PD-AAV-665
44050

SOUTHERN ZONE WATER MANAGEMENT PROJECT

(685-0295)

PROJECT PAPER

Dakar, August 1st, 1988

PD-AAU-665

ACTION MEMORANDUM FOR THE DIRECTOR

FROM: D. Myers, PDO H Gubell for DM

SUBJECT: Project Authorization: Southern Zone Water Management (SZWM) Project 685-0295

I. ACTIONS REQUESTED

Your approval is requested for a grant of eighteen million dollars ($18 million) from the Section 121, Sahel Development Program and the Sub-Saharan Africa, Development Assistance Appropriation (DFA) (Pub. L. 100-102) to Senegal for the Southern Zone Water Management Project (685-0295). It is planned that a total of $6.5 million will be obligated in Fiscal Year 1988.

II. DISCUSSION

A. PROJECT BACKGROUND AND DESCRIPTION

The proposed project represents a multi-disciplinary approach to assist in meeting part of the basic food requirements of Senegal from the higher agricultural potential of the southern zones (Casamance). The decline in rainfall in Senegal during the past fifteen years has particularly reduced valley farm-land crop yields in the Casamance due to land salinization. Farmers also lack the technical and organizational capacity to reclaim salinated lands and to manage available water properly. Local government and the private sector cannot provide farmers with the requisite institutional capacity or the technical wherewithal to plan and to execute water control/management programs. This proposed project will concentrate on approximately 15,000 hectares in Ziguinchor and the Kolda regions which are recoverable and/or improvable through small water control and retention infrastructure operations to produce cereals, principally rice. Four priority zones will be addressed: Sedhiou, Soungrougrou, Bignona/Baïla, and last the upper Casamance River Basin. The project committee has reviewed and approved the analyses of the ten initial sites within the four priority zones recommended by the PP design team (see PP attached Page 27, Tables 1 & 2).

The project's goal is to increase cereal (mainly rice) production in the Ziguinchor and in the Kolda Regions by 50% on approximately 15,000 hectares from 54,000 tons in 1987/88 to 81,000 tons in 1999. This goal is compatible with the GOS' New Agricultural Policy (NAP). The project's purpose is to improve farmer recovery of land and water utilization for agricultural production purposes.

As stated above and as developed in the PP, this will be a multi-disciplinary effort. The following are the key inter-related elements:

1. Water Control and Management

Each water retention or anti-salt structure planned will be done only in cooperation with a Village Water Management Committee. The villagers must:

(a) organize themselves into a committee;
(b) elect a spokesperson/leader;
(c) participate in the design, layout and construction of the structure, and,
(d) provide post construction operation and maintenance labor in conjunction with local government technical personnel.

First phase anti-salt and water control structures will be followed by construction of second and third phase works such as upland terracing and berms.

2. Institutional Strengthening

The technical services of the Ministry of Rural Development and of the Ministry of Hydraulics will be strengthened by project-financed technical assistance to support water management development. Additionally, the village farmer groups will receive support and training in developing their capacity to operate and maintain water control infrastructure. Private sector firms in the project area will be encouraged to provide the full range of water management services, e.g., leveling, surveying, construction, rehabilitation, etc.

3. Operations and Applied Research

The project will assist national and locally based research institutions to help identify locally adapted water, soil, and crop management practices which could ensure maximum project benefits, and increase farmer's ability to reclaim salinized land and to increase crop production.

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4. Environment and Project Monitoring

Consistent with the IEE as amended, the project will systematize environmental monitoring of the impact of all project structures and activities in the Casamance Basin and its estuary. Project monitoring will include baseline data collection in each valley or watershed as part of a continuous feedback system to support project management and evaluation.

B. PROJECT IMPLEMENTATION AND STRATEGY

The proposed project covers an eight year effort in the amount of $18 million with an initial tranche in FY 1988 of six and one half million dollars ($ 6.5 million). The lead ministry proposed is the Ministry of Rural Development (MDR) via its Directorate of Agriculture (DA). Field work will be done by water management teams composed of staff from both DA and the Ministry of Hydraulics (MH) via its rural construction unit Direction des Aménagements et Infrastructures Hydroagricoles (DAIH).

A Project Management Unit (PMU) in Ziguinchor will field manage all project activities and will be headed by a MDR appointed project director. The Project Director and the respective heads of the regional services of DA and of MH will form a Regional Technical Committee in each project area to ensure close technical and managerial coordination. Project funding will provide for competitively procured technical assistance, training, commodities and other inputs. Four long-term TA consultants staggered appropriately over LOP are envisioned:

(1) Water Resources Specialist (Chief of Party),
(2) Water Resources Engineer
(3) Agronomist, and
(4) Sociologist.

All project funds for training, construction, research and monitoring will be managed by a contract Administrative Assistant who will report to the Chief of Party.

Construction funds will not be approved by the Mission Project Officer unless there is convincing evidence that a viable farmer's group with a named leader has been formed and is committed to water structure design, construction, and sustainability. The Mission Project Officer will be field assisted by a locally-hired U.S. contractor. They will be responsible for coordinating all U.S. inputs and monitoring activities during the life of the project. A project organizational chart is found on page seven (7) of the attached Project Paper. A tentative schedule of principal project activities can be found on page 64 of the PP.

C. WAIVERS

No waivers are required for the project.

D. CONDITIONS AND COVENANTS

1. Conditions

The Grant Agreement in addition to the standard clauses will also contain language for requiring prior to initial disbursement, that (1) the GOS name in writing the lead Ministry, (2) the GOS agree to disburse all allocated decentralized funds for rehabilitation to the Ziguinchor and Kolda regional Agricultural Inspectorates, and (3) that the GOS officially form Regional Technical Committees in Ziguinchor and in Kolda to coordinate and manage the respective Water Management Teams.

2. Additional Disbursements

Conditions precedent have been crafted to ensure that the two Ministries appoint appropriate technical personnel to the project, and that the GOS provide full budgetary support for all GOS project personnel. The full additional disbursement conditions are found at page xii of the attached Project Paper.

2. Covenants

These play an important role in the project agreement. In addition to the standard language that the GOS will facilitate, use best efforts and coordinate all GOS inputs, the covenants will also seek agreement that farmer assistance will become part of the mandates of the Regional Services of MDR and MH in the Ziguinchor and the Kolda regions. Agreement will also be sought for making construction funds available through the use of local tax rebates (Fonds de Concours) at the local level. Other covenants deal with the IEE, and highly specific technical constraints which must be addressed to ensure project success. The full covenant text is found at page xiii, B of the PP.

III. ECONOMIC AND FINANCIAL SUMMARY

Eighteen million dollars ($18 million) is proposed from DFA funds out of a total project cost of $20,700,000 as follows (in 000's):

Technical Assistance	$5,600
Local professionals/support staff	1,000
Infrastructure development	3,800
Training	900
Research and Monitoring	1,100
Equipment/Commodities	1,900
Logistical support/O&E	1,200
Evaluations/Audits	400
Sub-Total	15,900
Contingencies/Inflation	2,100
Grand Total	$18,000

Pages 54 and 55 of the attached Project Paper show annual estimated cost breakdown over the LOP. $2,700,000 in local costs is planned in contributory labor, salaries, etc. split near evenly between the GOS and the village organizations.
The Project has a highly favorable Internal Rate Return of 22%. Even with a drop in some of the planned benefits the return on investment is still robust.

IV. COMMITTEE ACTION AND CONGRESSIONAL NOTIFICATION

The PID received ECPR approval in AID/W July 9, 1987. The amended IEE was approved by AID/W on March 14, 1988. The project is shown in the FY 1988 Congressional Presentation and no further advice to the Congress is required.

V. RESPONSIBLE OFFICERS

The Irrigation, Water Management and Engineering Office (IWME) will be responsible for Mission implementation. The IWME Deputy will be Project Officer under the Direction of the Chief, IWME. Close coordination with Agricultural Development Officers will be necessary to ensure success. As field realities shift, the Project Development Office (PDO) will be called on for advice vis à vis any future design changes that might be required.

The contract Field Officer will work closely with and report as appropriate to the IWME Project Officer and to the Chief. Principle liaison with the GOS will be done by the IWME Deputy and the Chief.

VI. GRAY AMENDMENT

The Mission has indicated preference for open competitive procurement for the proposed project's required technical services. We have indicated, however, that we would give full attention to encouraging potential prime firms to contract in a prime-sub relationship with Gray Amendment firms for a portion of the technical assistance.

VII. SECTION 611(E) CERTIFICATION

AA/AFR has authorized you to field approve the project taking into consideration and approving the text of Certification (provided in Dakar 0205). The AA/AFR stipulated that the PP should address in detail concerns raised in the PID guidance cable. The Project Committee has reviewed the PP and has determined that all PID guidance concerns have been addressed regarding 611 (E) Certification.

VIII. **RECOMMENDATION**: that you sign the attached Project Authorization and the Project Paper.

Approved _____

Disapproved _____

Date _____

Clearances:

PDO:MKane	MKane	date	8/8/88
RCON: TWalsh		date	
IWME:GHaycock		date	8/8/88
PRM:SCissé		date	8/8/88
ADO:RHarvey		date	8/8/88
RLA:EDragon	EAD	date	8/8/88

Drafter:IWME:CShorter:bd

1838R

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: ____ — DOCUMENT CODE: 3

COUNTRY/ENTITY: SENEGAL

3. PROJECT NUMBER: 685-0295

4. BUREAU/OFFICE: AFR — 06

5. PROJECT TITLE (maximum 40 characters): SOUTHERN ZONE WATER MANAGEMENT

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 06 DD 30 YY 96

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)

A. Initial FY 88 — B. Quarter 4 — C. Final FY 91

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 88 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	5,300	1,200	6,500	9,700	8,300	18,000
(Grant)	(5,300)	(1,200)	(6,500)	(9,700)	(8,300)	(18,000)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country		400	400		2,700	2,700
Other Donor(s)						
TOTALS	5,300	1,600	6,900	9,700	11,000	20,700

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) SSA	123	022				18,000		18,000	
(2)									
(3)									
(4)									
TOTALS						18,000		18,000	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 851 — 021 — 031

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code	BSW	PART	ENV	LAB	DEL		
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

Recover lost productive farmland and improve farmer utilization of water for agricultural purposes in the southern regions of Senegal.

14. SCHEDULED EVALUATIONS

Interim MM 06 YY 90 — MM 06 YY 93 — Final MM 01 YY 96

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [X] Local [X] Other (Specify) 935

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

Concurrence: Controller: T.J. Walsh

17. APPROVED BY

Signature: [signature]

Title: Sarah Jane Littlefield, Director, USAID/Senegal

Date Signed: MM 08 DD 19 YY 88

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

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PROJECT AUTHORIZATION

COUNTRY : SENEGAL

PROJECT TITLE : Southern Zone Water Management

PROJECT NUMBER : 685-0295

1. Pursuant to Section 121 of the Foreign Assistance Act of 1961, as amended, and the Foreign Operations, Export Financing, and Related Programs Appropriations Act, 1988, (Pub. L. 100-202). I hereby authorize the Southern Zone Water Management Project for Senegal involving planned obligations of not to exceed eighteen million dollars ($18,000,000.00) in grant funds over a four year period from the date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the project. The planned life of the project is eight years from the date of initial obligation.

2. The Project will help farmers recover lost productive farmland and improve their utilization of water to increase production of crops. The Project consists of four components which will be coordinated to protect and reclaim salinized lands, improve water control on non-salinized lands, and increase cereal crop production. The project will finance technical assistance, training, commodities, infrastructure development services and other costs supportive of the four components. The four components of the project are:

a. Water Control and Management, which will include water management plans development with village water management committees and dikes and berms constructed with villages and private contractors;

b. Institutional Strengthening, which will enhance the capabilities of the Ministry of Rural Development and Ministry of Hydraulics to support water management development in the southern zone; develop village-level capacity to operate and maintain water-control infrastructure; and encourage private sector services for water management in the project area;

c. Operational and Applied Research, which will support contracts with national research institutions to help identify locally adapted water, soil and crop management practices to maximize benefits of anti-salt protection, improve farmers' ability to reclaim salinized land, and increase crop production;

d. Environmental and Project Monitoring, which will track the impact of this Project and other water-control projects in the Casamance Basin and its estuary.

3. The Project Agreement which may be negotiated and executed by the officers to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority, shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

a. Source and Origin of Commodities, Nationality of Services.

Except as A.I.D. may agree otherwise in writing:

(1) Commodities financed by A.I.D. under the Project shall have their source and origin in the United States, The Cooperating Country, or in countries included in Geographic Code 935;

(2) The suppliers of commodities and services financed by A.I.D. under the Project shall have the United States, the Cooperating Country, or countries included in Geographic Code 935 as their place of nationality;

(3) The procurement policies established by AA/AFR for the Development Fund for Africa shall be applied to the procurement of goods and services financed by A.I.D. under the Project.

b. Conditions Precedent

1. First Disbursement

Except as A.I.D. may agree otherwise in writing:

(a) Prior to initial disbursement, or the issuance of any commitment documents under the Project Agreement, the Cooperating Country shall advise A.I.D. in writing of the governmental agency which will be the lead agency for the project.

(b) Prior to initial disbursement, or the issuance of any commitment documents under the Project Agreement, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the Government of Senegal agrees to disburse all allocated decentralization funds for office rehabilitation of the Regional Inspectorates of Agriculture in the regions of Ziguinchor and Kolda.

(c) Prior to initial disbursement, or the issuance of any commitment documents under the Project Agreement other than the contract for technical assistance, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the Government of Senegal has officially formed Regional Technical Committees in the regions of Ziguinchor and Kolda, composed of the respective Regional Inspector for Agriculture and the Regional Head of the Hydraulic Division in each region and the Project Director (Chairman of Committee), to coordinate and manage the activities of the respective Regional Water Management Teams.

2. Additional Disbursement

Except as A.I.D. may agree otherwise in writing:

(a) Prior to any disbursement under the Project Agreement for any construction in the Kolda region, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that:

(1) The Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Kolda region one Agronomist with soils training and one Village-Project Liaison Officer or Sociologist to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team; and

(2) The Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Kolda region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team.

(b) Prior to any disbursement under the Project Agreement for any construction in the Ziguinchor region, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that:

(1) The Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Ziguinchor region one Agronomist with soils training and one Village-Project Liaison Officier or Sociologist to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team; and

(2) The Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Ziguinchor region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team.

(c) Prior to disbursement of any construction funds under the Project Agreement starting in Year Four (4) of the project, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the respective budgets of the Regional Inspectorates of Agriculture and Regional Divisions of Hydraulics in the Ziguinchor and Kolda regions have been increased sufficiently to pay for all per diem of GOS employees and vehicle operating costs of vehicles assigned to these divisions starting Year Four (4) of the project and continuing after the end of the project.

(d) Prior to disbursement, or the issuance of commitment documents for the disbursement of funds for the purchase of project vehicles, the GOS will agree that travel authorizations for vehicles purchased under the project for official travels may be approved by the Project Director for vehicles at the Project Management Unit, and by the Regional Inspectors of Agriculture or the Regional Heads of the Hydraulic Divisions for vehicles assigned to the two Water Management Teams.

C. **COVENANTS**

The Cooperating Country will covenant, in substance, as follows:

1. That it will assure coordination of all donor-funded and GOS-funded water management activities in the Ziguinchor and Kolda regions through bi-annual meetings of all involved donors and Ministries, organized by the Ministry of Plan and Cooperation.

2. That it will make its best efforts to ensure that (a) staff assigned to the regional Water Management Teams will remain for at least three years and that they will be replaced immediately; and (b) Regional Inspectors of Agriculture and Regional Hydraulic Division Chiefs remain at post for at least three years and their replacements will be at post prior to the departure of the incumbents.

3. That the assistance to farmers to improve water management and reclaim salinized lands will become part of the mandates of the regional services of Agriculture and Hydraulics in the Ziguinchor and Kolda regions.

4. That additional financial resources for dike construction or maintenance may be made available through the use of Fonds de Concours at the local level.

5. That the issues of (a) anti-salt barrage effectiveness in controlling upstream salinity; (b) the effects of infrastructure on groundwater quantity, quality and distribution; (c) the cumulative effects of regional barrage construction on estuarine and other aquatic ecosystem resources; (d) the effects of regional infrastructural development on water-associated disease incidence rates; and (e) the effects of infrastructural development on terrestrial ecosystems and endangered, protected or commercially important species, as described in the Project IEE Amendment, shall be addressed as described except as those issues, assessments or approaches may be modified by mutual agreement.

6. That implementation plans for infrastructural development will be modified in accordance with the findings of the five issue assessments listed in paragraph 5. above.

7. That anti-salt dikes shall only be constructed where the areas of high potential acid sulfate soils or already acidified soils of the toxonomic subgroup of typic sulfaquents (USDA Soil Taxonomy) do not exceed 15 percent plus or minus two percent of the service area upstream of the dike.

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8. That siting of water retention dikes will be undertaken with the full knowledge, advice and consent of the affected village population.

9. That any irrigation system funded under this project shall have had sufficient technical analysis performed to indicate that salinization and waterlogging potential in the affected area will be minimal; measures will be available to the target population to mitigate any salinization or waterlogging which may occur in the future; and sedimentation rates upslope of the primary structure are sufficiently low to permit use of the reservoir for irrigation throughout a reasonably long facility target life.

S.J. Littlefield
Director
USAID/Senegal

Clearances (as shown in Action Memorandum).

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SOUTHERN ZONE WATER MANAGEMENT PROJECT

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ABBREVIATIONS/ACRONYMS

ADO:	Agriculture Development Office
A.I.D.:	Agency for International Development (Washington)
AFDB:	African Development Bank
AFSI:	African Food Systems Initiative
APS:	Agricultural Production Support Project
BCEOM:	Bureau Central d'Etudes Outre-Mer (French Consulting Firm)
CER:	Centre d'Expansion Rurale (extension service)
CDSS:	Country Development Strategy Statement
CFR:	Code of Federal Regulation
COP:	Chief of Party
CP:	Conditions Precedent
CRODT:	Centre pour la Recherche Océanographique de Dakar-Thiaroye (ISRA research center)
CU.M.:	Cubic Meter
DA:	Direction de l'Agriculture/Directorate of Agriculture
DAIH:	Direction des Aménagements et Infrastructures Hydroagricoles (Ministry of Hydraulics)
DERBAC:	Projet de Développement Rural de la Basse Casamance (AFDB-funded Lower Casamance Rural Development Project)
FAO:	Food and Agriculture Organization
FCFA:	Communauté Financière de l'Afrique (Local currency unit)
GOS:	Government of Senegal
HA:	Hectare
IEE:	Initial Environmental Examination
INAV:	Institut National Agronomique et Vétérinaire (Rabat, Morrocco)
IRR:	Internal Rate of Return
ISRA:	Institut Sénégalais de Recherches Agricoles (Senegal Agriculture Research Institute)
ITA:	Ingénieur des Travaux Agricoles
IWME:	Irrigation, Water Management and Engineering Office
KG:	Kilogram
KM:	Kilometer
LDC:	Local Development Committee
M:	Meter
MH:	Ministry of Hydraulics
MRD:	Ministry of Rural Development
MS:	Master of Sciences Degree
MSD:	Ministry of Social Development
MT:	Metric ton
NAP:	New Agricultural Policy
NGO:	Non-Governmental Organization
O&M:	Operation and Maintenance
ORSTOM:	Office de la Recherche Scientifique et Technique d'Outre-Mer (French Research Center)
PACD:	Project Assistance Completion Date
PC:	Project Committee
PCV:	Peace Corps Volunteer (USA)

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PDO:	Project Development Office
PID:	Project Identification Document
PIDAC:	Projet pour le Développement Agricole de la Casamance (A.I.D.-funded Casamance Development project)
PM:	Person months
PMO:	Project Monitoring Officer
PMU:	Project Management Unit
PO:	Project Officer
PP:	Project Paper
PRIMOCA	Projet Intégré de la Moyenne Casamance
PRM:	Program Office
PSC:	Personal Services Contract
PVO	Private Voluntary Organization
RIA:	Regional Inspectorate of Agriculture
RDA:	Regional Development Authority
RDC:	Regional Development Committee
RHD:	Regional Hydraulic Division
RTC:	Regional Technical Committee
RCON:	Regional Controller's Office
RLA:	Regional Legal Advisor
RWMT:	Regional Water Management Team
SCS:	Soil Conservation Service (USA)
SO:	Service Officiel (GOS vehicle registration title)
SODAGRI:	Société de Développement Agricole et Industriel (RDA in Kolda)
SOMIVAC:	Société de Mise en Valeur de la Casamance (RDA for the Casamance)
SZWMP:	Southern Zone Water Management Project
T:	Ton (metric)
TA:	Technical Assistance
TS:	Techniciens Supérieurs
USAID:	United States Agency for International Development (Senegal)
USDA:	United States Department of Agriculture

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MISSION PROJECT COMMITTEE

S.J. Littlefield, Director
George Carner, Deputy Director
Terry Myers, Project Development Office (PDO), Chief
Campbell Mcclusky, Program Office
Edward Dragon, Regional Legal Advisor
Richard Greene, Program Economist
Tom J. Walsh, Controller
Gilbert Haycock, Irrigation and Water Management Office (IWME), Chief
Charles Shorter, IWME
Khoi Le, IWME
Jean LeBloas, IWME
Wayne Nilsestuen, Agriculture Development Office, Chief

PROJECT PAPER DESIGN TEAM

William Hammink, PDO, Design Leader
Mamadou Kane, PDO
Don Humpal, Agronomist, Development Alternatives, Inc. (DAI)
Gene White, Engineer DAI
Frans Van Eysinga, Ag. Economist DAI
James Brown, Soil Scientist DAI
Chris Elias, Sociologist, PSC
Jean Albergel, Hydrologist, ORSTOM

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EXECUTIVE SUMMARY

GRANT: $18 million over the 8-year life of project with $6.5 million to be obligated in FY 1988. The project will improve farmer utilization of water and recovery of fertile valley lands for agricultural purposes in the southern regions of Senegal.

GRANTEE: Government of Senegal (GOS)

IMPLEMENTING AGENCY: Overall management responsibility of the Ministry of Rural Development, working in close coordination with the Ministry of Hydraulics.

A. WHY?

Senegal meets barely one-half of its basic food requirements from domestic sources. The southern zones of Senegal offer a high agricultural potential, with generally higher average yields and lower variations in yields than other regions in Senegal for all cereals, peanuts and cotton.' Nonetheless, annual production of major cereals lags behind the potential due to a number of factors, the most important of which are related to erratic and decreased levels of rainfall.

The decline in average annual rainfall during the past 15 years has resulted in significant loss of productive farmland in the valleys due to salinization and in decreased yields for major crops. There is an urgent need to help farmers reclaim lost productive valley lands and improve their utilization of the available water. At the same time, farmers lack the technical and organizational capacity to significantly reclaim lands and manage available water effectively. Likewise, local government services and the private sector in the regions do not have the institutional capacity to assist farmers plan and execute water control and management programs.

1. Land and Water Availability for Increased Production

Since the drought of the late 1960's there has been a decline in the average annual rainfall in the Casamance river basin by about one-fourth. As a consequence, salt intrusion in the Casamance river has reached 220 km inland with extreme hypersalinity levels in the central and upper reaches of the river system. Lands in the valley have been exposed to increasing periods of tidal seawater intrusion and the concentration of salts from the capillary rise during the dry season.

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The result has been a sharp decline in paddy rice surface area due to salinization and subsequent abandonment of productive valley lands.

Estimates of loss of productive rice lands are as high as 77 percent in one department in the Ziguinchor region. Another report estimates that between 20-60 percent of the cultivated rice lands in the valleys in the Ziguinchor region have been lost in the past 8-10 years due to the low rainfall and salt intrusion.

In response to these dramatic environmental changes, farmers shifted their rice production onto the less productive basin valley slopes. The cropping mix moved from an aquatic rice pattern to one incorporating rainfed rice on the slopes, and an increasing upland peanut and cereal cultivation. The upland and slope areas have lighter soils with lower fertility and lower water-holding capacity than those of the lowlands. Loss of valley lands and lower yields on slope lands have created a rice deficit for nearly every household. Production of other cereals has not made up the gap. Current estimates are that only half of the cereal requirement is met from household production. The Ziguinchor and Kolda regions now import nearly 50 percent of their cereal needs. Fieldwork during project design and other recent research clearly indicate the overriding priorities of farmers in the area: to reclaim lost ricelands, to increase rice production, and to reach self-sufficiency in food production.

There are an estimated 40,000 hectares in the Ziguinchor and Kolda regions which are recoverable and/or improvable through water control infrastructure operation. In the near-to-medium term, recovery of the more productive valley lands is one of the most cost-effective ways to sustainably increase crop production in southern Senegal and is the highest priority of farmers in the area. In effect, project analyses show that better retention techniques alone can increase availability of water and lead to increased production, especially for rice. Estimates are that the average yield of paddy rice will increase from current average levels of .5-.8 tons/ha to 1.8-2.3 tons/ha. Also, increased availability of water reduces risk and farmers will have more incentive to use other yield-increasing inputs such as fertilizer and improved seeds.

2. Farmer Capacity to Reclaim Lands and Improve Water Utilization

Farmers are generally efficient in use of resources under their control. Many farmers close to the mouth of the Casamance river have considerable experience in water control and management in the valleys. However, the lower average rainfall has changed dramatically their options for improving water management. Most farmers lack the knowledge and means to build and operate the more durable water-control works required to protect and recover the valleys.

At the same time, where projects have assisted farmers to build dikes, farmers have not been involved in the planning and design nor in the subsequent required operation and maintenance of the dikes. This has led to a low level of reclamation and improved water utilization behind the dikes.

3. Institutional Capacity to Assist Farmers Improve Water Management

In the mid-1970s, Rural Development Authorities (RDAs) such as SOMIVAC (RDA for the regional development of the Casamance) and SODAGRI (RDA for irrigation agricultural development in the Kolda region) were given the mandate to design and execute water control and management programs. Starting in 1982, the AID-funded Casamance Rural Development project, through SOMIVAC, constructed 31 small anti-salt dikes using village labor.

The dominance of the RDAs and autonomous donor-funded projects in water-control works effectively excluded the local development of private services in Ziguinchor and Kolda for the planning, design and construction of planned works or for specialized services in earth moving, concrete works or survey and planning.

At the same time, the regional offices of the line Ministry of Rural Development (MRD) and Ministry of Hydraulics (MH) have been involved only recently in water-control infrastructure development and currently have little capacity to plan and execute water management programs.

The GOS has formally changed its policy through the New Agricultural Policy (NAP). The NAP includes four major provisions affecting the southern zone: (1) local populations are expected to mobilize and manage resources for local development; (2) RDAs have a much reduced role in providing direct services to farmers; (3) traditional technical ministries are to be revitalized to provide those services defined to be in the public domain; and (4) the private sector has a vital role to play in providing direct services to farmers.

Therefore, the line Ministries (MRD and MH) have now been given direct responsibility for assisting farmers to plan, execute and manage water-control works, working closely with the local villagers and utilizing the private sector where feasible. The institutional capacity of the regional offices of MRD and MH must be improved, therefore, but keeping within a level of assistance which is sustainable for the GOS and focused on specific needs of farmers.

B. WHAT?

1. Project Goal: Increase Cereals Production

The goal of the project is to increase cereals production, mainly rice production, in the Kolda and Ziguinchor regions of southern Senegal. The project will lead to an increase in rice production in the project area of 50 percent, from 54,000 tons of paddy rice in 1987/88 to 81,000 tons in 1999, once the project-funded water-control interventions are fully operational and land reclaimed on 15,000 hectares. If the GOS and farmers continue to invest in the water management activities initiated by the SZWMP once the project is over, recovery of valley lands and improvement of production could occur on approximately 40,000 ha over a twenty-year period. This would be a major step towards making the two regions self-sufficient in rice production.

Also, the institutionalization of water management methodology, when applied in other areas of the southern zone of Senegal, will contribute further to increased production.

2. Project Purpose: Improved Water Control and Management

The SZWMP will help farmers recover lost productive farmland and improve their utilization of water to increase production of crops. By the end of the project approximately 60 valleys and 15,000 hectares of land will have been recovered or will have improved water control and utilization. The improved water control and utilization will lead to production stability during years of variable or low rainfall and to average increases in rice production of 1.8 metric tons per hectare during years of normal rainfall.

The project will also develop the capacity of the regional services of the MRD and MH specifically to formulate and execute water management plans while including local farmers in all planning and construction activities.

Most importantly, local farmer groups will be organized and trained to operate and maintain the water-control infrastructure, thereby improving the impact and assuring sustainability.

While developing this capacity, the project will determine the most appropriate set of methodologies and approaches to provide the most technically, environmentally, economically and socially appropriate mix of water-control structures, water management techniques, and forms of local participation.

3. Project Components

The Southern Zone Water Management Project (SZWMP) targets four major but related components:

o Water Control and Management component: Water management plans for watersheds will be developed with village water management committees and water-control dikes constructed. Villagers will provide the labor for the placing and compaction of all dike and berm embankments while private sector contractors will provide the embankment materials and construct sluice gates and spillways. Small anti-salt dikes will be constructed in the lower valleys for salinization control and reclamation while water retention structures and contour berms and dikes will be constructed on the mid and upper valleys for freshwater runoff catchment. The project will work in seven to ten new valleys per year once teams are in place in each region for a total of about 60 valleys over the life-of-project affecting about 15,000 hectares. First phase anti-salt dikes and retention dams will be followed by construction of second and third phase works such as upland terracing and berms.

o Institutional Strengthening component: The project will help the traditional technical services of the MRD and MH develop the capacity to support water management development in the southern zone. It will help villagers develop the capacity to operate and maintain water-control infrastructure and to fully utilize improved availability of water for agricultural purposes. Also, the project will encourage locally-based private sector firms to provide the full range of water management services.

o Operational and Applied Research component: national research institutions will help identify locally adapted water, soil, and crop management practices which could ensure maximum benefits of anti-salt protection, increase farmers ability to reclaim salinized land, and increase crop productivity levels.

o Environmental and Project Monitoring component: consistent with the findings in the IEE Amendment, the project will track the impact of project interventions and other water-control projects on the Casamance Basin and its estuary. The types of infrastructural interventions planned in the project are designed to result in the environmental protection and/or amelioration of agricultural and other lands upslope from the structures. Also, as part of the formulation of the water management plans, project monitoring will include collection of baseline data in each valley or watershed to allow for continuous feedback and project approach modification and for periodic evaluations of project progress.

C. HOW?

Project implementation will be the responsibility of the MRD. The MH will be closely involved in planning and executing the dike construction. The Directorate of Agriculture (DA) in the MRD will be primarily responsible for project implementation. Water Management Teams composed of technicians from both the DA and the MH will be set up in each region. These teams will work under the respective regional services of the DA and the MH in the regions.

A Project Management Unit (PMU) will be set up, based in Ziguinchor, to plan, manage and coordinate all project activities in the two regions, to be headed by a MRD-assigned Project Director. The Project Director and the respective heads of the regional services of DA and MH will form a Regional Technical Committee in each region to assure close technical and managerial coordination.

USAID will contract directly with a U.S. institution, university or consortium to provide technical assistance, training, commodities and other inputs. Four long-term technical advisors will be provided: Water Resources Specialist (Chief of Party), Water Resources Engineer, Agronomist and Sociologist. All funds for training, construction, research and monitoring will be managed by the contractor.

The project has been discussed extensively with the GOS which concurs in its objectives and specific approaches to water management and reclamation.

Regular evaluations, audits and monitoring by USAID will be critical to project success. The USAID project officer will be the Deputy Chief of the Irrigation, Water Management and Engineering Office, assisted by a locally-hired U.S. contractor. They will be responsible for coordinating U.S. inputs and monitoring activities during the life of the project.

The A.I.D. funds will be used in the following manner:

U.S. Contributions	($000)
- Technical Assistance	5,600
- Support Staff	1,000
- Infrastructure Development	3,800
- Training	900
- Research and Monitoring	1,100
- Equipment/Commodities	1,900
- Logistical Support/Operating Costs	1,200
- Evaluation/Audit	400
- Contingency/Inflation	2,100
	18,000

Senegalese Contributions	
- Salaries of GOS personnel working on project activities	1,300
- Logistical Support/Operating Costs	300
- Labor contribution of villagers for construction	1,100
	2,700

4. FEASIBILITY?

The technical feasibility of improving water utilization through the use of small retention dikes, berms and terracing is clear and straightforward. The technical feasibility of reclaiming salinized land using small anti-salt dikes has been tested in various ways throughout the southern zone. The approach works but the most effective means of flushing salts and reclaiming lands will be researched and developed during the project implementation.

The most important challenge for the project will be the institutional feasibility of organizing and training village organizations and improving the capacity of the regional services of MRD and MH to provide appropriate services to those farmers and farmer groups who need it. However, the farmers in the area see reclamation and improved water utilization as their top priority and the GOS views improved water management and land reclamation as the top short-term priority in the southern zone of Senegal. There is considerable interest

at all levels in the proposed project activities; what is needed most is the technical and financial assistance to plan and design appropriate water-control structures given the changed environmental conditions.

The project's Internal Rate of Return of 22 percent demonstrates a strong economic return from project interventions, including activities not directly applicable to production such as research and monitoring. The Social Soundness Analysis concludes that farmers are eager to reclaim lost lands and improve their water utilization to become self-sufficient in cereals requirements.

Finally, a 121 (d) negative determination is included.

5. COVENANTS AND CONDITIONS

In addition to standard Conditions Precedent (CPs), the Grant Agreement will contain the following:

A. Conditions Precedent

1. First Disbursement

a. Prior to initial disbursement, the GOS will agree to disburse all allocated decentralization funds for office rehabilitation of RIAs in the regions of Ziguinchor and Kolda.

b. Prior to disbursement, or the issuance of any commitment documents under the Project Agreement other than the contract for technical assistance, the GOS will officially form Regional Technical Committees in the regions of Ziguinchor and Kolda, composed of the respective Regional Inspector for Agriculture and the Regional Head of the Hydraulic Division in each region and the Project Director (chairman of Committee), to coordinate and manage the activities of the respective Regional Water Management Teams.

2. Additional Disbursement

a. Prior to any disbursement, or the issuance of any commitment documents under the Project Agreement for the disbursement of any construction funds in the Kolda region, the GOS will furnish evidence that:

(1) the Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Kolda region one Agronomist with soils training and one Village-Project Liaison Officer or Sociologist to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team; and

(2) the Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Kolda region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team.

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b. Prior to disbursement, or the issuance of any commitment documents under the Project Agreement for the disbursement of any construction funds in the Ziguinchor region, the GOS will furnish evidence that:

(1) the Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Ziguinchor region one Agronomist with soils training and one Village-Project Liaison Officer or Sociologist to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team; and

(2) the Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Ziguinchor region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team.

c. Prior to disbursement of any construction funds under the Project Agreement starting Year Four (4) of the project, the GOS will increase the respective budgets of the Regional Inspectorates of Agriculture and Regional Divisions of Hydraulics in the Ziguinchor and Kolda regions sufficiently to pay for all per diem of GOS employees and vehicle operating costs of vehicles assigned to these divisions starting Year Four (4) of the project and continuing after the end of the project.

d. Prior to disbursement of funds for the purchase of vehicles, the GOS will agree that travel authorizations for vehicles purchased under the project for official travels which are registered in the SO series may be approved by the Project Director for vehicles at the PMU, and by the Regional Inspectors of Agriculture or the Regional Heads of the Hydraulics Divisions for vehicles assigned to the two Water Management Teams.

B. COVENANTS

The Project Agreement shall contain in substance the following covenants:

1. Agreement that the GOS will assure coordination of all donor-funded and GOS-funded water management activities in the Ziguinchor and Kolda regions through bi-annual meetings of all involved donors and Ministries, organized by the Ministry of Plan and Cooperation.

2. Agreement that the Government of Senegal will make best efforts to ensure that (a) staff assigned to the Regional Water Management Teams will remain for at least three years and that they will be replaced immediately; and (b) Regional Inspectors of Agriculture and RHD chiefs remain at post for at least three years and their replacements will be at post prior to the departure of the incumbents.

3. Agreement that the assistance to farmers to improve water management and reclaim salinized lands will become part of the mandates of the regional services of Agriculture and Hydraulics in the Ziguinchor and Kolda regions.

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4. Agreement that additional financial resources for dike construction or maintenance may be made available through the use of Fonds de Concours at the local level.

5. Agreement that the issues of (a) anti-salt barrage effectiveness in controlling upstream salinity; (b) the effects of infrastructure on groundwater quantity, quality and distribution; (c) the cummulation effects of regional barrage construction on estuarine and other aquatic ecosystem resources; (d) the effects of regional infrastructural development on water-associated disease incidence rates; and (e) the effects of infrastructural development on terrestrial ecosystems and endangered, protected or commercially important species, as described in the Project IEE Amendment, shall be addressed as described except as those issues or approaches may be amended by the agreement of both parties.

6. Agreement that implementation plans for infrastructural development will be modified in accordance with the findings of the five issue assessments listed in 5. above.

7. Agreement that:

(a) anti-salt dikes shall only be constructed where the areas of high potential acid sulfate soils or already acidified soils of the taxonomic subgroup of typic sulfaquents (USDA Soil Taxonomy) do not exceed 15 percent plus or minus two percent of the service area upstream of the dike;

(b) siting of water retention dikes will be undertaken with the full knowledge, advice and consent of the affected village population; and

(c) any irrigation system funded under this project shall have had sufficient technical analysis performed to indicate that salinization and waterlogging potential in the affected area will be minimal; measures will be available to the target population to mitigate any salinization or waterlogging which may occur in the future; and sedimentation rates upslope of the primary structure are sufficiently low to permit use of the reservoir for irrigation throughout a reasonably long facility target life.

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I. PROBLEM AND PROJECT DESCRIPTION

A. PROBLEM

Senegal meets barely one-half of its basic food requirements from domestic sources. The southern zones of Senegal offer a high agricultural potential, with generally higher average yields and lower variations in yields than other regions in Senegal for all cereals, peanuts and cotton. Nonetheless, annual production of major cereals lags behind the potential due to a number of factors, the most important of which are related to erratic and decreased levels of rainfall.

The decline in average annual rainfall during the past 15 years has resulted in significant loss of productive farmland in the valleys due to salinization and in decreased yields for major crops. There is an urgent need to help farmers reclaim lost productive valley lands and improve their utilization of the available water. At the same time, farmers lack the capability and capacity to significantly reclaim lands and improve their water management. Likewise, local government services and the private sector in the regions do not have the institutional capacity to assist farmers plan and execute water control and management programs.

1. Problem: Land and Water Availability for Increased Production

The key technical problems the SZWMP addresses are how to (a) protect and reclaim salinized land, (b) improve water management, and (c) minimize yearly variation in crop production due to rainfall amount and timing.

Since the drought of the late 1960's there has been a major decline in the average annual rainfall in the Casamance river basin. The average rainfall for the period 1940-1960 was 1500 mm for the Ziguinchor region. By contrast, the average rainfall for the period 1965-1985 in the Ziguinchor department was 1100 mm and in the Bignona department only 900 mm. Average annual rainfall has declined about one-third in the last 15 years.

As a consequence, salt intrusion in the Casamance river has reached 220 km inland with extreme hypersalinity levels in the central and upper reaches of the river system. The region has a number of estuaries and creeks which constitute areas favorable to the intrusion of salt water into primary and secondary tributaries and onto the bordering lands. Lands in the valley have been exposed to increasing periods of tidal seawater intrusion and the concentration of salts from the capillary rise during the dry season.

The result has been a sharp decline in rice surface area due to salinization and subsequent abandonment of productive valley lands. Estimates of loss of productive rice lands are as high as 77 percent in one department in the Ziguinchor region. Another report estimates that between 20-60 percent of the cultivated rice lands in the valleys in the Ziguinchor region have been lost in the past 8-10 years due to the low rainfall and salt intrusion.

In response to these dramatic environmental changes, farmers shifted their rice production onto the less productive basin valley slopes. The Diola cropping mix moved from an aquatic rice pattern to one incorporating rainfed

rice, and an increasing upland peanut and cereal cultivation. The women farmers of the Mandinka ethnic group, once solely rice farmers, have begun to cultivate upland crops. The upland and slope areas have lighter soils with lower fertility and lower water-holding capacity than those of the lowlands, making them less suited to cereals, especially rice, production. Loss of valley lands and lower yields on slope lands have created a cereals deficit for nearly every household. Production of other cereals has not made up the gap. Current estimates are that only half of the cereal requirement is met from household production. Farm families make up the difference by purchasing rice from the proceeds of peanut sales and, increasingly, by seasonal and permanent out-migration to seek employment in towns and cities. The Ziguinchor and Kolda regions now import nearly 50 percent of their cereal needs.

Fieldwork during project design and other recent research clearly indicate the overriding priorities of farmers in the area: to reclaim lost lands, to increase rice production, and to reach self-sufficiency in food production.

There are an estimated 40,000 hectares in the Ziguinchor and Kolda regions which are recoverable and/or improvable through water control infrastructure operation. In the near-to-medium term, recovery of the more productive valley lands is one of the most cost-effective ways to sustainably increase crop production in southern Senegal and is the highest priority of farmers in the area. At the same time, increased availability of water through better retention techniques alone will lead to increased production, especially for rice. Estimates are that the average yield of paddy rice will increase from current average levels of .5-.8 tons/ha to 1.8-2.3 tons/ha. More importantly, increased availability of water reduces risk and farmers will have more incentive to use other yield-increasing inputs such as fertilizer and improved seeds.

2. Problem: Farmer Capacity to Reclaim Lands and Improve Water Utilization

Farmers are generally efficient in use of resources under their control. Many farmers close to the mouth of the Casamance river have considerable experience in water control and management in the valleys. During periods of higher rainfall, farmers used locally hand-built dikes to flush salts from valley lands to allow rice cultivation. The lower average rainfall has completely changed farming operations and the technical options for improving water management. Most farmers lack the knowledge and means to build and operate the more durable water-control works required to protect and recover the valleys.

At the same time, where donor-funded projects have assisted farmers to build dikes, farmers have had minimal involvement in planning and design and in subsequent operation and maintenance. This has led to a low level of reclamation and improved water utilization behind the dikes. Farmers must be organized and trained to operate and maintain water-control structures in order to fully exploit the increased availability of water to increase production.

3. Problem: Institutional Capacity to Assist Farmers Improve Water Management

There have been a number of factors inhibiting development of an institutionalized capacity to improve water management. Early efforts failed to include village organizations in planning and design. In the mid-1970s, Rural Development Authorities (RDAs) such as SOMIVAC (RDA for the regional development of the Casamance) and SODAGRI (RDA for irrigation agricultural development in the Kolda region) were given the mandate to design and execute water control and management programs. Large anti-salt dikes were built in the Casamance with little participation of local farmers; they have not been as successful as planned. Similarly, starting in 1982, the AID-funded Casamance Rural Development project, through SOMIVAC, constructed 31 small anti-salt dikes using village labor.

The dominance of the RDAs and autonomous donor-funded projects in water-control works effectively excluded the local development of private services in Ziguinchor and Kolda for the planning, design and construction of planned works or for specialized services in earth moving, concrete works or survey and planning. Dakar-based firms contract for larger-scale specific services in the regions, but no local firms have developed.

At the same time, the regional offices of the line Ministry of Rural Development and Ministry of Hydraulics have not been involved in water-control infrastructure development and currently have little capacity to plan and execute water management programs.

However, the GOS has formally changed its policy through the NAP. The NAP includes four major provisions affecting the southern zone: (1) local populations are expected to mobilize and manage resources for local development; (2) RDAs have a much reduced role in providing direct services to farmers; (3) traditional technical ministries are to be revitalized to provide those services defined to be in the public domain; and (4) the private sector has a vital role to play in providing direct services to farmers.

The line Ministries (MRD and MH) have now been given direct responsibility for assisting farmers to plan, execute and manage water-control works, working closely with the local villagers and utilizing the private sector where feasible. This clearly indicates the need for the SZWMP to improve the institutional capacity of the regional offices of MRD and MH, keeping within a level of assistance which is sustainable for the GOS and focused on specific needs of farmers.

B. PROJECT DESCRIPTION

1. Project Goal: Increase Cereals Production

The goal of the project is to increase cereals, mainly rice, production in the Kolda and Ziguinchor regions. The project will lead to an increase in rice production in the project area of about 50 percent, from 54,000 tons of paddy rice in 1987/88 to 81,000 tons in 1999, once the

project-funded water-control interventions are fully operational and land reclaimed in the targetted 15,000 hectares. If the GOS and farmers continue to invest in the water management activities initiated by the SZWMP once the project is over, recovery of valley lands and improvement of production could occur on approximately 40,000 ha over a twenty-year period. This would be a major step towards making the two regions self-sufficient in rice production.

The project should not only lead to an increase in overall production of cereals, but also an important increase in the productivity, or yield per hectare, of affected cereal crops. Achievement of maximum agricultural production depends on many factors. In southern Senegal improved water utilization and reclamation of valley lands are key.

2. Project Purpose: Improved Water Control and Management

The SZWMP will help farmers recover lost productive farmland and improve their utilization of water to produce crops. By the end of the project, approximately 60 valleys and 15,000 hectares of land will have been recovered or will have improved water control and utilization. Full restoration of protected lands in these valleys will take five to six years after the project because of the phasing of works and the difficulty of reclaiming certain soils. The improved water control and utilization will lead to production stability during years of variable or low rainfall and to average increases in rice production of 1.8 metric tons per hectare during years of normal rainfall.

The project will develop the capacity of the regional services, the MRD and MH specifically, to develop and execute water management plans while including local farmers in planning and construction activities. Most importantly, it will organize and train local farmer groups to operate and maintain the water-control infrastructure, improving the project's impact and assuring sustainability. In so doing, the project will determine an appropriate set of methodologies and approaches to provide a technically, environmentally, economically and socially sound mix of water-control structures, water-management techniques, and forms of local participation.

3. Project Components

The SZWM Project has four related components:

- Water Control and Management
- Institutional Strengthening
- Operational and Applied Research
- Environmental and Project Monitoring

These four components will be coordinated to protect and reclaim salinized lands, improve water-control on non-salinized land, and increase cereal crop productivity. Under the Water Control and Management component, water management plans will be developed with village water management committees and dikes constructed. These activities will address priority concerns of farmers to protect, recover and make more productive valley lands lost to drought and salt intrusion during the past 15 years. The Institutional Strengthening component will enhance the ability of the traditional technical services of the MRD and MH to support water management development in the southern zone; develop village-level capacity to operate and maintain water-control infrastructure; and encourage private sector services for water management in the project area. The Operational and Applied Research component will support contracts with national research institutions to help identify locally adapted water, soil, and crop management practices which maximize benefits of anti-salt protection, improve farmers' ability to reclaim salinized land, and increase production. The Environmental and Project Monitoring component will track the impact of SZWMP and other water-control projects on the Casamance Basin and its estuary.

a. Water Control and Management for Increased Cereals Production

Outputs of this component will be watershed management plans for about 60 valleys and 15,000 hectares of land. The watershed management plans will generally include a first phase of anti-salt dikes and an upstream retention dike. The second and third phases may include a second set of dikes regulating flow higher in the valley and soil conservation works, if needed, to protect against erosion or silting of structures in the valley. Finally, microbasins and surface drains may be built to improve on-farm water-control, and to reclaim acidified soils. These plans will use a holistic watershed planning approach to ensure that structures are sited, sized, and operated to protect land and water use rights and permit construction of downstream structures. The plans will include water management extension programs to optimize farmer returns from their investment in dikes.

Two technical elements distinguish this project component from other water-control efforts in the southern zone. First, the SZWMP will plan with the farmers from the perspective of a whole watershed or subwatershed. Second, its water-control program extends beyond planning and construction to the operation and maintenance of the constructed works.

The SZWMP will not plan and construct anti-salt dikes and small retention dams as independent interventions but instead examine the hydrologic links between these structures and consider the secondary works needed to achieve land reclamation or enhance land productivity. The watershed plans developed by SZWMP will support farmer objectives of reclaiming valley rice land lost to salinization and low rainfall. It will also help farmers plan for secondary works needed to control water depth for rice production, divert early season runoff to storage structures, protect structures from silting, where erosion is a problem, and, where feasible, increase the rate of land recovery through tillage and surface drainage.

Once teams are in place in each region, the project will work in seven to ten new valleys per year, improving water control on approximately

2,300 hectares annually. First phase anti-salt dikes and retention dams will be completed in all sites by the end of the project. Second and third phase works will be constructed at some sites during the life of the project although some secondary works may be left to local follow-through.

Evaluations and field visits have shown that previous projects greatly underestimated the staff time required to organize village water management committees for construction and to prepare them for the transition to operations and maintenance (O&M). The SZWMP recognizes that the organized transition to O&M is one of the key links to effective use of constructed works. It will use the construction period to train farmers in maintenance and emergency repair procedures, plan operations and maintenance guidelines with Village Committees from the outset, equip the Committees with the basic tools needed for maintenance, and provide technical follow-up to help Committees adjust their O&M programs over time. Project field staff will work with the Village Committees to help them organize farmer participation, village dues or use payments to obtain new tools, transport services, and masonry services. The option of helping farmers to collect funds to organize an operations and maintenance (O&M) revolving fund will be explored during project implementation. An estimated two percent of the capital cost of the infrastructure will be needed for annual maintenance. Based on the estimated infrastructure costs on the ten sample sites, average annual maintenance costs for the three to six dikes at each site is approximately $1,300.

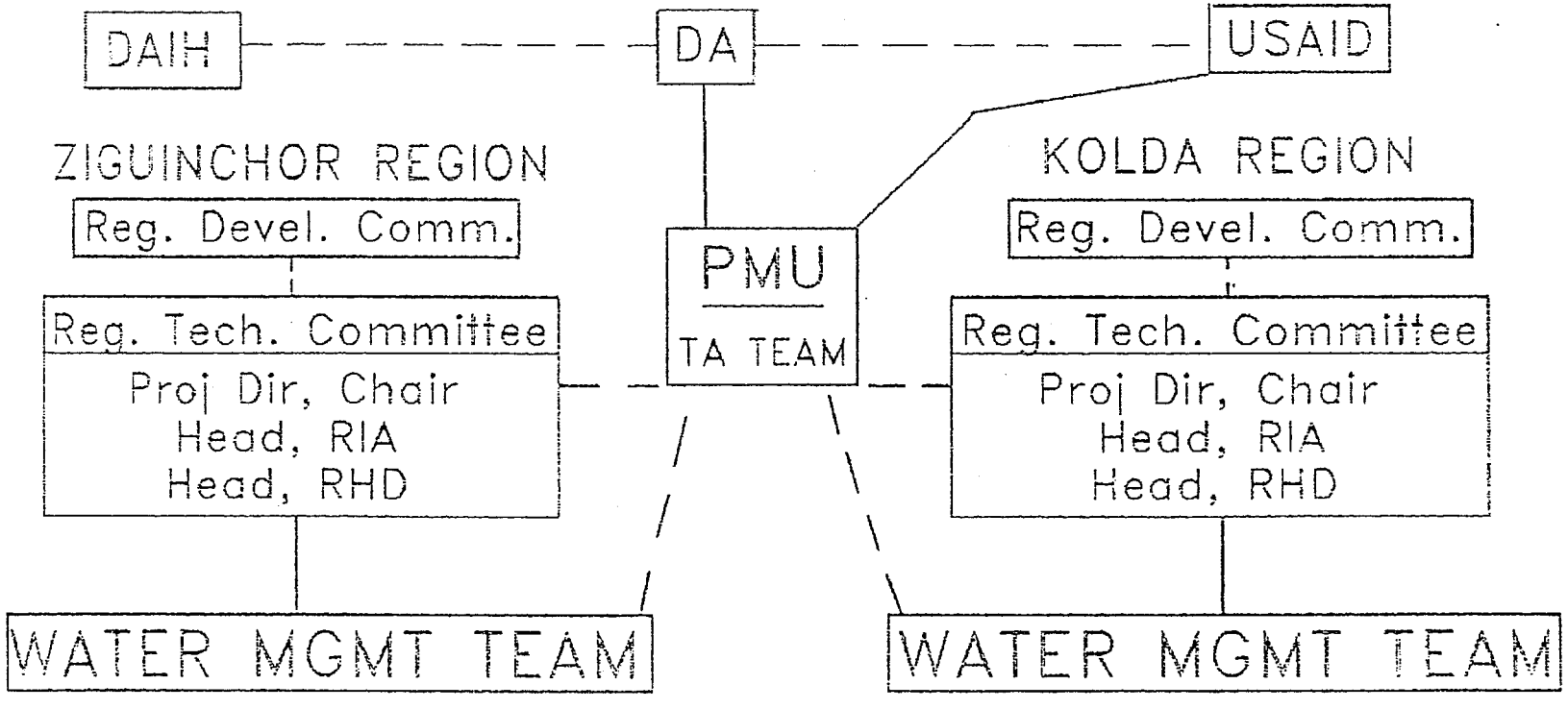
In addition, the SZWMP will work with farmers to improve their soil and water management practices. Initial priority will be on assisting farmers to adapt their cropping practices to the operation of the water-control structures. Then, using the results of applied research from ISRA (Institut Sénégalais de Recherches Agricoles) and other institutions working in similar environments, SZWMP will work with farmers to improve on-farm water and fertility management on reclaimed land.

