitable, so shrimp fishing is limited to the estuary, where canoes with stownets are used. Oysters and cockles are collected seasonally by women who retire to their farms during the rainy season. Oysters are found on mangroves, and it is felt that aquaculture could be used to develop an oyster supply for the tourist market. Upriver fishing is with weirs and nets set by night. The fish population in the river reaches its peak at the end of the rainy season, undergoing a high mortality in the dry season.

The biology of the bonga (Ethmalosa fimbriati) is of considerable interest, since it is the dominant fish in Gambian waters, and the basis of the entire smoked fish industry. It is a phytoplankton feeder capable of tolerating a wide range of salinity, from 2-35 percent. Abundant in the estuary almost the entire year, bonga move upstream during the dry season to the limit of salinity about 200 km from Banjul. Spawning takes place in both the sea and the estuary all year long, but upriver spawning is only during the saline intrusion from January to July. Breeding conditions apparently depend on both proper salinity and warm temperatures, and it is felt that the mixing of waters in the estuary provides ideal circumstances. No information is available as yet on the effect of the proposed salinity barrage on the bonga population, but an assessment was planned to begin in mid-1979.

4.0 Current and Potential Environmental Problems

Environmental problems of The Gambia are of two kinds: current problems of natural or human origins, and potential problems of proposed development schemes. Current problems, including disease and degradation of soils and forests, were introduced in previous sections and are summarized here. Problems of proposed development schemes, covered here for the first time, stem primarily from plans to use Gambia River water for irrigation by constructing a salinity barrage.

4.1 Current Problems ^{9/}

Current environmental problems are primarily caused by increased pressure on the land from growing human and livestock populations. These problems are loss of wood resources, degradation of land, and loss of natural diversity in the flora and fauna. Major health problems are caused by water-borne diseases, including malaria, schistosomiasis, and intestinal parasites.

4.1.1 Loss of Wood Resources

The various causes and extent of the loss of wood resources in The Gambia were introduced in sections 2.3.3 and 3.4.2. The causes are:

- 1) demand for fuelwood from an increasing population;
- 2) clearing of forests for cultivation;
- 3) destruction by natural and man-made fires;
- 4) wasteful use of available resources;
- 5) browsing by livestock; and
- 6) lack of managed forests and plantations.

The extent of present and future losses under current conditions of exploitation are shown in Table 13, which indicates a rapid drop in the ability of Gambian forests to meet national needs.

4.1.2 Degradation of Land and Loss of Natural Diversity

Soil erosion in The Gambia is not as severe as it might be given the prevailing land-use practices, because the topography is subdued. Among the practices contributing to soil erosion are:

- 1) crop cultivation up and down slope instead of on the contour;
- 2) cultivation of natural drainages;
- 3) overgrazing; and
- 4) trampling of soil and formation of permanent tracks by cattle.

⁹ Sources: Dunsmore et al. 1976.
Hubbard. 1977.
UNDP. 1980.
U.S. AID. 1979.

Table 13. Present and Projected Coverage of National Wood Requirements by Forest Resources

	1976	1985	1990	2000
Annual forest production potential (000 m ³) <u>a/</u>	390.7	577.6	494.2	174.9
Gambia population (000 persons)	538.8	690.8	793.1	1,045.4
Wood requirements (000 m ³) <u>b/</u>	964.4	1,233.7	1,414.8	1,860.0
Coverage of requirements by natural growth (%)	41	47	35	9
Net change in wood resources during year	-573.7	-656.1	-920.6	-1,685.1

a/ Represents total annual growth of forests and woodlands with mean annual growth per hectare reduced by 1 percent per year to reflect present trend of uncontrolled exploitation and bush burning.

b/ Assumes the following constant per capita consumption (m³ equivalent):

	Charcoal	Firewood	Saw Logs	Total
Rural	0.25	1.56	.01	1.82
Urban	0.89	0.78	.03	1.70

Source: UNDP. 1980.

The most widespread problems are water runoff losses and sheet erosion: gully erosion is more common in the North Bank and Upper River divisions. In general, the situation is not severe and can be controlled by stabilizing structures built with local materials and labor. Ultimately, solution of erosion problems will depend on coordinated land management programs and education of farmers and herdsman.

A variety of other forms of environmental degradation are caused by increased pressure from human and livestock populations in the absence of management controls and land-use planning. Symptomatic problems include loss of desirable grasses from burning, grazing, and harvesting for thatch; soil compaction and vegetation loss near livestock watering points; loss of wildlife habitat; and reduction of soil fertility from decreased fallow time.

4.1.3 Water-borne Diseases

Important water-borne diseases in The Gambia are malaria, schistosomiasis, trypanosomiasis and intestinal parasites (see Sec. 2.3.3). Malaria is seasonal, peaking in September and October at the end of the rainy season, when Anopheles mosquito populations are highest. Mosquitos breed in irrigated rice fields, and their numbers can be expected to increase as the area under irrigation increases. Chemical controls and oil emulsions aimed at destroying the larvae can be toxic to irrigated plants and wildlife. Controls without severe side-effects include the introduction of larvae-eating fish (Gambusia), removal of emergent and trailing vegetation from irrigation ditches and impoundments, and drainage of standing water.

