CHAPTER 6 PRESENT CONDITIONS OF WATER USE SECTORS

6.1 Agriculture, Livestock and Fishery

6.1.1 Agricultural Land and Major Crops

Total agricultural farmland is estimated at 7,248,430 ha in 1995, which is equivalent to 22.5% of total area of Côte d'Ivoire, as shown in table below. Among agricultural lands, 51.3% of the farmland are for food crops 44.7% for perennial crops and 4.0% for industrial crops in 1995.

Agricultural farmland was increased to 7,248,430 ha from 6,070,630 ha with an annual growth ratio of 1.37% for 13 years from 1982. The growth ratio of that period was much lower than population growth ratio of about 3.7%. In this period, cultivation areas of cotton, sweet banana, vegetables and paddy rice have been increased rapidly with an higher annual growth ratio than 3%. On the other hand, sugarcane and coffee have been decreased due to disadvantage of price in international market.

Table 6.1-1 Cropped Area and Production in 1982 and 1995

Crops	Year 1995				Year 1982		Growth
	Cropped Area (ha)	Production (t)	Yield (t/ha)	Area Ratio (%)	Cropped Area (ha)	Area Ratio (%)	Ratio of Area (%/yr)
Food Crops							
Paddy	592,000	868,430		8.2%	363,500	6.0%	3.82%
Rained Paddy	570,000	798,020	1.4	7.9%	350,000	5.8%	3.82%
Irrigated Paddy	22,000	70,410	3.2	0.3%	13,500 *1	0.2%	3.83%
Maize	669,100	552,040	0.825	9.2%	520,000	8.6%	1.96%
S.F.M.	136,400	90,980	0.667	1.9%	92,500	1.5%	3.03%
Yam	264,900	2,868,850	10.83	3.7%	230,000	3.8%	1.09%
Cassava	316,200	1,608,220	5.086	4.4%	233,000	3.8%	2.38%
Ground nut	136,200	143,040	1.05	1.9%	93,000	1.5%	2.98%
Plantain Banana	1,203,000	1,335,320	1.11	16.6%	1,207,000	19.9%	-0.03%
Taro	376,900	352,050	0.934	5.2%	334,000	5.5%	0.93%
Vegetables	27,000 *2	540,000	20	0.4%	15,600 *2	0.3%	4.31%
Total	3,721,700			51.3%	3,088,600	50.9%	1.44%
Perennial Crops							
Cocoa	1,723,400	915,670	0.5313	23.8%	1,338,400	22.0%	1.96%
Coffee	1,250,000	236,660	0.1893	17.2%	1,273,900	21.0%	-0.15%
Oil Palm	150,700	274,900	1.824	2.1%	100,600	1.7%	3.16%
Coconut	53,140	23,020	0.433	0.7%	51,550	0.8%	0.23%
Rubber	64,680	69,320	1.072	0.9%	41,850	0.7%	3.41%
Total	3,241,920			44.7%	2,806,300	46.2%	1.12%
Industrial Crops							
Sugarcane	21,310	140,410	6.589	0.3%	31,390	0.5%	-2.94%
Cotton	242,400	233,320	0.9625	3.3%	124,610	2.1%	5.25%
Sweet Banana	5,600	232,000	41.43	0.1%	3,210	0.1%	4.37%
Pineapple	15,500	210,020	13.55	0.2%	16,520	0.3%	-0.49%
Total	284,810			3.9%	175,730	2.9%	3.78%
Grand Total	7,248,430			100.0%	6,070,630	100.0%	1.37%

(Source) Statistic Agricole, MINAGRA 1982-1995, and FAO Yearbook 1998 (Vol.52) (Details are in Table 2.2-1-7 to 19.)
(Notes) S.F.M.: Sorghum, Fonio, Millet *1: assumption (3.9% of rained paddy as same ration as in 1995.)
*2: estimated based on consumption of vegetables (36kg/capita/yr) and Population in 1995 (15,368,000) and in 1982 (8,684,000).
*3: estimated based on projection data using unit yield presented in above table.

Cocoa and coffee share extensive area of agricultural farmland. Cocoa shares 23.8% and coffee 17.2%, totally 41% of the farmland in 1995. Cocoa and coffee have been expanded as main export crop for the country. Plantain banana, one of staple food crops, follows cocoa and coffee and shares 16.6% of the farmland. Maize and paddy rice comes into 4th and 5th position in area of about 9.2%

and 8.2% of the farmland. Taro, cassava and yam are also important food crop for Côte d'Ivoire, which share 5.2%, 4.4% and 3.7% respectively. Palm and rubber tree are also important perennial tree crops for domestic oil supply and export. They are grown by companies like as SODEPALM and SOGB, or a group of farmers in large scale plantation in the tropical rainforest climate zone in the southern area, and share 2.1% for palm and 0.9% for rubber in the farmland.

Cotton is also an important industrial crop and is grown mainly in northern area of the country. Intensive cotton cultivation is controlled by CIDT, a textile development company, and cotton cultivation has been introduced into all the northern regions for the past 25 years. All the villages of the region have been organised into GVCs, an agricultural vocation group, that are affiliated to the CIDT. Cultivation of cotton is on large portions of land and use of mechanical devices, ploughs and nitrogenous fertilisers and chemicals.

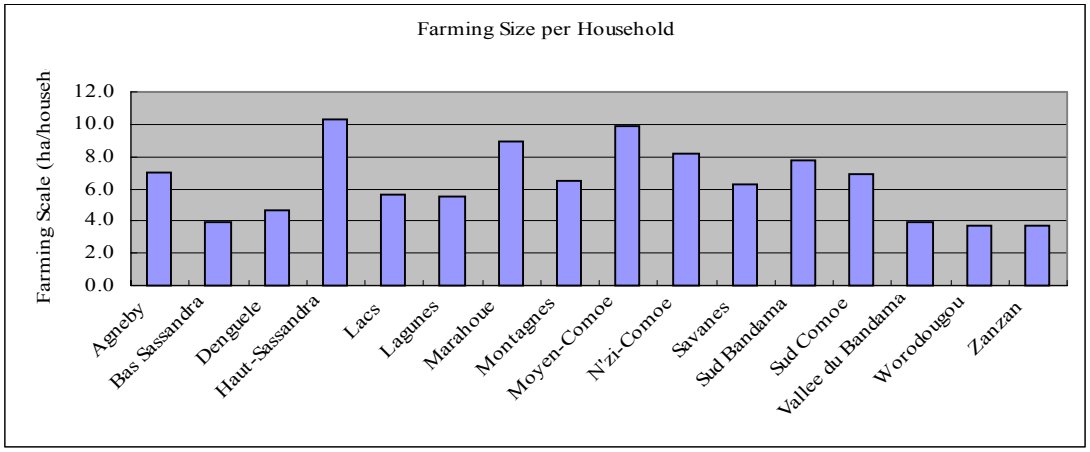
Sugarcane is grown in the northern area of the country, and is also an important crop for sugar industry for export and domestic consumption. Sugar farms are operated by the sugar companies like SODESUCRE, and mostly irrigated. The cultivation area of sugarcane is decreased recently due to disadvantage of price in international market.

6.1.2 Agricultural Population and Farming Size per Household

Agricultural population is estimated at 7,004,000 and agricultural households are 1,132,000 in 1998. Total farmland in the country is 7,248,430 ha as of 1995, so that average farming size of one agricultural household is estimated at about 6.4 ha.

The figure below shows the farming size of one agricultural household by regions:in Haut-Sassandra and Moyen-Comoe regions, it is extremely large, more or less 10 ha per household. In these regions, industrial crops like cocoa and coffee are extensively planted.

Figure 6.1-1 Farming Size per Agricultural Household by Regions



On the other hand, in Bas Sassandra, Vallee du Bandama, Worodougou and Zanzan regions, farming sizes are extremely small as less than 4ha. In these regions, industrial crop intensity is extremely lower than former two regions.

(1) Agricultural Scale by Region

Agricultural scales are much different by the regions as shown in the following figures. In Haut-Sassandra and Moyen-Comoe, farmland areas reach 65% and 57% of total regional area. Marahoue, Sud Bandama and Sud Comoe regions are grouped in second active region in agriculture. In these regions, industrial crops such as cocoa and coffee are extremely cultivated.

Figure 6.1-2 Farmland Scale by Region

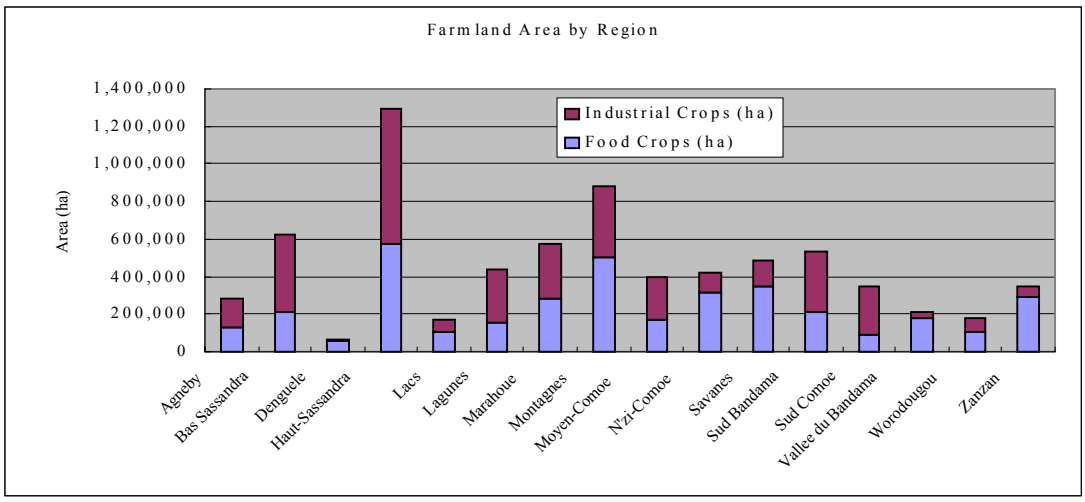
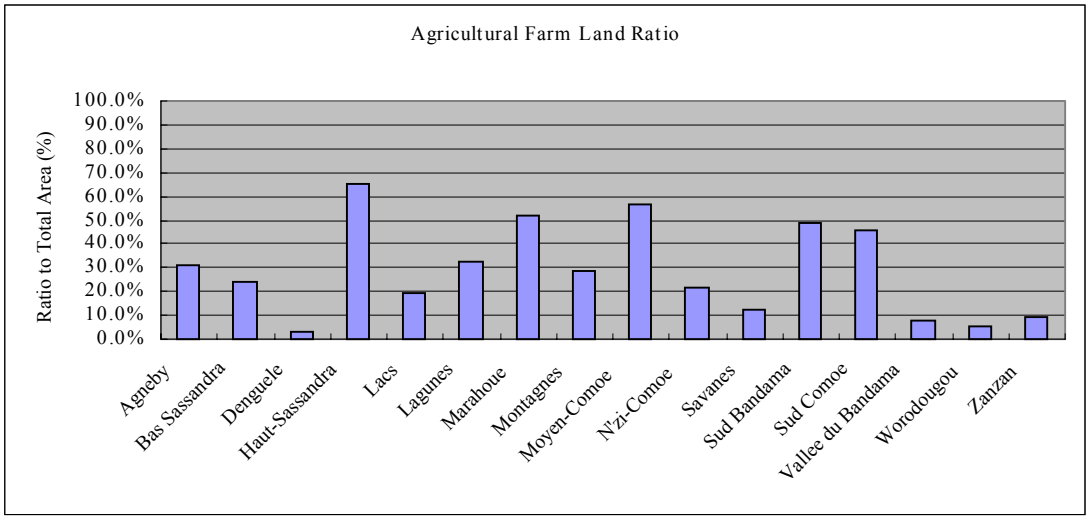


Figure 6.1-3 Ratio of Farmland Area by Region

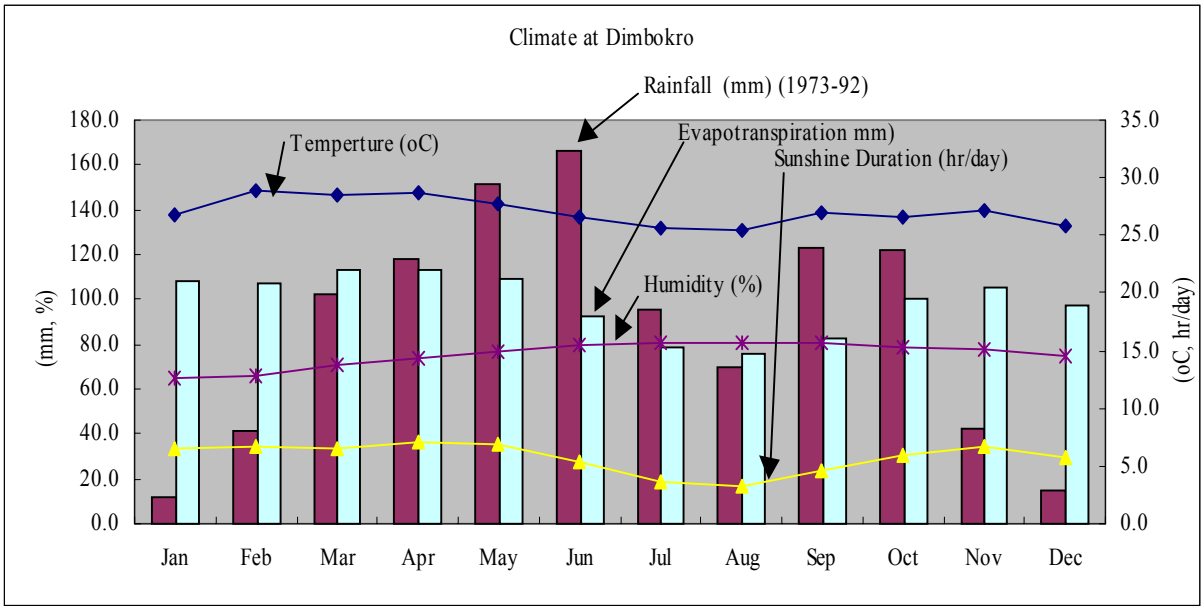


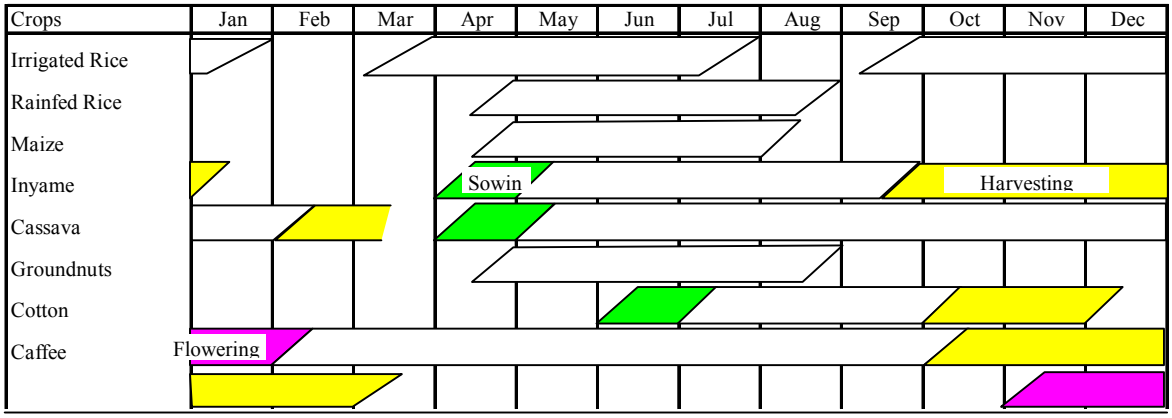
(2) Cropping Calendar in Côte d'Ivoire

Most food crops are grown in wet season from April to September, and perennial crops like coffee and cocoa are grown through the year. Almost crops are rained without any irrigation. Irrigate crops are rice in food crops, sugarcane in industrial crops, sweet banana and pineapples in fruit crops.

Evapotranspiration exceeds rainfall from April to October so that rained crops can be grown in this period. Rained rice, maize, groundnuts and cotton are grown in this period.

Figure 6.1-4 Cropping Calendar in Côte d'Ivoire





(Source) Etude du Projet de Development Rural Integre de la Moyenne Vallee du N'Zi, August 1995, JICA

(3) Per Capita Consumption and Staple Food

Staple food depends on cereal and starchy crops. Per capita staple food consumption is composed of 109kg of cereals and 240kg of starchy crops. Rice is main crop of cereals, and yam and cassava are main starchy crops. Rice is consumed at 61.6 kg/capita/year in 1992-94, that is little lower than in Japan, because of large consumption of starchy crops.

Meat and fish consumption are estimated at 10.9 and 13 kg/capita/year respectively. These consumption levels are lower than in Japan, but large portion of them are imported. Import meat and fish share 88% and 67% of consumption respectively.

Table 6.1-2 Per-Capita Food Balance in Côte d'Ivoire in 1992 - 94

Nutrients and Food	(unit)	Cote d'Ivoire	comparison	Japan
Calory	(cal)	2,356	<	2,890
Protein	(g/capita/day)	48.6	<	95.0
Fat	(g/capita/day)	43.4	<	78.9
Cereales	(kg/capita/year)	108.7	<	146.1
Wheat	(kg/capita/year)	15.1		46.0
Rice	(kg/capita/year)	61.6		75.4
Maize	(kg/capita/year)	27.0		23.2
others	(kg/capita/year)	5.0		1.5
Starchy Roots	(kg/capita/year)	240.1	>>	36.1
Potatoes	(kg/capita/year)	0.6		27.7
Sweet potatoes	(kg/capita/year)	2.3		4.8
Yams	(kg/capita/year)	120.2	(>>)	1.2
Cassava	(kg/capita/year)	99.6	(>>)	0.1
others	(kg/capita/year)	17.4		2.3
Sweeteners	(kg/capita/year)	9.9	<	31.6
Oil Crops	(kg/capita/year)	6.4	<	10.5
Soyabeans	(kg/capita/year)	0.3		9.0
Goundnuts	(kg/capita/year)	5.9		1.0
Others	(kg/capita/year)	0.2		0.5
Vegetables	(kg/capita/year)	36.2	<	106.5
Tomates	(kg/capita/year)	8.2		7.7
Onions	(kg/capita/year)	0.0		10.6
Vegetables	(kg/capita/year)	28.0		88.2
Fruits	(kg/capita/year)	86.5	>	58.7
Stimulants	(kg/capita/year)	4.7	<	7.7
Spices	(kg/capita/year)	1.0	>	0.7
Alcoholic, Beverages	(kg/capita/year)	16.1	<	74.7
Meat	(kg/capita/year)	10.9	<	39.7
Bovine Meat	(kg/capita/year)	3.4		9.6
Mutton & Goat Meat	(kg/capita/year)	0.7		0.4
Pig Meat	(kg/capita/year)	1.2		15.2
Poultry Meat	(kg/capita/year)	3.6		14.1
Other Meat	(kg/capita/year)	2.1		0.3
Milk	(kg/capita/year)	12.7	<	68.2
Egg	(kg/capita/year)	0.9	<	19.9
Fish and Seafood	(kg/capita/year)	13.0	<	66.7

(Source) FAO (average food balance in 1992 - 94)

(4) Irrigation Area in Côte d'Ivoire

Total irrigation area is estimated at about 52,400 ha in Côte d'Ivoire in 1995 based upon the results of Irrigation Inventory Survey and PNR and DCGTx information. Out of total irrigation area, paddy rice and sugarcane share a large portion of irrigation, 22,000ha and 21,310ha or 42.0% and 40.6% of irrigation area respectively. Sweet banana and pineapple are also irrigated but irrigation area is rather smaller than those former two crops. Irrigation area of sweet banana and pineapple is 5,600ha and 3,500ha or 10.7% and 6.7% of irrigation area. Most sweet banana is irrigated to ensure harvest, but pineapple is irrigated only 22.6% of total pineapple farm. Yield of pineapple, therefore, differs greatly by the condition of rained and irrigation.

Table 6.1-3 Estimations of Irrigated Area in Côte d'Ivoire in 1995

Irrigated Crops	Irrigated Area (ha)	Area Composition (%)	Remarks
Paddy Rice	22,000	42.0%	Crop intensity = 125%
Sugarcane	21,310	40.6%	
Banana	5,600	10.7%	
Pineapple	3,500	6.7%	22.6% of total pineapple area (15,500ha).
Total	52,410	100.0%	

(Note) estimated based on Irrigation Inventory Survey 1999 and PNR and DCGTx information

6.1.3 General Features of Livestock

Table 6.1-4 Number of Livestock in Côte d'Ivoire

(Unit: 1,000heads)

Livestock	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Growth 1987-98 (%/yr)
Cattle													
Bull	645	663	675	704	726	758	767	776	785	794	804	814	2.1%
Zebus	290	330	374	404	419	422	438	455	473	492	512	532	5.7%
Total	935	993	1,049	1,108	1,145	1,180	1,205	1,231	1,258	1,286	1,316	1,346	3.4%
Small Ruminants													
Sheep	1,064	1,090	1,115	1,134	1,161	1,190	1,219	1,251	1,282	1,314	1,347	1,381	2.4%
Goats	835	856	875	888	908	931	954	978	1,002	1,027	1,053	1,079	2.4%
Total	1,899	1,946	1,990	2,022	2,069	2,121	2,173	2,229	2,284	2,341	2,400	2,460	2.4%
Pigs													
Traditional Pigs	293	300	307	314	324	332	340	349	358	237	243	249	-1.5%
Modern Pigs	48	48	44	46	48	50	52	54	56	27	28	29	-4.5%
Total	341	348	351	360	372	382	392	403	414	264	271	278	-1.8%
Poultry													
Traditional Poultry	16,200	16,600	17,000	17,400	17,800	18,200	18,600	19,130	19,600	19,600	20,090	20,590	2.2%
Broiler	6,310	6,190	5,460	5,800	6,200	6,120	6,060	5,970	6,120	8,100	8,400	8,050	2.2%
Egg poultry	1,150	1,310	1,280	920	1,140	950	1,190	1,100	1,130	2,750	2,600	2,200	6.1%
Total	23,660	24,100	23,740	24,120	25,140	25,270	25,850	26,200	26,850	30,450	31,090	30,840	2.4%

(Source) Annuaire des Statistiques Agricoles (1991, 1993, 1995 and 1998), Direction de la Programmation, MINAGRA

Meat Production, Import and Consumption

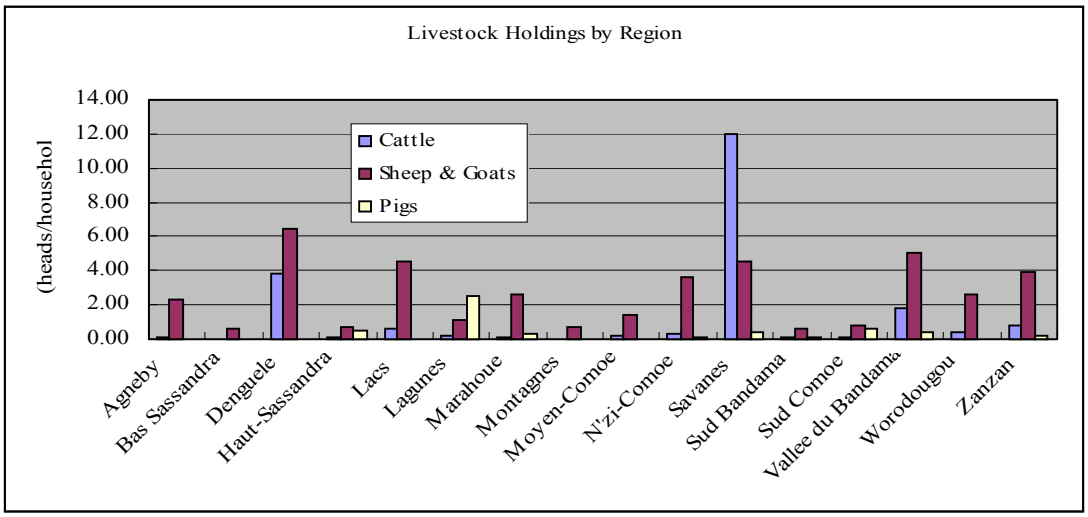
Meat	1975		1980-89		1990-1998	
Production (t/yr)	22,980	33.0%	42,134	38.3%	53,796	51.0%
Import (t/yr)	46,690	67.0%	67,806	61.7%	51,638	49.0%
Total (t/yr)	69,670		109,940		105,434	
Consumption (kg/capita/yr)	10.4		11.3		8.0	

(Source) Statistiques Agricoles 1998, DP, MINAGRA

(1) Livestock Breeding Area and Production

Cattle and small ruminants (sheep and goats) are mostly grazed in natural grassland and forest so that their distribution and grazing density is very important for natural environment not only from an aspect of water resources but also from soil erosion. Cattle and small ruminants are grazed in savannah and forests in the northern area of the country. In dry season, cattle is grazed also from Mali and Burkina Faso beyond the international boundary, and number of cattle is estimated to increase to 1.4 times.

Figure 6.1-5 Livestock Holdings by Region



(Note) Derived from Table 2.4-7

Livestock holdings are 1.1 heads of cattle, 2.0 small ruminants, and 0.4 pigs for one household; cattle holdings are quite high as 12 heads per household in Savannah Region.

