JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CABINET OF THE PRIME MINISTER
THE REPUBLIC OF COTE D'IVOIRE

MASTER PLAN STUDY
ON
INTEGRATED WATER RESOURCES MANAGEMENT
IN
THE REPUBLIC OF COTE D'IVOIRE

FINAL REPORT

SUMMARY

JANUARY 2001

SANYU CONSULTANT INC.
KATAHIRA & ENGINEERS INTERNATIONAL

PREFACE

In response to a request from the Government of the Republic of Côte d'Ivoire, the Government of Japan decided to conduct a Development study on Integrated Water Resources Management in the Republic of Côte d'Ivoire and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Takao Kume of SANYU CONSULTANTS INC. (and consist of SANYU CONSULTANTS INC. and KATAHIRA ENGINEERS INTERNATIONAL) to Côte d'Ivoire, two times between July 1999 and July 2000. In addition, JICA set up an advisory committee headed by Mr. Tuyoshi Koike, Deputy Director of River Development Division River Bureau, Ministry of Construction between July 1999 and January 2001 (and by Mr. Shinya Mitsuishi, Deputy Director of River Development Division River Bureau, Ministry of Construction between Aug 2000 and January 2001), which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Côte d'Ivoire and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Côte d'Ivoire for their close cooperation extended to the Team.

January 2001

Kunihiko Saito
President
Japan International Cooperation Agency

January 2001

Kunihiko Saito
President
Japan International Cooperation Agency (JICA)
Tokyo

Letter of Transmittal

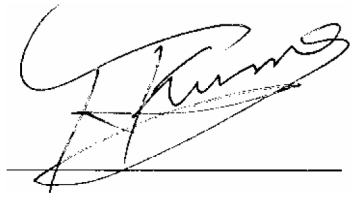
Dear Sir,

We are pleased to submit to you our Final Report on the Master Plan Study on Integrated Water Resources Management in the Republic of Côte d'Ivoire. This Report incorporates the findings and the master plans formulated, as well as advice and suggestions of the authorities concerned of your Agency and the Government of Japan.

This Study aims to formulate a national master plan of integrated water resources management for the Target Year 2015. The Study covers the whole land of Côte d'Ivoire, and the objectives of the Study area to study water resources development potential for sustainability and to establish national institution for water resources management for better in water use. The Government of Côte d'Ivoire is recommended to make financial arrangement for creation of Water Authority and three (3) Basin Water Agencies which aim at an integrated management of water resources to resolve the problems caused by sectarian management.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs of the Government of Japan. We also wish to express our deep gratitude to Cabinet of Prime Minister, the Republic of Côte d'Ivoire for the close cooperation and assistance extended to us during our studies.

Very truly yours,



Takao KUNE
Leader of the Study Team

LIST OF REPORTS

This volume is part of the following reports :

- SUMMARY（FRENCH / ENGLISH）
- MAIN REPORT（FRENCH / ENGLISH）
- SUPPORTING REPORT（ENGLISH）

Exchange Rate

1 US Dollar	=	700.6	FCFA
1 US Dollar	=	110.0	Japanese Yen
1 FCFA	=	0.157	Japanese Yen

July 2000

REPUBLIQUE DE COTE D'IVOIRE

GESTION INTEGREE DES RESSOURCES EN EAU

BASIN AND CONTROL POINT MAP WITH CARTOGRAPHIC FEATURES

LEGEND

- Capital of Country
- Capital of Region
- Capital of Department
- Capital of Sub-Prefecture
- Control Point
- Country Boundary
- Region Boundary
- Department Boundary
- River Network
- Water Body
- Main Basin Boundary
- Boundary Based on Control Point

This summary briefs the objectives, present conditions, future framework, water balance study, water resources management plan and recommendations, along with the descriptive flow of the main reports.

Prior to the explanation, outline of the water balance and implementation schedule are described below.

1. Monthly Surface Water Balance in Future (AD 2015)

The monthly water balances of representative rivers are as shown in Figures 1 & 2. From these Figures, the water balance of each river is summarized as follows;

a) Sassandra Upstream and San Pedro Rivers

The river flow is sufficient for water supply compared with the demand.

b) Bani-Niger River

Water supply is possible during only four months of August, September, October and January, while other 8 months are experiencing shortage of the water supply.

c) Bandama Upstream River

Water supply during only two months, September and October, could be carried out while during other 10 months considerable shortage of the water supply is the reality.

d) Agneby River

Water supply during only two months of June and July could be effected while in other 10 months water supply trends to falter.