The project staff from MRD's Department of Agriculture and the MH's Department of Hydraulic and Irrigation Works will work on project activities full-time under their respective regional offices. However, because of the limited capacity of these regional offices, the SZWMP will use a Project Management Unit (PMU) to initiate project activities. The two Regional Agricultural Inspectors, incorporated into the PMU from the outset, will take over planning responsibilities of the GOS Project Director during the life of the project. The transfer of GOS responsibility for program management to the Regional Inspectors will take place once the procedures for watershed planning and plan execution have been established. The Regional Hydraulic Divisions (RHD) will be closely involved in the planning and execution of the program. Figure 1 shows the organizational structure for the project. Detailed analysis of this structure is given in the Institutional and Administrative Analysis.

The SZWMP will bring together two interdisciplinary regional teams of GOS staff to work with farmers and local organizations in the full cycle of watershed planning, design, construction of primary water-control works, O&M, construction of secondary works, and improvements in soil reclamation and water management practices. The advantage is that the teams can modify their approach as they gain experience in watersheds with different natural and socioeconomic conditions and with the different phases of the watershed plan. Each Regional Water Management Team will initially consist of an

FIGURE 1 – ORGANIZATIONAL CHART

Southern Zone Water Management Project



——— Hierarchical and Functional Lines

– – – Functional Line

Irrigation/Civil Engineer and a Surveyor/Construction Supervisor to come from the MH and an Agronomist and a Village-Project Liaison Officer to come from the MRD. Others may be added if required. They will be responsible for identifying sites where villages are committed to providing both construction and O&M support, developing and executing watershed plans, organizing villagers in Water Management Committees, and training villagers in O&M.

The SZWMP will build on the experience and lessons learned of predecessor projects in working with village organizations. These lessons are:

- the importance of village initiation of assistance requests, joint planning of structural works, and commitment of labor and other support;
- resolution of land tenure conflicts before construction starts;
- careful programming of construction pace to match labor availability; and
- maintaining the Village Management Committee's sense of responsibility for and ownership of the water-control works and developing local capacity for operation and maintenance of the works.

The project will formalize contacts between the project and villages by requiring each participating village to establish a Water Management Committee. Given the diversity of formal and informal village organizations, the project will be opportunistic in its search for the appropriate local partner to assist in village organizational efforts. Other projects, non-governmental organizations (NGOs), Peace Corps Volunteers (PCVs), and/or the field staff of the Ministry of Social Development (MSD) will be solicited depending on their presence and effectiveness in working with the local village groups. The Village-Project Liaison Officer will play a key role in assisting villages to form the Water Management Committees and in incorporating the above listed lessons into project programming.

Initially, discussions will be held with villagers to determine their water management needs. In-depth inter and intra-village discussions will assure that villagers understand the land tenure, agronomic, social and other implications of the requested and proposed water control structures. Organization of Village Water Management Committees will take place concurrently with the detailed technical study of the related valley and overall watershed. The Water Management Teams will work with the villagers to determine the final number of structures and the location of the structures. It is difficult to estimate how long it will take to set up the requisite village organizations, obtain village approval of the plans and ensure that the villages have established work schedules for the construction phase. Timing of the pre-construction phase will depend on the level and type of existing village organizations, competing demands on villager's time, extent of land tenure and inter-village problems and other socio-cultural factors.

Once this phase is completed, it is estimated that the technical siting, surveying, design and contract documentation preparation for a typical dike involving a number of structures will take three months. The contract should be awarded for construction support activities and villages organized to start construction work at the end of the harvest season when village labor is available. Initially, most of the movement of earth for dike embankment using laterite materials will be carried out by the project using tractors and trailors. Construction of reinforced concrete control structures will be carried out by private sector firms. During this phase, contract documents will be prepared to encourage private firms to become involved in the movement of dike embankment and laterite materials as well as construction of the control structures. The farmers will provide all of the labor for the placement and compaction of the dike and berm embankments.

The project design recognizes that the heavy reliance on farmer labor for construction, operation and maintenance means that execution of the full watershed management plan may take several years in larger valleys. Of the 40,000 hectares which can be recovered or improved, somewhat more than a third will be affected by the project over eight years. The pace of the project will be directly tied to the timing and amount of farmer labor available for construction, operations and maintenance. Crop production benefits will also depend on farmer access to complementary inputs for crop production and reclamation.

Resources

Technical assistance (TA), vehicles, tractors and trailers, tools and equipment, contract construction services, applied research services, environmental monitoring services, and a three-year operating subsidy for vehicle costs and GOS staff per diem will be provided by USAID. Performance bonuses will be financed by USAID throughout the project. The project will pay for the rental of office space and the operational costs of the PMU over the life of the project.

The TA team will consist of the following: Water Resources Specialist/Chief of Party (COP), Civil Engineer, Agronomist and Sociologist/Water User Association Specialist and Administrative/Financial Officer. A senior Water Resources Specialist/COP will be assigned to the project for seven years. A Civil Engineer with a specialization in water resource engineering will also be assigned to the project for seven years. In Year Five of the project, when the emphasis on soil and water management activities will take on major importance, an Agronomist will join the team for the last four years of the project. A Sociologist/Water User Association Specialist will work for two years during project start-up to train the water management teams in water user organization and develop guidelines and procedures for Water Management Committee formation. The specialist will return each year for two months in years three through eight. Short-term technical assistance will be provided in sociology (15 pm), agronomy (6 pm), soil science (11 pm), economics (4 pm), development ecology (7 pm), and specialized engineering (6 pm). The relatively high allocations of sociology and soil science expertise reflects the need for specialist assistance in starting the field work and improving key skills of GOS staff. The Administrative/Financial Officer will provide necessary administrative and financial management for seven years. In addition, a local-hire Administrative Assistant, Secretary and Motorpool Supervisor/Mechanic will be funded by the project to staff the PMU over seven years.

The GOS will provide the professional staff for the Water Management Teams and a full-time Project Director from the MRD to work in the PMU. The GOS will assure that the Regional Inspectors of Agriculture and the Heads of the Regional Hydraulic Divisions provide required input on all project activities. The GOS will provide drivers for the 10 vehicles and five tractors purchased under the project. The GOS will also provide office space in the RIA and RHD in Ziguinchor for the Ziguinchor Regional Water Management Team and office space in Sedhiou for the Kolda Regional Water Management Team.

In addition, starting Year Four, the GOS will pay for per diem for official travel for all GOS employees working on the project, including the Project Director, and for operating costs of the vehicles assigned to the Water Management Teams and the tractors, including petrol and maintenance.

The GOS will, as a Condition Precedent, agree to disburse all allocated decentralization funds for office rehabilitation to the Ziguinchor and Kolda regions. The GOS will covenant to make a best effort to assure that a portion of the arrondissement rebate of taxes (fonds de concours) may be made available for investment in water-control structures at the local level.

b. Institutional Strengthening

The SZWMP supports the GOS policy of revitalizing specific water management services provided by the Ministry of Rural Development and the Ministry of Hydraulics to local farmers. The project will enable them to fill their roles as planners and supervisors of water development and management and as specific service providers to farmers. The project provides for better construction of structures through contractor-assisted earth moving and concrete work. The key to sustainability of the project's water management activities will be the project's performance in organizing village participation in watershed planning and development.

The SZWMP approaches institutional strengthening at three different levels: technical ministries, village groups, and the private sector.

(1) Technical Ministries

On-the-job training for MRD and MH technical personnel will be an on-going activity under the project. The training will be provided by the long-term and short-term technical advisors. Much of the work with the engineering staff will be in the application of their theoretical knowledge to different field settings. Both engineers and agricultural staff will need to develop new skills in operations and maintenance, soil reclamation, soil and water management, and soil conservation works.

The project will also support 12 short workshops and seminars in Senegal. These will generally be run by the long and short-term technical advisors and include specialists from the institutions working on the research and environmental programs, e.g., ISRA, ORSTOM, CRODT. Short-term TA will be charged, as part of their scopes of work, to hold a seminar or workshop on their field investigations, methodology and findings.

In addition, relevant short-term technical training will be provided in Africa, Asia and the U.S. to approximately 14 participants. Training on small dam construction, gate design, and rural water-control works is available in Burkina Faso and Morocco. The U.S. Bureau of Reclamation and the USDA Soil Conservation Service can provide practical internships for foreign participants. Short-term training in Asia will be for practical aspects of water user organization for construction, operations and maintenance. The project will also provide study trips for up to six individuals to visit related programs in the Gambia, Guinea Bissau, Sierra Leone, Burkina Faso and/or Ivory Coast.

Finally, four M.S. degrees in civil engineering and soil and water management will be financed by the project. This training will be carried out in the U.S. or third countries. The Training Plan (Annex J) gives details on types of training, location of training and number of participants.

Effective financial planning, management, accounting and control are key ingredients to successful project execution and to cost-effective technical service delivery. The SZWMP will provide short-term assistance to the PMU to establish financial and management systems for the project and training programs for the financial staff of the Regional Inspectorates of Agriculture and Regional Hydraulic Divisions.

(2) Village Groups

The SZWMP will provide direct assistance to village groups in watershed planning, construction, and O&M. The project will develop a training of trainers approach for the Water Management Teams. Team members will be trained to train Village Water Management Committee organizers drawn from NGOs, PCVs, local villages or the MSD. These organizers should be easily accessible to the village groups and have a limited area of responsibility so they can work through an entire watershed plan.

The proximity of water management projects in The Gambia and Guinea Bissau will enable the SZWMP to organize field visits for approximately 80 members of Water Management Committees. Similar local languages are spoken in The Gambia, Guinea Bissau, and Senegal, so farmers can talk directly with their counterparts and technicians in these countries.

(3) The Private Sector

The SZWMP will contract with the private sector for construction, hauling of materials, surveying and other services whenever possible. The project will encourage private sector development related to water-control infrastructure planning and construction by establishing simplified contracting procedures for increased GOS use of private sector contractors.

The project will also explore ways to simplify control structure design, provide training to enable local masons to build gates to acceptable engineering standards, and encourage use of local suppliers for construction and maintenance equipment.

In addition, NGOs are active in construction of water-control structures, but have only intermittent access to technical specialists with knowledge of water management planning, construction techniques, and operations and maintenance. Where NGOs are playing an important role in water-control, the project will include them in its project work. It will provide training to NGO staff who work directly with farmers in group organization, construction and O&M techniques.

c. Operational and Applied Research

(1) Operational Research

The project will support a minimal monitoring program of one large anti-salt structure in the Casamance: the Affiniam dam. SZWMP will support a minimum level of monitoring of this dam to model large anti-salt structure effects on upstream land reclamation as it relates to project-funded land reclamation and to monitor environmental effects. The Affiniam Dam is being turned over to the GOS in early 1988. The minimal monitoring program will require negotiation between the GOS and USAID and will take place after Year Three of the project when project interventions are planned in the Bignona area. SZWMP will support short-term TA to design an operational research program to carry out the targetted monitoring.

(2) Applied Research

ISRA has a well-defined program of research in water management, soil survey and analysis, rice cropping systems, production systems research, and farm management. The SZWMP will define and write research contracts for specific activities over the life of the project consistent with ISRA's priorities and programs in the southern zone of Senegal. Research areas will include:

- Water control structure operation to optimize surface area and season length available for cultivation.
- Multiple site trials to match rice varieties to water and soil conditions brought about by project interventions.
- Surface water and groundwater exchange in developed valleys.
- Reclamation of acidified soils.
- Fertilizer optimization on the different valley soils under various reclamation conditions.
- Weed control in the alternately wet and dry rice fields.

d. Environmental and Project Monitoring

The SZWMP will finance specific research contracts with ISRA, ORSTOM, and the CRODT, supported by some technical assistance, to carry out the environmental studies or reviews described in detail in the IEE amendment (Annex H). These activities will include:

- Round table discussions on anti-salt dikes.
- Review of the effects of water control structures on the shallow groundwater table.

- o Regional study of cumulative effects of water control under a range of watershed development scenarios reflecting no, low, moderate, and full control of upstream flows.
- o Effects of water control structures on water-associated disease incidence.
- o Impact of water control on terrestrial ecosystems.

Resources required for these activities will be provided by USAID in the form of approximately 11 pm of short-term expert consultancies.

As part of the environmental monitoring activities, the SZWMP will also finance a paired-watersheds study over five years to answer specific, applied questions concerning effects of water management structures on soils, water, crops, flora and fauna. ISRA will carry out this study under a sub-contract with the primary contractor.

4. Project Organization, Phasing and Selection Criteria

a. Project Organization

(1) National Level

The lead GOS ministry will be the Ministry of Rural Development. The Directorate of Agriculture will have implementation responsibility for the project. The Directorate of Hydraulic and Irrigation Works will assign engineering and survey personnel on a full-time basis to the Regional Hydraulic Divisions. The MRD will assign its personnel to the Kolda and Ziguinchor Regional Inspectorates of Agriculture. All GOS personnel will be assigned on an affectation basis, i.e., personnel will have their salaries and related benefits paid from the national budget, not A.I.D. funds. This will assure that project technicians will continue to work in their positions once the project is completed.

The MRD, the MH, and USAID will form a national-level oversight committee. It will be composed of representatives from the DA, the DAIH, and USAID. The Ministry of Rural Development will designate a Project Director to direct, on a full-time basis, the Project Management Unit. The Project Director will be based in Ziguinchor. The MRD will delegate financial management and operational authority to the PMU. Project accounts will be managed directly by the PMU based upon a six-month financial and operational program. The Project Director will approve all vouchers submitted to USAID from the contractor. All A.I.D.-supplied funds will be funded through an A.I.D. direct contract, whereby the contractor will be financially responsible for the funds.

A Project Monitoring Officer (PMO) will be hired by USAID to begin project activities under a Personal Services Contract (PSC). The PMO will work with the USAID Project Officer and the GOS to ensure that Conditions Precedent and Covenants are met, manage vehicle and equipment procurement, and arrange for housing, office rental, office rehabilitation, and other logistic requirements for the TA team. In addition, USAID will hire a short-term (9-month) Water Resources Specialist under a PSC to assist the MH and MRD in Ziguinchor in initiating project organization, GOS staffing, liaison with

local administrative officials and village groups and village organizations at initial sites. This expert will basically initiate project activities during the long contracting process prior to the arrival of the long-term technical assistance (TA) team.

USAID will contract for technical assistance with an experienced U.S. company or institution. The GOS will participate in evaluation of the U.S. contractor and approve the individual resident experts on the TA team.

(2) Project Management Unit (PMU) in Ziguinchor

The PMU will be headed by the GOS Project Director. The Chief of Party (COP) and the rest of the TA team will be formally included in the PMU. The PMU will be responsible for planning and implementation of project activities and financial management of project funds. The TA team will include an Administrative/Financial Officer to manage the daily functions of the project and project accounts. Also, the contractor will hire a local-hire Administrative Assistant, a bilingual Secretary and a Motorpool Supervisor/Mechanic.

The Regional Agriculture Inspectors from Ziguinchor and Kolda will be members of the Project Management Unit from the beginning of the project. They will work with the Project Director and the COP to develop the annual, quarterly, and monthly work plans. They will then be responsible for coordinating and supervising the work of the technical team in their respective regions. The head of the Regional Hydraulic Division will serve as the second member of the Special Technical Committee in each region. When the USAID and GOS joint review concludes that project activities are well-established and management systems in place, probably by about Year Four of the project, the Inspectors will assume co-leadership of the PMU along with the COP.

The other long-term and all short-term TA will work out of the PMU but in close collaboration with their technical counterparts on the Water Management Teams.

The PMU will assure that all project-funded vehicles and tractors are properly maintained and utilized. The Motorpool Supervisor/Mechanic will initially utilize private garages for required vehicle maintenance and repairs. If adequate private sources are not available at a reasonable cost, the Motorpool Supervisor/Mechanic will repair and maintain the vehicles within a PMU motorpool.

(3) Regional Water Management Teams

The first Regional Water Management Team will be established in Sedhiou in the Kolda region. The implementation team, with USAID and the GOS, will decide when the second Water Management Team will be established. Each team will include:

- 1 Water Resources/Civil Engineer
- 1 Surveyor/Construction Superviser

- o 1 Agronomist with soils training
- o 1 Village Project Liaison Officer

The teams will use local survey assistants. They will work with the TA team and short-term specialists to evaluate village requests for assistance, facilitate the formation of Village Water Management Committees, develop watershed plans, supervise construction, and develop the approach for the transition from construction to operations and maintenance. They will have responsibility for supervising contractor performance of earth and concrete works. The Team will also work with the Village Committees to develop their technical and organizational capacity to plan and execute subsequent water control works.

(4) Villages and Village Water Management Committees

The villages will provide labor for the placing and compaction of all dike and berm embankments during construction, and also for operations and maintenance of the water-control infrastructure once the construction is completed. The project will assist the villagers in forming Water Management Committees. The Water Management Committees will interact with the Regional Water Management Teams to develop watershed plans, mobilize and supervise labor for construction and establish operations and maintenance guidelines and emergency repair procedures. It is anticipated that the Water Management Committees will serve as an organizing focus for intensification of crop production on land that is recovered or benefits from a more regulated water supply due to the water control structures.

(5) Regional Technical Committees and the Regional Development Committees

The GOS will establish a Regional Technical Committee (RTC) in each region. This Committee will be composed of the Regional Inspectors of Agriculture, the heads of the Regional Hydraulic Divisions, the GOS Project Director and the COP. The Project Director will initially lead these Committees. The Committees will call upon the advice and support of other regional services as required for the successful implementation of the project. It will be responsible for execution of the work programs and plans developed with the Project Management Unit. The second major role of the RTC will be to report to the Regional Development Committees (RDCs) already established in each region. The RDCs are chaired by the Regional Governor or his designate. The RTC-RDC link will enable the project to maintain good working relations with the regional administrations.

b. Priority Zones for Project Activities

Overall ranking of zones and suggested time phasing for project operations have been done primarily on the basis of technical soundness, rainfall, topography, soils, land tenure, and farmer participation criteria. Specific selection criteria as delineated below will be used to select individual watersheds.

First Priority Zone -- Sedhiou Department

(1) The left bank of the Casamance River downstream of Sedhiou tributaries have good potential for development. Higher rainfall should

permit faster land reclamation behind anti-salt dikes, and the topography of the upper watersheds lends itself to low-cost water retention and regulation structures. Farmer enthusiasm is high and collective organization for construction is promising.

(2) The Sedhiou sites on the right bank of the Casamance River have similar potential, but are more difficult to reach because of the poor condition of the roads and lack of bridges. The Italian-assisted PRIMOCA project will improve the road network and may finance construction of roads at some of these sites.

Second Priority Zone -- Soungrougrou

(3) The Soungrougrou sites receive less rainfall than the preceding two. Existing anti-salt dikes and retention structures need to be rehabilitated and provided with gates. Small additional investments in infrastructure and a much greater emphasis on O&M will yield early returns. Farmer interest will be greater for anti-salt dikes than for retention structures and improved upland water management.

Third Priority Zones -- Bignona and Baila

(4) The Bignona Valley has relatively good rainfall, but severe salinization and potential soil acidification problems in the lower parts of the landscape. The future of aquatic rice production is now linked to the Affiniam dam. In the lower part of the valley, the Diola farming systems are severely labor constrained. In the upstream part of the valley salinity problems are lower, greater potential exists for water retention works, and labor availability is potentially greater in the mixed Mandinka-Diola farming systems.

(5) The upper Baila Valley has been intensively studied for its irrigation potential. A pilot small storage dam, reservoir, and irrigation perimeter was studied by the project design team. The cost of the dam and irrigation works, lack of prior irrigation experience in the area, the use of the reservoirs primarily for supplemental irrigation, and the lack of opportunity for double-cropping make the pilot project unattractive. The construction of small cross-valley water retention dikes in the unsalinized subwatersheds of the Baila show greater potential.

Fourth Priority Zone -- Upper Casamance River Basin

(6) The Upper Casamance basin above Kolda has numerous sites that are topographically well-suited to water retention. Previous studies examined these from the perspective of potential small reservoir development for irrigation. The conclusion was that most sites were unfeasible because of potentially high siltation rates. Also, the dams would be expensive to build, involve extensive land clearing, and generally require pumping to service downstream irrigation sites. The SZWMP implementation team will further study these sites to determine their viability for cross-valley water retention dikes. The Yorofoula bolong in the Gambia River Basin has also been recommended by the Kolda regional authorities as a site to be further studied during project implementation. Accessibility is a key problem in this area.

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c. Phasing of Project Work in the Priority Zones

(1) Years One and Two - Concentration in the Sedhiou area on the left and right banks of the Casamance.

(2) Year Three - Addition of the Soungrougrou and Baila zones.

(3) Year Four - Addition of Bignona and Kolda zones. Bignona is delayed until Year Four because of questions about the effects of the Affiniam Dam on upstream structures and because of the need to determine whether and how the SZWMP should work with the African Development Bank - financed DERBAC project.

(4) Year Four and Following - All zones with site priority determined by site - specific social, technical and economic feasibility combined with the efficiency of use of personnel and other project resources.

d. Site Selection Criteria

The PMU and Water Management Teams will prioritize and choose specific watersheds or valleys for interventions based on the following key selection criteria:

(1) Farmer Participation

(a) Consensus among villages
(b) Agreement to form Water Management Committees
(c) Labor availability, commitment to provide labor for construction and O&M.

(2) Economic Considerations

(a) Cost/Benefit relationships
(b) Financial returns to farmers

(3) Physical Criteria

(a) Soil quality/suitability/salination/acidification indicators
(b) Topography

(4) Social, Labor and Other Factors

(a) Prior exposure to improved water management technology
(b) Absence of land tenure problems

C. PROJECT BENEFICIARIES

Major project beneficiaries include three groups: the farmers of the southern zone; the GOS technical services of Agriculture and Hydraulics; and private contractors.

1. The Farmers: Cereals farmers and their families in the project zones will be the primary beneficiaries. Improved water management

and increased availability of water will increase rice production, decrease the food deficit of participating farmers and increase incomes. The proposed activities will halt salt intrusion, reclaim lost rice lands, and improve control of rainwater runoff for rice cultivation on these lands. The water-control structures may also replenish the shallow aquifers, thereby allowing more groundwater for village consumption and small garden production.

Both women and men will benefit from the project. Nearly all women in the project zone are active rice farmers, and, depending on the ethnic group, often have full responsibility for rice production. (In Diola areas, men prepare rice land for planting and assist with other operations as well). Women will have a voice in determining the use of additional rice production. Men are generally responsible for purchasing rice when household production is insufficient to meet consumption needs. Increased rice production will permit the reallocation of some of these scarce cash resources.

Both men and women will participate in water management committees and in the construction of water-control structures. Women will be important participants in all decisions concerning design and implementation of water management plans.

2. GOS Technical Services: The GOS will benefit from reinforced regional services of Agriculture and Hydraulics with trained technicians capable of continuing water management activities in the southern zone after project termination. The staff of the regional services will also benefit from increased operating budgets, enabling them to undertake substantially more field activity.

3. Private Contractors: At present, no local contractors in Ziguinchor and Kolda are involved in construction of water-control works. The project will use local contractors to construct and repair sluice gates and spillways and to participate in the transportation of dike embankment materials to the sites. In addition, the project will encourage the GOS and village groups to utilize private contractors whenever possible.

4. National Level: At the same time, the nation as a whole will benefit because of reduced rice import requirements. By 1999, project interventions should result in over 25,000 metric tons less imported rice than would be the case without the project.

D. RELATIONSHIP TO USAID AND GOS STRATEGY

1. Relationship to USAID Strategy

USAID/Senegal's FY 1987 CDSS (February 1985) gives top priority to increasing agricultural production. The overriding long-term objective is to help Senegal achieve food security, defined as the capacity to feed its people by domestic production and trade, even in drought years.

The CDSS targets a number of "hurdles" to positive growth in agricultural production. Most critical is water management and soil conservation. "It is clear to USAID that throughout the country, the non-availability of water at appropriate times and in appropriate amounts is a major constraint. Senegal cannot continue to count on rainfall, which is sporadic and highly variable at best." (CDSS, p. 44).

The SZWMP directly advances the USAID strategy of increased agricultural production through improved water management and soil conservation. It will also make a dramatic impact in the reversal of salinization in the valleys of the lower and middle Casamance River basin, and in the reversal of overall environmental degradation in the area.

The major role played in the project by farmer organizations, the use of local NGOs for local action, and emphasis on the use of local private sector contractors for dike construction and other services are all key project elements consistent with overall USAID strategy and the GOS New Agricultural Policy (NAP).

2. Relationship to GOS Water Development Plans and Policy

The GOS water resource policy promotes rational exploitation of a limited resource upon which multiple demands are placed. While the Casamance basin has generally been considered by the GOS to be an area of relative abundance of surface water, the administration and its relevant technical ministries have formally acknowledged that the long dry period since 1969 has reduced surface water supplies and quality. In discussions with the MRD and MH, senior officials have made it clear that they agree with the project's watershed approach to water planning and water control structure construction. There is also strong agreement with the project approach of protecting interior valleys against further salt intrusion. The President of Senegal recently announced (December 1987) an emergency plan of action against salt intrusion in the regions of Ziguinchor and Kolda. The project is consistent with this major new policy directive and has been included in the GOS Public Investment Plan.

The government owns all rural land and natural resources. Land use confers land access rights, but traditional land tenure systems are generally not challenged unless disputes cannot be settled locally. There are no specific policies, and no implementation guidelines with respect to prior use rights for surface water. The GOS appears to assume that prior use rights are not being infringed upon by water control structure construction. This is obviously not always the case. Structures have been designed and operated in ways that reduced downstream access to water. Generally, farmers have gained respect for upstream uses and prior use by involving local authorities, normally resulting in increased upstream releases from small retention structures.

The SZWMP will follow a policy consistent with the spirit of farmer practice in the Casamance. The project will not construct water control structures which prejudice the existing rights of downstream users. The SZWMP will formalize this approach as a matter of policy within the regional services and promote it through project-sponsored workshops with other branches of the GOS and other donors.

Formal laws exist on control of groundwater extraction. Control is vested in the MH, although enforcement of these laws and policy is not strict. But groundwater is exploited principally for domestic and livestock uses. This is a proper and sustainable use for the region's current limited groundwater resource. No policy dialogue action is required unless the GOS should undertake major new development of groundwater for crop irrigation.

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SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
GOAL			
To increase cereals production in the southern zone of Senegal.	1. Rice production in the project area increased by 50 percent by 1999 on 15,000 hectares; from 54,000 tons in 87/88 to 81,000 tons of paddy rice in 1999.	1. Statistics provided by Ministry of Rural Development.	1. No severe and prolonged drought affects the Casamance during project years. Political stability continues.
	2. Overall cereals production in the project area increased by 25 percent by 1999; from 105,000 tons in 87/88 to 132,000 tons in 1999.	2. Project monitoring stastistics.	2. Cereals can be exported or consumed locally. Marketing not a problem.
		3. Post-project impact evaluations.	3. Both financial and cultural incentives exist to increase production of cereals.
			4. Applied research findings for particular crops/areas produced and extended to farmers.
			5. Farmers will have access to and use fertilizer and improved seeds.
PURPOSE			
To improve farmer recovery of land and utilization of water for agricultural production purposes.	1. 15,000 ha. of valley land recovered or benefitting from improved water supply.	1. Project evaluations	1. No labor constraints in using new fields or new techniques.
	2. Better availability of water throughout growing season leading to less plant stress and lengthened growing season.	2. On-going project monitoring and project documents.	2. Demand for improved water management is high. Farmers want to follow through, see it to their advantage.
	3. Increased yield and production stability during years of variable or low rainfall. Rice yields increased by 1.8 MT per hectare during years of normal rainfall.	3. ISRA reports.	

SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
	4. Set of methodologies and approaches determined to provide most technically, environmentally, economically and socially appropriate mix of water control infrastructure, water management techniques, soil and water conservation practices in the watersheds, and forms of local participation.		
	5. Increased regional and local capacity to plan, execute, operate and maintain water control works.		
	6. Technical Ministries in regions assisting farmers improve 2,000 ha. per yer through better water management.		
OUTPUTS			
1. Water management plans, including designs, for small watershed areas completed and implemented at request and through assistance of local farmers.	1. Water management plans for 60 sites on a small watershed basis (including plateaus, slopes and valleys) completed leading to installation of mix of: anti-salt dikes, water retention dikes, land-terracing, land leveling, diversions and waterways, and contour berms; depending on needs, requirements, technical, social and environmental constraints in each watershed area.	1. Contractor Reports.	1. Availability of COS functionnaires able and willing to do required work.
2. Protection of highrisk valleys against salt-intrusion.	2. Small anti-salt dikes installed using village labor and maintained by villagers, resulting in desalination of 10,000 has, improved water availability on an additional 5,000 hectares.	2. Project evaluations	2. Support of administrative officials at all levels; cooperation from NGO.

SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
3. Well-defined set of institutional relationships between MRD and MH and capacity for supervising and carrying out water management planning, development, follow-up, and evaluation/monitoring.	3. Working group: - following standardized approach and procedures, - organizing villages and local organizations, - planning and designing best mix of water management structures, - getting agreement among villagers and villages on the plans and designs, - following through with construction and organization of management committee for maintenance and follow-on.	3. Project monitoring reports.	3. Coordination and good working relationship among all organizations, Ministries involved in project implementation.
4. Research completed by ISRA or other research organizations on topics related to water management concerning social/cultural problems, infrastructure/technical questions, soil and topography, and best mix of water management techniques.	4. Applied research results leading to improved methodologies and approaches starting in year 4 of the project.	4. ISRA and other research reports.	4. Land tenure and land distribution are not constraints to infrastructure development and improved water management and water utilization.
5. Private sector involved in infrastructure development.	5. a. 60 percent of overall value of infrastructure construction carried out by private sector. b. Procedures and relationships developed for GOS to increase use of private sector.	5. MRD reports	5. Local population provides labor for infrastructure development.
6. PVOs and possibly PCVs working closely with village organizations in developing and supporting water management activities and improved water utilization.	6. 60 local organizations formed and trained by PVOs and PCVs for using better water management techniques and maintaining infrastructure.	6. Project reports	6. Private contractor and/or GOS can procure materials for construction in a timely manner.
7. Environmental studies completed on impacts of water control structures on soils, water, flora and fauna in the project area.	7. - Anti-salt dike round-table, - ground water study, - regional water control modeling study, - water-borne disease assessment, - and terrestral ecosystem study all completed as scheduled.	7. Study Reports	7. Available private contractors and PVOs willing to provide required services at acceptable quality standards and costs.

SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
INPUTS	Budget ($000)	Project Documents GOS records	
USAID			
1. Technical Assistance	$6,600		
2. Training	900		
3. Equipment/Commodities	1,900		
4. Construction Materials/Contracts	3,800		
5. Logistical Support/Operating Cost	1,200		
6. Research and Monitoring	1,100		
7. Evaluation/Audit	400		
8. Inflation and Contingency	2,100		
TOTAL USAID	$18,000		
OTHER			
1. GOS personnel	1,300		
2. Logistical support of GOS personnel	300		
3. Village Labor to construct/maintain infrastructure.	1,100		
TOTAL OTHER	2,700		

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II. SUMMARY OF PROJECT ANALYSES

A. BACKGROUND

In August 1987, a team composed of USAID and GOS officials and TA consultants reviewed the technical, economic and social feasibility of the various water management options proposed in the SZWMP PID. The TA team included a Tropical Agronomist, a Water Resources Engineer, an Agricultural Economist, and a Rural Sociologist.

Five zones of potential intervention were investigated for the project: the Baila Valley, the Bignona Valley, the Sedhiou Region, the Soungrougrou Valley and the Kolda Region. These zones were jointly identified by the GOS and by USAID during PID development. Thirty-five sites were visited during the prefeasibility study in these zones to investigate the range of conditions within each zone and to prioritize the zones for project intervention in terms of their technical, economic, and sociological feasibility.

The PP design team subsequently selected ten sites which best represented the characteristics of each zone and which showed the most immediate potential for project intervention in the respective zones. It was decided to study these sites in greater depth during the PP design to:

- verify the zone prioritization of the prefeasibility team; and
- obtain site-specific data on which to base structural design specifications, costings, benefits and operations and maintenance approaches.

These ten sites are only a representative sample of the estimated 120 valleys throughout the priority zones. The PP team conducted detailed soils, hydrological, sociological, economic and engineering analyses on these ten sites to establish detailed cost estimates and overall water management plans. A complete range of infrastructure types were designed and costed out. Based on these cost estimates and the cultivable service area above the dikes, an average cost per hectare for construction of dikes was established assuming village labor is utilized for the placing and compaction of all dike and berm embankment.

For the ten sites, total estimated construction costs for the dikes when village labor is utilized is about $676,000, of which an estimated $463,000 is for contractor costs and an estimated $213,000 is the village labor contribution. The total cultivable service area in these ten sites is almost 3,000 hectares. The average contractor cost of the infrastructure which will be paid for by the project is $159 per hectare of cultivable service area. This average cost <u>only</u> includes the estimated contracted cost of the construction itself. If other costs related to the infrastructure development, such as TA, GOS personnel, village labor, logistical support and equipment and commodities are included, the estimated investment cost is $947 per hectare.

The following sections summarize the engineering, agronomic, soils, hydrological, economic, financial, sociological, and institutional analyses completed during PP field work.

B. TECHNICAL ANALYSES

1. Engineering Analysis

a. Major Design Alternatives

In order to improve water management in the Casamance Basin and improve beneficial use of rainfall in the region, the following engineering structures were studied:

- anti-salt dikes
- water retention dikes
- water control structures
- water storage dams
- gravity irrigation systems
- contour berms

Anti-salt dikes should be placed at the mouths of marigots to reverse the salinization process. These dikes should be provided with gated reinforced concrete control structures. The purpose of the dikes would be to prevent saltwater from coming onto farm lands and, at the same time, enable fresh rainwater to be stored on a given area and dissolve soil salts. The control structure would be opened at intervals during the rainy season to wash away the salts that have been dissolved by the stored rainwater. During the dry season, salty water would be allowed onto the lands to keep them moist and prevent acidification.

In some upstream areas less affected by saltwater intrusion, water retention dikes are proposed. These dikes would be similar to the anti-salt dikes but their purpose would be to store rainwater. This water would be stored to a depth of 0.5 meters and would be used to grow aquatic rice upstream from the dike.

For upland rice growing areas not greatly affected by saltwater intrusion, contour berms and selective land shaping are proposed to direct and control flow to harvest water and reduce erosion.

One further alternative was studied: the storage of excess rainwater behind small earthen dams and water release to a downstream service area via an outlet located at the bottom of the dam. The water would be distributed to the service area via earthen gravity-fed canals provided with turnout structures to direct the water to irrigation blocks. The cost estimates for such a system, based on simple technical designs, although much lower than previous studies, ran $4,000 per hectare and could not be justified for supplemental irrigation.

Plan and cross section surveys were carried out for each of the sites selected. Plotted plans and cross sections for each site are presented in

Appendix A of the Engineering Annex. These surveys were used to compute construction quantities and costs.

b. Preliminary Structure Designs

Typical preliminary structure drawings are presented in Appendix B of the Engineering Annex. Design calculations for each site are presented in Appendix A of the Engineering Annex. A brief summary description of the alternative designs is presented below:

(1) Anti-salt Dikes: These dikes shall be constructed of clayey material which can be obtained from borrow areas located near the dikes. The dikes will have side slopes of 2 to 1. The top width will be two meters and the dike slopes will be provided with laterite protection. The dike height will be about one meter. A reinforced control structure with removable stop-logs will be provided. The structure will have a number of 1.5 meter bays depending on the size of the upstream drainage area. A top'slab will have removable pieces so that stop-logs can be lifted and lowered. A one-meter deep upstream cutoff wall will be provided.

(2) Water Retention Dikes: The water retention dikes shall have a top width of one meter, 1 to 1 side slopes and be approximately 0.5 meters high. The dike will be provided with the same control structure provided for the anti-salt dike. The only difference will be that this structure will store excess rainwater for upstream rice cultivation.

(3) Contour Berms: Contour berms shall be constructed of clayey material, be approximately 0.5 meters high, have a top width of one meter and have 1 to 1 side slopes. The purpose of these berms will be to direct overland flow, harvest this flow and reduce soil erosion. These berms will be located along the contours in the upper half of the service area.

c. Construction Quantities and Cost Estimates

(1) General: Field surveys were carried out at each of the ten selected representative sites to determine lengths of proposed dikes. Drainage areas and design floods were calculated to size the control structure widths. Gross and net service areas were measured from soil maps prepared in the field.

(2) Quantities: A summary of anti-salt and water retention dike lengths, contour berm lengths and control structure widths are presented in the following table:

Table 1

Control Structure Widths/Dike Lengths/Berm Lengths

No.	Name	Control Structure Widths (M.)	Anti-Salt Dike Length (M.)	NO.	Retention Dike Length (M.)	NO.	Contour Berm Length (M.)
1.	Tanaff	4.5	450	1	800	2	6,000
2.	Samine Escale	3.0	1,165	1	1,600	4	13.000
3.	Kinndiri Medina	3.0	1,244	1	800	2	6,900
4.	Bounkiling	12.0	600	1	800	2	4,500
5.	Ndiama	10.5	600	1	400	1	3,300
6.	Mayor	1.5	-	-	800	2	1,600
7.	Diatok	4.5	876	1	400	1	1,300
8.	Balingore	3.0	3,876	1	800	2	4,100
9.	Djimande	1.5	-	-	1,126	2	1,000
10.	Essoum	1.5	-	-	1,600	4	2,800

A summary of construction quantities for anti-salt dikes, water retention dikes, and contour berms for each of the ten selected sites is presented in the following table. Also, net service area is shown for each site. The ten sites represent a net service area of 2,915 hectares. Detailed calculations are presented in Appendix A of the Engineering Annex.

Table 2

Summary Dike/Berm/Control Structure Quantities

No.	Name	Net Service Area (ha)	Dike Fill (Cu.M.)	Laterite (Cu.M.)	R.C. Concrete (Cu.M.)	Berm Fill (Cu. M.)
1.	Tanaff	424	1,231	495	10.1	4,500
2.	Samine Escale	822	1,827	1,282	10.1	9,750
3.	Kinndiri Medina	446	2,736	1,368	7.8	5,175
4.	Bounkiling	335	1,758	660	21.6	3,375
5.	Ndiama	230	1,788	660	19.3	2,475
6.	Mayor	83	600	-	5.5	1,200
7.	Diatok	80	1,819	964	10.1	975
8.	Balingore	245	11,063	4,264	7.0	3,075
9.	Djimande	64	1,701	-	5.8	800
10.	Essoum	186	1,200	-	22.0	2,100

d. Unit Prices/Costs

The costs for the construction of the dikes and berms at each project site were estimated using two different sets of unit prices. First, all contractor unit prices were used. Secondly, a combination of contractor and village labor unit prices were used, whereby the villagers would provide all of the labor required for dike fill. Village labor substantially decreases the unit cost of the dike fill. A summary of the two sets of unit prices is presented in the following table:

Table 3

Unit Prices Assumed

Item	Contractor Unit Price ($)/cu.m.	Combination Village Labor/Contractor Unit Price ($)/cu.m.
Dike fill	12.76	5.00 (villagers providing labor)
Laterite	20.00	20.00
R.C. Concrete	400.00	400.00

Costs for each item of work were computed using both sets of unit prices. The total construction cost of the water control works including 29 dikes and contour berms using the combination village labor and contractor unit prices was about $ 676,000. The cost using all contractor unit prices was approximately $ 1,230,000. A 20 % contingency factor was applied. The details for using only contractor unit prices is presented in the Engineering Annex. The details for using the combination of village labor and contractor unit prices for each valley is presented in the following table:

Table 4

Summary Estimated Costs Using Village Labor For Dike/Berm Embankment ($000)

Name	Dike Fill	Laterite	R.C. Concrete	Berm Fill	Total	Of which: Contract	Village
Tanaff	3.8	11.9	4.9	30.6	51.2	30.6	20.6
Samine Escale	3.8	25.6	4.9	65.4	99.7	58.2	41.5
Kinndiri Med.	12.8	65.5	3.7	34.8	116.8	88.2	28.6
Bounkiling	6.9	15.8	10.4	24.0	57.1	38.6	18.5
Ndiama	8.9	15.8	9.3	16.8	50.8	35.4	15.4
Mayor	3.6	-	5.3	7.2	16.1	9.6	6.5
Diatok	9.1	23.1	4.9	7.8	44.9	34.8	10.1
Balingore	62.8	102.4	3.4	22.2	190.8	139.8	51.0
Djimande	10.2	-	2.8	4.8	17.8	8.8	9.0
Essoum	7.2	-	10.6	12.6	30.4	18.5	11.9
TOT.EST.COSTS:	$129.1	$260.1	$60.2	$226.2	$675.6	$462.5	$213.1

e. Preliminary Construction Specifications

(1) Dikes/Berms: Dikes shall be constructed of clayey materials. The embankment material shall be placed in layers not exceeding 0.15 M. . in a moistened condition. Compaction shall be carried out by means of hand tampers. Anti-salt dikes shall have 2 to 1 side slopes and water retention dikes and control berms shall have side slopes of 1 to 1. Anti-salt dikes shall have a top width of 2.0 meters and a height of 0.8 meters. Water retention dikes and control berms shall have a top width of 1.0 meters and a height of 0.5 meters. Laterite slope protection shall be provided for anti-salt side slopes.

(2) Control Structures: Dike control structures shall be constructed with 350 kg. class reinforced concrete. Rock aggregate shall be used. Deformed reinforcing bars shall be used. Sand shall be well graded and clean. Concrete shall be mixed and tamped into place by hand. Water used to prepare concrete shall be free of impurities. Wooden stop-logs shall be provided.

A typical mix of infrastructure would be the provision of an anti-salt dike and control structure at the downstream end of the basin across the mouth of the marigot that penetrates the basin. Approximately one-third of the way up the basin a water retention dike would be provided with a one-bay control structure. Two-thirds of the way up the basin another water retention dike would be provided. Over approximately one-half of the service area, contour berms would be provided to control overland flow, harvest water and prevent erosion.

f. Operation and Maintenance, Anti-salt System

(1) Operation: The anti-salt system will be operated to prevent salt-water intrusion and keep potentially acid sulfate soils moist enough to avoid acidification and mineral toxicity problems. It is proposed that the system be operated as follows:

When the rainy season commences, the stop-logs are closed to prevent saltwater from entering the protected lands. This will allow rainwater to dilute salts lying on the upstream lands. At intervals during the rainy season, the stop-logs should be withdrawn to allow dissolved salts to flow out. The stop-logs should be opened and closed in cycles to bring about flushing and filling. At the end of the rainy season the lands should be drained to the level of the high potential acid soils.

The control structures for water retention dikes are used to control the upstream level of water used for rice cultivation.

(2) Maintenance: It is recommended that preventive maintenance be carried out every year after the harvest season. Dike and berms should be repaired and erosion around control structures repaired. Excessive dike settlement and bank erosion should be repaired each year. After a few years, stop-logs may require replacement.

It is proposed that a minimum of two percent of the capital cost of the anti-salt system be set aside by farmers for annual maintenance. For the ten sample sites, this would amount to a total of $9,260, or approximately $3.20 per hectare of cultivable area for annual maintenance requirements. Farmers will be provided with hand tampers, shovels and wheelbarrows left over from the construction period.

2. Agronomic and Water Management Analysis

a. Estimation of Areas for Recovery or Improved Water Control

Existing studies by ORSTOM, ISRA, Harza and soil and land use maps, combined with field visits and soils analyses were used to make an assessment of the total amount of land potentially recoverable or improvable through improved water control, as presented in Table 5.

Table 5

Estimated Surface Area for Recovery and/or Improved Water Supply in the Lower and Middle Casamance Basin

Sub-Basin	Estimated Recoverable/ Improvable (ha)	Now in Cropped (ha)
Bignona	6,800	2,800
Baila	8,000	1,600
Soungrougrou	12,600	2,000
Sedhiou	12,000	3,600
Kolda Area	3,000	600
Total	42,400	10,600

These estimates are considered to be reasonable. Additional areas may benefit from improved water control, without investments in anti-salt structures, in the Kolda and Velingara Departments. But, these areas are more sparsely populated and have higher rates of erosion than other parts of the project area. The implementation team will need to carry out further analysis of these sites. The sub-basins shown above include over 120 valleys. The valleys are not consistently of the same size. Their watershed areas range from a few square kilometers to over 800 square kilometers.

b. Scenarios for Crop Production on Different Soil Types

(1) Non-Saline Valleys and Soils: structures will include retention dikes, interior ridging and side valley berms for water accumulation and diversion. The first steps will be the addition of rice land as water supply becomes more regular up and down the toposequence. Peanut production in the upper watershed may decline in Diola areas and perhaps Mandinka areas depending on peanut prices and labor availability. In the lower part of the toposequence, transplanting will probably replace the direct seeding that dominates the drier valleys. Direct planting can be maintained by terracing the slopes of the valleys, but the flat terrain and slight slopes reduce the advantages of this approach. Rice intensification will occur if inputs are available. Likely intensification moves would be some return of longer cycle varieties, fertilization, mechanical weed control if the hand-pushed rotary weeder is perfected for Senegalese conditions, and plant protection.

(2) Slightly Acid to Moderately Acid and Salinized Soils: these soils can be recovered and their productivity increased through the diking of parcels. The individual paddies formed can then be used to collect rainwater and flush out salts. Rice plants require a rooting depth of about 30 cm and a soil electrical conductivity of less than about 10 mmohms/cm. Using the Diola approach of ridging soils, the slightly to moderately acid soils can be used for rice production within one to three years. Farmers will probably continue to use short-cycle varieties on these soils to avoid the early season peak of acidity, iron, and aluminum toxicity. Farmers may move to longer cycle varieties after four or five years as carry-over salt levels drop and if varieties tolerant to high aluminum and iron are introduced. Crop yields can be substantially improved up to a practical maximum of 3.5-4 tons/ha if fertilization or liming is practiced. Phosphate fertilization may be the most cost effective way to increase yields if acidity levels are not too high.

(3) Acidified Fat Clays: while desalting these soils will not be difficult, ultimate recovery of these highly acid soils is dependent on the length of time that they have been oxidized and acidified and the subsequent rate of leaching of jarosite minerals below the 50 cm level. While about half of the soils studied in the field are approaching this point, the best management practice may be to avoid any further investment in them until vegetation begins to re-establish itself. When these signs of recovery begin to take place, the reclamation process may be hastened by liming or heavy phosphate fertilization. The project should await additional research results including an economic analysis of returns from soil reclamation efforts before attempting extension of these techniques with farmers.

(4) Upland Soils: these soils are not subject to salt intrusion or intense acidification, but they have low soil fertility status and, in some cases, are subject to erosion. Conservation approaches to these soils would be to promote contour plowing of the upland soils, particularly with peanuts, to reduce competition for water, nutrients and light by improving weeding practice, particularly with animal drawn weeders, to plant tree bands on the slopes, and to fertilize soils to increase the yields and the amount of crop trash which can be fed to animals or left as a soil cover. These practices are not anticipated to be a major focus of project activities in the first four years.

c. Rice Productivity and Production

Current average rice yields vary from a high about 2.0 t/ha for aquatic rice to less than 400-700 kg/ha for upland rice. Much more rice is grown under alternating wet and dry conditions than under constant wet conditions. The spread in rice yields is large but to be expected when rice is grown across a diverse set of soil conditions and as a transplanted and a direct-seeded crop. All rice crops in the Casamance start as rainfed rice with low or no water control. While early season drought stress will not directly have a major effect on crop yield, blast disease infection develops rapidly in many seed beds. This is a problem both for transplant nurseries and direct-seeded fields. In both direct-seeded and transplanted areas, variability in yields is high because of relatively great differences across short distances in desalting rates and in flooding, dissolving, accumulation and precipitation of toxic ions of aluminum and iron. Variability in seasonal distribution of rainfall also leads to a spread in yields.

The largest effects on rice crop productivity can be expected from the return of rice production to the valleys after desalting. These environments have a higher natural fertility than the sandier high terraces, slopes and upland soils. The first effect on rice crop production will be a gain in surface area cultivated. The second major impact will occur as growing conditions improve through reduced variability in water supply and reduced salt and acidity levels early in the growing season. With the dikes in place yields on the valley soils should stabilize at around 2 to 2.5 t/ha.

Supply of improved rice varieties, fertilizer and plant protection materials would boost yields substantially higher. But, the project will not provide extension services in input supply. Instead it will concentrate on water control work to desalt salinized areas, provide secondary water retention dikes control to improve fresh water supply to the highest potential soils, and following the results of applied research, extend techniques in accelerated land reclamation and more advanced water control work such as land levelling and terracing. Improvements in water supply and land availability will improve the use of inputs obtained from other sources.

d. Applied Research

While there is a substantial backlog of descriptive research on soil and water issues in the Casamance, the drought has rendered early approaches to soil and water management problematic. ISRA, ORSTOM and others have been active in searching to define how management practices need to adapt to the new conditions. The SZWMP will support research aimed at identifying practical management options of broad applicability to the valleys of the south. The project will place special emphasis on extension of ISRA's area of research to include the Middle Casamance. Areas for individual research activities under the project include:

- Water control structure operation to optimize surface area and season length available for cultivation.
- Multiple site trials to match rice varieties to water and soil conditions brought about by project interventions.

- o Surface water and groundwater exchange in developed valleys.
- o Reclamation of acidified soils.
- o Fertilizer optimization on the different valley soils under various reclamation conditions.
- o Weed control in the alternately wet and dry rice fields.

3. Soils

Field surveys, sample collection, laboratory analysis, and evaluation of findings were done in the ten sample watersheds. The major soil groups described and evaluated are presented below.

a. Major Soil Groups

(1) Mangrove Saline Soils: The Mangrove soils occur along the drainage ways and in depressional areas of the watershed basins.' Soils of this group remain saturated with saltwater throughout most of the year. These soils are highly saline with a large amount of sulfides. Despite their high sulfide levels, they have not undergone extensive acidification because of their water saturated, reduced state.

(2) Acid and Saline Soils: The acid saline soils primarily occur on broad flats within the basin and adjacent to the saline (but non-acid) Mangrove soils. These soils are frequently inundated with saltwater and have undergone extensive acidification to a point where most have become sterile. This is due to the moisture deficit during the dry season and, as a result, oxidation of sulfides.

(3) Soils with High Potential for Acidification and Salinization: These soils occupy broad flats and very low terraces along the drainage ways within the watershed basins. They are young undeveloped soils that remain saturated with saltwater most of the year, except for the period just prior to the transplanting of rice. They contain a high amount of sulfides and salts within 50 centimeters of the surface. As a result, these soils will become extremely acid when allowed to dry for long periods.

(4) Soils with Moderate Potential for Acidification and Salinization: These soils are on low terraces of the second bottom of the drainage basins, and on slightly higher broad interfluves between small drainage ways of the same basins. They are slightly developed at depths from below the surface layer to approximately 90 centimeters in depth. They have also undergone some oxidation of sulfides in the upper 50 centimeters of the soil depth. The ground water table fluctuates seasonally, but remains high throughout most of the year. As a result, they have a very low pH and iron sulfate (jarosite) mottles at least in the upper portion of the soil profile.

(5) Soils with Slight Potential for Acidification and Salinization: these soils are on mid-level terraces of the basin, and on low terraces along narrow drainage ways at the middle to upper reaches of the watershed basins. Typically the soils of this landform position in the landscape reflect a somewhat deeper groundwater table, or shorter periods when

the soil is saturated. Evidence is that they are not affected by salinization of the ground water table, but do receive surface inundation from saltwater intrusion.

However, these soils do manifest evidence of probable acidification in future years, if placed into a situation of continued wetting and drying year after year, as is the current practice in rice culture. This practice, along with continued cultivation without proper fertilization, will greatly increase the probability of acidification due to the oxidation of iron and sulfides.

b. Soil Management Approaches and Siting Criteria

(1) Acid and Saline Soils: These soils have already been acidified (due to oxidation) and salinized. Any environmental damage from acidification has already occurred. All sites visited had significant areas of these soils with the exception of Djimande and Essoum. They are generally sterile and are undergoing some maturation (development) or ripening which will permit recolonization by plants and rice cultivation. Generally, severalyears of reclamation will be required before rice can be grown on them, with the exception of those soils which have already shown some maturation and a reduction in sulfide concentration in the upper soil horizon.