Table 6.1-5 Livestock Holdings and Grazing Density

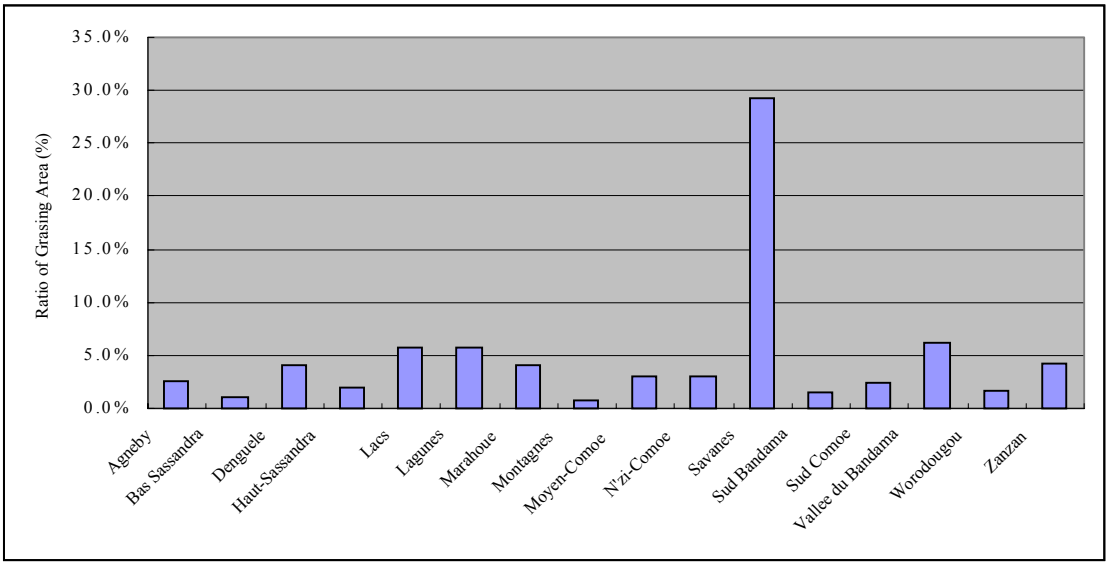
Region		Area (km^2)	Agri. House holds	Number of Livestock				Holdings (heads/household)			Grazing Density		
				Cattle (heads)	Sheep & Goats (heads)	Pigs (heads)	Poultry (1000) (heads)	Cattle	Sheep & Goats	Pigs	Poultry	Necessary Area (km^2)	Ratio to Total Area
1	Agneby	9,105	40,537	3,200	94,020	180	990	0.08	2.32	0.00	24	227	2.5%
2	Bas Sassandra	26,205	159,258	5,100	90,500	5,780	3,800	0.03	0.57	0.04	24	254	1.0%
3	Denguele	20,892	14,161	53,790	91,540	260	470	3.80	6.46	0.02	33	829	4.0%
4	Haut-Sassandra	19,883	125,766	8,730	91,980	59,120	3,430	0.07	0.73	0.47	27	407	2.0%
5	Lacs	8,811	30,776	19,500	138,040	410	780	0.63	4.49	0.01	25	511	5.8%
6	Lagunes	13,296	80,019	16,040	87,800	204,430	1,650	0.20	1.10	2.55	21	777	5.8%
7	Marahoue	11,124	64,293	6,860	169,330	16,650	1,730	0.11	2.63	0.26	27	454	4.1%
8	Montagnes	30,941	135,560	3,510	95,900	3,670	3,050	0.03	0.71	0.03	22	241	0.8%
9	Moyen-Comoe	6,996	39,810	7,500	58,200	1,930	910	0.19	1.46	0.05	23	210	3.0%
10	N'zi-Comoe	19,597	51,708	16,260	187,020	4,780	1,330	0.31	3.62	0.09	26	579	3.0%
11	Savanes	40,146	76,865	917,400	345,790	34,490	1,850	11.94	4.50	0.45	24	11,769	29.3%
12	Sud Bandama	10,873	69,173	4,920	42,380	10,640	1,720	0.07	0.61	0.15	25	165	1.5%
13	Sud Comoe	7,614	50,405	3,340	41,200	28,750	1,020	0.07	0.82	0.57	20	180	2.4%
14	Vallee du Bandama	28,393	53,841	99,240	269,140	22,650	1,120	1.84	5.00	0.42	21	1,774	6.2%
15	Worodougou	30,770	47,077	21,210	120,760	100	1,190	0.45	2.57	0.00	25	496	1.6%
16	Zanzan	38,080	92,755	71,400	360,400	20,160	1,810	0.77	3.89	0.22	20	1,618	4.2%
Total		322,365	1,132,004	1,258,000	2,284,000	414,000	26,850	1.11	2.02	0.37	24	20,492	6.4%

Acceptable grazing density is considered to be one cattle to 10,000m^2 (one cttle/ha) of savannah grassland according to MINAGRA. One cattle (250kg) is considered to be equivalent to five (5) small ruminants or five (5) pigs.

Livestock Unit and Acceptable Grazing Density

Livestock Unit	1 unit = One cattle (250 kg/head)
	1 unit = 5 small ruminants or 5 pigs
Acceptable Grazing Density	1 unit/ha in savannah grassland

Figure 6.1-6 Present Grazing Area Ratio by Regions



6.1.4 General Features of Fishery

One distinguishes three major fisheries: marine, lagoon and inland fisheries. Marine fishery is conducted along the coast of about 500km length both by industrial large scale fishery and small-scale fishery. On the other hand, lagoon fishery is mostly conducted by small-scale fishermen with a small boat. Inland fishery is composed of natural freshwater fishery and aquaculture. Natural freshwater fishery is conducted by a small boat with net in lakes, reservoirs and rivers like as Buyo and Kossou dams and major rivers. Aquaculture has been recently introduced in inland since a decade and expanded rapidly. On the other hand, lagoon aquaculture was started in earlier stage in an enclosure of lagoon or in a floating cage. Machoiron and tilapia are major species for aquaculture both for inland and lagoon.

Total fish catch is estimated at about 71,600 ton in a year as an average from 1993 to 1995. Composition of each sector of fishery is as shown as below:

Table 6.1-6 General Features of Fishery in Cote d'Ivoire

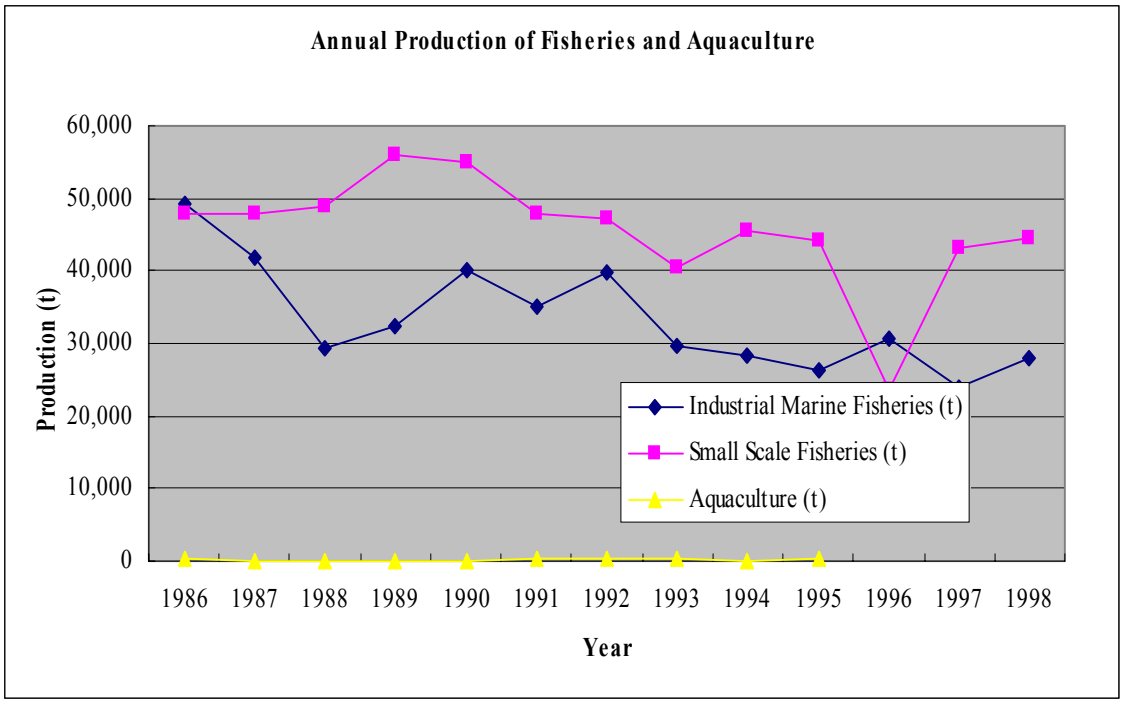
Descriptions	Average in 1993-95	Composition (%)	
Population (1000)	13,375		
Marine Fishery (t)	57,858	80.8%	
Large scale fishery	28,027	39.1%	
Small scale fishery	29,831	41.7%	
Inland Fishery (t)	13,740	19.2%	
Inland fisheries	13,472	18.8%	
Lagoon aquaculture	162	0.2%	
Inland aquaculture	106	0.1%	
Grand Total (t)	71,598	100.0%	31.1%
Import (t)	158,762		68.9%
Total Consumption (t)	230,360		100.0%
Per capita Consumption (kg/capita/yr)	17		

(Data Source) Agricultural Statistics 1995 and 1998, DP,MINAGRA

Cote d'Ivoire imports a large amount of fish every year in order to satisfy demand. Total annual import of fish amounts to about 160,000 t, that is double of production. Per capita consumption of fish is estimated at about 17kg/capita/year.

(1) Fishery Area and Production

Figure 6.1 -7 Production Tendency of Industrial Marine Fishery and Small Scale Fisheries



(A) Freshwater Fishery

There are about 3,500 km^2 of water bodies in inland of Cote d'Ivoire. The principal fishery activities are concentrated in lakes of Kossou (800 km^2), Buyo (600 km^2), Ayame (160 km^2) and Taabo (70 km^2) with activities of more than 10,000 fishermen. Total fish production of these lakes and other water bodies is estimated at around 20,000 t to 30,000 t although in decline in tendency. The production concentrates to essentially *tilapia nilotica* species (50 to 70%) and other species like *Chrysichtys (Machoiron), Heterotis, Hemichromis, Heterobranchus, Labeo* and, *Alestes*.etc..

Freshwater fishery has a potentiality of about 200 to 250 kg/ha/year, but weakness of the means of production limits the level at 30,000 ton/year, that is 86.9kg/ha/year.

Table 6.1-7 Potential and Production Level of Freshwater Fishery

Water bodies	Surface Area (ha)	Potentiality		Actual Production	
		(t/year)	(kg/ha/yr)	(t/year)	(kg/ha/yr)
Kossou lake	80,000	20,000	250	5,000	62.5
Buyo lake	60,000	15,000	"	8,000	133.3
Ayame lake	16,000	4,000	"	960	60.0
Taabo lake	7,000	1,750	"	650	92.9
Morrisson lake	3,700	925	"	410	110.8
Faye lake	3,000	750	"	180	60.0
Rivers/stream	108,000	26,975	"	1,000	92.6
Other lakes (93)	70,000	17,500	"	5,000	71.4
Total	347,700	86,900	250	30,200	86.9

(Source) Agricultural Master Plan 1992 - 2015

Training of fishermen is getting lax because of the lack of available means in the training facilities.

Moreover, progressive invasion of floating plants became very anxious for future fishing due to progressive of entrophication of water and decrease of rural younger population is also problem for this sector.

(B) Aquaculture

Aquaculture is developed rapidly but sill lower at production scale and production level. Production scale is only 255 ton/year or 0.3% of national production, and production level is less than 4 ton/ha/yr at 3.3 ton/ha/yr in average. (Agricultural Master Plan 1992 - 2015) Total area of aquaculture is estimated less than 100ha at 1995 year level.

Table 6.1-8 Present Condition of Aquaculture

Project Location	Development Type	Department	Area (ha)	Fish	Production (t/yr)	Productivity (t/ha)
1 Central East Project	Pond	Dimbokro	10.68	Tilapia	47	4.4
2 Femes Project	Pond	Yamoussoukro	10	Tilapia	30	3.0
3 BAD-West Project	Pond	Biankouma,Bangolo, Danane, Duekoue, Guilglo, Man, Toulepleu	100	Tilapia + Silure	200	2.0
4 Central Project	Pond	Yamoussoukro, Tiebissou, Bouake	30	Tilapia	100	3.3
5 Daloa Project	Pond	Daloa	97	Tilapia, Cameroun	90	0.9
6 Adzope Project	Pond private	Adzope	45	Tilapia	120	2.7
7 Brobo Project	Pond private	Bouake	2	Tilapia	10	5.0
8 Bongouanou Project	Pond private	Bongouanou	3.5	Tilapia	10	2.9
9 Aboisso Project	Pond private	Aboisso	11	Tilapia	40	3.6
10 Alepe+Anyame Project	Pond private	Alepe	11	Tilapia + Silure	40	3.6
11 South-Western Project	Pond	San-Pedro	30	Tilapia	50	1.7
Total			350.18		737	2.1

(Source) DP, MINAGRA, 1989

6.2 Domestic and Industrial Water Supply

Domestic water supply consists of urban and rural water. The urban water is controlled by SODECI under the influence of the Ministry. The rural water supply system is provided by the Ministry and supposed to be maintained by the committee established within the locality, under the influence of the Ministry.

Industrial water is all from urban water system, except owned well. One considers as industrial using consumption over 300 m^3.

6.2.1 Urban Water

The urban water system is provided basically in the area with more than 4,000 residents. SODECI is fully responsible on the operation and maintenance.

Under the implementation of the National Program of the Urban Water Supply, the number of networks equipped with potable water production plant increased from 38 in 1973, to 267 in 06-30-99. These installations cost more than 250 billions CFA.F (without taxes).

By July 1998, the capacity of annual average production is 130 millions m^3 of water, with 548 water distribution networks throughout the country, covering 155 sub-prefectures which corresponds to a coverage rate of 78%. The total length of water networks is 11,000 km with 350,000 water meters.

Table 6.2-1 Regional Coverage by Region

Administrative regions	Number of localities with aep	Number of localities without aep	Cover rate
AGNEBY	38	9	80%
BAS-CAVALLY	14	3	82%
DENGUELE	13	3	81%
HIGH-SASSANDRA	40	22	65%
LAKES	81	1	99%
LAGOONS	81	10	89%
MARAHOUE	12	9	57%
MOUNTAINS	22	20	52%
MIDDLE-COMOE	25	5	83%
N'ZI-COMOE	46	5	90%
SAVANNAS	20	8	71%
SOUTH-BANDAMA	7	9	44%
SOUTH-COMOE	25	7	78%
BANDAMA VALLEY	88	9	90%
WORODOUGOU	15	17	47%
ZANZAN	21	6	77%
TOTAL	548	143	78%

(1) Achievements in Abidjan city

Potable water supply in Abidjan city is made in 9 production zones, each including at least one deep wells, one treatment plant and one or two storage reservoirs. The water supply facilities in Abidjan comprises:

- 72 deep wells under exploitation with a total discharge of 17,000 m^3/h
- 9 Treatment plants whose cumulated nominal capacity is about 15,000 m^3/h
- 7 water towers of 22,000 m^3
- 10 tanks of 55,000 m^3
- 3,200 kilometres of pipes including all the diameters.

(2) Urban Water Consumption in 1998

About 66 % of the whole water produced and 84 % of industrial water is being consumed in the Lagoons Region. Industrial water is about 12 % of the total production of urban water. Water consumption is concentrated in the region of Lagunes.

Table 6.2-2 Water Consumption by Use

Region	Water Consumption in 1998 (M3)			
	Domestic Total	Industry	Administration	Total
Agneby	1,703,821	240,197	191,280	2,135,298
Bas Sassandra	2,391,968	296,996	206,535	2,895,499
Denguele	520,521	17,796	246,023	784,340
Haut Sassandra	2,875,775	114,799	839,128	3,829,702
Lacs	3,219,723	202,493	2,073,951	5,496,167
Lagunes	52,204,009	12,639,089	14,585,869	79,428,967
Marahoue	1,084,384	14,686	114,450	1,213,520
Montagnes	1,852,270	78,796	514,286	2,445,352
Moyen Comoe	1,652,375	81,079	204,688	1,938,142
N'zi Comoe	2,108,374	181,377	320,954	2,610,705
Savannes	2,482,919	100,222	573,159	3,156.300
Sud Bandama	1,023,008	45,433	139,193	1,207,634
Sud Comoe	1,657,892	126,793	327,968	2,112,653
Vallee du Bandama	6,336,978	850,115	1,915,054	9,102,147
Wordougou	676,880	22,819	218,168	917,867
Zanzan	1,030,892	24,755	181,005	1,236,652
Total	**82,821,789**	**15,037,445**	**22,651,711**	**120,510,945**

6.2.2 Rural Water Supply

(1) Criteria for Application of Rural Water Supply

A new well is to be installed for a village with a population of 100 to 600 inhabitants and additional well is installed for every additional 400 inhabitants.

(2) Output of Rural Water Supply

The Government has so far installed 17,779 wells throughout the country. Among them, 4,476 wells had no water and were abandoned. 2,930 wells are shallow wells now in use, which are rather easily contaminated. According to the report of the Ministry, 21,738 wells are necessary to satisfy the whole rural populations at present. There still remain about 8,400 wells uninstalled yet, though needed.

Table 6.2-3 Rural Water Coverage by Antenna

Antenna	No. of Wells Installed					
	Population 1988	Required Number	Deep well	Shallow well	Abandoned	Needed Number
Abengourou	355,163	664	517	27	77	197
Abidjan	689,191	1,276	1,227	35	352	530
Bondoukou	483,861	1,525	1,256	221	329	377
Bouake	604,008	1,942	1,839	323	814	594
Daloa	1,249,053	3,457	1,699	465	449	1,742
Divo	1,841,084	2,159	734	790	318	953
Korhogo	652,617	2,487	1,287	965	599	834
Man	906,773	2,525	1,591	164	41	811
Odienne	279,346	919	633	336	263	213
San Pedro	742,894	1,680	727	154	50	849
Seguela	339,441	1,001	628	153	165	385
Yamousssoukro	776,037	2,103	2,058	114	1,010	941
Gross Total	8,919,468	21,738	14,032	3,747	4,467	8,426
Coverage	61.24%					

(3) Present Issue of Rural Water Supply

Some facilities installed previously are not durable. This is especially applicable to the shallow wells that were installed at the start of the NPRH, not complying with the due standard. The problems are observed on those facilities.

The SDH/DE has organised 11,908 rural wells management committees (RWPMG) for the operation and maintenance of the wells, and also prepared the framework of the Rural Hydraulic Readjustment program (from 1989 to 1991) to achieve installation of new wells. The committee is needed for all the villages where there are wells provided by the PNHV. But, only 9,028 committees are organised, 6796 of which are effectively working. The other 2881groups are not well-organised nor active.

6.2.3 Present Use and System for Domestic and Industrial Water Supply

(1) Source of Water

Well and surface water is the source of urban water supply. The list of the sources with the brief information by region, as inventory data, is to be referred below:

Table 6.2-4 List of Urban Water Supply (July 1999)

ADMINISTRATIVE REGIONS	Areas with Water Supply	Water Supply Plant		Supplied Areas	Sub-Prefecture
		No. of Treatment Plant.	No. of Deep Well		
AGNEBY	20	4	18	38	9
LOW-SASSANDRA	9	3	13	14	5
DENGUELE	13	2	14	13	13
HIGH-SASSANDRA	12	4	10	40	6
LAKES	34	5	31	81	10
LAGOONS	35	1	124	81	11
MARAHOUE	6	1	12	12	5
MOUNTAINS	20	3	26	22	15
MIDDLE-COMOE	14	2	16	25	4
N'ZI-COMOE	31	3	33	46	12
SAVANNA	20	20	25	20	20
SUB-BANDAMA	5	2	7	7	4
SOUTH COMOE	11	2	15	25	7
BANDAMA VALLEY	15	8	16	88	15
WORODOUGOU	10	3	9	15	8
ZANZAN	12	0	21	21	11
TOTAL	**267**	**63**	**390**	**548**	**155**

(by Urban Water Section of MIE, in July 1999.)

(A) Well

390 deep and shallow wells are in use at present for urban water supply. But, due to the deterioration of the shallow ground water and the lowering of ground water level, the decision has been made not to provide further shallow well by the Ministry. As for the treatment method of ground water, most of the plants adopted simplified method with only chlorination, except Grand Bassam.

(B) Intake of Surface Water

As described in Table 6.2-4, there are 63 water intakes from river, of which 22 are dam type and the rest are from small weir and run-off river type. The brief of the dam type water intakes are described below:

Table 6.2-5 Surface Water Source for Urban Water Supply

	River Basin Name	Name of Dam	Construction (Year)	Present Use	Catchment Area (km²)	Dam Height (m)	Reservoir Capacity (1000 m³)
1	AGNEBI	EHUIKRO	1971	AEP	20.00	12.00	3,000
2	AGNEBI	BONGOUANOU	1986	AEP	4.00	6.00	500
3	AGNEBI	ASSIE-AKPESSE		AEP		5.00	1,500
4	AGNEBI	SODECI		AEP		5.00	1,500
5	AGNEBI	RUBINO	1978	AEP		10.00	1,000
6	BANDAMA	LOKA	1978	AEP + PISCICULTURE	127.00	12.00	22,300
7	BANDAMA	LOKPOHO	1972	AEP + CANNE A SUCRE	1200.00	8.50	10,500
8	BANDAMA	KORHOGO		AEP	18.00		2,131
9	COMOE	DAOUKRO1	1976	AEP	4.00		
10	COMOE	SODECI		AEP			
11	COMOE	ABENGOUROU	1977	AEP	38.90	12.00	5,000
12	COMOE	SEGBONO	1978	AEP + RIZ + PISCICULTURE	60.00	14.00	7,800
13	COMOE	OUANGOLO		AEP		5.00	
14	MARAHOUE	SEGUELA	1986	AEP + PISCICULTURE	54.10	13.77	2,500
15	ME	SODECI		AEP + PISCICULTURE		10.00	3,000
16	NIGER	TENGRELA	1975	AEP	68.00	8.25	4,400
17	N'ZI	KONGOULO 1	1970	AEP	38.90	12.14	3,800
18	N'ZI	TRENOU	1968	AEP	18.80	20.00	2,800
19	N'ZI	NIKOLO	1974	AEP		4.00	
20	N'ZI	NIANKARA	1977	AEP		4.00	
21	SAN-PEDRO	SAN-PEDRO		AEP + RIZ	2424.00	10.00	25,000
22	SASSANDRA	DUEKOUE	1980	AEP		6.00	

(2) Water Treatment

Three types of water treatment systems are applicable depending upon the quality of raw water. Simplest treatment system is so called T1 which utilizes only Chlorination. This is applicable to most of well water. T2 is applied to rather charasteristic well water, with neutralization and chlorination. T3 is called complete system with the process of condensing, neutralization and chlorination etc., applying to surface water. Ratio of water produced from the complete treatment system is 22% in urban water production.

(3) Installation of the New Improved Rural Water Supply System (H.V.A)

The Ministry has introduced a new water supply system, including a deep well equipped with manual motor pump, with a reservoir of 5 to 20 m^3 and a simplified water supply network comprising fire-hydrants. This is a transitory system to urban water supply system from the rural water supply, in order to take further step forward in future. This system is applicable only to the villages that have 1000 to 4000 inhabitants, due to the high demand of portable water in the areas and the difficulty of financial support in the areas less than the population.

The rural residents in use of the system, is obliged to shoulder the burden of 10 to 15% of operation costs for the maintenance under the guidance of the Water Department of the Ministry, with the assurance of the operation and maintenance.

Table 6.2-6 Selection criteria

Population at the basic year	1000 inhab ≤ population ≤ 4000 inhab
Electricity	Yes
Deep well	Discharge ≥ 3 m^3/h
Housing planning	Yes
Contribution	The population must show its willingness to participate to the financing of the project with a rate of 15% to 20% of the capital cost.
Management	The willingness to set up a management committee
Water needs	10 to 15 l/day/inhab
Rate of supply	100% of the involved population
Capital cost per inhabitant	≤ 45,000 FCA.F
Exploitation cost price	≤ 120 CFA.F /m^3 consumed
Total cost	≤ 350 CFA.F /m^3 Produced

(5) Industrial Water Use

Increment of subscribers from 1987 to 1997 has been indicated as payable connections that are understood for industrial use, in the table below:

Table 6.2-7 Increment in Subscription for Urban Water

Year	1987	1990	1992	1993	1994	1996	1997
Number of subsidized connections	14681	19468	15381	12689	20246	25094	30334
Number of not free connections	1117	2140	2900	3112	2020	1261	1500

The share rate in 1998, of industrial consumption is about 12 % of total urban water consumption, being rather small in comparison with the one of the domestic, and concentrated in Laguna Area including Abidjan, where consumes more than 84 % of water for industrial use.

Due to the fact mentioned above, the industrial water use being comparatively low, the demand of this will be included in the per capita demand of urban water demand.

6.3 Hydro-Electric Power

6.3.1 Past and Present Operations of Power Plants

(1) Power Production and Consumption

The past records of hydroelectric power generation of these six stations are summarised as follows:

Table 6.3-1 Power Production

Description	AYAME I	AYAME II	KOSSOU	TAABO	BUYO	GRAH
Operation year	1959 -present	1965 - present	1972 - present	1979 - present	1980 - present	1983 - present
1996-97	67,958	122,167	189,344	636,602	876,836	359
Max.	106,945	171,717	247,745	744,410	876,836	4,585
Mini.	15,310	47,543	2,265	112,030	172,132	359
Mean	64,245	111,328	109,641	439,507	611,600	2,811

(Note: GWh)

The actual consumption of electricity of the latest years is recorded as follows:

Table 6.3-2 Power Consumption

Year	Consumption (Low tension)	Consumption (High tension)	Consumption (Total)	Ratio to Production
1996-97	1,081,360 MWh	1,387,340 MWh	2,468,700 MWh	82.0%
1998	1,248,482 MWh	1,556,065 MWh	2,804,547 MWh	81.1%

(2) Use by Category

The distribution of consumption by category in 1994/95 is presented as follows:

Table 6.3-3 Power Consumption by Category

Category of consumer	Percentage
Rural houses	20.86 %
Urban houses	42.64 %
CIE staff houses	1.33 %
Free (No payment)	2.32 %
Industry and commercial	21.23 %
Public light	11.62 %
Total	100 %

(3) Operation and Management

Under the influence of the Ministry of Energy, there are the following governmental agencies or companies which are running power generation:

(a) CIE

A private company, but the government has 49 % of stock share. CIE is in charge of operation and maintenance. The electric fee is also collected by CIE.