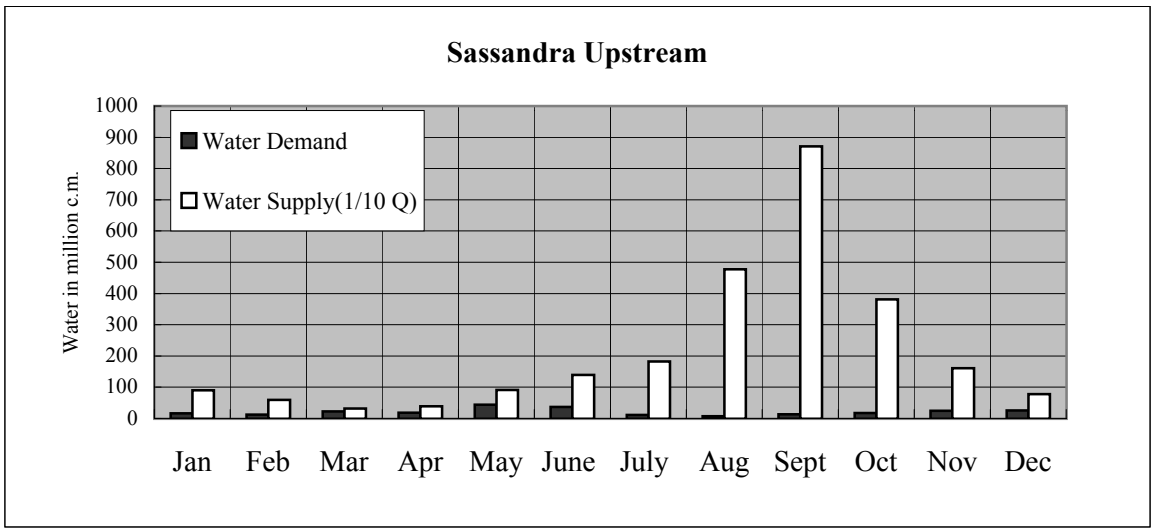
e) Comoe River

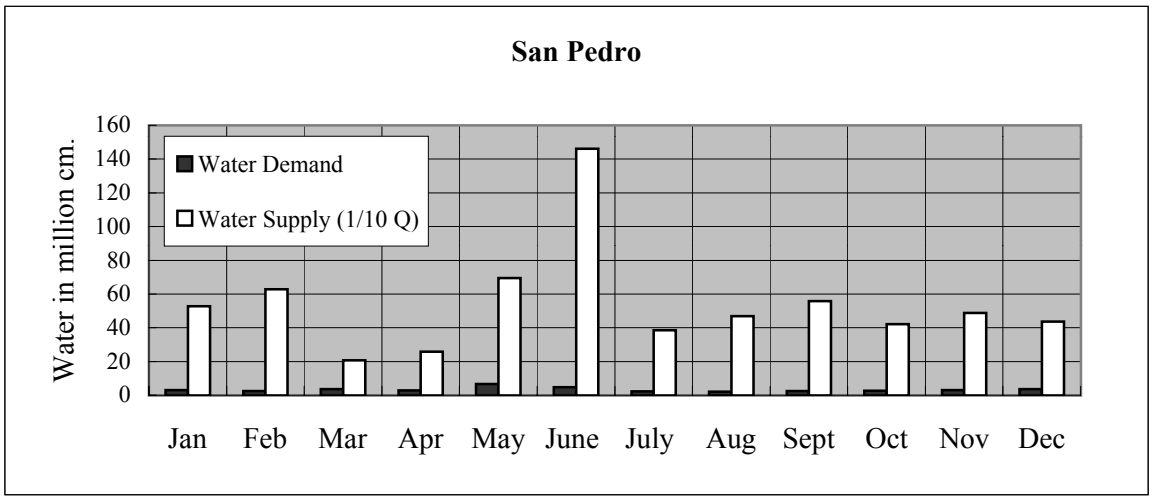
Although there is plenty river flow in four months from July to October, the river flow in other 8 months are of very small quantity, especially the river flow in February and March indicates 0.

2. Financing and Implementation Schedule

The required program for the period 2000 to 2015 is as shown in Table-1.

The required budget for water resources management is calculated at 22.3 billion FCFA while water resources development requires 679.8 billion FCFA.





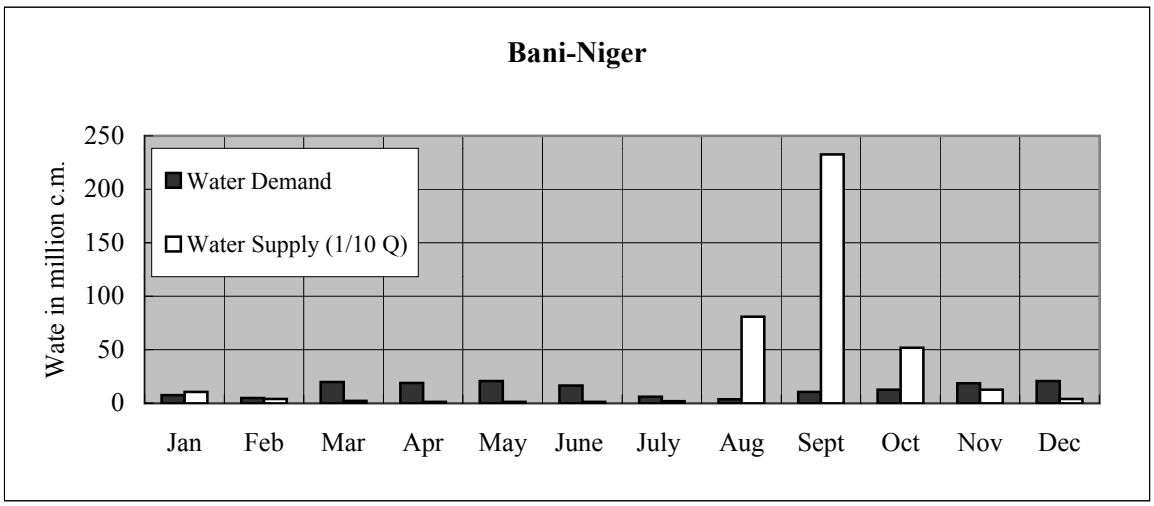
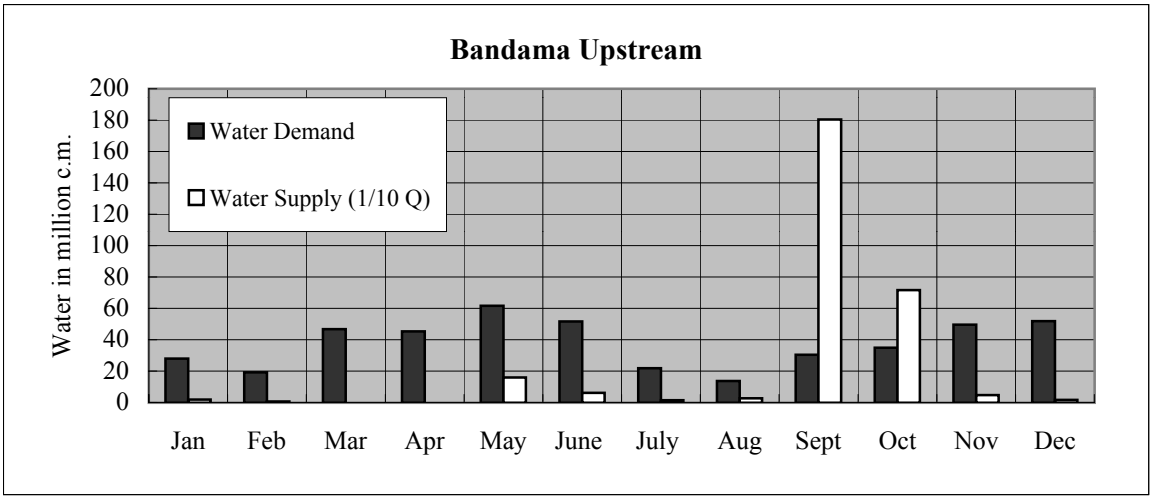
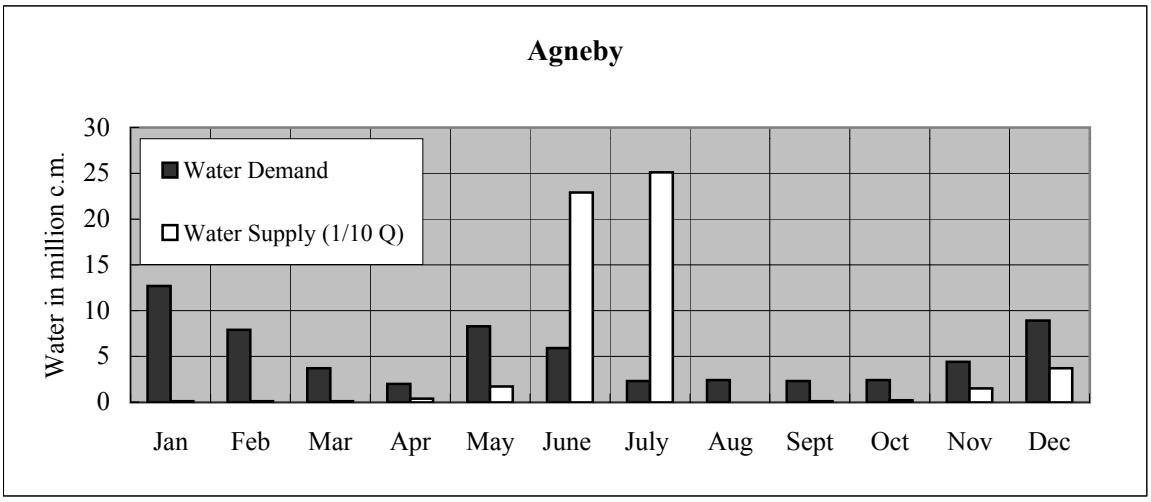


Figure 1 Monthly Water Balance in 2015
(Sassandra/ San Pedro/ Bani-Niger)