ISRA and ORSTOM soil scientists believe that these soils can be used if the upper 20 to 30 centimeters in depth can be reclaimed. Microcatchments and drains are one way of reclaiming this land. Soil amendments such as lime, ground rock phosphate, phosphate slag, and some phosphate fertilizers can also be used to permit rice cultivation. Rice will withstand relatively acid conditions (down to about a 3.5 pH threshold) if nutrient availability is not below crop growth requirements.

(2) Potentially acid soils: Field investigations by the PP team separated the potentially acid soils into three categories based on their potential acidity, which relates directly to sulfide content. Sulfide accumulation is in turn a function of slope position and, probably, of the amount of time over which sulfur has been deposited on these soils. The soils higher on the slope have lower sulfide content and lower potential for acidification. The slight and moderate potential soils have already undergone some oxidation. They have also matured more than the potentially high acid soils. All three sub-categories of this potentially acid soils group are currently being used for rice production. There is no mangrove vegetation on these soils because they either dry out each year or because they are salinized.

Site selection will not be significantly affected by the presence of the slight to moderate potentially acid soils. The high potentially acid soils are the more recent (less altered) soils. Their presence in significant quantities will require that the water control structures be operated to keep them at field capacity moisture content (or above) throughout the year. This may require the inflow of saltwater during part of the dry season. Soil salinity will remain a problem on these soils. They are and can continue to be used for rice production if kept moist.

(3) Mangrove Soils: Mangrove soils are those formed under the influence of mangrove vegetation. At all sites visited the native vegetation was almost entirely absent. These soils are highly organic and have an extremely high acidification potential. While some have altered from fibric to muck status, none offer much potential for rice production. Only small strips of these soils exist at most sites. They border the water courses of the bolongs. They lie next to the high potential acid soils in many areas.

Where the mangrove soils are of broader extent, they should be avoided. Building dikes on them would cause no further or irreversible environmental damage, but their lack of structure and consolidation makes it difficult to build stable dikes and concrete sluice gates on them. Their extensive presence in the Tanaff bolong caused the exclusion of the central bolong site and its replacement by selected side valleys as the preferred sites for dikes. The option of excavation and/or building structures on pilings was excluded as being too expensive. The Bounkiling dike site has been moved upstream from the initial site to avoid these soils. An existing structure is steadily sinking into the muck mangrove soils there.

The only recommended management approach to these soils is to maintain them in their wet state. Diking will probably improve the moisture status of these soils when they occur upstream in small valleys. Existing dikes have generally resulted in some recovery of mangrove stands as salt concentrations have dropped behind the dikes.

4. Hydrology

The hydrology studies were carried out by an ORSTOM scientist and data was used by the engineer to determine appropriate siting and specification for the water-control works. Annex G.1.d. provides detailed information. The key points of the study are:

o Small antisalt dikes can withstand both the calculated ten year floods and the known high tide levels;

o While the drought has led to a decline in average annual rainfall, neither the length, general date of onset, nor peak intensity of rainfall has changed;

o There has been an increase in variability of rainfall events early in the season and at the end of the rainy season;

o Runoff rates from the plateau and valley slopes are relatively low. Erodibility is not high. There should be sufficient early season runoff to provide designed levels of water for anti-salt dikes and retention structures;

o There will need to be additional work done during the project on the linkage between the valley and surrounding groundwater aquifer recharge and water quality characteristics.

The succession of lower-rainfall years since 1969 and especially since 1979 has modified the hydrogeological conditions of the Casamance valleys. Ten meter decreases have been noted in some water-table levels. In the project region, one shallow aquifer and some deep aquifers are present. Of the deep aquifers, only the acquifer in the sandy clay deposits of the upper Ecocene is exploited. The fresh groundwaters flow toward the tributaries and along the banks "compete" on a continuous front with the salt waters of the tributaries.

C. ECONOMIC ANALYSIS

The calculated Economic Internal Rate of Return (IRR) of the SZWMP is 22%. The sensitivity analysis shows that with a decrease in benefits of 30%, the IRR would drop to 17% and a decrease in benefits of 50% would still show an IRR of 12%. The details of the economic analysis are presented in the Economic Analysis annex (Annex G.2). Table 6 summarizes the sensitivity analysis. It shows that the project design is robust and makes economic sense even at greatly reduced benefit flows.

Table 6

Sensitivity of Project IRR to Decreased Surface Area and Yield Levels.

Projected Surface Area	Expected yield 1800 kg/ha	IRR	Yield - less 30% 1260 kg/ha	IRR
expected 15,000 ha	x $243 = $6.561 mil	22%	x $243 = $4.593 mil	17%
reduced by 30% 10,500 ha	x $243 = $4.593 mil	17%	x $243 = $3.215 mil	9%

Note: Estimated economic Casamance farm gate price for paddy in 1990 is $243/t.

Although the technical assistance, training, research, monitoring and evaluation costs are substantial, the economic viability of the project does not rest on the calculation of post-project spread effects, notably the further reclamation and improvement of land and the value of the creation of institutional capability. The IRR is based on the assumption that during the eight years of USAID assistance, 15,000 ha will benefit from the project. The total economic cost from all sources (USAID, GOS, villages) for the recuperation/improvement of 15,000 ha amounts to $14,203,000 at constant 1987 prices. The investment cost per ha will be $947. The contribution of the Senegalese economy in the form of village labor, investments in civil works, government officials, logistical support and office space is approximately $2.7 million.

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The net production figure of 1.8 tons of paddy rice per hectare takes into consideration the existing rice production on the uplands, the expected decrease in production of other (cash) crops and the village labor required for the maintenance of the infrastructure, which is deducted from the gross production expected to be 2.5 t/ha. It is expected that the private sector may become more active in supplying the necessary inputs as a result of the NAP and the A.I.D.-funded Agricultural Production Support project. On 15,000 ha the annual production would be the equivalent of 19,500 tons of white rice. This production would have a value of $4,739,000 and represent approximately 6% of the present annual level of national rice imports.

If project activities would continue at the same pace for another 12 years, an additional 25,000 ha could be reclaimed and/or improved, bringing the total area affected by the project to 40,000 hectares. Once this surface area has reached full production, and if at least 50% of the farmers has access to modern inputs, the net additional production per hectare could be conservatively estimated at two tons of paddy rice per ha per year. Based on the World Bank projected 1990 world market price for rice, the economic value of the Casamance paddy rice would be $243 per ton. Therefore, the total additional value would be nearly $20 million. The November 1987 economic farm gate price is $205/ton whilst the government fixed farm gate price for the 1987 harvest is $300/ton.

The total additional paddy production on these 40,000 ha would be the equivalent of 52,000 tons of white rice, which is 15% of the present level of rice imports (340,000 tons/yr. The foreign currency savings to the Senegalese economy if full production on 40,000 ha could be achieved would amount to nearly $20 million per year at estimated 1990 world market rice price levels.

Other substantial economic benefits are environmental and natural resource related. However, insufficient data is available to value them. The anti-salt dikes will recover substantial amounts of valley land, which will lower the pressure on the uplands. Overall water resources will be better used as a result of improved water management. In addition, recovery of palms and other trees around the lower valleys is expected as well as an increase in fishery potential.

D. FINANCIAL ANALYSIS

The financial analysis concentrates on the benefits that the farmers and their families would stand to gain from the project intervention. The results of the field work carried out and typical farm budgets are presented in the Financial Analysis (Annex G.3.).

Yields are expected to increase a net 1.8 tons of paddy per hectare as a result of the availability of more fertile valley lands, and the better use of available water. The total available surface area per family suitable for rice production will increase. The increase in yield will make the families benefitting from the project self-sufficient in rice. Rice production per family in the reclaimed and/or improved valleys will be four to seven times higher than the production obtained on the slope and uplands, given that present yields are on average 500 kg per hectare.

The value of production per person day worked on the cultivation of rice will increase by a factor of six when compared with the cultivation of rice on the uplands. The value of paddy per person day worked under present conditions averages FCFA 170. The return to labor will increase to FCFA 1100 in the with-project situation.

Production of rice will provide the highest return to labor in the with-project scenario. This contrasts with the current situation in which peanut production gives the highest return to labor at approximately FCFA 750/day.

From the interviews conducted with the farmers, it was evident that they are still primarily subsistence farmers. In the present situation, in which rice can no longer be cultivated in the valleys and rice production has shifted to the less productive uplands, it would make financial sense to concentrate on the production of groundnuts, and use the proceeds of the sale of groundnuts to purchase rice. The proceeds of one ha of peanuts at current prices would allow the purchase of the equivalent production of four ha of upland rice.

However, it was found that every family was still producing rice, despite the lower yields and the fact that peanut production would be more remunerative. In a few villages, it was noted that some families had partially shifted away from rice production in favor of peanut production, but this shift was not a general one.

At present price levels, calculated revenues per person day worked in rice and peanut production are equal at a yield of 1.2 tons of paddy per hectare and one ton of peanuts per hectare.

E. SOCIAL SOUNDNESS ANALYSIS

The Social Soundness Analysis is presented in Annex G.4. The analysis presents the most important aspects of the farming systems in the project zone affecting project implementation. In addition, the analysis assesses the validity of a number of key assumptions to achieving project objectives. Throughout the analysis, the importance of pre-construction baseline data on each key assumption emerges as critical to project success, hence the important emphasis placed on the role of the regional water management teams in the project design.

1. Farming Systems in the Project Zone

Two major ethnic groups, and their respective farming systems, predominate in the project zone. Both groups, Diola and Mandinka, grow rice, millet, sorghum, maize, and groundnuts. Among the Diola, farming tasks for all crops are shared between men and women. Men are responsible for land clearing and tilling, while women do the planting. Both sexes participate in weeding and harvesting all crops. Agricultural tasks among the Mandinka are divided between men and women by crop. Women are entirely responsible for rice production while men cultivate maize, millet, sorghum, and groundnuts.

In both farming systems, producers have been forced to shift their rice fields from the increasingly saline valley floors to the higher slopes. Although not salt-affected, the soils on the slopes have a poorer water retention capacity than the valleys, and consequently a lower yield potential. The cultivation of upland cereal crops among the Diola intensified only as a response to declining rice yields. Although these crops have long been a part of the Mandinka farming system, women are gradually including groundnut cultivation in their farming calendar to compensate for poor rice yields.

Rice is the preferred staple food in the project zone. In the past, farm families grew sufficient quantities of rice each year to subsist at least until the following harvest. Surpluses were common, and their sale allowed farmers to invest in cattle or other personal needs. Recently, however, most families have been faced with deficit rice production levels. With declining rainfall levels and the rapid intrusion of salt water into the river and tributary valleys, the surface area of productive rice land is continuously shrinking. It is not uncommon for families to begin purchasing rice only three months after the harvest. Furthermore, since yields from upland food and cash crops have also declined, many households have been forced to borrow on subsequent harvests. The incidence of families living in continuous debt is becoming more and more frequent.

2. Demand for Water-Control Structures

Two types of demand for water-control structures exist: explicit and implicit. Furthermore, the type and magnitude of demand for particular kinds of structures -- anti-salinity, water retention, and upland contour berms -- vary between the Ziguinchor region and Sedhiou department.

a. Anti-salinity Dikes

The tradition of anti-salinity dike construction among the Diola in the Ziguinchor region has been well-established for centuries. With the introduction of improved gates which could regulate the water level upstream of the dikes, farmers immediately recognized their potential benefit. The demand for anti-salinity dikes in the Ziguinchor region can be described as explicit. For the most part, rice farmers in this area clearly understand the function of the dikes, have years of experience with them, and see them as important in protecting rice land from salt water degradation.

Further east in the Sedhiou department, saline intrusion is a relatively new phenomenon. In the upstream portions of some Sedhiou valleys, salt intrusion occured for the first time this year. Without mitigative measures, these farmers will soon be coping with the same problems as their downstream neighbors.

Examples of anti-salt dikes are scattered around the Sedhiou department; however, demand in the Sedhiou department appears to be more implicit in nature. That is, the need to arrest saline intrusion is clear, but the solution of constructing anti-salinity dikes is not as evident to farmers as it is in the western part of the Ziguinchor region.

b. Water Retention Dikes

In both Ziguinchor and Sedhiou, the demand for water retention dikes appears to be more implicit than explicit. Only six retention dikes have thus far been constructed under PIDAC supervision in eastern Casamance. In Sedhiou, retention dikes are even more scarce.

The implicit demand is clearly illustrated by farmers' own efforts at developing water retention strategies. For example, a labor intensive system of digging small holes to trap rainwater in rice fields is being practiced in both regions. This system produces very low yields because the plant density per unit area is very low.

A further indicator of the implicit demand for retention dikes is the manner in which many villages choose to operate the sluice gates on their anti-salinity dikes. The timing of opening and closing the gates recommended to farmers is designed to facilitate the flushing of salt from the barren areas. However, farmers give priority to securing yields on present rice fields rather than to recovering fields for future use. In practice, this means keeping the gate closed to allow the impounded water level to reach beyond the abandoned area to higher ground, the location of their present fields.

c. Plateau Structures

Farmers have little, if any, experience with soil and water conservation structures (contour berms, water diversions, etc.) on the plateaus. No evidence was found of any organizations which have attempted to introduce such structures.

The project design requires villages to initiate the process of water management by making a formal request for assistance to the project. Past experience is an indicator of the varying validity of the requests vis-a-vis the village's commitment to provide all requisite construction labor. While some villages made requests with no intention to mobilize the needed labor force, others have been completed with village labor. Clearly, the validity of requests cannot be assessed simply by the village's written letters. The project design defines a procedure whereby each village request is systematically evaluated and subsequently monitored by a multi-disciplinary water management team.

Where implicit demand exists, the project will have to strike a balance between waiting for village initiation and developing an awareness of the options available to farmers in solving the water management problems.

The project has proposed a strategy of coordinated watershed management. Not even an implicit demand exists for upland soil and water conservation structures. Therefore, any demand for these structures will have to be generated through an intensive program of farmer education and extension. The concept might best be introduced on a pilot basis in one watershed where more than one water-control structure already exists.

3. Labor Availability

The exodus of able-bodied adults from the rural areas has been a well-documented phenomenon, notably by the Harza Master plan in 1984 and more recent ISRA research reports. The project, therefore, can expect to be confronted with a limited availability of construction labor in some villages. Experiences of water management projects confirm this limited labor availability, particularly during the dry season when seasonal migrants leave the village in search of wage labor.

To compensate for construction labor shortages, the project will provide basic machinery to lighten the work load; for example, a tractor-drawn plow to loosen the soil and a trailor to haul soil to the dike site. Furthermore, project assistance with dike compaction and stabilization (with laterite) will minimize the need for maintenance labor during the life of the dike.

Supplemental construction labor could also be hired by the villages using the local tax rebate (fonds de concours). These funds are returned to the village through the sous-prefet and are intended for use on village-based development projects.

Labor availability is not expected to be a constraint to exploiting reclaimed and improved valley land. At sites where anti-salt dikes have been constructed and previously saline soils recovered, the original owners have tended to shift back to the valley floor. No instances have been cited where this land was left uncultivated. Rice farmers consider it to be the superior land. With the construction of water-retention dikes, the issue of exploiting the improved land does not arise because this land had not been abandoned in the first place. The issue is one of stabilizing and improving yields on already cultivated rice land.

The amount of available labor varies from village to village. Work schedules must be determined on a site-by-site basis taking full account of the labor available to each village. This implies that the speed of development may be slower than what may be considered ideal by the project.

In spite of farmers' genuine efforts to provide all requisite labor for dike construction, there will be some villages which lack a large enough work force. The project will work first with those villages that can indeed provide the requisite labor. Requests from labor-poor villages could be monitored to verify a genuine shortage, then assisted with the deficit in later years of the project. Without dike construction, more land will be lost to salt intrusion forcing more people to leave the village, thereby further reducing labor supply. The project should make a contribution to breaking the cycle of rural-urban permanent migration.

4. Village Participation

There are a number of traditional village institutions which are common to nearly all ethnic groups in Ziguinchor and Sedhiou. They include the village chief, council of elders, men's and women's groups of age peers, and agricultural work groups.

Organizational structures linking two or more villages have traditionally been somewhat informal. As villages are no longer self-sufficient in food, and as the traditional economy becomes ever more market oriented, inter-village links become essential and more frequent. Superimposed on the structure of traditional village groups is a plethora of modern organizations. Some are formal institutions set up under the auspices of national government agencies while others have been organized by PVOs around particular development activities. The most common of these structures are described in detail in the Institutional Analysis (Annex G.4.).

Given the project strategy of coordinated watershed management, the importance of involving all concerned villages from the onset cannot be overemphasized. A common constraint to working with village groups is the varying degree of cohesion and strength among the groups concerned. Some villages are more difficult to work with than others. For example, villages which, in the past, have benefited from "free" donor assistance are not interested in collaborating on projects contingent on village participation. Also, difficulties have been encountered in reaching a village concensus in fragmented or very large villages.

The project has adopted a well-defined strategy for assessing village readiness to participate. Before honoring a village's request for assistance, the project team will convene a series of general village orientation meetings to assess: the village's clarity in problem identification; the presence of a felt need for a particular water control intervention; an understanding of the proposed intervention; the solidity of the villagers commitment to see the project through; their unity in this objective; and their ability to mobilize themselves to complete the task. This will often be a long and painstaking process through which agreements are reached on the type and location of the proposed dike (if not already started by the village), and the expected contributions of the village and the project. This pre-construction site preparation and sensitization process ("sensibilisation") will be vital in establishing an effective working relationship with the village.

No system has yet been introduced to quantify expected village labor contributions. Experience has shown that a written contract between the project and a village leader alone carries little weight as far as villagers are concerned. The project will first negotiate the agreements between the project Water Management Teams and the Village Water Management Committees. Then, to ensure that all concerned villagers are behind the agreement, a general meeting will be convened at which the agreements are communally witnessed and each individual acknowledges concurrence with the agreements presented. This creates a strong motivation for villagers to abide by the terms. The definition of sanctions against villagers who do not abide by the terms of the contract should be left entirely with the Water Management Committee.

Two elements emerge as critical for ensuring effective operation and maintenance of completed structures. Firstly, it is much easier to set up a maintenance and operation system if done gradually throughout the planning and construction phase rather than waiting until after construction is complete. Secondly, villages need information on how to go about operating the sluice gates and maintaining the dikes. The project entrusts this responsibility to the same Village Water Management Committee charged with overseeing the construction phase. In this way, not only are the problems of operation and maintenance dealt with from the onset, but continuity is insured between construction and operation.

5. Land Tenure System

The land tenure system is based on usufructory rights with all villagers having the right to the use of land for subsistance. The founding families generally have permanent tenurial rights over the best land by virtue of their early settlement in the area and their choice of the most productive land for clearing. Nevertheless, collective concerns are fundamental and any villager can at least borrow land for cultivation.

Despite these basic rights, numerous land-related conflicts have emerged in the course of water-control project implementation. These conflicts have been of two basic types:

- Between borrowers and original land holders -- Under traditional land tenure law, eternal rights over land rest with the original tillers. With the introduction of the national land law (loi sur le domaine national), primary rights are theoretically extended to the current users. Although the traditional laws are still respected in the villages, borrowers will always wish to own land of their own. A common source of land conflict, therefore, is when borrowers attempt to override the traditional laws and stake land claims of their own. By constructing improvements such as water-control dikes, their status as current user is enhanced.

- Between two villages with conflicting claims -- Often, two villages claim tenurial rights over the same plot of land. In cases of long-standing conflicts, the two villages tend to come to some sort of temporary settlement in the interest of peaceful co-existence; for example, leaving disputed land uncultivated or letting the conflict lie dormant. With the intiation of dike construction, these conflicts often resurface.

Many of these inter- and intra-village land conflicts will be averted in the initial stages of implementation by the regional water management teams. A key task of the team is to prepare a land use and land tenure map of the area affected by the water control structure. Before construction begins, agreements will be reached among land "owners" and borrowers as to the post-construction use of the land. This will be vital to project success.

Despite the precautions taken by the project to avert land conflicts, uncertainties remain about the implications of the national land law and the extent to which, in practice, it will override traditional law. Under this law, tenurial rights are based on possession of the land and on productive use of the land. Conflicts result when units which have long used such land resist their return to the traditional owners. Family units borrowing land also have a chance, under the same law, to be able to claim the land. Because of this, the vital role of the project Water Management Teams in monitoring potential land disputes cannot be overemphasized.

F. ENVIRONMENTAL ANALYSIS

The SZWMP has undergone an unusually intense level of environmental review, in part because of the biological and physico-chemical complexity of the environment in which it will work, and, in part because deferral of some environmental review will be required until specific infrastructural mixes and intervention sites are identified.

The original IEE for the project recommended categorical exclusions for the TA, training, studies and commodity components of the projects, and these exclusions were approved by A.I.D./Washington on 11 July 1987. The IEE also recommended deferral for infrastructural interventions pursuant to the provisions of 22 CFR 216. 3(a)(7), with A.I.D./Washington later requesting in 87 State 260192 additional information on 1) intervention zone environmental characteristics, 2) the range of infrastructural alternatives to be considered for project financing, and 3) a list of environmental criteria for construction of each infrastructural type. Each of these requests was responded to in a detailed amendment prepared by the REDSO/WCA Regional Environmental Officer along with the findings of additional environmental review undertaken during PP development. Based on further analysis during project paper design, the IEE recommends a negative determination for the infrastructural activities with the assurance that relevant regional and sub-regional environmentally-related studies take place during the project.

As with the original IEE, the IEE amendment was submitted to A.I.D./Washington with the written concurrence of the USAID/Senegal Project Development Office, Irrigation and Water Management Office, Mission Legal Advisor, and Mission Director. The negative determination recommended in the IEE amendment was approved by A.I.D./Washington on March 11, 1988. A copy of the approval is included in Annex H.

The overwhelming consensus among technical specialists (engineers, soil scientists, agriculturalists, aquatic ecologists and fisheries specialists) familiar with the southern zone region, its naturally changing environmental characteristics, and the mix of engineering infrastructural interventions which have taken place there to date, is that water and salinization control through construction of small anti-salt dikes in the lower valleys and freshwater runoff catchment through construction of water retention structures in the mid and upper valleys are critical to stabilizing the prevailing deterioration of agricultural land and water quality occuring naturally in the region. Far from representing the potential to result in significant adverse

environmental impact, these types of infrastructural interventions are designed to result in the environmental protection and/or the amelioration of adverse environmental conditions on agricultural and other lands upslope from the structures.

With the possible exception of soil acidification potential, there are few if any environmental threshold criteria for the water control infrastructure the exceedance of which would result in significant adverse environmental impact at the scale envisioned for project interventions. The environmental issues raised in the IEE, as amended, for the SZWMP (e.g., estuarine impacts, terrestrial impacts, social and human health impacts) will be appropriately addressed on a watershed, subregional or regional basis rather than through establishment of intervention - or site - specific environmental threshold criteria.

The issues associated with construction of small dikes and berms represent very gradual and cumulative impacts potentially occuring due to development of the water-control infrastructure regionally by the GOS and donor-funded projects. The issue of soil acidification is addressed through a covenant which assures that anti-salt dikes will only be constructed above areas with a certain percentage of potential acid sulfate soils or already acidified soils.

The IEE, as amended, requires the project to undertake a number of regional or sub-regional studies over the life-of-project, as follows:

- o round-table discussion of the lessons learned from the whole range of anti-salt barrages and operation of these barrages in the southern zone, to take place in Year Three or Four;
- o study of the effects of water-control structures on the shallow groundwater table, to take place in Year Two or Three;
- o regional study of the cumulative effects of water control structures under a range of watershed development scenarios reflecting no, low, moderate and full control of upstream flows, to take place in Year Five;
- o study of the effects of water control structures on water-associated disease incidence, to take place in Year Two; and
- o study of the impact of water control structures on terrestrial ecosystems and endangered species, to take place in Year Two or Three.

The contractor will be responsible to assure that these studies and reviews are carried out as planned.

In addition, the project will carry out a paired-watershed study over five years as part of the environmental monitoring of project interventions. The study will answer applied, specific questions concerning effects of project water control structures on soils, water, crops, flora and fauna.

Both the IEE and IEE Amendment are appended to this PP as Annex H, Environmental Determination. The three environmental-related covenants to be included in the Project Agreement between USAID and the Grantee are given in Section III as well as in Annex H.

G. INSTITUTIONAL AND ADMINISTRATIVE ANALYSIS

1. Introduction

The project will strengthen the capability of the GOS technical services to provide specific services to farmers for design, construction, operation and maintenance of water-control works, and improved water management in order to increase agricultural production. The strategy will be to work closely with villagers on planning, siting, and constructing water-control works as well as having villagers take full responsibility for the operation and maintenance of these structures. Project success will greatly depend on the capability of its institutional structures to facilitate productive project-village dialogue.

The administrative structure of the project will be kept streamlined, whereby authority and responsibility will be delegated to the PMU or regional offices as much as possible. Roles and responsibilities will be clearly defined.

A number of administrative and logistical constraints exist which need to be resolved if the project is to perform well. The sustainability of project activities after project completion depends on this performance.

2. Project Organization, Location and Staffing

a. Project Organization, Management, and Administration

The Ministry of Rural Development will be the lead institution in this project because: (1) the goal of the project is increased agricultural production; and (2) a key phase of the implementation process will be follow-up to maximize the benefits from the water-control works. Funding for the project will be provided through a direct A.I.D. contract to an implementing U.S. contractor.

The Directorate of Agriculture and the Regional Inspectorates of Agriculture are key players in the project institutional structure. The DA and RIAs will have the support of the Directorate of Irrigation and Water-Control Works and the Regional Hydraulic Divisions of the Ministry of Hydraulics. Three new structures will be created for project implementation:

- Project Management Unit (PMU)
- Regional Water Management Teams (RWMTs)
- Regional Technical Committees (RTCs)

The functional and hierarchical relationships between them are given in the project organizational chart on page seven of the PP and discussed in Section I.B.4. of this project paper. The RWMTs and the RTCs will continue to provide the institutional framework for continued services to farmers once A.I.D.-funding is completed.

b. Project Location

The PMU's main office will be in Ziguinchor. It will rent office space near the RIA and the RHD headquarters (both share the same premises). The water management teams will be based at the respective RIA and RHD headquarters in Ziguinchor and, at least initially, in Sedhiou for the Kolda region. This will entail minimal rehabilitation of the RIA and RHD offices and facilities.

The choice of Ziguinchor is based on logistical convenience: frequency of air travel; communications availability and reliability; housing facilities for TAs; office space; educational facilities for GOS staff families; and travel distance of less than two hours between Ziguinchor and most proposed early project activities.

This location may create an imbalance in favor of Ziguinchor or affect the full participation of the Inspector in Kolda. This can be alleviated by: (a) establishing weekly coordination meetings between the PMU and the two Inspectors during the first six months to one year from project-start; (b) programming periodic visits of the Project Director, the COP and other project staff to Kolda; and (c) organizing interregional training sessions to address technical and implementation issues.

3. Regional Traditional Technical Services: RIAs and RHDs

The Rural Development Agencies took over many of the activities once mandated to the RIAs. Although still involved in agricultural surveys, extension, and farmer training, the RIAs have concentrated mostly on collecting agricultural and rainfall data. It is now the intention of the GOS to restore their responsibilities to provide targeted direct services to farmers.

The RIAs are staffed at all administrative levels. The Ziguinchor RIA has thirty staff members which have potential for participating in the project: two senior professionals (agricultural economist and irrigation technician) with MS equivalent degree (Ingénieurs de Conception); six mid-level professionals (Ingénieurs des Travaux Agricoles-ITA) with BS equivalent degrees; and 21 extension agents with high school plus three years of vocational training.

The region of Kolda totals sixty people in the Agricultural Service: three senior professionals (two agronomists and one hydrotechnician); six mid-level professionals (ITA); and 51 extension agents.

The mandates of the RHDs were also shifted to the RDAs. They now collect hydrological data and coordinate well-digging contracts. Again, the GOS intention is to restore their service role. Unlike the RIAs, the RHDs in the two regions are severely understaffed. The Ziguinchor staff includes seven mid-level professionals (Techniciens Superieurs-TS) with BS equivalents. The Kolda RHD has only two TSs currently at post.

Clearly, vital staff weaknesses presently exist in the RIAs and RHDs which will limit their effective participation in project activities. Few of the irrigation technicians nor the agricultural agents have work experience relevant to water management or the operation and maintenance of water-control structures. Some of the skills vital to project implementation, such as soil and water management, land reclamation, and rural sociology are not represented.

The Regional Hydraulic Divisions are weaker than the RIAs in field experience and level of staffing. Staff currently at the regional services do not have any practical experience in constructing and operating water-control structures, nor professionals with the expertise needed for watershed planning. Furthermore, RIAs and RHDs suffer from inadequate logistical support and operating budgets. The entire RIA of Ziguinchor, for instance, has only four vehicles: one pick-up (1984), two four-wheel drive vehicles (1985), and one station wagon. A few motorbikes are available, but most are out of order. The operational budget of the RIA is below minimum requirements. Fuel allocations amount to CFA 4,198,000/year while only CFA 50,000/year is allocated for travel expenses.

The identified functional weaknesses in the RIAs and RHDs can be surmounted. Qualified staff (trained in the U.S., USSR, Eastern and Western Europe, China, etc.) do exist within the ministries and will be drawn upon to strengthen the regional services and staff the Water Management Teams. It should not be difficult to reassign underemployed staff from other regions to the Ziguinchor and Kolda regions. However, the GOS must reassign appropriate staff and increase the operational budgets of the RIAs and RHDs. Both of these requirements are included as conditions precedent to additional disbursement actions.

4. Other Formal and Informal Organizations in the Project Zone

There are a number of formal and informal organizations and structures with which the project can work to reach the local population for project implementation. Given the diversity of formal and informal village organizations and other groups, the project will be opportunistic in utilizing NGOs, PCVs or MSD agents in village organizational efforts and in post-construction water management assistance. Assistance will be solicited from dynamic locally-based NGOs depending on their presence and effectiveness in working with the local village groups.

Among the formal GOS organizations are: the regional services of the Ministry of Social Development (MSD); Centres d'Expansion Rurale (CERs); and the Local Development Committees (LDC). These organizations are close to the local population and provide them with organizational and technical assistance. The staff from MSD in particular has been able to set up and organize about 700 women and youth groups in the two regions. Working with these structures will necessitate establishing initial contacts with and seeking cooperation of the regional and local authorities.

Major locally-based NGOs in the project zone are: Comite d'Action pour le Developpement du Fogny; Association des Jeunes Agriculteurs de la Casamance; and Association pour la Lutte Contre l'Exode Rural; French Volunter services; and Peace Corps, which is planning its African Food System Initiative (AFSI) in the Ziguinchor region. It is expected that some AFSI Peace Corps Volunteers will be involved in village organization and follow-up.

Until now, there has been little demand for water management-related services from locally-based private firms. There are no private enterprises based in the two regions that could provide technical services or logistical support to the project. The project will stimulate the local establishment of private firms offering construction and/or other services applicable to project activities by offering local contracts and by encouraging joint ventures between local people and Dakar-based contractors.

5. Constraints to Project Implementation

Two major personnel management issues may hinder project efficiency: (a) GOS policy on travel authorization; and (b) GOS policy on civil servant posting.

a. GOS policy requires all civil servants travelling outside their administrative boundaries to have a travel authorization (ordre de mission). This must be approved by Service Heads and their lead ministers or designees, for civil servants posted in Dakar, or by the Governor for personnel serving in a region.

Conformance to this policy by the water management teams and Regional Agriculture Inspectors implementing the project will undoubtedly inhibit project activities. Through a condition precedent, the GOS will ensure that authority for signing travel authorization for the water management teams is delegated to the Regional Agricultural Inspectors, heads of the RHDs and to the GOS Project Director for vehicles assigned to the PMU.

b. GOS policy usually grants a request for reassignment to any civil servant who has served two years at post. Although not strictly enforced, team members could be transferred simultaneously two years after project start-up. This may cause problems since there is no guarantee that the reassigned person(s) will be replaced and on time.

Through a covenant, the GOS will make best efforts to ensure that: (1) assigned personnel will remain for at least three years; and (2) no more than one-third of the team will be reassigned at a time to facilitate the training of new arrivals.

6. Project Sustainability

Institutionally, the sustainability of project activities is predicated on two key assumptions:

- The traditional technical services of Hydraulics and Agriculture will be technically experienced in collaboratively planning and executing the activities at new sites in their respective regions after the project terminates; with defined responsibilities part of overall RIA and RHD field responsibilities.

- The MRD and the MH will continue to provide salaries for staff and operating expenses for watershed management activities.

These two conditions are themselves predicated on:

- The need to maintain the personnel necessary for the technical teams for a sufficient period of time to allow continuity of water management activities, i.e. to allow newcomers to be trained by experienced team members; and

- resources (vehicles, fuel, operating budget, etc.) must be made available to, and resource management and control vested in, the technical services.

The project, through a covenant, will ensure that water management expertise will be established and will permanently remain in the technical services of Agriculture and Hydraulics to respond to farmer demand for construction and utilization of the water-control structures.

Also, the GOS will ensure that financial resources may be made available for financing water-control structures through the use of the "fonds de concours" granted to the qualified rural councils and through other reflows, in addition to villagers' labor contribution.

Finally, a CP for additional disbursement after year three will ensure that the GOS takes over recurrent operating costs to prepare the smooth transition to post-project development and operation of water-management structures.

III. COVENANTS AND CONDITIONS

In addition to standard Conditions Precedent (CPs), the Grant Agreement will contain the following:

A. CONDITIONS PRECEDENT

1. First Disbursement

a. Prior to initial disbursement, or the issuance of any commitment documents, under the Project Agreement, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the Government of Senegal agrees to disburse all allocated decentralization funds for office rehabilitation of RIAs in the regions of Ziguinchor and Kolda.

b. Prior to initial disbursement, or the issuance of any commitment documents under the Project Agreement other than the contract for technical assistance, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the Government of Senegal has officially formed Regional Technical Committees in the regions of Ziguinchor and Kolda, composed of the respective Regional Inspector for Agriculture and the Regional Head of the Hydraulic Division in each region and the Project Director (chairman of Committee), to coordinate and manage the activities of the respective Regional Water Management Teams.

2. Additional Disbursement

a. Prior to any disbursement under the Project Agreement for any construction funds in the Kolda region, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that:

(1) the Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Kolda region one Agronomist with soils training and one Village-Project Liaison Officer or Sociologist to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team; and

(2) the Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Kolda region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Sedhiou to carry out project activities as part of the Kolda regional, interdisciplinary Water Management Team.

b. Prior to any disbursement under the Project Agreement for any construction funds in the Ziguinchor region, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that:

(1) the Ministry of Rural Development has appointed to the Regional Inspectorate of Agriculture in the Ziguinchor region one Agronomist with soils training and one Village-Project Liaison Officer or sociologist to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team; and

(2) the Ministry of Hydraulics has appointed to the Regional Division of Hydraulics in the Ziguinchor region one Irrigation/Civil Engineer and one Surveyor/Construction Supervisor to be based in Ziguinchor to carry out project activities as part of the Ziguinchor regional, interdisciplinary Water Management Team.

c. Prior to disbursement of any construction funds under the Project Agreement starting Year Four (4) of the project, the Cooperating Country shall furnish in form and substance satisfactory to A.I.D., evidence that the respective budgets of the Regional Inspectorates of Agriculture and Regional Divisions of Hydraulics in the Ziguinchor and Kolda regions have been increased sufficiently to pay for all per diem of GOS employees and vehicle operating costs of vehicles assigned to these divisions starting Year Four (4) of the project and continuing after the end of the project.

d. Prior to disbursement, or the issuance of commitment documents for the disbursement of funds for the purchase of project vehicles, the GOS will agree that travel authorization for vehicles purchased under the project for official travel may be approved by the Project Director for vehicles at the PMU, and by the Regional Inspectors of Agriculture or the Regional Heads of the Hydraulic Divisions for vehicles assigned to the two Water Management Teams.

B. COVENANTS

The Project Agreement shall contain in substance the following Cooperating Country covenants:

1. Agreement that the Government of Senegal will assure coordination of all donor-funded and GOS-funded water management activities in the Ziguinchor and Kolda regions through bi-annual meetings of all involved donors and Ministries, organized by the Ministry of Plan and Cooperation.

2. Agreement that the Government of Senegal will make best efforts to ensure that (a) staff assigned to the regional Water Management Teams will remain for at least three years and that they will be replaced immediately; and (b) Regional Inspectors of Agriculture Regional Heads of Hydraulic Divisions remain at post for at least three years and their replacements will be at post prior to the departure of the incumbents.

3. Agreement that the assistance to farmers to improve water management and reclaim salinized lands will become part of the mandates of the Regional Services of Agriculture and Hydraulics in the Ziguinchor and Kolda regions.

4. Agreement that additional financial resources for dike construction or maintenance may be made available through the use of Fonds de Concours at the local level.

5. Agreement that the issues of (a) anti-salt barrage effectiveness in controlling upstream salinity; (b) the effects of infrastructure on groundwater quantity, quality and distribution; (c) the cummulation effects of regional barrage construction on estuarine and other aquatic ecosystem resources; (d) the effects of regional infrastructural development on water-associated disease incidence rates; and (e) the effects of

infrastructural development on terrestrial ecosystems and endangered, protected or commercially important species, as described in the Project IEE Amendment, shall be addressed as described except as those issues or approaches may be amended by the agreement of both parties.

6. Agreement that implementation plans for infrastructural development will be modified in accordance with the findings of the five issue assessments listed in 5. above.

7. Agreement that:

(a) anti-salt dikes shall only be constructed where the area of high potential acid sulfate soils or already acidified soils of the taxonomic subgroup of typic sulfaquents (USDA Soil Taxonomy) do not exceed 15 percent plus or minus two percent of the service area upstream of the dike;

(b) siting of water retention dikes will be undertaken with the full knowledge, advice and consent of the affected village populations; and

(c) any irrigation system funded under this project shall have had sufficient technical analysis performed to indicate that salinization and waterlogging potential in the affected area will be minimal; measures will be available to the target population to mitigate any salinization or waterlogging which may occur in the future; and sedimentation rates upslope of the primary structure are sufficiently low to permit use of the reservoir for irrigation throughout a reasonably long facility target life.

IV. COST ESTIMATE AND FINANCIAL PLAN

TABLE 7
BUDGET SUMMARY OF ESTIMATED EXPENDITURES ($000)

	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		TOT EST COSTS	ROUNDED TO
	P/Y	Cost	P/Y	Cost	P/Y	Cost	P/Y	Cost	P/Y	Cost	P/Y	Cost	P/Y	Cost	P/Y	Cost		
TECH. ASST.																		
L-T US	0	$0	4	$660	4	$660	3	$480	4	$660	4	$660	4	$660	4	$660	$4,440	$4,500
Support Staff	.5	$50	4	$132	4	$132	4	$132	4	$132	4	$132	4	$132	4	$132	$974	$1,000
S-T US (P/M)	12	$180	10	$150	10	$150	11	$165	8	$120	7	$105	6	$90	6	$90	$1,050	$1,100
INFRASTRUCTURE DEVELOPMENT		$174		$236		$416		$456		$662		$553		$602		$661	$3,761	$3,800
TRAINING		$0		$266		$276		$126		$102		$70		$30		$10	$880	$900
RESEARCH & MONITORING		$0		$325		$240		$200		$170		$160		$0		$0	$1,095	$1,100
EQUIP/COMMOD.		$930		$100		$80		$45		$589		$45		$45		$45	$1,879	$1,900
LOG. SUPPORT/ OPER. COSTS		$110		$192		$177		$205		$146		$122		$122		$122	$1,196	$1,200
EVAL/AUDIT		$0		$55		$75		$0		$135		$0		$75		$60	$400	$400
SUB-TOTAL		$1,444		$2,116		$2,206		$1,810		$2,716		$1,847		$1,756		$1,780		$15,900
INFL/CONTINGENCY																		$2,100
TOTAL PROJECT		$1,444		$2,116		$2,206		$1,810		$2,716		$1,847		$1,756		$1,780		$18,000

TABLE 8
SUMMARY COST ESTIMATE AND FINANCIAL PLAN
($000)

Source	AID FX	AID LC	Host Count FX	Host Count LC	Village Lab FX	Village Lab LC	TOTAL
Technical Asst.	$5,200	$400	$0	$0	$0	$0	$5,600
Local Professionals/ Support Staff	$800	$200	$0	$1,300	$0	$0	$2,300
Infrastructure Devel.	$500	$3,300	$0	$0	$0	$1,100	$4,900
Training	$800	$100	$0	$0	$0	$0	$900
Research and Monitoring	$200	$900	$0	$0	$0	$0	$1,100
Equipment/Commodities	$700	$1,200	$0	$0	$0	$0	$1,900
Logistical Support/ Operating Costs	$100	$1,100	$0	$300	$0	$0	$1,500
Evaluation/Audit	$300	$100	$0	$0	$0	$0	$400
Contingency/Inflation	$1,100	$1,000	$0	$0	$0	$0	$2,100
GRAND TOTAL PROJECT	$9,700	$8,300	$0	$1,600	$0	$1,100	$20,700

B. BUDGET NOTES

1. Technical Assistance:

A factor of $180,000 per year for long-term advisors and a factor of $15,000 per person/month for short-term advisors were used. This includes salary, overhead, fringe benefits, allowances, furniture, and other costs as appropriate, including per diem for short-term consultants.
A factor of $120,000 per year was used for the Administrative/Financial Officer.

2. Indemnities

Payment of any project-financed indemnities will be in accordance with the USAID Indemnity Policy in effect at the time.

3. Infrastructure Development

Engineering cost estimates for site preparation, movement of earth and construction of reinforced concrete control gates for the 2,915 hectares in the sampled 10 sites are $462,420, or $159/ha. These costs do not include the village labor component for construction which is approximately $73/ha. In addition, hand tools such as hand tampers, shovels, picks and wheel barrows will be purchased for use by villagers during years two through eight. Also, funds are budgeted for the purchase of five 50 hp. tractors and five trailers during the first three years, and replacement tractors in year five, along with funds for spare parts and operation and maintenance of the tractors.

4. Training

Twelve in-country workshops and conferences (operations and maintenance, land reclamation, watershed planning, village organization) have been budgeted over the life of the project, at $5,000 per workshop or conference. This includes funds for a Third Round-Table on Anti-salt Dikes in the Casamance. Also, $20,000 is budgeted for 20 study trips or observational tours over the life-of-project. The actual cost will vary considerably whether the trip is to Asia or the U.S. or to neighboring Gambia or Guinea Bissau. Also, 20 short-term courses are budgeted at $6,000 per course for training in the U.S. and in other countries such as Morocco and Philippines with relevant programs. Finally, funds are provided for four M.Sc. degrees in the U.S., budgeted at $75,000 for each average 30-month program.

5. Research and Monitoring

Specific environmental studies are required under the approved Initial Environmental Examination. The studies will require approximately 13 person/months of short-term technical assistance, budgeted at $15,000 per month. Also, a paired-valley study will be conducted by ISRA over a five year period. $500,000 are budgeted for this study, to include personnel, transport, field equipment and some office equipment and sub-contracts with ORSTOM and possibly CRODT. In addition, $400,000 is budgeted for contracting with ISRA for directed and specific, water-management and soils reclamation applied research activities over the life of the project.

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6. Equipment/Commodities

(a) Ten vehicles and spare parts for technical assistance personnel (three), Project Director (one) and Water Management Teams (three per team) to be purchased in the first year with replacement of nine vehicles in the fifth year (Project Director will only be in place during first four years).

(b) Operation and maintenance of the 10 vehicles for the first three years of the project, after which the GOS will cover operations and maintenance costs of the six vehicles assigned to the Water Management Teams in the Regional Inspectorates. USAID funds will continue to cover operational costs of the vehicles assigned to the PMU.

(c) Standard office equipment such as desks, chairs, filing cabinets, typewriters and computers will be purchased for the PMU, the RIAs, the RHDs and the Sedhiou office of the regional Water Management Team during year one with replacement of required items in year five. Office supplies for the PMU only will be provided over the life of the project.

(d) Field equipment will include surveying equipment and soil testing equipment.

(e) Annex I provides a detailed indicative procurement plan.

7. Logistical Support/Operational Costs

(a) In-country per-diem will be provided for the TA team over the life of the project. In-country per-diem will be provided for the GOS members of the Water Management Teams and other GOS employees (including the Project Director) traveling on official project business for the first three years of the project only following the USAID Indemnity Policy. Starting year four, the GOS will pay all in-country per-diem costs other than for the TA team and contract personnel.

(b) Performance awards for the Project Director, Water Management Teams, the Regional Inspectors of Agriculture, and Regional Heads of Hydraulic Divisions may be provided by the project in accordance with the USAID Indemnity Policy.

(c) Funds have been budgeted for rental of long-term TA housing in Ziguinchor and for rental of an office for the PMU located close to the RIA and RHD. In addition, the project will provide up to $100,000 for minimal rehabilitation of the offices of the RIAs in Ziguinchor and Kolda.

8. Evaluations and Audit

Three evaluations will require approximately $175,000 over the life of the project. In addition, funds are provided for three external audits during years three, five and seven, at $75,000 for each audit.

9. Contingency and Inflation

An exchange rate of CFA 283 to U.S.$1 has been used for all local currency costs. A sufficient contingency is required in case the dollar continues to drop. Also, although inflation has not been a significant factor on U.S. costs, the local inflation rate requires an inflation factor on those local currency costs subject to inflation such as construction costs. Therefore, the contractor construction costs have a 10 percent inflation factor built into the line item.

C. FINANCIAL PLAN

During the first year of the project, USAID will arrange for the procurement of vehicles, office equipment, initial office supplies and field equipment and rental of office space in Ziguinchor for the PMU. USAID will contract directly with a short-term water resources expert to start project organization and planning activities in Ziguinchor and a Project Monitoring Officer based in Dakar. USAID will also manage the short-term assistance of the Development Ecologist in accordance with the IEE Amendment and the evaluations and audit. All other inputs will be included in one A.I.D. direct technical assistance contract with a U.S. firm or university, or consortium, following A.I.D.'s competitive contracting rules. Since the contractor will manage all project funds not managed directly by USAID, a 121 (d) negative determination has been approved (Annex E). The sub-contracts with ISRA for specific research activities will be requirements-type contracts which will not require accounting of funds pursuant to 121 (d).

Since almost all technical assistance, training, commodities, and construction funds will be provided by one U.S. contractor, their monthly invoices will provide, in one document, a continuing and effective system of monitoring expenditures. Contractor quarterly progress reports should include progress against budgets and work plans. The COP and the Project Director will meet with the USAID Controller during the first week on site to ensure that their records, reports, and financial control systems are complete and satisfactory. The U.S. contractor will be reimbursed monthly from AID by submission of form 1034 vouchers in accordance with AID regulations.

Three important external audits have been budgeted in years three, five and seven of the project in line with current A.I.D. policy regarding use of non-federal auditing firms to monitor and improve project accounting and inventory control practices. The audits may be performed by local audit firms, if approved by RIG/Dakar, and will focus on financial management and accountability of contract funds in the PMU.

D. METHODS OF IMPLEMENTATION AND FINANCING

Method of Implementation	Method of Financing	Est. $000
1. AID Direct Contract with U.S. private firm or university to provide: TA, training, commodities, research and monitoring, construction costs, logistical support.	Direct Payment	13,600
2. USAID Commodity Purchases initial vehicles, office equipment and initial supplies, field equipment, and rehabilitation of offices.	Direct payment or Bank L/Comm for PSAs	1,000
3. USAID Evaluations and Audit	Direct Payment	400
4. USAID Direct Contract for Initial Short-Term Water Resources Expert and for Project Monitoring Officer.	Direct Payment	900
5. Contingencies/Inflation		2,100

V. IMPLEMENTATION PLAN

Implementation pace will be influenced by two major factors: (1) the need to rebuild the capacity of the technical Ministries in the project zone to carry out water management activities; and (2) the requirement to involve villagers and village committees in the planning and design stage and to assure that inter and intra-village coordination takes place prior to construction of water control infrastructure.

A. CONTRACTING

1. Technical Assistance Contract

Project long-term and short-term technical assistance, training, research and monitoring, commodity procurement, and costs of infrastructure development will be provided under one direct A.I.D. contract with a private U.S. organization, university or consortium of organizations. The contract will be competitively bid in accordance with A.I.D. Handbook 14 procedures.

2. Project Start-Up Activities

Since there is generally a delay of nine to twelve months before long-term technical advisors are in place following project approval, USAID will hire locally two U.S. Personal Services Contractors (PSC) to start specific project activities. A long term PSC who will be the Project Monitoring Officer will work closely with the Direction of Agriculture in Dakar to assure that all of the conditions precedent are being met, especially concerning the GOS staffing requirements for the Kolda regional Water Management Team. In addition, the PMO will procure vehicles, rent office space for the PMU, arrange for rehabilitation of the RIA and RHD offices in Ziguinchor and Kolda, and carry out other activities in preparation of the arrival of the technical assistance team. In addition, a short-term Water Resources Expert will be hired for 9 months to work in Ziguinchor to start discussions with and organization of village groups in the first phase sites. This expert will develop an interim workplan and start to develop procedures and programs for formulating basin-wide water management plans.

B. RESPONSIBILITIES

1. USAID

USAID/Senegal will designate the Deputy Chief of the Irrigation, Water Management and Engineering (IWME) office to be the USAID Project Officer (PO), to be assisted by the PMO. The PO will be responsible for A.I.D. approval, guidance and general monitoring of the contract in accordance with its terms and conditions. He will be responsible for advancing project activities, keeping implemention moving, and working closely with the Director of Agriculture, the Director of DAIH and other GOS officials. The PO will be supported in USAID by the Mission Project Committee which may be convened at any time to examine specific problems.

2. Government of Senegal

The Ministry of Rural Development will appoint and finance a Project Director for at least three years to be stationed in Ziguinchor and in charge of the Project Management Unit. The Project Director will serve as the primary counterpart to the COP and be responsible for all project activities. The Project Director will be in place and the PMU set up within nine months after the Grant Agreement is signed.

The MRD and MH will also appoint highly-qualified field personnel to staff each regional Water Management Team. The MRD will provide an Agronomist with soils training and a Village-Project Liaison Officer or Sociologist for each region while the MH will provide an Irrigation/Civil Engineer and a Surveyor/Construction Supervisor for each region. These field personnel on the regional Water Management Teams will work on project activities full-time under the GOS civil service arrangemnt called affectation whereby the GOS continues to pay full salaries and all indemnities due to the personnel. USAID-provided funds under the project will not be used to pay any GOS salaries, salary supplements or indemnities. In addition, the MRD will provide drivers for project vehicles and for the tractors to be used for moving earth.

The MRD and MH will assure that the heads of the regional services in each region will provide appropriate management and technical oversight over their respective staff on the Water Management Teams in close cooperation with the Project Director and the technical assistance team. In addition, the GOS will establish a Regional Technical Committee in each region to ensure close coordination between MRD and MH and appropriate management of project activities.

In addition, the GOS will provide office space and office supplies for the water management teams based in Sedhiou and in Ziguinchor.

A.I.D. grant funds will be used to pay costs of per diem for GOS personnel and operation and maintenance of vehicles for the Water Management Teams for the first three years of the project only. Starting the fourth year, the GOS will pay for all per diem costs and operation and maintenance of vehicles for the GOS Water Management Teams.

3. Technical Assistance Contractor

The technical assistance contractor will provide necessary inputs and actions required for implementation as described in their contract. The contractor will provide staff to carry out planned and ad hoc studies. The technical assistance team will be located in the PMU in Ziguinchor and all staff will be stationed in Ziguinchor. The contractor will hire locally an Administrative Assistant, Bilingual Secretary and Motorpool Supervisor/Mechanic to provide administrative and secretarial services to the PMU.

The Water Resources Expert will be the COP and will provide leadership and assistance over the seven-year life of the contract. The Water Resources Engineer will also provide long-term assistance for the seven-year life of the contract. The Agronomist will provide short-term assistance of two

person-months per year during the first three years of the contract and will be stationed full time in Ziguinchor during the final four years of the contract. The Sociologist/Water-User Associations Expert will be at post for the first two years of the contract and then for two person-months per year through the end of the contract. The Administrative/Financial Officer will provide necessary administrative and financial management for the MU for seven years. Short-term technical assistance timed to coincide with the farming calendar will be a vital input to help establish guidelines for baseline data collection, develop initial procedures and methodologies for the Water Management Teams, and provide on-the-job training for the teams. Short-term TA for the first year of implementation will include a Soil Scientist, Agronomist, Economist, and Natural Resource Specialist.