(b) SOPIE

Public corporation in charge of a new development plan and export of electricity.

(c) SOGEPE
Public corporation in charge of financial and property management of structures and equipment for water sector.

(d) CIPREL
Private company, which has a thermal power station.

(e) CINERGY
Private company, which has a thermal power station.

(f) ANARE
Co-ordination agency (public corporation) among agencies and companies related to electricity. The investigation and assessment is carried out for solving issues or establishment of regulations.

Among them, CIE takes most important role for control, operation and management of existing systems. Every power station together with the related facilities are operated and maintained by CIE. The dispatching centre of CIE collects all the information and records of all the electrical power stations, except isolated small stations. It also decides the daily operation of all the power stations, based on the projected demand fluctuation and various conditions in each station. The operation at each power station as well as the control of major substation is carried out according to the instruction from the dispatching centre.

6.4. Other Water Sectors

6.4.1 Navigation

The navigation system has been developed in lagoons located along the coast. There are mainly three long and middle distance services of navigation as follows:

(a) Abidjan-Grand Lahou route: Between Asagny and Tiebissou, One passenger boat a day to each direction and tens of ships for carrying goods (fish, logs, etc.) a week.

(b) Abidjan-Ghana route: Served by 2 ships. Between Abidjan in Ebrie lagoon and Frambo in Aby lagoon (through Bingerville, Grand-Bassam, Moossou, Assinie, Assouinde, Adiake), where Ghana boundary is located closely, Frequent and significant use until 1990, Transportation for both goods and passengers.

(c) Frambo-Tiapoum-Adiake route: Medium distance in Aby lagoon, 2 ships, a part of Abidjan-Ghana route

Beside the long middle distance services, local short distance routes in Abidjan (Abidjan urban routes) are comparatively used actively. The Abidjan urban routes are used mainly for transportation of workers to and from their living areas and their working places. The major routes are listed as follows:

(a) Treichville – Vridi, which is located in an industrial zone (From Vridi 385 passengers a day)

(b) Petit Cocody – Plateau, which is one of administrative and affairs centres of the capital (250 – 300 passengers a day from each side)

(c) Tbobo-Doume – Plateau

(d) Locodjro – Treichville

(e) Locodjro – Plateau – Trechville

The urban routes in Abidjan are categorised by classification of owners as follows:

(a) The private small scale owners

(b) SOTRA and other companies

6.4.2 Ferry Service

The ferry service is considered as a kind of navigation services. However, it is separately classified for surface water transportation crossing a river or a narrow part of lagoon. In addition, the supervising governmental office is different between the navigation and the ferry services.

There are 16 public ferry services operated by Road Department of Ministry of Infrastructure and Economics as listed as follows:

Table 6.4-1 List of Public Ferry Services

No.	Name of Ferry Service	Name of Water way
Ferry boat with Motor		
A1	Akrou	Ebrie lagoon
A2	Jacqueville	Ebrie lagoon
A3	Grand lahou	Tagba lagoon
A4	Mo blohoua	Bandama River
A5	Bettie	Comoe River
A6	No.5	Ebrie lagoon
Ferry boat without motor		
B1	Prollo	Cavally River
B2	Bin Houye	Nipoue River
B3	Bafing	Baffing River
B4	Kanebly	Sssandra River
B5	Marahoue	Marahoue River
B6	Serebou	Comoe River
B7	Toupe	Comoe River
B8	Vonkoro	Black Volta
B9	Kokonou	(Not operated)
B10	Mbaso	Comoe River

There are private ferry services in small streams. However, the data for private sector are not available. The private ferry service needs fare, except for the local inhabitants.

6.4.3 Recreation and Sports

Recreational use, including sports, in and around surface water areas is not a matter of concerns for most people in Côte d'Ivoire at present. Although there are a lot of beautiful and wide water surfaces in the country, only some limited parts of lagoons and canals are used for recreational site by hotels and restaurants at present. In and around reservoirs, lakes and rivers, the use for recreation looks rare, except for bathing by local children and fishing by some local inhabitants.

6.4.4 Environmental Conservation

The remarkable water use for natural environmental conservation is not found in Cote d'Ivoire at present. However, some research activities are carried out by Ecological Research Centre in some reservoirs, such as Buyo, Ayame and Taabo. In addition, the water quality survey and inspection is carried out at representative points of rivers, reservoirs and lagoons by CIAPOL and SIIC, both under the Ministry of Environment and Forestry.

6.4.5 Sand Mining

The sand collection/mining from rivers is not active in Côte d'Ivoire. The sands for construction purposes are mostly taken from coastal sandbars. And the mining from river for mineral resources (precious metals like gold) is not active. Such uses, if any, are tentative and small in scale.

CHAPTER 7 PRESENT ENVIRONMENTAL CONDITIONS

7.1 Natural Environment

7.1.1 Land Resources

(1) Land Form

Land in the country lies with the land slope of 1 to 1,000 from the north to south direction and is formed with undulated plateau area having the elevation of 700 to 500 m in the north region, 500 to 200 m in the central and 200 to 0 m in the south. There are no existing high mountain ranges except the spot mountain with elevation of more than 1,000 m in the north-west region.

There are four large river basins of the Cavally, Sassandra, Bandama and Comoe covering total basin area of 280,000 Km^2 which originates at the northern region and empty into the Gunia bay. There are no development of delta area at the river mouths because the rivers flows down with a steep slope 1 to 1,000 even in the coastal area of the southern region. There are coastal line of 520 Km being formed with rocky cliffs in the west coast and sandy beach in the east coast. The large lagoons with total area of 1,400 Km^2 are developed along the coastal line. Small coastal rivers of Tabou, San-Pedro Boubou, Agneby, Me, Bia, etc are empty into the lagoons and Gunia bay.

(2) Soil

The major part is constituted of ferrallitic soils made from weathered granite rock and including acid, aluminium and iron. The ferrallitic soil is classifying into 3 groups depending on rainfall intensity, called highly unsaturated ferrallitic soil under high rainfall more than 1,500 mm, highly unsaturated ferrallitic soil less than 1,500 mm and meanly ferrallitic soil with gravel horizon. Ferrallitic soil has not viscosity and is easily eroded by high intensity rainfall. There are existing high soil erosion areas showing 500 ton/ha/year at bare land in hilly areas of the south region. The other minor soils are soils on basic rock occupied mainly the hills, tropical ferruginous soils with a sandy humid horizon, and hydromorphic soils localized in lowland area. Soil erosion has been accelerated year by year due to forest devastation and becomes a large problem for the sustainable watershed management.

(3) Land Use

Forest area was once 160,000 to 180,000 Km^2 occupying 50 % of the country area but decreases largely to 25,000 to 30,000 Km^2 at present due to large expansion of cocoa plantation area, cutting of tree and slush and burn cultivation. Reforestation is the most important program to maintain the watershed of the river basin.

The existing farmland area is estimated at 5.8 million ha occupying 18 % of the country area. Out of 58,000 Km^2, 60 % perennial crop area and 40 % for food crop area. Cocoa, coffee and palm plantation occupy a large portion of 10 %, 15 % and 15 % of the total farm area respectively.

Those crops are mainly planted at hilly area in the southern region with a rich rainfall. Food crops are paddy, yam, cassava, taro, etc which are mainly cultivated at the northern and western area of the Bandama river basin.

7.1.2 Ecological Conditions

(1) Bio-Diversity of Forest

A conserving natural approach of bio-diversity based on the protection of the ecosystems must make a sample of conserving surfaces in each principal areas of vegetable and specifically interest areas. Then it is crucial to conserve many surfaces in the Soudanean savanna, Guinean forest and coastal area.

The endemic forestry block in the central east region situated near the forest of Ghana, actually doesn't have protection site. Two action plans are recommend the development of protected areas in that region and proposed the whole classified forest name of Songan, Tamin, Mabi and Yaya to accomplish this role. These areas are very rich in forest species. It shows that about 100,000 ha of old forest would exist in these classified areas.

The transition area and Guinean savanna have got two protection areas, national park of Marahoue and Mont Sangbe. These are to be protected in priority. The bio-diversity of Soudanean area must be conserved in the two sites, national park of Comoe and fauna reserve of Haut Bandama. These areas are very rich to Soudanean species and have a potential of rapid restoration.

(2) National Park, Natural Reserved Area and Botanic Reserved Area

National Parks are situated on 8 areas in the whole country, totally 1,742,100 ha. The Tai National Park and Mont Nimba Integral Reserved Area which have 330,000 and 5,000 ha respectively, are registered by site of world legacy.

The Azagny National Park which locates at the coastal near lagoon has 19,400 ha area, and is specification place by Convention on wetlands of International Importance Especially as waterfowl Habitat, called as Convention of Ramsar, 27 June, 1996.

And, the other surface areas of protected are constituted 5 Natural Reserves and 16 Botanic Reserves.

(3) Lagoon

The 1,200 Km2 of lagoon provides a habitat for numerous cash of fish, and serves of nurseries for some inshore species. They constitute some important sanctuaries for local and migratory birds. This environment has been protected as a basis of attraction for the human facilities previously, but nowadays it serves to the navigation, fishing, fish farming, tourism and also the receptacle for the domestic and industrial wasted water.

(4) Fauna and Flora

About 250,000 ton/year of fish are consumed, but only 130,000 ton/year (30,000 tones coming from the continental fishing, and 100,000 tones coming from coastal fishing in addition to the craft fishing) is representing by national production. Then more than 70 % of total production is coming from the coastal surface water and more than 100,000 tons of fish are imported. The fish farming in the coastal zone is essentially practiced in the lagoon water and its production for 38 ton/year is included in the coastal fishing.

Six hundreds birds species, more than around two hundred mammals, some reptiles, thousand of different insects and many species of fishes are living in the different ecosystems of the riverside zone and some of them are particularly in this country. It is to notice the elephants, the buffalo, the monkey, the crocodiles, the tortoise of sea, the hippopotamus, the manatee, etc.

7.2 Social Environment

(1) Socio-Economics

The territory of the country is divided into four big ethnic groups, that they are found in the neighboring countries. The group Mande extends largely, and is located in the limited northern forest area. The other principal ethnic groups are the Dan, the Yacouba and the Toura. They live in the mountain region of Man and Gouro on horseback of the savanna, and in the forest between Bandama and Sassandra river.

In the mineral field, the efforts made by the Ivoirian State for some decades have permitted to reveal in the Precambrian socle, numerous signs of precious mineral, important mining lodes and industrial material (iron, manganese, nickel, copper, bauxite, diamond, gold, tantalite, cobalt, tungsten, tin, etc.) of which some such as manganese, diamond, gold, and tantalite have already been industrially and manually exploited.

(2) Diseases

The shortage and the bad quality of water are the main causes of diseases and the high rate of morbidity. Indeed, according to the World Health Organization (WHO), more than 80% of the globe diseases are linked to water. The main hydrous diseases registered are of four types.

- Diseases resulting from germs which penetrate man at the same time as drinking water: typhoid fever, gastro-enteritis or cholera, etc.

- Easily transmitted diseases due to a chronic shortage of water or its bad quality: diarrheic and dysentery diseases coming upon all over the country, goiter due to lack of iodine which leads to the swelling of the thyroid gland at the bottom of the neck. Goiter ranges particularly in the West regions of Biankouma, Danane and Duekoue.

- Diseases resulting from parasites living in water and which enter under the skin: schistosomiasis transmitted by an aquatic mollusk, dracontiasis transmitted by the guinea worm and frequent in Beoumi, Kouassi-Dattekro, Bouake.

- Diseases of which the vectors reproduce in water: malaria of which renewed outbreak is linked with the proliferation of mosquitoes, onchocerciasis transmitted by a species of flies and signaled out along the big rivers.

(3) Pollution

Considering as one of the most visible results of economical development, the industrial growth is also one of the principal factors of the air and water pollution. The use of water in the industrial process gives everyday some important volume of industrial wastewater. Their composition changes by the type of industry, some materials of them are very poisonous and contain some varieties of composing organic synthetic. Especially, uncontrolled discharged water from industrial areas contains some poisonous compounds in the municipal sewers or courses of water, and constitutes a permanent danger.

7.3 Water Quality

7.3.1 Monitoring Organization and System

(1) Organization

The Center of Ivorian Pollution Control (CIAPOL) is a national public establishment with administrative characters, created by the decree N. 91-662 of October 09, 1991. It is on the authority of the administrative and technical department of the Ministry of Environment and Forest. The CIAPOL is managed by the consultative commission of management. The main roles are as follows.

- The systematic analysis of natural water, waste and residue according to the national observation network called as RNO
- The valuation of the pollution and nuisance of different receptors area, water, air, and soil
- The collection, evaluation and spread of environmental data
- The regular supervision of the marine area and lagoon with the patrol group
- The control of wrecked pollution in the sea and lagoon

(2) Monitoring Station

The National Observation Network Stations for monitoring of surface water are established to 28 points in the Comoe, Bandama and Sassandra river basin, 9 points at coastal area and lagoon of Ebrie.

7.3.2 Existing Water Quality

(1) River Water

The river water is used for domestic, laundry, dish, swimming, etc., and reservoir water additionally used for human feeding. At the present, There is not serious pollution in the quality of surface water. But, at the mouth of main rivers, water quality is progressing increase of total dissolved solids shown electric conductivity according to inflow of life drainage etc. And also it is noticed in the dry season that the quality of SS, EC, COD and coliformes deteriorates at the several areas (refer to Figure 7.3-1).

(2) Groundwater

There is no problem for water quality in the almost regional areas, but in Abidjan area, contents of sodium, chlorine and sulfate tend to be higher level compared with other surveyed regional areas. This tendency didn't admit wide difference in the rainy and dry season.

The Quality of groundwater in northern and central parts are classified into calcium bicarbonate and sodium bicarbonate types under stagnation environmental condition. On the other hand, in Abidjan and eastern parts, chloride and sulfide tend to be expensive and, it's quality is coming to non sodium bicarbonate (refer to Table 7.3-1).

The groundwater is used for drinking water, especially in Abidjan. The groundwater quality in Abidjan shows low pH and acidity. Many groundwater has been withdrown in Abidjan area and it's water quality has been changed by the lowering of groundwater level. According the monitoring program for water quality will be required in future.

(3) Lagoon

The water quality of Lagoon Ebrie has serious problems. The life drainage and industrial effluent is discharged to the lagoon in a situation without treatment. As a result, eutrophication goes forward, EC as an indicator is coming to highly. The content of heavy metals of Ebrie lagoon sediment is comparatively high level except for iron and manganese. The variation of the waste organic chloride like PCB, DDT is detected in ppb level (refer to Table 7.3-2 and 7.3-3).

7.3.3 Evaluation of Water Quality

The standard of WHO is applied for water quality evaluation of drinking water. According to urban water supply section of Ministry of Infrastructure and Economy, drinking water is supplied by processing flocculated reagent, neutralized reagent, sterilized treatment.

The monitoring for industrial effluent is implemented by Service de I' Inspections des Installations Classes (SIIC) under Ministry of Environment and Forest. The standard of WHO is applied for effluent standard. At the present, effluent standard items are pH, temperature, COD, BOD, SS, oil

and grease, and total nitrogen.

7.4 Environmental Organization and Law

7.4.1 Organizations Related to Environmental Control

The Ministry of Environment and Forest was established by decree N 98-688 of November 25 1998, considering the decree N 96-725 related to the structural organization of the Ministry of Agriculture and some Animal facilities.

The central management offices are 6 directions:

- Direction of the protection of the nature, constituted of two sub-directions; mainly to charge of manage, protect the national parks, botanical and zoological gardens etc.

- Direction of the production, some forest industries, reforestation, constituted of three sub-directions; mainly to charge of initiate the actions relative to the construction of forestry public domain and private etc.

- Direction of the forestry police and contentious; mainly to charge of the forest domain supervising of the state, the community and the particulars, and its preservation against the clearing etc.

- Direction of the environment, constituted of two sub-directions; mainly to charge of coordinating the actions for protection of some aquatic areas, lagoons and marine implementation etc.

- Direction of the planning and programming of the studies; this Direction is linked with whole ministry structures to elaborate and to coordinate, the strategies of forestry development policy and the protection of environment

- Direction of the administrative and financial affairs

7.4.2 Environmental Law and Regulation

(1) Survey Procedure Concerning an Environmental Impact of Development Project

In 1996, Ministry determined the role and applicable survey procedure concerning an environmental impact of development project by Decree N 96-894. Article 2 mentions related to development projects which makes the subject to the survey of environmental impact study, and locate of risked areas and ecological sensitive areas. There are as follows.

- Protected areas and analogue reserves
- Wet areas and mangroves
- Areas of scientific interest, cultural, and tourists

- Defined areas of economically sensible
- Protection points of surface water
- Seaside areas under national and international jurisdiction or the other international seas

(2) The survey of Environmental Impact

The Environmental Impact Survey is an assessment report of the probable impacts of scheduled activity on the environment. The Survey composed of 5 main activities, identification, analysis, evaluation, corrective measurements and, support and control. The survey must contain as following elements.

(A) Identification; detailed description of the project

(B) Analysis; this analyze must carry on the natural environment concerned with fauna, flora, hydrographic system, climate, soil type etc., on the landscape, ecological and human environment.

(C) Evaluation; the reason for the project has been retained the presentation of the variances will be made for the following classified spheres. (a)Agriculture, (b)Forest development, (c)Mining factory, (d)Waste disposal, (e)Food industry, (f)Chemical industry, (g)Metal work, (h)Textile, leather, and wood industry.

(D) Corrective measurements; the measurements of prevention, suppression, reduction, and/or compensation have been considered by the project owner or the petitioner in order to avoid the aftermath of the project.

(E) Support and control; the impact survey is permitted with given the measurements of prevention, suppression, reduction and compensation.

(3) Joining Situation to International Act

The government ratifies the international act of Convention on International Trade in Endangered Species of Wild Fauna and Flora called CITES in August 25, 1994, and Convention on Wetlands of International Importance Especially as Waterfowl Habitat called Convention of Ramsar in June 27, 1996.

7.5 Initial Environmental Examination

7.5.1 Objective and Necessity

The river basin in the country is not placed always the desirable physical environmental conditions such as thin soil layer consisting of ferrallitic soils which is easily eroded by heavy rainfall, scarce rainfall and surface water in the dry season etc. The large forest area in the basin has been lost by tree cutting, burn farming and conversion to farmland.

The surface water resources in the country have been developed mainly by dams in order to store a rich water in the wet season and meet the water demand in the dry season. This development strategies will be continued in future. On the other hand, the dams and reservoirs are already constructed and under operation have brought about some environmental impact.

Accordingly, the Initial Environmental Examination (IEE) was carried out by the local consultants related to physical conditions, ecological conditions, human use values and quality of life values.

7.5.2 Survey for Initial Environmental Examination

The following six projects are selected for IEE study (refer to Figure 7.5-1).

(1) Existing Two Hydropower Dam of Kossou and Buyo

The existing two hydropower dams of Kossou and Buyo were constructed at 1972 and 1981 respectively and have been operated up to now. The environmental impact assessment (EIA) by the project was not carried out at the planning to construction stage because EIA was not required for any project in 1970s to 1980s.

It is necessary however to assess the existing environmental impact by the dams and to set up the mitigation measure plan because two dams are very large scale and will give some impact to the river basin. Especially the Kossou dam has faced the water shortage problem and decreased hydropower production. The IEE study result by monitoring the existing environmental conditions will be very useful for the feasibility study of the proposed dams in future.

(2) New Hydropower Dam in the Comoe Basin

At the present, Bandama and Sasandra basin are controlled by the two dams, Kossou and Buyo. On the contrary there is no dam on the Comoe river and now study is carried out by Ministry of Energy level, on the possibility of building a new dam.

(3) Irrigated Agricultural Project by Small and Medium Scale Dams at Korhogo and Boundiali Districts

The Korhogo and Boundiali districts are located at the upper basin of the Bandama river and the Niger tributary in the north central region. In accordance with agricultural statistics, the north central region is the important and famous agricultural region to produce paddy, cotton, maize, yam, etc under Savanna climate and to feed a number of cattle and sheep.

These agricultural activity will be largely expanding in future by providing irrigation system. Many small and medium scale reservoirs are now under study by government to provide irrigation water for crops and drinking water for livestock.

(4) Medium Scale Water Resources Development at Central Western Region in the Sassandra Basin

The central western region holds many populations of 2 million and important agricultural region in the country to cultivate coffee of 200,000 ha (30% of the country production), cocoa of 404,000 ha (40%), paddy of 97,000 ha (30%), Maize of 82,000 ha (30%), etc. Since the region has a little rich rainfall and stream flow as compared with the other river basins, agriculture and agro-industry have been developed and will be further expanding.

The water resources development for irrigated agriculture and domestic/industrial water supply accordingly will be accelerated in future. The medium scale water resources development consisting of dam and barrage will be most suitable in the region taking into account topographical condition in tributaries and rich water in the rivers and tributaries. However the western high land area are suffered from the particular diseases related to the water, which shall be cared in the water resources development.

(5) Fish Breeding Project in the Ebrie Lagoon

The fish breeding space of lagoon undergoes a serious difficulty because of water pollution. This pollution causes important losses of fish consisting of Tilapias, Catfishes etc., wildlife and human health. The causes of water quality degradation include uncontrolled or untreated discharge from waste substances, proliferation of aquatic weeds.

7.5.3 Initial Environmental Survey on the Six Areas

Environmental survey for initial environmental examination was summarized in the Supporting Report. These are shown as the principal features of the respective area, as following.

(1) Existing Kossou Hydropower Dam

(A) Good transportation and line of communication: There is effectively good transportation on the lake. It is mainly fish transportation. This trade which was done by a few women in the beginning is now practiced by Bozos with a little number of women. The lake also represents a line of communication for the transportation of people among the surrounding villages

(B) Domestic use of water: Water is needed for domestic use (dish, laundry) and for human feeding (the lake water is utilized for human consumption). Aquatic plants do not exist in this lake.

(C) Surrounding flora and fauna: So the massive destruction of the vegetation as in the case the of Buyo does not exist here. Consequently, the bed of the lake does not comprise stumps, nor floating dead woods. No problem concerning forbidden forests, rare essences and sacred forests is to be signaled.

Concerning the fauna, the species to be noticed in this savanna environment are does, agouties, scoundrel monkeys. The most frequent fish species in the lake are tilapia, snail fish(crysitis), mormarus, catfish, breaded, barbel, lates and cameroun fish.

(D) Surrounding mining activities: Since a few months, the Angovia gold mine whose reserves are estimated at 17.3 tons of gold metal is being exploited by the Mining Company of Africa (MCA) in association with the SODEMI.

(E) Endemic diseases: The region of Beoumi close to the dam, is renowned for its guinea worms. But, this hydrous disease might not be linked especially to the waters of the lake. The population however signals the presence of onchocercosis, bilharziosis and malaria, which could have a direct connection with the holding of water.

(F) Clearing out, compensation and reinsertion of population: The great works of the creation of the dam disturbed not only the flow of water used, but also the life of the populations who are subject to clearing out, homesickness and impoverishment. The creation of dam in Taabo, Kossou and Buyo required the decamping of numerous villages to faraway regions and often amidst different ethnic groups. In regions where there have moved, there are sometimes confronted with serious integration and settlement problems on new grounds suitable for the cultivation.

(2) Existing Buyo Hydropower Dam

(A) Transportation of goods and line of communication: There is a real transportation of goods and persons on the lake, which represents a veritable line of communication between the surrounding villages and the fish unloading docks.

(B) Domestic use of the lake water: The lake water, and in general, the river water, is used at all levels: hydroelectricity, drinkable water supply of populations by the C.I.E and in the household of villages. For important human consumption, the C.I.E treats the lake water before its distribution to the population. As for surrounding villages, they also utilize the lake water for their domestic use (dish, laundry, etc.), and for their own feeding, but this time without any treatment.

(C) Aquatic vegetation and floating plants: There are effectively aquatic plants at certain places on the lake. But these plants stop at the level of Mossidougou near Guessabo, upstream. Here, these floating plants are blocked in their progression downstream by artificial fishing cords stretched by fishermen. From the center of lake to the banks, no stratification of aquatic plants is noticed. It is mainly water hyacinth and pistias racemosas.

(D) Presence of unexpected guests and endemic diseases: The presence, of such a vast stretch of surface water is causing proliferation of mosquitoes, flies, midges, insects,

tsetse flies, etc. Consequently, numerous hydrous diseases are frequent in the region, onchocercosis, malaria and diarrheic diseases.

(E) Surrounding flora and fauna: There are the presence of a multitude of dead wood stumps on the lake showing the importance of the damages caused by water on the environment. In these forbidden forests, the main floristic tree species are samba, iroko, frake.

The main species signaled in the surroundings of the lake are monkeys, elephants, panthers, chimpanzees and does. There is no fish breeding in Buyo. The fish species are tilapias, crysistis, lavex, mosmurus which are more numerous than several other species.