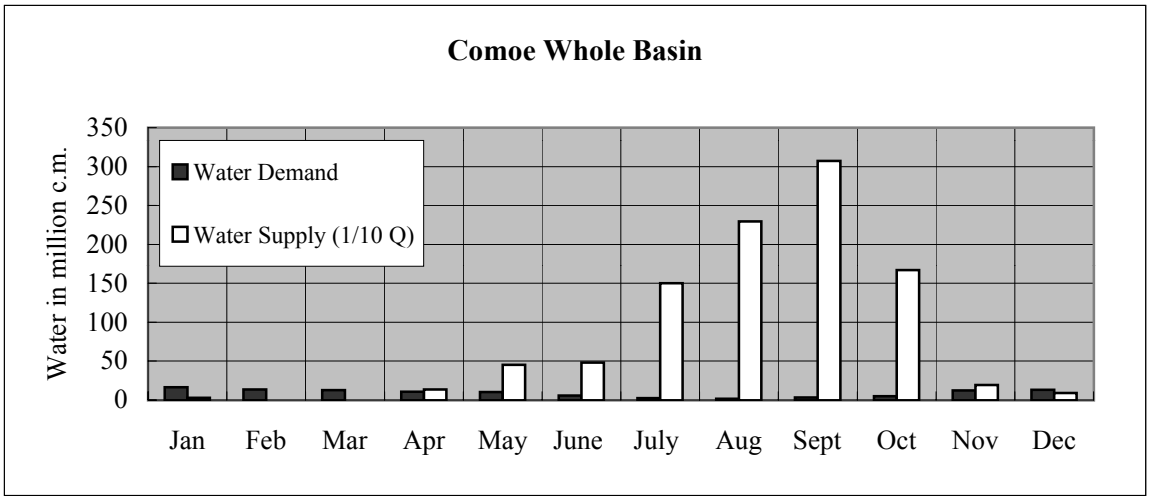


Figure 2 Monthly Water Balance in 2015
(Bandama/ Agneby/ Comoe)

Table 1 Financing and Implementation Schedule

(million FCFA)

	Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Water Resources Management Plan	**Study on Watershed Management**	**1,305**	**345**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,650**
	Effective management for increase of forest area	515														515
	Increase of agricultural production by irrigation	330	345													675
	Management for effective land use	460														460
	Study on O/M of water control facilities	**670**	**966**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,636**
	Agricultural facilities	400	390													790
	Rural water supply facilities	270														270
	Urban water supply facilities		221													221
	Hydro-electric power facilities		355													355
	Establishment of data base for river	**0**	**0**	**480**	**588**	**392**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,460**
	Study			480												480
	Preparation of river ledger				588	392										980
	Water quality control analysis materials	**161**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**161**
	Establishment of hydro-meteorological network		**1,630**	**2,450**	**2,440**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6,520**
	Establishment of water authority	**0**	**609**	**2,030**	**3,732**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6,371**
	Construction		609	2,030	2,030											4,669
	Equipment				1,702											1,702
	Criteria and manuals	**450**	**900**	**1,800**	**1,350**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4,500**
	River works	450	900	900	450											2,700
	Establishment of water right			900	900											1,800
	Sub-Total	**2,586**	**4,450**	**6,760**	**8,110**	**392**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**22,298**
Water Resources Development Project	**Integrated development project**	**290**	**1,400**	**1,450**	**8,290**	**44,400**	**78,080**	**87,170**	**95,990**	**83,280**	**1,120**	**1,120**	**1,100**	**0**	**0**	**403,690**
	Agneby river	180	300	150	2,730	2,730	2,740									8,830
	Dounou river							40	80	40	1,120	1,120	1,100			3,500
	Marahoue river	110	200	200	100	12,670	12,670	12,680	12,670							51,300
	Comoe river		900	1,100	4,100	27,640	61,340	61,340	61,340	61,340						279,100
	N'Zi river				1,360	1,360	1,330	13,110	21,900	21,900						60,960
	Integrated rural development	**110**	**230**	**110**	**2,180**	**2,250**	**2,170**	**1,620**	**3,360**	**4,785**	**3,210**	**10,781**	**46,105**	**52,650**	**41,640**	**171,201**
	Sanppedro plain	110	230	110	2,110	2,110	2,100									6,770
	Karogou Womo									35	70	35	645	650	640	2,075
	Tiassale				70	140	70	1,250	1,250	1,220						4,000
	Rice irrigation in centre-north							370	750	750	360	9,326	11,000	11,000		33,556
	Marabadiassa sugarcane								500	1,050	1,050	550	13,650	15,000	15,000	46,800
	Serebou sugarcane								860	1,730	1,730	870	20,810	26,000	26,000	78,000
	Hydropower	**200**	**400**	**200**	**3,740**	**3,740**	**3,720**	**0**	**0**	**0**	**860**	**1,730**	**4,070**	**3,230**	**2,360**	**24,250**
	Aboisso	200	400	200	3,740	3,740	3,720									12,000
	Soubre										860	1,730	1,730	870		5,190
	Louga												2,340	2,360	2,360	7,060
	Abidjan water supply	**980**	**1,790**	**1,790**	**800**	**25,100**	**25,100**	**25,080**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**80,640**
	Sub-Total	**1,580**	**3,820**	**3,550**	**15,010**	**75,490**	**109,070**	**113,870**	**99,350**	**88,065**	**5,190**	**13,631**	**51,275**	**55,880**	**44,000**	**679,781**
Total		**4,166**	**8,270**	**10,310**	**23,120**	**75,882**	**109,070**	**113,870**	**99,350**	**88,065**	**5,190**	**13,631**	**51,275**	**55,880**	**44,000**	**702,079**

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Abbreviations

ANADER	Agence Nationale d'Appui au Développement Rural *National Agency for Supporting Rural Development*
ADRAO *(*WARD*A)*	Association pour le Développement de la Riziculture en Afrique de l'Ouest *West Africa Rice Development Association*
AGRIVOIR	(société de mouture du riz) *Ivorian Agriculture (Rice milling Company)*
ANAM	Agence Nationale des Aérodromes et de la météorologie (-1997) *National Meteorology Agency (-1997, presently SODEXAM)*
ANDE	Agence National de l'Environnement *National Agency of Environment*
APROMAC	Association des Producteurs et Manufacturiers de Caoutchouc Naturel *Association of Natural Rubber Producers and Manufacturers*
ARSO	Autorité pour l'Aménagement de la Région du Sud-Ouest (1968-1980) *Southwestern Region Development Authority (1968-1980)*
AVB	Aménagement pour la Vallée du Bandama *Bandama Valley Development*
BAD *(ADB)*	Banque Africaine de Développement *African Development Bank*
B/C	Rapport de Bénéfice par Coût *Benefit-Cost Ratio*
BCEAO	Banque Centrale des Etats de l'Afrique de l'Ouest *Central Bank of West African Countries*
BEIE	Bureau d'Etude d'Impact sur l'Environnement *Bureau of Environmental Impact Assessment of ANDE*
BIRD *(IBRD)*	Banque Internationale pour la Reconstruction et le Développement *International Bank for Reconstruction and Development - Word Bank*
BNDA	Banque Nationale pour le Développement Agricole *National Bank for Agricultural Development*
BNETD	Bureau National d'Etudes Techniques et de Développement *National Office for Technique and Development Studies*
BOAD	Banque Ouest Africaine de Développement *West African Development Bank*
CA	Conseiller Agricole *Agricultural Adviser*
CAI	Centre Agro-industriel *Agro- industry Center*
CAISTAB *or CSSPPA*	Caisse de Stabilisation et de Soutien des Prix des Productions Agricoles (1955-1992) *House for Stabilization and Support of Agricultural Products Prices*
CCP	Compagnie des Caoutchouc du Pakidié *Pakidié Rubber Company*
CCT	Centre de Cartographie et de télédétection (BNETD) *Remote Sensing and Map-Making Center*