Schistosomiasis is carried by snails (Bulinus senegalensis) which prefer calm, fresh water, such as occurs in ponds and creeks (bolons) in The Gambia during the wet season. Schistosoma eggs in human feces or urine passed in the water hatch into larvae which infest the snails and reinfest humans. Snail habitat may increase with increased irrigation, causing an increase of the disease. Improved sanitation is the best control.

Trypanosomiasis or sleeping sickness is carried by tsetse flies, which breed in moist sand shaded by low bushes. The fly is found along the entire length of the river, although its habitat is being decreased by clearing and burning of vegetation. Human transmission of the disease is highest at the end of the dry season when flies are restricted to water holes used for swimming and bathing. Although present destruction of vegetation is helping reduce this disease, such measures are not sound land-management practice and alternative controls must be found.

Infections of intestinal parasites are caused by inadequate sanitation of drinking water (see Sect. 1.3.3). Waste disposal facilities are planned for Banjul, but problems can be expected to continue in rural areas until public education and well sanitation are improved.

4.2 Potential Development Problems ^{10/}

4.2.1 Background

The OMVG (Organization pour le Mise en Valeur du Fleuve Gambie), or Organisation for the Development of the Gambia River, was formed on June 30, 1978 by the governments of The Gambia and Senegal to promote and coordinate the development of the Gambia River basin. Membership in the OMVG by the Republic of Guinea was requested and approved in July 1980 and should be made formal soon. The predecessor of the OMVG, called the Coordinating Committee for Development of the Gambia River Basin, was formed in 1976 and requested a general plan for the development of land and water resources in the basin from the United Nations Development Programme (UNDP). Following the preparation of a series of 13 sectoral reports in April/May 1977, the UNDP presented a draft report of development options to country representatives in 1979. The representatives chose comprehensive development strategies for their countries founded on specific options for rainfed agriculture, water-managed agriculture, livestock, and forestry. Options and strategies were published in a final report (UNDP 1980). The strategies remain to be approved by the OMVG and presented to the community of donors for funding and expert support.

4.2.2 The Development Strategy

The following development strategy was chosen by The Gambia:

Rainfed agriculture. Described as "intensive development" with "a rapid upgrading of farmers to higher yielding cultivation techniques," the plan includes proper land preparation, animal traction, mechanical seeders, high rates of fertilizer and pesticide application, and some postharvest mechanization. Crops included are upland rice, millet, maize, groundnuts, and cotton. Specific techniques are to be devised by national and donor research cooperation.

Water-managed agriculture. The plan calls for the construction of a salinity barrage to irrigate 24,000 ha of double-cropped rice.

Livestock. This program's goals are to improve animal health, relieve competition between farmers and herders for access to land, and prevent overgrazing. Improved animal husbandry techniques, increased animal offtake rates, marketing improvements, credit availability, and expanded livestock extension services are the major components of this strategy. Controlled grazing areas with water supplies are included.

Forestry. Self-sufficiency in wood products and preservation of riverbank stability are the major priorities. Suggested measures

¹⁰Sources: Hubbard. 1977.
Johnson. 1978.
UNDP. 1980.
U.S. AID. 1980.

include forest management, fire control and plantation establishment, as well as salvage of mangroves above the salinity barrage and management of mangroves below the barrage. Finally, various alternatives to reduce dependency on charcoal are suggested, such as use of butane, mineral coal, agricultural wastes, bio-gas, or solar energy, and the use of more efficient stoves.

Although not specifically indicated as part of the development strategy chosen by The Gambia, dredging the river's entire length in The Gambia to improve navigation was proposed (Demers 1977) as part of the general development of the river basin.

4.2.3 Environmental Effects of the Development Strategy

Probable environmental effects of the proposed development strategy were treated by Hubbard (1977), and briefly summarized in the final report (UNDP 1980). A detailed consideration of the effects of the salinity barrage on the mangroves upstream is found in Johnson (1978). With the exception of the latter report, which includes a census of the mangroves, existing interpretations of the possible environmental effects of the development scheme suffer from a lack of basic census information. The lack is particularly acute in the case of such river resources as fisheries, which are likely to be profoundly affected by the salinity barrage or dredging project. The absence of adequate environmental information has been recognized by potential donors, and funding for the development scheme will depend on the completion of thorough environmental impact studies. To meet this need, the OMVG is currently working with U.S. AID on a proposal to conduct the basic environmental survey work required to evaluate the development plan.

Much of the development strategy will cause only minor or negligible adverse environmental effects. Indeed, parts of the livestock and forestry plans are aimed at eliminating current sources of environmental degradation, such as overgrazing and destruction of natural forest lands for fuelwood. The application of fertilizers and pesticides required to increase crop yields does have inherent dangers, especially to the aquatic environment. The salinity barrage and dredging projects are potentially the most damaging to the environment, and are treated separately below.

4.2.4 The Salinity Barrage

As mentioned above, complete information required to evaluate the environmental impact of the proposed salinity barrage is still forthcoming. Nonetheless, it is possible here to outline the nature of the project and some of the potential effects.