(F) Flood risks due to the presence of the dam: The Buyo dam is located in the western mountainous region where fields present a pronounced slope. Before the building of the dam, this region did not undergo catastrophic flood phenomena. Only the ruptures of water pockets located in the flanks of mountains caused avalanches (crumblings, landslides, mud avalanches, etc.). But, since the building of the dam, floods have become frequent in Guiglo and surrounding villages, because the situation of the dam in the middle of the river shortens the flowing distance of waters which formerly flowed easily on the low coast, or in the sea without flooding.

(3) Comoe Basin

(A) Sacred places and protected or forbidden areas: The classed forests are Songon (38,248ha), Manzan (4,500ha) which is the more degraded, and Mabi. There is also the sacred forest, which is Mabi one and covering 15ha, with workable but untouchable plants. This forest is annually worshipped by the population, or at the special request of villager. There is also a sacred spring in Abradinou having the same rituals as the sacred wood.

(B) Endemic diseases: There are “similies” (gnats) which cause onchocercosis in the Comoe basin.

(C) Use of the Comoe water: The surrounding population utilizes the Comoe water for domestic uses and human consumption. There is a natural spring for the supplying of the village of Abradinou in drinkable water.

(D) Surrounding flora and fauna: The SODEFOR is presently on reforesting campaign. There has been a reforestation of 1,000 to 1,200ha of land per year since 1993 up to present for the recovery and the rehabilitation of the damaged parcels of land. New opening of forests are presently forbidden. This reforestation is done with local essences. There are about 75 vegetable species and essences to protect. Among them,

some are subject to a particular protection such as Niangon (or red wood), cashew, Anegre (red and white that are disappearing), Assobe and Badi.

The elephant that are mainly pushed towards the Bia and panthers, are the most protected species. There are other species non less protected such as antelopes, does, rodents, for their impact on the forest. The most frequent species are tilapia, macharon, catfish, pike, etc. The hippopotamus and the lamentin are rare protected species.

(4) Korhogo and Boundiali Region in the Upper Basin of Bandama River

(A) Surrounding flora and traditional agriculture: The area is characterized by the savanna. It is notice that a forest gallery along side the Bandama and a forbidden forest called Badenou forest with the local essences of the SODEFOR, and alternation of rice growing low ground, cotton farms; maize farms, millet farms and peanuts farms. There are several sacred forests around each village.

(B) Small dams for breeding and agriculture: In northern areas (Korhogo, Ferkessedougou, Boundiali, Odienne, Tingrela, etc.) intensive and modern culture of cotton induced creation of numerous small dams. Their waters are used for irrigation and herd feeding. These are small tights hill shaped built with soil. Upon these tights, evaporation phenomena would probably be enhanced by the sub-sahelian climate.

(5) Central Western Region in the Sasandra River

(A) Hydrous diseases: The vectors of diseases are mosquitoes, tsetse flies, gnats (similies), bilharzias or the lack of iodine in the water of human consumption. The main hydrous diseases signaled are: malaria, diarrhea, goiter (swelling of the neck at the basis of the thyroid), guinea worm (in the feet of patients), dysentery, ulcer of burilis and zona.

(B) Use of water: The river water is needed for domestic uses, laundry, dish, swimming, etc. But for human consumption, the villagers use the water of deep drillings. The water of these wells is also used for human feeding and domestic uses.

(C) Surrounding flora and fauna: Apart from fallow and disordered clearings, where it hasn't noticed big plantations of coffee and cocoa, there is the closed forest of Scio. This forest, containing plants already cited in Abradinou, is a looking place for logging companies. The forest is also destroyed by the action of clandestine immigrants and autochthonous farmers who illegally settle in these closed forests.

In Kahin, the animal species are the same as closed forests of Abradinou and Buyo. Here, there is the National Park of Mount Pekou in addition to elephant and panthers, buffaloes. The fish species are tilapia, machoiron, catfish, cameroon.

(D) Development project in the region: There is rice project out of the Kahin village. This

project whose surface is estimated at more than 15ha is estimated in the low grounds of Kpangnehi and Grou, both tributaries at the Nzo. There is fish breeding project in Guiglo-Srokpan.

(6) Jacqueville in the Ebrie Lagoon

(A) Vegetation: The vegetation essentially consist of coconut groves, cassava fields which are pushing back the mangrove. There are also raphia trees in the low-grounds and some places turning into savannas.

(B) Fish breeding activities: The fish breeding space of Jacqueville undergoes a serious difficulty because of water pollution lasting for two months from a factory. This pollution causes important loss of fish consisting of snail fish, tilapias and snooks, etc.

(C) Pollution: The signs of pollution are characterized by the greenish color and the turbid state of the water. This pollution is extending progressively to the whole lagoon. The origin of this pollution is to be linked to either the opening of channel between the sea and the lagoon in the west (towards Grand-Lahou). In the rainy season Survey, it is caused the death of fish in the fish breeding space. This contamination spreads from the western part of the lagoon. It presently stops in the village of Coho whereas the fish from the village of Tabloth are not yet touched.

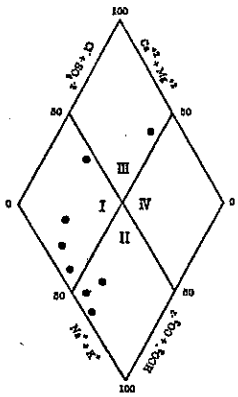
(D) Urbanization and drainage system of the town: The town gets big in a traditional way and the population is settled along the sea and lagoon. There is no drainage system which can converge to the sea or lagoon. The cleansing system is based on individual latrines and cesspool.

Table 7.3-1 Type of Groundwater Quality by Linear Diagram

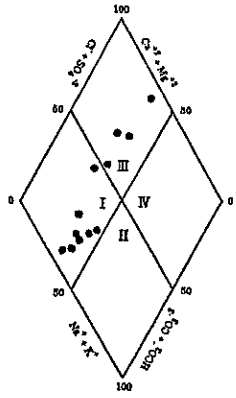
Regional Area	Groundwater Type (%)				
	Number	I	II	III	IV
1. Savanes	8	4 (50)	3 (38)	1 (12)	0 (0)
2. Vallee Du Bandama	12	8 (67)	0 (0)	4 (33)	0 (0)
3. Moyen Comoe	11	7 (64)	3 (27)	1 (10)	0 (0)
4. Lacs and N'zi Comoe	6	4 (66)	1 (17)	1 (17)	0 (0)
5. Haut and Sassandra	7	3 (43)	1 (14)	2 (29)	1 (14)
6. Montagnes	4	2 (50)	1 (25)	1 (25)	0 (0)
7. Sud-Comoe	5	2 (40)	0 (0)	2 (40)	1 (20)
8. Agneby	6	0 (0)	1 (17)	2 (33)	3 (50)
9. Lagunes	5	0 (0)	1 (20)	1 (20)	3 (60)

Note: I ; Calcium Bicarbonate, II; Sodium Bicarbonate, III; Non Calcium Bicarbonate, IV; Non Sodium Bicarbonate

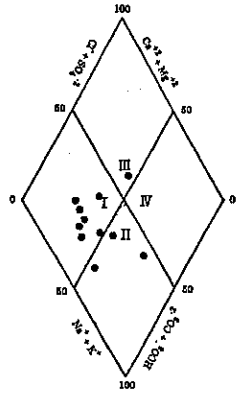
Source: Laboratoire National d'Essais de Qualite de Metrologie et d'Analyses



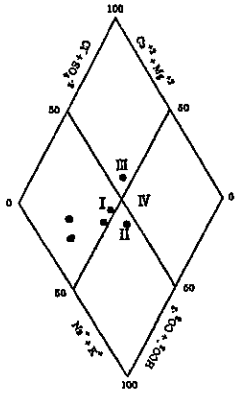
1. Savanes Area



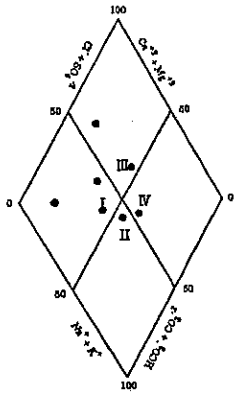
2. Vallee Du Bandama Area



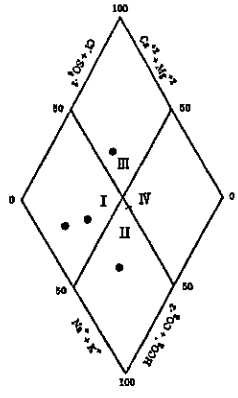
3. Moyen Comoe Area



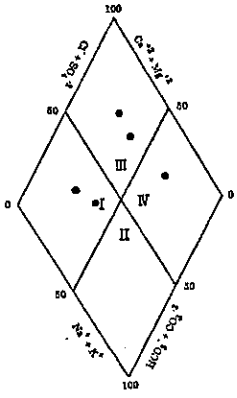
4. Lacs and N'zi Comoe Area



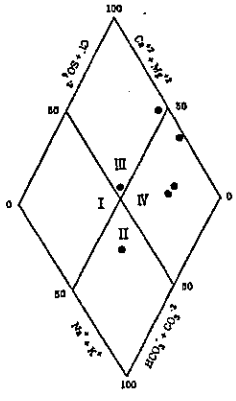
5. Haut and Sassandra Area



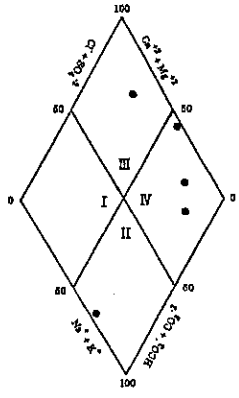
6. Montagnes Area



7. Sud-Comoe Area



8. Agneby Area



9. Lagunes Area

Table 7.3-2 Content of Metals of Ebrie Lagoon Sediments and the Beach

Station	Cr(ppm)	Cu(ppm)	Fe(g/Kg)	Hg(ppm)	Mn(ppm)	Pb(ppm)	Zn(ppm)
Lagune							
1	156	30	48	0.1	404	31	158
2	119	43	50	0.3	221	17	79
3	1718	3	61	0.4	234	54	232
4	465	30	41	0.1	156	10	47
5	286	55	67	0.3	169	61	139
6	429	76	52	0.5	182	89	269
7	358	41	56	0.3	208	17	56
8	135	43	57	0.1	365	18	46
9	135	52	61	0.3	378	41	139
10	109	33	51	0.1	430	16	93
11	69	13	20	0.3	521	11	88
12	120	49	62	0.5	534	41	398
13	21	3	1	0.1	24	4	6
Plage							
PL1	17	6	8	0.1	40	4	10
PL2	118	9	7	0.1	68	2	10
PL3	57	6	12	0	69	3	16
PL4	29	5	17	0	88	2	18
PL5	24	8	11	0	112	2	16

Source: CIAPOL(1994)

Table 7.3-3 Variation of the Concentration of Total Hydrocarbon and the Waste Organic Chloride in the Sediment of Abidjan Lagoon

Station	HC (ppm)	PCB (ppb)	Lindane (ppb)	DDE (ppb)	DDD (ppb)	DDT (ppb)	ΣDDT (ppb)
Chenal Central Ouest	46-596	3-77	0.6-19	0-4.5	0.5-11	0-18	2.0-25
Baie du Banco	408-1790	117-170	0.5-7	4.0-8	5.5-23	0-30	13-60
Baie de Cocody	636-1606	40-55	0.5-1.7	7	0.5-7	0-2	8.0-16
Zone Portuaire	293-455	36-46	3.3	5	4.9-12	3-7.6	19
Baie de Marcory	2440	187	9.7	149	803	45	997
Baie de Bietri	57-1194	4-194	0.5-0.9	1.0-17	0.2-47	0-7	2.0-72
Baie de Koumassi	35-314	2-151	0.5-4.2	2.0-18	1.0-11	0-2.5	6.0-32
Chenal Central Est	191-565	3-213	0.5-2.2	0-10	0.2-35	0-113	1.0-159
Ile Boulay	477	2-32	0.5-1.1	0-3.4	0.5-7	0-6.4	2.0-17

Source: CIAPOL(1994)

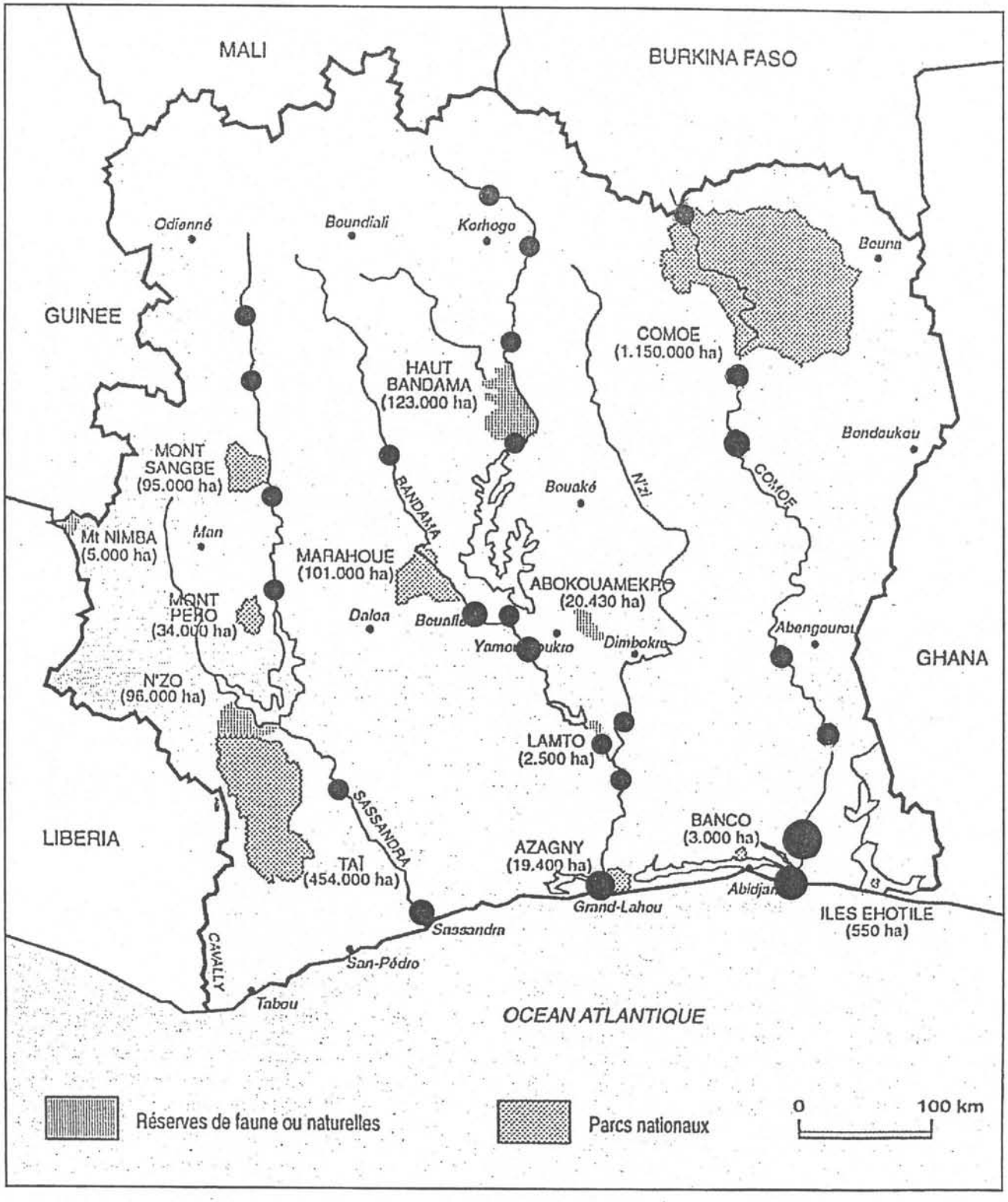


Figure 7.3-1 **Change of River Water Quality of EC, analyzed by CIAPOL in the National Observation Network Station between 1998 from 1995**

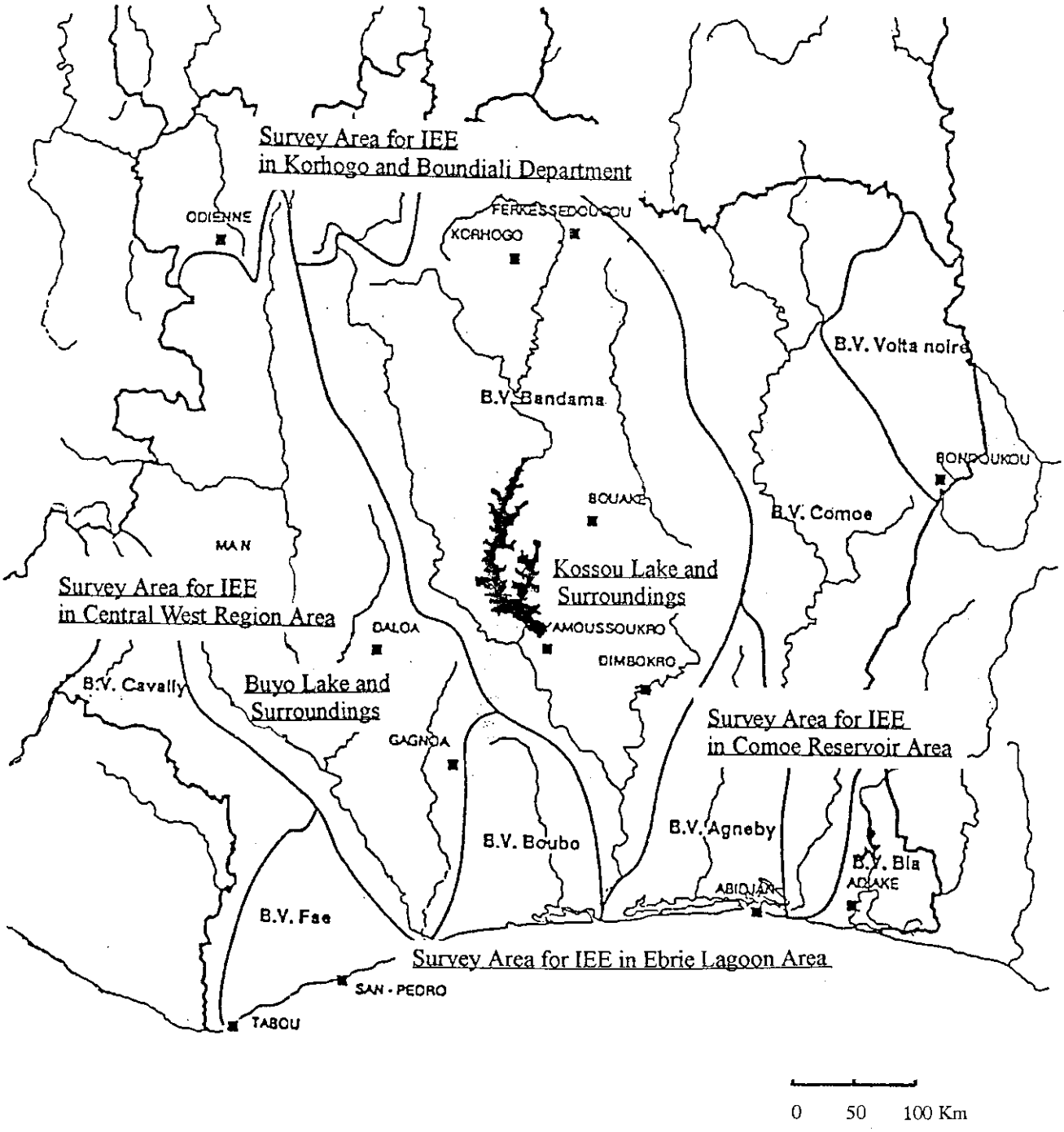


Figure 7.5-1 Survey Areas for Initial Environmental Examination (IEE)

PART 3 FORMULATION OF FRAMEWORK IN 2015

CHAPTER 8 SOCIAL AND ECONOMIC FRAMEWORK IN 2015

8.1 Forecasts for Population

Previous projections carried out from the results of the 1988 census have ever been found on the basis of constant or nearly constant rates established from the former years. In this exercise, the Consultant starts from the 1998 census, applies a uniform growth regional rate to found the basis year 2000 and then calculates distinct regional rates every three years.

8.1.1 Definitions

(1) Database

Database is the result of the application of the established regional rate in 1998 to the year 2000. The results are showing in the tabular form.

Table 8.1-1 Basis 2000 Population

	2000
région des lagunes	4 118 359
région du haut Sassandra	1 552 914
région des savanes	966 725
région de la vallée du Bandama	1 125 163
région des lacs	503 280
région du moyen Comoe	419 685
région des montagnes	1 544 035
région du Zanzan	692 881
région du bas Cavally	1 628 097
région du Denguele	231 078
région de la Marahoue	775 024
région du N'Zi Comoe	651 442
région du sud Comoe	498 461
région du Worodougou	554 050
région du sud Bandama	725 035
région de l'Agneby	546 146
TOTAL GENERAL REGIONS	16 532 376

Source: raw data from 1998 census and calculation of the Consultant

(2) Rural and Urban Populations

In order to fix the basis of the year 2000, the split between urban and rural population takes into account the distribution given by the 1998 census as follows: the urban population is definite as the population who lives in a village-centre having a status of commune while the rural population is constituted remainder of the total population what means the whole population living in non communal areas added to the population living in encampments located on a communal zone.

Based on these definitions, the 1998 starting year develops the following distribution:

Table 8.1-2 Starting Year 1998 Urban and Rural Population

	1998 urban population (strictly)	1998 rural population (large)	total year 1998	1998 % urban (strictly)
Lagunes	3,328,773	479,673	3,808,446	87.4%
Haut Sassandra	464,848	978,627	1,443,475	32.2%
Savanes	417,628	505,387	923,015	45.2%
Vallée du Bandama	758,561	308,148	1,066,709	71.1%
Lacs	266,806	210,350	477,156	55.9%
Moyen Comoe	143,514	253,015	396,529	36.2%
Montagnes	534,900	890,990	1,425,890	37.5%
Zanzan	175,929	483,143	659,072	26.7%
Bas Sassandra	325,322	1,069,884	1,395,206	23.3%
Denguele	95,081	124,351	219,432	43.3%
Marahoue	238,759	490,707	729,466	32.7%
N'Zi Comoe	266,111	368,465	634,576	41.9%
Sud Comoe	176,280	288,635	464,915	37.9%
Worodougou	194,019	320,087	514,106	37.7%
Sud Bandama	187,780	494,952	682,732	27.5%
Agneby	235,709	291,316	527,025	44.7%
GRAND TOTAL	**7,810,020**	**7,557,730**	**15,367,750**	**50.8%**

Source: 1998 census, INS and calculations of the Consultant

8.1.2 Assumptions

Two categories of assumptions are achieved.

First, assumptions concerning the global growth rate by region is the same than this established for the 1998 census, then every three years a new rate is calculated by region, taking into account the physical absorptive capacity in one hand and the main trends of internal migrations in the other. The results are on an average yearly growth rate, on a three year step by step basis and give a final result in terms of nation-wide population, the results are as following in the tabular form:

2000/2003	2003/2006	2006/2009	2009/2012	2012/2015
3.6% per year	3.5% per year	3.3% per year	3.2% per year	3.1% per year

Second, assumptions concern the evolution of the distinct growth rates for urban and rural populations. The basis year is the 1998 census from which it constructs the starting distribution structure region by region as seen above, then assumptions are made for the year 2000 in terms of percentage of urban population, region by region. Lastly, a second assumption is made for the year 2015, in the same terms while taking into consideration the land using ratio.

These set of assumptions is summarised in the following tabular form:

Table 8.1-3 Assumptions on Urban Population Weight by Region

	1998 % urban (strictly)	2000 % urban assumptions	2015 % urban assumptions
Lagunes	87%	87%	90%
Haut Sassandra	32%	32%	45%
Savanes	45%	45%	47%
Vallée du Bandama	71%	71%	75%
Lacs	56%	55%	65%
Moyen Comoe	36%	36%	40%
Montagnes	38%	37%	45%
Zanzan	27%	26%	35%
Bas Sassandra	23%	23%	35%
Denguele	43%	43%	45%
Marahoue	33%	32%	35%
N'Zi Comoe	42%	41%	45%
Sud Comoe	38%	37%	45%
Worodougou	38%	37%	40%
Sud Bandama	28%	27%	35%
Agneby	45%	44%	50%
GRAND TOTAL	51%	54%	57%

Source: calculation of the Consultant

8.1.3 Results

The nation-wide population would exceed 27 millions of inhabitants located on the 16 regions of which five would have more one million of residents against only one single today.

The gross yearly growth rate would stand for 3.3% on the period and keep distinct characters by region.

Thus the west-southern region bas Sassandra would develop still the highest growth rate but with a percentage lower than one known these ten last years. The region of “lagoons” keeps the first place in terms of population even if its gross growth would be attenuated.

Globally, the growth rate in urban areas would be upper than the growth in rural ones: 4.1% against 2.4% in yearly average. This means it would become more and more difficult to open new rural territories while the urban areas would have to be better managed, for lack of what, it will become extremely difficult – even impossible, to integrate any new citizen from the rural zones, specially for some regions such as “lagoons” and its neighbours whose the density would reach a maximum.