The COP will have primary responsibility for assuring the progress of this project on behalf of the contractor and for carrying out all contract activities. The COP will integrate and advance the implementation of the project's activities and be responsible for the following major activities:

a. Work daily and collaboratively with the GOS Project Director on all aspects of project implementation and overall project planning.

b. Meet regularly with the USAID Project Officer, with other members of USAID, with relevant GOS officials from the MRD and MH both at the regional levels and national level, with administrative officials from the regions of Ziguinchor and Kolda and with other involved GOS and other donor organizations in the Ziguinchor and Kolda regions.

c. Coordinate project activities within the two regions, assuring that all relevant local officials are aware of the project activities and that smooth relations continue under the project with all administrative officials of the two regions.

d. Assist the Project Director to recruit, select and supervise local hire personnel. Institute appropriate management systems for the smooth functioning of the PMU and overall project activities.

e. Formulate with the GOS Project Director the project's annual workplans that define the activities to be carried out by the Water Management Teams, the TA team and other project participants under a distinct timetable.

f. Assure that the project's activities are implemented as defined in the project's annual workplans.

g. Assist the Project Director in all PMU functions, including procurement, contracting, inventory control, contract management of research activities and studies, and financial accounting; and, after the departure of the Project Director, manage the PMU activities in close collaboration with the respective Regional Inspectors of Agriculture.

h. Manage the project monitoring and evaluation system using timely short-term technical assistance as required.

Annex K includes the specific scopes of work for the other long-term technical advisors.

C. FIELD IMPLEMENTATION PLAN

1. General

Based on the prioritization of zones for project action (Section I.B.4.b.), only the Kolda Regional Water Management Team will be formed during the first year of field implementation. This team will be based in Sedhiou because of its proximity to the priority sites. After the first year and as implementation progresses, the decision will be made as to when to form the Water Management Team in the Ziguinchor region.

The project will initially work in the left bank of the Casamance River in the Sedhiou department, using the selection criteria delineated in Section II.B.4.d. to choose specific sites. Based on the analyses carried out during PP design using these criteria, the team will focus initial efforts in the high-potential Samine Escale and Tanaff valleys.

2. Typical Site Implementation Plan

Initially, discussions will be held with villagers to determine their water management needs. In-depth inter and intra-village discussions will assure that villagers understand the land tenure, agronomic, social and other implications of the requested and proposed water control structures. Organization of Village Water Management Committees will take place concurrently with the detailed technical study of the related valley and overall watershed. The Water Management Teams will work with the villagers to determine the final number of structures and the location of the structures. It is difficult to estimate how long it may take to set up the requisite village organizations, obtain village approval of the plans and ensure that the village has established work schedules for the construction phase. Timing of the pre-construction phase will depend on the level and type of existing village organizations, competing demands on villagers time, extent of land tenure and inter-village problems and other socio-cultural factors.

Once this phase is completed, it is estimated that the technical siting, surveying, design and contract documentation preparation for a typical dike involving a number of structures will take three months. The contract should be awarded for construction support activities and villages organized to start construction work at the end of the harvest season when village labor is available. Initially, most of the movement of earth for dike embankment using laterite materials will be carried out by the project. Construction of reinforced concrete control structures will be carried out by private sector firms. During this phase, contract documents will be prepared to encourage private firms to become involved in the movement of dike embankment and laterite materials as well as construction of the control structures. The farmers will place and compact dike/berm embankment materials.

D. SCHEDULE OF MAIN EVENTS

Event	Date
Obligation of funds (Grant Agreement signature)	Aug. 88
RFP for TA contract completed and issued	Oct. 88
Initial PSCs hired to begin project procurement and work with GOS on setting up Water Management Teams	Oct. 88
Regional Technical Committees for Kolda and Ziguinchor regions formed	Jan. 89
GOS meets initial Conditions Precedent	Jan. 89
Technical Assistance contractor selected and contract approved	Jan. 89
GOS assigns staff to water management team in Kolda region and Project Director for PMU	Jan. 89
TA team arrives in country and begins work	March 89
TA team, Project Director, RIA and RHD heads submit first year workplan	April 89
First watershed plan completed and village organization groups formed	May 89
Dikes constructed in first priority zone	June, 89
Paired-watershed research activity started	Jan, 90
Long-term participants depart for M.Sc. training	Jan, 90
Water Management Team in Ziguinchor region organized	March, 90
First formal evaluation to evaluate project implementation	May, 90
GOS takes over costs of local per-diem, vehicle operation and maintenance and other RIA operational costs	June, 91
Project Director departs and Regional Agriculture Inspectors take over management of project activities with the TA team	June, 92
Long-term Agronomist arrives	June, 92
Second formal evaluation to evaluate project implementation and project impact to date	June, 93
Final Impact Evaluation takes place	Dec, 95
Water Resources Specialist (COP) departs, submits contractor final report	Jan, 96

VI. MONITORING AND EVALUATION PLAN

A. USAID MONITORING PLAN

The Deputy Chief of the USAID Irrigation and Water Management Office as Project Officer will have primary responsibility for monitoring the progress of this project on behalf of AID. The Project Officer will be assisted in monitoring by a Project Monitoring Officer who will be a U.S. Personal Services Contractor. These two individuals will utilize the following activities in monitoring overall project progress:

1. Workplan and Monitoring Plan

Following arrival on site, initial annual work and monitoring plans will be developed by Senegalese and contractor staff and approved by the USAID. The USAID, GOS and the contractors will use the work and monitoring plans as a basis to measure project progress. The plans will be reviewed and modified on an as-needed basis but at least every 12 months and implementation adjustments will be made accordingly.

2. Site Visits

The Project Officer and/or Project Monitoring Officer will visit project activity sites on no less than a quarterly basis. These sites will include the offices in Ziguinchor, Kolda and Sedhiou and construction sites throughout the project zone.

3. Project Committee Meetings

The Mission maintains an active system of project committees (PC). The PC is composed of representatives from key Mission offices and meets at least two times per year to review project progress and objectives. The PC may be convened at anytime by the Project Officer to discuss specific implementation problems, proposed modifications, plans for evaluation, etc. The Mission PC provides the project officer with valuable, multi-disciplinary support. The PC includes representatives from IWME, ADO, PRM, PDO, RCON and RLA.

4. Joint Reviews

Annual joint reviews are held for each major Mission project. The joint review brings together the USAID Mission Director, a senior GOS official and their key staff and is usually held at the project site. Joint reviews examine progress made towards achieving project purpose and whether planned activities are likely to produce the intended impact. Assumptions are also reviewed. Mission experience with the joint review system has shown it to be a very useful exercice for (a) reaffirming that the USAID and GOS are still managing for the same objective and (b) removing obstacles that could not be otherwise resolved.

5. Audits

This project provides for a rigorous audit schedule with audits planned during years three, five and seven. Audits will be conducted by private accounting firms, preferably locally-based, in accordance with A.I.D. regulations. The audits will focus on the financial management and accounting systems set up by the PMU for contract funds.

6. Evaluations and Monitoring

As described below, three evaluations are scheduled during the life of project. A formal program of environmental monitoring has been designed for the project. It is described in detail in the Amendment to the Initial Environmental Examination.

B. EVALUATION

The SZWMP will have an eight year life. Three external evaluations are planned. The first should be conducted at the end of the second year after initial obligation of project funds. The second should be conducted during the fifth year of the project. A final impact evaluation should be conducted at the end of the eighth year of the project.

Baseline data for project evaluations will come from three sources. Two are project sources, the third is independent of the project. The first will be the water management plans developed by the project team. These will contain data on population, labor mobilization, land tenure, land use, water control structure design, estimated economic benefits, construction programs and scheduling, and estimates of land recovery. The second source of data will be that obtained from the operational research and the environmental monitoring program which will provide a basis for comparing the impact of execution of watershed plans on soil and water characteristics, flora and fauna. The third set of data will track crop production impact and be built up from the independent crop statistics of the Directorate of Agriculture. The water management and crop statistics will be available for the first scheduled evaluation. The data from the environmental monitoring program will be available for the second evaluation.

The evaluations will be under the general direction of the USAID project officer in collaboration with the DA and the USAID Evaluation Officer. The DAIH will also participate in these evaluations, as well as other appropriate GOS or USAID personnel.

The first evaluation should be carried out by a three person team to include: a water resources engineer, an agricultural economist, and a social scientist. The first evaluation should be formative in nature, assessing the project institutional arrangements and watershed management approach for course corrections. The key project assumptions to be tested include: the pace of water management plan development execution; working relationships between the PMU, RIAs and RHDs; overall coordination with villages and village

groups; the development of the regional Agricultural Inspectorates' ability to take over substantial management responsibility for executing project by Year Four of the project; the ability and commitment of the GOS to take over operating expenses of the project in Year Four of the project; and the feasibility of the approach of using private contractors as providers of fill transport services and concrete works for villager-constructed dikes. An overall judgement should be made of the validity of the institutional framework, attainment of project outputs and course modifications needed, if any.

The second evaluation should be carried out by a three person team with the same composition as the first evaluation, and with assistance on the environmental and crop statistics data from ISRA and the DA. The major focus of this evaluation should be both summative and formative. The summative evaluation points should include measurement of progress towards execution of watershed management plans; of achievement of quantitative objectives for land recovery and crop production; of identification of improved water management technologies from the applied research program; of operating budget allocation and disbursement by the DA to the RIA's; of execution of reviews, workshops, round tables, and seminars; and of the amount and kinds of training carried out. The formative evaluation points should include: assessment of the ability of the regional services to replenish and train replacement staff for the project; need for modifications or improvements in the watershed planning approach; examination of the roles and effectiveness of the Village Water Management Committees; assessment of the effectiveness of using NGOs or local government services in mobilization of demand and village organization. An overall judgement should be made: whether sufficient progress is being made toward achieving the project purpose; whether unanticipated benefits are being obtained; and whether additional actions should be pursued by USAID after the PACD.

In addition, a final impact evaluation will be carried out by a similar three-person, external team. This summative evaluation will utilize the considerable monitoring data generated under the project to evaluate the overall project impact to date. This final evaluation will delineate lessons learned from the project methodology, means of replication, and success toward meeting the project purpose and goal. This evaluation will also be vital to determine if a phase II is warranted, and future A.I.D.-funded water management activities in the southern zone.

C. TECHNICAL MONITORING PLAN

As mentioned above two general types of technical monitoring will take place within the project. One type is an intensive data collection and analysis which will be done as part of the operational research and the environmental monitoring components of the project. The second type is a well-defined set of information needed to monitor project progress and impact and refine methodologies and approaches as implementation progresses. The research and environmental monitoring data collection and analysis will be

comprehensive. It will require and has been accorded a significant portion of project resources. Monitoring of project progress and impact cannot be as intense without incurring unnecessarily high costs and diverting project personnel from their primary work objectives. The research and environmental monitoring components have to respond to the need for information with scientific accuracy and precision. The monitoring of project progress and impact can be measured more simply by focusing on accurate reporting of input use and by identifying key indicators of project progress. The operational research and environmental monitoring components are described elsewhere in this PP. The plan for project monitoring and evaluation is presented here.

1. Objectives and Approach

The project monitoring and evaluation system is designed to achieve the following objectives:

- to provide baseline data on the physical, socioeconomic, and agricultural conditions of watersheds before project interventions occur;
- to track project input use on a whole project and on an individual watershed basis;
- to monitor changes in prices for rice, peanuts and other important crops, rice surface area, rice yields, peanut surface area, peanut yields, areas and yields of other significant crops in selection areas, dike breeches and repair events, contour berm damage and repair events, and percent completion of watershed plans;
- to make calculations of benefit streams and overall cost:benefit ratios of project interventions in the individual watersheds.
- to perform special studies, if needed, to explain unexpected variance in the indicators.

The objectives are highly specified to avoid heavy and time-consuming data collection and analysis burdens being placed on project personnel. The baseline data is a first step in preparing watershed management plans. The tracking of inputs is a tool intended to signal variance from expected cost of execution of watershed plans. The impact measures are designed to provide objectively verifiable indicators of the success or failure of watershed interventions. Rice surface area and yield integrate all relevant factors of project activities. If rice area and yields do not increase, the project is not working. The operations indicator of gate opening and closing is intended to provide a more frequent signal of the functional status of project works and whether operating rules are being followed. The benefit streams and cost/benefit calculations flow from the impact indicators. The special studies provide project management with a small pool of resources to investigate variance from anticipated progress. By keeping the range of

measures small and quantitative, project management can focus on acquiring accurate data and using it on a regular basis.

It is extremely important to note what this system is not intended to do. It is not intended to measure factors such as rainfall, which are already collected and reported by existing services. It is not intended to measure year to year changes in soil and water quality within the watersheds. It is not intended to provide diagnostic information on benefit distribution, reasons for yield fluctuation, population movements, etc. The diagnostic work and the search for solutions to specific technical problems are areas of inquiry for the research and environmental monitoring activities. The small pool of resources for special studies is meant to be a tool to identify the reasons for problems and figure out if they can be handled by adjustment to project operations, by additional research, or require external intervention or assistance. It is not intended to respond to any other agenda than a responsible tracking of project resource use and project impact in order that major adjustments can be made in project approach and to provide the data set needed for project evaluations.

USAID and the GOS will avoid placing additional expectations and demands for data collection and special studies on the monitoring system of the project. Special requests should be funded by the research or environmental monitoring programs and executed by personnel external to the project implementation team.

The project monitoring and evaluation system will be managed directly by the COP/Water Resource Specialist. The following sections describe data gathering and analysis procedures to be followed by the project.

2. Baseline Data

a. Options

Several approaches to baseline data collection were considered during PP design. These were:

o Baseline Questionnaire Surveys -- a traditional baseline survey based on design and execution of a questionnaire and using standard economic and social science methodology. Such a survey could be carried out by ISRA which is equipped with the FAO Farm Map software, Dbase III, MSTAT, and has recently started work with the microcomputer version of SPSS. Problems frequently encountered with this approach are the almost inevitable debates and delays about design of the survey, the attempt to collect too much information, the long start-up time required to design and test the questionnaire, execute the field survey, the long delays generally experienced between data collection, analysis and interpretation, and reporting. Above all, this type of baseline survey often results in unverifiable data, since it is based on farm family recall. Repetition of this survey at intervals throughout the project is subject to the same problems as the initial survey. Seldom is the same design executed twice, and seldom is the information provided quickly enough to be used to adjust field activities.

design executed twice, and seldom is the information provided quickly enough to be used to adjust field activities.

o Diagnostic Analyses -- diagnostic analysis approaches as developed by the AID-funded Water Management Synthesis project using interdisciplinary teams of expatriate and national scientists to carry out rapid reconnaissance of both physical and socioeconomic factors. This approach has the advantage of combining both physical measures and farmer recall and attitudinal data. It can provide a comprehensive overview of the water management system and the full environment in which it works. Its classic application in Asia has required long periods of training of national scientists and recurring data collection that approaches the intensity needed for linear programming models. Its high costs have made it feasible only for large and sophisticated irrigation systems. The approach has more recently been trimmed down to use rapid reconnaissance techniques with teams that come together for four to six weeks. This approach has been used in Africa to identify key operating and maintenance problems, but does not provide the accuracy of output measurement needed for impact evaluation. It relies very heavily on secondary data sources.

o Resource Inventory -- natural resource inventory approaches as currently being used in the Mauritania Agricultural Research Project which combine aerial photography with ground survey work. This approach is useful for overall land use and cropping pattern work. Combined with survey work this approach provides good physical data and useful socioeconomic data. The socioeconomic data is still constrained by problems of accuracy of farmer recall. Aerial photography costs have come down in recent years and the work can be done fairly rapidly. This approach is most useful for observing gross changes in land use patterns over larger areas and over at least two to three year intervals. Often, however, the accuracy of the aerial photography leads interpreters to assume that the ground survey work is done at the same level of accuracy. This is seldom the case. Variance in the production and socioeconomic survey results tend to lead to the application of large correction factors which often either magnify the differences in observed production figures or income, or result in inconclusive separation in productivity and economic return data across different natural zones.

o Limited Data Set Measurement -- concentration on the measurement on a site specific basis of a limited set of physically measurable variables. This approach is useful when a few key variables integrate the effects of project activities. It is most useful when the project has a single clear objective and is operating within a well-defined geographical area. The approach avoids the problem of reliance on subjective farmer recall. It is also generally of lower cost than the other options, permitting more frequent measurements. An additional advantage is that the period between data collection and interpretation is greatly reduced. Often the data can be collected and analyzed by field staff and used by project management within a few weeks time. Its chief drawback is the need for high accuracy in data collection and, to the extent that sampling procedures are used, the accuracy of selection of representative areas for sampling.

The approach of measuring a limited data set is the most appropriate baseline data collection and subsequent monitoring option for the SZWMP. The SZWMP will work in well-defined watersheds and sub-watersheds. The objective of the project is to improve farmer control of water resources. The only reliable measures of improved water control are increased surface area and/or increased yield. Two crops are expected to be most sensitive to recovery of valley lands. These are rice and peanuts. The project is based on the expectation that one to three years will be required to achieve significant recovery of land and increased rice yields. An intermediate indicator of the operation of the water control structures is needed to ensure that the minimum conditions for improved water control are being met. The gate opening and closing, breech incidence and repair, and contour berm incidence and repair provide this indicator.

b. Procedures

The following procedures will be used to establish baseline data for the project:

o Baseline data will be established on a watershed by watershed basis. The Water Management Teams will collect the baseline data as they begin work in each watershed.

o Base maps at 1:20,000 scale will be prepared from aerial photographs to delineate land forms and surface areas. Then available imagery will be combined with a ground truth survey to develop baseline status of land use and cropping patterns. Soil sampling will be done using rapid field techniques of analysis. The longitudinal slope of the valley will be measured and transects will be surveyed at the technically indicated intervals for cross-valley structures. Existing structures will be mapped. As most plans will be done over the course of a rainy season, the first measurements of surface area of rice and peanuts can be done and crop cutting sample grids laid out. The results of the population and land tenure surveys will be prepared as overlays to the base maps.

o Computerized data base files will be prepared to enable the key factors to be tracked.

3. Water Management Plans and Monitoring

Plans for the construction and phasing of water control structures will be developed with farmers as overall water management plans. These plans will include operations and maintenance guidelines and estimates of recovery time for each major soil category in the valley areas. Copies of these plans will be held by the project and the Village Water Management Committee.

During construction, the project staff will monitor resource use and construction progress using standard tracking sheets, copies of which will remain with the Village Water Management Committees.

After construction, monitoring will be done on a monthly and seasonal basis. Each month the team will collect copies of forms in notebooks in which the Village Water Management Committees will record gate opening and closings with gauge levels, the dates of any breeches and dates of repair. During each growing season, the Water Management Teams, assisted by other staff of the RIAs, will do a crop survey for rice and peanut area. They will also perform a crop cut of rice and peanuts for yield estimation on each part of the toposequence.

4. Data Collection

a. Agricultural Data

Before work starts in a given watershed the record of existing crops should be prepared and estimates made of pre-project crop yields. The gross and net areas to be affected by the projected works in the watersheds should be measured. This data is necessary to determine development costs per hectare and to compute benefits that can be attributed to the project interventions.

b. Cost Data

The costs of all project inputs, such as construction, consulting and village incurred expenses will be recorded. This information will be essential to carry out future evaluations and prepare accurate completion reports.

c. Sociological Data

Project area population figures should be collected in order to determine beneficiaries and land tenure data collected.

d. Water Data

Water quality data should be measured to determine the impact of the project on levels of salinity and salt-water intrusion. Gauge levels at the control structures should be recorded to confirm and establish an operation plan for the anti-salt dike/control structure system

e. Soil Data

Soil types at each project location should be classified and planimetered before the construction is implemented. This data will be used to determine benefits and monitor project impact.

f. Construction Data

Construction quantities completed and planned should be recorded along with records of progress. This data will be useful for predicting future progress and evaluating past performance.

5. Use of Data and Reporting

The baseline data will be the most detailed set of information used by the project for monitoring and evaluation purposes. The baseline will provide the pre-project status of each watershed. The plans and tracking reports will be summarized for presentation to the GOS and USAID in quarterly reports. The Water Management Teams will prepare the baseline data and collect most of the data. Design of the system will require short-term technical assistance in cartography/photo-interpretation and statistical design. A total of two person-months of short-term will be funded by the project for this purpose. One person-months time of an Information System Specialist will be needed to assist in the design of the data base, field data records, and analytic techniques. The same Specialist will return for one month to assist in the first cycle of data analysis and interpretation and to adjust the data base and records design, if necessary.

When significant variance occurs from expected results the COP and the Project Director will investigate these events. They can fund brief special studies if outside assistance is needed. If a longer term effort is needed, then the funds in the applied research or environmental monitoring program should be used to design and execute a research program.

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E.O. 12356: N/A
SUBJECT: PID APPROVAL AND PP GUIDANCE FOR SO. ZONE WATER MANAGEMENT PROJECT (685-0295)

REF: DAKAR 08134

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1. ECPR APPROVED SUBJECT PID ON JULY 9, 1987. PURSUANT TO DOA 551 AND SUBJECT TO GUIDANCE CONTAINED HEREIN, MISSION IS AUTHORIZED TO PROCEED TO FINALIZE THE PP FOR MISSION APPROVAL AND PROJECT AUTHORIZATION FOR FISCAL YEAR 1988 OBLIGATION.

2. ENVIRONMENTAL REUIREMENTS. THE STRATEGY PROPOSED IN THE PID AND IEE ANNEX FOR ENVIRONMENTAL REVIEW AND APPROVAL OF INFRASTRUCTURE ACTIVITIES IS ONE OF DEFERRING ENVIRONMENTAL REVIEW TO THE IMPLEMENTATION PHASE OF THE PROJECT. THE IEE STATES THAT THE GRANT AGREEMENT WOULD CONTAIN A COVENANT WHICH WOULD REQUIRE THAT ACTUAL INFRASTRUCTURE CONSTRUCTION BE SUBJECT TO ENVIRONMENTAL ANALYSIS PRIOR TO INITIATION OF CONSTRUCTION, BUT POST-AUTHORIZATION AND INITIAL OBLIGATION OF FUNDS. THE ECPR REVIEWED THE PROPOSED MISSION STRATEGY AND IS OF THE OPINION THAT ENVIRONMENTAL CONSIDERATIONS AND ANALYSES REQUIRED FOR

PROJECT AUTHORIZATION SHOULD BE COMPLETED TO THE MAXIMUM EXTENT POSSIBLE PRIOR TO PROJECT AUTHORIZATION. TO IMPLEMENT THIS DECISION, THE MISSION IS REQUESTED TO PROVIDE THE FOLLOWING INFORMATION TO AID/W (AFR/PD AND AFR/TR/ PRO)PRIOR TO AUTHORIZING THE PROJECT:

(A) AN ANALYSIS OF AVAILABLE DATA WHICH INDICATES THAT A SUFFICIENT NUMBER OF ENVIRONMENTALLY ACCEPTABLE SITES EXIST IN THE PROJECT REGIONS. THIS WILL BE IMPORTANT INFORMATION FROM THE POINT OF VIEW NOT ONLY OF ENVIRONMENTAL CERTIFICATION, BUT ALSO WILL BE INDISPENSABLE FOR 611(A) AND 611(E) PURPOSES. PROJECT COMMITTEE REPRESENTATIVES BELIEVE THAT THIS DATA HAS BEEN COMPILED IN USEABLE FORM WITHIN THE VARIOUS ENGINEERING AND OTHER STUDIES RELATED TO THE PROPOSED PROJECT AREAS. MISSION MAY CABLE THIS ANALYSIS AT ITS EARLIEST CONVENIENCE BUT PRIOR TO SUBMISSION OF IEE AMENDMENT, AS DESCRIBED IN PART B, BELOW.

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(B) AN IEE AMENDMENT FOR INFRASTRUCTURE ACTIVITIES WHICH SPECIFIES (1) THE ENVIRONMENTAL CHARACTERISTICS OF DIFFERENT REGIONS WHERE INFRASTRUCTURE WILL BE BUILT; (2) THE MIX OF SPECIFIC INFRASTRUCTURE ALTERNATIVES TO BE CONSIDERED FOR PROJECT FINANCING (NOTE: THIS WILL ALSO BE REQUIRED FOR 611(A) AND (E) PURPOSES AS DISCUSSED IN PARA. 3, BELOW); AND (3) A LIST OF ENVIRONMENTAL CRITERIA FOR CONSTRUCTION OF EACH INFRASTRUCTURE TYPE; E.G. QUOTE IN AREAS WHERE PH CONTENT OF THE SOIL IS ABOVE (X AMOUNT), (Y INFRASTRUCTURE TYPE) WILL NOT BE USED UUOTE. THE PURPOSE OF ESTABLISHING SUCH A CRITERIA LIST IS TO SET OUT THE ENVIRONMENTAL PARAMETERS TO BE APPLIED DURING PROJECT IMPLEMENTATION PRIOR TO AUTHORIZATION THEREBY ENABLING THE PROJECT TO MOVE FORWARD WITH AN APPROVED IEE. ONLY TO THE EXTENT THAT DEVIATIONS FROM THE CRITERIA ARE RECOMMENDED DURING IMPLEMENTATION WOULD ENVIRONMENTAL ASSESSMENTS (PER MISSION SUGGESTION) OR AN ENVIRONMENTAL IMPACT STATEMENT BE REQUIRED.

3. 611(A) AND 611(E) REQUIREMENTS. TO COMPLY WITH STANDARD 611(A) AND 611(E) REQUIREMENTS FOR PROJECT AUTHORIZATION AND AS INPUT TO THE ECONOMIC ANALYSIS, THE PP SHOULD PROVIDE DETAILED COST ESTIMATES FOR EACH PROPOSED INFRASTRUCTURE TYPE AND THEN PROVIDE A DETAILED, BUT ILLUSTRATIVE, MIX OF INFRASTRUCTURE PROPOSED FOR PROJECT FINANCING.

4. PARTICIPATION. THE PID PLACES GREAT IMPORTANCE ON THE PARTICIPATORY ASPECTS OF PROPOSED ACTIVITIES AS

VITAL TO THE ULTIMATE SUCCESS OF THE PROJECT. THE PROJECT COMMITTEE APPLAUDS THIS STRATEGY. HOWEVER, THE PROJECT COMMITTEE FELT STRONGLY THAT IT SHOULD NOT BE ASSUMED THAT PARTICIPATION WILL OCCUR SPONTANEOUSLY. RATHER LOCAL PARTICIPATION IN PROJECT ACTIVITIES MUST BE AGGRESSIVELY SOUGHT, BUILT UP, AND SHOULD BE HIGHLY STRUCTURED. DURING INTENSIVE ANALYSIS, MISSION IS ENCOURAGED TO EXAMINE VILLAGE LEVEL FINANCING AND PARTICIPATION SCHEMES AND EXPERIENCE UNDER OTHER A.I.D. EFFORTS, ESPECIALLY IN ANE BOTH FROM THE S&T WATER MANAGEMENT SYNTHESIS II PROJECT AND FROM OTHER SOURCES. MISSION MIGHT WISH TO CONTACT STAN PEABODY, SENIOR WATER MANAGEMENT ADVISOR, ANE/TR/ARD, FOR RECOMMENDATIONS EMERGING FROM RELEVANT EXPERIENCE.

ECPR ALSO RECOGNIZES THAT THE PARTICIPATORY ASPECTS OF THE PROJECT EXTEND BEYOND ENCOURAGING POTENTIAL BENEFICIARIES TO PARTICIPATE IN PROJECT ACTIVITIES. THE FACT THAT SMALL INFRASTRUCTURE INSTALLATIONS (DIKES,

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DAMS, AND THE LIKE) WILL REQUIRE COOPERATIVE ACTION AMONG SEVERAL VILLAGES TO MAINTAIN AND OPERATE WILL DEMAND A SENSE OF RESPONSIBILITY FOR, AND PARTICIPATION IN WATER MANAGEMENT SYSTEMS LONG AFTER THE PROJECT IS OVER.

5. TRAINING. FROM THE POINT OF VIEW OF IDENTIFYING AND DESCRIBING A SPECIFIC PROJECT STRATEGY, THE TRAINING ACTIVITY WAS THE LEAST CLEAR OF ALL THE PROPOSED PROJECT COMPONENTS PROPOSED IN THE PID. THE MISSION REPRESENTATIVE CLARIFIED THE POINT BY DESCRIBING THE TYPES OF TRAINING CONTEMPLATED AND THE PURPOSE OF THE TRAINING (I.E., TO ENSURE THAT ADEQUATE PROMOTION CAPABILITIES EXIST TO IMPLEMENT THE PROJECT). THE ECPR APPRECIATED AND CONCURRED WITH THE MISSION'S PREFERENCE FOR INFORMAL TRAINING, AS STATED BY THE MISSION REPRESENTATIVE. HOWEVER, ECPR PARTICIPANTS WISHED TO UNDERSCORE TO THE MISSION THE IMPORTANCE OF ENSURING THAT PROMOTERS ARE ADEQUATELY TRAINED. THE SUCCESS OR FAILURE OF VILLAGE PARTICIPATION IN THE PROJECT WILL, TO A GREAT DEGREE, DEPEND ON THE ABILITIES OF THE PROMOTERS. ALONG THIS LINE AND TO ENCOURAGE THE BEST POSSIBLE TRAINING FOR PROMOTERS, WE WISH TO ENCOURAGE THE MISSION TO EXPLORE THE POSSIBILITY OF INCLUDING A TRAINING OF TRAINERS ACTIVITY UNDER THE TRAINING COMPONENT.

6. DISSEMINATION OF NEW AGRONOMIC TECHNOLOGIES. THE PP SHOULD ADDRESS IN DETAIL THE LINKAGE BETWEEN TECHNOLOGY DEVELOPMENT, AS PROPOSED UNDER THE ISRA ACTIVITY, AND

TECHNOLOGY DISSEMINATION. WE WOULD EXPECT TO SEE A DETAILED DESCRIPTION OF THE TECHNOLOGY FLOW FROM ISRA TO PARTICIPATING FARMERS AND WHAT MEANS WILL BE USED TO ENSURE THAT THAT FLOW HAPPENS.

7. PROJECT MANAGEMENT ARRANGEMENTS.

(A) COORDINATION. PROJECT IMPLEMENTATION WILL DEPEND ON SUCCESSFUL COORDINATION OF ACTIVITIES AND STAFF AT THE FIELD LEVEL BETWEEN VARIOUS DIVISIONS OF TWO GOS MINISTRIES, INFORMAL WATER MANAGEMENT GROUPS AT THE REGIONAL AND VILLAGE LEVELS, PVOS, AND PEACE CORPS. AS THE MISSION POINTS OUT IN THE PID, INVOLVEMENT OF SUCH A LARGE NUMBER OF FORMAL AGENCIES AND LESS FORMAL GROUPS, AS WELL AS PROJECT BENEFICIARIES, WILL UNDOUBTEDLY RESULT IN PROJECT IMPLEMENTATION COMPLICATIONS. ECPR STRONGLY RECOMMENDS THAT AUTHORITY AS WELL AS RESPONSIBILITY FOR PROJECT IMPLEMENTATION BE VESTED TO THE MAXIMUM EXTENT POSSIBLE IN ONE ENTITY, PREFERABLY THE PROPOSED ON-SITE PROJECT IMPLEMENTATION UNIT. TO THE EXTENT THAT THIS REQUIRES SPECIAL DELEGATIONS TO THE HEAD OF THIS UNIT, THE MISSION IS ENCOURAGED TO VIGOROUSLY PURSUE SAME. WITHOUT DELEGATION OR COMPARABLE ACTION WHICH PLACES FULL AUTHORITY AT FIELD LEVEL, ECPR SERIOUSLY QUESTIONS FEASIBILITY OF PROPOSED PROJECT DESIGN. PLEASE KEEP AFR/PD ADVISED OF PROGRESS OF NEGOTIATIONS ON THIS ISSUE.

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(B) SUSTAINABILITY OF MANAGEMENT ARRANGEMENTS AND REPLICABILITY OF MODEL. WHILE ECPR SUPPORTS MISSION PROPOSED MANAGEMENT ARRANGEMENTS (SUBJECT TO PROVISO ON DECENTRALIZATION OF MANAGEMENT AUTHORITY DISCUSSED ABOVE), ECPR REMAINS CONCERNED THAT THE PROJECT SHOULD LEAVE IN PLACE OR OTHERWISE PROVIDE FOR A MANAGEMENT UNIT WHICH CAN REPLICATE PROJECT MODEL IN OTHER AREAS. THE PP SHOULD, THEREFORE, DISCUSS/ANALYZE THIS ISSUE AND OUTLINE A STRATEGY TO ENSURE MANAGEMENT CAPACITY TO IMPLEMENT A SIMILAR PROGRAM AFTER THE A.I.D. PROJECT CLOSES.

8. RECURRING COSTS OF WATER MANAGEMENT SYSTEMS. THE PP SHOULD OUTLINE SPECIFIC PLANS TO GUARD AGAINST OVERDESIGN VIS-A-VIS SUBSEQUENT OPERATION AND MANAGEMENT COSTS WHILE ENSURING TECHNICAL MAINTENANCE OF WATER CONTROL WORKS, ADMINISTRATIVE FOLLOW-UP OR MONITORING ARRANGEMENTS WHICH DEMAND THAT MAINTENANCE RECEIVE PRIORITY ATTENTION, AND FUNDING SOURCES OR FINANCING ARRANGEMENTS SUFFICIENT TO COVER THE COSTS OF REQUIRED MAINTENANCE.

9. GOS WATER MANAGEMENT POLICIES. PID DISCUSSION OF THE VARIOUS OTHER DONOR WATER MANAGEMENT PROGRAMS LED ECPR TO QUESTION WHETHER THE GOS HAS A CONSISTENT WATER MANAGEMENT POLICY OR STRATEGY. THE PP SHOULD ADDRESS/RATIONALIZE WHAT APPEAR TO BE VERY DIFFERENT WATER MANAGEMENT POLICIES.

10. LAND TENURE CONCERNS. ECPR APPLAUDS MISSION FOR PRIORITY BEING PLACED ON THIS ASPECT OF PROJECT FEASIBILITY. IN ADDITION TO OUTLINED SCOPE OF WORK FOR THIS STUDY, ECPR RECOMMENDS THAT FOLLOWING THREE ASPECTS OF THIS ISSUE BE SPECIFICALLY ADDRESSED BY STUDY TEAM.

(A) IS TENURE ADEUATELY SECURE TO ENSURE THAT LAND, ONCE IMPROVED BY BEING IRRIGATED, WILL NOT BE OVERTAKEN

OR CLAIMED BY PREVIOUS OCCUPANTS? HOW EASY WOULD IT BE FOR OTHER CLAIMANTS TO DISPUTE TENURE RIGHTS OF CURRENT OCCUPANTS?

(B) IS TENURE ADEQUATELY SECURE ON AN INDIVIDUAL OR FAMILY BASIS RATHER THAN GROUP BASIS SO AS TO ENSURE THAT THE FACT THAT LAND MAY BE HELD COMMUNALLY IS NOT AN IMPEDIMENT TO INDIVIDUAL INVESTMENT IN NEW WATER AND AGRONOMIC TECHNOLOGIES?

(C) IS THERE A DISTINCTION BETWEEN LAND RIGHTS AND WATER RIGHTS IN SENEGAL? IF SO, WE RECOMMEND THAT WATER RIGHTS UNDER SENEGALESE LAW AS WELL AS TRIBAL CUSTOMS BE AS THOROUGHLY RESEARCHED AS THE LAND TENURE ISSUE.

11. IEE. A CATEGORICAL EXCLUSION WAS APPROVED ON JUNE 11, 1987, FOR THE FOUR PROJECT INPUTS AS DESCRIBED IN THE DRAFT IEE (TECHNICAL ASSISTANCE, TRAINING, STUDIES AND COMMODITIES OTHER THAN CONSTRUCTION EQUIPMENT AND MATERIALS). IF ADDITIONAL ACTIVITIES ARE CONTEMPLATED, OR IF ANY ADDITIONAL ACTIVITY AFFECTING THE PHYSICAL ENVIRONMENT IS CONTEMPLATED IN THE FUTURE, THESE WILL BE SUBJECT TO AID/W ENVIRONMENTAL REVIEW.

12. PROJECT BACKGROUND AND RELATIONSHIP TO OTHER A.I.D. ACTIVITIES. AS PART OF THE BACKGROUND TO THE PROJECT, MISSION IS REQUESTED TO INCLUDE IN THE PP A MORE COMPLETE DESCRIPTION OF THE EXTENSIVE HISTORY IT HAS WITH IRRIGATION PROJECTS, ISRA RESEARCH CAPACITIES (ESPECIALLY IN THE PROPOSED PROJECT AREA), AND WELL CONSTRUCTION AND USE IN THE PROPOSED PROJECT AREA.

13. EVALUATION. MISSION EXPERIENCE WITH THE

PARTICIPATORY MODELS DEVELOPED UNDER THIS PROJECT SHOULD BE DOCUMENTED IN GREAT DETAIL AS THE AGENCY IS VERY INTERESTED IN LEARNING DEVELOPMENT LESSONS FROM SUCCESSFUL PARTICIPATION SCHEMES. IN ORDER TO FULLY EVALUATE PROJECT IMPACT, MISSION IS REQUESTED TO ENSURE THAT ADEQUATE DATA IS GATHERED TO FULFILL BASELINE DATA REQUIREMENTS. A.I.D./W RECOMMENDATION IS THAT MISSION INCLUDE FUNDING FOR A BASELINE DATA GATHERING EFFORT IN FINAL DESIGN UNLESS MISSION IS CONVINCED THAT ADEQUATE DATA COVERING ENTIRE PROJECT AREA EXISTS TO MEASURE BOTH PURPOSE LEVEL AND, EVENTUALLY, GOAL LEVEL IMPACT.

14. PROCUREMENT PLAN. IN CONJUNCTION WITH THE DEVELOPMENT OF THE PROJECT'S DETAILED PROCUREMENT PLAN, MISSION IS REQUESTED TO INCORPORATE ALL WAIVERS. TO THE EXTENT THAT WAIVERS WHICH CAN ONLY BE APPROVED IN AID/W ARE IDENTIFIED, MISSION IS ENCOURAGED TO REQUEST SAME IN ADVANCE OF AUTHORIZATION.

15. SPECIAL CONCERNS. GIVEN INCREASING CONGRESSIONAL INTEREST, THE MISSION SHOULD MAKE EXPLICIT IN THE PP THE LINKAGE BETWEEN THIS PROJECT AND NATURAL RESOURCE PROTECTION AND PROMOTION.

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16. OTHER COMMENTS.

(A) ECPR WISHES TO COMPLIMENT MISSION ON ITS TREATMENT OF WID ISSUES IN THIS PID. WE WERE ESPECIALLY PLEASED WITH THE WAY WID CONCERNS ARE FULLY INTEGRATED INTO PROJECT ACTIVITIES.

(B) IN GENERAL, ECPR FOUND THE PID TO BE OF HIGH QUALITY AND QUITE COMPREHENSIVE. AT THE SAME TIME, WE ARE COMPELLED TO POINT OUT THAT RECENT GUIDANCE HAS PROVIDED THAT PIDS BE LIMITED TO 15-20 PAGES OF SINGLE-SAPCED, STANDARD SIZE TYPE. WHITEHEAD
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REPUBLIQUE DU SENEGAL
UN PEUPLE - UN BUT - UNE FOI

MINISTERE DU PLAN
ET DE LA COOPERATION

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OBJET : Mise en oeuvre du Projet de Gestion des Eaux dans le Sud.

REFERENCE : V/L du 7/11/1986 et 31/03/1988
M/L MPC/DP/DPSE/P. du 20/11/1986.

Madame le Directeur,

Par lettre AID/PDO/035/88 en date du 31 Mars 1988, vous avez bien voulu me transmettre le document préparatoire du Projet de Gestion des Eaux dans le Sud.

Conformément à ma lettre n° 7667 du 20 Novembre 1986, je vous confirme la haute importance que le gouvernement du Sénégal attache à la réalisation de ce projet dont les objectifs, ainsi que le montant du financement proposé rencontrent mon agrément.

Je puis vous assurer que toutes les dispositions utiles seront prises du côté du gouvernement pour la réalisation de ce projet dans les meilleures conditions.

En vous remerciant pour le soutien constant que votre institution apporte au développement économique et social du Sénégal, je vous prie de croire, Madame le Directeur, à l'assurance de ma haute considération.

MINISTERE DU PLAN ET DE LA COOPERATION

Pour le Ministre
du Plan et de la Coopération
et par délégation
Le Directeur de Cabinet
Mahmoudou Cheikh KANE

+) Madame le Directeur
de l'USAID
D A K A R

5C(2) - PROJECT CHECKLIST

Listed below are statutory criteria applicable to projects. This section is divided into two parts. Part A includes criteria applicable to all projects. Part B applies to projects funded from specific sources only: B(1) applies to all projects funded with Development Assistance; B(2) applies to projects funded with Development Assistance loans; and B(3) applies to projects funded from ESF.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE? HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?	Yes

A. GENERAL CRITERIA FOR PROJECT

1. FY 1988 Continuing Resolution Sec. 523; FAA Sec. 634A. If money is sought to obligated for an activity not previously justified to Congress, or for an amount in excess of amount previously justified to Congress, has Congress been properly notified?	Congressional Notification will be sent to Congress.
2. FAA Sec. 611(a)(1). Prior to an obligation in excess of $500,000, will there be (a) engineering, financial or other plans necessary to carry out the assistance, and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	(a) detailed financial, engineering and other plans have been prepared. (b) Project Paper includes reasonably firm cost estimates.
3. FAA Sec. 611(a)(2). If legislative action is required within recipient country, what is the basis for a reasonable expectation that such action will be completed in time to permit orderly accomplishment of the purpose of the assistance?	No legislative action required.

4. FAA Sec. 611(b); FY 1988 Continuing Resolution Sec. 501. If project is for water or water-related land resource construction, have benefits and costs been computed to the extent practicable in accordance with the principles, standards, and procedures established pursuant to the Water Resources Planning Act (42 U.S.C. 1962, et seq.)? (See A.I.D. Handbook 3 for guidelines.)	Yes
5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and total U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability to maintain and utilize the project effectively?	Yes. See Annex D of Project Paper.
6. FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	No
7. FAA Sec. 601(a). Information and conclusions on whether projects will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	(a) N/A (b) Yes (c) Yes (d) N/A (e) Yes (f) N/A
8. FAA Sec. 601(b). Information and conclusions on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	U.S. long and short-term technical Assistance will be furnished under the project. Project commodities will be from U.S. wherever possible. Much training will also be in the U.S.
9. FAA Secs. 612(b), 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized in lieu of dollars.	USAID will ensure that GOS and local farmers are contributing to project, both in kind and in cash, those items as agreed upon in the Project Agreement.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	No
11. FY 1988 Continuing Resolution Sec. 521. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity?	No
12. FY 1988 Continuing Resolution Sec. 553. Will the assistance (except for programs in Caribbean Basin Initiative countries under U.S. Tariff Schedule "Section 807," which allows reduced tariffs on articles assembled abroad from U.S.-made components) be used directly to procure feasibility studies, prefeasibility studies, or project profiles of potential investment in, or to assist the establishment of facilities specifically designed for, the manufacture for export to the United States or to third country markets in direct competition with U.S. exports, of textiles, apparel, footwear, handbags, flat goods (such as wallets or coin purses worn on the person), work gloves or leather wearing apparel?	No
13. FAA Sec. 119(g)(4)-(6). Will the assistance (a) support training and education efforts which improve the capacity of recipient countries to prevent loss of biological diversity; (b) be provided under a long-term agreement in which the recipient country agrees to protect ecosystems or other wildlife habitats; (c) support efforts to identify and survey ecosystems in recipient countries worthy of protection; or (d) by any direct or indirect means significantly degrade national parks or similar protected areas or introduce exotic plants or animals into such areas?	(a) No (b) Yes. Thru anti-salt dikes, valleys will be protected against the further intrusion of salination. (c) Yes (d) No

14. FAA 121(d). If a Sahel project, has a determination been made that the host government has an adequate system for accounting for and controlling receipt and expenditure of project funds (either dollars or local currency generated therefrom)?	This is a Sahel Project. No project funds will be made available directly to the GOS.
15. FY 1988 Continuing Resolution If assistance is to be made to a United States PVO (other than a cooperative development organization), does it obtain at least 20 percent of its total annual funding for international activities from sources other than the United States Government?	N/A
16. FY 1988 Continuing Resolution Sec. 514. If funds are being obligated under an appropriation account to which they were not appropriated, has prior approval of the Appropriations Committees of Congress been obtained?	N/A
17. FY Continuing Resolution Sec. 515. If deob/reob authority is sought to be exercised in the provision of assistance, are the funds being obligated for the same general purpose, and for countries within the same general region as originally obligated, and have the Appropriations Committees of both Houses of Congress been properly notified?	N/A
18. FY Continuing Resolution Sec. 541. If assistance is being made available to a PVO, has that organization provided upon timely request any document, file, or record necessary to the auditing requirements of A.I.D., and is the PVO registered with A.I.D.?	N/A

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FY 1988 Continuing Resolution Sec. 558 (as interpreted by conference report). If assistance is for agricultural development activities (specifically, any testing or breeding feasibility study, variety improvement or introduction, consultancy, publication, conference, or training), are such activities (a) specifically and principally designed to increase agricultural exports by the host country to a country other than the United States, where the export would lead to direct competition in that third country with exports of a similar commodity grown or produced in the United States, and can the activities reasonably be expected to cause substantial injury to U.S. exporters of a similar agricultural commodity; or (b) in support of research that is intended primarily to benefit U.S. producers?	(a) No. (b) No.
b. FAA Secs. 102(b), 111, 113, 281(a). Describe extent to which activity will (a) effectively involve the poor in development by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, dispersing investment from cities to small towns and rural areas, and	(a) Village-level farmers and farmer groups will directly benefit from improved water availability and protected land. All villagers have land both in the valleys and highlands; thus all families will benefit from improved water management. (b) Project will help develop and organize water management groups allowing farmer groups to increase production and improve income. (c) Project focused on total involvement of villagers in dike construction, maintenance and operation; responsibility rests with villagers.

	insuring wide participation of the poor in the benefits of development on a sustained basis, using appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward a better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries.	(d) Women are major force in rice production and will be greatly involved in project activities and affected by project. (e) Training and observational tours will be carried out in regional countries.
c.	FAA Secs. 103, 103A, 104, 105, 106, 120-21. Does the project fit the criteria for the source of funds (functional account) being used?	Yes. FAA Section121.
d.	FAA Sec. 107. Is emphasis placed on use of appropriate technology (relatively smaller, cost-saving, labor-using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor)?	Yes. Small dikes are most appropriate technology for water management in the area.
e.	FAA Secs. 110, 124(d). Will the recipient country provide at least 25 percent of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or is the latter cost-sharing requirement being waived for a "relatively least developed" country)?	N/A to Section 121.
f.	FAA Sec. 128(b). If the activity attempts to increase the institutional capabilities of private organizations or the government of the country, or if it attempts to stimulate scientific and technological research, has it been designed and will it be monitored to ensure that the ultimate beneficiaries are the poor majority?	Yes. Institutional capabilities will be developed to assist village farmers.

g. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental processes essential to self-government.	Project will fund activities aimed at and managed by Senegalese themselves. Training and technical assistance will strengthen the capacities of the GOS to provide appropriate services to farmers, the private sector to support water management and especially the farmers to take responsibility for the dikes and improve production.
h. FY 1988 Continuing Resolution Sec. 538. Are any of the funds to be used for the performance of abortions as a method of family planning or to motivate or coerce any person to practice abortions?	No.
Are any of the funds to be used to pay for the performance of involuntary sterilization as a method of family planning or to coerce or provide any financial incentive to any person to undergo sterilizations?	No.
Are any of the funds to be used to pay for any biomedical research which relates, in whole or in part, to methods of, or the performance of, abortions or involuntary sterilization as a means of family planning?	No.
i. FY 1988 Continuing Resolution. Is the assistance being made available to any organization or program which has been determined to support or participate in the management of a program of coercive abortion or involuntary sterilization?	No.
If assistance is from the population functional account, are any of the funds to be made available to voluntary family planning projects which do not offer, either directly or through referral to or information about access to, a broad range of family planning methods and services?	N/A

j.	FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes.
k.	FY 1988 Continuing Resolution. What portion of the funds will be available only for activities of economically and socially disadvantaged enterprises, historically black colleges and universities, colleges and universities having a student body in which more than 20 percent of the students are Hispanic Americans, and private and voluntary organizations which are controlled by individuals who are black Americans, Hispanic Americans, or Native Americans, or who are economically or socially disadvantaged (including women)?	No project funds are set aside solely for such organizations. All interested organizations will be encouraged to submit proposals in open competition or as joint venture partners.
l.	FAA Sec. 118(c). Does the assistance comply with the environmental procedures set forth in A.I.D. Regulation 16? Does the assistance place a high priority on conservation and sustainable management of tropical forests? Specifically, does the assistance, to the fullest extent feasible: (a) stress the importance of conserving and sustainably managing forest resources; (b) support activities which offer employment and income alternatives to those who otherwise would cause destruction and loss of forests, and help countries identify and implement alternatives to colonizing forested areas; (c) support training programs, educational efforts, and the establishment or strengthening of institutions to improve forest management; (d) help end destructive slash-and-burn agriculture by supporting stable and productive farming practices; (e) help conserve forests which have not yet been degraded by helping to increase production on lands already cleared	- Yes. - Project will encourage conservation of tropical tree species thru anti-salt program. - (a) Yes (b) N/A (c) N/A (d) N/A (e) Yes (f) Yes (g) N/A (h) N/A (i) N/A (j) N/A (k) Yes.

or degraded; (f) conserve forested watersheds and rehabilitate those which have been deforested; (g) support training, research, and other actions which lead to sustainable and more environmentally sound practices for timber harvesting, removal, and processing; (h) support research to expand knowledge of tropical forests and identify alternatives which will prevent forest destruction, loss, or degradation; (i) conserve biological diversity in forest areas by supporting efforts to identify, establish, and maintain a representative network of protected tropical forest ecosystems on a worldwide basis, by making the establishment of protected areas a condition of support for activities involving forest clearance or degradation, and by helping to identify tropical forest ecosystems and species in need of protection and establish and maintain appropriate protected areas; (j) seek to increase the awareness of U.S. government agencies and other donors of the immediate and long-term value of tropical forests; and (k)/utilize the resources and abilities of all relevant U.S. government agencies?

m. FAA Sec. 118(c)(13). If the assistance will support a program or project significantly affecting tropical forests (including projects involving the planting of exotic plant species), will the program or project (a) be based upon careful analysis of the alternatives available to achieve the best sustainable use of the land, and (b)/take full account of the environmental impacts of the proposed activities on biological diversity?

N/A, Project will not significantly affect tropical forests

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n. FAA Sec. 118(c)(14). Will assistance be used for (a) the procurement or use of logging equipment, unless an environmental assessment indicates that all timber harvesting operations involved will be conducted in an environmentally sound manner and that the proposed activity will produce positive economic benefits and sustainable forest management systems; or (b) actions which will significantly degrade national parks or similar protected areas which contain tropical forests, or introduce exotic plants or animals into such areas?

(a) No.
(b) No.

o. FAA Sec. 118(c)(15). Will assistance be used for (a) activities which would result in the conversion of forest lands to the rearing of livestock; (b) the construction, upgrading, or maintenance of roads (including temporary haul roads for logging or other extractive industries) which pass through relatively undegraded forest lands; (c) the colonization of forest lands; or (d) the construction of dams or other water control structures which flood relatively undegraded forest lands, unless with respect to each such activity an environmental assessment indicates that the activity will contribute significantly and directly to improving the livelihood of the rural poor and will be conducted in an environmentally sound manner which supports sustainable development?

(a) No.
(b) No.
(c) No.
(d) No.

p. FY 1988 Continuing Resolution If assistance will come from the Sub-Saharan Africa DA account, is it (a) to be used to help the poor majority in Sub-Saharan Africa through a process of long-term development and economic growth that is equitable, participatory, environmentally sustainable, and self-reliant; (b) being provided in

(a) Yes.
(b) Yes.
(c) Yes.
(d) Yes.
(e) Yes.

accordance with the policies contained in section 102 of the FAA; (c) being provided, when conistent with the objectives of such assistance, through African, United States and other PVOs that have demonstrated effectiveness in the promotion of local grassroots activities on behalf of long-term development in Sub-Saharan Africa; (d) being used to help overcome shorter-term constraints to long-term development, to promote reform of sectoral economic policies, to support the critical sector priorities of agricultural production and natural resources, health, voluntary family planning services, education, and income generating opportunities, to bring about appropriate sectoral restructuring of the Sub-Saharan African economies, to support reform in public administration and finances and to establish a favorable environment for individual enterprise and self-sustaining development, and to take into account, in assisted policy reforms, the need to protect vulnerable groups; (e) being used to increase agricultural production in ways that protect and restore the natural resource base, especially food production, to maintain and improve basic transportation and communication networks, to maintain and restore the natural resource base in ways that increase agricultural production, to improve health conditions with special emphasis on meeting the health needs of mothers and children, including the establishment of self-sustaining primary health care systems that give priority to preventive care, to provide increased access to voluntary family planning services, to improve basic literacy and mathematics especially to those outside the formal educational system and to improve primary education, and to develop income-generating opportunities for the unemployed and underemployed in urban and rural areas?