CFA	Communauté Financière Africaine *African Financial Community*
CGE	Compagnie Générale des Eaux *Water Distribution Corporation*
CGPP	Caisse Générale de Péréquation des Prix des Produits de Grande Consommation *General Treasury for the pricing of Higher Consumed Products*
CIAPOL	Centre Ivoirien d'Antipollution *Anti-Pollution Center of Côte d'Ivoire*
CIDT	Compagnie Ivoirienne pour le Développement des Textiles *Ivorian Company for Textile Development*
CIDV	Compagnie Ivoirienne pour le Développement du Vivrières *Ivorian Company for Food Crop Development*
CIE	Compagnie Ivoirienne d'Electricité *Ivorian Electric Company*
CIRES	Centre Ivoirien de Recherches Economiques et Sociales *Ivorian Social and Economic Researches Center*
CITES	Convention sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction *Convention of International trade in Endangered Species of Wild Fauna and Flora (1973)*
CNRA	Centre National de Recherche Agricole *National Center for Agricultural Research*
COFRUITEL	Coopérative de Commercialisation des Fruits et Légumes de Côte d'Ivoire *Côte d'Ivoire Fruits and Vegetable Marketing Cooperative*
COOP	Coopérative *Cooperative*
COOPEC	Coopérative d'Epargne et de Crédit *Loan Cooperative*
CNTIG	Comité National de Télédétection et d'Information Géographique *National Comity of Remote Detection and Geographic detection*
CREP	Caisse Rurale d'Epargne et de Prêts *Rural Saving Fund*
CTFT	Centre Technique Forestier Tropical *Tropical Forest Technical Center*
DCGTx	Direction et Contrôle des Grands Travaux (BNETD) *Management and Control of Detailed Design and Works (presently BNETD)*
DAI	Direction de l'Agro-Industrie, MINAGRA *Directory of Agro-Industry, MINAGRA*
DCC	Direction de Café Cacao *Direction of Coffee-Cacao*
DD	Direction Départementale, MINAGRA *Department Directory, MINAGRA*

DE	Direction de l'Eau *Water Direction*
DDETT	Direction Départementale de l'Equipement, des Transports et des Télécommunications *Telecommunication, Transportation and Equipment Department Directory*
DE	Direction de l'Environnement *Direction of Environment*
DGA	Direction Générale de l'Agriculture, MINAGRA *General Direction of Agriculture, MINAGRA*
DGEF	Direction Générale des Eaux et Forêts, MINAGRA *General Direction of Water and Forest, MINAGRA*
DGRA	Direction Générale des Ressources Animales, MINAGRA *General Direction of Animal Resources, MINAGRA*
DMC	Direction de la Mutualité et de la Coopération, MINAGRA *Direction of Mutual Aid and Cooperation, MINAGRA*
DME	Direction de la Modernisation des Exploitations, MINAGRA *Direction for the Modernization of Operation, MINAGRA*
DP	Direction de la Programmation, MINAGRA *Direction of Planning, MINAGRA*
DPA	Direction de la Production Agricole, MINAGRA *Direction of Agricultural Production, MINAGRA*
DPIF	Direction de la Production et des Industries Forestière, MINAGRA *Direction of Forestry and Forestry Industry, MINAGRA*
DPN	Direction de la Protection de la Nature *Direction of Natural Protection*
DPVQ	Direction de la Protection des Végétaux et du Contrôle de la Qualité *Direction of Vegetation Protection and Control Quality*
DR	Direction Régionale, MINAGRA *Regional Directory, MINAGRA*
EECI	Energie Electrique de Côte d'Ivoire *Electrical Energy of Côte d'Ivoire*
EIE	Etude d'Impact sur l'Environnement *Environmental Impact Study*
EIMPE	Evaluation de l'Impact sur l'Environnement *Environmental Impact Assessment*
EI.	Elévation *Elevation*
FAC	Fonds d'Aide à la Coopération *Aid Funds for Cooperation*
FAO	Fonds des Nations Unies pour l'agriculture et l'alimentation *Food and Agriculture Organization, United Nation*
FAD	Fonds Africaine de Développement *African Development Fund*

FCFA	Franc CFA
	CFA Franc
FF	Franc Français
	French Franc
FMI	Fonds Monétaire International
(IMF)	*International Monetary Fund*
FOB	Freight on Board
	(Prix à bord)
FRAR	Fonds régionaux d'Aménagement Rural
	Regional Fund for Rural Development
GI	Groupement Informel
	Informal Group
GOCI	Gouvernement de la République de Côte d'Ivoire
	Government of the Republic of Côte d'Ivoire
GOJ	Gouvernement du Japon
	Government of Japan
GVC	Groupement à Vocation Coopérative
	Cooperative Group
HCH	Haut Commissariat à l'Hydraulique
	High Commissariat of Hydraulics
IDESSA	Institut des Savanes
	Savanna Institute
IDEFOR	Institut des Forêts
	Institute for Forest
IEE	Examen Initial de l'Environnement
	Initial Environmental Examination
INS	Institut National des Statistiques
	National Institute of Statistics
IRAT	Institut de Recherche en Agronomie Tropicale
	Tropical Agriculture Research Institute
JICA	Agence Japonaise de Coopération Internationale
	Japan International Cooperation Agency
LANEMA	Laboratoire National d'Essais de Qualité, de Métrologie et d'Analyses
	National Laboratory of Quality Tests, Metrology and Analyses
LBTP	Laboratoire de Bâtiment et de Travaux Publics
	Building and Public Works Laboratory
MCE	Ministère de la Construction et de l'Environnement
	Ministry of Construction and Environment
MCM	Million de mètre cube
	Million Cubic Meter (X 1,000,000 m3)
MEF	Ministère de l'Economie et des Finances
	Ministry of Economy and Finance
METT	Ministère de l'Equipement, des Transports et des Télécommunications
	Ministry of Telecommunication, Transportation and Equipment