Table 8.1-4 Forecast Population in 2000 and 2015

	RURAL POPULATION			URBAN POPULATION		
	2000	2015	yearly rate	2000	2015	yearly rate
Lagunes	535,387	709,177	1.9%	3,582,973	6,382,595	3.9%
Haut Sassandra	1,055,981	1,425,816	2.0%	496,932	1,166,577	5.9%
Savanes	531,699	707,243	1.9%	435,026	627,178	2.5%
Vallée du Bandama	326,297	411,778	1.6%	798,866	1,235,333	2.9%
Lacs	226,476	247,861	0.9%	276,804	478,884	3.7%
Moyen Comoe	268,598	368,622	2.1%	151,087	245,748	3.3%
Montagnes	972,742	1,397,209	2.4%	571,293	1,143,171	4.7%
Zanzan	512,732	638,100	1.5%	180,149	343,593	4.4%
Bas Sassandra	1,253,635	2,372,698	4.3%	374,462	1,277,606	8.5%
Denguele	131,714	181,555	2.2%	99,363	148,545	2.7%
Marahoue	527,016	770,562	2.6%	248,008	414,918	3.5%
N'Zi Comoe	384,351	426,570	0.7%	267,091	349,012	1.8%
Sud Comoe	314,030	445,834	2.4%	184,430	364,773	4.7%
Worodougou	349,052	556,559	3.2%	204,999	371,039	4.0%
Sud Bandama	529,276	720,861	2.1%	195,760	388,156	4.7%
Agneby	305,842	350,130	0.9%	240,304	350,130	2.5%
Total	8,224,828	11,740,575	2.4%	8,307,548	15,287,258	4.1%

Source: Calculation and modelling of the Consultant

8.2 Economic Framework

8.2.1 Methodology for its Establishment

Table 8.2-1 Building-up the Basic Year 2000

variation rate regarding the previous year

	1997	1998	1999	2000
domestic demand	**5.4%**	**8.4%**	**4.2%**	**2.2%**
consumption	2.7%	4.4%	3.0%	0.9%
private	*1.9%*	*3.7%*	*2.9%*	*0.9%*
public	*0.8%*	*0.7%*	*0.0%*	*0.0%*
investment	2.7%	4.0%	1.2%	1.3%
public	*1.2%*	*1.3%*	*-0.8%*	*0.4%*
private	*1.5%*	*2.5%*	*2.0%*	*1.0%*
external balance	**1.2%**	**-2.4%**	**-0.2%**	**1.2%**
GDP	**6.6%**	**6.0%**	**4.0%**	**3.5%**

importation, exportation, variation rate in %

importation	**6.6%**	**13.0%**	**5.0%**	**5.0%**
exportation	**12.5%**	**6.4%**	**3.0%**	**6.0%**
primary	9.0%	2.0%	-0.8%	5.0%
other	16.3%	13.0%	12.1%	12.0%

evolution commercial balance in % of GDP

	12.5%	10.0%	9.0%	10.0%

average price index, yearly basis

(cumulated 93/98)	1997	1998	1999	2000
69.6%	5.6%	5.8%	5.0%	3.0%

variation in % regarding the previous year

	1997	1998	1999	2000
exchange rate index **(UEMOA)**	-2%	2%	-5%	-2%
primary X prices	4%	1%	-4%	1%
import prices	1%	-1%	1%	3%

Source: these tables are summarised the calculation and modelling of the Consultant

Above tables are the result of several calculations. Firstly the years 1997 and 1998 are gross data coming from the economic data collected from different sources, mainly DCPE, INS and BCEAO. Then year 1999 and the expressed ratios included in it are the result of :

i) The extension of the observed tendencies

ii) Several adjustments and corrections taken into consideration political events of the end of the last year and some provisional results concerning the execution rate of the state budget for the first semester.

iii) Finally, the year 2000 is the expression of the extension of the observed tendencies for the three previous years but while taking into consideration the only components of the demand.

This modelling is in fact founded on the accounting equation which considers the GDP as the expression of the sum of consumption, investment and the current balance. This latter takes into account export and import of goods and services and is thus also the expression of the external demand's point of view.

Table 8.2-2 State Accounts and Main Export Prices

variation in % regarding the previous year

	primary balance / GDP apart grants and ext. I.	*primary balance / GDP apart grants*	*budgetary revenue apart grants / GDP*	*current growth budgetary revenue*	*current growth export revenue*	*primary expenses / GDP apart Inv. and grants*	*current growth salaries wages*	*current growth public Investment*
year 1993	*1.6%*	*-3.7%*	*17.6%*	*-12.9%*	*1.8%*	*18.2%*	*-1.7%*	*-13.1%*
year 1994	*5.3%*	*0.7%*	*19.9%*	*63.5%*	*2,365.0%*	*14.6%*	*4.3%*	*114.8%*
year 1995	*7.0%*	*2.5%*	*22.1%*	*30.3%*	*26.3%*	*14.0%*	*5.6%*	*43.6%*
year 1996	*7.7%*	*3.1%*	*22.4%*	*11.7%*	*16.0%*	*13.8%*	*12.5%*	*8.5%*
year 1997	*6.7%*	*2.3%*	*22.0%*	*7.8%*	*-15.8%*	*13.5%*	*4.7%*	*22.5%*
year 1998	*3.5%*	*-2.6%*	*22.3%*	*4.6%*	*13.0%*	*18.0%*	*1.7%*	*22.0%*
year 1999	*3.0%*	*-3.3%*	*20.7%*	*-4.2%*	*-33.0%*	*17.1%*	*4.8%*	*-11.0%*
year 2000	*3.1%*	*-3.3%*	*20.6%*	*4.8%*	*5.0%*	*16.9%*	*0.0%*	*9.0%*

main export prices

	variation in % regarding the previous year				prices in $ or cent		
	1997	*1998*	*1999*	*2000*	*1998*	*1999*	*2000*
coffee (c/kg)	-4%	5%	-13%	3%	182	159	163.1
cocoa (c/kg)	11%	4%	-28%	8%	168	120	130
cotton (c/kg)	1%	-17%	-11%	3%	145	128	132.3
palmoil ($/tm)	13%	-10%	-12%	0%	909	800	800
timber ($/$m^3$)	0%	1%	-6%	4%	286	270	280
crude oil $/bbl	-6%	-32%	19%	10%	13	15.5	17
$ / FCFA	14%	2%	3%	5%	590	610	640

The results for the year 2000 represent the deep tendencies of the last three years: the economic growth rate is somewhat eased notably by weaker external balance and investments.

Roughly, the GDP would keep a significant growth rate around 3.5% but this gross result is certainly affected by the continuous slowdown of the rate during the years 1997-1999 and the external results which would not reach a level as high as expected.

These set of calculations are based while taking into account the absorptive capacity of the domestic demand which could be expressed as the value of the following formulation:

Domestic demand = (Consumption + Investment)

The second part of this equation depends mainly on external conditions, the modelling estimates the value of consumption and investment to the given conditions by the observed tendencies – these are the inputs, and applies an external rate for the evolution of export and import – these are the outputs.

Based on these conditions and assumptions, the modelling estimates the value of GDP.

Table 8.2-3 The 3 Starting Years and the Basic Year 2000

figures in FCFA billion		gross	upgraded		
Starting point 1997	1 997	1998	1998	1999	2000
GDP	6 047	6 034	6 410	6 679	6 938
Consumption	4 567	4 718	4 992	5 398	5 610
private	3 967	4 114			
public	600	604			
Investment	887	902	954	1 014	1 058
private	621	629			
public	266	273			
inventory variation	77				
Export	2 559	2 723	2 750	2 691	2 881
Import	2 043	2 309	2 286	2 424	2 611
current balance	516	414	464	267	270

Source: database and adaptation by the Consultant, modelling base: "Jumbo" AFD group

8.2.2 Results in 2015

From the basic figures in 2000, the averages of consumption and investment are taken on the basis of the average during the last three years or the last rate registered. Then assumptions are chosen concerning the growth rates of export and import.

In this version, the kept rates are:

i) for the export, an average of 2.7% per year which constitutes an average on a long trend (more than 25 years) and avoids to take into account the erratic movements on short periods such as those met these last two years very particularly,

ii) for the import, an average of 2.5% per year which constitutes an average on a medium term (after the year of devaluation) and takes into account the absorptive capacity of the public sector as well as the private one

The estimation gives a GDP at 12,285 FCFA billion with calculated levels of consumption at a 3.9% growth rate per year against a 3.5% for investment.

At an exchange rate of: one American dollar for FCFA 650, and while taking into account the forecast population the same year (around 27 millions), the GDP per capita would reach for the year 2015 an average of 700 (seven hundred) US $.

The table hereafter summarises the main results of this modelling.

Table 8.2-4 Results in 2015

figures in FCFA billion	variation 2000/1999	per annum last 3 years	per yearly assumptions	results 2015	GDP GROWTH RATE
GDP	3.9%	2.7%	calculated	12,285	3.9%
Consumption	3.9%	4.0%	3.9%	9,998	
private					
public			calculated		
Investment	4.3%	3.5%	3.5%	1,772	
private					
public					
			output data		
Export	7.1%	1.6%	2.7%	4,296	
Import	7.7%	4.5%	2.5%	3,782	
current balance	1.0%	-16.6%		514	

Source: calculation and assumptions by the Consultant

8.3 Social Conditions in the 2015 Framework

Consumption and investment would know significant growth rates during the period. However investment rate would be lower, voicing thus a regular but normal withdrawal of the state part whereas private investors would have to confirm their foremost weight in the gross fixed capital. Consumption would be the "leader" of the growth, drawing the broad growth at a level and with a weight around the expected final rate (3.9%).

The domestic demand would allow a noteworthy increase of the domestic production and in parallel a slowdown of final consumption's goods presently imported. This latter assertion is one of the conditions for an higher export growth rate: the weight of the imports must be less important, and above all, those be used as final goods would have to decrease strongly whereas intermediate inputs would be able to keep a certain weight if they are incorporated in the formation of fixed investment. This condition is directly linked with the forecasts concerning agriculture and major crops.

The evolution of private consumption would have likely a most important increase than the public one. Rather than to support the economic growth, the administrative entities will have firstly to develop a lower gross weight and consequently will have to expense better rather than bigger: this presupposes a big improvement in management and administration of resources (Human as well as material).

The exportation factor is an "external" variable in the modelling but its forecast growth rate is largely dependent on investment rate. In these conditions and with the projections concerning industrial sectors (from primary as well as secondary sector), exportations would expect for knowing significant growth rates during the period. That means a related link between the external demand and the domestic one. The only factor on which it is very difficult to project reasonable outlook is the evolution of the debt's weight in the external accounts of Côte d'Ivoire. In any case, this weight will have to decrease significantly for lack of what the fragile external equilibrium would be broken and consequently, monetary results and administrative ones would be out of the breakeven point.

CHAPTER 9 WATER SECTOR FRAMEWORK IN 2015

9.1 Agriculture

Framework for agriculture will be set principally based on the Agricultural Master Plan 1992-2015, and the National Rice Development Plan 2005. In the framework, present condition is set in 1995 due to availability of statistical data.

9.1.1 Agricultural Framework in 2015

Regarding to food crops, relation between present conditions and the target of the Agricultural Master Plan 1992 – 2015 are summarised below.

Table 9.1-1 Comparison of Production and Consumption Level of Food Crops between Present and Target Year

Target Year	Present (1995)		Growth	Future (2015)		
Population	13,824,000		Ratio	27,028,000		
	Production (t)	Consumption (kg/capita/yr)	(%/yr)	Target (t)	Consumption (kg/capita/yr)	
Food Crops						
Paddy Rice						
Production	868,430			5,924,000	**(too High Target)**	
Imort	856,000			-		
Total	1,724,430			5,924,000		
Rice (0.5 x paddy)	862,215	62		2,962,000	110	rice
	rice		6.99%			
				3,352,000	**(reasonable Target)**	
				1,676,000	62	rice
Maize	552,040	39.9	3.08%	1,013,000	37.5	
S.M.F.	90,980	6.6	1.48%	122,000	4.5	
Yam	2,868,850	207.5	1.36%	3,759,000	139.1	
Cassava	1,608,220	116.3	2.77%	2,778,000	102.8	
Groundnuts	143,040	10.3	3.81%	302,000	11.2	
Plantain Banana	1,335,320	96.6	0.96%	1,615,000	59.8	
Taro	352,050	25.5				
Vegetables	540,000	39.1	6.59%	1,937,000	71.7	

(Note) S.F.MSorghum, Fonio, Millet

According to the Agricultural Master Plan 1992-2015, production target of paddy rice has been set at very high level able to achieve per-capita 110 kg consumption by national production. At present, demand of 62 kg per capita is satisfied by national production and import. PNR has a policy to achieve self-sufficiency at the level of 62 kg per capita per year. Consequently, the target of paddy rice production is set to achieve self-sufficiency at 62 kg per capita.

On the other hand, the target of vegetables is also set at high level to achieve production of 1,937,000 t and increase of supply from 39 kg to 72 kg per capita. To achieve it, crop area of vegetables is to be

increased at 6.59% per annum. As discussed in 2.2-1, vegetable consumption is still low level at about 1/3 of Japan one, so that vegetables are planed to increase at high level.

Industrial crops are difficult to give economical evaluation due to shortage of evaluation data in this study, and this is not a main subject .in this study. It is, therefore, production plan of industrial crops are to follow the Agricultural Master Plan 1992 – 2015.

According to above considerations, agricultural land use plan will be as follows:

Table 9.1-2 Cropped Area and Production in 1995 and Target Year 2015

Crops	Year 1995				Growth Ratio of Area (%/yr)	Year 2015			
	Cropped Area (ha)	Yield (t/ha)	Production (t)	Area Ratio (%)		Cropped Area (ha)	Yield (t/ha)	Production (t)	Area Ratio (%)
Food Crops									
Paddy	592,000		868,430	8.2%	4.30%	1,373,000		3,353,560	11.9%
Rained Paddy	570,000	1.4	798,020	7.9%	4.06%	1,263,000	1.94	2,450,230	11.0%
Irrigated Paddy	22,000	3.2	70,410	0.3%	8.38%	110,000	8.212	903,330	1.0%
Maize	669,100	0.825	552,040	9.2%	3.08%	1,227,800	0.825	1,013,000	10.7%
S.F.M.	136,400	0.667	90,980	1.9%	1.48%	182,900	0.667	122,000	1.6%
Yam	264,900	10.83	2,868,850	3.7%	1.36%	347,090	10.83	3,759,000	3.0%
Cassava	316,200	5.086	1,608,220	4.4%	2.77%	546,160	5.086	2,778,000	4.7%
Ground nut	136,200	1.05	143,040	1.9%	3.81%	287,550	1.05	302,000	2.5%
Plantain Banana	1,203,000	1.11	1,335,320	16.6%	0.96%	1,454,960	1.11	1,615,000	12.6%
Taro	376,900	0.934	352,050	5.2%	0.00%	376,900	0.934	352,050	3.3%
Vegetables	27,000	20	540,000	0.4%	6.59%	96,830	20	1,937,000	0.8%
Total	3,721,700			51.3%	2.32%	5,893,190			51.2%
Perennial Crops									
Cocoa	1,723,400	0.5313	915,670	23.8%	0.00%	1,723,400	0.5313	915,670	15.0%
Coffee	1,250,000	0.1893	236,660	17.2%	2.98%	2,250,070	0.1893	426,000	19.6%
Oil Palm	150,700	1.824	274,900	2.1%	0.00%	150,700	1.824	274,900	1.3%
Coconut	53,140	0.433	23,020	0.7%	0.00%	53,140	0.433	23,020	0.5%
Rubber	64,680	1.072	69,320	0.9%	9.88%	425,470	1.072	456,000	3.7%
Total	3,241,920			44.7%	1.77%	4,602,780			40.0%
Industrial Crops									
Sugarcane	21,310	6.589	140,410	0.3%	3.49%	42,350	6.589	279,040	0.4%
Cotton	242,400	0.9625	233,320	3.3%	6.66%	880,000	0.9625	847,000	7.6%
Banana	5,600	41.43	232,000	0.1%	2.76%	9,650	41.43	400,000	0.1%
Pineapple	15,500	13.55	210,020	0.2%	8.29%	76,230	13.55	1,033,000	0.7%
Total	284,810			3.9%	6.52%	1,008,230			8.8%
Grand Total	7,248,430			100.0%	2.34%	11,504,200			100.0%

(Notes)
1) Yield of Irrigated Paddy Rice = 4.78 t/ha * 1.72 (crop cycle) = 8.212 t/ha (4.78 t/ha: PNR 2005 Target Yield: see Table 2.2-4-3)

To achieve the necessary agricultural production proposed in the Agricultural Master Plan 1992-2015, it is necessary to increase farmland from 7,248,430 ha in 1995 to 11,504,200 ha in 2015. Farmland is necessary to increase 2.34% annually. Among proposed crops, encouragement should be given to irrigated paddy rice and vegetables in food crops, and to rubber, cotton and pineapples in industrial crops.

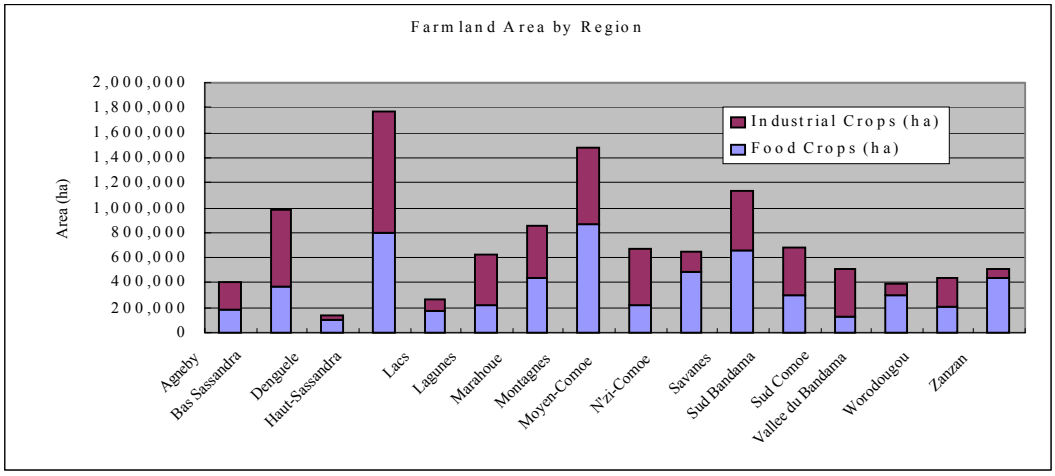
In order to satisfy above necessary increase of the area, farmland has been extended in accordance with the current trend of farmland scale in each department. The result of farmland extension is summarised as shown in the next table.

Table 9.1-3 Farmland Area and Farming Scale by Region in 2015

(unit: ha)

	Region	Area (km^2)	Agr. House holds	Food Crops (ha)	Industrial Crops (ha)	Total (ha)	Farming Scale (ha/ household)	Area Ratio in the Area (%)
1	Agneby	9,105	52,283	189,840	214,830	404,670	7.7	44.4%
2	Bas Sassandra	26,205	422,105	371,400	607,270	978,670	2.3	37.3%
3	Denguele	20,892	17,590	103,480	36,160	139,640	7.9	6.7%
4	Haut-Sassandra	19,883	202,348	796,590	975,700	1,772,290	8.8	89.1%
5	Lacs	8,811	38,126	173,100	90,870	263,970	6.9	30.0%
6	Lagunes	13,296	116,525	223,890	402,620	626,510	5.4	47.1%
7	Marahoue	11,124	93,226	435,910	424,330	860,240	9.2	77.3%
8	Montagnes	30,941	222,464	869,400	610,870	1,480,270	6.7	47.8%
9	Moyen-Comoe	6,996	62,906	220,030	446,520	666,550	10.6	95.3%
10	N'zi-Comoe	19,597	51,109	480,640	163,600	644,240	12.6	32.9%
11	Savanes	40,146	107,279	660,180	476,900	1,137,080	10.6	28.3%
12	Sud Bandama	10,873	109,940	300,480	377,970	678,450	6.2	62.4%
13	Sud Comoe	7,614	79,338	124,800	380,530	505,330	6.4	66.4%
14	Vallee du Bandama	28,393	74,539	295,110	100,920	396,030	5.3	13.9%
15	Worodougou	30,770	76,623	212,760	223,440	436,200	5.7	14.2%
16	Zanzan	38,080	122,259	435,580	78,480	514,060	4.2	13.5%
Total		322,365	1,848,660	5,893,190	5,611,010	11,504,200	6.2	35.7%

Figure 9.1-1 Farmland Scale by Region



The major issues are as follows:

(a) Farmland will share 36% of the country in 2015.

(b) Farming activities will be concentrated to certain regions, such as Haut Sassandra, Marahoue and Moyen-Comoe regions.

(c) In these regions, farmlands will share a large portion of the region, so that land use plan should be carefully established to preserve soil and water.

9.1.2 Livestock Framework in 2015

Framework of livestock development will be set as follows:

(a) Livestock is planned to extend with 3.8% annual growth rate through the country.

(b) Livestock will be increased to almost double (2.108 times) in 2015.

(c) Livestock development will be extremely concentrated into northern area, as in Savannah Region.

(d) In Savannah Region, farming type agriculture is not so encouraged and farmland will be limited within 30% of the area, so that livestock development will be major earnings in this region.