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2. Development Assistance Project Criteria (Loans Only)

a.	FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan at a reasonable rate of interest.	N/A.
b.	FAA Sec. 620(d). If assistance is for any productive enterprise which will compete with U.S. enterprises, is there an agreement by the recipient country to prevent export to the U.S. of more than 20 percent of the enterprise's annual production during the life of the loan, or has the requirement to enter into such an agreement been waived by the President because of a national security interest?	N/A.
c.	FY 1988 Continuing Resolution. If for a loan to a private sector institution from funds made available to carry out the provisions of FAA Sections 103 through 106, will loan be provided, to the maximum extent practicable, at or near the prevailing interest rate paid on Treasury obligations of similar maturity at the time of obligating such funds?	N/A.
d.	FAA Sec. 122(b). Does the activity give reasonable promise of assisting long-range plans and programs designed to develop economic resources and increase productive capacities?	N/A.

3. Economic Support Fund Project Criteria

a. FAA Sec. 531(a). Will this assistance promote economic and political stability? To the maximum extent feasible, is this assistance consistent with the policy directions, purposes, and programs of Part I of the FAA?	N/A.
b. FAA Sec. 531(e). Will this assistance be used for military or paramilitary purposes?	N/A.
c. ISDCA of 1985 Sec. 207. Will ESF funds be used to finance the construction, operation or maintenance of, or the supplying of fuel for, a nuclear facility? If so, has the President certified that such country is a party to the Treaty on the Non-Proliferation of Nuclear Weapons or the Treaty for the Prohibition of Nuclear Weapons in Latin America (the "Treaty of Tlatelolco"), cooperates fully with the IAEA, and pursues nonproliferation policies consistent with those of the United States?	N/A.
d. FAA Sec. 609. If commodities are to be granted so that sale proceeds will accrue to the recipient country, have Special Account (counterpart) arrangements been made?	N/A.

5C(3) - STANDARD ITEM CHECKLIST

Listed below are the statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. PROCUREMENT

1. FAA Sec. 602(a). Are there arrangements to permit U.S. small business to participate equitably in the furnishing of commodities and services financed?	Yes.
2. FAA Sec. 604(a). Will all procurement be from the U.S. except as otherwise determined by the President or under delegation from him?	Yes.
3. FAA Sec. 604(d). If the cooperating country discriminates against marine insurance companies authorized to do business in the U.S., will commodities be insured in the United States against marine risk with such a company?	N/A.
4. FAA Sec. 604(e); ISDCA of 1980 Sec. 705(a). If non-U.S. procurement of agricultural commodity or product thereof is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity? (Exception where commodity financed could not reasonably be procured in U.S.)	No offshore procurement of agricultural commodities.
5. FAA Sec. 604(g). Will construction or engineering services be procured from firms of advanced developing countries which are otherwise eligible under Code 941 and which have attained a competitive capability in international markets in one of these areas? (Exception for those	Construction services will be procured from local firms capable of carrying out required services.

countries which receive direct economic assistance under the FAA and permit United States firms to compete for construction or engineering services financed from assistance programs of these countries.)

6. FAA Sec. 603. Is the shipping excluded from compliance with the requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 percent of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S. flag commercial vessels to the extent such vessels are available at fair and reasonable rates? — No.

7. FAA Sec. 621(a). If technical assistance is financed, will such assistance be furnished by private enterprise on a contract basis to the fullest extent practicable? Will the facilities and resources of other Federal agencies be utilized, when they are particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs? — Yes. Not used.

8. International Air Transportation Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will U.S. carriers be used to the extent such service is available? — Yes.

9. FY 1988 Continuing Resolution Sec. 504. If the U.S. Government is a party to a contract for procurement, does the contract contain a provision authorizing termination of such contract for the convenience of the United States? — Yes.

10. FY 1988 Continuing Resolution Sec. 524. If assistance is for consulting service through procurement contract pursuant to 5 U.S.C. 3109, are contract expenditures a matter of public record and available for public inspection (unless otherwise provided by law or Executive order)? — Yes.

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B. CONSTRUCTION

1. FAA Sec. 601(d). If capital (e.g., construction) project, will U.S. engineering and professional services be used?	U.S. services will be used to supervise work carried out by local contractors.
2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable?	Yes.
3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the U.S. not exceed $100 million (except for productive enterprises in Egypt that were described in the CP), or does assistance have the express approval of Congress?	N/A.

C. OTHER RESTRICTIONS

1. FAA Sec. 122(b). If development loan repayable in dollars, is interest rate at least 2 percent per annum during a grace period which is not to exceed ten years, and at least 3 percent per annum thereafter?	N/A.
2. FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights?	N/A.
3. FAA Sec. 620(h). Do arrangements exist to insure that United States foreign aid is not used in a manner which, contrary to the best interests of the United States, promotes or assists the foreign aid projects or activities of the Communist-bloc countries?	Yes.

4. Will arrangements preclude use of financing:

a. FAA Sec. 104(f); FY 1987 Continuing Resolution Secs. 525, 538. (1) To pay for performance of abortions as a method of family planning or to motivate or coerce persons to practice abortions; (2) to pay for performance of involuntary sterilization as method of family planning, or to coerce or provide financial incentive to any person to undergo sterilization; (3) to pay for any biomedical research which relates, in whole or part, to methods or the performance of abortions or involuntary sterilizations as a means of family planning; or (4) to lobby for abortion? YES

b. FAA Sec. 483. To make reimbursements, in the form of cash payments, to persons whose illicit drug crops are eradicated? YES

c. FAA Sec. 620(g). To compensate owners for expropriated or nationalized property, except to compensate foreign nationals in accordance with a land reform program certified by the President? YES

d. FAA Sec. 660. To provide training, advice, or any financial support for police, prisons, or other law enforcement forces, except for narcotics programs? YES

e. FAA Sec. 662. For CIA activities? YES

f. FAA Sec. 636(i). For purchase, sale, long-term lease, exchange or guaranty of the sale of motor vehicles manufactured outside U.S., unless a waiver is obtained? YES

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g.	FY 1988 Continuing Resolution Sec. 503. To pay pensions, annuities, retirement pay, or adjusted service compensation for prior or current military personnel?	YES
h.	FY 1988 Continuing Resolution Sec. 505. To pay U.N. assessments, arrearages or dues?	YES
i.	FY 1988 Continuing Resolution Sec. 506. To carry out provisions of FAA section 209(d) (transfer of FAA funds to multilateral organizations for lending)?	YES
j.	FY 1988 Continuing Resolution Sec. 510. To finance the export of nuclear equipment, fuel, or technology?	YES
k.	FY 1988 Continuing Resolution Sec. 511. For the purpose of aiding the efforts of the government of such country to repress the legitimate rights of the population of such country contrary to the Universal Declaration of Human Rights?	YES
l.	FY 1988 Continuing Resolution Sec. 516. To be used for publicity or propaganda purposes within U.S. not authorized by Congress?	YES

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CLASS: UNCLASSIFIED
CHRGE: AID 12/21/87
APPRV: DIR:SJLITTLEFIELD
DRFTD: PDO:WHAMMINK:AMAT
CLEAR: 1. IWME:CSHORTER
2. IWME:GHAYCOCK
DISTR: A.D AMB DCM

AIDAC

FOR AFR/PD/SWAP, D. ROBINSON

E.O. 12356: N/A
SUBJECT: SOUTHERN ZONE WATER MANAGEMENT PROJECT (685-0295): 611 (E) CERTIFICATION

REF: HB 3, APPENDIX 3L

1. THIS CABLE PROVIDES TEXT OF CERTIFICATION BY USAID/SENEGAL MISSION DIRECTOR ON CAPABILITY OF SENEGAL TO EFFECTIVELY MAINTAIN AND UTILIZE SUBJECT PROJECT AS REQUIRED UNDER SECTION 611 (E) OF THE FAA. REQUEST AFR/PD/SWAP ASSURE THAT THE AA/AFR HAS RECEIVED AND TAKEN INTO CONSIDERATION THIS CERTIFICATION.

2. QUOTE. 1. DESCRIPTION

THE SOUTHERN ZONE WATER MANAGEMENT PROJECT WILL CONSTRUCT WATER MANAGEMENT FACILITIES CONSISTING OF ANTI-SALT DIKES, WATER RETENTION DIKES, CONCRETE CONTROL STRUCTURES AND CONTOUR BERMS WHICH HAVE A TOTAL ESTIMATED COST OF APPROXIMATELY $3.5 MILLION. THE PP TEAM ENGINEER AND THE MISSION ENGINEER HAVE TAKEN INTO ACCOUNT THE COUNTRY'S HUMAN RESOURCE AND FINANCIAL CAPABILITY TO EFFECTIVELY MAINTAIN AND UTILIZE THESE STRUCTURES AS INDICATED BY PAST PERFORMANCE AND PRESENT ANALYSIS. MAINTENANCE AND OPERATION OF THE WATER CONTROL FACILITIES ARE VITAL ELEMENTS OF OVERALL PROJECT DESIGN AND CONSIST PRINCIPALLY OF ORGANIZING THE FARMERS NEAR EACH SET OF STRUCTURES INTO A WATER USERS GROUP AND PROVIDING TRAINING TO THE FARMERS IN THESE GROUPS IN EFFECTIVE MAINTENANCE AND UTILIZATION PROCEDURES AND PROVIDING THEM WITH SUFFICIENT HANDTOOLS TO CARRY OUT THE PERIODIC MAINTENANCE REQUIRED FOR THE PROPOSED WATER CONTROL FACILITIES. THE FACILITIES TO BE CONSTRUCTED WILL BE OF A DESIGN APPROPRIATE TO THE FARMERS' AND THE GOVERNMENT'S ABILITY TO UTILIZE AND MAINTAIN WITHIN THEIR RESPECTIVE TECHNICAL AND FINANCIAL CAPACITIES.

2. CERTIFICATION

I, SARAH JANE LITTLEFIELD, THE DIRECTOR OF THE AGENCY FOR INTERNATIONAL DEVELOPMENT MISSION TO SENEGAL, HAVING TAKEN INTO ACCOUNT, AMONG OTHER THINGS, THE MAINTENANCE AND UTILIZATION OF SIMILAR WATER MANAGEMENT FACILITIES IN PROJECTS PREVIOUSLY FINANCED OR ASSISTED BY THE UNITED

STATES, DO HEREBY CERTIFY THAT IN MY JUDGMENT THE LOCAL POPULATION AND THE GOVERNMENT OF SENEGAL HAVE BOTH THE FINANCIAL AND HUMAN RESOURCE CAPABILITIES TO EFFECTIVELY MAINTAIN AND UTILIZE THE FACILITIES CONSTRUCTED UNDER THE SOUTHERN ZONE WATER MANAGEMENT PROJECT, NUMBER 685-0295. UNQUOTE.

3. PLEASE ADVISE. WALKER
BT
#0205

NNNN

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AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

ACTION MEMORANDUM FOR THE DEPUTY ASSISTANT ADMINISTRATOR FOR AFRICA

FROM : AFR/SWA, Phyllis Dichter, Director Phyllis Dichter

SUBJECT : FAA 121(d) Determination for Senegal: Southern Zone Water Management (685-0295)

Purpose: To make a finding that the Determination set out in Section 121(d) of the Foreign Assistance Act of 1961, as amended (the "FAA"), for either Sahel Development Fund Program or Development Fund for Africa funds, is not required for the Southern Zone Water Management Project, Number 685-0295.

Background: Section 121(d) states:

> Funds available to carry out this section (including foreign currencies acquired with funds appropriated to carry out this section) may not be made available to any foreign government for disbursement unless the Administrator of the Agency for International Development determines that the foreign government will maintain a system of accounts with respect to those funds which will provide adequate identification of and control over the receipt and expenditure of those funds.

Discussion: There is no longer a Sahel Development Program appropriation account. However, the Joint Explanatory Statement of the Committee of Conference provides that it is the intent of the Conferees that provisions of law that make reference to FAA Section 121 (and to FAA Sections 103 through 106) will apply to funds made available from the Development Fund for Africa appropriation.

In Dakar 13316 of December 29, 1987, The Mission Director has certified "that no Sahel Development Program or Development Fund for Africa funds will be made available to the Government of Senegal for disbursement concerning the subject project." A copy of the cable is attached.

Recommendation: I recommend that you approve a finding that the requirement for a determination set out in FAA Section 121(d) does not apply to this project for either Sahel Development Fund Program or Development Fund for Africa funds.

Attachment: Dakar 13316

APPROVED: [signature]

DISAPPROVED: _____

DATE: 1/22/88

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Clearances:
AFR/SWA:GJones (draft)
GC/AFR:PJohnson

Drafter:AFR/SWA/S:Wvaitaitis, 01/12/88:8798U/p.5

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UNCLASSIFIED

Department of State

INCOMING TELEGRAM

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ACTION AID-00

ACTION OFFICE AFFW-04

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FOR AFR/SWA - H. VIATIATIS

E.O. 12356: N/A

SUBJECT: FAA SECTION 121 (D) CERTIFICATION FOR SOUTHERN ZONE WATER MANAGEMENT PROJECT (685-0295)

I, SARAH JANE LITTLEFIELD, MISSION DIRECTOR, USAID/SENEGAL, CERTIFY THAT NO SAHEL DEVELOPMENT PROGRAM OR DEVELOPMENT FUND FOR AFRICA FUNDS WILL BE MADE AVAILABLE TO THE GOVERNMENT OF SENEGAL FOR D SBURSEMENT CONCERNING THE SUBJECT PROJECT. WALKER

UNCLASSIFIED

128

SZWM8 dated 6/29/88

SOUTHERN ZONE WATER MANAGEMENT PROJECT
Detailed Summary of Estimated Expenditures ($000)

	LOP P/Y	Cost/ P/Y	Year 1 P/Y	Year 1 Cost	Year 2 P/Y	Year 2 Cost	Year 3 P/Y	Year 3 Cost	Year 4 P/Y	Year 4 Cost	Year 5 P/Y	Year 5 Cost	Year 6 P/Y	Year 6 Cost	Year 7 P/Y	Year 7 Cost	Year 8 P/Y	Year 8 Cost	TOTAL COSTS	Rounded Tot	AID Direct	AID Contract
I. Technical Assistance																						
Long-Term U.S.																			($4,440)	$4,500		
- Water Res. Mgmt Exp. (COP)	7	$180			1	$180	1	$180	1	$180	1	$180	1	$180	1	$180	1	$180	$1,260			$1,260
- Engineer	7	$180			1	$180	1	$180	1	$180	1	$180	1	$180	1	$180	1	$180	$1,260			$1,260
- Agronomist	4	$180									1	$180	1	$180	1	$180	1	$180	$720			$720
- Sociologist	2	$180			1	$180	1	$180											$360			$360
- Admin/Financial Officer	7	$120			1	$120	1	$120	1	$120	1	$120	1	$120	1	$120	1	$120	$840			$840
Support Staff																			($974)	$1,000		
- Admin. Asst/Sec. (PMU)	7	$12			1	$12	1	$12	1	$12	1	$12	1	$12	1	$12	1	$12	$84			$84
- Bilingual Secr. (PMU)	7	$10			1	$10	1	$10	1	$10	1	$10	1	$10	1	$10	1	$10	$70			$70
- Project Monitoring Officer	7.5	$100	0.5	$50	1	$100	1	$100	1	$100	1	$100	1	$100	1	$100	1	$100	$750		$750	
- Motorpool Supervisor (PMU)	7	$10			1	$10	1	$10	1	$10	1	$10	1	$10	1	$10	1	$10	$70			$70
Short-term U.S.	P/M																		($1,050)	$1,100		
- Initial Water Mgmt Expert	9	$15	9	$135															$135		$135	
- Sociologist	15	$15			0	$0	0	$0	3	$45	3	$45	3	$45	3	$45	3	$45	$225			$225
- Engineer	6	$15											2	$30	2	$30	2	$30	$90			$90
- Agronomist	6	$15			2	$30	2	$30	2	$30									$90			$90
- Soil Scientist	11	$15			3	$45	3	$45	3	$45	2	$30							$165			$165
- Economist	4	$15			1	$15	1	$15	1	$15	1	$15							$60			$60
- Dev. Ecologist	7	$15	3	$45	2	$30	2	$30											$105			$105
- Other	12	$15			2	$30	2	$30	2	$30	2	$30	2	$30	1	$15	1	$15	$180			$180
II. Infrastructure Development	HA.																		($3,761)	$3,800		
Civil Works	15000	$0.159	0	$0	1200	$190	2300	$401	2300	$441	2300	$483	2300	$533	2300	$587	2300	$646	$3,284			$3,284
Handtools						$36		$5		$5		$5		$10		$5		$5	$71			$71
Equipment/Maintenance				$174		$10		$10		$10		$172		$10		$10		$10	$406			$406
III. Training																			($900)	$900		
Long-Term M.Sc.	4	$75			2	$150	2	$150											$300			$300
In-Country Training																						
- Workshops, Seminars, Conf.	12	$5					2	$10	2	$10	2	$10	2	$10	2	$10	2	$10	$60			$60
Short-Term U.S. & 3rd Country	20	$6	0	$0	6	$36	6	$36	6	$36	2	$12							$120			$120
Observational/Study Tours	20	$20	0	$0	4	$80	4	$80	4	$80	4	$80	3	$60	1	$20			$400			$400
IV. Research and Monitoring																			($1,095)	$1,100		
	P/M																					
Environmental Studies	13	$15			7	$105	4	$60	2	$30									$195			$195
Paired valley study/ISRA						$140		$100		$90		$90		$80					$500			$500
Related ISRA applied research						$80		$80		$80		$80		$80					$400			$400

SOUTHERN ZONE WATER MANAGEMENT PROJECT
Detailed Summary of Estimated Expenditures ($000)

	LOP	Cost/ Item	Year 1 P/Y	Year 1 Cost	Year 2 P/Y	Year 2 Cost	Year 3 P/Y	Year 3 Cost	Year 4 P/Y	Year 4 Cost	Year 5 P/Y	Year 5 Cost	Year 6 P/Y	Year 6 Cost	Year 7 P/Y	Year 7 Cost	Year 8 P/Y	Year 8 Cost	TOTAL COSTS	Rounded To:	AID Direct	AID Contract
V. Equipment/Commodities																			($1,259)	$1,300		
Vehicles	19	$23.5	10	$235							9	$212							$447		$235	$212
Spare parts				$70								$62							$132		$70	$62
Oper. and Maint. (3 yrs/6 veh)				$60		$65		$65		$30		$30		$30		$30		$30	$340			$340
Office Equipment				$145								$50							$195		$195	
Office supplies				$20		$15		$15		$15		$15		$15		$15		$15	$125		$20	$105
Field equipment						$20													$20			$20
VI. Logistical Support/Operating Costs																			($1,195)	$1,200		—
In-country per diem		$0.08	60	$5		$80		$60		$108		$25		$25		$25		$25	$372			$372
GOS Performance Awards				$8		$25		$25		$25		$25		$25		$25		$25	$183			$183
Housing/Utilities U.S. TA						$48		$48		$48		$72		$48		$48		$48	$360			$360
Office space rental	7.5	$24	0.5	$12		$24		$24		$24		$24		$24		$24		$24	$180		$24	$156
Rehab of Reg. Insp offices in Ziguinchor, Kolda & Sedhiou				$85		$15													$100		$100	
VII. Evaluation/Audit																			($400)	$400		
External Evaluations																						
- End year 2						$55													$55		$55	
- Year 5												$60							$60		$60	
- Year 8																		$60	$60		$60	
Audit - Year 3, 5 and 7								$75				$75				$75			$225		$225	
SUB-TOTAL PROJECT				$1,044		$2,116		$2,206		$1,810		$2,496		$1,847		$1,756		$1,780	$15,054	$15,300	$1,929	$13,125
VIII. Inflation/Contingency																				$2,700		
TOTAL PROJECT																				$18,000		

SOUTHERN ZONE WATER MANAGEMENT

PROJECT PAPER

ENGINEERING ANNEX

GENE F. WHITE, P.E.
Associate
Development Alternatives, Inc.

FOR USAID/DAKAR

DECEMBER 15, 1987

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ENGINEERING ANNEX

I. GENERAL

A Development Alternatives Inc., (DAI), Team was hired by USAID, Dakar, to visit the Casamance basin in August-October, 1987. The team's mandate was to determine the feasibility of improved water management practices as well as optimization of rainfall in the lower and middle Casamance basin in order to counteract the adverse effects of reduced rainfall in the region. The feasibility team visited 35 sites and selected ten sites from the 35 that were representative of priority zones. The team returned to the Casamance in early November to prepare portions of a Project Paper for the Southern Zone Water Management Project and carried out detailed investigations at the ten preselected sites. The engineering studies that follow describe and present: the existing conditions at each of the sites; the investigations carried out; the solutions recommended; typical designs; quantity and cost estimates; typical construction specifications; operation and maintenance considerations; and implementation staff requirements.

II. MAJOR DESIGN ALTERNATIVES

In order to achieve improved water management in the Casamance Basin, engineered structures which included anti-salt dikes, water retention dikes, water control structures for the dikes, water storage dams and gravity irrigation systems were studied for the sites visited. The primary emphasis was placed on the engineering structures to achieve improved water management, but secondary water control practices were also investigated to achieve the desired goals. These secondary items included the control and management of overland flow by selective land shaping and the provision of contour berms to direct flow and reduce soil erosion, and active operation and maintenance program for the proposed facilities.

The prefeasibility study determined that it is necessary to place anti-salt dikes at the mouths of marigots to reverse the salinization process. These dikes would be provided with gated, reinforced concrete control structures. The purpose of these dikes would be to prevent saltwater from coming onto the farm lands and, at the same time, enable fresh rainwater to be stored on a given area and dissolve soil salts. The control structure would be opened at intervals during the rainy season to wash away the salts that have been dissolved by the stored rainwater. During the dry season, salty water would be allowed onto the lands to keep them moist and prevent acidification.

In some areas that are slightly upstream and less affected by saltwater intrusion, water retention dikes are proposed. These dikes would have the same configuration as the anti-salt dikes and would be provided with a gated control structure. The purpose of these dikes would be to store excess rain water which would be used to cultivate rice. The dikes would be low and the depth of the stored water would average approximately 0.5 meters. This would be an ideal depth for growing medium-straw rice. The control structure would make it possible to control the depth of the stored water. If excess rain fall occurred, this excess could be released through the control structure.

For slope rice growing areas which are not greatly affected by the salt water intrusion, contour berms and selective land shaping are proposed to direct and control the flow of rainwater.

The alternative approach of irrigation was investigated by the PP Design Team. This alternative design included storage of excess rainwater behind a small earthen dam and the release of this water to a downstream service area via an outlet works located at the bottom of the storage dam. The water would be distributed to the service area via gravity-fed earthen irrigation canals provided with division structures to direct the water to irrigation blocks. This concept was studied as a basis for a pilot project to determine the feasibility of surface storage utilizing gravity-fed irrigation systems in the Casamance. No irrigation systems have been used in the lower Casamance before, but a few run-of-the-river and groundwater pumping systems have been tried in the middle and upper Casamance. The farmers have no experience with such systems, and, so far, all systems proposed have been estimated to cost in the region of $ 7,000 to $ 12,000 per hectare. The PP Team estimated the cost of a simplified irrigation system as a pilot study at Essoum. These costs came to approximately $ 4,000/ha. Details of these costs are presented in the cost section below. This scheme was finally determined to be unfeasible and was dropped.

Some projects require only improved operation and maintenance of anti-salt dikes and control structures. At some sites, where existing facilities have already been constructed by villages and other local departments, only some rehabilitation is required.

III. SITE CONDITIONS

A. General

A summary of the existing site conditions, surveys carried out, proposed solutions, design floods assumed, quantities and cost estimates and typical construction specifications are presented below and in Appendices A and B for each of the ten locations visited by the team. Typical photos of each site are presented in Appendix C. A Project Location Map is presented in Appendix D. Appendices A, B, and C are contained in a separate folder and filed in the official project file in USAID/Senegal.

1. Tanaff

At Tanaff, the villagers had decided in a meeting of the elders of the adjacent villages that they should construct an anti-salt dike across the mouth of the main marigot just upstream from the Casamance River. This site was visited by the PP Team. It was not possible to survey directly across the marigot at the location selected by the villagers because of the existence of a large quantity of water. A survey was attempted approximately 500 meters upstream from this location. After traversing 600 meters of the marigot in a northerly direction, extremely soft, bottomless muck was encountered approximately 200 meters from the northern edge of the marigot. The survey was abandoned and the site judged not to be feasible for the villagers to construct a dike.

The first marigot arm to the left when facing upstream was then selected as an alternative site. An existing anti-salt dike/road, located a few hundred meters from the mouth of this arm was traversed in a south-westerly direction and this location was selected for rehabilitation. A 450-meter survey was carried out.

It is proposed that an additional anti-salt dike embankment be placed at this location, that laterite slope protection be placed on the upstream and downstream slopes, and that a control structure with a total width of 4.5 meters or three bays be provided. Throughout half of the gross service area of 456 ha. it is proposed that contour berms be constructed with a length of 6000 meters. Two water retention dikes, each with a length of 400 meters, are proposed for construction upstream from the anti-salt dike at one-half kilometer intervals. Design calculations, quantities and costs are presented in Appendix A1.

2. Samine Escale

At Samine Escale an anti-salt dike had been constructed by the villagers. It has been completed for approximately two years. During the pre-feasibility mission, two breaches were observed in the dike. By the time the team returned these breaches had been repaired. Two control structures existed. The dike surveyed had a length of 1,165 meters. The dike was in relatively good condition. One hand tamper had been used during the construction. This tamper was inspected. It was a square weight of approximately 5 kg. attached to the end of a handle. This dike requires the placement of some additional embankment, provision of upstream and downstream laterite slope protection and the construction of one additional control structure having a width of 4.5 meters or three bays.

Four water retention dikes, each with a length of 400 meters, are proposed for construction at one-half kilometer intervals upstream from the anti-salt dike.

Contour berms with a length of 13,000 meters should be constructed over half of the gross 972-ha. service area. The plans, typical

cross sections, quantity and cost estimates are presented in Appendix A2.

3. Kinndiri Medina

At this site an anti-salt dike had been constructed by the villagers over a two-year period. During the last season a control structure had been constructed with three 1.5 meter bays. The existing dike surveyed had a length of 1,244 meters and had an east-west orientation. During the first visit by the team, the dike had been found in sound condition. By the second visit, four breaches had occurred. These breaches had been blocked with bags filled with soil. It was evident that no embankment compaction had been carried out. The stop-logs installed in the structure were not high enough to block off the flow. This resulted in ineffective operation of the system.

The dike should be repaired, some additional height added to bring the dike level with the top of the control structure, laterite slope protection provided and one additional control structure constructed having a width of 3.0 meters or two bays.

Two water retention dikes, each with a length of 400 meters, are proposed for construction at one-half kilometer intervals upstream from the anti-salt dike.

Throughout half of the gross service area of 515 ha., contour berms with a length of 6,900 meters should be constructed. The plans, typical sections, quantity and cost estimates, and control structure width calculations for this site are presented in Appendix A3.

4. Bounkiling

At this site an anti-salt dike had been constructed by the villagers. The dike had a measured length of 600 meters. The existing dike needs rehabilitation. The dike requires additional height and top width. Laterite slope protection should be provided and a concrete control structure constructed having a width of 12.0 meters or eight bays.

Two water retention dikes, each with a length of 400 meters, are proposed for construction at one-half kilometer intervals upstream from the anti-salt dike.

Throughout half of the gross service area of 351 ha. it is proposed that contour berms with a length of 4,500 meters be provided. The plans, sections, control structure width calculations and quantity and cost estimates for this site are presented in Appendix A4.

5. Ndiama

At this site a partially constructed dike exists. It had a surveyed length of 300 meters. This dike should be improved to function as an anti-salt dike and should have a completed length of 600 meters. Laterite

slope protection should be provided and one concrete control structure constructed having a width of 10.5 meters or seven bays.

One water retention dike with a length of 400 meters is proposed for construction upstream from the anti-salt dike.

Contour berms with a length of 3,300 meters should be provided over half of the gross service area of 247 ha. Plans, sections, control structure width calculations, and quantity and cost calculations are presented in Appendix A5.

6. Mayor

At this site two water retention dikes are proposed. They should be located at respectively 500 and 1,000 meters upslope from the road/berm that traverses the project area. Each retention dike would have a length of 400 meters and be provided with a single bay, width 1.5 meters, control structure.

Contour berms with a length of 1,600 meters are proposed for half of the gross service area of 104 ha. Plans, sections, and quantity and cost estimates are presented in Appendix A6.

7. Diatok

At this site an anti-salt dike constructed by the villagers exists. The villagers stated that the dike caused some improvement, but the operation of the Affiniam anti-salt dam had caused their soils to totally dry out. More immediate harm than benefits have been gained, but farmers are willing to wait to see if desalinization will occur by 1989. The Diatok dike had a surveyed length of 876 meters. This site should be improved, laterite protection provided and a concrete control structure having a width of 4.5 meters, or three bays, constructed.

One water retention dike with a length of 400 meters is proposed for construction upstream from the water retention dike.

Contour berms with a length of 1,300 meters are proposed for half of the gross service area of 111 ha. Plans, sections and quantity and cost calculations are presented in Appendix A7.

8. Balingore

The villages have constructed an anti-salt dike at this site. It requires significant improvement. PIDAC has constructed two concrete control structures. The dike has a surveyed length of 3,876 meters. The dike requires a large quantity of compacted embankment to bring it up to proper height and width. Laterite slope protection should be provided for both the upstream and downstream slopes. One additional control structure with a width of 3.0 meters should be constructed.

Two water retention dikes with a length of 400 meters are proposed for construction at one-half kilometer intervals upstream from the water retention dike.

Contour berms with a length of 4,100 meters should be provided for half of the gross service area of 328 ha. Plans, sections, control structure width calculations and quantity and cost calculations for this site are presented in Appendix A8.

9. Djimande

At this site an existing retention dike exists. Two control structures exist. One structure was constructed recently by PIDAC and the other about ten years ago by ILACO. The dike requires additional length and some improvement. The existing dike has a measured length of 300 meters. It should be extended for an additional 300 meters. A 400-meter long water retention dike should be constructed across the basin and about 500 meters above the road that crosses the basin. This dike should be provided with one control structure having a width of 1.5 meters or one bay.

Contour berms with a length of 1,000 meters should be provided for half of the gross service area of 64 ha. The plans, sections, control structure width calculations and quantity and cost estimates for this site are presented in Appendix A9.

10. Essoum

For this site two alternatives have been studied. Feasibility studies for an irrigation system have been prepared by BCEOM. These studies described a very complicated and expensive system. The cost of that system was estimated at $9,500/ha. A revised plan for irrigation is presented in Appendix A10. The cost of this less complicated system is $4,000/ha. However, a less expensive solution seems more attractive than either irrigation option. This scheme would entail the provision of four 400-meter long water retention dikes constructed at one-half kilometer intervals along the basin, each provided with one control structure having a width of 1.5 meters or one bay.

Contour berms with a length of 2,800 meters should be provided over half of the estimated gross service area of 186 ha.

Plans, sections, quantity and cost estimates for both schemes are presented in Appendix A10. It is proposed that the latter scheme be considered and that the pilot irrigation scheme be dropped.

B. Plan and Cross Section Surveys

Plan and cross section surveys were carried out for each of the ten sites. To measure distance, a fifty- meter tape was used. A magnetic compass was used to take bearings. Cross sections were measured with a

folding engineer's rod and a hand level. Each survey has been plotted and the plans and typical cross sections are presented in Appendix A. These plans and cross sections were used to compute construction quantities and costs. The lengths of the surveys at each of the ten sites are presented in the following table:

Survey Plan Lengths

No.	Project	Total Length (m.)
1.	Tanaff	450
2.	Samine Escale	1,165
3.	Kinndiri Medina	1,244
4.	Bounkiling	600
5.	Ndiama	600
6.	Mayor	800
7.	Diatok	876
8.	Balingore	3,876
9.	Djimande	1,126
10.	Essoum	1,600

IV. PRELIMINARY STRUCTURE DESIGNS

Typical preliminary structure drawings are included in Appendix B. Designs for each specific site are presented in Appendix A. A brief summary description of the design alternatives is presented below:

A. Anti-salt Dams

The anti-salt dams proposed will be earthen dikes constructed of clayey material which is obtained from borrow areas near the dikes. The dike will be relatively impervious and will have side slopes of 2 horizontal to 1 vertical. The top width will be two meters, the dike height 0.8 meters and the dam slopes will be provided with laterite protection. An analysis of the wave variation by the PP Team Hydrologist indicated that the anti-salt dike with a height of 0.8 meters will be safe from overtopping from downstream waves. These waves will have a maximum height of 0.65 meters leaving a freeboard of 0.15 meters.

A gated, reinforced concrete control structure will be provided. Gates will consist of wooden stop-logs. The control structure will be sized to pass a ten-year flood and thus will act as an emergency spillway as well as a control structure. It will have a number of 1.5 meter bays depending upon the size of the drainage area which contributes the flood. The depth of the structure will be 1.5 meters. A top slab will be provided that has removable sections so that the wooden stop-logs can be placed and removed. Two rows of stop-log guides will be provided. These rows should be about one-third of a meter apart so that when two stop-logs are placed, earth can be placed between the front and rear stop-logs, thus providing a positive cutoff.

As an alternative, the provision of an ungated, earthen side channel emergency spillway could be considered. If such a spillway were provided the control structure widths could be reduced, but the anti-salt dike height would have to be increased by approximately one-half a meter. This alternative can be studied by the implementation team.

B. Water Retention Dikes

The water retention dikes shall have a top width of one meter, 1 to 1 side slopes and a height of 0.5 meters. The dikes shall be provided with the same control structure/emergency spillway as the anti-salt dike. The only difference will be in the structure function. The purpose of the water retention dike is to store excess rain water for deep water rice cultivation

The water retention dike height has been set slightly lower than the anti-salt dike height, so that the water held behind that dike is not too deep to cultivate rice.

C. Contour Berms

Contour berms will be constructed of clayey material, be approximately 0.5 meters in height, have a top width of one meter and have 1 to 1 side slopes. The purpose of these berms will be to direct the overland flow, harvest this flow and reduce soil erosion. Directing the overland flow by the use of the contour berms will increase the water yield of the basin by directing the water to locations where it can be captured. The berms will be located over the upper one-half of the gross service area. Grading and shaping the land and the berms could be accomplished with tractors and discs.

D. Water Storage Dams

To store a large quantity of excess rainwater at selected locations, a zoned earthfill dam was studied. The dam would be provided with an impervious core and a impervious cutoff trench. The dam would have a height in the range of three to four meters with a top width of two meters. The upstream dam slope would be provided with riprap protection and the downstream slope with grass protection. The dam would be provided with a reinforced concrete ungated broad-crested weir emergency spillway which is sized to pass a 100-year flood. A concrete chute would be provided at the downstream slope of the dam and would be provided with a stilling basin to dissipate energy. An escape channel would lead from the stilling basin. A gated outlet works would be provided through the body of the dam to provide for irrigation water releases. This alternative was finally discarded because of the high cost per hectare.

E. Irrigation Facilities

To distribute irrigation water to a service area located below the dam, primary trapezoidal-shaped earthen canals could be constructed. Reinforced concrete irrigation division/turnout structures would be provided

at frequent intervals along the main canals. The irrigation water would be delivered to the fields via secondary and tertiary earthen canals. The entire irrigation system would be gravity fed. These facilities were later discarded because of high cost.

V. CONTRUCTION QUANTITIES AND COST ESTIMATES

A. General

Field surveys were carried out at each of the ten proposed sites by the PP Team Engineer to determine lengths of proposed dikes. The PP Team Hydrologist determined the drainage area and design discharge for each site. The gross and net service areas for each site were measured from soil maps prepared by the PP Team Soil Scientist. Drainage areas, gross and net service areas and control structure design flows are presented for each of the ten sites visited in the following table:

Drainage Area/Design Flows/Service Areas

No.	Name	Drainage Area (Sq. Km.)	Design Flow (CMS)	Gross Service Area (Ha.)	Net Service Area (Ha.)
1.	Tanaff	31	9.5	456	424
2.	Samine Escale	122	16.0	972	822
3.	Kinndiri Med.	316	26.0 (14.0)	515	446
4.	Bounkiling	203	22.0	351	335
5.	Ndiama	170	18.0	247	230
6.	Mayor	-	2.5	104	83
7.	Diatok	12	7.5	111	80
8.	Balingore	21	8.5	328	245
9.	Djimande	7	6.0	64	64
10.	Essoum	-	2.5	186	186

At Kinndiri Medina a design flow of 14.0 CMS was adopted. The PP Team Hydrologist later revised this value to 26.0 CMS. The design was not changed to reflect this change.

B. Control Structure Widths

The control structure widths required to pass the design flows, (10-year flood), and dike/berm lengths are presented for each site in the following table. The broad-crested weir formula was used to size the structure widths from the design flows calculated by the PP Team Hydrologist. Detailed calculations for each site are presented in Appendix A.

Control Structure Widths/Dike Lengths/Berm Lengths

No.	Name	Control Structure Widths (M.)	Anti-Salt Dike Length (M.)	No.	Retention Dike Length (M.)	No.	Contour Berm Length (M.)
1.	Tanaff	4.5	450	1	800	2	6,000
2.	Samine Escale	3.0	1,165	1	1,600	4	13,600
3.	Kinndira Medina	3.0	1,244	1	800	2	6,900
4.	Bounkiling	12.0	600	1	800	2	4,500
5.	Ndiama	10.5	600	1	400	1	3,300
6.	Mayor	1.5	-	-	800	2	1,600
7.	Diatok	4.5	876	1	400	1	1,300
8.	Balingore	3.0	3,876	1	800	2	4,100
9.	Djimande	1.5	-	-	1,126	2	1,000
10.	Essoum	1.5	-	-	1,600	4	2,800

C. Quantities

A summary of construction quantities for anti-salt dikes, water retention dikes, and contour berms for each of the ten selected sites is presented in the following table. Detailed calculations are presented in Appendix A.

Summary Dike/Berm/Control Structure Quantities

No.	Name	Dike Fill (CU.M.)	Laterite (CU.M.)	R.C. Concrete (CU.M.)	Berm Fill (Cu.M.)
1.	Tanaff	1,231	495	10.1	4,500
2.	Samine Escale	1,827	1,282	10.1	9,750
3.	Kinndiri Medina	2,736	1,368	7.8	5,175
4.	Bounkiling	1,758	660	21.6	3,375
5.	Ndiama	1,788	660	19.3	2,475
6.	Mayor	600	-	5.5	1,200
7.	Diatok	1,819	964	10.1	975
8.	Balingore	11,063	4,264	7.0	3,075
9.	Djimande	1,701	-	5.8	800
10.	Essoum	1,200	-	22.0	2,100

D. Unit Prices

1. Using Private Contractors

Using estimated contractor unit prices of $12.76/Cu.M. for supplying and placing compacted dike embankment, $ 20.00/Cu.M. for obtaining and placing laterite slope protection and $ 400.00/Cu.M. for supplying and

placing 350 kg. reinforced concrete, the costs for each item of work were computed. Additionally, a 20% contingency factor was applied to account for unforeseen items. A summary of the costs for each item of work at each site using contractor unit prices are presented in the following table:

Summary of Costs @ Contractor Unit Prices

No.	Name	Dike Fill ($000)	Laterite ($000)	R.C. Concrete ($000)	Berm Fill ($000)	Total ($000)
1.	Tanaff	18.8	11.9	4.9	68.9	104.5
2.	Samine Escale	28.0	25.6	4.9	149.3	207.8
3.	Kinndiri Medina	41.9	65.5	3.7	79.2	190.3
4.	Bounkiling	26.9	15.8	10.4	51.7	104.8
5.	Ndiama	27.3	15.8	9.3	37.7	90.1
6.	Mayor	9.2	-	5.3	23.9	38.3
7.	Diatok	27.9	23.1	4.9	14.9	70.8
8.	Balingore	169.4	102.4	3.4	47.1	322.3
9.	Djimande	26.0	-	2.8	12.2	41.0
10.	Essoum	18.4	-	10.6	32.2	61.2
				Total Cost		1,231.1

It is noted that the costs presented above for the Essoum site include four simple water retention dikes provided with control structures and the provision of contour berms over 50% of the service area. Feasibility studies which include a complete irrigation system have been carried out by BCEOM. The cost of that system was approximately $ 9,500/ha. This system was judged to be excessively expensive. A preliminary design of a less costly system has been prepared by the PP Team. The details of this system are provided in Appendix A10. The estimated costs per ha. for this scheme are in the range of $4,000/ha. This scheme was still judged to be excessively expensive and was later dropped.

2. Using Village Labor

If it is assumed that villagers carry out the placing and compaction of all dike and berm embankment and that contractors provide the embankment materials, place the laterite slope protection and construct the control structures, reduced costs will result. Assuming that it costs $2.00/Cu.M. to haul the dike/berm embankment and that a village laborer can place 0.5 cubic meters of embankment per day at a daily labor rate of $1.50, the resulting unit price for villager-placed dike embankment used was $5.00/Cu. M. The following table presents the resulting reduced costs:

Summary Costs Using Village Labor For Dike/Berm Embankment ($000)

Name	Dike Fill	Laterite	R.C. Concrete	Berm Fill	Total	Of which: Contract	Village
Tanaff	3.8	11.9	4.9	30.6	51.2	30.6	20.6
Samine Escale	3.8	25.6	4.9	65.4	99.7	58.2	41.5
Kinndiri Med.	12.8	65.5	3.7	34.8	116.8	88.2	28.6
Bounkiling	6.9	15.8	10.4	24.0	57.1	38.6	18.5
Ndiama	8.9	15.8	9.3	16.8	50.8	35.4	15.4
Mayor	3.6	-	5.3	7.2	16.1	9.6	6.5
Diatok	9.1	23.1	4.9	7.8	44.9	34.8	10.1
Balingore	62.8	102.4	3.4	22.2	190.8	139.8	51.0
Dijmande	10.2	-	2.8	4.8	17.8	8.8	9.0
Essoum	7.2	-	10.6	12.6	30.4	18.5	11.9
TOT.EST.COSTS:	$129.1	$260.1	$60.2	$226.2	$675.6	$462.5	$213.1

VI. SELECTION AND PRIORITIZATION OF ZONES OF INTERVENTION

Four zones of intervention were investigated by the PP Team. These zones were the Bignona Valley; the Baila Valley; the area between the Casamance River and the Soungroungrou near Sedhiou and an area south of the Casamance River upstream from Ziguinchor in the Sedhiou Department; and an area north of the Soungroungrou. These four areas described fell into four zones which can be described in the table presented below:

Zone	Description
Baila	Water retention dikes, minor salt water intrusion, lower rainfall
Bignona	Higher rainfall, serious saltwater intrusion problems.
Sedhiou	Higher rainfall, less saltwater intrusion problems.
Soungroungrou	Less rainfall, shorter history of saltwater intrusion problems, but current year-round hypersalinity.

The zones of intervention are prioritized as

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presented in the following table:

Zone	Priority
Sedhiou	1
Soungroungrou	2
Bignona	3
Baila	4

Within the four zones, 10 sites were visited as potential startup sites for the Southern Zone Water Management Project. The prioritization of the ten sites is presented in the following table:

Project Priority

Project	Zone	Priority
Tanaff	Sedhiou	1
Samine Escale	Sedhiou	2
Kinndiri Medina	Sedhiou	3
Bounkiling	Soungroungrou	4
Ndiama	Soungroungrou	5
Mayor	Soungroungrou	6
Diatok	Bignona	7
Balingore	Bignona	8
Djimande	Bignona	9
Essoum	Baila	10

VII. PRELIMINARY CONTRUCTION SPECIFICATIONS

A. Earthen Dikes

Anti-salt and water retention dikes shall be constructed of impervious clayey materials. The clayey material shall be placed in the dike embankment in layers of approximately six inches, 0.15 M., and in a moistened condition. Compaction shall be carried out by means of hand tampers and as a result of the four passes of construction vehicles over the dike embankment during construction. Mechanical compaction by the use of hand operated compactors is preferred. The anti-salt dikes shall have maximum side slopes of two horizontal to one vertical, a top width of two meters and a height of 0.8 meters. Water retention dikes and contour berms shall have a top width of one meter, 1 to 1 side slopes and a height of 0.5 meters. Laterite slope protection shall be provided for both the downstream and upstream slopes of anti-salt dikes when available, otherwise grass slope protection shall be provided.

B. Control Structures

Control structures for anti-salt and water retention dikes shall be constructed with 350 kg. class reinforced concrete. It is desirable that rock aggregate be used instead of sea shells in order to obtain the 350 kg. strength. Deformed reinforcing bars are preferred. Well-graded clean sand shall be used. The concrete shall be hand-mixed and tamped into place by hand. The water used shall be free of impurities. Wooden stop-logs shall be provided. Typical plans and sections for this structure along with backup for quantities and cost estimates are presented in Appendix B.

VIII. ILLUSTRATIVE MIX OF INFRASTRUCTURE

A typical mix of infrastructure would be the provision of an anti-salt dike at the downstream end of the basin across the mouth of the marigot that penetrates the basin. Approximately one-third of the way up the basin a water retention dike would be provided across the basin to insure an adequate depth of water to cultivate deep water rice. Two-thirds of the way up the basin another water retention dike would be provided. Over approximately one half of the gross service area, cross contour berms would be provided at constant intervals to harvest water, control overland flow and prevent erosion.

IX. OPERATION AND MAINTENANCE, ANTI-SALT SYSTEM

A. Operation

The operation of the anti-salt dike and control structure has the object of excluding salt water intrusion and reversing the salinization process that has taken place during the last decade due the fall in average rainfall. The operation of the system is also intended to keep potentially acid sulfate soils moist enough to avoid acidification and mineral toxicity problems. The greatest benefits will occur when the desalinization process is rapid, say three years. As the salinized land is being reclaimed, conflicts will arise amongst the farmers. Short-term benefits will occur when water is held behind the anti-salt dike. Whereas, long-term benefits will arise from evacuation of dissolved salts after they have been put into solution by yearly sweet rainwater. The farmers must decide which benefit is more valuable to them. Also operating rules will have to be adjusted to low rainfall and high rainfall years.

When completed, the anti-salt system shall consist of a well-compacted earthen dike and a number of reinforced concrete control structures provided with wooden stop-logs which will enable the farmers to regulate flows. The system will allow rainwater to be retained up to a height of 0.8 meters and will prevent excessive salt water intrusion.

It is proposed that the system described above be operated as follows:

When the rainy season commences, the stop-logs are placed into the control structure to prevent downstream salty water from entering the protected lands. This will allow rainwater to dilute the salts lying on the upstream land. At intervals during the rainy season the stop-logs should be withdrawn to allow the dissolved salts to flow out. The stop-log gates would be opened and closed in cycles to bring about flushing and filling. At the end of the rainy season the lands should be drained to the level of the high potential acid soils. Normally, it will take three years to achieve significant reclamation. When the stop-logs are closed the upstream water levels must be observed to insure that the dike is not overtopped. A gage should be installed to monitor water levels. If the water level becomes too high, the control structure will be used as a spillway. The stop-logs must be removed to prevent the dike from being overtopped. During the dry season, it will be desirable to allow some downstream-originating saltwater onto the thin strips of mangrove and potentially acid sulfate soils to prevent the excessive drying out of the soils and reduce excessive buildup of acidity.

The following critical dates should be established:

- closing date of control structure
- starting date for flushing of dissolved salts and the frequency
- maximum upstream and downstream water levels
- date of entry for downstream salty water

B. Maintenance

It is recommended that preventive maintenance be carried out every year after crops are harvested and village labor is available. After each wet season, breaches in the dike must be fully repaired. The control structure should be inspected to insure that excessive erosion is not occurring around the structure. Dike banks should be repaired where significant rivulet erosion has occurred. After a few years of operation, some of the wooden stop-logs may become warped or split, they should be replaced at this time. If excessive settlement or erosion occurs in the dike, it should be brought back to its original cross section. When repairs to the dike are carried out, the materials placed should be clayey and properly compacted.

Contour berms will require periodic maintenance. This can be done with hand tools and hand tampers. The land and contour berms can be graded and shaped with discs and tractors.

It is proposed that a minimum of 2% of the capital cost of the anti-salt system be allocated by the farmers for annual preventive maintenance. It is also proposed that the farmers at each site be provided with some of the hand tampers, shovels, hand picks and wheel barrows used during construction to use for dike embankment repairs.

X. TRAINING NEEDS

A. Technicians

Technicians assigned to the project by the Government of Senegal will have the chance to get extensive on-the-job training by working with the TA Team. In addition, the TA Team will periodically hold workshops for technicians in various fields which will be identified by the TA Team. These workshops could cover such items as survey, design, construction supervision, agronomy, soil science, sociology, operation and maintenance, budgeting, planning and project monitoring. A small number of technicians could be selected for further training overseas. Short courses for technicians are also available in adjacent countries in West Africa.

B. Farmers

Farmers will require training in construction, operation and maintenance of the proposed systems and assistance in setting up water user's groups and improved agriculture and farming practices. The training could be in the form of workshops, on-the-job training and observation tours for key farmers.

C. PCVS

PCVs that are assigned to the project should have prior experience in the field of construction. In addition they can gain on-the-job training by working with the TA Team, and at the same time by participating in workshops in the same fields as mentioned above for in-country technicians.

XI. STAFF REQUIREMENTS-ENGINEERING

It is proposed that the implementation team be composed of members coming from four different sources, the Ministry of Rural Development (MRD), the Ministry of Hydraulics (MH), the TA Team (TA), and the US Peace Corps (PCV). The summary of those requirements are presented in the following table:

	MRD/MH	TA	PCV
Civil Engineers	4	1	2

It is proposed that two of the engineers from the MRD/MH be stationed in Sedhiou along with the two PCVs. It is proposed that the other

members be stationed in Ziguinchor. It is proposed that the TA Engineer be the Technical Chief of the TA Team.

The PCVs should have some construction experience and preferably they should be recently graduated Civil Engineers.

It is proposed that all of the staff be assigned to the project at the time of startup.

XII. APPLIED RESEARCH

Two existing anti-salt dams will offer areas for research into the effectiveness of large anti-salt dams. These two existing projects are Guidel and Affiniam.

At Affiniam, the operation of the system was started this year. The dam has had success in its first season of operation in reducing salt-water intrusion, but at the same time it has allowed the removal of excess water from the basin above the dam with the accompanying increase in acidification of soils that were already highly affected. The result has been that one of the subprojects contemplated for inclusion in the Southern Zone Water Management Project, Balingore, appears very unattractive because of the lack of downslope tidal water. The operation of this dam would offer an excellent opportunity to determine the negative effects of operating the system.

At Guidel, ISRA has already started operating this anti-salt system as a research project. This research should be continued. The SWZM Project should stay abreast of this research in order to better design the anti-salt systems proposed for that project.

When the first project anti-salt dikes are completed, records should be kept to determine effectiveness of the systems.

XIII. EVALUATION

It will be very important to establish baseline existing conditions before the start of the project so that changes in data such as water quality and crops production recorded during the life of the project can be evaluated to determine the impact of the project. To accurately evaluate the project results thorough and careful record keeping will be necessary. It is important that all data to be monitored be identified early in the project so that a complete set of information is available to carry out periodic evaluations.