MFPF	Ministère de la Famille et de la Promotion de la Femme *Ministry of Women Promotion and Family*
MI	Ministère des Infrastructures *Ministry of Infrastructures*
MID	Ministère de l'Intérieur et de la Décentralisation (MID) *Ministry of Interior and Decentralization*
MIT	Ministère de l'Indutstrie et du Tourisme (MIT) *Ministry of Industry and Tourism*
MINAGRA	Ministère de l'Agriculture et des Ressources Animales *Ministry of Agriculture and Animal Resources*
MLCVE	Ministère du Logement, du Cadre de Vie et de l'Environnement *Ministry of Habitation, Life Quality and Environment*
MEF	Ministère de l'Economie et des Finances *Ministry of Economy and Finance*
MPD	Ministère de la Planification du Développement, chargé de la Coordination du Gouvernement *Ministry of Development Planning in charge of Government Coordination*
MSP	Ministère de la Santé Publique *Ministry of Public Health*
OCPV	Office d'Aide à la Commercialisation des Produits Vivriers *Office for Support to Commercialization of Food Crops*
O.M. *(O&M)*	Opération et Maintenance *Operation and Maintenance*
OMS *(WHO)*	Organisation Mondiale de la Santé *World Health Organization*
ONG *(NGO)*	Organisation Non Gouvernementale *Non-Government Organization*
OPA	Organisation Professionnelle Agricole *Agricultural Professional Organization*
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre-Mer (Institut français de Recherche Scientifique pour le Développement en Coopération) *Office for Overseas Technical and Scientific Research* *(French Institute of Scientific Research for Development Cooperation)*
PASA	Programme d'Ajustement Structurel Agricole *Agricultural Structural Adjustment Program*
PNAE	Plan National d'Actions pour l'Environnement *National Action Plan for Environment*
PNASA	Programme National d'Appui au Service Agricole *National Program for Agricultural Supporting Service*
PNB *(GNP)*	Produit National Brut *Gross National Product*
PNGERNAT	Projet National de la Gestion des Ressources Naturelles et de l'Environnement *National Project for Management of Natural Resources and Environment*

PRB	Produit Régional Brut *Gross Regional Product*
PNR	Projet National Riz, MINAGRA *Rice National Project, MINAGRA*
RO	Bureau Régional d'Administration *Regional Administration Office*
RYMV	Virus Causant des Taches Jaunes sur Paddy *Rice Yellow Mottle Virus*
SAPH	Société Africaine de Plantation d'Hévéa *African Rubber Plantation Company*
SATMACI	Société d'Assistance Technique pour la Modernisation de l'Agriculture en Côte d'Ivoire (1958-1994) *Public Corporation of Technical Assistance for Agricultural Modernization in Côte d'Ivoire (especially Coffee and Cacao) (1958-1994)*
SDTPT	Service Départemental des Travaux Publics et des Transports *Department Office of Public Works and Transports*
SIIC	Service de l'Inspection des Installations Classées *Inspection Bureau in charge of Classified Installations*
SIG	Système d'Information Géographique *Geographic Information System (GIS)*
SODECI	Société de Distribution d'Eau en Côte d'Ivoire *Water Distribution Public Corporation*
SODEFOR	Société de Développement des Forêts, MINAGRA *Forest Development Public Corporation, MINAGRA*
SODEPRA	Société pour le Développement de la Production Animale *Animal Production Development Public Corporation*
SODEPALM	Société pour le Développement des Palmerais *Palm Tree Farming Development Public Corporation*
SODERIZ	Société pour le Développement de la Riziculture, MINAGRA (1977-1984) *Rice Farming Development Public Corporation, MINAGRA (1977-1984)*
SODESUCRE	Société de Développement du Sucre, MINAGRA *Sugarcane Farming Development Public Corporation, MINAGRA*
SODEXAM	Société de Développement d'Exploitation Aéroportuaire, Aéronautique et Météorologique *Development of Airport, Aeronautic and Meteorology Public Corporation*
SOGB	Société des Caoutchoucs de Grand Béréby *Grand Béréby Natural Rubber Public Corporation*
SOPAGRI	Société pour la Promotion de l'Agriculture, MINAGRA *Public Corporation for the Promotion of Agriculture, MINAGRA*
SOPRORIZ	Structure d'Organisation et de Promotion de la Riziculture (Projet National Riz), MINAGRA *Public Corporation for Promotion of Rice Farming (PNR), MINAGRA*

SORIZCI	Société des Rizeries de Côte d'Ivoire *Rice Mills Public Corporation*
TIR (E)	Taux Interne de Rentabilité Economique
(EIRR)	*Economic Internal Rate of Return*
TIR (F)	Taux Interne de Rentabilité Financière
(FIRR)	*Financial Internal Rate of Return*
TS	Technicien Spécialisé *Technician on Specialty*
UNEP	Programme des Nations Unies pour l'Environnement
(PNUE)	*United Nations Environmental Program*
UNESCO	Organisation des Nations Unies chargée de l'Education, de la Science et de la Culture *United Nations Educational Scientific and Cultural Organization*
USA	Etat Unis d'Amérique *United States of America*
UTEXI	Union Industrielle de Textile de Côte d'Ivoire *Côte d'Ivoire Textile Industry Union*
VAN	Valeur Actualisée Nette
(NPV)	*Net Present Value*
WFP	Programme de Travail pour la Nourriture *Work of Food Program*

ERRATA
(Summary)

1. Replace of Table 5-5 (P19)

Please replace Table 5-5 as below.

Table 5-5 Specific Discharge

No. of Division	Name of Division	Mean Runoff Rate ($m^3/s/100km^2$)	Monthly Min. Runoff Rate (1983) ($m^3/s/100km^2$)
I	Sassandra (Piebly)	0.54	0.05
II	Bandama (Katiola-Dabakala)	0.17	0.01
III	Comoe (Abrodnou)	0.15	0.01
IV	Cavally (Tate)	1.61	0.34
V	Nuon	No record	No record
VI	Niger	0.38 – 0.95	0.01
VII	Black Volta (Vonkoro)	0.09	0.01
VIII	Bia (Ayame-2 Dam)	0.45	0.04
IX	Agneby (Agboville)	0.10	0.01
X	Boubo	0.24 – 0.54	0.01
XI	San Pedro	0.98 – 1.48	0.04

2. Correction (P20)

The table below shows the ~~maximum~~ storage capacity of dams in eleven divisions:

Table 5-7 Storage Capacity of Dams in 11 Divisions

No. of River Division	Name of River Division	Total storage capacity of dams In million m^3 (%)
I	Sassandra	8,336.6 (21%)
II	Bandama	29,941.4 (76%)
III	Comoe	37.3 (0%)
IV	Cavally	0.0 (0%)
V	Nuon	0 (0%)
VI	Niger	31.7 (0%)
VII	Black Volta	3.0 (0%)
VIII	Bia	969.0 (3%)
IX	Agneby	24.0 (0%)
X	Boubo	0 (0%)
XI	San Pedro	25.0 (0%)
Total		39,368.0 (100%)

(Inventory Survey in 1999)

Please correct as below:

The table below shows the storage capacity of dams in eleven divisions:

Table 5-7 Storage Capacity of Dams in 11 Divisions

No. of River Division	Name of River Division	Total storage capacity of dams In million m^3 (%)
I	Sassandra	8,336.6 (22%)
II	Bandama	28,796.4 (75%)
III	Comoe	37.3 (0%)
IV	Cavally	0.0 (0%)
V	Nuon	0 (0%)
VI	Niger	31.7 (0%)
VII	Black Volta	3.0 (0%)
VIII	Bia	969.0 (3%)
IX	Agneby	24.0 (0%)
X	Boubo	0 (0%)
XI	San Pedro	25.0 (0%)
Total		38,223.0 (100%)

(Inventory Survey in 1999)

3. Correction (P21)

Table 5-8 Number of Dams in Classification of Main Purpose

Use	Number of dams	
Livestock	361	62.5%
Agriculture	120	20.8%
Fish culture	25	4.3%
Domestic water	22	3.8%
Hydro-electricity	6	1.0%
Mixed	38	6.6%
Other	6	1.0%
Total	578	100%

(Inventory Survey in ~~1995~~ 1999)

4. Correction (P33 1st Phase 5th line)

Please put following new sentence below 5th line:

(b) supplying 65 litters to the urban residents by 1980.
(Source: Village and Urban Hydraulic National Programs 1990, Water Management Department, Ministry of Economic Infrastructure)

5. Correction (P41 Table 11-1)

Table 11-1 Water Use by Sector at Present and in Future

Analyzed Year/ Water Use	Present (MCM/yr)			Future in 2015 (MCM/yr)		
	Surface Water	Groundwater	Total	Surface Water	Groundwater	Total
Average Year						
Agricultural Water	653	51	704	4,726	181	4,907
Domestic and Industrial Water	25	121	146	324	420	744
Total	678	172	850	5,050	601	5,651
1/5 Drought Year	~~678~~	~~172~~	~~850~~	~~5,050~~	~~601~~	~~5,651~~
Agricultural Water	742	95	837	5,152	340	5,492
Domestic and Industrial Water	25	121	146	324	420	744
Total	767	216	983	5,476	760	6,236

6. Correction (P61)

It could be recommended to decide the maintenance discharge based on 9 items study as above-mentioned and it is realistically for Cote d'Ivoire to use as a standard figure "~~The monthly average the lowest discharge~~"

Please correct as below:

It could be recommended to decide the maintenance discharge based on 9 items study as above-mentioned and it is realistically for Cote d'Ivoire to use as a standard figure "drought discharge in the 10 year drought year", that is to be $0.01m^3/s/100km^2$ as shown in Table 5-5.

1 INTRODUCTION

1.1 Background of the Study

Eleven important rivers and groundwater are the main water sources of the country. Large dams for hydropower generation and many arrangements and works of reservoirs for agriculture and stock farming were progressively realized to develop water resources in 1970s which were the economically prosperous years of the country. However, water resources have been separately developed and managed by each water user sector without any integrated water resources development and management plan. As a result, water resources have not been efficiently distributed among sectors.

In the country, the necessity of legal provision and organizational strengthening to manage and allocate water resources effectively and to satisfy the annual water demand in the face of the limitation of water resources has rapidly grown and thus is an urgent subject.

Under such circumstances, the Government of the Republic of Côte d'Ivoire requested the Japanese Government for technical assistance for a master plan study on integrated water resources management.

On the basis of the said request, the Japan International Cooperation Agency (JICA), the official agency responsible for technical cooperation programs, sent a Study Team consisting of fifteen (15) members.

1.2 The Study

This Study aims to formulate a national master plan of integrated water resources management for the Target Year 2015. The Study covers the whole land of Côte d'Ivoire which covers 322,463km^2. The objectives of the Study are:

a) to study water resources development potential for sustainability,

b) to establish national institution for water resources management for better in water use, and

c) to pursure technology transfer to counterpart personnel in the course of the study.

2 PRESENT SOCIO-ECONOMY

2.1 Administration

Côte d'Ivoire has 16 regions, 58 departments distributed through 232 sub-prefectures which constitute the central-state administration, one meets 253 towns, 196 communes added to Abidjan and 8,549 villages in year 1999.

2.2 Population

Côte d'Ivoire accounted for a grand total population of 15.4 millions according to the census carried out during the year 1998. Related to the previous census of 1988, the average per year increase ratio reached 3.6%. The same ratio calculated between the 1988 census and the previous one in 1975 raised 3.7%.

Table 2-1 Population and Growth Rates by Region

region	year 1965	evolution 65/75 per year (%)	year 1975	evolution 75/88 per year (%)	year 1988	evolution 88/98 per year (%)	year 1998
Lagoons	569,300	8.89	1,333,920	5.19	2,575,524	3.99	3,808,446
Upper Sassandra	294,500	6.27	540,968	4.85	1,001,665	3.72	1,443,477
Savannah	424,700	1.83	509,302	2.83	732,390	2.34	923,017
Bandama Valley	446,900	2.27	559,282	2.96	816,945	2.70	1,066,707
Lakes	182,900	3.71	263,263	2.56	365,522	2.70	477,156
Medium Comoe	77,800	8.42	174,532	4.22	298,566	2.88	396,530
Mountains	494,000	3.06	667,503	2.82	957,706	4.06	1,425,891
Zanzan	209,900	6.39	389,891	2.14	513,220	2.53	659,072
région du bas Cavally	90,500	7.44	185,553	10.06	644,805	8.02	1,395,206
Denguele	116,600	0.64	124,263	2.41	169,433	2.62	219,431
Marahoue	194,800	6.22	356,225	3.23	538,824	3.08	729,464
N'Zi Comoe	350,200	5.02	571,618	-0.21	556,565	1.32	634,574
South Comoe	114,800	6.61	217,703	3.21	328,165	3.54	464,916
Worodougou	209,800	1.25	237,607	3.11	353,659	3.81	514,109
South Bandama	148,300	6.36	274,851	4.80	505,478	3.05	682,731
Agneby	173,000	6.43	322,724	2.43	440,995	1.80	527,023
Grand TOTAL REGIONS	**4,098,000**	**5.08**	**6,729,205**	**3.71**	**10,799,462**	**3.59**	**15,367,750**

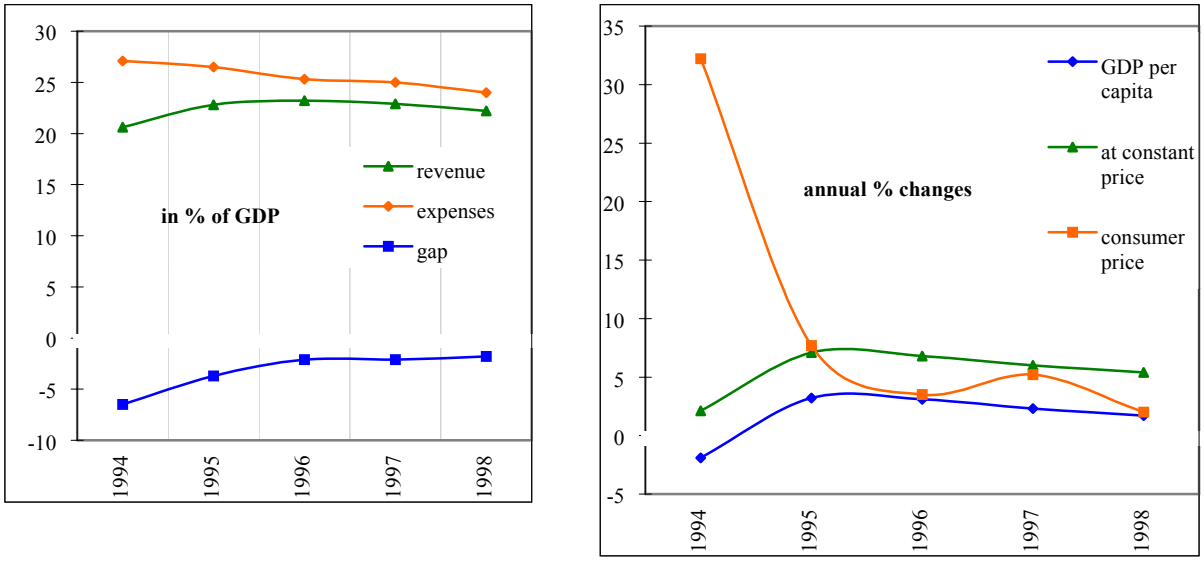
Source: National Census - INS

2.3 Economic Conditions

Côte d'Ivoire has the largest economy of the West Africa Economic Monetary Union (UEMOA). The economy depends on agriculture, and cocoa for which it alone accounts for close to 40% of world production. Out of cocoa the main export crops are coffee, timber, cotton, pineapples, and bananas. Agro-industrial processing includes edible oils, especially palm-oil, sugar, cassava, fruit juices and cocoa by-products.