Figure 9.1-2 Livestock Holdings by Agricultural household

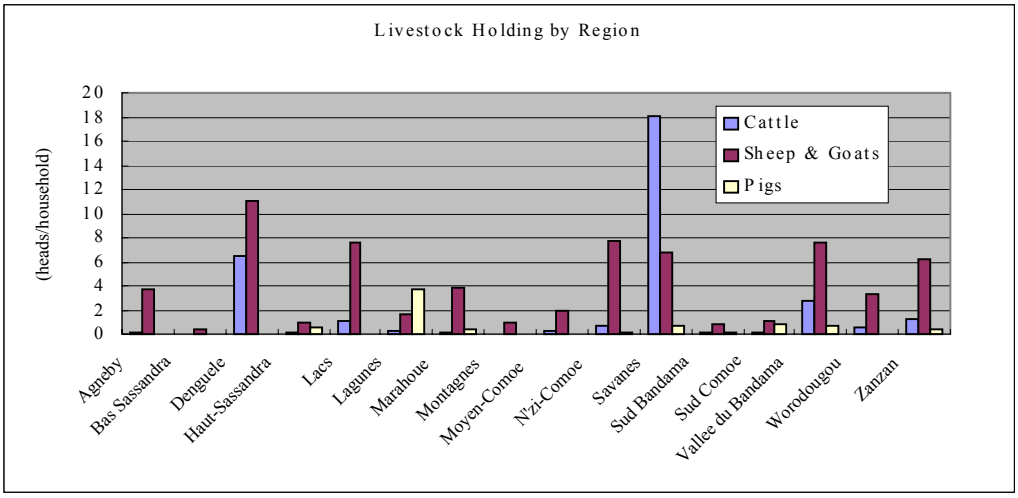


Figure 9.1-3 Necessary Grazing Area and Ratio by Region

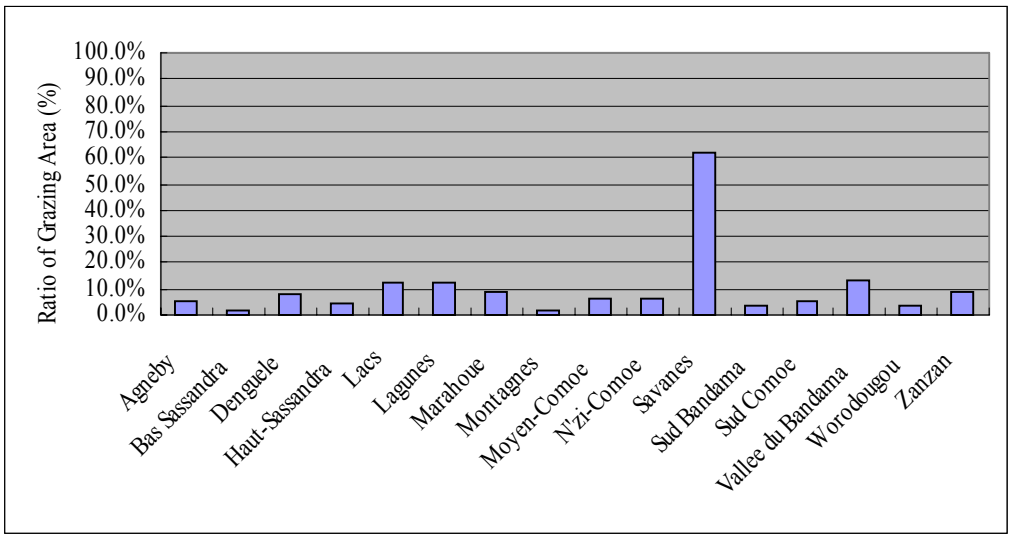


Table 9.1-4 Livestock Development by Department and by Region

Region		Department	Area	Agri.	Number of Livestock				Holdings (heads/household)				Grazing Density	
			Area (km^2)	House holds	Cattle (heads)	Sheep & Goats (heads)	Pigs (heads)	Poultry (1000 heads)	Cattle	Sheep & Goats	Pigs	Poultry	Necessary Area (km2)	Ratio to Total Area
1	Agneby	5 Adzope	5,218	20,735	4,870	104,110	170	930	0.23	5.02	0.01	0.04	267	5.1%
1	Agneby	6 Agboville	3,887	31,548	1,880	94,120	210	1,160	0.06	2.98	0.01	0.04	211	5.4%
2	Bas Sassandra	43 San-Pedro	6,848	147,399	4,830	42,930	0	2,090	0.03	0.29	0	0.01	144	2.1%
2	Bas Sassandra	44 Sassandra	4,966	67,141	1,520	53,340	12,190	1,370	0.02	0.79	0.18	0.02	149	3.0%
2	Bas Sassandra	47 Soubre	8,540	187,299	2,890	74,150	0	3,770	0.02	0.4	0	0.02	183	2.1%
2	Bas Sassandra	48 Tabou	5,851	20,266	1,520	20,390	0	780	0.08	1.01	0	0.04	59	1.0%
3	Denguele	40 Odienne	20,892	17,590	113,410	193,000	550	990	6.45	10.97	0.03	0.06	1,748	8.4%
4	Haut-Sassandra	21 Daloa	5,388	54,822	9,170	52,060	39,550	2,260	0.17	0.95	0.72	0.04	293	5.4%
4	Haut-Sassandra	28 Gagnoa	4,545	58,925	3,160	55,530	85,090	1,750	0.05	0.94	1.44	0.03	319	7.0%
4	Haut-Sassandra	32 Issia	3,722	32,623	780	36,010	0	1,350	0.02	1.1	0	0.04	81	2.2%
4	Haut-Sassandra	56 Vavoua	6,228	55,978	5,290	50,330	0	1,880	0.09	0.9	0	0.03	164	2.6%
5	Lacs	52 Tiebissou	2,307	10,867	4,720	68,880	270	400	0.43	6.34	0.02	0.04	195	8.5%
5	Lacs	55 Toumodi	2,698	8,073	26,140	72,870	0	380	3.24	9.03	0	0.05	459	17.0%
5	Lacs	571 Yamoussoukro1	2,108	13,178	4,170	60,740	230	360	0.32	4.61	0.02	0.03	172	8.2%
5	Lacs	572 Yamoussoukro2	1,698	6,008	6,070	88,550	360	510	1.01	14.74	0.06	0.08	251	14.8%
6	Lagunes	2 Abidjan	2,702	19,805	7,230	24,690	110,460	530	0.37	1.25	5.58	0.03	357	13.2%
6	Lagunes	8 Alepe	2,176	27,747	8,710	29,710	132,910	630	0.31	1.07	4.79	0.02	430	19.8%
6	Lagunes	20 Dabou	2,195	30,865	10,610	36,200	162,010	760	0.34	1.17	5.25	0.02	524	23.9%
6	Lagunes	30 Grand Lahou	2,036	14,749	2,020	17,350	0	480	0.14	1.18	0	0.03	59	2.9%
6	Lagunes	33 Jacqueville	745	1,012	1,640	5,590	24,980	130	1.62	5.52	24.68	0.13	81	10.9%
6	Lagunes	51 Tiassale	3,442	22,347	3,610	71,580	650	950	0.16	3.2	0.03	0.04	188	5.5%
7	Marahoue	15 Bouafle	4,185	28,219	6,160	108,450	30,740	1,140	0.22	3.84	1.09	0.04	352	8.4%
7	Marahoue	41 Oume	2,358	17,812	1,960	75,040	60	840	0.11	4.21	0	0.05	174	7.4%
7	Marahoue	46 Sinfra	1,643	24,175	1,010	37,740	0	860	0.04	1.56	0	0.04	88	5.4%
7	Marahoue	58 Zuenoula	2,938	23,020	5,330	135,780	4,300	800	0.23	5.9	0.19	0.03	344	11.7%
8	Montagnes	9 Bangolo	2,127	39,516	230	27,350	0	860	0.01	0.69	0	0.02	57	2.7%
8	Montagnes	11 Biankouma	5,020	17,190	3,350	29,070	1,010	570	0.19	1.69	0.06	0.03	100	2.0%
8	Montagnes	22 Danane	4,601	43,628	1,140	45,120	0	1,520	0.03	1.03	0	0.03	104	2.3%
8	Montagnes	26 Duekoue	3,017	37,307	130	13,010	0	910	0	0.35	0	0.02	28	0.9%
8	Montagnes	31 Guiglo	10,557	46,215	670	36,140	800	1,140	0.01	0.78	0.02	0.02	82	0.8%
8	Montagnes	37 Man	4,808	31,685	1,750	44,250	5,760	1,200	0.06	1.4	0.18	0.04	121	2.5%
8	Montagnes	54 Toulepleu	811	6,923	130	7,250	170	230	0.02	1.05	0.02	0.03	16	2.0%
9	Moyen-Comoe	1 Abengourou	5,143	45,865	13,180	74,570	4,070	1,390	0.29	1.63	0.09	0.03	315	6.1%
9	Moyen-Comoe	7 Agnibilekrou	1,853	17,041	2,640	48,130	0	530	0.15	2.82	0	0.03	128	6.9%
10	N'zi-Comoe	12 Bocanda	3,262	10,829	7,210	81,530	4,760	510	0.67	7.53	0.44	0.05	259	7.9%
10	N'zi-Comoe	14 Bongouanou	5,593	18,996	4,910	63,760	3,750	1,120	0.26	3.36	0.2	0.06	194	3.5%
10	N'zi-Comoe	23 Daoukro	3,958	6,514	3,880	104,530	0	340	0.6	16.05	0	0.05	256	6.5%
10	N'zi-Comoe	24 Dimbokro	1,564	2,700	2,340	26,480	1,560	170	0.87	9.81	0.58	0.06	84	5.4%
10	N'zi-Comoe	39 M'bahiakro	5,220	12,070	15,940	118,010	0	670	1.32	9.78	0	0.06	427	8.2%
11	Savanes	18 Boundiali	7,956	17,360	346,760	117,540	0	820	19.97	6.77	0	0.05	4,396	55.3%
11	Savanes	27 Ferkessedougou	17,224	43,939	669,240	225,530	13,160	1,180	15.23	5.13	0.3	0.03	8,508	49.4%
11	Savanes	35 Korhogo	12,696	42,388	720,050	304,870	58,700	1,640	16.99	7.19	1.38	0.04	9,368	73.8%
11	Savanes	50 Tengrela	2,270	3,592	198,170	81,110	860	250	55.17	22.58	0.24	0.07	2,542	112.0%
12	Sud Bandama	25 Divo	8,139	81,819	7,400	68,100	8,050	2,760	0.09	0.83	0.1	0.03	241	3.0%
12	Sud Bandama	36 Lakota	2,734	28,121	2,970	21,250	14,380	860	0.11	0.76	0.51	0.03	107	3.9%
13	Sud Comoe	3 Aboisso	4,474	48,571	2,130	50,710	0	1,290	0.04	1.04	0	0.03	127	2.8%
13	Sud Comoe	4 Adiake	1,714	21,761	950	22,600	0	570	0.04	1.04	0	0.03	57	3.3%
13	Sud Comoe	29 Grand Bassam	1,426	9,006	3,960	13,560	60,620	300	0.44	1.51	6.73	0.03	196	13.7%
14	Vallee du Bandama	10 Beoumi	2,609	17,820	14,800	86,340	0	590	0.83	4.85	0	0.03	350	13.4%
14	Vallee du Bandama	16 Bouake	4,709	13,423	39,810	177,860	46,950	480	2.97	13.25	3.5	0.04	927	19.7%
14	Vallee du Bandama	19 Dabakala	9,761	18,714	44,170	217,350	0	530	2.36	11.61	0	0.03	965	9.9%
14	Vallee du Bandama	34 Katiola	9,440	19,991	103,460	52,060	590	460	5.18	2.6	0.03	0.02	1,347	14.3%
14	Vallee du Bandama	42 Sakassou	1,874	4,591	7,000	33,840	210	300	1.52	7.37	0.05	0.07	152	8.1%
15	Worodougou	38 Mankono	10,603	41,703	20,490	57,690	0	1,140	0.49	1.38	0	0.03	361	3.4%
15	Worodougou	45 Seguela	11,460	17,658	13,300	136,200	0	670	0.75	7.71	0	0.04	432	3.8%
15	Worodougou	53 Touba	8,707	17,262	10,920	60,720	210	700	0.63	3.52	0.01	0.04	253	2.9%
16	Zanzan	13 Bondoukou	9,844	60,376	20,600	234,640	10,690	1,560	0.34	3.89	0.18	0.03	738	7.5%
16	Zanzan	17 Bouna	21,846	27,669	118,870	286,680	24,250	1,050	4.3	10.36	0.88	0.04	2,048	9.4%
16	Zanzan	49 Tanda	6,390	34,214	11,070	238,540	7,570	1,200	0.32	6.97	0.22	0.04	625	9.8%
1	Agneby		9,105	52,283	6,750	198,230	380	2,090	0.13	3.79	0.01	0.04	478	5.2%
2	Bas Sassandra		26,205	422,105	10,760	190,810	12,190	8,010	0.03	0.45	0.03	0.02	535	2.0%
3	Denguele		20,892	17,590	113,410	193,000	550	990	6.45	10.97	0.03	0.06	1,748	8.4%
4	Haut-Sassandra		19,883	202,348	18,400	193,930	124,640	7,240	0.09	0.96	0.62	0.04	858	4.3%
5	Lacs		8,811	38,126	41,100	291,040	860	1,650	1.08	7.63	0.02	0.04	1,077	12.2%
6	Lagunes		13,296	116,525	33,820	185,120	431,010	3,480	0.29	1.59	3.7	0.03	1,638	12.3%
7	Marahoue		11,124	93,226	14,460	357,010	35,100	3,640	0.16	3.83	0.38	0.04	958	8.6%
8	Montagnes		30,941	222,464	7,400	202,190	7,740	6,430	0.03	0.91	0.03	0.03	509	1.6%
9	Moyen-Comoe		6,996	62,906	15,820	122,700	4,070	1,920	0.25	1.95	0.06	0.03	443	6.3%
10	N'zi-Comoe		19,597	51,109	34,280	394,310	10,070	2,810	0.67	7.72	0.2	0.05	1,220	6.2%
11	Savanes		40,146	107,279	1,934,220	729,050	72,720	3,890	18.03	6.8	0.68	0.04	24,814	61.8%
12	Sud Bandama		10,873	109,940	10,370	89,350	22,430	3,620	0.09	0.81	0.2	0.03	348	3.2%
13	Sud Comoe		7,614	79,338	7,040	86,870	60,620	2,160	0.09	1.09	0.76	0.03	379	5.0%
14	Vallee du Bandama		28,393	74,539	209,240	567,450	47,750	2,360	2.81	7.61	0.64	0.03	3,741	13.2%
15	Worodougou		30,770	76,623	44,710	254,610	210	2,510	0.58	3.32	0	0.03	1,046	3.4%
16	Zanzan		38,080	122,259	150,540	759,860	42,510	3,810	1.23	6.22	0.35	0.03	3,411	9.0%
Total			322,365	1,848,660	2,652,320	4,815,530	872,850	56,610	1.43	2.6	0.47	0.03	43,205	13.4%

9.1.3 Fishery Framework in 2015

Fishery framework is set to achieve self-sufficiency at per-capita 17 kg of fish consumption supplied by national product. In order to achieve this supply product has to reach 473,000 ton in 2015.

When freshwater fishery is exploited to 2/3 of potential or 170 kg/ha/year, it is expected to produce 59,000 ton/year of fish from total water bodies of 347,700 ha. Marine and lagoon fisheries are expected to realize a production of 133,000 ton per year. On the other hand, aquaculture is expected to raise productivity level from 4 ton/ha/year to 8 ton/ha/year by the Agricultural Master Plan. If aquaculture is able to realize production of remaining 281,000 ton with a productivity of 8ton/ha/year, it needs to expand fishpond to about 35,000 ha.

Fish Production Plan by Aquaculture

Necessary Fish production in 2015 28,030,000 habit x 17 kg/capita/yr =	473,000 t/yr
Expected Production by Natural Fishery Marine fishery Fresh water fishery 347,700ha x 250 kg/ha x 2/3 = 347,000 x 170 kg/ha = Total Production	 133,000 t/yr 59,000 t/yr 192,000 t/yr
Necessary Production by Aquaculture	281,000 t/yr
Necessary Fishpond Productivity : 8 t/ha Fishpond : 281,000 t/ha / 8 t/ha =	 35,000 ha

For realising such extensive fishpond, lowland is the fist target to develop fishpond. It is therefore, subject to flooding area is the target area to develop fishpond. Such area can be found adjacent area to the low lying paddy prevailing area. It is supposed to able to develop fishpond along the proportion of paddy area distribution in each department.

Figure 9.1-4 Fishpond Development Direction by Department

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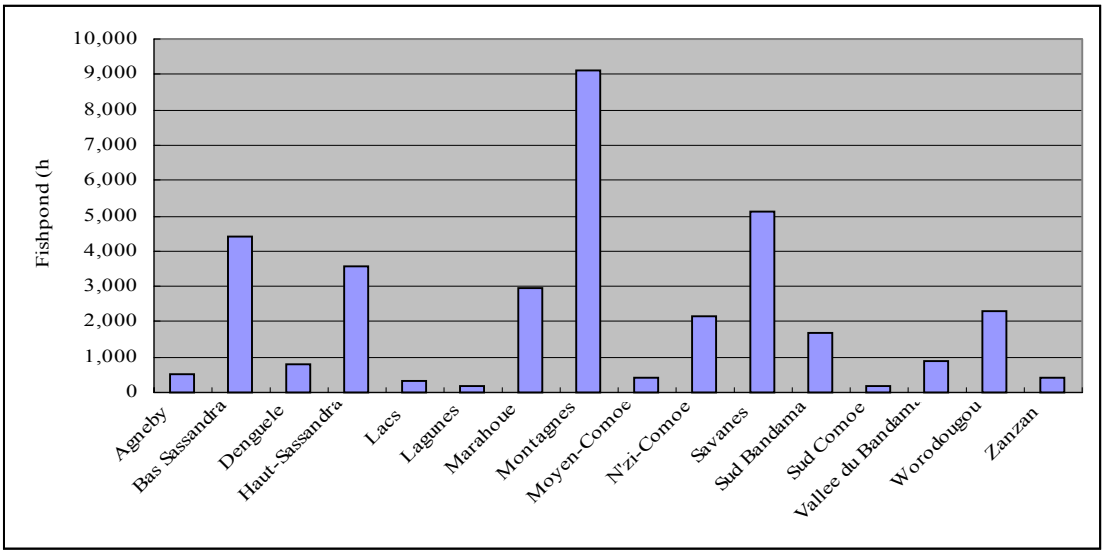


9.2 Domestic and Industrial Water Supply

There is no national frame works toward the year of 2015 and after. There obtained the list of the projects in rather short term planing, as listed in the following chapter.

In 1970's, there were targets for :

(a) supplying 20 litters in all rural areas by 1980, and

(b) supplying 65 litters to the urban residents by 1980.

Though, the target had not been fully satisfied by that time, neither till now. Therefore, the study team, upon the understanding that the target is still in valid at present, proceeded with the works and projected the demands.

9.3 Hydro-Electric Power

After 1983, no project has been implemented, although many development plans were prepared before 1978. The present capacity of power plant is approximately double of the demand, though operational condition is not well fitted to the requirement to ultimate use of the facilities.

It is now on-going to review the past development plans and renew the Master Plan under the Ministry, which is expected to complete by middle of 2000.

9.4 Other Water Sectors

It is more or less difficult to prepare the frameworks of these sectors with definite back-data due to the following reasons:

(a) There is no definite future plan prepared by the government

(b) There is no definite basis, such as population and production for these sectors, to estimate the future conditions.

Accordingly the conditions of these sectors in 2015 are to be described from general points of view as follows:

9.4.1 Navigation

Although there is some expectancy of future development for this sector, it seems more realistic to expect that the navigation services, especially of mid-long distance, would be more or less diminish in 2015 due to the following reasons:

(a) The road-network will be more developed. The passengers by navigation boat will be reduced. Actually in the past, some navigation routes reduced its frequency of services

after new roads were constructed along or nearby the lagoons or canals.

(b) The depth of lagoons and canals will be gradually reduced due to sedimentation coming from rivers. That is, it becomes difficult to keep constant services during the dry season, when the water depths could be less than the necessary draft for boats at some locations. The constant maintenance of navigation routes by dredging will be costly and not feasible from the economic viewpoints.

(c) The navigation through lagoons and canals may not be used actively for sightseeing, except some local areas and temporary use. The landscape from lagoons and canals would be not attractive enough for expecting many tourists, although natural and fresh atmosphere could be tasted.

(d) The transportation requirement by navigation of industrial or agricultural products will not be increased in the future. It will not be probable to develop industrial areas along the lagoons and canals due to necessity of water quality conservation. The transportation of logs also will not be active. The logging activities in forests will be restricted more severely for the environmental conservation. In Cote d'Ivoire, the forest areas have been reduced too much and no more reduction will be accepted, especially in the coastal zone.

However, it is considered that the navigation services will be still active in 2015 in Abidjan and the surrounding areas due to the following reasons:

(a) The city of Abidjan is developed facing to lagoons and the navigation service will be convenient for many passengers even in 2015. They have to take roundabout routes on road with occasional heavy traffic at various locations, which requires more time, if no navigation service is available. It is unlikely that long bridges or tunnel will be constructed across the wide lagoons, as it is costly.

(b) The navigation services in Abidjan area is mainly for passengers and the boats are small enough in the relatively shallow water depth.

On the other hand, there is no definite plan for additional navigation services at present. There is, however, an idea by a government office that additional navigation routes could be newly opened in the following locations:

(a) Bandama River : From the river mouth to nearly 50 km upstream site.

(b) Comoe River: From the river mouth to nearly 50 km upstream site.

It is difficult to anticipate the possibility due to shortage of data on these routes. However, it is considered that the additional routes of navigation services through these rivers would be not realised in 2015, due to the following reasons:

(a) There are no remarkable towns along these river stretches.

(b) The road network will further developed by 2015.

(c) No appropriate products using the navigation services are found.

(d) For passengers, the road will be more convenient and efficient to move.

9.4.2 Ferry Service

It is expected that the locations of ferry services would be more or less reduced by 2015.

The government operates the ferry services at locations, where no bridge is constructed yet although the major roads are already extended to the both banks of rivers. Accordingly the ferry services are provided until the bridges will be constructed. That is, some new bridges can be substituted for some ferry services in the future.

9.4.3 Recreation and Sport

There is no definite plan of water body (Lagoons, canals, reservoirs, rivers) for recreation and sports at present. However, it is anticipated that the recreational uses will remarkably increase by 2015. The major purposes will be as follows:

- Park along water course(walking, cycling or relaxing)
- Fishing
- Swimming
- Boat /canoe, water ski
- Lodging & camping

9.4.4 Environmental Conservation

The rivers in Cote d'Ivoire generally keep natural conditions except the dam sites and weir sites, which impound and control the river flow. No other particular works such as revetment works and groundsill works are seen, except some locations in town area. That is, there are variety of faunas and floras in and around the rivers and lagoons. It would be quite necessary to maintain the present natural conditions as much as possible.

The definite framework for environmental conservation in respect to water body is not established yet. So that, it is assumed that general targets for the environmental conservation are as follows:

(a) To prevent water contamination
(b) To conserve fauna and flora, especially endangered species
(c) To maintain natural landscape
(d) To keep water body and the surrounding areas clean

9.4.5 Sand Mining

The sand mining is generally not from the rivers but from the coast. This condition will not be changed in 2015. Further, no remarkable mining of precious minerals will be carried out from riverbed.

PART 4 WATER BALANCE STUDY

CHAPTER 10 WATER RESOURCES POTENTIAL

10.1 Establishment of Control Points

10.1.1 Necessity and Criteria for Control Points

(1) Necessity for Control Points

It is indispensable to be setting-up the control points for the water resources management and development. Major purpose to be setting-up the control points are as follows:

① To execute the hydrological analysis /water balance calculation and the monitoring of water quantity/quality at the control points;

② To grasp the flow regime in the basins by observing of water level - discharge;

③ To judge of water supply quantities by observing of water level - discharge;

④ To be monitoring the river maintenance discharge;

⑤ To grasp the pollution source in the basins by observing of water quality; and

⑥ To be automatically transporting the monitoring results to the control center

(2) Criteria for Control Points

For control points, it should be selected that a point which furnishes a sufficient quantity of past hydrological data, becomes base point for hydrological analysis and that has close relation with the plan concerning low-water discharge. A multiple number of control points may be established. It is also desirable to select the control point by considering the conflux of tributaries and intake point. A multiple number of control points may be set up, but the control point at the main point may preferably be made to coincide with the design control point concerning high-water discharge.

10.1.2 Establishment of Control Points

Based on above-mentioned purposes and criteria, control points of total fifty-eight (58) are selected. The 58 control points are classified as follows on the basis of the purposes:

- Main control points of 23 contain all purpose ①～⑥
- Other control points of 35 contain only purpose ①/②/③

The detailed contents of established control points are as shown on Table 10.1-1, Table 10.1-2 and Table 10.1-3.

10.2 Rainfall Potential

The rainfalls by dry and rainy season respectively for the four climatic zones were statistically calculated. On an average, the following results can be concluded and as illustrated in Figure 4.2-3. It can be read that the rainwater almost concentrates during the rainy season. Therefore, many ponds were developed in order to use the available rainfall potential.

Table 10.2-1 Rainfall and Rainfall Ratio by Dry and Rainy Seasons

Classification By Climatic Zone	Target Year	Long-term Average (AD 1980-1996)		Drought Year (AD 1983)	
	Season	Dry	Rainy	Dry	Rainy
Attie	Rainfall	223 mm	1,298 mm	176 mm	1,053 mm
	Ratio	**15%**	**85%**	**14%**	**86%**
Baoule	Rainfall	186 mm	911 mm	126 mm	641 mm
	Ratio	**17%**	**83%**	**17%**	**83%**
Sudanese	Rainfall	166 mm	962 mm	119 mm	673 mm
	Ratio	**15%**	**85%**	**15%**	**85%**
Mountainous	Rainfall	79 mm	1,370 mm	89 mm	1,049 mm
	Ratio	**6%**	**94%**	**8%**	**92%**
Simple Average	Rainfall	164 mm	1,135 mm	128 mm	854 mm
	Ratio	**13%**	**87%**	**13%**	**87%**

On the other hand, as stated in Paragraph 4.2, isohyetal maps of annual rainfall for long-term period (AD 1980-1996) and drought year of AD 1983 were respectively completed for further study. The rainfall potential for the major eleven (11) river basins, were respectively estimated on the basis of the isohyetal maps. Table 10.2-2 summarized the estimated rainfall potential by long-term period (AD 1980-1996) and drought year of AD 1983 for the Control Points.

10.3 Surface Water Potential

10.3.1 Method for Potential Estimate of Surface Water

The potential of surface water for the Control Points were estimated based on the monthly discharge data at the gauging stations and then tabulated on Table 10.3-1.

10.3.2 Average Surface Water Potential

Using the average discharge of long-term period with from AD 1980 to 1996, the average surface water potential for the control points were calculated and also tabulated on Table 10.3-2.

10.3.3 Surface Water Potential in Drought Year

Using the average discharge in AD 1983, the surface water potential in drought year for the control points were calculated and also tabulated on Table 10.3-1.

10.4 Method of Estimation of Groundwater Potential

Method of groundwater potential estimation follows " Carte de planification des ressourses en eau de Cote d'Ivoire"(The water resources map 1978), in which groundwater potential was estimated as renewable resources corresponded with effective rainfall and storage capacity classified with lithological characteristics. The estimation process is as follows in accordance with the description of the Water resources map;

10.4.1 Elements of Groundwater Potential Estimation

(1) Effective Rainfall

Effective rainfall (Rf) is a extract (Ex) after subtract real evaporation (Er) from rainfall (R).,

i.e. $Rf = Ex = R - Er$

Er is calculated from relationship between P, Ep (evapo-transpiration), VR (soil moisture content variation) and RFU (water retaining capacity of soil that is easily usable for plant). Er was calculated as average of 20 years (1955-1975). Effective rainfall contour line is shown on Figure 10.5-1.

(2) Infiltration Capacity (relating with lithological character)

Infiltration capacity of the ground that is how many percent of Er can be infiltrate into ground is defined following 3 grade of ratio relating with lithological character of ground.

1/4 of effective rainfall for sedimentary rocks, slate, sandy slate, metamorphosed volcanic rocks of Precambrian

1/3 of effective rainfall for granitic rocks, gneiss, migmatite etc. of Precambrian.

1/2 of effective rainfall for non-metamorphosed sedimentary rock of the Continental terminal.

(3) Lithological and Stratigraphical Classification

(A) Discontinuous Aquifer

Concerning hydrogeological characteristic the discontinuous aquifer is classified following 5 classes ;

i) Granitc rocks of Ebrunian period

ii) Metamorphic rock of sedimentary rock origin, sandstone, conglomerate, crystalline schist, etc.

iii) Metamorphic rock of volcanic and volcano-sedimentary rock origin, tuff, tuff breccia, crystalline tuff.

iv) Metamorphic rock of volcanic rock origin, acidic to basic lava

v) Granite, gneiss, migmatite, etc.of Pre-Birrimian

(A) General Aquifer

Quaternary system and the Continental terminal formation are distributed coastal area and consists of sand, silt, clay and, fluvial and eolian deposit.

(4) Classification of Renewable Groundwater Resources Capacity

Combining above mentioned ratio and lithological and stratigraphical characteristic, renewable groundwater resources is classified 7 ranks as Table 10.4-1. Unit potential of every hydrogeological class is defined taking minimum value of the rank define in the water resources map.

Table 10.4-1 Classification of Renewable Groundwater Resources Capacity

Rank	Unit potential (mm)	Rang of potential	
		(mm)	(m^3/km^2/year)
I	400	More than 400	More than 400,000
II	300	300 to 400	300,000 to 400,000
III	200	200 to 300	200,000 to 300,000
IV	150	150 to 200	150,000 to 200,000
V	100	100 to 150	100,000 to 150,000
VI	50	50 to 100	50,000 to 100,000
VII	25	Less than 50	Less than 50,000

10.4.2 Process of Estimation

(1) Division of Drainage Basin

At first the study area is classified to two big hydrogeological unit, one is the Discontinuous aquifer area and another is the General aquifer area. Then, each unit is divided to drainage basin and sub-basin almost in accordance with the control point. The discontinuous aquifer area is divided into 32 drainage basin and the general aquifer area is divided into 4. Then areas of sub-basin and areas belong to groundwater potential ranks are measured.