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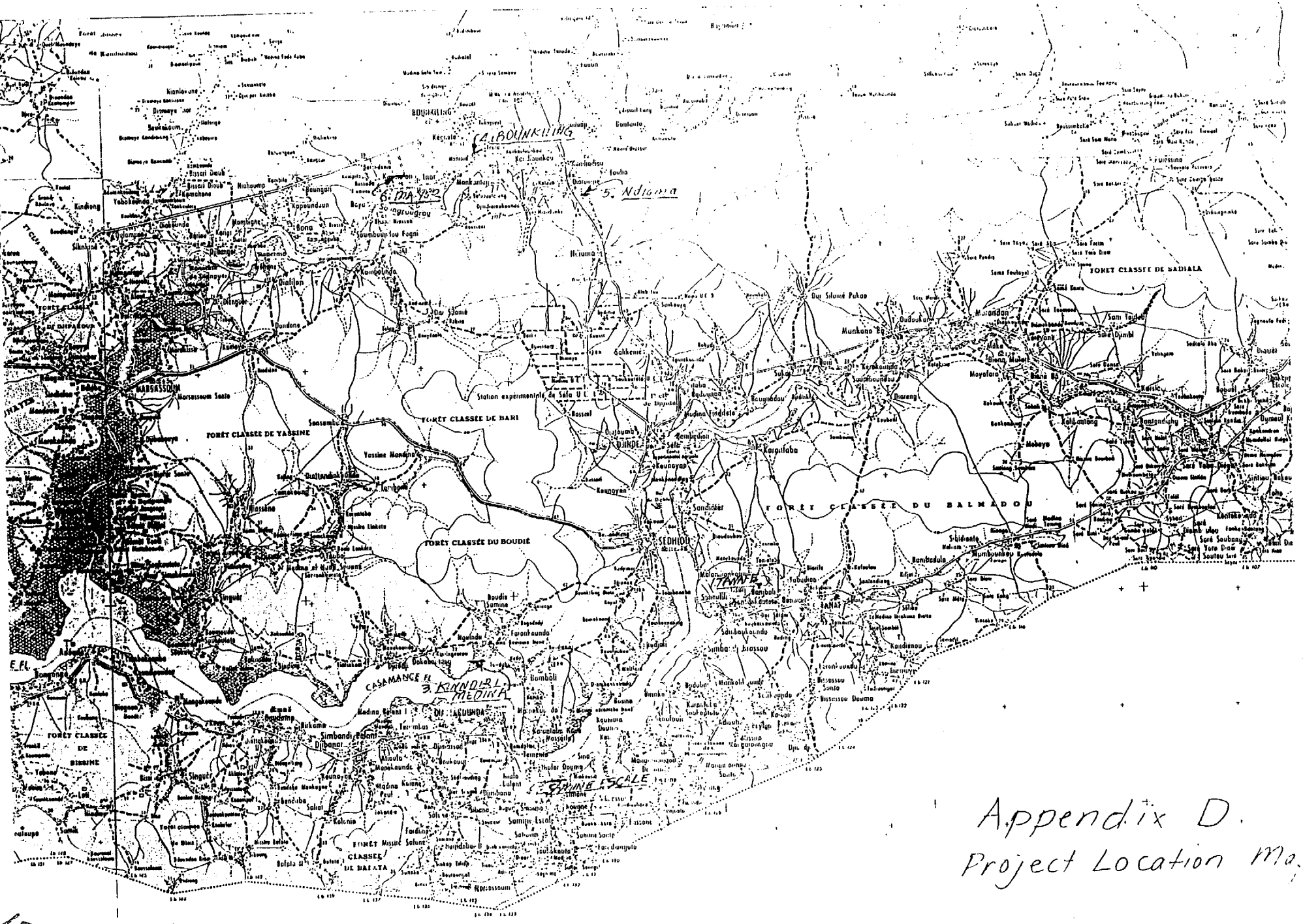

Appendix D.
Project Location Ma

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SOUTHERN ZONE WATER MANAGEMENT

PROJECT PAPER

AGRONOMIC AND WATER MANAGEMENT

PRACTICES ANNEX

DONALD HUMPAL
Associate
Development Alternatives, Inc.

FOR USAID/DAKAR

DECEMBER 15, 1987

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AGRONOMIC AND WATER MANAGEMENT PRACTICES ANNEX

Field visits were made in August-September, 1987 and again in November 1987 to examine cropping patterns and production practices, to examine crop condition, and to study with the soil scientist the factors conditioning potential land protection and land recovery. Discussions were held with farmers, Department of Agriculture staff, researchers from ISRA and ORSTOM, and staff of development projects and rural development authorities (RDA's). The field studies were combined with analysis of prior project experience and research work to produce the following synthesis.

I. EXISTING CROPPING PATTERNS, CROPPING SYSTEMS AND CROP PRODUCTIVITY

A. Cropping Patterns

The PID and Prefeasibility Study describe the cropping patterns in the five zones of project intervention. Table 1 provides a summary of these cropping patterns.

TABLE 1. CROPPING PATTERNS BY PROJECT INTERVENTION ZONE
(% Area Cultivated by Crop on an Average Farm)

	INTERVENTION ZONE				
	SEDHIOU	SOUNGROUGROU	BAILA	BIGNONA	KOLDA
Rice	21 %	16 %	13 %	21 %	2 %
Peanuts	40 %	46 %	53 %	66 %	14 %
Maize	15 %	7 %	7 %	7 %	20 %
Millet	18 %	31 %	23 %	<1 %	15 %
Sorghum	6 %	N/A	4 %	N/A	34 %
Cowpeas/ Other	N/A	N/A	N/A	6 %	N/A
Cotton	N/A	N/A	N/A	N/A	15 %

While these figures are indicative, they do reflect observable patterns of land use in the five zones. The drier zones of the Soungrougrou, Baila, and Kolda have the highest percentages of drought resistant millet and sorghum. Rice has its greatest representation in the wetter areas of Bignona and Sedhiou. Maize cultivation is more widespread where there is a favorable growing environment. A long period of intensive extension and development

project effort has been devoted to this crop in Sedhiou and Kolda. The peanut cash crop which dominates four of the zones is replaced by cotton in the area of intensive SODEFITEX extension and marketing effort around Kolda.

B. Cropping Systems

Cropping systems have been described in detail in the lower Casamance by ISRA and others. Less detailed studies have been made of cropping systems in the middle and upper Casamance. Key factors in the current characteristics of cropping systems are: the decline in average annual rainfall; the sexual division of labor by crop and landscape type; the proportion of land and other resources devoted to lowland and upland production; the use of animal traction; the proportion of cash crop production; and access to inputs and credit.

Declining rainfall has led farmers to increase their planting of short-cycle crop varieties as a means of avoiding drought stress in the uplands and the salinity problems in the lowlands. The move in many areas from transplanted rice to direct seeded rice has been accompanied by other changes, e.g., a greater weed challenge, exposure to iron toxicity in the groundwater zones, the need to alter water retention microstructures to conserve water on previously wet terraces. The increased salinity has led farmers to move rice production onto higher and sandier terraces once occupied by peanuts and upland cereals. On these areas, the growing season has been shortened by the low water-holding capacity of the soil, and yields reduced due to low soil fertility.

The two dominant patterns of sexual division of labor are described in detail in the Social Soundness Analysis in Annex G.4. In the Diola system, men till the rice fields and women carry out the bulk of the cropping practices. The added labor, power and use of heavier tools used permit both deeper land preparation and the construction of more solid ridges around rice parcels. In the Mandinka system, women do all land preparation and crop operations, men work only on upland crops. Land preparation is done with a light swinging hoe, and little soil is used to form ridges. Ridges are also formed later in the season when women weed. In some cases ridges are not formed at all. Instead, the women make small 0.8 m diameter depressions to hold water, leach salts, and provide an oxidized zone to protect roots from high iron concentrations. The Mandinka system allocates less labor at critical land preparation and weeding periods. It reduces investment of labor in water management and constrains timeliness of cropping practices, reducing potential yields in all but the well-watered and non-saline valleys.

As the valley lands have been lost to salt intrusion and acidification, the proportion of upland to lowland areas cropped has increased. Productivity on the uplands is lower because of lower soil fertility and generally low to moderate water-holding capacity. Cropping systems have had to change to accomodate these problems. As in the lowland areas, the drier conditions have led generally to the use of shorter cycle varieties. The weed challenge is strong in the uplands, requiring heavier labor input. Weeds also reduce both water and nutrient availability to crop

plants. Staggered planting dates and intercropping reduce peak labor requirements for land preparation and weeding. Intercropping of sorghum/millet and corn reduces mid and late season weeding requirements. These practices also spread the risk of crop failure across planting dates and crops. These strategies are employed throughout the Casamance River Basin. As the Social Soundness and Economic Annexes point out, they are employed to secure a subsistence level of food in an environment of decreased land availability and increased weather variability.

Animal traction is a factor directly affecting both field size and timing of operations. It is more widely used in Mandinka, Mandinka-ized Diola, and Fula fields. Upland crop land is plowed and planted with animal drawn equipment. Subsequent operations are done by hand. The exception is the limited areas of cotton, which are hilled up using moldboard plows and, occasionally, ridgers. The expansion of planted surface area in zones where animal traction is used is probably constrained by available weeding labor. Animal traction programs have always found it difficult to extend the use of weeding equipment because of the greater effort needed to train both animals and drivers; the potential to damage crops if animals and equipment are not carefully-guided; the additional investment costs and three to four year period of negative cash flows which result; and, the poor performance of many of the early designs of weeding tools which were adapted from tractor drawn equipment. Animal traction is little used in rice production apart from areas of intensive extension effort in direct seeding of rice in northern Bignona and the Baila valleys. Some plowing for transplanted rice is done in the area around Marsassoum in the Sedhiou department, the only case seen where bulls were working in water.

The cropping systems are also shaped by the proportion of cash crops in the mix. As Table 1 indicates, peanuts are by far the most important cash crop. PP Team discussions in the sample areas showed, however, that this cash crop is grown to enable farmers to buy rice, their cereal of preference. The large proportion of peanuts in the cropping pattern is largely a result of the high official buying price and input subsidies, which have, up until quite recently, provided exceptional incentives to product peanuts. Economic analysis (Annex G.2.) shows that land, labor and capital have probably been overallocated to this crop. But, the peanut plant is very well suited to the drier zones of the Casamance uplands. It is relatively drought tolerant, and it produces a portion of its own nitrogen needs through symbiotic fixation. In Kolda, cotton plays a central role in that area's cropping. It is solely a cash crop, as it can be sold only to one buyer, SODEFITEX. But, it brings with it an intensive program of extension, input supply, and input use supervision. As in the case of oilseeds, natural fibers are also part of a highly competitive world marketplace.

It should be noted that peanuts and cotton have been the principal carriers of agricultural technology in the Casamance. Both crops have had intensive research, extension, and are part of a well-articulated structure linked to the industrial sector. The plows, planters, carts and weeding equipment manufactured in Senegal were developed for these crops. The development of the fertilizer industry in Senegal was based in large part on

the requirements of these crops. The related needs for agricultural chemicals support a plant protection industry. And, large parts of the agricultural research network, infrastructural and human, owe their existence to the programs devised to support these crops. Cropping systems seen in the Casamance have been greatly affected by these programs. Their productivity, if not their economic efficiency, has been tied to the large network of supporting services surrounding these crops. On a smaller scale, the same was true for rice, up until the time that the Senegal River Basin became the major site for investment in this crop.

The supporting structures for the cash crops are undergoing radical transformation under the NAP. The short-term effect is to decrease the access of farmers to inputs which have traditionally arrived at their farms under very concessional terms. The Southern Zone Water Management Project will operate in a greatly different support service and input supply environment. Cropping systems will change during the project through direct action by the project to protect and reclaim land and to increase water supply to crops. Indirectly, the project will rely on the supply of services and inputs to the farming population that invests in water control infrastructure.

C. Crop Productivity

Crop productivity varies widely from year to year and from farm to farm. The level of variability intrinsic to the shift in environmental conditions makes it difficult to establish average cases. Table 2 gives a rough approximation of average yields as reported by previous studies and by the Department of Agriculture.

Table 2. AVERAGE YIELDS OF CROPS BY INTERVENTION ZONE (MT/HA)

	INTERVENTION ZONE				
CROP	SEDHIOU	SOUNGROUGROU	BAILA	BIGNONA	KOLDA
Rice	1.2	1.6	2.6	.4-2.9	0.8
Peanuts	1.4	1.2	1.1	.4-1.0	1.0
Maize	1.5	1.5	1.0	.6-1.0	1.1
Millet	0.8	1.5	0.6	.4	1.0
Sorghum	1.3	1.5	0.4	--	1.0
Cowpeas/ Other	--	--	--	.2	--
Cotton	--	--	--	--	1.1

Sources: Fall et al, 1986; Harza, 1984; Kolda Region Agricultural Inspection; Berger, Coyne et Bellier, 1985.

Rice yields are the average figures from aquatic and groundwater rice. Upland rice yield averages are less than 0.7 MT/ha. It should be noted that many of the team's interviews with farmers showed that rice yields were currently in the 0.4 to 0.7 MT/ha range. These low yields are due to salinity, positions of fields on the sandy slopes, and water stress. ISRA farming systems team data for Bignona show the range in yields encountered. The spread in rice yield levels is large, but to be expected when the crop is grown across a diverse set of soil conditions as a transplanted and a direct seeded crop. All rice crops in the Casamance start as rainfed rice with low or no water control. While early season drought stress will not directly have a major effect on crop yield, blast disease infection develops rapidly in many seed beds. This is a problem both for transplant nurseries and direct seeded fields. In both direct seeded and transplanted areas, variability in yields is high because of relatively great differences across short distances in desalting rates and in flooding regimes and, therefore, in dissolving, accumulation and precipitation of toxic ions of aluminum and iron. Besides this spatial source of variability, the variability in seasonal distribution of rainfall also leads to a larger spread in yields.

II. ANTICIPATED CHANGES IN CROPPING PATTERNS, CROPPING SYSTEMS AND PRODUCTIVITY WITH IMPROVED WATER CONTROL

Changes in cropping patterns, cropping systems, and productivity levels will depend on the rate of infrastructure development, the rate at which salinized lands are desalted, the rate at which already acidified soils are reclaimed, and the year-to-year reliability of water supply to anti-salt dikes and retention structures.

A. Cropping Patterns

The Social Soundness (G.4.) and Economic (G.2.) Analyses Annexes describe the anticipated changes in cropping patterns which will occur when valley lands are recovered and the reliability of operation of the anti-salt dikes and retention structures are demonstrated. Recovery of valley land and anticipated declines in producer prices for peanuts over the next few years will lead to a marked restructuring of cropping pattern in the Diola areas. The importance of upland crop production will diminish. A smaller portion of effort will be devoted to peanut production with some decline in millet and sorghum production. Corn, the upland crop most sensitive to the low fertility status of the upland soils, may be reduced to very small surface areas, particularly if the need increases for land near houses for transplant nurseries. To the extent that cash cropping is reduced, it is conceivable that farmer ability to pay for inputs will decline in the Diola areas. In the Mandinka and Mandinka-ized systems, women will reduce their efforts to grow upland crops. The cropping of the same or similar upland areas before and after valley protection and recovery should help improve farmers ability to pay for inputs as food needs are met from valley rice production.

B. The shifts in cropping systems will be important ones as valley lands are recovered. In the initial period after anti-salt dike construction, farmers will allocate labor to move ridges toward the water course to impound

water. The shortest cycle rice varieties will be planted where residual salinity exists. These will generally be transplanted crops. As salinity drops the farmers should be able to plant these lands earlier, permitting a switch to longer cycle transplanted varieties in the deeper water areas. The groundwater zones on the sandier terraces will be maintained in direct seeded rice for the most part. In the areas behind upstream retention dikes, taller and longer rice crop varieties will be transplanted along the watercourse; the higher land planted in shorter cycle varieties of medium straw length. Local varieties, old introductions from the 1960's, and new varieties are available for the range of flooded and unflooded conditions.

One of the chief problems facing farmers in the recovered valleys and upstream retention sites will be weeds. Labor requirements for weeding rice lands will increase. There are a large number of aquatic weeds of the Cyperaceae family which are removed as part of land preparation for transplanting along with flooding tolerant grasses (Echinochloa sp.). The Diola system uses male labor to remove these weeds quickly with the Cajando. The Mandinka system relies on women to use small swinging hoes for land preparation, slowing land preparation and leaving substantial amounts of roots and rhizomes which resprout and require additional weeding effort.

Farmers can control aerobic weeds in the lower part of the landscape if they can maintain a more constant depth of water across their parcels. Such an approach will require more closely spaced contour or rectangular ridges, and in more sloping areas, some land levelling. This is not likely to be a priority for farmers until a higher degree of water control is achieved and lowland parcels are recovered, a process of from three to five years duration. In many watersheds, this control can come from secondary works such as contour berms to divert early season rainfall to retention structures in the valleys. Early season flooding will control aerobic weed growth. In the upper part of the landscape where continuous flooding is not possible, it is unlikely that a herbicide strategy will be cost effective. The use of medium-to-long straw varieties with broad leaves, the current Brazilian and IRAT ideotypes for upland rice, may be the cheapest way to reduce weeding effort.

The Soils Annex (Annex G.1.c.) describes the soils of the valleys, the degree of salt and acidity problems, soil use, and management alternatives. As the soils with slight and moderate salt and acidity problems are reclaimed over a two to four year period, there will also be some improvement, further ripening and leaching of the areas of already acidified soils. Farmers will attempt to recover these lands when the upper part of the soil profile loses its toxic properties and is recolonized by halophytes and grasses. By this time, the applied research activities of the project should have sorted out the major financially viable options for accelerated recovery of these soils. The management of soil amendments and microbasins and drainage works would result in important shifts in labor and capital allocations. It is likely that these shifts would not occur without external assistance.

In the areas where animal traction is important, e.g., the Baila Valley, valleys subjacent to the Sefa plateau, and the Kolda department, animal traction has the technical potential to play an important role in valley farming. PIDAC ran a program concentrating on direct planting using plows and row planters to establish the rice crop in non-salt affected valleys. This practice enables farmers to compress their land preparation and planting effort. In areas with shallow slopes, animal-drawm moldboard plows and ridgers could be used to make small contour ridges in the upper catchment. A third use may be in plowing land after early rains to accelerate the dissolving and flushing of salts from the salinized lands. While these are potentially important changes in cropping systems, they do conflict with the need for upland crop land preparation and seeding. It is likely that animal traction use in the rice lands will continue to be a very small part of the cropping systems in the project area.

C. Crop Productivity

After protection and recovery from salinity rice crop productivity should increase. A global increase to a yield of 2 MT/ha should be acheivable over most of the recovered land without substantial additional inputs. In the retention sites it should be possible to move average rice yields to a level of about 2.5 t/ha with better water control. With additional inputs of fertilizer an average yield of 3 to 3.5 tons per hectare could be achieved. Additional improvements in varieties and plant protection might push the yield figure to 4 MT/ha, but this level of cropping intensity would require an input supply and credit support system that is in the future.

III. ESTIMATION OF SURFACE AREA AND RATES OF RECOVERY OF POTENTIALLY RECOVERABLE LAND THROUGH IMPROVED WATER CONTROL

The Soils Annex (Annex G.1.c.) gives the results of field studies at the ten sample sites studied by the PP team. It was the conclusion of the soil studies that all soils other than the Mangrove Soils could be reclaimed and used for agricultural purposes. However, as a practical matter, the costs and time required to rehabilitate the already acidified soils and the management problems posed by the potentially highly acid and saline soils places these soil groups outside the development purview of the project. The reclamation or management of the potentially highly acid and highly saline soils and the already acidified and salinized soils will be part of the applied research program to be financed by the project. Table 3 presents the PP team's estimation of the time and rates of soil recovery due to project interventions at the ten sample sites.

Table 3. ESTIMATION OF TIME AND RATES OF SOIL RECOVERY

Sedhiou Zone (3 sites)	Surface Area (ha.)	Current Used	Surface Recoverable	Time to Recovery
Non-Salt/ Non-Acid Soils	493	70 %	Improve Water Supply	0
Slightly Salt/ Acid Soils	472	20 %	All	1-2 Yrs
Moderately Salt/ Acid Soils	423		All	1-3 Yrs
High Salt/Acid Soils	201		None	Keep Wet
Acidified Soils	@ 196		Half	4-12 Yrs
Mangrove Soils	154		None	Keep Wet

Soungrougrou Zone (3 sites)	Surface Area (ha.)	Current Used	Surface Recoverable	Time to Recovery
Non-Salt/ Non-Acid Soils	354	70 %	Improve	0
Slightly Salt/ Acid Soils	97	20 %	All	1-2 Yrs
Moderately Salt/ Acid Soils	81		All	1-3 Yrs
High Salt/Acid Soils	28		None	Keep Wet
Acidified Soils	103		Half	4-12 Yrs
Mangrove Soils	39		None	Keep Wet

Baila Zone (1 site)	Surface Area (ha.)	Current Used	Surface Recoverable	Time to Recovery
Non-Salt/ Non-Acid Soils	127	20 %	Improve Water Supply	0
Slightly Salt/ Acid Soils	59	20%	Improve Water Supply	1 Yr
Moderately Salt/ Acid Soils	N/A		All	1-3 Yrs
High Salt/Acid Soils	N/A		0	Keep Wet
Acidified Soils	N/A		Half	4-12 Yrs
Mangrove Soils	N/A		0	Keep Wet

Bignona Zone (3 sites)	Surface Area (ha.)	Current Used	Surface Recoverable	Time to Recover
Non-Salt/ Non-Acid Soils	94	70 %	Improve	
Slightly Salt/ Acid Soils	82	20 %	All	1-2 Yrs
Moderately Salt/ Acid Soils	26		All	1-3 Yrs
High Salt/Acid Soils	77		Will Acidify 1988	Keep Wet
Acidified Soils	148		Half	4-12 Yrs
Mangrove Soils	79		May Acidify 1988	Keep Wet

At least one of the nine sites studied should be dropped from the list as a potential SZWM site. This site is Balingor in the Bignona valley. Much of this site will require a long reclamation period, the existing potentially highly acid soil will probably go acid in 1988 because of Affiniam dam operations, the proposed dike is too long for the surface area to be recovered, and the local population does not appear to have sufficient labor to carry out dike construction. Diatok is another site which may be dropped

off the list due to Affinam dam operations. Upstream dikes may not be permitted to operate as retention structures in the Bignona Valley, making their construction a moot point until operating rules change.

Estimation of the amount of land throughout the Lower and Middle Casmance which is potentially recoverable needs careful study. The PP team used existing studies by ORSTOM, ISRA, Harza, and soil and land use maps, combined with their field visits and soils analyses to make an assessment of the total amount of land potentially recuperable through improved water control. Table 4 presents the team's estimates.

Table 4. ESTIMATED SURFACE AREA FOR RECOVERY AND/OR IMPROVED WATER SUPPLY IN THE LOWER AND MIDDLE CASAMANCE BASIN

Sub-Basin.	Estimated Recoverable Improvable (ha)	Now in Crops (ha)
Bignona	6,800	2,800
Baila	8,000	1,600
Soungrougrou	12,590	2,000
Sedhiou	12,000	3,600
Kolda	3,000	600
Total	42,390	10,600

These estimates are considered to be reasonable by the team. Additional areas may have their water control improved, without investments in anti-salt structures, but these sites are in Kolda and Velingara Departments. They are less densely populated and have higher rates of erosion than other parts of the project area. The implementation team will need to carry out further analysis of these sites in the second year of the project to decide if the project should eventually move into these zones.

It is important to note that reclamation of salinized lands has become increasingly difficult since 1983 when the annual cycle of fresh water flushing of salts out to sea to reduce the salt concentration of the Casamance and its tributaries to less than seawater stopped. Since 1983 the Casamance and its tributaries have been saltier than seawater year round. The lowered rainfall has also led to oxidation and acidification of soils, creating a more widespread area of tannes nues. Final rates of land reclamation will depend on the rainfall amount, the effort expended by the population to protect and reclaim land, and the within-season distribution of rainfall.

IV. SCENARIOS FOR CROP PRODUCTION ON DIFFERENT SOIL TYPES

A. Non-Saline Valleys and Soils

Structures will include retention dikes, ridging and side valley berms for water accumulation and diversion. The first steps will be the addition of rice land as water supply becomes more regular up and down the toposequence. Peanut production in the upper watershed may decline in Diola areas and perhaps Mandinka areas depending on peanut prices. In the lower part of the toposequence, transplanting will probably replace the direct seeding that dominates the drier valleys. Direct planting can be maintained by terracing the slopes of the valleys, but the flat terrain and slight slopes reduce the advantages of this approach. Rice intensification will occur if inputs are available. Likely intensification moves would be some return of longer cycle varieties, fertilization, mechanical weed control, if a hand-pushed rotary weeder is perfected for Senegalese conditions, and plant protection.

B. Slightly Acid to Moderately Acid and Salinized Soils

These soils can be recovered and productivity increased through the diking of parcels. The individual paddies formed can then be used to collect rainwater and flush out salts. Rice plants require a rooting depth of about 30 cm which has a soil extract electrical conductivity of less than about 10 mmohms/cm. Using the Diola approach of ridging soils, the slightly to moderately acid soils can be used for rice production within one to three years. Farmers will probably continue to use short-cycle varieties on these soils to avoid the early season peak of acidity, iron, and aluminum toxicity. Farmers may move to longer cycle varieties after four or five years as carry-over salt levels drop, and if varieties tolerant to high aluminum and iron are introduced. Crop yields can be substantially improved up to a practical average level of 3.5 -4 tons/ha if fertilization or liming is practiced. Phosphate fertilization may be the most cost effective way to increase yields if acidity levels are not too high.

C. Acidified Cat Clays

While desalting these soils will not be difficult, ultimate recovery of these highly acid soils is dependent on the length of time that they have been oxidized and acidified and the subsequent rate of leaching of jarosite minerals below the 50 cm level. While about half of the soils studied in the field are approaching this point, the best management practice may be to avoid any further investment in them until vegetation begins to re-establish itself. When these signs of recovery begin to take place, the reclamation process may be hastened by liming or heavy phosphate fertilization. The project will await additional research results including an economic analysis of returns from soil reclamation efforts before attempting extension of these techniques with farmers.

D. Upland Soils

These soils are not subject to salt intrusion or intense acidification, but they have low soil fertility status and, in some cases, are subject to erosion.

Standard management approaches for these soils are: to promote contour plowing of the upland soils, particularly with peanuts; to reduce competition for water, nutrients and light by improving weeding practice, particularly with animal drawn weeders; to plant tree bands on the slopes; and to fertilize soils to increase the yields and the amount of crop trash which can be fed to animals or left as a soil cover.

V. COMPLEMENTARY INPUT SUPPLY SITUATION AND OUTLOOK

A. Seeds

The seed supply situation in the Kolda and Zinguinchor regions is generally poor. The historical exceptions have been cotton and peanut seed, and more recently, maize seed. Cotton seed will continue to be supplied by SODEFITEX. Peanut seed multiplication has been done through contract multipliers supervised by the regional agricultural services, but seed storage and distribution has been under the control of SONACOS, the processing and marketing parastatal. Maize seed is supplied to cooperating farmers of the German-assisted maize production project.

The Chinese rice missions, and a series of other projects have introduced rice varieties. These projects date from the mid-1960's when BDPA and SATEC worked in the Sedhiou area. Other projects include PRS I and II, SODAGRI efforts first at Sefa, then in the Anambe basin, SOMIVAC and PIDAC, among others.

Farmers generally use the same rice varieties today as they did 20 years ago. Their major change in choice of varieties has been to drop the longer cycle aquatic and groundwater rice varieties. The women indicated that if water supply improved they would switch back to some of the longer cycle varieties. There are reservoirs of the traditional varieties which are maintained in several of the better watered valleys.

Farmers store their own rice seed or obtain it in exchanges with other farmers. When asked if they would use new varieties, they responded that they would if the varieties were better than those currently used. No one interviewed outside the ISRA research area or the PIDAC intensive extension area has seen a recent demonstration of new rice varieties.

The USAID-financed Agricultural Production Support (APS) project will support the development of private sector seed multiplication and distribution. Breeder seed and quality control for foundation seed will be provided by ISRA. Private seed companies and contract seed growers are then supposed to bulk up and distribute certified seed. To be effective in efforts

in Ziguinchor and Kolda, APS will have to coordinate its efforts in seed supply with those of the DERBAC and PRIMOCA projects, which will assist farmers to obtain seed.

B. Fertilizer

Fertilization or manuring would be beneficial on nearly all project area soils. The upland soils are very poorly supplied in nitrogen and suffer from low levels of phosphates. Micronutrients are deficient on the coarser textured sandy soils. The lowland soils are generally better supplied in nutrients than those of the uplands, but the vast majority of soils are generally poorly supplied with nitrogen and phosphorus. Potassium deficiencies are present in many rice fields.

Important yield improvements can be made with fertilizer applications in relatively small quantities. Figure 1 shows the response to increasing levels of fertilization of five rice varieties as studied by ISRA. All fertilizer levels applied were well-below the level needed to maximize production. They lie on the linear portion of the fertilizer response curve, where marginal returns to investment are highest.

Figures 2 and 3 show that, when the rice crop is well-fertilized, there is a significant yield increase with increased water supply. The results shown are from nearly 50 multiple site trials conducted in the 1970s.

C. Agricultural Chemicals

Agricultural chemicals are in extremely short supply in the Ziguinchor and Kolda regions. The major sources of supply in the past were the Rural Development Agencies, development projects, and emergency pest control programs. As the RDAs have withdrawn from direct involvement in plant protection supply, the availability of insecticides and herbicides has been reduced. SODEFITEX is still a major supplier of herbicides, fungicides, and insecticides, but only for its cotton growers.

The regional inspectorates of agriculture receive a quota of plant protection chemicals which are further subdivided into quotas for the departmental services. The departmental service retains a portion of this quota for targeted application against grasshoppers and blister beetles. The remainder is divided into quotas for the Rural Expansion Centers and distributed. There is little flexibility in this system. The timing and amount of chemicals delivered and applied bear little relationship to actual crop protection needs. The national campaigns produce a higher level of coordinated effort.

Except for a few small suppliers of insecticides and fungicides for vegetable producers in Ziguinchor and Kolda, no private sector supply of plant protection materials was found.

Figure 1. Rice Yield Response

to Fertilizer Levels

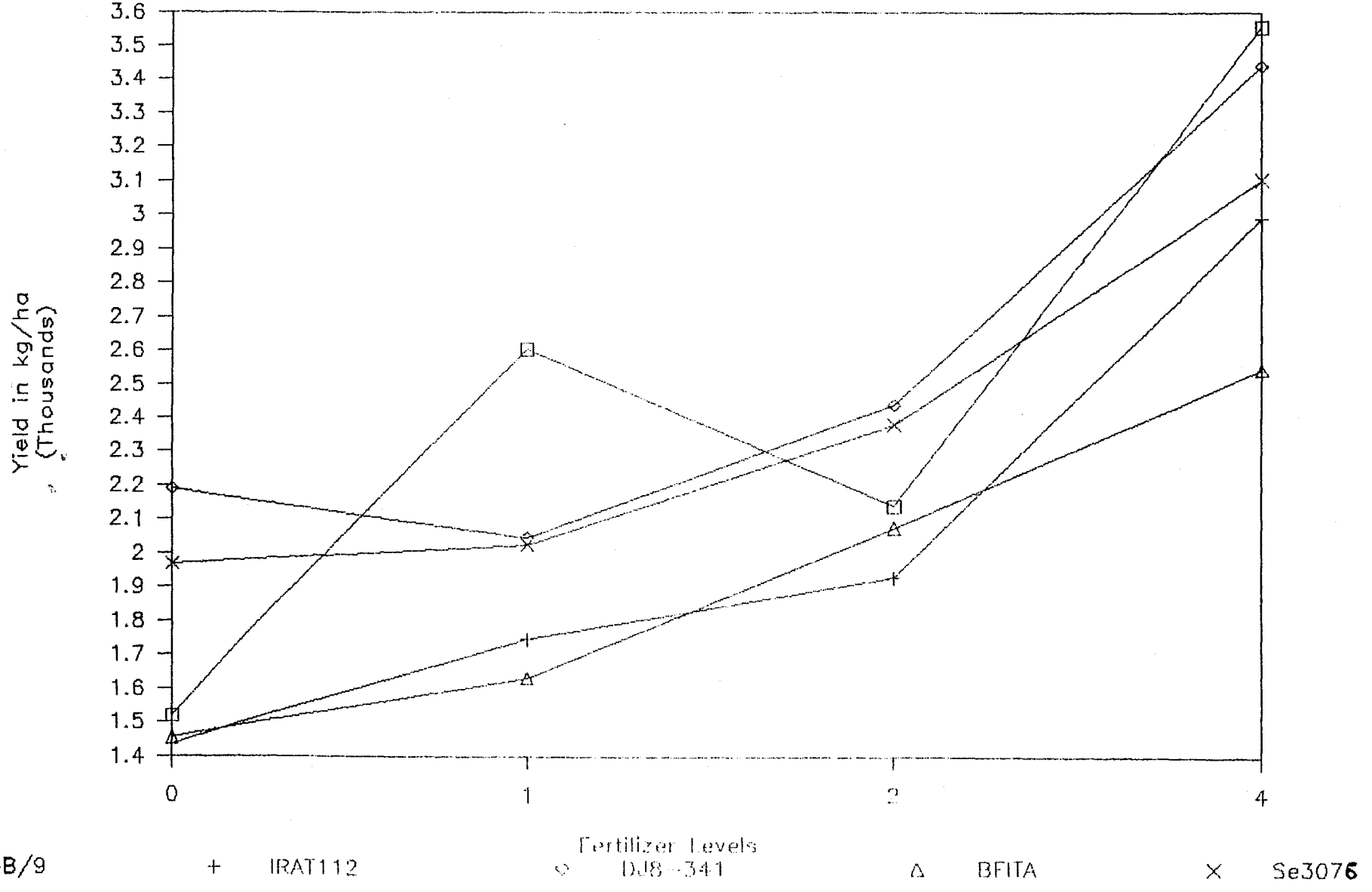

Figure2. Comparison of IKP and 63/83

at Different Rainfall Levels (mm)

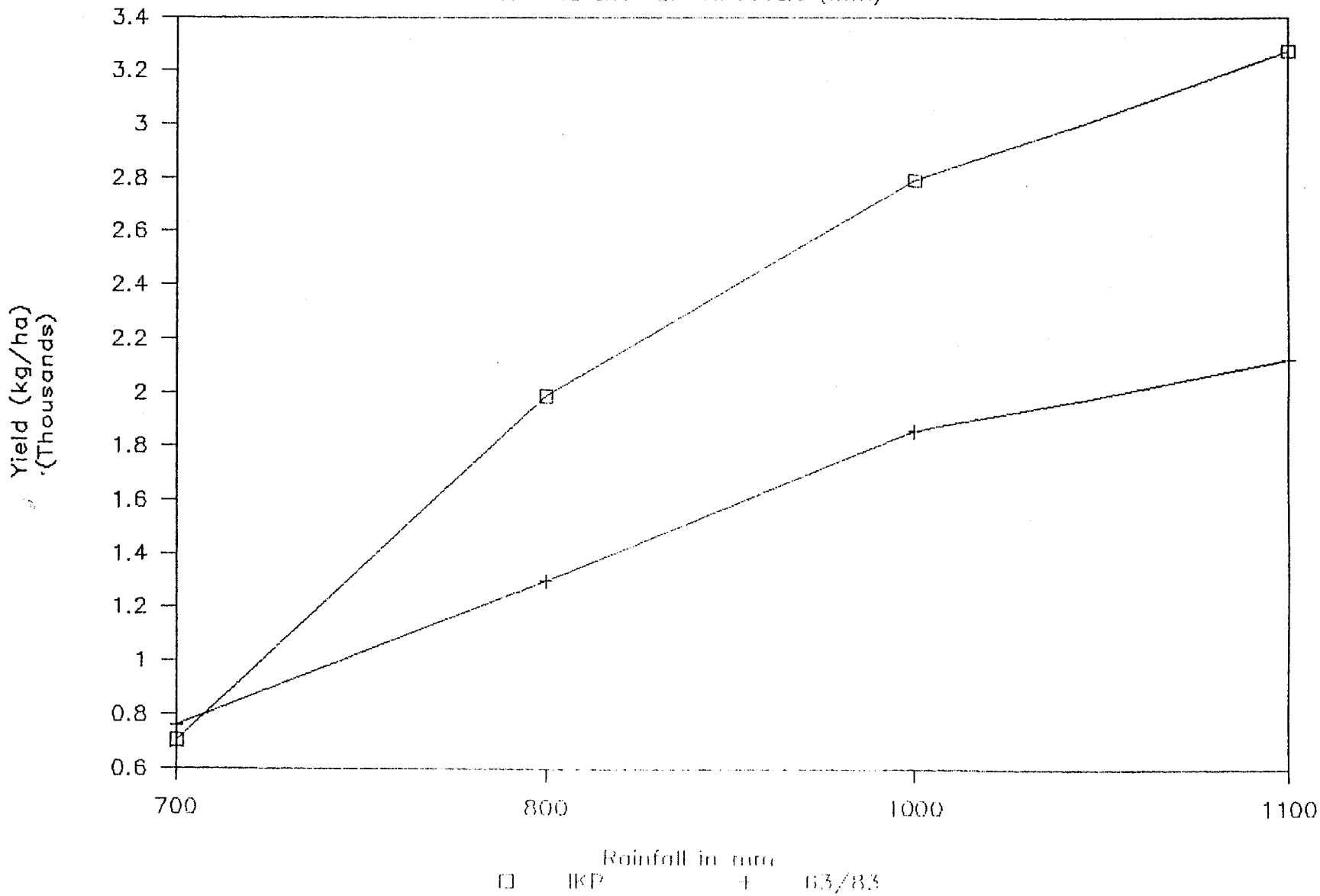

Figure 3. Comparison of IKP and TS123

at Different Rainfall Levels (mm)

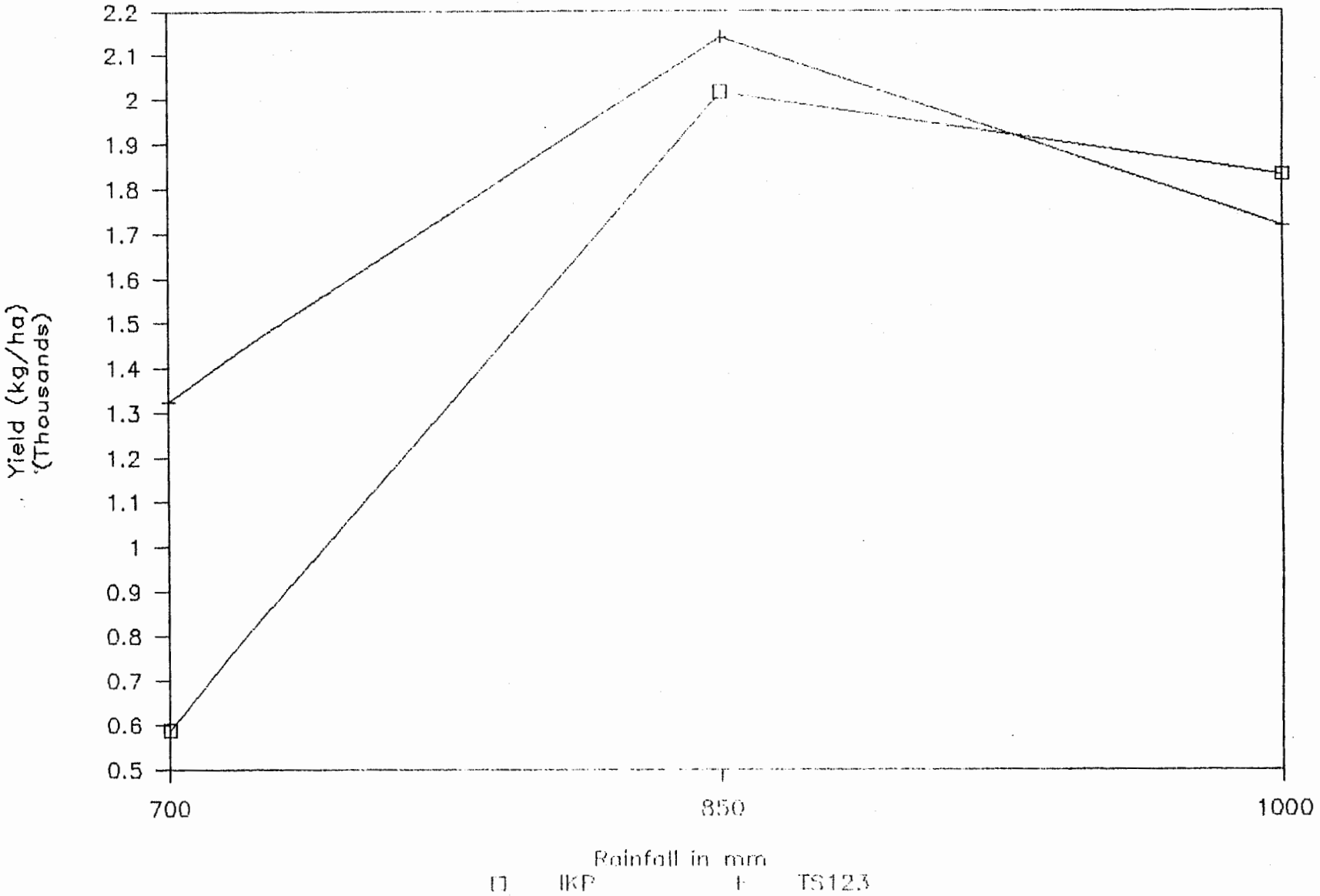

Table 5. Rice Yield Response to Fertilizer Levels

Fertilizer Level	Rice Variety Yields in Kg/Ha				
	144B/9	IRAT-112	DJ8-341	BARAFITA	Se3076
0	1517	1434	2190	1453	1968
1	2603	1745	2044	1631	2025
2	2139	1929	2438	2075	2380
4	3555	2990	3441	2545	3104

Source:Mbodj et al, 1985.

0 = ON, OP, OK
1 = 21 KG N, 9KG P205, 13.5KG K20
2 = 2 X A1
4 = 4 X A1

Table 6. Comparison of Yields of I Kong Pao and 63/83 at Different Rainfall Amounts (Kg/ha)

Rainfall (mm)	IKP	63/69
700	703	758
800	1988	1298
1000	2792	1858
1100	3272	2124

Results of 35 local site trials run between 1967-72 in the Casamance. Source: Magne, 1973.

Table 7. Comparison of Yields of I Kong Pao and TS123 at Different Rainfall Amounts (Kg/ha)

Rainfall (mm)	IKP	TS123
700	587	1324
850	2016	2141
1000	1830	1717

Results of 21 local site trials run between 1967-72 in the Casamance. Source: Magne, 1973.

D. Conclusions

The SZWMP is not intended to support input supply to farmers. It will increase farmer access to more fertile valley soils and improve water supply on the valley terraces. While there will be substantial return from improved water control, full benefits will depend on the development of input supply systems. The current level of private sector supply of inputs is negligeable. In the very near-term this supply is likely to come from other donor-assisted projects and in the medium-term from increased private sector sources.

VI. ADAPTIVE RESEARCH

A. Overview

Agricultural research programs in the Casamance have most recently been reviewed by Posner (1985) in an ISRA publication. The focus of much of the early research in the historical Casamance Region began in Sefa near Sedhiou on the Sefa plateau. Originally established in 1947 to accompany an estate development scheme, it was taken over by IRAT in 1960. Substantial research on plateau soils, soil conservation, agroclimatology, general agronomy, plant improvement, and livestock production had been done by that time. In 1967, Djibelor was established as a major sub-station to Sefa, becoming the principal regional station in 1975 under ISRA. The small staff at Sefa now conduct little research other than meteorological data collection. The other major active research station in the region is located near Kolda and concentrates on agropastoral research.

The Djibelor station manages the applied research efforts for the natural region of the Casamance. It is the major historical center for rice research in Senegal. USAID assisted ISRA to build up a strong farming systems program there, which is now managed entirely by Senegalese researchers.

ISRA has developed regional program objectives in support of national policy directives. In July 1987, ISRA released its overall strategy and program orientation for the Casamance. Eight programs were identified:

- Water Management and Infrastructure Development
- Soil Fertility and Bioclimatology
- Rice Improvement and Intensification
- Farming Systems Research
- Production Economics
- Agricultural Mechanization for the Casamance
- Casamance Fisheries
- Inventory and Improvement of Forest Resources

The first three of these programs contain projects which treat directly the main technical problems faced by the project.

B. Water Control and Water Management Infrastructure

This program is based in Djibelor. It works only in the Lower Casamance. Its primary actions are:

- o management of water behind the Guidel and Katoure anti-salt dams;
- o the study of approaches to valley development and techniques of desalting at Guidel and Katoure;
- o socioeconomic study of water control structures;
- o study of the impact of water control structures on the environment; and
- o a sub-region wide inventory of natural resources in developed bolongs.

The objectives of the program are to establish a typology of bolongs and watersheds behind dikes, establish maps of land use and constraints to improved land use, establish an operating model for the dams, to propose an approach to secondary water control works behind anti-salt structures, evaluate the socioeconomic factors which influence the success of dikes for production purposes, and evaluate the environmental changes brought about by the works.

The research programs have resulted in a better understanding of the surface water and shallow groundwater table dynamics and water quality. They have demonstrated that salinization and acidification have dramatically altered the natural environment of the small valleys. They have also demonstrated that anti-salt dikes are esssential if further salinization is to be avoided. Perhaps the key general observation is that upstream works are necessary if anti-salt dikes are to function efficiently in reclaiming salinized lands.

ISRA and ORSTOM are currently cooperating on a study of the monitoring of undeveloped and developed valleys to determine what the effects of existing anti-salt and upstream retention structures are on recovery from salinization; whether dikes have a significant effect on the bordering shallow aquifers; and, how small dikes need to be managed to increase recovery rates. A recent paper by Boivin and Lebrusq (1985) points out that, in their study zone, the mangrove zones have been essentially lost to rice production from hypersalinization and mangroves have been reduced to a minor component of the landscape. Secondly, the major areas of high potential acidity have for the most part, already gone acid. Thirdly, the dominant problem on the non-acid soils is salt. These results are entirely consistent with the observations of

the field team. Three recommendations for water control are made:

- to build an anti-salt dike near the mouth of the marigot to prevent further salt intrusion. Dike location is recommended at the juncture between the highly acid soils and the point at which the marigot widens to become dominated by mangrove soils.

- upstream development using either cross-valley dikes or contour ridging to hold as much rainwater and runoff as possible on the upper terraces of the valley to accelerate their desalting.

- subsequent ridging and draining of the oxidized and acidified soils to reduce salt concentration and transfer of salts by groundwater to the higher terraces.

Key issues remaining to be studied for this type of valley are the design and placement of dikes, ridges and drains, their sequencing, and their effectiveness in normal, wet, and dry years.

It is recommended that the SZWMP establish a contract with ISRA to support an extension of their current work on small dams and the impact on land recovery and management, as well as the environmental montoring program described in the environmental analysis (Annex H). USAID financing will be used for research to be carried on in the Middle Casamance, as well as for the regional studies described in the IEE Amendment and Environmental Analysis. The AFDB will support much of the Lower Casamance research on these questions. USAID will provide a complementary amount for the middle Casamance.

A summary of the major research needs of the SZWMP project includes:

- watershed dynamics, runoff, interception, and groundwater links;

- water balance;

- salt balance;

- desalinization rates;

- physical characteristics and electrochemical characteristics of surface and groundwater;

- analysis of technical and economic characteristics of the small dams;

- analysis of the organization and management by farmers of small dams;

- technical and economic evaluation of secondary and tertiary works; and

- monitoring of the O&M of the Affinian anti-salt structure.

C. Fertilization of Soils and Bioclimatology

1. Overview

This program is based in Djibelor. It concentrates on finding substitutes for mineral nitrogen sources using biological nitrogen fixers, experimenting with water control techniques to avoid iron and aluminum toxicity as well as using local soil amendments, using high phosphate content gypsum to reduce aluminum toxicity, and the use of NP fertilizer and rice straw to maintain macronutrient supply, the search for the right blend of organic and mineral fertilizer for upland and lowland crops, and the collection and analysis of agroclimatic data in collaboration with the AGRHYMET program.

2. Research on Saline, Acid Land Reclamation

There has been at least 20 years of research into the reclamation and management of salinized, potentially acid sulfate and acid sulfate soils in the lower Casamance. There have also been some medium-scale attempts to try to carry out experimental land reclamation on an applied scale, most notably in trials managed by ILACO.

The studies and trials have indicated that soils can be reclaimed and that they can be managed to produce substantial yields of rice. But, there has not been the sustained effort to define potential rates of reclamation, water management norms, and crop and soil management practices needed to maintain reclaimed lands in stable production.

The sub-humid nature of the salinized bolongs and mangrove areas along the Casamance makes it essential that the solutions advanced for land reclamation be simple and robust ones, capable of withstanding important swings in water supply without causing acidification of potential cat clays. To date no one has found an economic solution that farmers, or technicians, can manage consistently. Current ISRA monitoring work is helping to describe the dynamics of wet year and dry year management of water behind anti-salt dikes, but guidelines for operating the structures to optimize surface area and season length available for cultivation are still very rough.

ISRA has begun to study the effects of land preparation procedures on salt and acidity status of soils. They have shown that practices need to be adapted to the soils of the valley terraces, and that year to year variation in water supply requires that secondary works be put in place if land preparation and cropping practices are to affect salt status of the soils. Phosphate and potash fertilization has been shown to have a beneficial effect on soil acidity, as well as crop yields, but the research is away from being able to be submitted to economic analysis for extension purposes.

Trials for the past 15 years in the Casamance have shown that all crops show significant responses to fertilizer applications under a wide variety of rainfall regimes. It can be safely concluded that nutrients are major limiting factors on the plateau soils and many of the nonsalinized

valley soils of the Kolda and Ziguinchor. The applied research challenge is to find the forms and quantities of fertilizing elements that will generate financial returns enabling the farmers to purchase and use them. ISRA has been conducting trials on this problem for the past several years. They have found that fertilizer doses that produce yields falling on the linear portion of the fertilizer response curve provide optimal returns to farmers.

Organic amendments have shown some effectiveness in rice fields. Part of the response to heavy manuring may be due to the calcium and phosphate contents of the manure. It should be noted, however, that very little of the regions' surface area could be fertilized with manure. Research in other locations has shown that equivalents of from 6 to 60 tons/ha of manure are needed to maintain soil fertility and organic matter content as well as more concentrated fertilizers. Some work has been done using organic amendments such as neem seed cake to retard detrification of urea fertilizer with some promising results.

SZWMP should support land reclamation and fertilization research as well as combined testing of water control and land preparation practices to accelerate land recovery.

D. Crop Improvement and Agronomic Research

Rice, peanuts, cotton, and corn have each been the subject of intensive crop improvement and agronomic research. As in other parts of the world, the search has generally been for shorter cycle, daylight insensitive varieties, with good fertility response, pest and disease resistance. This overall orientation has served the Casamance reasonably well. Historically, multiple site testing of advanced breeding lines and stable varieties was widespread in the Casamance. The shorter cycle varieties have been retained by farmers faced by declining rainfall and increased drought and salt stress in rice fields.

ISRA Djibelor has proposed a set of rice varieties for each part of the toposequence from upland to deeply flooded rice. But, these varieties have not made it into the hands of farmers. This points out the need for an applied research-development linkage. There is a need for extensive multiple site testing of stable varieties which can be evaluated and adopted, perhaps even multiplied by farmers. Farmers have stayed loyal to shorter cycle varieties and local varieties which are under their control, reducing the risk of mixed varieties or weed contaminated varieties being delivered to them.

Trials on rice, peanuts, maize and cotton have shown the sensitivity of these crops to delays in weeding after planting. On-station studies by ISRA have shown that yields of direct seeded rainfed rice may decline by half when only one weeding is done six weeks after planting. The applied research challenge is to find ways of controlling weeds on upland soils which do not increase labor requirements and can be paid for by the returns from increased yields. Herbicides, hand weeders, and animal drawn weeders are being tested by ISRA Djibelor.

E. Farming Systems Research

The Farming Systems Research team has been working intensively in the Lower Casamance to describe farming systems, to run technology orientation trials, and to develop technology for transfer to farmers. Their extensive documentation is too complicated to summarize here, but it is important to underline a theme which runs through the classification of their farming systems zones and their work to define production dynamics and farmers' choice of techologies. Labor stands out as the major constraint to both extension of surface area cultivated and to intensification of production without external inputs. Sometimes this constraint is due to the sexual division of work tasks, sometimes it is due to the sexual division in crop production practices, and sometimes it is due to peak labor demands across several crops falling at the same time.

The adaptive research challenge is to improve returns to land with technologies which also demand low marginal increases or net decreases in labor requirements. Doing this within the capital availabiilty of smallholders is the second part of this challenge.

F. Applied Research Proposals

These proposals are presented as a recapitulation of the challenges research faces which were identified above:

- sustained long-term effort to define potential rates of reclamation, water management norms, and crop and soil management practices needed to maintain reclaimed lands in stable production;
- guidelines for operating the anti-salt structures to optimize surface area and season length available for cultivation;
- extensive multiple site testing of stable varieties which can be evaluated and adopted, perhaps even multiplied by farmers;
- find the forms and quantities of fertilizing elements that will generate financial returns enabling the farmer to purchase and use it;
- find ways of controlling weeds on upland soils that do not increase labor requirements and can be paid for by the returns from increased yields; and
- improve returns to land with technologies which also demand low marginal increases or net decreases in labor requirements, and do this within the capital availabiilty of smallholders.

SOUTHERN ZONE WATER MANAGEMENT

PROJECT PAPER

SOILS ANNEX

JAMES A. BROWN
Certified Professional Soil Scientist

Development Alternatives, Inc.