The concept of a salinity barrage on the Gambia River was first proposed in a Coode and Partners (1977) report for the Ministry of Overseas Development on behalf of the Gambian government, and amended in subsequent reports (Coode and Partners 1979). The proposed location is at Yelitenda, 170 km upstream from Banjul near the present Trans-Gambian Highway crossing. The locality is also called Farafenni. The barrage would be a 360 meter long stone-filled structure with a

navigation lock and would also serve as a bridge. It would prevent natural saltwater flows from reaching 80 km further upstream in the dry season and store freshwater trapped in the wet season for the potential irrigation of 24,000 ha of double-cropped rice. High reservoir level is to be equivalent to the mean high spring tide level, which will flood all mangroves. It may be necessary to inject a substantial amount of saltwater by the end of the dry season to support an upper lens of freshwater at levels adequate for irrigation pumping. This saltwater would be flushed out through the barrage gates at the beginning of the wet season.

Some environmental problems which can be anticipated from the construction of the barrage are:

- 1) Loss of mangrove forests upstream. The area in mangroves upstream of the barrage is 3,600 ha, or about 5 percent of the total area of mangroves in The Gambia, and contains over 1,000,000 cubic meters of wood. These forests will be killed either by excessive flooding or by very acid soil conditions developed by exposure when lake levels are low. The wood could be salvaged, but represents the loss of a renewable resource. Loss of mangroves will also encourage erosion of river banks.
- 2) Loss of fisheries resources. The barrage will change estuarine conditions by impeding the natural flush of freshwater and nutrients carried by the river. Effects on estuarine fisheries, particularly shrimp and bonga, are likely to be profound. The possibility of similar projects on the Senegal and Casamance rivers also raises the larger question of whether the entire breeding area for estuarine organisms in the region may be lost. Although an improved freshwater fishery above the barrage is envisioned, the injection of saltwater behind the barrage may be unfavorable to fish, either by restricting access to the bottom or by convective mixing of salt and fresh water. Loss of fisheries represents not only an economic loss of exports, but the loss of a major local protein supply which must be replaced, perhaps at greater cost.
- 3) Creation of habitat for disease organisms. Bulinus snails, which carry schistosomiasis, thrive in the shallow, sluggish freshwater conditions which will be created behind the barrage, as do Anopheles mosquitos, which carry malaria. This problem could be exacerbated by increased human settlement around the impoundment.
- 4) Disposal of irrigation tail water. Runoff from intensively cultivated lands around the impoundment will carry increasing loads of pesticides and fertilizers. High nutrient levels in the impoundment could cause an excessive growth of plants, which then die and decay, lowering oxygen levels and killing fish. Pesticides can be concentrated in aquatic organisms, eventually reaching toxic levels. Shrimp are particularly sensitive.
- 5) Changes in estuarine dynamics. Impoundment of river flow behind the barrage will cause a loss of the transport capacity of that flow and particle transport will depend entirely on the tide. This can affect flushing of wastes, rate of sediment deposition, and nutrient transport in the estuary.

- 6) Loss of natural flora and fauna. How extensive the damage to native flora and fauna will be is hard to evaluate without proper background data, but certainly the destruction of mangrove forest and increasing cultivation of riverside alluvial soils will cause the reduction or elimination of many local populations.

4.2.5 The Dredging Project

The status of the proposed dredging project in the current development strategy of The Gambia is unclear. It is discussed here in recognition of the possibility that it may be included in future plans.

The project calls for suction dredging to create a 137 meter wide and 6 meter deep channel between Banjul and Kau-ur and a 75 meter wide and 3 meter deep channel between Kau-ur and Fatoto. Twenty-nine sections of the river would be dredged and spoil deposited in 39 sites selected primarily on the basis of the minimum distance for disposal. Disposal areas are to be diked to prevent return flow of spoils with a bulkhead and spillway, included for drainage of excess water. Composition of dredged material is unknown.

Potential environmental problems associated with the dredging project arise primarily from the disturbance of river bottom and the disposal of spoils. Feeding areas for bottom fish could be disturbed and spawning areas covered with silt on sand spread by currents. Spoil disposal in swamps, marshes, mangroves and woodlands would destroy or change wildlife habitat. Mangroves would be smothered and destroyed by spoils in some sites, eliminating their stabilizing influence on river banks. Agricultural use of spoils from saline areas of the river would be delayed by salts in the soil until they are leached by rain and run-off. Potential use of spoils from anywhere along the river would depend on their composition. As with the salinity barrage, more census information on the river environment is required before the effects of dredging can be properly evaluated.

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APPENDIX I

National Environmental Policy, Agencies, and Law

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Appendix I. National Environmental Policy, Agencies, and Law

The most comprehensive treatment of Gambian environmental policy, agencies, and law available at present is that of Hubbard (1978) ¹/_. The following material is summarized from that document.

National Environmental Policy

The Gambian government has shown a remarkably strong interest in conservation and environmental planning, particularly during the late 1970's under the administration of President Dawda Jawara. President Jawara has addressed environmental issues in public statements, including the following:

"It is a sobering reflection that in a relatively short period of our history most of our larger wildlife species have disappeared together with much of the original forest cover. The survival of the wildlife still remaining with us and the setting aside of protected natural habitats for them is the concern of all of us. It would be tragic if this priceless natural heritage, the product of millions of years of evolution, should be further endangered or lost for want of proper concern. This concern is a duty we owe to ourselves, to our great African heritage and to the world. Thus I solemnly declare that my Government pledges its untiring efforts to conserve for now and posterity as wide a spectrum as possible of our remaining fauna and flora."