(2) Estimation of Average Groundwater Potential of Sub-basins

Secondary, the areas belonging to each groundwater potential ranks (I-VII) of sub-basin are measured. Then average groundwater potential of the sub-basin is estimated by weighted average of different groundwater potential rank.

10.5 Groundwater Potential

Groundwater potential of big hydrogeological units and main river basins are summarized as Table-10.5-1.and detail estimation of each sub-basins are shown as Table 10.5-2, and also distribution of groundwater potential of sub-basins is compiled as "Renewable Groundwater Potential map" (Figure 10.5-1). Average annual groundwater potential of the discontinuous aquifer area is about 28,000 MCM or 91 mm converted into water depth, on the contrary one of the general aquifer area is 2,800 MCM or 334 mm.

10.5.1 Discontinuous Aquifer

(1) Sassandra and Surrounding Basin

The basin is mostly underlain by granitic rocks. Average groundwater potential is 148 mm. Average groundwater potential of sub-basins are higher in eastern zone such as Gavally and San Pedro basin, and Kahin sub-basin ranging more than 200 mm.

(2) Bandama and Surrounding Basin

The basin is underlain by granitic rocks and metamorphosed sedimentary rocks. Average groundwater potential is 56 mm. It is mostly lower in major area of the basin reflecting low rainfall. It is only higher in Boubo river basin (119 mm).

(3) Comoe and Surrounding Basin

The basin is mostly underlain by metamorphosed sedimentary rocks in southern area and underlain by granitic rocks in northern area. Average groundwater potential is 54 mm. It is mostly lower from middle to upper stream of the basin and only higher in southern area such as Bia and Agneby basin, and Lower Comoe basin ranging 90 – 135 mm.

10.5.2 General Aquifer

The groundwater basins of general aquifer are independent from surface water basin and are subject to the area underlain by the Continental terminal formation. Average annual groundwater potential is 200 – 380 mm reflecting high infiltration capacity of the formation and large amount of precipitation of coastal area. While infiltration capacity of the Continental terminal is estimated as 230 mm or 310 MCM/ km^2 for average annual precipitation of 1725 mm (1977 – 1995) according to the study for water supply and aquifer protection program of Abidjan city.

Table 10.5-1 Summary of Groundwater Potential for River Basins
(Renewable Groundwater Resources)

Hydrogeology	River basin	Area of unit basin	Groundwater potential	
		(km^2)	(mm)	MCM/y
	Total of Sassandra and surrounding basin	119,744	148	17,752
	Total and average of Bandama and surrounding basin	111,714	56	6,245
	Total and average of Comoe and surrounding basin	82,150	54	4,437
Total or average of Discontinuous aquifer		313,608	91	28,484
Total General aquifer		8,392	334	2,803
Grand total		322,000	97	31,238

Modified from the "Carte de planification des ressources en eau de Cote d'Ivoire"1978

Table 10.1-1 Synthetic Table of Control Points Classified on 11 Main River Basins

Basin	River	Main Control Points		Other Control Points		Total	Remark
Ⅰ SASSANDRA	Sassandra Main	Ⅰ - C1,C3,C4	3	Ⅰ - C2, C5	2	5	
	Sassandra Tributaries		0	Ⅰ - C6, C7,C8, C9, C10	5	5	
	Total		3		7	10	
Ⅱ BANDAMA	Bandama Main	Ⅱ - C2, C3,C4, C5,C6	5	Ⅱ - C1, C7	2	7	
	Bandama Tributaries	Ⅱ - C10,C12	2	Ⅱ - C8,C9,C11,C13, C14, C15, C16	7	9	
	Total		7		9	16	
Ⅲ COMOE	Comoe Main	Ⅲ - C2,C4,C5	3	Ⅲ - C1*,C3,C6	3	6	Ⅲ -C1* will be established for monitoring of Ebrie Lagoon water quality as same as Comoe river management
	Comoe Tributaries						
	Total		3		3	6	
Ⅳ CAVALLY	Cavally	Ⅳ - C1	1	Ⅳ - C2	1	2	
Ⅴ CETOS							No control point; It will be studied on next stage
Ⅵ BANI-NIGER	Bani-Niger	Ⅵ - C2,C4	2	Ⅵ - C1,C3,C5	3	5	
Ⅶ VOLTA NOIRE (KOLODIO)	Kolodio	Ⅶ - C1	1	Ⅶ - C2	1	2	Ⅶ - C2 is Kolodio river
Ⅷ BIA (Ayame dam area)	Bia	Ⅷ - C3,C4	2	Ⅷ - C1*,C2	2	4	Ⅷ -C1* will be established for monitoring of Aby Lagoon water quality
Ⅸ AGNEBY	Agneby Main	Ⅸ - C4	1	Ⅸ - C5	1	2	
	Adjin			Ⅸ - C1	1	1	
	Me	Ⅸ - C2	1	Ⅸ - C3	1	2	
	Ira			Ⅸ - C6	1	1	
	Total		2		4	6	
Ⅹ BOUBO	Boubo	Ⅹ - C2	1	Ⅹ - C1	1	2	
	Nouniourou			Ⅹ - C3	1	1	
	Bolo			Ⅹ - C4	1	1	
	Total		1		3	4	
ⅩⅠ SAN PEDRO	San Pedro	ⅩⅠ - C1	1			1	
	Nero			ⅩⅠ - C2	1	1	
	Dodo			ⅩⅠ - C3	1	1	
	Total		1		2	3	
Grand Total			23		35	58	

Note: Numbering of the control points is indicated as follows:

- Ⅰ、Ⅱ、Ⅲ,・・: Eleven (11) main river basins' number
- C1, C2, C3 ・・: C = Control Points, 1, 2, 3 ・・= Numbers are indicated from river mouth or confluence to upstream direction

Table 10.1-2 Control Points at Main Sites (Dam Sites, River Mouths and Confluences with Major Tributaries)

Control Point				Catchment Area (km^2)	Selected Reason for the Control Points
No.	River Basin	River Name	Name		
	SASANDRA AND SURROUNDING River BASINS				
I - C4	SASSANDRA	Sassandra	PIEBLY	32,619	Inflow point into BUYO Dam on the SASSANDRA Main River
I - C3	- do. -	-do. -	BUYO Dam	42,250	Existing dam site
I - C1	- do. -	-do. -	GAHOULOU	70,550	River mouth of the SASSANDRA Main River
IV - C1	CAVALLY	Cavally	TATE	28,800	River mouth of the Cavally River
XI - C1	SAN PEDRO	San Pedro	SAN PEDRO	3,320	River mouth of the SAN PEDRO River
VI - C4	BANI-NIGER	Bani-Niger	DJIRILA	3,970	Boundary point with MALI on Ba Oule River
VI - C2	- do. -	-do. -	KOUTO AVAL	4,740	Representative site of the Bagoe River
V - C1	CESTOS	Cestos			No control point *It will be studied on next stage.
	BANDAMA AND SURROUNDING BASINS				
II - C6	BANDAMA	Bandama	TORITAYA AMONT	14,500	Representative site of upstream on the BANDAMA Main River
II - C5	- do. -	-do. -	BADA	24,050	Inflow point into KOSSOU Dam on the BANDAMA Main River
II - C4	- do. -	-do. -	KOSSOU Dam	32,400	Existing KOSSOU Dam
II - C12	- do. -	Marahoue	BOAUFLE	19,800	Site before confluence with the BANDAMA Main River on the Marahoue River (A Tributary of the Bandama River: The Red Bandama)
II - C3	- do. -	Bandama	TAABO Dam	57,800	Existing TAABO Dam
II - C10	- do. -	N'zi	M'BAHIAKRO	15,700	Representative site of the N'zi River (A Tributary of the BADAMA River)
II - C2	- do. -	Bandama	TIASSALE	99,150	Gauging station of the most downstream of the BANDAMA Main River
X - C2	BOUBO	Boubo	GRAND-LAHOU	4,702	River mouth of the BOUBO River
	COMOE AND SURROUNDING BASINS				
III - C5	COMOE	Comoe	KAFOLO	21,200	Boundary point with BURKINA FASO
III - C4	- do. -	-do. -	GANSE	43,700	Representative site of the COMOE Main River
III - C2	- do. -	-do. -	ABARADINOU	74,300	Gauging station of the most down stream of the Comoe Main River
IX - C4	AGNEBY	Agneby	KOSSIHOUEN	7,361	River mouth of the AGNEBY River
IX - C2	ME	Me	IRHO	2,458	River mouth of the ME River
VIII - C4	BIA	Bia	BIAN	6,800	Boundary point with GAHNA
VIII - C3	- do. -	-do. -	AYAME Dam-No.2	9,330	Existing AYAME Dam-No.2
VII - C1	KOLODIO	Kolodio	KONTODOU	2,097	Boundary point of the KOLODIO River with GAHANA

Table 10.1-3 Control Points at Other Sites (Tributaries and Remainning Basins between Main Sites)

Control Point				Catchment	Selected Reason for the Control Points
No.	River Basin	River Name	Name	Area (km^2)	
SASANDRA AND SURROUNDING River BASINS					
I - C2	SASSANDRA	Sassandra	SOUBRE	57,670	Site after confluence with the Lobo River (Tributary of the SASSANDRA Rive on the SASSANDRA Main River
I - C5	- do. -	-do. -	DABALA	16,600	Representative site of upstream on the SASSANDRA Main River
I - C10	- do. -	Tiemba	DIOULATIEDOUGOU	2,790	Representative site of the Tiemba River on the SASSANDRA upstream River
I - C9	- do. -	Bafing	BADALA	5,930	Representative site of the Bafing River on the SASSANDRA tributary River
I - C8	- do. -	N'zo	KHIN	4,310	Representative site of the N'zo River on the SASSANDRA tributary River ; Right side River of the SASSANDRA River
I - C7	- do. -	Lobo	LOBOVILIE	12,745	Site before confluence with the SASSANDRA Main Riv on Labo River
I - C6	- do. -	Davo	DAKPADOU	6,816	Site before confluence with the SASSANDRA Main Riv on Dabo River
IV - C2	CAVALLY	Cavally	TOULEPLEU	4,670	Representative site of the Cavally upstream River
XI - C3	SAN PEDRO	Dodo	WEOULO	649	River mouth of the Dodo River
XI - C2	- do. -	Nero	GRAND BEREBY	1,266	River mouth of the Nero River
VI - C1	BANI-NIGER	Bani-Niger	PAPARA	8,950	Boundary with MALI on the Bagoe River
VI - C3	- do. -	-do. -	DEBETE	5,550	Boundary with MALI on the Ba River
VI - C5	- do. -	Kouroukele	IRADOUGOU	1,490	Representative site of the Kouroukele River
BANDAMA AND SURROUNDING BASINS					
II - C7	BANDAMA	Bandama	TAWARA AMONT	5,375	Representative site in northern part of the BADAMA upstream River
II - C6	- do. -	Bou	BORON	3,754	Representative site of the Bou Riv (Tributary of the BANDAMA River ; BNDAMA Rouge)
II - C13	- do. -	Marahoue	ZUENOULA	16,615	Representative site of the Marahoue River (Tributary of the BANDAMA River ; BADAMA Rouge)
II - C14	- do. -	-do. -	MANKONO	6,700	Representative site of the Marahoue upstream River
II - C15	- do. -	Banoroni	KOUROUKORO	4,810	Site before confluence with the Marahoue River
II - C8	- do. -	N'zi	ZIENOA	35,000	Site before confluence with the BANDAMA Main River on N'zi River
II - C9	- do. -	-do. -	DIMBOKRO	24,100	Midle site between Z'ENOA and M'BAHIAKRO control points on the N'zi River
II - C11	- do. -	-do. -	RTE KATIOLA-DABAKALA	6,620	Representative site in the upstream of the N'zi River
II - C1	- do. -	Bandama	NZIDE *Addition	101,767	River mouth of the BANDAMA River
X - C3	BOUBO	Niouniourou	DAHIRI	2,112	River mouth of the Niouniourou River *Addition → Tiassale+remaining
X - C4	- do. -	Bolo	FRESCO	1,330	River mouth of the Bolo River
X - C1	- do. -	Boubo	GRAND-LAHOU	2,192	Riber mouth of the Boubo River
COMOE AND SURROUNDING BASINS					
III - C3	COMOE	Comoe	AKAKOMOEKRO	57,000	Midle site between ABARADINOU and GANSE on the COMOE Main River
III - C6	- do. -	Ba	N'DAKRO	6,222	Site before confluence with the COMOE main River on the Ba River
III - C1	- do. -	Comoe	GRAND BASSAM *Addition	77,637	River mouth of the Comoe River *Addition → ***Monitoring of Ebrie Lagoon water quality**
IX - C5	AGNEBY	Agneby	AGBOVILLE	4,878	Representative site of the Agneby upstrean River
IX - C3	ME	Me	LOBOAKOUDZIN	1,274	Representative site of the Me upstream River
IX - C6	AGNEBY	Ira	IRA	444	River mouth of the Ira River
IX - C1	- do. -	Adjin	ADJIN (LA.ADJIN) *Addition	592	Planning poits of ABIDJAN urban water supply intake site
VIII - C2	BIA	Bia	KRINDJABO *Addition	10,033	River mouth of the Bia River ;Down stream of the Ayame No.2 Dam
VIII - C1	- do. -	-do. -	MOUTH OF ABY LAGOON	12,149	Mouth of Aby Lagoon **;Monitorin of Aby Lagoon water quality**
VII - C2	KOLODIO	Volta-Noire	VONKORO	111,500	Gauging station in Cote d'Ivore area on the KOLODIO River

Table 10.2-2 Estimated Rainfall Potential by Long-term Period (AD 1980-1996) and AD 1983 for the Control Points

Name of Basin	Name of River	Number of Control Point	Name of Control Point	Catchment Area (km^2)	Estimated Rainfall Potential (mm)		◎: Main ○: Others
					Long-term Average (AD 1980-1996)	Drought Year AD 1983	
Sassandra and Surrounding River Basins							
Sassandra	Sassandra	I-C5	Dabala	16,600	1,250	708	○
		I-C4	Piebly	32,600	1,313	808	◎
		I-C2	Buyo Dam	42,250	1,383	914	◎
		I-C2	Soubre	57,670	1,392	926	○
		I-C1	**Gaoulou Pont**	**70,550**	**1,366**	**958**	◎
	Tiemba	I-C10	Dioulatiedougou	2,790	1,300	900	○
	N'zo	I-C8	Khin	4,310	1,650	1,300	○
	Bafing	I-C9	Badala (Bafingdala)	5,930	1,500	1,100	○
	Davo	I-C6	Dakpadou	6,816	1,200	1,100	○
	Lobo	I-C7	Loboville	12,745	1,200	800	○
Cavally	Cavally	IV-C2	Toulepleu (Saihibli)	4,670	1,700	1,400	○
		IV-C1	**Tate**	**28,800**	**1,951**	**1,400**	◎
San Pedro	Dodo	XI-C3	Weoulo (Ouaoulo)	649	1,800	1,500	○
	Nero	XI-C2	Rte Grand Bereby	1,266	1,600	1,300	○
	San Pedro	XI-C1	San Pedro	3,320	1,400	1,250	◎
Bani-Niger	Kouroukelle	VI-C5	Iradougou	1,490	1,300	1,000	○
(Baoule)	Baoule	VI-C4	Djirila	3,970	1,350	1,000	◎
	Kankelaba	VI-C3	Debete	5,550	1,100	900	○
	Bagoe	VI-C2	Kouto Aval	4,740	1,100	800	◎
		VI-C1	Papara	8,950	1,053	753	○
Cestos	Cestos	V-	-	-	-	-	◎
Bandama and Surrounding River Basins							
Bandama	Bandama	II-C7	Tawara Amont	5,375	1,150	700	○
		II-C6	Toritaya Amont	14,500	1,181	763	◎
		II-C5	Bada	24,050	1,172	735	◎
		II-C4	Kossou Dam	32,400	1,154	673	◎
		II-C3	Taabo Dam	57,800	1,140	663	◎
		II-C2	**Tiassale**	**99,150**	**1,102**	**693**	◎
		II-C1	Nzide (River Mouth Bandama)	101,767	1,102	693	○
	Bou	II-C16	Rte Boron-Kadyoha	3,754	1,250	750	○
	Marahoue	II-C14	Mankono	6,700	1,150	700	○
		II-C13	Zuenoula	16,615	1,134	697	○
		II-C12	Bouafle	19,800	1,129	580	◎
	Banoroni	II-C15	Kouroukoro	4,810	1,150	500	○
	Nzi	II-C11	Rte Katiola-Dabakala	6,620	1,150	800	○
		II-C10	M'Bahiakro	15,700	1,063	685	◎
		II-C9	Dimbokro	24,100	1,059	725	○
		Ii-C8	Zienoa (N'zianoa)	35,000	1,056	748	○
Boubo	Bolo	X-C4	Fresco	1,330	1,300	1,000	○
	Boubo	X-C2	Grand-Lahou	4,702	1,200	900	◎
	Boubo	X-C1	Grand-Lahou	2,192	1,200	900	◎
	Niouniourou	X-C3	Dahiri	2,112	1,300	1,000	○
Comoe and Surrounding River Basins							
Comoe	Comoe	III-C5	Kafolo	21,200	1,100	600	◎
		III-C4	Ganse	43,700	1,049	703	◎
		III-C3	Akakomoekro	57,000	1,049	656	○
		III-C2	**Abaradinou**	**74,350**	**1,080**	**696**	◎
		III-C1	Grand Bassam (River Mouth)	77,687	1,080	696	○
	Ba	III-C6	N'dakro	6,222	1,150	700	○
Agenby	Agenby	IV-C5	Agboville	4,878	1,136	800	○
		IX-C4	Kossihouen	7,361	1,076	818	◎
	Me	IV-C3	Lobo Akoudzin	1,274	1,300	800	○
		IX-C2	Irho	2,458	1,365	926	◎
	Ira	VI-C6	Ira	444	1,300	900	○
		VI-C1	Adjin (Lag. Adjin)	592	1,365	926	○
Bia	Bia	**VIII-C4**	**Bianouan Aval**	**6,800**	**1,300**	**1,200**	◎
		VIII-C3	Ayame-2 Dam	9,330	1,284	1,200	◎
		VIII-C1	Mouth Lagoon	-	-	-	◎
		VIII-C2	Krindjabo (Downstream Ayame)	10,033	1,284	1,200	○
Volta-Noire	Kolodio	**VII-C1**	**Kontodou**	**2,097**	**1,000**	**700**	◎
	Volta-Noire	VII-C2	Vonkoro	111,500	1,100	800	○

Note: "-" means data not available, ◎Main Control Points=23 points, ○Other Points =35 Points

Table 10.3-1 Surface Water Potential and 1/10 Probability Surface Water at Each Control Point

Name of Basin	Name of River	Number of Control Point	Name of Control Point	Catchment Area (km^2)	Long-term Average				A.D. 1983			◎Main ○Others
					Rain(mm) ①	Surface(mm) ②	1/10 Prb.(mm) ③	(%) ⑥=②/①	Rain(mm) ①	Surface(mm) ②	(%) ⑥=②/①	
Sassandra and Surrounding River Basins							Note-2					
Sassandra	Sassandra	I-C5	Dabala	16,600	1,250	325	165	26.0	708	132	19.0	○
		I-C4	Piebly	32,600	1,313	170	126	13.0	808	101	13.0	◎
		I-C2	Buyo Dam	42,250	1,383	217	-	16.0	914	198	14.6	◎
		I-C2	Soubre	57,670	1,392	148	134	16.0	926	161	17.0	○
		I-C1	**Gaoulou Pont**	**70,550**	**1,366**	**173**	**139**	**12.7**	**958**	**167**	**17.0**	◎
	Tiemba	I-C10	Dioulatiedougou	2,790	1,300	176	71	14.0	900	57	6.0	○
	N'zo	I-C8	Khin	4,310	1,650	278	283	17.0	1,300	227	18.0	○
	Bafing	I-C9	Badala (Bafingdala)	5,930	1,500	261	194	18.0	1,100	155	14.0	○
	Davo	I-C6	Dakpadou	6,816	1,200	120	99	10.0	1,100	79	7.0	○
	Lobo	I-C7	Loboville	12,745	1,200	139	-	12.0	800	-	-	○
Cavally	Cavally	IV-C2	Toulepleu (Saihibli)	4,670	1,700	447	238	26.0	1,400	271	20.0	○
		IV-C1	**Tate**	**28,800**	**1,951**	**523**	**285**	**26.8**	**1,400**	**221**	**16.0**	◎
San Pedro	Dodo	XI-C3	Weoulo (Ouaoulo)	649	1,800	469	414	26.0	1,500	321	21.0	○
	Nero	XI-C2	Rte Grand Bereby	1,266	1,600	410	308	26.0	1,300	239	18.0	○
	San Pedro	XI-C1	San Pedro	3,320	1,400	334	321	24.0	1,250	249	20.0	◎
Bani-Niger	Kouroukelle	VI-C5	Iradougou	1,490	1,300	211	150	16.0	1,000	176	18.0	○
(Baoule)	Baoule	VI-C4	Djirila	3,970	1,350	151	110	11.0	1,000	129	13.0	◎
	Kankelaba	VI-C3	Debete	5,550	1,100	132	48	12.0	900	54	6.0	○
	Bagoe	VI-C2	Kouto Aval	4,740	1,100	173	83	16.0	800	44	6.0	◎
		VI-C1	Papara	8,950	1,053	148	66	14.0	753	35	5.0	○
Cestos	Cestos	V-	-	-								
Bandama and Surrounding River Basins												
Bandama	Bandama	II-C7	Tawara Amont	5,375	1,150	76	42	7.0	700	13	2.0	○
		II-C6	Toritaya Amont	14,500	1,181	83	42	7.0	763	13	2.0	◎
		II-C5	Bada	24,050	1,172	76	33	7.0	735	10	1.4	◎
		II-C4	Kossou Dam	32,400	1,154	88	-	8.0	673	16	2.3	◎
		II-C3	Taabo Dam	57,800	1,140	107	-	9.0	663	24	3.6	◎
		II-C2	**Tiassale**	**99,150**	**1,102**	**88**	**26**	**8.0**	**693**	**22**	**3.0**	◎
		II-C1	Nzide (River Mouth Bandama)	101,767	1,102	126	26	11.0	693	22	3.0	○
	Bou	II-C16	Rte Boron-Kadyoha	3,754	1,250	73	12	6.0	750	10	1.3	○
	Marahoue	II-C14	Mankono	6,700	1,150	82	11	7.0	700	6	0.9	○
		II-C13	Zuenoula	16,615	1,134	76	11	7.0	697	6	0.9	○
		II-C12	Bouafle	19,800	1,129	79	11	7.0	580	6	1.0	◎
	Banoroni	II-C15	Kouroukoro	4,810	1,150	82	20	7.0	500	6	1.2	○
	Nzi	II-C11	Rte Katiola-Dabakala	6,620	1,150	54	10	5.0	800	0	0.0	○
		II-C10	M'Bahiakro	15,700	1,063	57	10	5.0	685	3	0.4	◎
		II-C9	Dimbokro	24,100	1,059	47	10	5.0	725	3	0.4	○
		Ii-C8	Zienoa (N'zianoa)	35,000	1,056	44	20	4.0	748	6	0.8	○
Boubo	Bolo	X-C4	Fresco	1,330	1,300	69	10	5.0	1,000	0	0.0	○
	Boubo	X-C2	Grand-Lahou	4,702	1,200	63	55	5.0	900	47	5.0	◎
	Boubo	X-C1	Grand-Lahou	2,192	1,200	63	55	5.0	900	47	5.0	
	Niouniourou	X-C3	Dahiri	2,112	1,300	195	140	15.0	1,000	120	12.0	○
Comoe and Surrounding River Basins												
Comoe	Comoe	III-C5	Kafolo	21,200	1,100	85	27	8.0	600	15	3.0	◎
		III-C4	Ganse	43,700	1,049	76	23	7.0	703	13	2.0	◎
		III-C3	Akakomoekro	57,000	1,049	60	18	6.0	656	10	1.5	○
		III-C2	**Abaradinou**	**74,350**	**1,080**	**47**	**19**	**4.4**	**696**	**10**	**1.4**	◎
		III-C1	Grand Bassam (River Mouth)	77,687	1,080	44	19	4.0	696	10	1.4	○
	Ba	III-C6	N'dakro	6,222	1,150	28	13	2.4	700	7	1.0	○
Agenby	Agenby	IV-C5	Agboville	4,878	1,136	32	25	2.8	800	13	1.6	○
		IX-C4	Kossihouen	7,361	1,076	58	25	5.0	818	13	1.6	◎
	Me	IV-C3	Lobo Akoudzin	1,274	1,300	189	150	15.0	800	79	10.0	○
		IX-C2	Irho	2,458	1,365	198	173	15.0	926	91	10.0	◎
	Ira	VI-C6	Ira	444	1,300	189	169	15.0	900	89	10.0	○
		VI-C1	Adjin (Lag. Adjin)	592	1,365	198	173	15.0	926	91	10.0	○
Bia	Bia	**VIII-C4**	**Bianouan Aval**	**6,800**	**1,300**	**88**	**60**	**6.8**	**1,200**	**60**	**5.0**	◎
		VIII-C3	Ayame-2 Dam	9,330	1,284	142	-	11.0	1,200	73	6.1	◎
		VIII-C1	Mouth Lagoon	-	-	-	-	-	-	-	-	
		VIII-C2	Krindjabo (Downstream Ayame)	10,033	1,284	142	-	-	1,200	-	-	○
Volta-Noire	Kolodio	**VII-C1**	**Kontodou**	**2,097**	**1,000**	**69**	**67**	**6.9**	**700**	**67**	**10.0**	◎
	Volta-Noire	VII-C2	Vonkoro	111,500	1,100	32	76	2.9	800	76	10.0	○