FOR USAID/DAKAR

DECEMBER 15, 1987

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VII.	CROP YIELD RESPONSE
VIII.	RECLAMATION RATES

SOUTHERN ZONE WATER MANAGEMENT SOILS ANNEX

I. TECHNICAL APPROACH

In order for the soil scientist to accomplish the soil-related tasks outlined for the project plan it was necessary for him to complete three general tasks. They were: (1) site visits of each of the ten selected watershed basins, (2) soil testing analysis and evaluation of such from each basin, and (3) the compilation of a planimetric map for each of the basins. After these three tasks were completed, soil and water management concerns could then be addressed, such as recommendations for reclamation of the acid and salt affected soils and the development of fertilizer recommendations.

A. Site Visits

The soil scientist's first activity during each site visit was to locate and define the basin limits and the three major soil groups within the basin itself. The major soil groups being the saline soils of the mangroves (symbol M), the soils that have become sterile as a result of extensive acidification and salinization (symbol A), and the soils which have the potential for acidification and salinization (symbol P). The potentially acid and saline soils were also further defined in accordance to their degree of potential acidity and salinity.

After orientation at the site on the relationship of each of the basic soil groups to the landscape, the soil scientist selected representative areas of each soil group. Typical pedon descriptions and soil samples were obtained from these areas. Along with this data and sample collection, soil boundaries were then plotted on a field overlay in order to permit their later compilation onto each planimetric map. U. S. National Cooperative Soil Survey Standards (NCSS) were followed for the soil sampling and mapping activities.

It was necessary to make all basin site visits with the team's engineer to correlate his input. This allowed the team the ability to establish the limits of the affected areas in each basin, and to determine the feasibility of each proposed structure.

B. Soil Testing

Soil testing was performed by the soil scientist for all samples collected from the typical pedons of each basin. The goals of these tests were to determine the amount and extent of acidification and salinization in each of the major soil groups, and in the degrees of these two conditions within the potentially acid and saline group.

Determination was made of the amounts of total dissolved salts, total sulfates, total sulfides, total sulfur, and total potential acidity from

typical pedons of each of the following soil groups:

M - Mangrove saline soils

A - Acid and saline soils

P - Potentially acid and saline soils
  h - with high potential
  m - with moderate potential
  s - with slight potential

In addition to these determinations, tests were also conducted to determine the amount of total dissolved salts present from all other samples collected from each basin.

The amount of total dissolved salts (TDS) was determined using electrical conductivity (ECe) method from 1:5 soil extracts. The Hach Model 44600 Conductivity/TDS Meter was utilized for these analyses. Total dissolved salts were determined in grams per liter (g/L) and then converted to percent for reporting purposes.

Another necessary requirement was to determine the amount and level of accumulation of sulfur in each of the three major soil groups. Extracts were prepared from the typical pedon samples of each soil group in order to determine the presence of sulfate. In addition, extracts were also prepared for total sulfides (S--) determination, total sulfur (S) determination, and total potential acidity.

The analysis of the extracts for sulfates, sulfides, and sulfur was accomplished using the Hach DR 100 Colorimeter Model 41100-19. All readings were given in milligrams per liter (mg/L) and then converted to parts per million (PPM) for reporting purposes.

Determination of total sulfides and sulfur outside of a well-equipped laboratory is very difficult. However, field analyses were performed by preparing an additional sample. This sample was first subjected to accelerated sulfur oxidation by titration with hydrogen peroxide (H_2O_2), before undergoing the normal extraction process using distilled water. Readings of sulfides and total sulfur were expressed in sulfate form and then calculated from conversions relative to the elemental formula weight of sulfur.

Total potential acidity was also determined from part of the aforementioned extract. This was performed by titration utilizing given normalities of sodium hydroxide (NaOH).

These results were then given in milli-equivalents per 100 grams of soil (meq/100g) for reporting purposes.

C. Planimetric Map Production

Planimetric maps of each of the ten watershed basins were

prepared utilizing available soils maps, hydrologic maps, and/or topographic maps as a base.

Where possible, the maps were compiled at a scale of 1:20,000. However, due to the unavailability of suitable base maps, and the size of the basins themselves, some of the basins were compiled at either a scale of approximately 1:25,000 or approximately 1:50,000.

The aforementioned major soil groups were plotted on these maps. In addition, the subgroupings of the potentially acid and saline soils were also identified on these maps. As a result, the project plan team was able to determine the distribution and calculate the extent of acidification and salinization intensity in each basin.

Contours could not be plotted since this data was not available below elevation of 20 meters mean sea level, and in some cases, elevation data below 40 meters mean sea level were not available. The only other alternative in obtaining such information would be that of utilizing a survey team for an extensive geodetic survey of each basin.

D. Development of Reclamation Recommendations

Reclamation recommendations were developed after all field work and laboratory testing were completed. The recommendations are also a result of collaboration with the tropical agronomist, and a search of existing soil and hydrologic data and documentation. Additional information was obtained from interviews with specialists from other organizations working on rice land acidification and salinization problems in the Casamance basin.

E. Development of Fertilizer Recommendations

These recommendations were primarily developed based on specific requirements (as a result of tests conducted during this field study and the studies of others) to offset the continued or potential acidification and salinization of the soils evaluated.

Since emphasis is mostly on acidification, methods whereby the affected soils might be somewhat neutralized were explored. This approach was evaluated taking into consideration the availability of fertilizer and soil amendments in the project area.

As in the case of the reclamation recommendations, this interpretation included input from specialists of other organizations who have knowledge and experience in the use of both currently available commercial fertilizers and alternative fertilizer amendments for this region.

II. EVALUATIONS OF SOIL GROUPS

The following sections describe and evaluate the major soil groups of the valleys in the Casamance basin using the U.S. Soil Taxonomy

classification system.

A. M -- Mangrove Saline Soils

The Mangrove soils occur along the drainage ways and in depressional areas of the watershed basins. The greatest amount of the soils on this particular landform position of the landscape are in the taxonomic subgroup classification of Fabric Terric Troposaprists. However, some areas immediately adjacent to and, in some cases, in the bolongs themselves will classify as Hemic Troposaprists. The latter soils contain more raw, partly decomposed plant fiber and other organic material. They also lack the gray clayey mineral soil that occurs within the upper meter of soil depth of the Fabric Terric subgroup. They make up a minor part of the total area covered by the mangrove saline soil group.

Soils of this group remain saturated with saltwater throughout most of the year. These soils are highly saline with a large amount of sulfides. Despite their high sulfide levels, they have not undergone extensive acidification because of their water saturated, reduced state.

Typical Pedon:

OA1 0 to 12 centimeters, black (N 2/0) muck; approximately 30 percent by volume of dark red (2.5YR 3/6) fabric material; structureless; very friable; pH 6.2; gradual wavy boundary.

(sample no. 1M1)

OA2 12 to 40 centimeters, black (10YR 2/1) peaty muck; approximately 45 percent by volume of dark red (2.5YR 3/6) fabric material; very weak coarse columnar structure parting to structureless; friable; pH 5.8; gradual irregular boundary.
(sample no. 1M2)

Cg1 40 to 88 centimeters, stratified layers of black (10YR 2/1) muck and very dark gray (10YR 3/1) clay; common medium prominent yellowish red (5YR 4/6) mottles; massive; very firm; pH 5.6; diffuse irregular boundary.
(sample no. 1M3)

Cg2 88 to 120 centimeters, very dark grayish brown (10YR 3/2) highly organic silty clay; few medium prominent yellowish red (5YR 5/8) and common fine distinct brownish yellow (10YR 6/6) mottles; massive very firm; pH 5.0.
(sample no. 1M4)

B. A -- Acid and Saline Soils.

The acid saline soils primarily occur on broad flats within the basin and adjacent to the saline (but non-acid) Mangrove soils. The soils

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which occupy this position in the landscape are predominantly in the taxonomic subgroup classification of Typic Sulfaquepts.

These soils are frequently inundated with saltwater intrusion and have undergone extensive acidification to a point where most have become sterile. This is due to the moisture deficit during the dry season and, as a result, oxidation of sulfides.

Typical Pedon:

Ap 0 to 22 centimeters, very dark gray (10YR 3/1) silty clay; common medium prominent reddish brown (5YR 4/4) and few coarse distinct reddish yellow (7.5YR 6/8) mottles; weak medium subangular blocky structure parting to moderate medium granular structure; friable; few black (N 2/0) organic matter stains; pH 3.8; clear wavy boundary. (sample no. 1A1)

Bg 22 to 54 centimeters, gray (10YR 5/1) clay; common coarse prominent yellowish red (5YR 4/6) and common medium distinct brownish yellowish (10YR 6/8) mottles; weak coarse prismatic structure to massive; very firm; pH 2.8; gradual irregular boundary. (sample no. 1A2)

Cg1 54 to 76 centimeters, light gray (10YR 6/1) silty clay; many medium prominent yellowish red (5YR 4/6) and common medium distinct brownish yellow (10YR 6/6) mottles; massive; very firm; ph 2.6; diffuse irregular boundary. (sample no. 1A4)

Cg2 76 to 120 centimeters, equally mottled dark gray (10YR 4/1) and light gray (10YR 6/1) clay; few medium distinct brownish yellow (10YR 6/6) mottles; massive; very firm; pH 2.8. (sample no. 1A4)

C. Ph -- Soils With High Potential for Acidification and Salinization

These soils occupy broad flats and very low terraces along the drainage ways within the watershed basins. They are young undeveloped soils that remain saturated with saltwater most of the year, except for the period just prior to transplanting of rice.

The soils on this landform position are within the taxonomic subgroup classification of Typic Sulfaquents.

They contain a high amount of sulfides and salts within 50 centimeters of the surface. As a result, these soils will become extremely acid when allowed to dry for long periods, continuously over several years.

Typical Pedon:

Ap 0 to 22 centimeters, black (N 2/0) highly organic loam; very weak medium granular structure to structureless; very friable; few pockets of dark reddish brown (5YR 3/4) fabric material; pH 4.2; clear wavy boundary.
(sample no. 7P1)

Cg1 22 to 56 centimeters, very dark gray (10YR 3/1) silty clay; few medium distinct brownish yellow (10YR 6/8) and common fine prominent yellowish red (5YR 4/6) mottles; massive; firm; pH 4.6; diffuse irregular boundary (sample no. 7P2).

Cg2 56 to 72 centimeters, equally mottled gray (10YR 5/1) and pale brown (10YR 6/3) clay; few medium distinct brownish yellow (10YR 6/8), common medium prominent reddish brown (2.5YR 4/4) and many coarse prominent yellowish red (5YR

4/6) mottles; clay; massive very firm; pH 4.6; clear irregular boundary.
(sample no. 7P3)

2Cg 72 to 120 centimeters, light gray (10YR 6/1) clay; many coarse prominent yellowish red (5YR 5/6) and few medium faint gray (10YR 5/1) mottles; ;massive; very firm; pH 4.2.
(sample 7P4)

D. Pm -- Soils With Moderate Potential For Acidification and Salinization

These soils are on low terraces of the second bottom of the drainage basins, and on slightly higher broad interfluves between small drainage ways of the same basins. They are slightly developed at depths from below the surface layer to approximately 90 centimeters in depth. They have also undergone some oxidation of sulfides in the upper 50 centimeters of the soil depth.

The soils of this position are within the taxonomic subgroup classification of Sulfic Tropaquepts.

The ground (seasonal) water table fluctuates somewhat, but remains high throughout most of the year. As a result, they have a very low pH and iron sulfate (jarosite) mottles at least in the upper portion of the soil profile.

Typical Pedon:

Ap 0 to 16 centimeters, very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; friable; pH 4.0; clear smooth boundary.
(sample no. 9P1)

Bg1 16 to 48 centimeters, dark gray (10YR 4/1) clay loam; few medium distinct brownish yellow (10YR 6/8) and few medium prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; firm; pH 3.8; gradual wavy boundary.
(sample no. 9P2)

Bg2 48 to 80 centimeters, grayish brown (10YR 5/2) clay; few medium distinct light gray (10YR 7/1) and common medium prominent strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; very firm; pH 4.0; gradual irregular boundary.
(sample no. 9P3)

Bg3 80 to 102 centimeters, gray (10YR 6/1) clay; many coarse prominent yellowish red (5YR 5/8) mottles; very weak coarse subangular blocky structure to massive; very firm; pH 4.0; clear wavy boundary.

Cg 102 to 120 centimeters, light gray (10YR 7/2) loamy fine sand; many coarse distinct yellow (10YR 7/8) and common coarse prominent yellowish red (5YR 5/8) mottles; single grained to structureless; friable; pH 4.2.
(sample no. 9P4)

E. Ps -- Soils With Slight Potential for Acidification and Salinization

These soils are on mid-level terraces of the basin, and on low terraces along narrow drainage ways at the middle to upper reaches of the watershed basins.

They have more development than other soils within the watershed basins, and are within the taxonomic subgroup classification of Aeric Tropaquepts.

Typically the soils of this landform position in the landscape reflect a somewhat deeper ground (seasonal) water table, or shorter periods when the soil is saturated. Evidence is that they are not affected by salinization of the ground water table, but do receive surface inundation from saltwater intrusion.

Typical Pedon:

Ap 0 to 22 centimeters, brown (7.5YR 5/4) loam; few medium distinct dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; friable; pH 5.0; clear wavy boundary.
(sample no. 1P1)

Bw1 22 to 58 centimeters, strong brown (7.5YR 5/8) sandy clay; common coarse prominent grayish brown (10YR 5/2) mottles; weak coarse columnar structure parting to weak medium subangular blocky structure; very firm; pH 4.4; gradual irregular boundary.
(sample no. 1P2)

Bw2 58 to 78 centimeters, strong brown (7.5YR 5/8) clay; common medium prominent gray (10YR 5/1) mottles; weak coarse and medium subangular blocky structure; very firm; pH 4.4; gradual wavy boundary.
(sample no. 1P3)

Bg 78 to 120 centimeters, gray (10YR 5/1) sandy clay loam; few medium distinct brownish yellow (10YR 6/8) and common medium prominent strong brown (7.5YR 5/8) mottles; very weak fine subangular blocky structure to structureless; friable to firm; pH 4.6.
(sample no. 1P4)

F. Pal and Pa2 -- Soils With Slight Potential for Acidification

These two soil groups evaluated occur in the Djimande and the Essoum watershed basins and have not been affected by saltwater intrusion. As a result, the soils of both of these basins are not typical of soils found in the other eight watershed basins evaluated.

However, these soils do manifest evidence of probable acidification in future years, if placed into a situation of continued wetting and drying year after year, as is the current practice in rice culture. This practice, along with continued cultivation without proper fertilization, will greatly increase the probability of acidification due to the oxidation of iron and sulfides.

Since these two soil types were not found extensively in the other eight basins, a typical (or representative) pedon could not be selected. However, field evaluation and tests reveal that the majority of the soils within these two above mentioned basins should be within the taxonomic subgroup classification of Typic Tropaquepts for the soils identified as Pal and Vertic Tropaquepts for the Pa2 soils. The surface textures of these soils may vary greatly due to their landform position, as they receive alluvium deposition as a result of erosion.

III. SOIL TEST RESULTS

Results of the soil test are given in Table 1.

Table 1

TEST RESULTS

Sample No.	Depth cm.	TDS %	SO_4^{--}	S--	S	ACIDITY meq/100g
			--------PPM--------			
BALINGOR						
1M1	0-12	2.51	1450	2225	1225	6.88
1M2	12-40	2.06	2175	3000	1719	5.63
1M3	40-88	2.51	2125	12575	4900	5.56
1M4	88-120	2.50	2025	11526	4517	5.56
1A1	0-22	1.15	525	1650	725	11.25
1A2	22-54	1.78	1977	575	850	12.22
1A3	54-76	1.81	2075	1450	1175	13.33
1A4	76-120	1.94	2008	2343	1750	15.56
1P1	0-22	0.03	375	500	438	5.81
1P2	22-58	0.04	375	475	425	5.00
1P3	58-78	0.05	400	595	498	6.80
1P4	78-120	0.08	413	137	275	6.25
DJIMANDE						
2Pa1-1	0-20	0.004	---	---	---	---
2Pa1-2	20-50	0.011	---	---	---	---
2Pa1-3	50-75	0.007	---	---	---	---
2Pa1-4	75-120	0.007	---	---	---	---
2Pa2-1	0-20	0.003	---	---	---	---
2Pa2-2	20-50	0.015	---	---	---	---
2Pa2-3	50-75	0.016	---	---	---	---
2Pa2-4	75-120	0.013	---	---	---	---
SAMINE ESCALE						
3M1	0-22	0.89	---	---	---	---
3M2	22-50	1.19	---	---	---	---
3A1	0-18	1.15	---	---	---	---
3A2	18-50	0.50	---	---	---	---

Sample No.	Depth cm.	TDS %	SO_4^{--}	S--	S	ACIDITY meq/100g
			---------PPM---------			
3P1	0-20	0.02	---	---	---	---
3P2	20-50	0.07	---	---	---	---
MAYOR						
4M1	0-20	3.82	---	---	---	---
4M2	20-50	2.05	---	---	---	---
4A1	0-20	0.59	---	---	---	---
4A1	20-50	0.55	---	---	---	---
4P1	0-20	0.19	---	---	---	---
4P2	20-50	0.18	---	---	---	---
BOUNKILING						
5M1	0-24	0.62	---	---	---	---
5M2	24-50	0.89	---	---	---	---
5A1	0-18	0.96	---	---	---	---
5A2	18-50	1.01	---	---	---	---
5P1	0-22	0.09	---	---	---	---
5P2	22-50	0.07	---	---	---	---
DIATOK						
6M1	0-20	3.19	---	---	---	---
6M2	20-50	2.14	---	---	---	---
6A1	0-20	2.96	---	---	---	---
6A2	20-50	4.00	---	---	---	---
6P1	0-20	0.02	---	---	---	---
6P2	20-50	0.02	---	---	---	---
TANAFF						
7M1	0-20	1.19	---	---	---	---
7M2	20-50	2.52	---	---	---	---
7M3	50-75	2.12	---	---	---	---
7M4	75-120	1.82	---	---	---	---

Sample No.	Depth cm.	TDS %	SO_4--	S--	S	ACIDITY meq/100g
			---------PPM---------			
7A1	0-16	1.03	---	---	---	---
7A2	16-54	0.84	---	---	---	---
7A3	54-80	1.89	---	---	---	---
7A4	80-120	2.27	---	---	---	---
7P1	0-22	0.03	1163	1312	825	4.58
7P2	22-56	0.05	1285	1575	952	4.38
7P3	56-72	0.07	1425	1588	1104	4.16
7P4	72-120	0.09	1416	1791	1069	3.96
KINNDIRI MADINA						
8M1	0-20	2.07	---	---	---	---
8M2	20-50	0.92	---	---	---	---
8A1	0-20	1.12	---	---	---	---
8A2	20-50	0.90	---	---	---	---
8P1	0-20	0.01	---	---	---	---
8P2	20-50	0.01	---	---	---	---
N DIAMA AMONT						
9M1	0-20	3.01	---	---	---	---
9M2	20-50	3.40	---	---	---	---
9A1	0-20	6.07	---	---	---	---
9A2	20-50	3.00	---	---	---	---
9P1	0-16	0.99	375	544	306	4.58
9P2	16-48	0.18	325	521	282	5.00
9P3	48-80	0.13	413	737	383	5.00
9P4	80-120	0.14	438	578	339	5.63
ESSOUM						
10Pa1-1	0-20	0.005	163	---	---	---
10Pa1-2	20-50	0.010	62	---	---	---
10Pa2-1	0-20	0.010	105	---	---	---
10Pa2-2	20-50	0.025	307	---	---	---

Table 2

SURFACE AREA ESTIMATES OF REPRESENTATIVE WATERSHED BASINS EVALUATED

WATERSHED BASIN	SOIL GROUPS						
	MANGROVE	ACID	POTENTIALLY ACID AND SALINE				
NOT	SALINE	SALINE	HIGH	MODERATE	SLIGHT	AFFECTED	
	HECTARES						
BALINGOR	52	127	62	8	31	48	
						TOTAL AREA	= 328
BOUNKILING	11	38	10	36	48	208	
						TOTAL AREA	= 351
DIATOK	27	21	15	18	25	8	
	(water area = 5 hectares)					TOTAL AREA	= 119
KINNDIRI MADINA	51	48	36	69	94	217	
						TOTAL AREA	= 515
MAYOR	14	29	13	13	16	19	
						TOTAL AREA	= 104
N DIAMA AMONT	14	36	5	32	33	127	
						TOTAL AREA	= 247
SAMINE ESCALE	70	87	127	278	309	97	
						TOTAL AREA	= 972
TANAF	33	61	38	76	69	179	
						TOTAL AREA	= 476

Table 3

SURFACE AREA ESTIMATES
OF
NON-REPRESENTATIVE WATERSHED BASINS EVALUATED

WATERSHED BASIN	SOIL GROUPS WITH PROBABLE POTENTIAL ACIDIFICATION ONLY		NOT AFFECTED	
	VERY SLIGHT	SLIGHT		
	HECTARES			
DJIMANDE	21	5	38	
			TOTAL AREA	= 64
ESSOUM	127	59	00	
			TOTAL AREA	= 186

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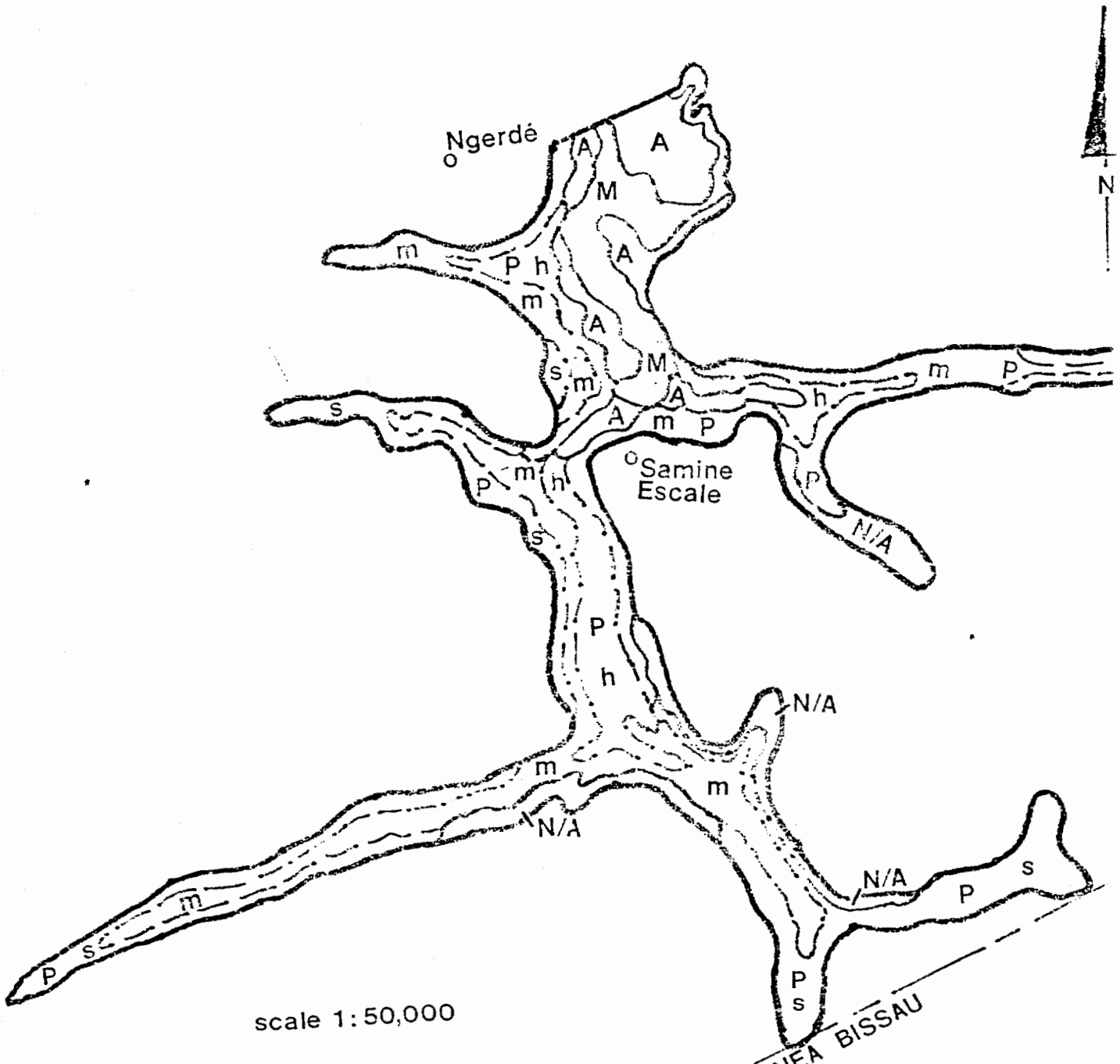
LEGEND

SOILS MAPS

M	=	Mangrove soils
A	=	Acidified soils
N/A	=	Not affected soils
Ps	=	Slight potential for acidity
Pm	=	Medium potential for acidity
Ph	=	High potential for acidity
Pa1	=	Not salt affected but with slight potential for acidity
Pa2	=	Not salt affected but with medium potential for acidity

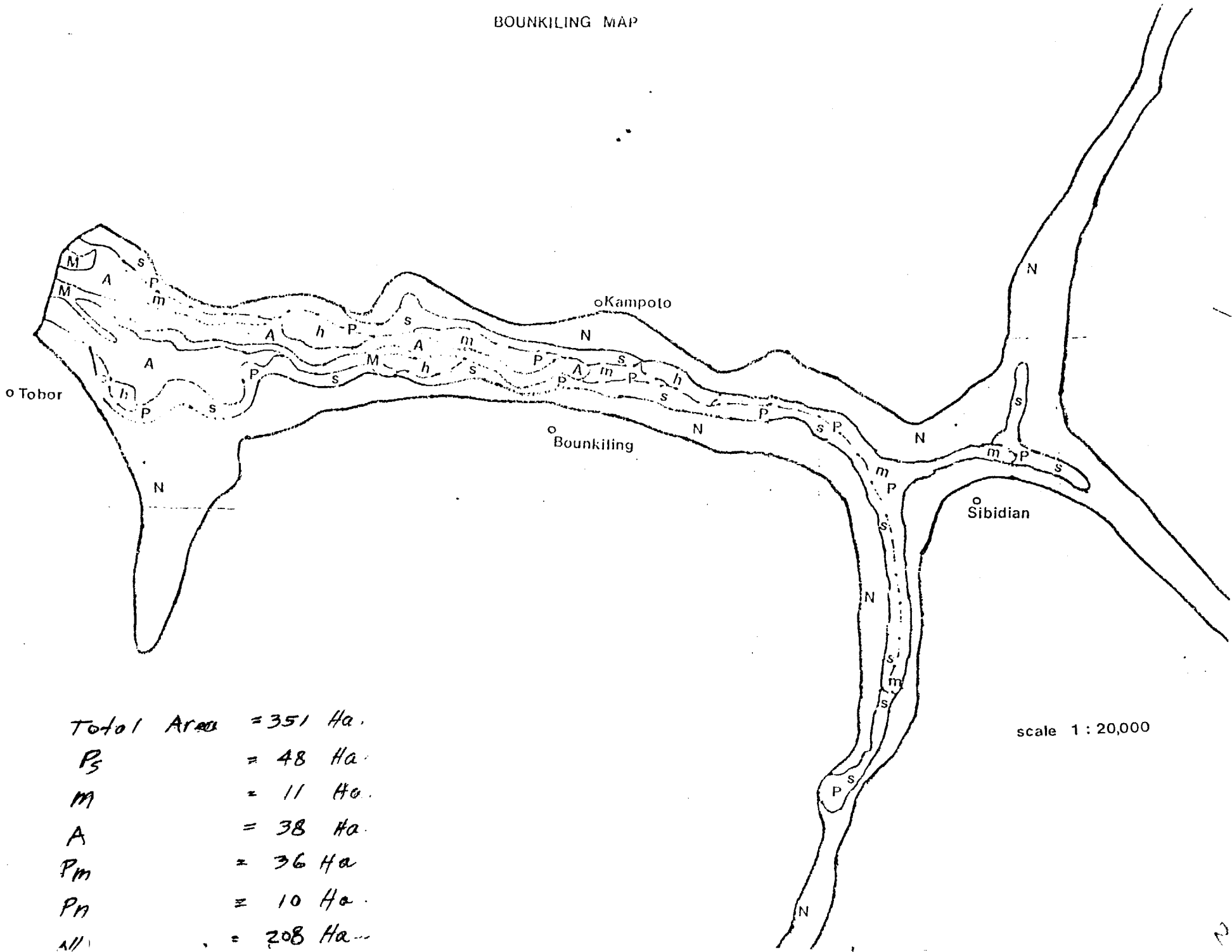
SAMINE ESCALE MAP



Total Area = 972 Ha.
N/A = 97 Ha.
M = 74 Ha.
A = 87 Ha.
Ps = 309 Ha.
Pm = 278 Ha.

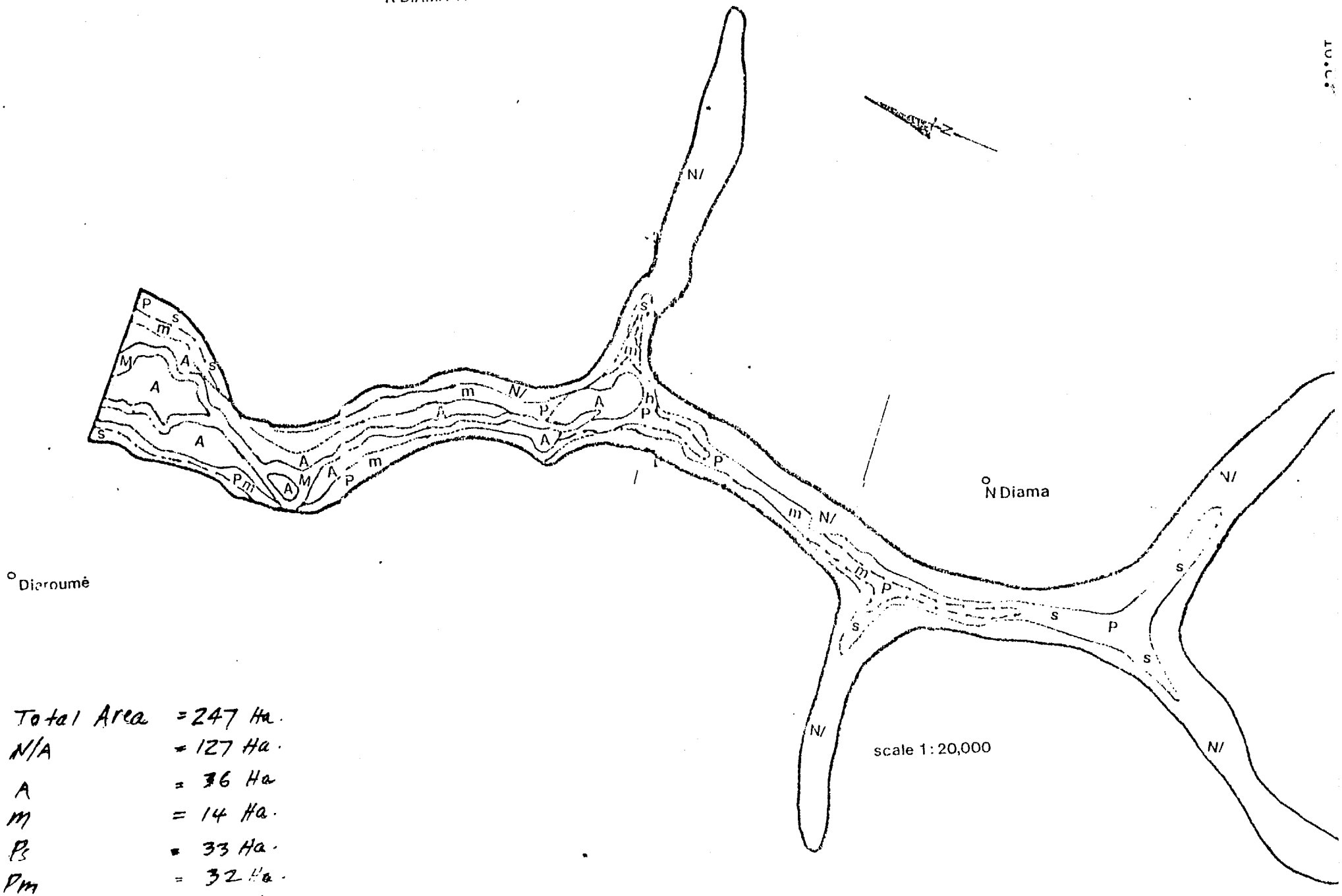
192

BOUNKILING MAP



Total Area = 351 Ha.
Ps = 48 Ha.
M = 11 Ha.
A = 38 Ha.
Pm = 36 Ha
Pn = 10 Ha.
All = 208 Ha.

N DIAMA AMONT MAP



Total Area = 247 Ha.
N/A = 127 Ha.
A = 36 Ha
m = 14 Ha.
Ps = 33 Ha.
Pm = 32 Ha.
Ph = 5 Ha

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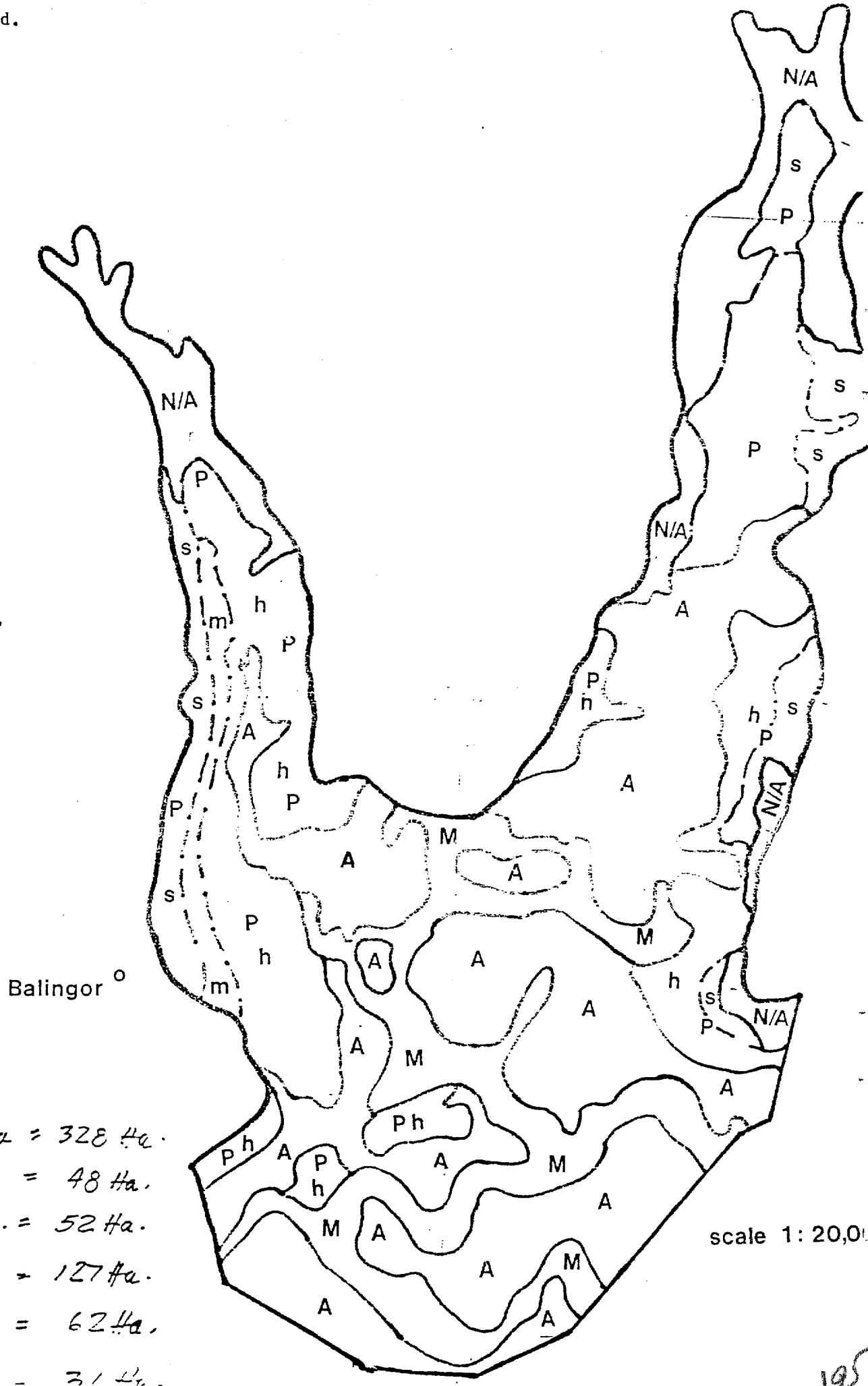
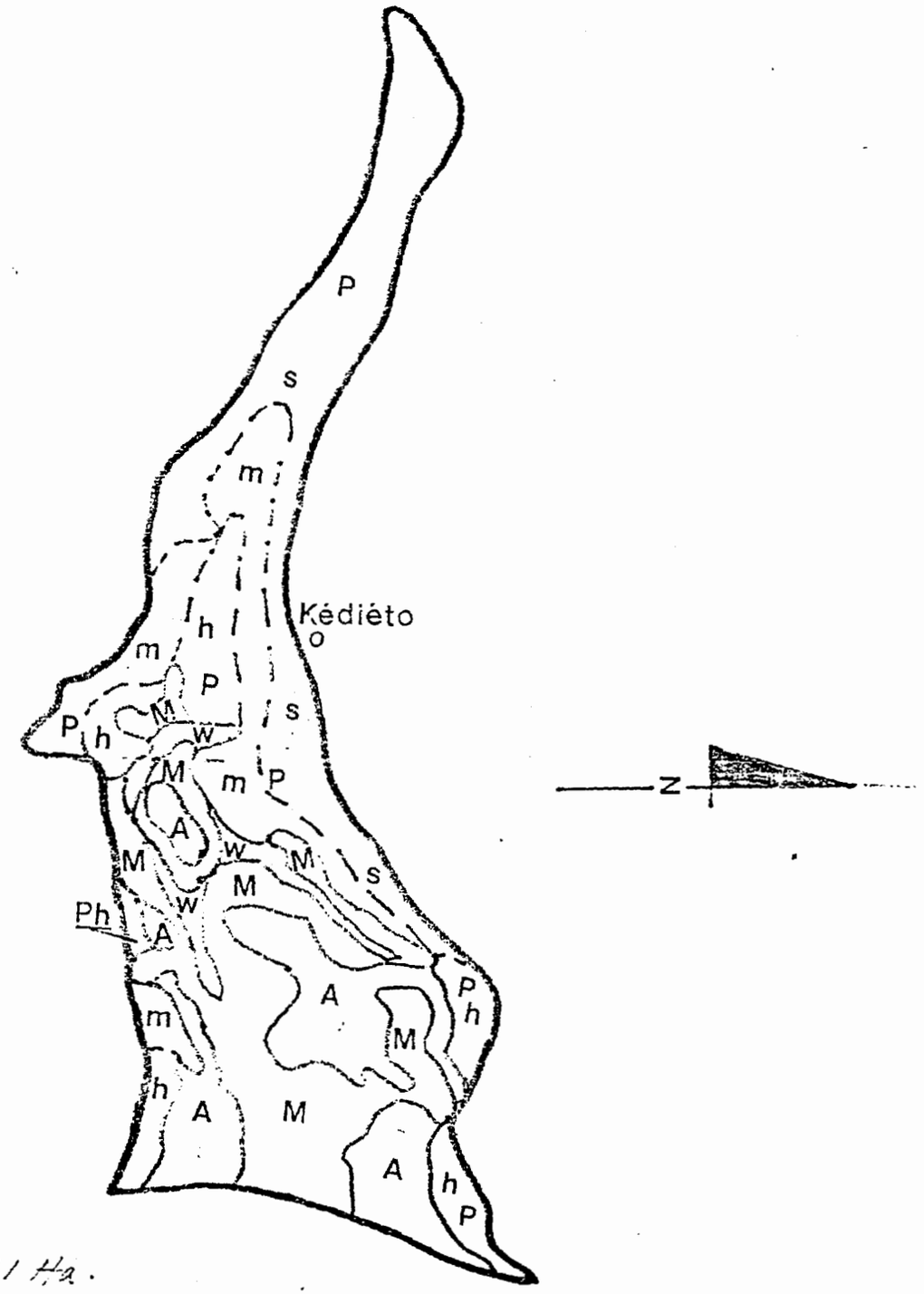


Total Area = 328 Ha.
N/A = 48 Ha.
m = 52 Ha.
A = 127 Ha.
Ph = 62 Ha.
P = 31 Ha.



scale 1 : 20,000

Total Area = 111 Ha.

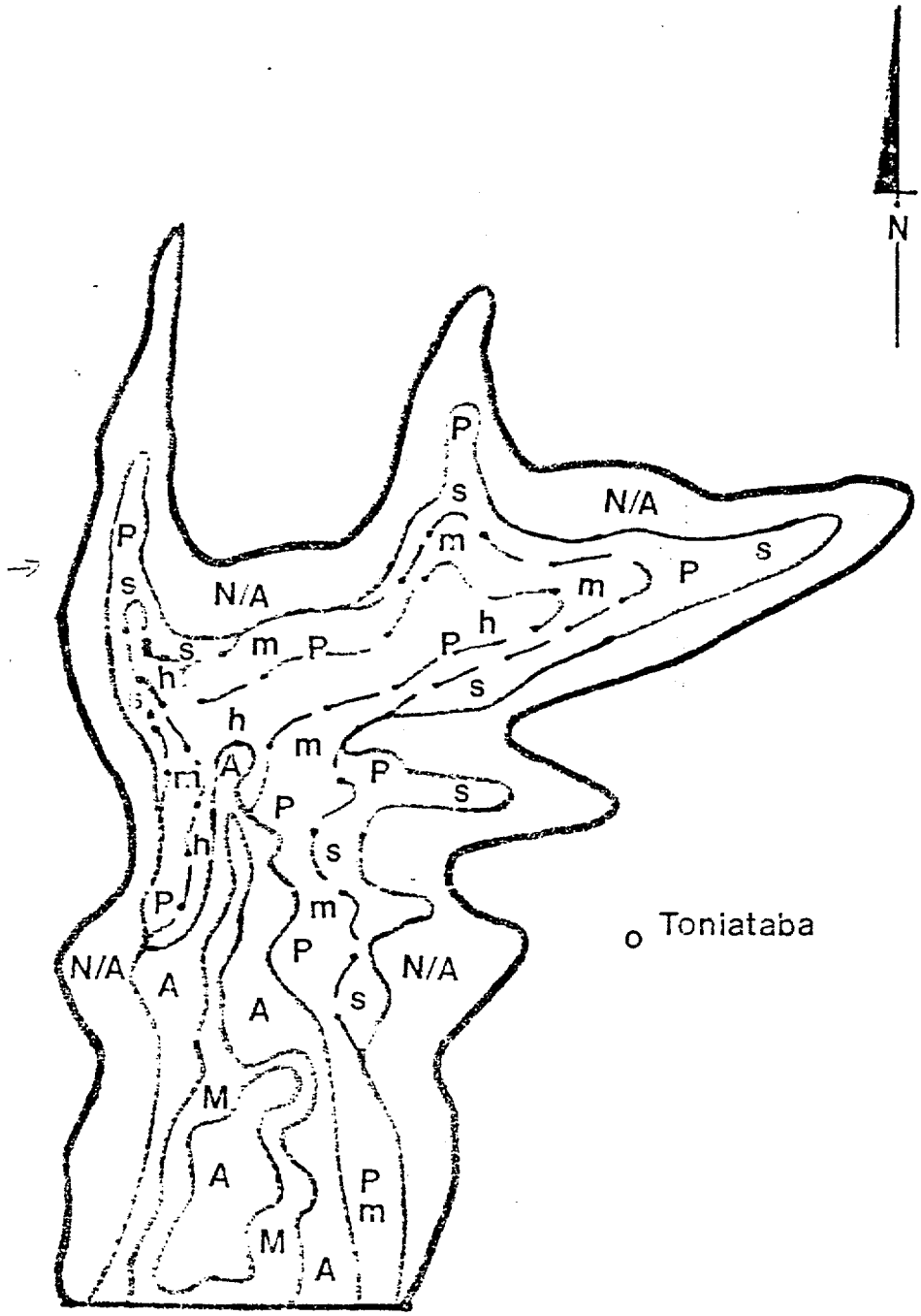
A = 21 Ha.

m = 27 Ha.

W = 5 Ha.

Ps = 25 Ha.

m = 18 Ha.



Total Area = 456 Ha.
N/A = 179 Ha.
A = 61 Ha.
m = 33 Ha.
Ps = 69 Ha.
Ph = 38 Ha.
Pm = 76 Ha.

scale 1: 25,000

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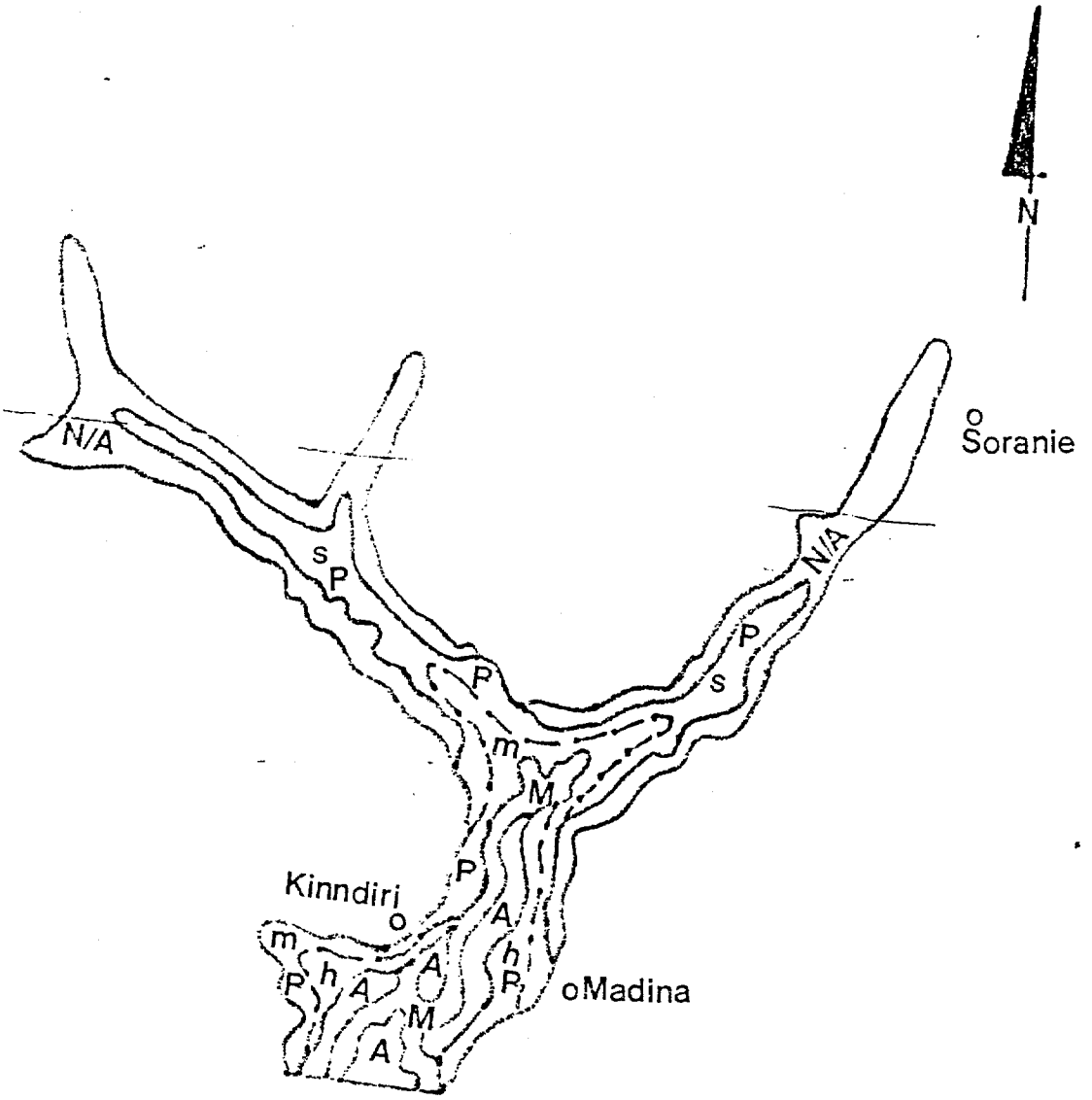
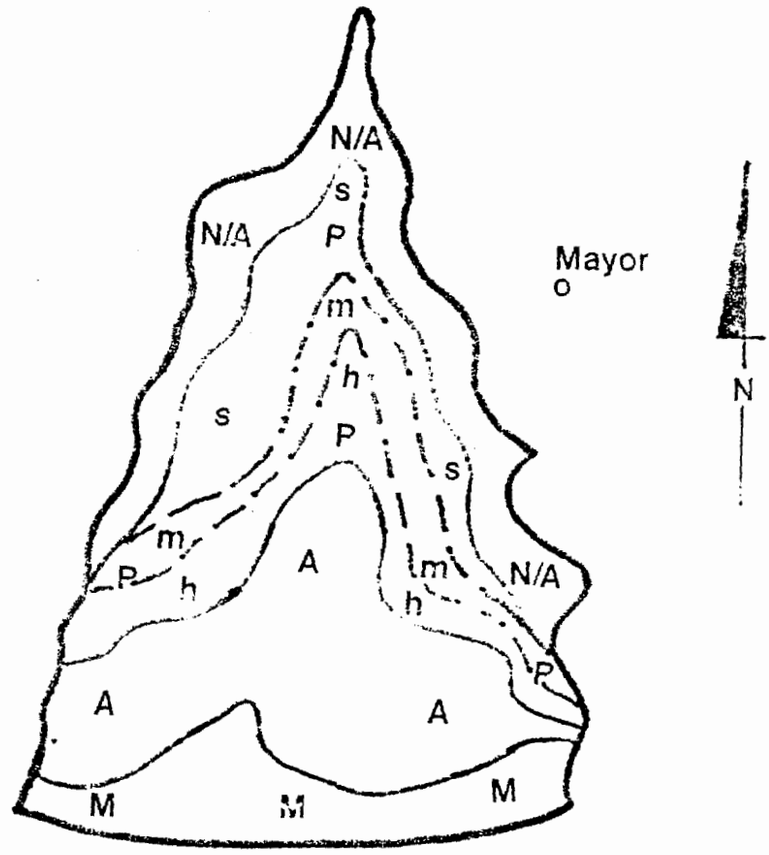
KINNDIRI MADINA MAP



scale 1 : 50,000

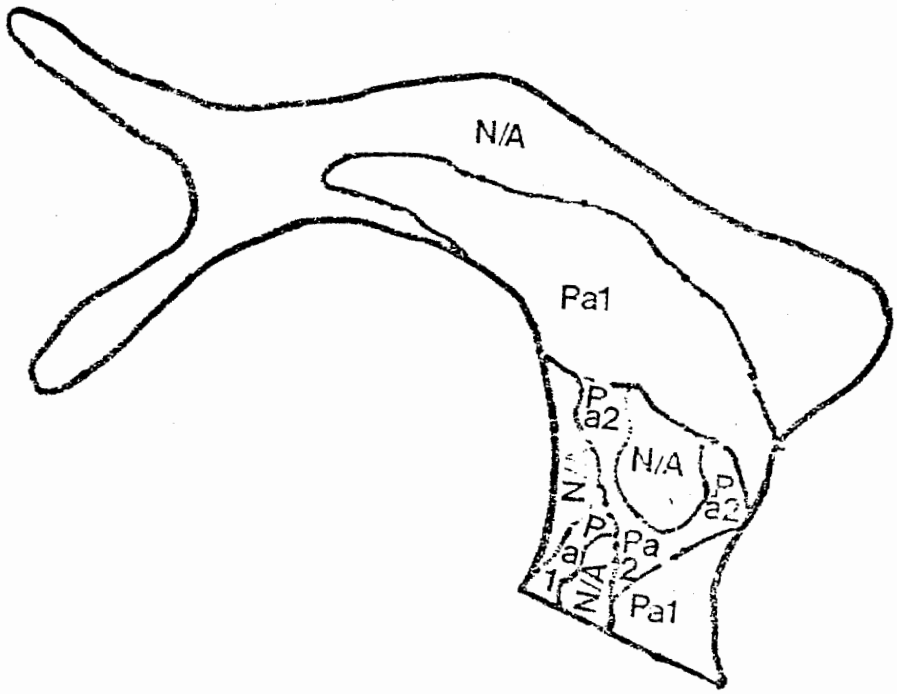
Total Area = 515 Ha.
N/A = 217 Ha.
m = 51 Ha.
A = 48 Ha.
P_h = 36 Ha.
P_s = 94 Ha.