During 1986/1993 per capita income fell by about 40%. In spite of some success, - partially due to the devaluation in 1994 and even if one registered strong growth performance (average 6.6% in 1995-97), the economic climate remains somewhat gloomy.

Figure 2-1 Economic Trends



The budgetary gap marks the overall financial situation and during the last two decades has obliged to turn to external loans. Hence, the debt service remains heavy : the only interest service still accounts for more than 20% of the total expenditures of the 1998 budget.

Development plans and programming are become weak. The so long duration of the financial crisis has obliged to manage on short term. This fact was available for each economic agent : administration, enterprise as well as households. Hence programming has been often minimised. Thus, the water sector like the bulk of the economic sectors has been marked by an under-evaluation of the demand.

3 PRESENT ORGANIZATIONS AND LAWS

3.1 Organizations Related to Water Resources Management

Main water sectors are separately developed and managed by water user sector. Namely, urban and rural water sector, agricultural water sector, and hydroelectric water sector are developed and managed by the Ministry of Infrastructures, the Ministry of Agriculture and Animals Resources, and the Ministry of Mines and Energy respectively.

Still more, following ten (10) ministries and governmental institutions other than the above three ministries are implicated into water resources management.

a) Ministry of Interior and Decentralization

b) Ministry of Agriculture and Animals Resources

c) Deputy Delegate of Ministry of Agriculture and Animals Resources in charge of Young Agricultural Operator

d) Ministry of Development Planning

e) Ministry of Public Health

f) Superior Education and Scientific Researches

g) Ministry of Construction and Environment

h) Ministry of Economy and Finance

i) Ministry of Industry and Tourism

j) Ministry of Transport

Water is a limited resources in quantity. Therefore, water resources management should be executed to satisfy equally all the different demands for finite water resources ; those of people, of industry, of agriculture, of hydroelectricity, etc. But, as stated above, there are a lot of organizations for water resources management, which may cause the fragmentation of management functions and the dispersion of water resources management. And such fragmentation of management function , in other words sectarian water resources management, have produced the following harmful effects on water resources development and management.

a) Development plan is liable to link with sector policy and sector benefit ;

b) Technical data and know-how are collected by each sector and not opened to other sectors ;

c) Financial imbalance between sectors happens, i.e. some sectors have good revenue source, such as water using fee, electricity using fee, and such revenues of rich sectors are not divided to other financial difficult sectors ;

d) As almost all the sectors have no clear penal regulations , it is difficult to pose sanctions against illegal water users.

3.2 Law and Regulations Related to Water Resources

In Cote d'Ivoire, a rule (not a law) related to water resources management was enacted by French colonial government in 1905. The rule was revised in 1921 and 1956. The colonial rule remained effective after Cote d'Ivoire gained independence from France in 1960.

In accordance with the increase of population and the progress of economy, conflicts over the utilization of water resources have gradually increased. The lack of legal referential basis found difficulty to resolve the conflicts. Because the conflicts came not to be solved by negotiation or mutual consent. The government was beginning to feel keenly the need to create a law related to water resources management.

The Law No. 98 - 755, dealing with creation of Water Code was enacted on December 23, 1998 with the aim of integrated management of water resources

Water Law consist of one hundred thirty – six (136) articles, which are divided into the six (6) Titles.

The objectives of Water Law can be summarized as follows :

a) Preservation of the aquatic ecosystem, and humid sites and zones.

b) Protection against any kind of pollution, and restoration of surface water, ground water and sea water.

c) Protection, mobilization and management of water resources.

d) Development and protection of hydraulic improvement and facilities.

e) Valorization of water as economical resources, and fare distribution of water to satisfy or to conciliate different usage, activities, works and demand.

f) Consistent planning for utilization of water at national level and basins level.

g) Improvement of life conditions of different classes people by respecting stabilization of environment.

h) Rational and durable utilization of water resources for present and future generations.

i) Establishment of new institution for water resources management reconsidering the roles of the parties concerned.

4 METEOROLOGY AND HYDOROGY

4.1 Rainfall Conditions

The tropical rain forest climate with high temperature and much rainfall commands the coast area in the countries along the Guinean Gulf. On the other hand, the dry season becomes long towards the interior area, thus the Savanna climate that the summer rainy season and winter dry season alternate become dominant.

The representative regional annual rainfall for long-term and in the year 1983 is presented in Table 4-1, and isohyetal map is shown in Figure 4-1.

Table 4-1 Estimated Regional Annual Rainfall

(Unit: mm)

Classified Region	Long-term (AD'80-'96)	Drought Year (AD 1983)
Coastal Region	1,000 – 1,200	600 – 1,200
Western Mountainous Region	1,800 – 2,200	1,800 – 2,000
Eastern Region	1,000 – 1,200	400 – 800
Central Region	1,000 – 1,200	400 – 800