- Banjul Declaration, 18 February, 1977

In his remarks at the State Opening of Parliament, 10 August, 1978, the President expressed the hope "...that we shall be able, over the years, to maintain and improve our environment so as to ensure our long-term survival." Regarding desertification problems, the President has placed highest priority on "protecting our natural resources and our very fragile ecosystem," and referred to programs "which seek the long-term improvement of the environment, that can save our agricultural soils from the kind of degradation from which it would be difficult to recover once established."

Environmental policy established in the "Five-Year Plan for Economic and Social Development, 1975/76-1979/80" (1st July 1975, Government of the Republic of The Gambia) states that "when a conflict arises between sustained yield and short-term exploitation, the former will prevail." Among the activities defined in the plan to carry out environmental policy are the following:

1. strengthening of existing environmental control legislation;
2. initiating a modest programme of appropriate education through existing media;

¹ Source: Hubbard, F. H. 1978. Report on establishment of a permanent environmental unit in the government of The Gambia. Consultant report to United Nations Environment Programme, New York.

3. developing detailed national programming for land use;
4. programmes for conservation of soil, water, forest, marine and other natural resources;
5. creating a small new national parks service;
6. balanced regional development of human settlements;
7. modest enhancement of the urban environment;
8. a research programme on social development; and
9. an enhancement of efforts concerned with the conservation and development of Gambian culture.

A major step toward accomplishing the first objective was taken with the establishment of a temporary environmental unit in the Attorney General's Chambers from 1976 to 1978. The unit, which consisted of a lawyer and scientist team provided through the U.S. Peace Corps, drafted a considerable body of environmental law which was later enacted, inventoried existing law, wrote briefs on environmental problems, and generally served as a focus of environmentally-related government business. The government is now interested in establishing a permanent environmental unit and has received assistance from the United Nations Environmental Programme for doing so.

National Agencies with Environmental Responsibility

1. National Planning Committee and Central Review Committee

The former is chaired by the President and includes all permanent secretaries and chairmen of divisional development committees, while the latter is chaired by the Minister of Economic Planning and Industrial Development and is made up of presidential appointees. Functions are to review and coordinate national planning strategies.

2. Ministry of Economic Planning and Industrial Development (MEPID)

MEPID is generally responsible for development planning and implementation.

3. Ministry of Agriculture and Natural Resources (MANR)

MANR is more directly related to environmental management than any other ministry. Included are the Departments of Agriculture, Fisheries, Forestry, Animal Health and Production, and Hydrometeorological Services and Cooperation: MANR exercises regulatory controls, provides technical assistance, education and training, and collects data. Parks and wildlife are the responsibility of a small unit in the President's Office, the Department of Wildlife Conservation.

4. Ministry of Health, Labour, and Social Welfare (MHLW)

MHLSW administers the Public Health Act, including water sanitation.

5. Ministry of Lands and Local Government (MLLG)

Allocates funds for local development projects in water supply and transportation, and reviews building applications.

6. Ministry of Works and Communications (MWC)

Responsible for the Gambia Utilities Corporation and the Gambia Ports Authority.

7. The Gambia National Investment Borad (GNIB)

Responsible for managing the government controlled Gambia Fisheries.

8. Fish Marketing Corporation

Develops and regulates export markets for fish and conducts commercial fishing and processing operations.

The OMVG ^{2/}

The OMVG (see Section 4.2.1) is an international agency with the following major environmental responsibilities in the entire Gambia River basin:

- To promote and coordinate the studies and works for the development of the basin
- To execute such technical and economic projects as member states wish to assign to it. In order to do this, it may receive donations, obtain loans and launch appeals for technical assistance.

The Convention for the Creation of the Gambia River Basin Organization, ratified by The Gambia and Senegal in 1978, states that the OMVG shall in no way act as an obstacle to the creation, the existence, or the workings of national or regional organizations embracing different areas of cooperation. The OMVG is important at this time as a focus for the UNDP project on development of the Gambia River basin (see Section 4.2), but it is understaffed and its administrative abilities remain to be established. An organizational chart of the OMVG is given in Figure 7.