Note: ⑥= Runoff Coefficient (%), ◎Main Control Points=23 points, ○Other Points =35 Points, Note-2: 1983 Surface Water×Table 5.2-8**mark figure

Table 10.3-2 Average Annual Rainfall v.s. Surface Water Potential

Basin Name	River's Name (Control Point)	Catchment Area(km^2) Basin	Catchment Area(km^2) River	Average Rainfall (mm)	Average Surface Water (mm)	Drought Year Water (mm) 1/10 Prb.	Drought Year Water (mm) 1/5 Prb.
	Sassandra	63,700*5					
SASSANDRA	(Gaoulou pont)		**70,750*1**	**1,366**	**173**	**139**	**152**
	Cavally						
CAVALLY	(Tate)	14,800	**28,800*2**	**1,951**	**523**	**285**	**342**
SAN PEDRO	Dodo		649	1,800	469	414	476
	Nero		1,266	1,600	410	308	354
	San Pedro		3,320	1,400	334	321	369
	Total	5,300	**5,235**	**1,497**	**369**	**264**	**304**
BANI-NIGER	Kouroukele		1,490	1,300	211	150	183
	Bauole		3,970	1,350	151	110	134
	Kankelona		5,550	1,100	132	48	59
	Bagoe (Papara)		8,952*3	1,053	148	66	97
	Total	18,000*6	**19,962**	**1,147**	**147**	**78**	**85**
BANDAMA	Bandama	101,800*7					
	(Tiassale)		**99,150**	**1,102**	**88**	**26**	**52**
BOUBO	Bolo		1,330	1,300	69	10	12
	Boubo		4,702	1,200	63	55	64
	Niouniourou		2,112	1,300	195	140	164
	Total	8,200	**8,144**	**1,240**	**98**	**65**	**76**
COMOE	Comoe	67,700*8					
	Abradinou		**74,350*4**	**1,080**	**47**	**19**	**28**
AGNEBY	Agneby		7,361	1,076	58	25	41
	Me		2,458	1,365	198	173	282
	Ira		444	1,300	189	169	275
	Total	10,300	**10,263**	**1,172**	**97**	**57**	93
BIA	Bia	10,100*9	**6,800**	**1,300**	**88**	**60**	**98**
VOLTA NOIRE	Kontodouo	2,100	**2,097**	**1,000**	**69**	**67**	**89**
TOTAL		302,000	**325,551**	**1,247**	**144**	**82**	**98**
Annual Volume (Billion m^3)		≒20,000*10	for 322,000 km^2	401.5	46.4	26.4	31.7

*1Including Guinne (6,850 km^2) Basin=28,800-14,000=14,800 km^2

*2 Including Liberia (about 14,000 km^2)

*3 Including some part of Burkina Faso (about 2,000 km^2)

*4 Including Burkina Faso (about 10,000 km^2)

*5 Ⅰ-C1- Gunee = 70,550-6,850 = 63,700 km^2

*6 Total －*3 = 19,962 －2,000 = 17,962 km^2 ≒18,000 km^2

*7 = Ⅱ-C1 101,767 ≒101,800 km^2

*8Ⅲ-C1-*4 = 77,687 - 10,000 = 67,687 km^2 ≒67,700 km^2

*9 = Ⅷ-C2

*10 = Area in out of Control Points

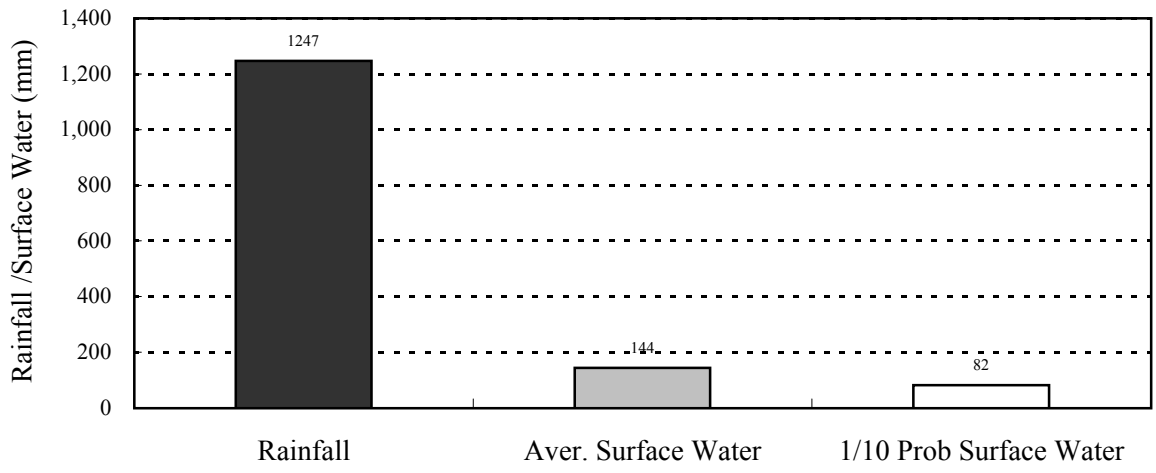


Figure 10.1-1 Surface Water Potential

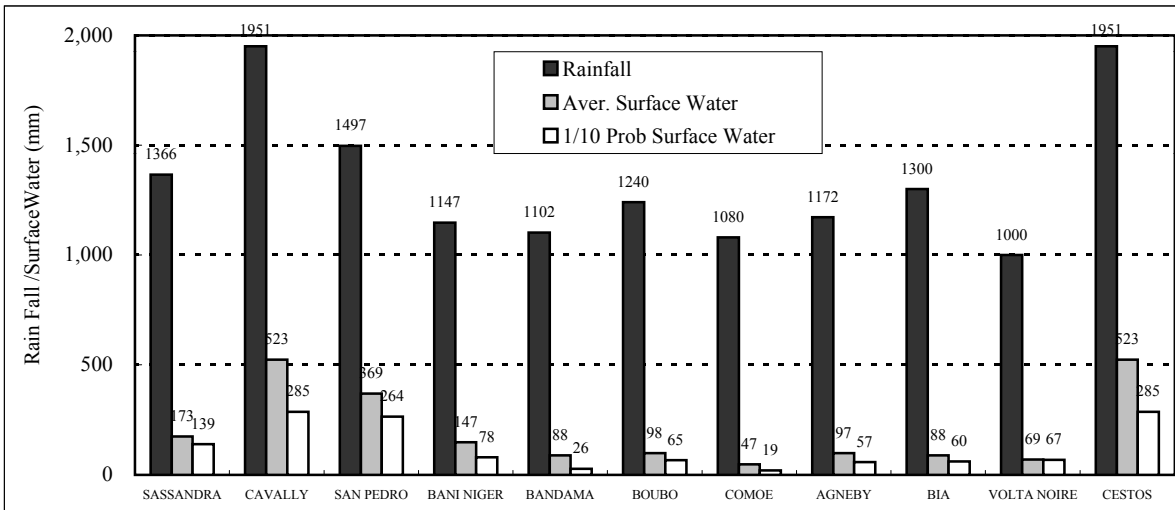


Figure 10.1-2 Surface Water Potential in 11 River Basins

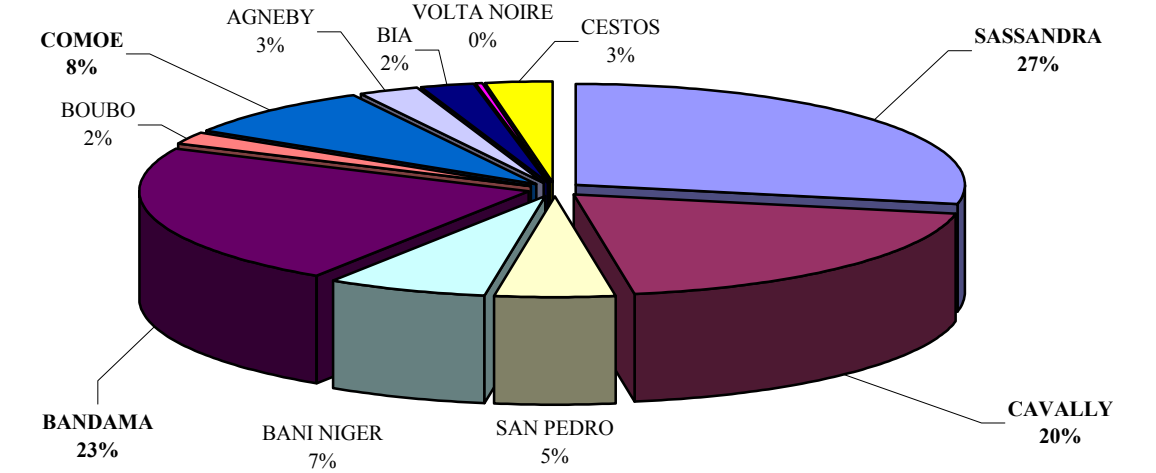


Figure 10.1-3 Surface Water Distribution by 11 River Basins

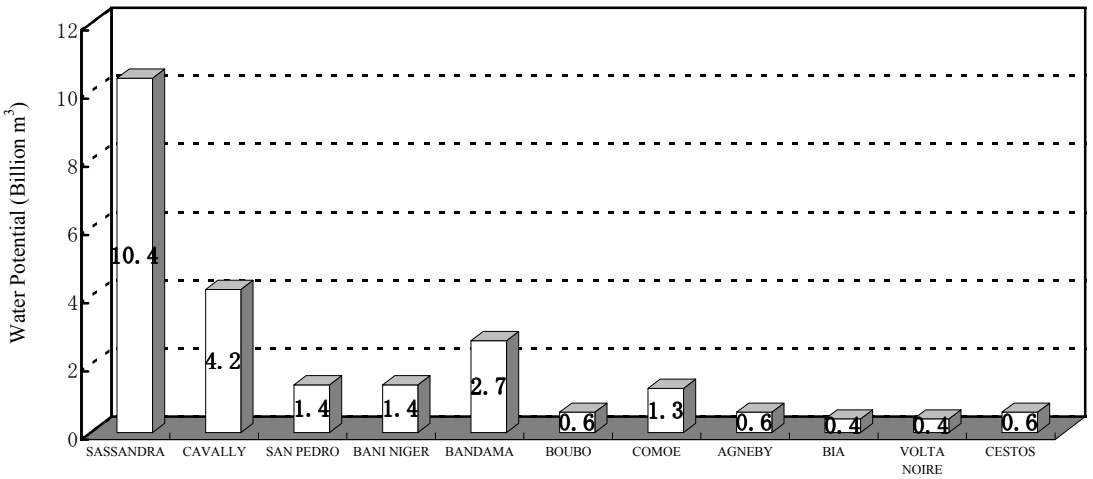


Figure 10.1-4 Potential of 1/10 Probable Surface Water

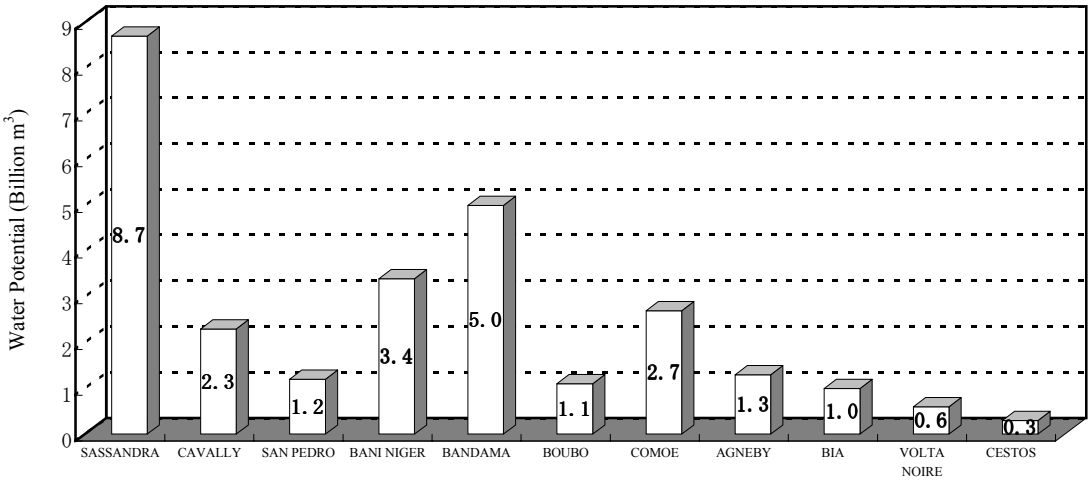


Figure 10.1-5 Potential of Groundwater

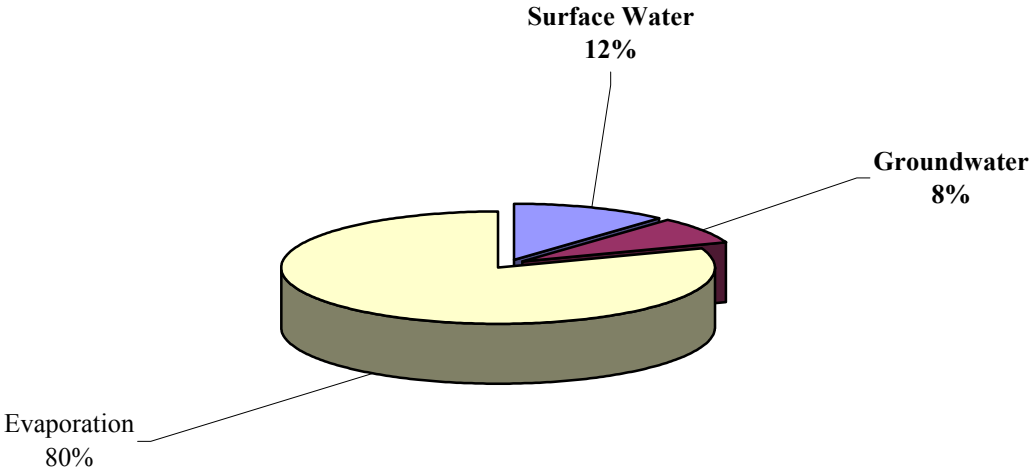


Figure 10.1-6 Water Potential Distribution

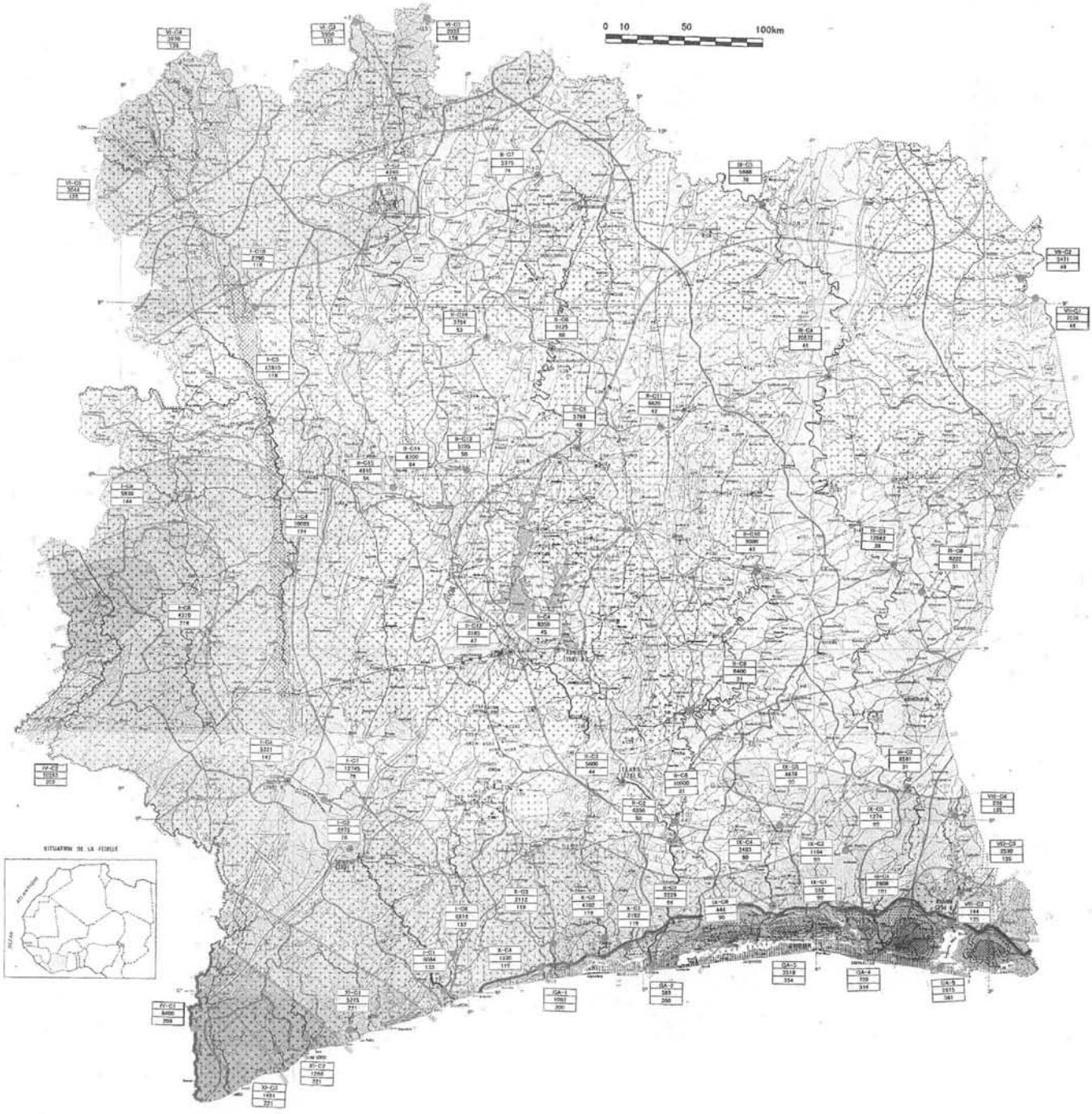
Table 10.5-2 Groundwater potential for river basins (Renewable groundwater resources)

Hydrogeology	River basin	River name	Sub basin	Control point (***bold-type*** = main Control Point) / Groundwater Basin		Area of unit basin	Groundwater potential	
				No	Name	(km2)	(mm)	MCM/y
Dis-continuous aquifer	Sassandra and surrounding basin							
	Sassandra	Sassandra	Gahoulou	I-C1	***Gahoulou***	6,064	133	807
		Sassandra+Lobo	Soubre	I-C2	Soubre	2,675	78	208
		Sassandra	Buyo	I-C3	***Buyo Dam***	5,321	147	781
		Sassandra	Piebly	I-C4	***Piebly***	10,089	124	1,253
		Sassandra	Dabala	I-C5	Dabala	13,810	116	1,602
		Sassandra	Dakpadou	I-C6	Dakpadou	6,816	133	907
		Sassandra	Loboville	I-C7	Lobovilie	12,745	78	994
		Nzo	Kahin	I-C8	Kahin	4,310	216	930
		Bafing	Badala	I-C9	Badala	5,930	144	851
		Tiemba	Dieulatiedougou	I-C10	Dioulatiedougou	2,790	116	324
		sub-total or average		sub-total Sassandra basin		70,550	123	8,656
	Gavally	Gavally	Tate	IV-C1	***Tate***	8,400	209	1,756
		Gavally+Nuon	Toulepleu	IV-C2	Toulepleu	10,383	244	2,533
	Ba-Oule	Bani-Niger	Papala	VI-C1	Papala	2,033	136	276
		Bani-Niger	Koute	VI-C2	***Kouto Point***	4,740	136	643
		Bani-Niger	Debete	VI-C3	Debete	5,550	136	753
		Bani-Niger	Djirila	VI-C4	***Djirila***	7,082	136	961
		Kouroukele	Iradougou	VI-C5	Iradougou	3,044	136	413
	San Pedro	San Pedro	San Perdo	XI-C1	***San Perdo***	5,215	221	1,153
		Nero	Grand Bereby	XI-C2	Grand Bereby	1,266	221	280
		Dodo	Weoulo	XI-C3	Weoulo	1,481	221	327
	Total of Sassandra and surrounding basin			total		119,744	148	17,752
	Bandama and surrounding basin							
	Bandama	Bandama	Lower Bandama	II-C1	Nzide	2,228	84	187
		Bandama	Tiassale	II-C2	***Tiassale***	6,350	50	315
		Bandama	Taabo Dam	II-C3	***Taabo Dam***	5,600	44	248
		Bandama	Kossou	II-C4	***Kossou***	8,350	45	378
		Bandama	Bada	II-C5	***Bada***	5,796	48	277
		Bandama	Toritaya	II-C6	***Toritaya***	9,125	68	621
		Bandama	Nyama	II-C7	Tawara amount	5,375	74	399
		Nzi	Mbimbe	II-C8	Zienoa	10,900	31	334
		Nzi	Dimbokro	II-C9	Dimbokro	8,400	31	258
		Nzi	Mbahiakro	II-C10	***Mbahiakro***	9,080	43	386
		Nzi	Kapele	II-C11	Rte Katiola-Dabakara	6,620	42	276
		Maraoue	Bouafle	II-C12	***Bouafle***	3,185	47	150
		Maraoue	Fizanlouma	II-C13	Zuenola	5,105	50	255
		Maraoue	Kouroukourouga	II-C14	Mankono	6,700	64	427
		Banoroni	Kouroukoro	II-C15	Kouroukoro	4,810	64	307
		Bou	Boron	II-C16	Rte Boron-Kadyoha	3,754	53	197
				sub-total Bandama basin		101,378	49	5,015
	Boubo	Boubo	Grand Lahou	X-C1	Grand Lahou	2,192	119	261
		Boubo	Grand Lahou	X-C2	***Grand Lahou***	4,702	119	560
		Niouniourou	Dahili	X-C3	Dahili	2,112	119	251
		Bolo	Fresco	X-C4	Fresco	1,330	119	158
	Total and average of Bandama and surrounding basin					111,714	56	6,245
	Comoe and surrounding basin							
	Comoe	Comoe	Lower Comoe	III-C1	Grand Bassan	2,608	101	263
		Comoe	Abaradinou	III-C2	***Abaradinou***	8,561	31	269
		Comoe	Akakomoekro	III-C3	Akakomoekro	12,562	39	493
		Comoe	Ganse	III-C4	***Ganse***	20,572	41	839
		Comoe	Kafolon	III-C5	***Kafolon***	5,668	76	433
		Comoe	N7dakro	III-C6	N'dakro	5,865	31	184
				Sub total Comoe basin		55,836	44	2,482
	Kolodio	Kolodio	Kontodou	VII-C1	***Kontodou***	7,078	46	328
		Volta Noire	Vonkoro	VII-C2	Vonkoro	5,471	46	253
	Bia	Bia	Mouth Lagoon	VIII-C1	Mouth Lagoon	0	135	0
		Bia	Krindjaabo	VIII-C2	Krindjaabo	144	135	19
		Bia	Ayame Dam2	VIII-C3	***Ayame Dam2***	2,530	135	342
		Bia	Bian	VIII-C4	***Bian***	236	135	32
	Agneby	Agneby	Adjin	IX-C1	Adjin	592	90	53
		Me	Irho	IX-C2	***Irho***	1,184	90	107
		Me	Loboakoudzin	IX-C3	Loboakoudzin	1,274	90	115
		Agneby	Kossihouen	IX-C4	***Kossihouen***	2,483	90	224
		Agneby	Agboville	IX-C5	Agboville	4,878	90	441
		Ira	Ira	IX-C6	Ira	444	90	40
	Total and average of Comoe and surrounding basin					82,150	54	4,437
Total or average of Discontinuous aquifer						313,608	91	28,434
General aquifer	Coastal area	Boubo	Grand Lahou	GA-1	Grand Lahou	1,083	200	217
		Bandama	Mouth of Bandama	GA-2	Mouth of Bandama	389	200	78
		Agenby	Abidjan	GA-3	Abidjan	3,516	354	1,244
		Comoe	Grand Bassan	GA-4	Grand Bassan	729	336	245
		Mouth Lagoon	Mouth of Lagoon	GA-5	Mouth of Lagoon	2,675	381	1,019
Total General aquifer						8,392	334	2,803
Grand total						322,000	97	31,238

Modified from the"Carte de planification des ressources en eau de Cote d'Ivoire"1978

Figure 10.5-1 Renewable Groundwater Ootential

Modefied from the "Carte planification des ressources en eau de Cote d'Ivoire" 1987



Renewable Aquifer Resources

Renewable groundwater resources corresponds with a fraction ob effective rainfall of concerning zone

1/4 for shale and slate
1/3 for granites gneiss and migmatite
1/2 for sand and sandstone non metamorphosed

Rank	Average unit potential (mm)	
I	400	more than 400 mm or 400,000 m^3/km^2 per year
II	300	between 300 and 400 mm or 300,000 and 400,000 m^3/km^2 per year
III	200	between 200 and 300 mm or 200,000 and 300,000 m^3/km^2 per year
IV	150	between 150 and 200 mm or 150,000 and 200,000 m^3/km^2 per year
V	100	between 100 and 150 mm or 100,000 and 150,000 m^3/km^2 per year
VI	50	between 50 and 100 mm or 50,000 and 100,000 m^3/km^2 per year
VII	25	less than 50 mm or 50,000 m^3/km^2 per year
	600	isoeffective rainfall line (annual average mm)

Renewable Groundwater of Unit Basin

Unit Basin	Lower Bandama
Area (km^2)	2346
Goundwater Potential (mm)	84

River basin

General aquifer groundwater basin