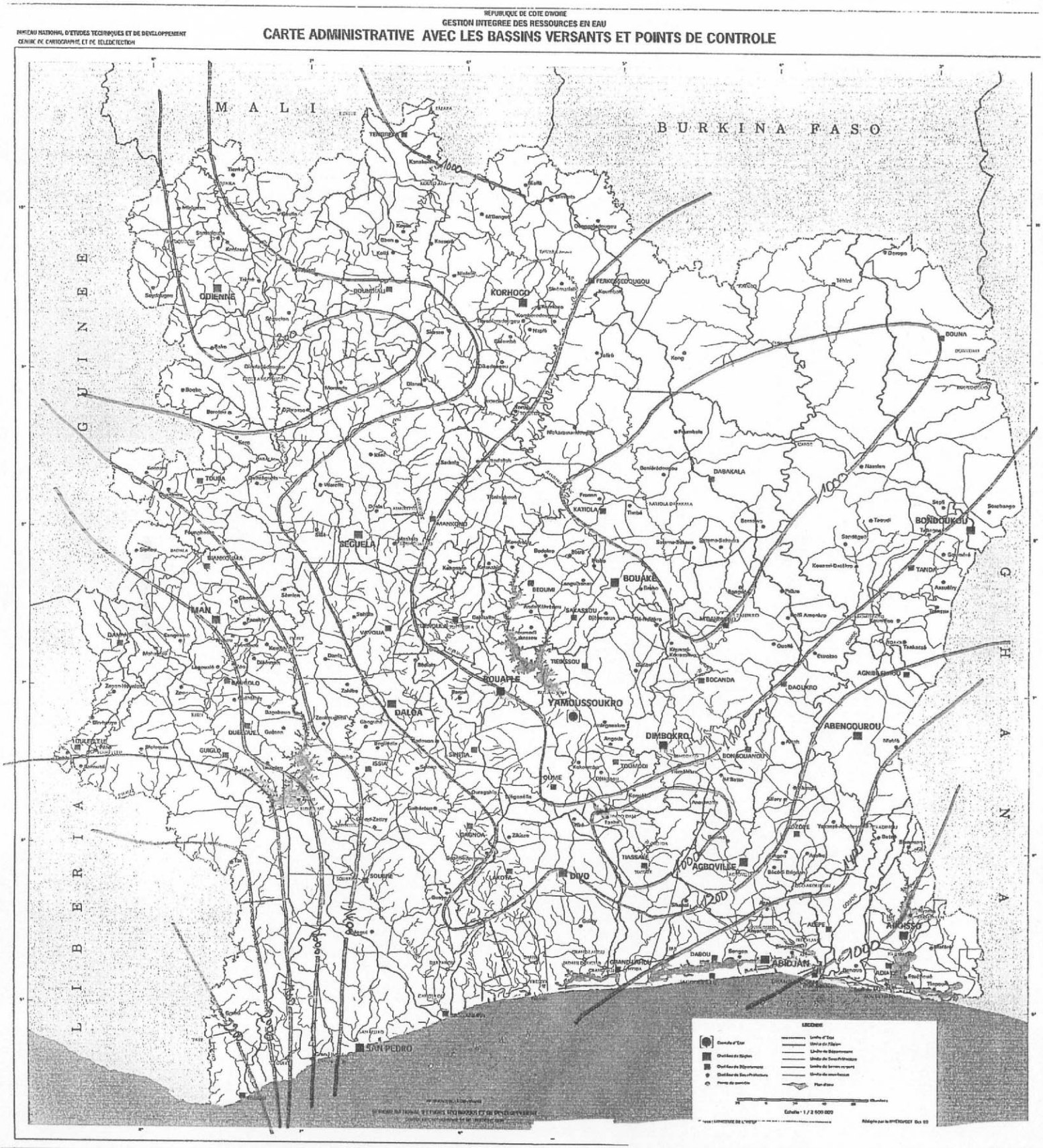


Figure 4-1 Isohyetal Map for Long-term Period (AD 1980 - 1996)

4.2 Evaporation

Average evaporation for the three (3) rain-gauge stations where are located within the Sudanese climate zone was summarized in Table 4-2. On the other hand, Table 4-3 shows the average evaporation to be observed from the rain-gauge stations near to these dams.

Table 4-2 Evaporation measured by A-Pan

(Unit: mm)

Observatory	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Boundiali	180	204	229	196	156	162	176	113	105	141	141	156	1,959
Ferkessedougou	179	211	131	234	177	171	155	111	105	135	141	155	1,905
Korhogo Aero	175	192	210	174	162	135	118	136	136	144	174	201	1,957

Source: "Etude de Faisabilite Technico-Economoque du Projet de Developpement Rural Integre de la Vallee de la Bagoue", Rapport Principal, Novembre 1998

Table 4-3 Evaporation from the Water Surface of Reservoirs

(Unit: mm)

Reservoir	Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Taabo Dam	145	145	166	159	144	116	108	108	118	138	137	130	1,614
Kossou Dam	-	-	-	-	-	-	105	-	-	-	-	-	-
Ayame-1 Dam	113	114	112	108	102	94	96	94	91	98	105	109	1,236

Note: "-" means data not to be collected during the stage I.. Source: Taabo Dam, Kosso Dam, and Ministry of Energy

4.3 Hydrological Conditions

(1) Gauging Stations and Discharge Records

Although there exist 157 gauging stations nationwide, only 137 can work well and the numbers equipped with automatic recorder are less than 20. However, the hydrometry had been carrying out well in spite of the definite manpower and budget.

(2) Low Water Analysis

a) Drought Year's Discharge

That AD 1983 is the drought year is clearly evident from the past records of rainfalls and discharges. And it has been adopted as a design criterion for the Cote d'Ivoire. Consequently, JICA Team also applied this unchangeable fact to the Master Plan Study. Some judgment can be obtained as below:

- In 1983, only the Bia River shows stable runoff during the rainy season.
- In 1983, the Cavally River and Bagoe River runoff declined during the rainy season.
- The Bandama River runoff is twice of that in the Comoe River during the rainy season, however, it declined extremely in 1983 and near to the same as that of the latter.
- Only the Sassandra River can discharge over 200 m^3/s/month through the year taking 1983's circumstantial evidence into account.

b) Long-term Average Discharge

JICA Study Team defined and standardized the periods with seventeen (17) years, from AD 1980 to 1996, as the long-term period for further analysis to accord with the same available periods of monthly rainfall. Some judgment can be obtained as below:

- Maximum runoff occurred in September and October.
- During the rainy season, runoff between the Sassandra River and the Cavally River seem nearly similar.
- During the rainy season, runoff pattern is similar between the Bandama River and the Cavally River. On the other hand, runoff pattern is similar between the Bandama River and the Sassandra River during the dry season.

4.4 Hydro-geology and Groundwater

(1) Hydro-geological Characteristics

Major two types of aquifers is divided in the country by "Carte de planification des ressources en eau de Cote d'Ivoire''(1978), one is Discontinuous aquifer formed in weathered and discontinuous fissure zone such as fault in the Precambrian which covers 97.6% of the country. Another is General aquifer which is formed in the porous and pervious layer mainly of the Continental terminal distributed on coastal area. Distribution and hydrogeological characteristic of each unit can be summarized as following Table 4-4 analyzing above mentioned borehole inventory.

Table 4-4 Characteristics of hydrogeological units

Aquifer unit		Proportion to surface of the country (%)*	Number of borehole (rate %) **	Depth of borehole (m) ***	Thickness of weathered zone ****	Static water level (m) *****	Yield (m3/h) ******
General Aquifer	Continental terminal	2.4	671 (6.8)	50.1	--	21.7	9.6
Discontinuous Aquifer	Granitic rocks	62.7	6786 (68.6)	57.2	21.3	10.5	3.0
	Metamorphosed sedimentary rocks	34.9	2441 (24.6)	63.0	28.4	17.4	3.3
	Sub-total	97.6	9227 (93.2)	58.73	23.18	12.32	3.08
Total		100	9890	58.15		12.95	3.52

* Quoted from Inventaire hydrogeologique a l'Hydraulique Villageoise (1982)

** Within registered 12,626 boreholes 9900 are hydrogeologically classified.

*** Average depth of boreholes

**** Average thickness of weathered zone of basement rocks

***** Average static water level measured with pumping test

****** Average of maximum discharge measured with pumping test

(2) Aquifer Protection Program of Abidjan Groundwater Basin

A study was implemented to get adequate management plan for the main groundwater resources of Abidjan capital and peripheral area by the authorities responsible for potable water distribution in the country as Water Direction, SODECI and BNETD. The authorities make a contract with SOGREAH to construct a mathematical model to simulate limit groundwater exploitation preventing rapid draw down of water level and sea water intrusion into the aquifer at the target year 2010.

Groundwater discharge of urban water supply for Abidjan city reached to about 2.3 m3/s, 73 MCM/year at 1993, and which corresponds with 23 % of average annual infiltration (310 MCM/year and 230mm/year).

As a result of the simulation, limit groundwater exploitation was estimated to 4.0 – 4.2 m3/s, 132MCM at year 2008, avoiding drastic draw down of water head to prevent sea water intrusion into aquifer. As a result of above simulation, it is required to consider rearrangement of pump station on future program.

Surface water of lagoon Potou and/or Aghien seems to have only slight salinity and discharge of 3m3/sec(260,000m3/day), therefor it is recommended to study water quality, environmental aspects of boss lagoons and intake facility to drive lagoon water (Information from officer of Water Direction)