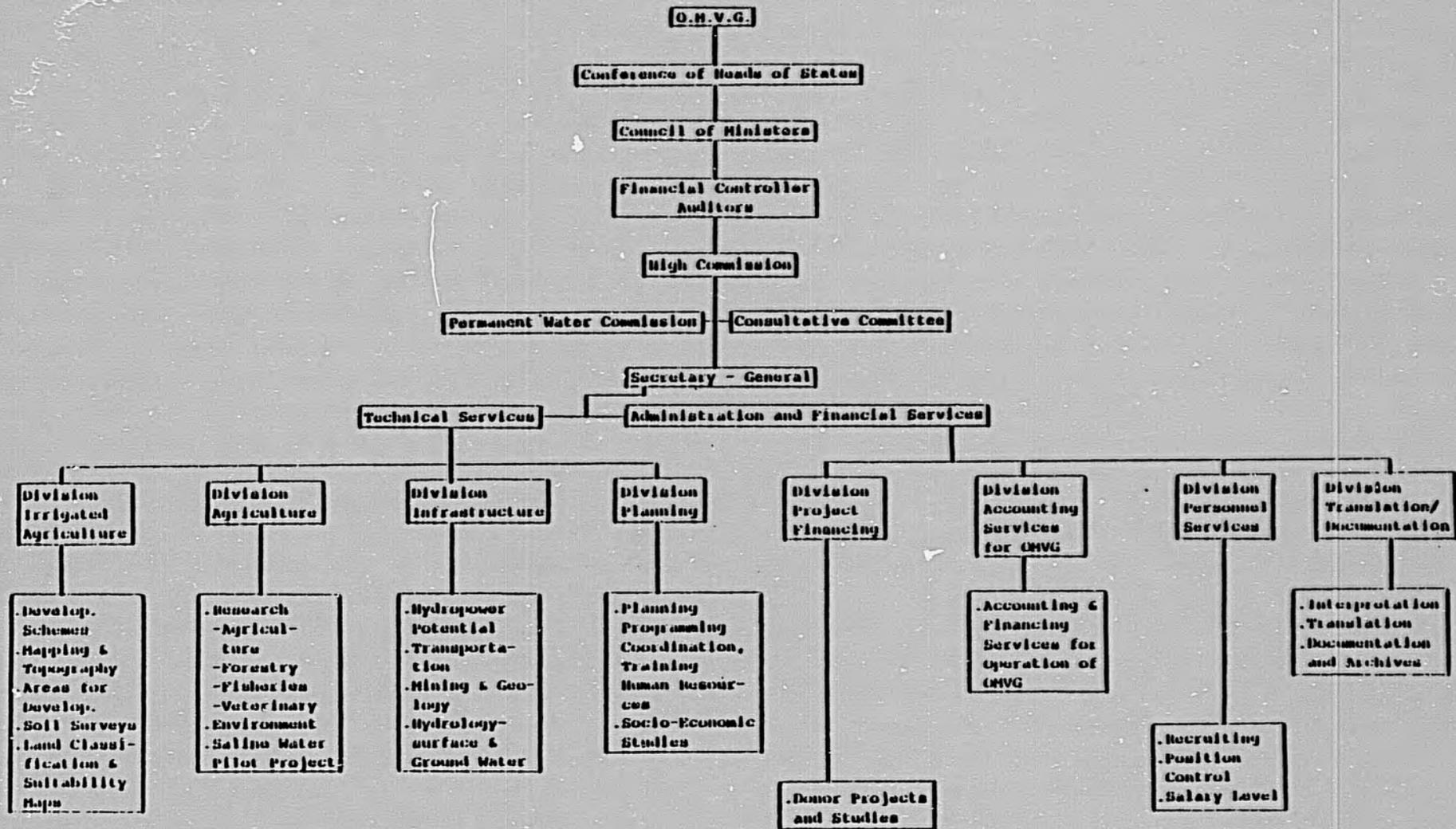
Environmental Law

A summary of environmental law prepared in 1977 by Barbara Lausche Mittleholtz, the environmental lawyer of the temporary environmental unit, remains the most recent treatment. A larger document inventorying water law is available in the Attorney General's Chambers. As of 1978, the Attorney General felt that no additional environmental law was necessary, with the possible exception of legislation to establish an environmental unit. The following survey of environmental law in The Gambia, by B. L. Mittleholtz, is reproduced from Hubbard's (1978) report. A list of pertinent laws is given following the survey.

²Source: U.S. AID. 1980.

Figure 7. Organization of the OMVG.

Technical staff remain to be hired.



Source: U.S. AID. 1980.

Survey of Commonwealth Environmental Law in The Gambia

I. Policy and Institutional Arrangements

The Constitution does not speak expressly in terms of "environmental protection". However, it does recognize the fundamental rights of life, security of person, protection of a person's right over or interest in his property of any description,^{3/} and the payment of adequate compensation for compulsory taking of property.

At present The Gambia has no legislation establishing an environmental protection authority, requiring environmental assessments of actions, or specifically addressing "environmental" planning, development, or protection. There are miscellaneous sections within various other nonenvironmental laws, however, which in effect could provide some indirect environmental protection. These are discussed under the various parts.

While not legislation, Chapter 8, "Environment" in the Five-Year Plan states a clear commitment by Government to development that is environmentally sound. This Chapter specifies as Government's "clear objective", the ordering of development in The Gambia--

"...in such a way as to ensure a continuance of its sources of potential welfare in the future. This will involve not only reclamation, restoration and preservation, but also enhancement of the environment."
(para. 8.2)

The Criminal Code contains some specific provisions concerning fouling air, fouling water, and injury to water containment structures which will be discussed below in the appropriate parts.

II. Land

A. Soil Protection and Conservation

Under the Forestry Act, 1977, the Minister of Agriculture and Natural Resources may declare any lands to be wind erosion areas and then make regulations in certain stated areas to prevent wind erosion.

Under Local Government legislation, each Area Council within its jurisdictional area in the provinces has the general authority to do what is necessary to prevent soil erosion, subject to any law in force.^{4/}

There is at present no other land or agriculture legislation related specifically to soil conservation.

³ Source: The Constitution of the Republic of The Gambia, No. 1 of 1970, s. 13 & 18.

⁴ Source: Local Government Act, Cap. 109, 1963, s. 27.

B. Town and Country Planning

A Town and Country Planning Act was enacted by the colonial Government in 1958, prior to independence, which still exists but has never been used. It allows creation of planning boards to direct preparation of draft plans for future layouts of areas. This law has no subsidiary legislation to give it some guidelines or substance, and is basically ineffective for any control over planning since the plans are approved, revoked or replaced solely at the discretion of the Minister. ^{5/} In practice, no planning boards have been established, and the process has not been used since independence.

At present, Government is considering the creation of some type of national land use and development control legislation. However, no specific policy or legal guidelines have as yet been negotiated.

C. Disposal of Solid Waste

Under the Public Health Act, the Medical Officer of Health is responsible for abating nuisances. In terms of waste disposal, any accumulation or deposit of rubbish of any kind whatever, whether in the form of refuse, manure, decayed or tainted food or in any other form may be considered a nuisance. Thus garbage, etc., should not be deposited randomly. Furthermore, the Minister may make regulations for the proper disposal or destruction of refuse. ^{6/}

In addition, under local government legislation, the Area Councils in the provinces and the Banjul City Council in Banjul have the responsibility to regulate and dispose of refuse, the prevention, abatement and removal of nuisances, and generally to oversee health and sanitation. ^{7/}

D. Planning Sites

There is no specific planning legislation dealing directly with industrial or utility development and environmental effects.

A Building Act is used generally in the Banjul/Kombo St. Mary area to require approval by an Approving Authority before any permanent building takes place. This Approving Authority is comprised of the Director of Public Works and the Medical Officer of Health jointly. Under the Act, the Ministers responsible for works, health, and local government may also make regulations concerning building standards, maintenance, and control. ^{8/} Any person who carries on building work

⁵ Source: Town and Country Planning Act, Cap. 181, 1958.

⁶ Source: Public Health Act, Cap. 154, 1935, s. 52.

⁷ Source: Local Government Act, Cap. 109, 1963, s. 27; Local Government (City of Banjul) Act, Cap. 110, 1946, s. 40

⁸ Source: Building Act, Cap. 17, 1964, s. 3

for domestic or business purposes must first obtain a building permit for the Approving Authority. ^{9/} A permit application must describe the work to be done, location of the site, and all overhead and underground services, adjoining streets, etc. At present, the building standards to be followed are very basic, do not contain environmental guidelines as such, and are generally related to dwelling units. Industrial construction, however, follows the same approving procedure.

III. Water

The National Water Resources Law Inventory for The Gambia should be consulted for an overview on water resources. A draft bill, entitled National Water Resources Council Act, was drafted by February 1978, but was still under review by Government in September 1978. The draft provides for "establishment of a National Water Resources Council to formulate a water policy to ensure the most rational development, management and conservation of water resources for present and future generations in view of its indispensable value for all human, animal and plant life, and its limited amount with respect to quality and quantity."

A. Drinking Water

There are no specific water quality or supply provisions as yet. Research and study are currently underway toward a new national water management law which is expected to encompass overall water regulation, including water quality and pollution control.

Presently, the Gambia Utilities Corporation has the general responsibility to provide, distribute, and conserve the supply of piped water for domestic purposes for the country. ^{10/}

B. Sewage and Treatment

The National Water Resource Law Inventory, pp. 16-17, section (C) Drainage & Sewage, should be consulted as a general reference.

C. Pollution

See the text of the National Water Resource Law Inventory, pp. 19-20, for a discussion on legal aspects of pollution control.

D. Flood Control Measures

See the text of the National Water Resource Law Inventory, p. 15, section (A) Flooding, Overflow and Bank Protection, for flood control legislation.

⁹ Source: Building Regulations, s. 5.

¹⁰ Source: Gambia Utilities Corporation Act, No. 19 of 1972, s. 4.

E. Irrigation and Water Storage

There is no specific legislative control in this area. Generally, the Area Councils in the provinces have authority to control and protect wells, springs, dams, and water supplies in general for their respective areas. ^{11/}

IV. Air

A. Air Pollution Controls

There is no specific legislation on air pollution. Certain disturbances might come under the nuisance sections of the Public Health Act, ^{12/} which defines "nuisance" to include"

"...Any premises in such a condition as to be injurious to health." (and) "...Any act, omission, place or thing which is or may be dangerous to life, or injurious to health or property."

In addition, the Criminal Code provides that "any person who voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighborhood or passing along a public way, is guilty of a misdemeanour." ^{13/}

B. Noise Pollution

There is no specific noise pollution legislation. Again, the Public Health Act provisions on "nuisance", as referred to above, might be used.

Also, in the Banjul/Kombo St. Mary area, any grant to lease land for occupancy and use contains an implied covenant, unless such covenant is expressly varied or excepted, that the grantee "will not at any time carry on or commit or cause or permit to be carried on or committed any noisy, offensive or dangerous trade or nuisance." ^{14/}

C. Motor Vehicle Noise and Exhaust

No specific legislation.

¹¹Source: Local Government Act, Cap. 109, 1963, s. 27.

¹²Source: Public Health Act, Cap. 154, 1935, s. 5.

¹³Source: Criminal Code, Cap. 37, 1934, s. 176.

¹⁴Source: Lands (Banjul and Kombo St. Mary) Act, Cap. 102, 1946, s. 14.

V. Regulation of Toxic Substances

This area is not yet being regulated. However, a draft was completed in 1977 of a Pesticides Act, which would regulate and manage the importation and local use of any pesticides in the country; the draft is under consideration by Government.

Other legislation could presently be used to deal with chemical regulation. For example, the Public Health Act provides that:

"Whoever by any act or default causes or suffers to be brought or to flow into any well, stream, tank, reservoir, aqueduct or pond used or intended for supplying water to man or beast or into any conduit communicating therewith any deleterious substance..shall be liable to a fine...." ^{15/}

VI. Natural Resource Regulation

- A. Forestry Act, 1977; regulations promulgated and Act in force.
- B. Fisheries Act, 1977; regulations promulgated and Act in force.
- C. Minerals Act and Rules, Cap. 121, 1954.
- D. Mining (Mineral Oil) Act and Regulations, Cap. 122.

VII. Protected Places and Species

- A. Parks and other protected natural sites

Under the Wildlife Act, the Minister may undertake surveys with a view to proposing the establishment of national parks or declaring areas for national reserves or local sanctuaries. ^{16/}

Presently, The Gambia has one national reserve, Abuko Nature Reserve, occupying about 73 hectares and located approximately 20 km from Banjul.

- B. Protected cultural and historic sites

Monuments and Relics Act, 1974.

¹⁵ Source: Public Health Act, Cap. 154, 1935, s. 15.

¹⁶ Source: Wildlife Conservation Act, No. 1 of 1977, Part III.

Under other laws, various provisions could also be used to protect sites. Legislation dealing with leasing of the rights to lands in Banjul/Kombo St. Mary and the provinces empowers authorities to condition any lease with such provisions as may be deemed proper. 17/

VIII. Marine Areas

No specific legislation.

Off-shore mineral exploitation is covered by leases and licences within the Mining (Mineral Oil) Regulations.

For pollution within the Continental Shelf, see the text on pollution in the National Water Resource Law Inventory, p. 20. (14)

Fisheries Regulations: Fisheries Act, No. 17 of 1977.

The Ports Act, No. 21 of 1972 contains specific pollution control powers under sections 7 and 76.

IX. Environmentally-Related Treaties and Conventions

August 1977: The Gambia acceded to the Convention on International Trade in Endangered species of Wild Fauna and Flora.

Legislation in Force

- City of Banjul Act, Cap. 25, 1912
- Navigation and Pilotage (Consolidation) By-laws, Cap. 129, 1916.
- Public Health Regulations, Cap. 154, 1931.
- District Tribunals Act Cap. 52, 1933
- District Tribunals Rules, Cap. 52, 1933
- Provinces Market Rules, Cap. 109, 1933
- Criminal Code, Cap. 37, 1934
- Provinces Act, Cap. 151, 1935
- Public Health (Banjul Market and Slaughter House) Regulations, Cap. 154, 1935
- Public Health (Excavations) Regulations, Cap. 154, 1944
- Lands (Banjul and Kombo Saint Mary) Act, Cap. 102, 1946
- Local Government (City of Banjul) Act, Cap. 110, 1946
- Public Health (Aerated Water Factory) Regulations, Cap. 154, 1948.

¹⁷ Source: Lands (Banjul and Kombo St. Mary) Act, Cap. 102, s. 5; Lands (Provinces) Act, Cap. 103, s. 7.

- Law of England (Application) Act, Cap. 104, 1953
- Minerals Act, Cap. 121, 1954
- Minerals Rules, Cap. 121, 1954
- Mining (Mineral Oil) Act, Cap. 122, 1955
- Mining (Mineral Oil) Regulations, Cap. 122, 1960
- Local Government Act, Cap. 109, 1963
- Area Councils Rates and Taxes (General Provisions) Regulations, Cap. 109, 1963
- Building Act, Cap. 17, 1964
- Basse Area Council Constitution Regulations, Cap. 109, 1964
- Brikama Area Council Constitution Regulations, Cap. 109, 1964
- Georgetown Area Council Constitution Regulations, Cap. 109, 1964
- Kerewan Area Council Constitution Regulations, Cap. 109, 1964
- Kuntaur Area Council Constitution Regulations, Cap. 109, 1964
- Mansakonko Area Council Constitution Regulations, Cap. 109, 1964
- Courts Act, Cap. 36, 1964
- Subordinate Courts (Civil Proceedings) Act, Cap. 177, 1964
- Continental Shelf Act, Cap. 32, 1965
- Building Regulations, Cap. 17, 1966
- Interpretation Act, Cap. 97, 1966
- Territorial Sea and Contiguous Zone (Amendment) Act, No. 9 of 1969
- The Construction of the Republic of The Gambia, No. 1 of 1970
- The Fisheries Act, No. 9 of 1971
- The Gambia Utilities Corporation Act, No. 19 of 1972
- The Gambia Utilities Corporation (Water Supply) Regulations No. 19 of 1972
- Ports Act, No. 21 of 1972
- Ports (Ferries) Regulations, 1973
- Ports (Wharves) Regulations, 1973
- City of Banjul Act, No. 5 of 1973
- Prohibition of Excavation of Sand (Beaches in Western Division) By-laws, Cap. 109, 1973
- The Gambia Gazette, Notice No. 91/77, 18th April 1977
- Wildlife Conservation Act, No. 1 of 1977
- Fisheries Act, 1977
- Ports (Amendment) Act, 1977
- Gambia National Investment Board Act, No. 7 of 1977
- Fish Marketing Corporation Act, 1977
- Forestry Act, and Regulations, 1977

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APPENDIX II

Current International Assistance Programs Related to the Environment

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Appendix II. Current International Assistance Programs Related to the Environment ^{1/}

Sector	No.	Agent*	Description	Status
Forestry	1.	UNSO/CILSS	-Green buffer zones around villages	Proposed
	2.	UNSO/CILSS	-Fire protection and management of natural vegetation	Proposed
	3.	FAO	-Equipment loan: vehicles, nursery equipment	Ongoing
	4.	BADEA	-Nursery equipment provided	Completed
	5.	USAID/FRG/BADEA	-Integrated reforestation programme	Funded
Fisheries	1.	EEC	-Artisanal fisheries development	Ongoing
	2.	UNDP/FAO/BADEA	-Integrated fisheries development (training, marketing, storage, handling, both industrial and artisanal)	Ongoing
	3.	UNDP/UK	-Study of fish resources in Gambia River, part of barrage project	Proposed
Range Management	1.	UNSO/CILSS	-Pasture development and protection of land around livestock water points	Proposed
	2.	UNSO	-Livestock watering points development: wells and boreholes	Ongoing
	3.	BADEA/FAO	-Animal disease control at livestock watering points	Ongoing
	4.	USAID	-Mixed farming and resource management	Ongoing
	5.	USAID	-Trypanosome tolerance research	Proposed
	6.	NETHERLANDS	-Animal health care, drug supply	Starting (1980)
Agricultural Development	1.	UK/IDA/BADEA	-Integrated rural development project: civil works, technical assistance, extension training, roads, etc.	Ongoing

¹Source: U.S. AID. 1980. (not an exhaustive list)

*Abbreviations defined following table

Appendix II. Current International Assistance Programs Related to the Environment (continued)

Sector	No.	Agent	Description	Status
Agricultural Development continued	2.	UNDP/FAO	-Crop protection	Ongoing
	3.	UNCDF	-Maintenance and improvement of irrigation structures	Ongoing
	4.	IDA/BADEA	-Vegetable and horticulture development pilot scheme at Yundum	Started
	5.	ADB	-Cotton development scheme, pilot project in URD	Ongoing
	6.	NETHERLANDS	-Development of Jakhaly-Patcharr Swamp: Feasibility study	Complete in 1980
	7.	PRC	-Irrigated rice expansion	Complete in 1980
	8.	UNDP/UK/UNOTC/USAID/CIDA	-Studies for the irrigated development of the Gambia River	Ongoing
	Water Supply and Conservation	1.	EEC	-Water pumps for community development
2.		UNDP/WMO	-Strengthening of hydrometeorological services	Ongoing
3.		USAID	-Soil and water resources management	Funded
4.		UK	-Rural piped water supply	Ongoing
5.		FRG	-German rural water supply project (boreholes)	Feasibility study started
6.		UNDP/UNICEF	-Rural water supply, wells program	Ongoing
7.		UNSO/UNDP	-Countrywide hydrogeological survey	Proposed
Health	1.	EEC	-Banjul sewerage improvement plans	Ongoing
	2.	UNFPA/UNESCO	-Health center in Serrekunda	Approval
	3.	UK	-Maternal and child health program	Ongoing
	4.	PRC	-Health center construction, technical assistance	To start, 1980
	5.	MRC	-Tropical disease research	Ongoing
	6.	Red Cross, Religious Missions	-Miscellaneous health care	Ongoing
	7.	UK/WHO/IDA/UNFPA/USAID	-National primary health care program	Done, interest expressed
	8.	LIBYA	-Medicine and equipment donations	Ongoing

Appendix II. Current International Assistance Programs Related to the Environment (continued)

Sector	No.	Agent	Description	Status
Energy	1.	IDA	-Alternative fuel supply study	Complete
	2.	UNSO	-Formulation of natural energy policy and action program to year 2000	Proposed

Abbreviations Used Above

ADB: African Development Bank
 BADEA: Arab Bank for Economic Development in Africa
 CIDA: Canadian International Development Agency
 CILSS: Permanent Interstate Committee on Drought Control in the Sahel
 EEC: European Economic Community
 FAO: Food and Agriculture Organization
 FRG: Federal Republic of Germany
 IDA: International Development Agency (World Bank)
 MRC: Medical Research Council
 PRC: People's Republic of China
 UK: United Kingdom
 UNCDF: UN Capital Development Fund
 UNDP: United Nations Development Program
 UNESCO: UN Educational, Scientific, and Cultural Organization
 UNFPA: UN Fund for Population Action
 UNICEF: UN Children's Fund
 UNOTC: UN Office of Technical Cooperation
 UNSO: UN Sahel Office
 USAID: United States Agency for International Development
 WHO: World Health Organization
 WMO: World Meteorological Organization

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APPENDIX III

Miscellaneous Reports on The Gambia

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Appendix IV

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1. Agriculture
2. Energy
3. Fauna and Wildlife Conservation
4. Fish and Fisheries
5. Flora and Forest Resources
6. Geology, Paleontology, and Mineral Resources
7. Social and Economic Aspects

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