MAYOR MAP.



scale 1:20,000

Total Area = 104 Ha.
m = 14 Ha.
N/A = 19 Ha.
Ps = 16 Ha
Pm = 13 Ha.
Ph = 13 Ha.
A = 29 Ha

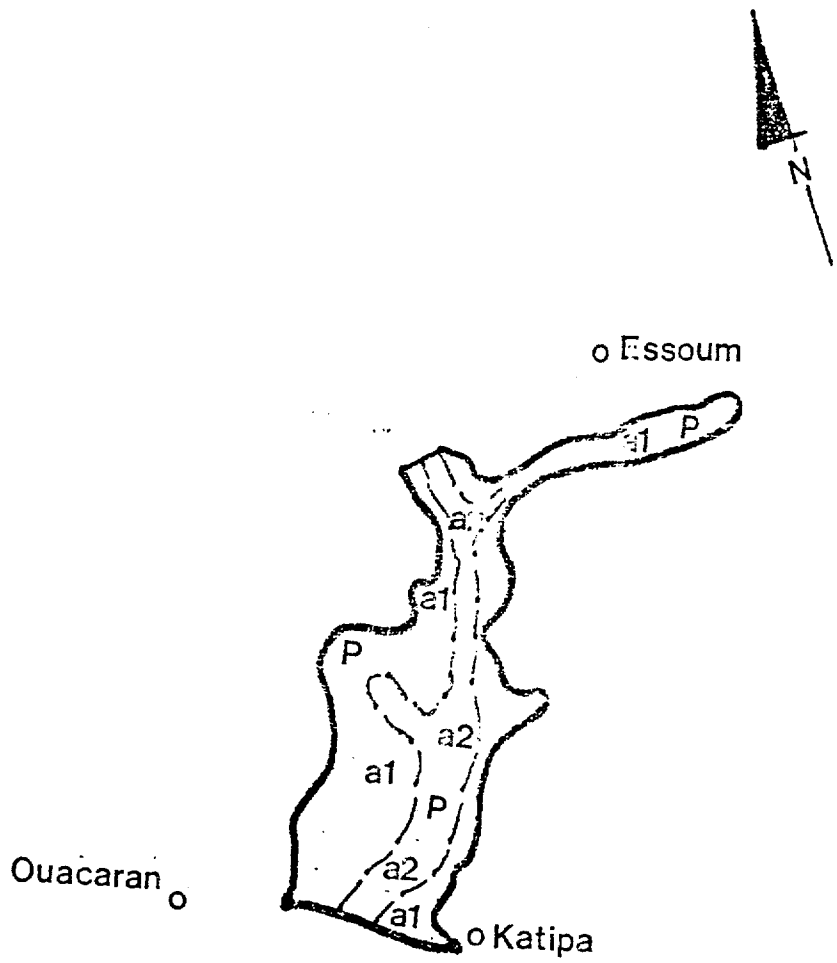


o Djimande

scale 1:20,000

Total Area = 64 Ha.
N/A = 38 Ha.
Pa1 = 21 Ha
= 5 Ha

ESSOUM MAP



Total Area = 186 Ha.

Pa1 = 127 Ha.

Pa2 = 59 Ha.

scale 1 : 50,000

V. SOIL MANAGEMENT APPROACHES AND SITING CRITERIA

A. Acid and Saline Soils (symbol A)

These soils have already been acidified (due to oxidation) and salinized. Any environmental damage from acidification has already occurred. All sites visited had significant areas of these soils with the exception of Djimande and Essoum. They are generally sterile and are undergoing some maturation (development) or ripening which will permit recolonization by plants and rice cultivation. Generally, several years of reclamation will be required before rice can be grown on them, with the exception of those soils which have already shown some maturation and a reduction in sulfide concentration in the upper soil horizon.

ISRA and ORSTOM soil scientists believe that these soils can be used if the upper 20 to 30 centimeters in depth can be reclaimed. Microcatchments and drains are one way of reclaiming this land. Soil amendments such as lime, ground rock phosphate, phosphate slag, and some phosphate fertilizers can also be used to permit rice cultivation. Rice will withstand relatively acid conditions (down to about a 3.5 pH threshold) if nutrient availability is not below crop growth requirements.

Presence of these soils will not affect the siting of anti-salt dikes, except in those areas where acidified-salinized soils represent so much of the available surface area that the benefits from rice production would not cover the construction costs for the dike itself.

Estimated percentages of acid saline soils by watershed basin are:

Balingor	-	39%
Bounkiling	-	11%
Diatok	-	18%
Kinndiri Madina	-	9%
Mayor	-	27%
N Diama Amont	-	15%
Samine Escale	-	9%
Tanaff	-	13%

Options for acidified soils (tannes nues) management:

1. Ignore them. When they mature and are recolonized by plants construct microcatchments and move onto them for rice production.

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2. Use soil amendments to recover them within one to two years.

a. Lime from oyster and other shells. The problems with this approach are the transportation costs, labor costs of collection, and energy costs of kilns. It is estimated that at least 5 t/ha of lime will be necessary. The recovery rate after calcining is about 33% of shell weight as calcium carbonate. This amount per hectare should raise the pH of the 20 cm rooting zone at least one full point.

b. Lime applications. Transport and purchase costs reduce the viability of this approach.

c. Phosphate Slag or Partially Acidulated Rock Phosphate. These materials are derived from the production of phosphoric acid. Transport costs limit the viability of this option.

d. Use DAP or other phosphatic fertilizers to provide nutrients to the rice plants on the more mature acid soils where nutrient availability rather than toxicity is a problem.

e. Increase the use of traditional soil amendments such as mango leaves, rice straw, etc. Caution must be exercised to avoid application of too much fresh organic matter which can reduce soil redox potential and induce the liberation of iron and aluminium cations.

3. Leach the soils through a system of microcatchments and drains.

Sites will have to be picked carefully because of the constraint to efficient drainage posed by the flat topography of most of the watersheds.

B. Potentially acid soils (Symbols Ps,Pm,Ph)

Field investigations by the PP team separated the potentially acid soils into three categories based on their potential acidity, which relates directly to sulfide content. Sulfide accumulation is in turn a function of slope position and, probably, of the amount of time over which sulfur has been deposited on these soils. The soils higher on the slope have lower sulfide content and lower potential for acidification. The slight and moderate potential soils have already undergone some oxidation. They have also matured more than the potentially high acid soils. All three sub-categories of this potentially acid soils group are currently being used for rice production. There is no mangrove vegetation on these soils because they either dry out each year (Ps and Pm) or because they are salinized (Ph).

Site selection will not be significantly affected by the presence of the slight to moderate potentially acid soils. The high potentially acid soils are the more recent (less altered) soils. Their presence in significant quantities will require that the water control

structures be operated to keep them at field capacity moisture content (or above) throughout the year. This may require the inflow of saltwater during part of the dry season. Soil salinity will remain a problem on these soils. They are and can continue to be used for rice production if kept moist.

The Bignona Valley presents a special soil and water management problem. The Affiniam anti-salt dam has just been operated for a full rainy season. It is being operated to flush the maximum amount of salt out of the valley as quickly as possible. Field observations show that the rapid draining of the valley has led to the early drying of the potentially acid soils. While samples should be taken later in the dry season to see if oxidation is resulting in wide-scale acidification, it is the opinion of the field team that current Affiniam dam operations will lead to oxidation and sterilization of the subcategory of high potential acidity soils. This problem highlights the need for monitoring and modeling of Affiniam dam operation. The protection against acidification and the maximization of salt flushing are conflicting objectives which need to be subjected to optimization analysis.

Percentages of potentially acid and saline soils for each watershed basin examined within the priority zones are:

BAILA VALLEY

Essoum (NOT SALT AFFECTED)

BIGNONA VALLEY

Balingor

slight	-	10%
moderate	-	2&
high	-	19%

Diatok

slight	-	21%
moderate	-	15%
high	-	13%

Djimande

(NOT SALT AFFECTED)

SEDHIOU VALLEY

Kinndiri-Madina

slight	-	18%
moderate	-	13%
high	-	7%

Samine Escale

slight	-	32%
moderate	-	29%
high	-	13%

Tanaff

slight	-	15%
moderate	-	16%
high	-	8%

SOUNGROUGROU VALLEY

Bounkiling

slight	-	14%
moderate	-	10%
high	-	3%

Mayor

slight	-	15%
moderate	-	13%
high	-	13%

N Diama Amont

slight	-	13%
moderate	-	13%
high	-	2%

1. The principal management approaches for these soils are:

a. Water management to maintain soil moisture using secondary dikes, ridges, and basins.

b. Fertility amendments.

c. Water management to flush salts from the surface layer.

d. Eventually, utilization of soil amendments to reduce soil acidity in the first 30 cm of the soil profile.

2. Specific management recommendations for these soils by

intensity of potential acidification and salinization are:

a. Potentially high acid saline soils (symbol Ph) -

(1) An accelerated reclamation approach

(a) to construct levees around these areas, with microcatchments on the area within the levees, and install either gates or utilize siphon hoses to maintain inundation with saltwater during the dry season (For the Bignona Valley, this is contingent upon changes in the present operations at the Affiniam anti-salt dam.), and then

(b) to remove the saltwater and allow inundation of at least 100 to 120 millimeters of rainfall prior to transplanting of rice, or

(2) strive to maintain a field moisture capacity of these soils during the dry season with rainfall, and then later with retained rainwater that has been drained from fields of higher elevation.

b. Potentially moderate acid saline soils (symbol Pm) -

(1) Construct small contour levees around the lower elevations of the moderately potential acid saline soils in order to prevent any saltwater intrusion during any period of the year. These soils do not need to be re-wetted during the dry season, as tests indicate that there presently is not a great amount of sulfides present. However, it intrusion of saltwater continues, the addition of sulfides from such would pose an added probability of sterilization in the future.

(2) After harvest incorporate with either a commercial grade fertilizer, calcium carbonate from powdered oyster shells, or rock phosphate, or, less feasibly, utilize available green manure.

(3) Interplant with leguminous trees.

c. Potentially slight acid saline soils (symbol Ps) -

(1) Maintain rainwater and runoff from higher elevations for one crop and then release excess (if any) to the potentially moderate and high acidification soils at lower elevation.

(2) Rotate these soils out of rice at least every third year, preferably with a legume crop, such as ground nuts or cowpeas. Care would have to be taken to avoid soil erosion with peanut cultivation.

(3) Plant leguminous trees along the upper elevations of these soil delineations. This should allow nitrogen fixing, reduce erosion, and also possibly provide a source of fuelwood for fertilizer production from oyster shells.

C. Mangrove Soils - (Symbol M)

Mangrove soils are those formed under the influence of mangrove vegetation. At all sites visited the native vegetation was almost entirely absent. These soils are highly organic and have an extremely high acidification potential. While some have altered from fibric to muck status, none offer much potential for rice production. Only small strips of these soils exist at most sites. They border the water courses of the bolongs. They lie next to the high potential acid soils in many areas.

Where the mangrove soils are of broader extent, they should be avoided. Building dikes on them would cause no further or irreversible environmental damage, but their lack of structure and consolidation makes it difficult to build stable dikes and concrete sluice gates on them. Their extensive presence in the Tanaff bolong caused the exclusion of the central bolong site and its replacement by selected side valleys as the preferred sites for dikes. The option of excavation and/or building structures on pilings was excluded as being too expensive. The Bounkiling dike site has been moved upstream from the initial site to avoid these soils. An existing structure is steadily sinking into the muck mangrove soils there.

The only recommended management approach to these soils is to maintain them in their wet state. Diking will probably improve the moisture status of these soils when they occur upstream in small valleys. Existing dikes have generally resulted in some recovery of mangrove stands as salt concentrations have dropped behind the dikes.

VI. POTENTIAL FOR USE OF ORGANIC, ROTATIONAL, FALLOW, AND AGROFORESTRY APPROACHES TO SOIL FERTILITY MANAGEMENT

The definition of organic approaches always poses a problem. The PP team uses the definition of organic materials as those materials used in their naturally occurring or slightly to moderately modified states. Included are: green manure, straw, leaves and crop trash; calcined sea shells; ground phosphate rock; animal manures; and, at the limit of the organic fertilizer definition, phosphate slag and gypsum wastes.

Diola farmers have traditionally used mango leaves and rice straw as organic amendments. These appear to be relatively effective on the lighter textured soils. Their influence may be as much on soil water moisture and chelation of iron and aluminum ions as it is on inherent soil fertility. The problems involved in widespread application of these materials are ones of obtaining sufficient quantities to fertilize substantial surface areas; of timing of application; and, of effort (labor and power) required to incorporate the organic matter in the soil for faster breakdown.

A similar problem exists with animal manures. There is simply not a large enough supply to fertilize more than very small parcels, probably less than a tenth of a hectare per farmer.

One sea shell kiln was seen during the teams visit. It's principal use seems to be in the building trade for mortar and cement work. The problems confronting agricultural use are cost of collection and transport, the energy needed to calcine the shells, and the cost of distribution and sales. If 5 t/ha of $CaCO_3$ - equivalents are needed, 15.2 tons of shells would be required.

Use of byproducts of the Senegalese phosphate industry should be seriously explored. The main constraint to their use is the cost of transport from Dakar and their subsequent distribution and sale. The citric acid solubility of Senegalese rock phosphate is only mediocre, but their use on highly acidic soils could be technically sound. Some research should be done with these products.

Agroforestry approaches have been tried by ISRA and PIDAC. Substantial yield response was obtained with neem tree cuttings, but no economic analysis was made of the costs and benefits of this approach.

ISRA should be contracted to conduct research with organic fertilizers, soil amendments, and agroforestry approaches to soil fertility management on the valley soils.

VII. CROP YIELD RESPONSE TO FERTILIZER AMENDMENTS UNDER DIFFERENT RAINFALL SCENARIOS

Cf. Agronomic and Water Management Annex

VIII. RECLAMATION RATES

Cf. Agronomic and Water Management Annex

HYDROLOGICAL SURVEY OF 11 SITES IN THE LOWER AND MIDDLE CASAMANCE

By
Jean Albergel
Hydrologist
Researcher with ORSTOM

Under the USAID Southern Zone Water Management Project, I was commissioned to conduct an hydrological survey on 11 sites considered for small scale water control structures. This survey included:

- Delimiting the watersheds related to the planned development and a summary mapping of runoff contributing zones.

- A statistical analysis of annual and daily rainfall

- Predetermining annual stream flows for each site.

- Computing the 10 year flood and the design flood for dimensioning the water discharge structure. The design flood for this project has a return period of 25 years.

- Determining maximum or minimum water levels and extreme amplitudes due to tides, and of possible interest for the project designer.

- A few data on the aquifers and water quality.

The survey conducted from November 9-30, 1987 was based on:

- An analysis of the hydrological data available in the ORSTOM data bank.

- The various hydrological surveys conducted in Casamance: fundamental works by ORSTOM, findings published by consulting firms: Louis Berger, Coyne et Belier, BCEOM, SOGREAH.

- Observations noted during a field trip to all sites.

1. The physical parameters of the watersheds to be developed.

The figures in Annex 1 show the limits and locations of the 11 sites. The 1/50,000 topographical maps helped delimit the lower floodable zones of the slopes and plateaux. Table 1 is a summary of the main characteristics of these watersheds.

Table 1

Characteristics of the watersheds to be developed

Watersheds	Total area km2	Lower area km2	Upper area km2	Relief. C (1)	Perm.C (1)
ESSOM	125	22	103	R2	P3-P4
MADINA	316	9.4	307	R3	P4
TANAF	445	30	415	R2	P3-P4
TOUMIATABA	31	.9	30.1	R2	P3-P4
SANSAKOUTO	13.4	.7	12.7	R2	P3-P4
SAMINE	122	31	91	R3	P4
NDIAMA	170	15	115	R3	P3-P4
BONKILING	203	8	195	R3	P3-P4
DIATOK	11.9	2.7	9.2	R2	P4
BALINGOR	21.0	6.7	14.3	R2	P4
DJIMANDE	6.5	1.2	5.3	R2	P4

(1) (1965) Rodier - Auvray Classification
R2: gentle slopes less than .5%. They are plain watersheds.
R3: moderate slopes between .5% and 1%. They are intermediate grounds between the plain and the undulating ground zones.
P3: rather impermeable watersheds including notably large permeable zones.
P4: rather permeable watersheds.
Permeability measured on various sites of the Continental Terminal in the Lower Casamance, ranges between.$5*10^{-5}$and and $11*10^{-7}$ m/S (BCEOM geotechnical report, Development of the Baila plain, 1985).

2. Rainfall analysis

The Casamance rainfall pattern is that of the maritime subguinean climate characterized by two clear-cut seasons: a rainy season of about 5 months and a dry season of about 7 months. Annual rainfall shows a latitudinal component and a maritime component; this results in parallel isohyetal lines in the NW-SE direction which draw closer together near the ocean (See isohyetal line maps, Annex 2).

After a critical review of rainfall data (double mass curve method), four reference stations were considered for a statistical analysis of the Lower and Middle Casamance rainfall.

Posts	:	Periods when observations are homogeneous
	:	
ZIGUINCHOR	:	1922-1986
SEDHIOU	:	1922-1986
DIOULOULOU	:	1950-1986
BIGNONA	:	1954-1986

2.1. Statistics of annual rainfall

Many authors have demonstrated the non-stationarity of the annual rainfall series throughout the tropical African countries stricken by the last 1969-1986 drought episode. Observations for the pre-1969 period are on average statistically different from those of the subsequent period. (Carbonnel and Hubert 1985, Snidjers 1986, Musy 1987). Table 2 includes estimated rainfall values for wet and dry year return events of 10, 50 and 100 years at the four reference stations. We give a value for a statistical adjustment on observations of the pre-1969 period and another value for an adjustment on the 1969-1986 observations. The project design will choose one of the two values based on the type of risk it wants to avoid: surplus or deficit rainfall; as no criterion can help forsee the length of the current drought episode.

The values of rainfalls of various return events can be obtained from an automatic adjustment of 10 statistical laws and from the choice of the best adjustment, using as a criterion the Brunet Moret test. This test favors an adjustment to extreme values (mininizing areas ranging from the theoretical curve and the experimental distribution curve).

Annex 3 illustrates the use of this method on the Ziguinchor rain gauge station.

If the series observed in Ziguinchor had been considered stationary, we would have observed between 1969 and 1986 six years when rainfall would be lower than the dry 10 year return event. Probability for observing in a stationary series, six times a value lower than the dry 10-year return event, is equal to:

$$P = C_{18}^{6} (.9)^{12} * (.1)^{6} = 5.2*10^{-3}$$

This probability is too low not to consider the assumption of the stationarity of the series.

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Table 2

Annual rainfall statistics

Post	Period considered	SURPLUS 100 years mm	25 years mm	10 years mm	median mm
ZIGUINCHOR (1)	< 1969	2194	2050	1926	1550
	> 1969	1624	1527	1442	1168
SEDHIOU (2)	< 1969	2150	1925	1758	1362
	> 1969	2013	1634	1400	993
BIGNONA (1)	< 1969	2393	2148	1950	1433
	> 1969	1671	1497	1358	998
DIOULOULOU (1)	< 1969	2505	2261	2057	1487
	> 1969	1615	1490	1383	1073

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Table 2 (continued)

Post	Period considered	DEFICIT 100 years mm	25 years mm	10 years mm	median mm
ZIGUINCHOR (1)	1969	798	1010	1130	1520
	1986	533	750	832	1168
SEDHIOU (2)	1969	830	944	1044	1362
	1969	698	741	787	993
BIGNONA (1)	1969	784	889	1005	1433
	1969	560	628	705	998
DIOULOULOU (1)	1969	605	775	944	1487
	1969	523	640	750	1073

(1) Goodrich's law
(2) Galton's law

2.2. Daily rainfall statistics

The daily rainfall statistical analyses (Albergel, 1986) have shown that the drought did not affect the probability of extreme daily rain return events. Table 3 shows the estimated values of daily rain for return events: once a year, once in 10 years, once in 25 years.

Daily rainfall observed at the reference stations were analyzed through PEARSON's Law (Brunet Moret, 1970).

Table 3

Daily rainfall statistics

POST	DAILY RAINFALL		
	1* a year mm	1* in 10 years mm	1* in 25 years mm
ZIGUINCHOR	103	170	200
SEDHIOU	95	143	170
DIOULOULOU	95	145	160
BIGNONA	95	140	165

2.3. Beginning, end and duration of the rainy season.

The rainy season lasts virtually five months only: June, July, August, September, October. August is the wettest month in the year in 70% of cases, September follows in 20% of cases and then July in 10% of cases.

Annex 4 indicates Brunet Moret's abacuses (1970) along with the median dates for the beginning and end of the rainy season as well as the dates observed and corresponding to probabilities 25% and 75%. On the same table, appears the median duration of the rainy season (143 days at any given post) as well as the probability durations of 25% and 75%.

A review of recent years does not reveal any significant modification of these results with the drought.

3. Predetermining annual stream flows.

Hydrological surveys effected by ORSTOM on the Bignona watersheds (Olivry and Chouret, 1981) and on the Baila marigot watersheds (Olivry and Dacosta, 1984) have helped make a rather accurate evaluation of flow coefficients according to the zones observed. For the emerged zone, plateaus, slopes, terraces, the flow coefficent is .17% in dry 10-year return event (measured value); it is 6% in median year. BCEOM, (1985) proposes, based on an extrapolation of flows observed in Kolda, a 10% coefficient for the rainfall value in wet 10-year return event.

For the lower zones, the almost permanent submersion gives them a very high flow coefficient, this coefficient is estimated at 80% in the above-mentioned surveys. It hardly varies, in any given year.

The division of areas into lower and upper zones is shown in Table 1. Table 4 shows flow coefficients and corresponding volumes for each site.

Table 4

Annual flows

Watershed	Dry 10 year return event		Median		Wet 10 year return event	
	KE%	VE Mm^3	KE %	VE Mm^3	KE %	VE Mm^3
ESSOM	14	13.1	18	25.3	22	38.4
MADINA	2	6.3	8	27.2	12	51.9
TANAF	5	19.5	11	49.4	15	88.9
TOUMIATABA	2	.6	8	2.5	12	5.1
SANSAKOUTO	4	.5	10	1.3	14	2.5
SAMINE	20	19.7	24	30.5	28	46.0
NDIAMA	7	6.9	11	19.1	14	31.9
BONKILING	3	4.8	9	18.2	13	35.1
DIATOK	18	1.5	23	2.7	27	4.4
BALINGOR	25	3.8	30	6.2	32	9.2
DJIMANDE	15	.7	20	1.3	23	2.0

KE: flow coefficient

VE: flow volume
Mm3: 1 million m3

Flow volumes were calculated on the basis of the annual rainfalls estimated from post-1969 observations (more unfavorable period). Despite high evaporations (average ETP 515 mm for the rainy period, June to October), flow levels should be sufficient not to po: any filling problems for the planned small-scale retention works.

Notes: In Casamance, data on climatological station evaporation exist, notably at Djibelor, but no study (to our knowledge) has been conducted to transpose these observations to the flooded valleys. These environments present the following peculiarities related to evaporation:

- salt water
- vegetables cover variable according to crops and to the date in the rainy season.
- situation of the valley in relation to the prevailing winds.
- influence of the variations in neighbouring water surfaces (tides).

It should be noted that evaporation is one of the climate variable most subject to "local conditions". Its quantification in very specific environments such as the Casaman flooded valleys would require a study.

4. Predetermining the 10-year flood and the design flood:

"The 10-year flood is the flood caused by a 10 year return shower; all other runoff conditions being average ones" (Rodier and Ribstein, 1986). Its determination was made by using the 1964 Rodier and Auvray method.

The project flood is an indicator of the natural risk. It was part of the scope of work of this survey to estimate the maximum flood discharge of 25 year return period. It was calculated by multiplying the maximum 10 year return flood discharge with the following ratio: a point rainfall of 25 year return event/point rainfall of 10 year return event.

Table 5 shows the 10 year return flood parameters for each site and table 6 shows the maximum design flood discharge:

Table 5

10 year return flood

Watersheds	10 year return shower Level	CR	R mm	RT hour	BT hour	Q10 m^3/s	q10 l/skm2
ESSOM	143	.85	9.7	10	50	17	136
MADINA	143	.75	7.5	10	50	26	85
TANAF	143	.70	6.0	15	50	30	67
TOUMIATABA	143	.95	10.8	7.5	38	9.5	306
SANSAKOUTO	143	1	11.8	5	20	8.0	597
SAMINE	143	.85	9.7	10	50	16	131
NDIAMA	143	.80	9.1	12	50	18	106
BONKILING	140	.75	7.6	13	50	22	108
DIATOK	140	1	11.9	4.7	20	7.5	630
BALINGOR	140	.95	10.6	6.5	30	8.5	405
DJIMANDE	140	1	11.9	4	15	6.0	923

CR: Coefficient of reduction of a shower
R: Runoff
BT: Base time, RT: Rise time
Q10: Maximum 10 year return flood discharge
q10: Maximum specific discharge of 10 year return flood.

The Rodier and Auvray method is limited to the watersheds whose area is less than 200 km2, we extrapolated it to areas of up to 400 km2. Olivry and Dacosta (1984), extrapolate this method for watersheds of over 1.000 km2 on the Baila marigot. The specific discharges obtained through this method are slightly higher than those given

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by the experimental curve proposed by Louis Berger (1985) (specific maximum discharge based on surface for the Lower Casamance watersheds).

Table 6

Design flood (25 years)

Watersheds	H10 mm	H25 mm	K	Q10 m/s	Q25 m/s
ESSOM	143	165	1.15	17	20
MADINA	143	170	1.18	26	31
TANAF	143	170	1.18	30	35
TOUMIATABA	143	170	1.18	9.5	11.2
SANSAKOUTO	143	170	1.18	8.0	9.4
SAMINE	143	170	1.18	16	19
NDIAMA	143	170	1.18	18	21
BONKILING	140	165	1.18	22	26
DIATOK	140	165	1.18	7.5	8.9
BALINGOR	140	165	1.18	8.5	10.0
DJIMANDE	140	165	1.18	6.0	7.1

Q10: Maximum discharge of 10 year return flood
Q25: Maximum discharge of 25 year return flood.

Note: The project flood estimated as for a continental watershed, does not correspond to the flow to be discharged by the structure since the old reach subject to the tide above the dam, will serve as an absorption reservoir; it is, at most, its upper limit (for the 25 year return event). Flood discharge becomes a management problem based on maximum levels needed upstream (crops) and levels downtream the structure (high or low tide).

5. Tide analysis

The tidal wave in front of a river mouth gives rise to a by-wave which runs upstream. This is a hydrological phenomenon which is more complex than that of the tide which produced it, because the river flow, the slope and bed shape are intervening factors. This tidal wave in the Casamance river has been analysed by Brunet Moret (1970) who provides an abacus with the maximum amplitudes of monthly and semi-diurnal tides (Annex 5). An identical abacus has been made for the Bignona marigot (Olivry and Chouret, 1981) and for the Baila marigot (Louis Berger, 1981).

Table 7 shows these amplitudes on the surveyed sites; we were not able to provide this data for the sites on the Zoungrourou river.

Table 7

Amplitudes of the tides

Watersheds	Amplitudes of semi-diurnal tides. cm			Amplitudes of semi-monthly tides		
	Max	Av.	Min.	Max.	Av.	Min.
ESSOM (1)	92	40	7	33	12	6
MADINA (2)	34	27	15	14	6	2
TANAF (2)	22	13	5	16	9	4
TOUMI. (2)	22	13	5	16	9	4
SANSAK. (2)	22	13	5	16	9	4
SAMINE (2)	23	14	7	16	9	4
NDIAMA	-	-	-	-	-	-
BONKILING	-	-	-	-	-	-
DIATOK (3)	65	-	21	52	42	31
BALING (3)	65	-	21	52	42	31
DJIMAN. (3)	65	-	21	52	42	31

(1) Baila marigot abacus (Louis Berger)
(2) Casamance river abacus (Brunet Moret)
(3) Bignona marigot abacus (Olivry and Chouret).

6. Aquifers and water quality

The succession of dry years observed since 1969 and above all since 1979 has modified the hydrogeological operation of the Casamance valleys. 10 m-falls have been noted in some water-table levels (Olivry, 1987).

In the surveyed region, one can distinguish one shollow aquifer and some deep aquifers. Of the deep aquifers, only that of the sandy clay deposits of the upper Ecocene is exploited.

The planned developments can include the shallow aquifer for which the following general data has been collected. A survey for each watershed to be developed would require a much longer intervention.

The shallow aquifer lies in the various deposits of the Continental Terminal: plateau red sands, laterite layers of the red sand base, terrace sands. The impermeable level is composed of the yellow clays of the Continental Terminal.

An observation of the piezometric maps drawn on a few valleys similar to those to be developed, leads to the following remarks:

- The piezometric surface is an accurate reflection of the geomorphology of the ground with very low gradients under the plateau surface and with a steeper slope downwards.

- The marigot drains the water-table, the contact line between the aquifer and the draining system follows all the marigot ramifications.

- On either side of the divides, the width of the flowing water-table is relatively low, the general aquifer is subdivided into rangy, narrow and sinuous elements.

The diagram (Annex 6) summarizes the operation of this shallow aquifer.

The quality of the low-land waters is dependent upon this operation.

- The fresh groundwaters flow towards the tributaries over almost all the banks and "compete" on a continuous front with the salt waters. It is to be noted that there are rice fields along all the banks.

- Based on rainfall, fresh water flows are more or less important and above all, last more or less long. Olivry shows, on the Baila marigot, the evolution of salinity according to water-table recharge (Annex 7).

Monitoring of piezometric levels and water salinity after completion of the developments, should help ensure a better management of anti-salt structures.

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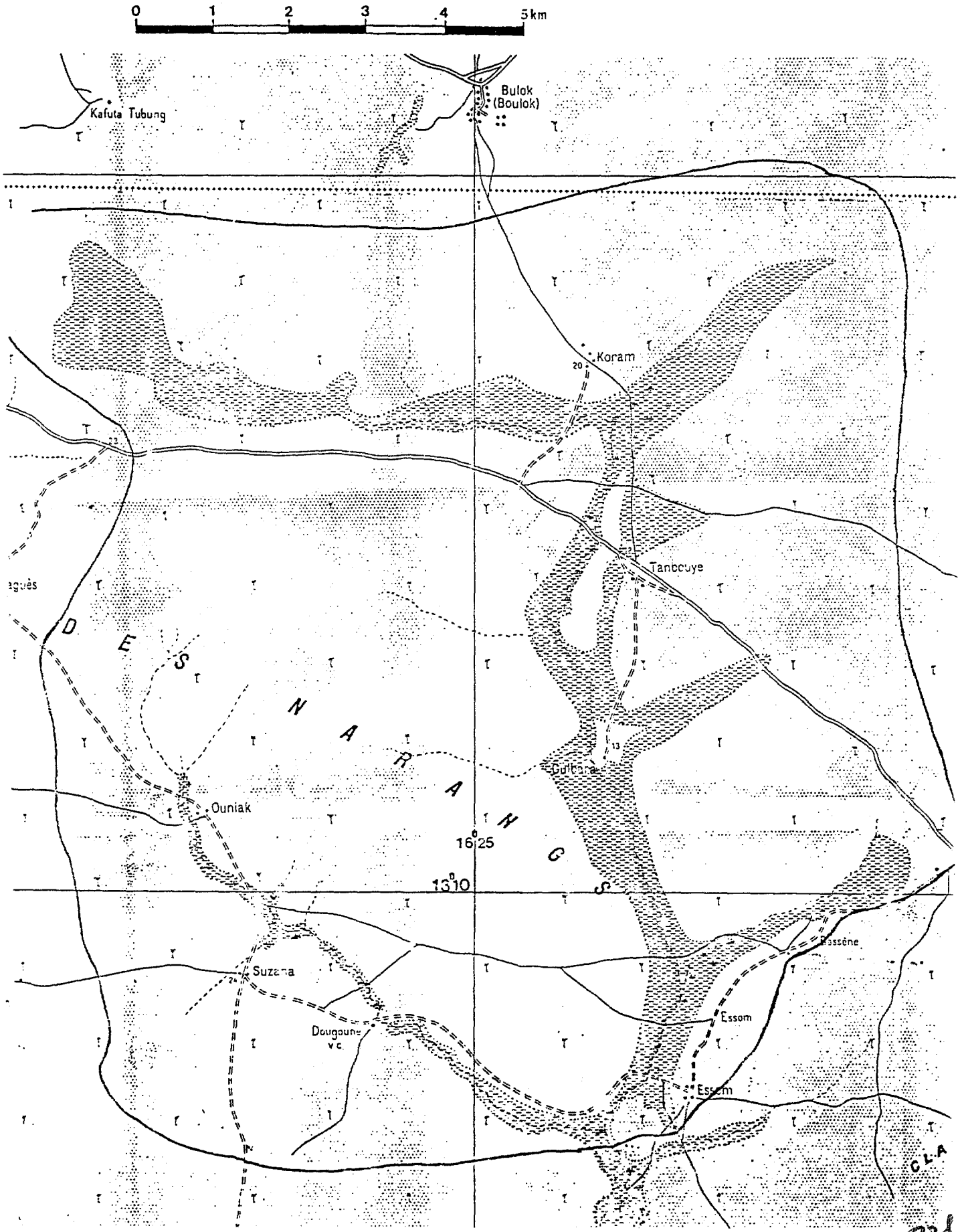
Annexe 1 : BASSIN D'ESSOM

Annex 1 : THE ESSOM WATERSHED



Annexe 1 : BASSIN DE MADINA et DE NDIAMA

Annex 1 : THE MEDINA AND NDIAMA WATERSHED

Annexe 1 : BASSIN DE TANAF et DE SAMINE-ESCALE

Annex 1 : THE TANAF AND SAMINE-ESCALE WATERSHED

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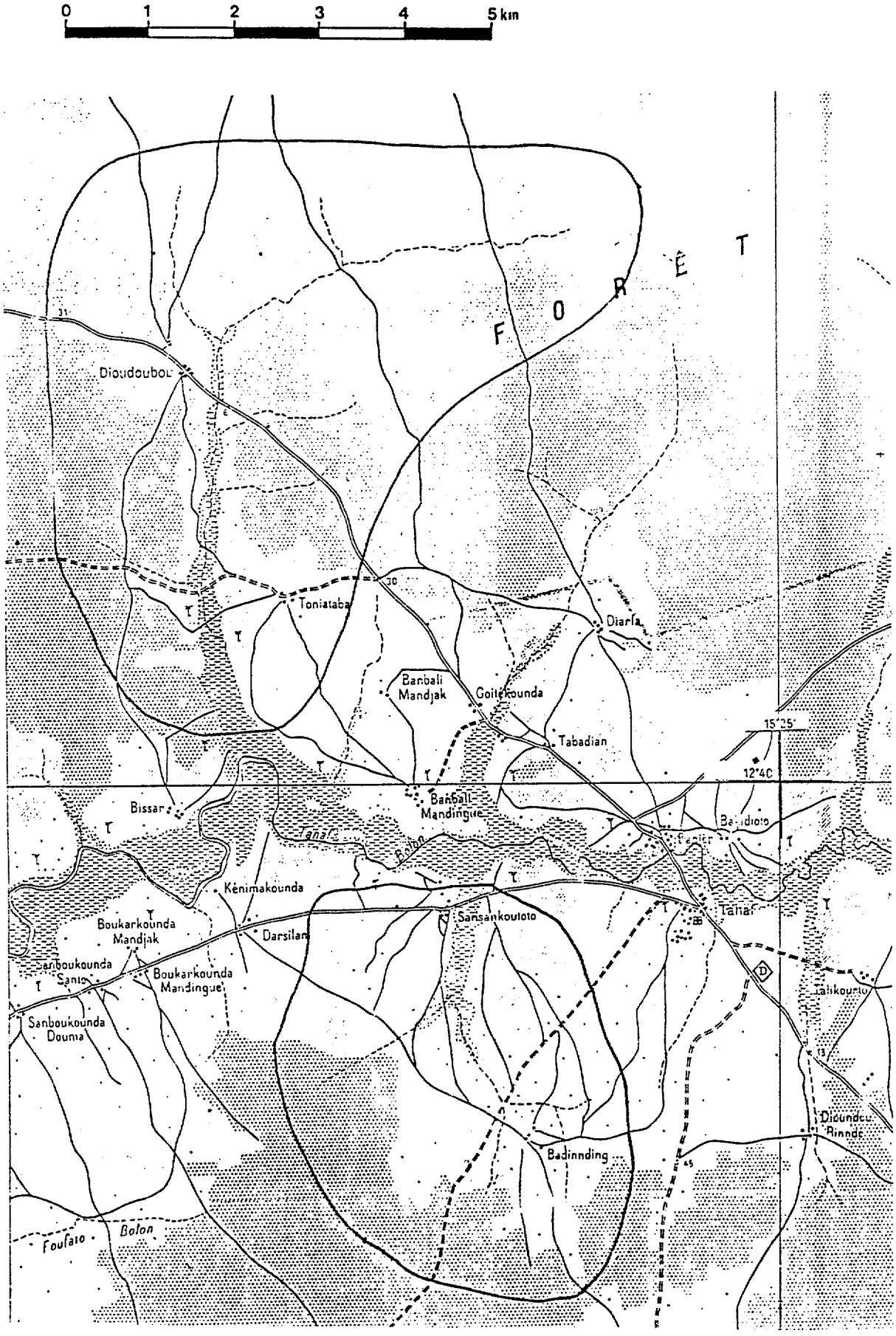
Annexe 1 : BASSIN DE TONIATABA et DE SANSAKOUTOTO
Annex 1 : THE TONIATABA AND SANSAKOUTOTO WATERSHED



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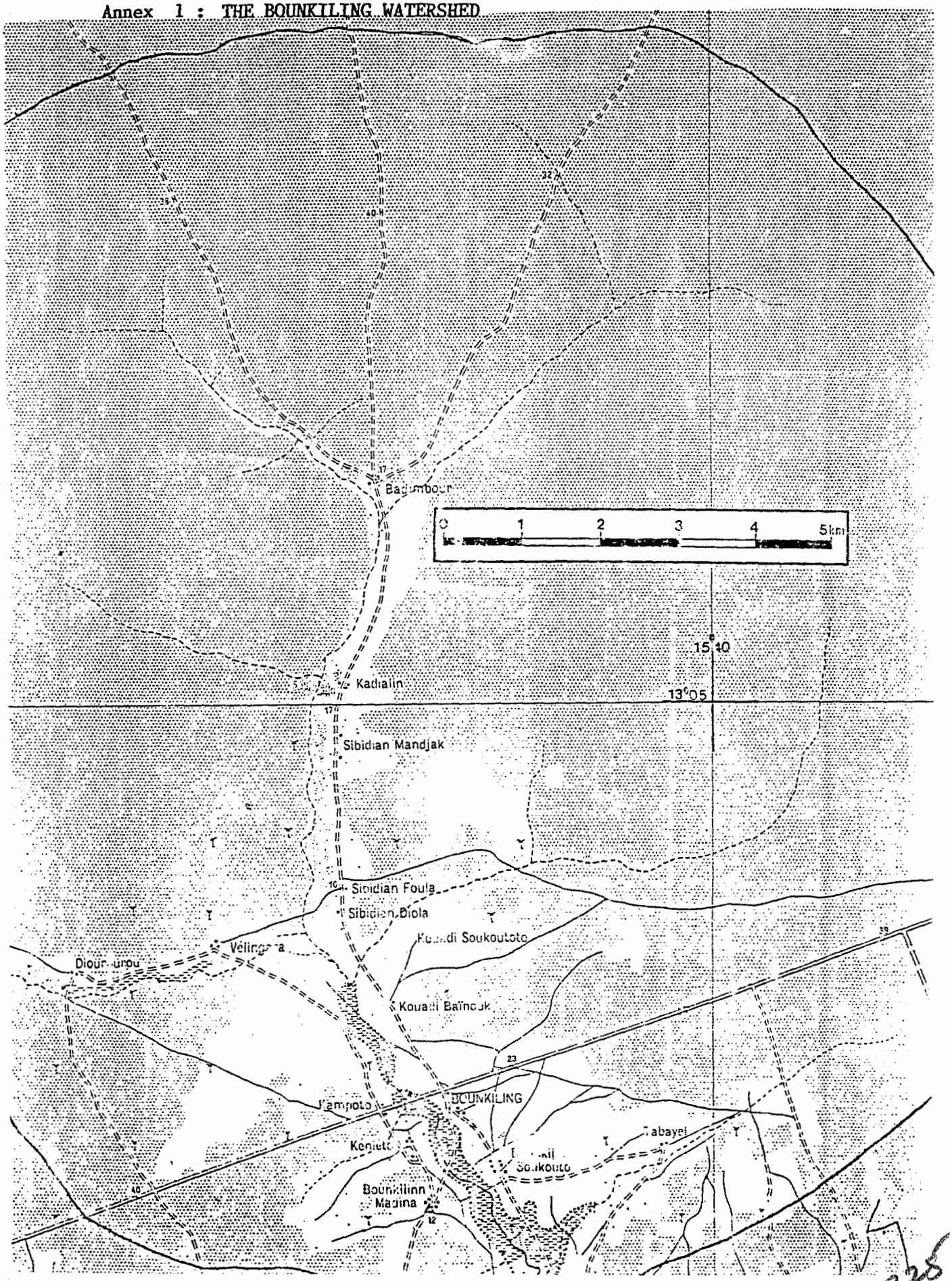
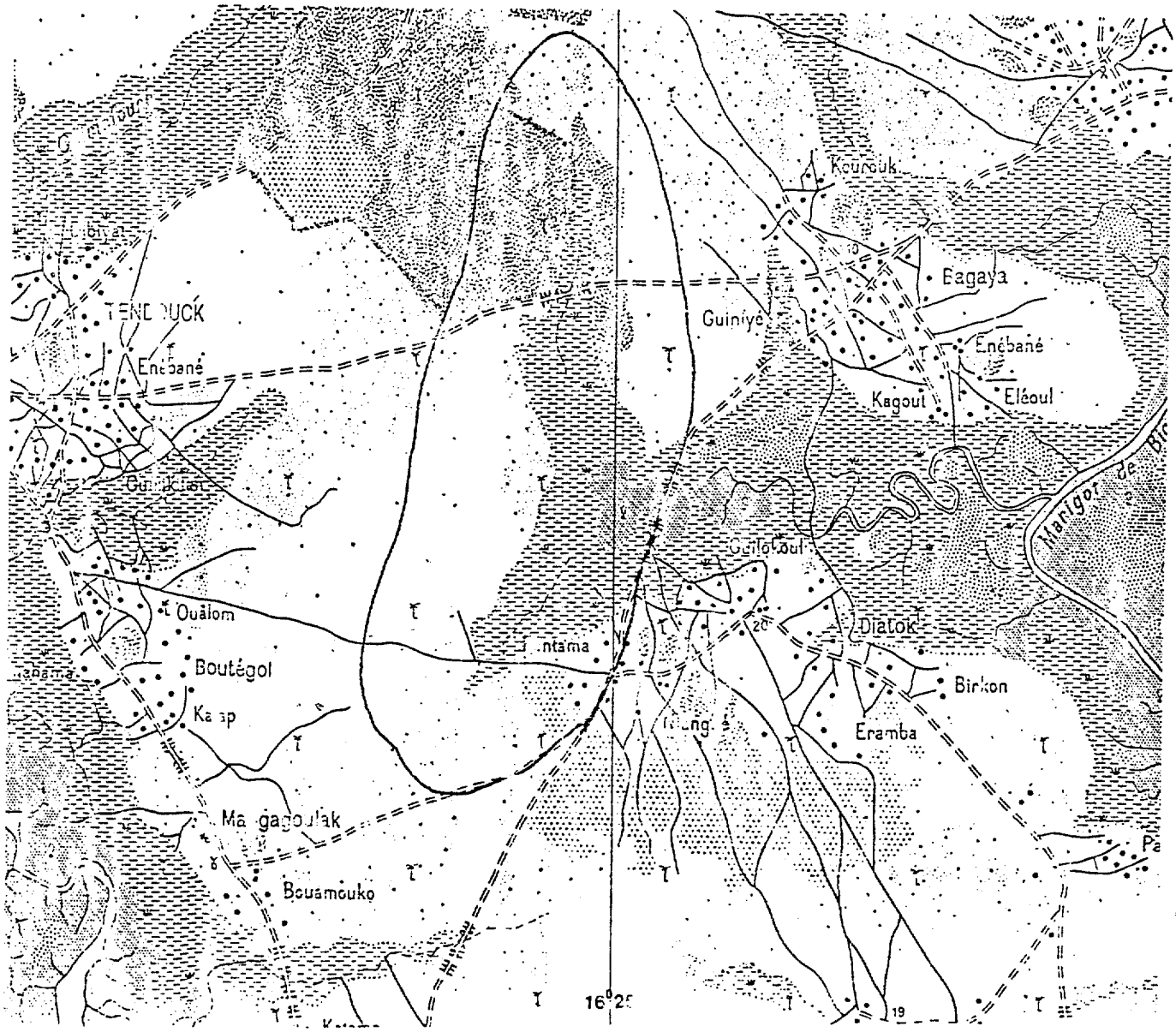
Annexe 1 : BASSIN DE BOUNKILING

Annex 1 : THE BOUNKILING WATERSHED



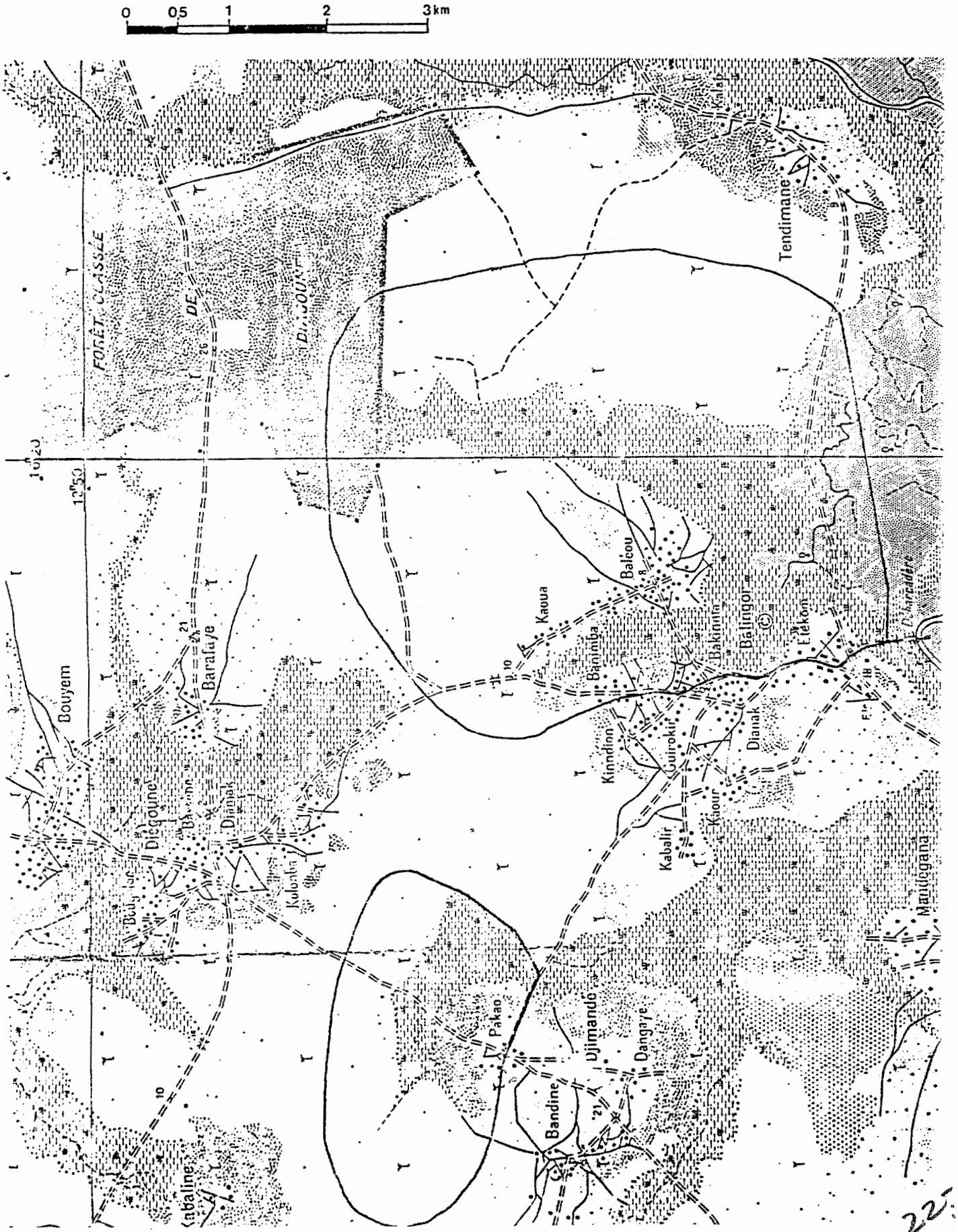
Annexe 1 : BASSIN DE DIATOK

Annex 1 : THE DIATOK WATERSHED



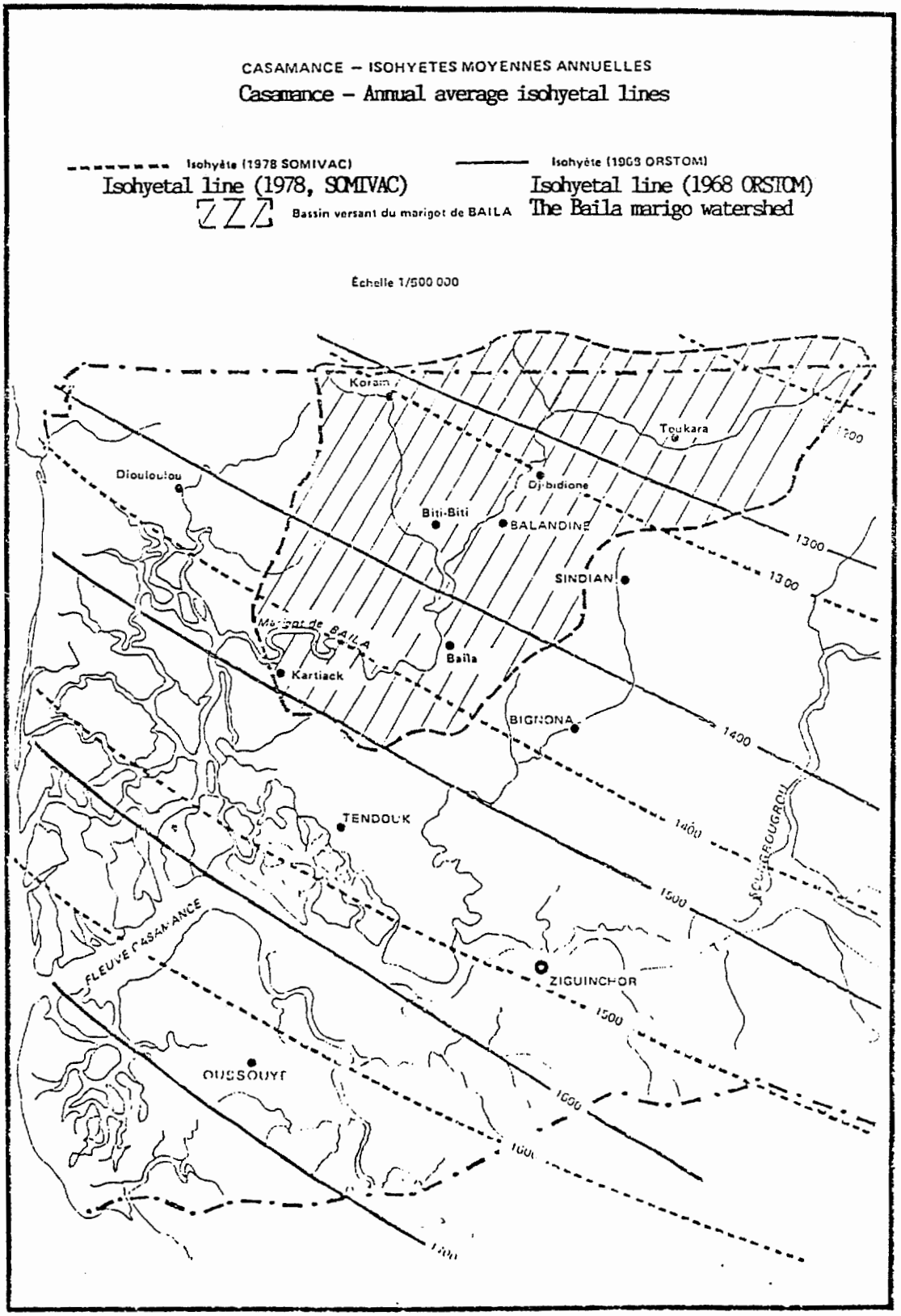
Annexe 1 : BASSIN DE BALINGOR et DE DJIMANDE

Annex 1 : THE BALINGOR AND DJIMANDE WATERSHED



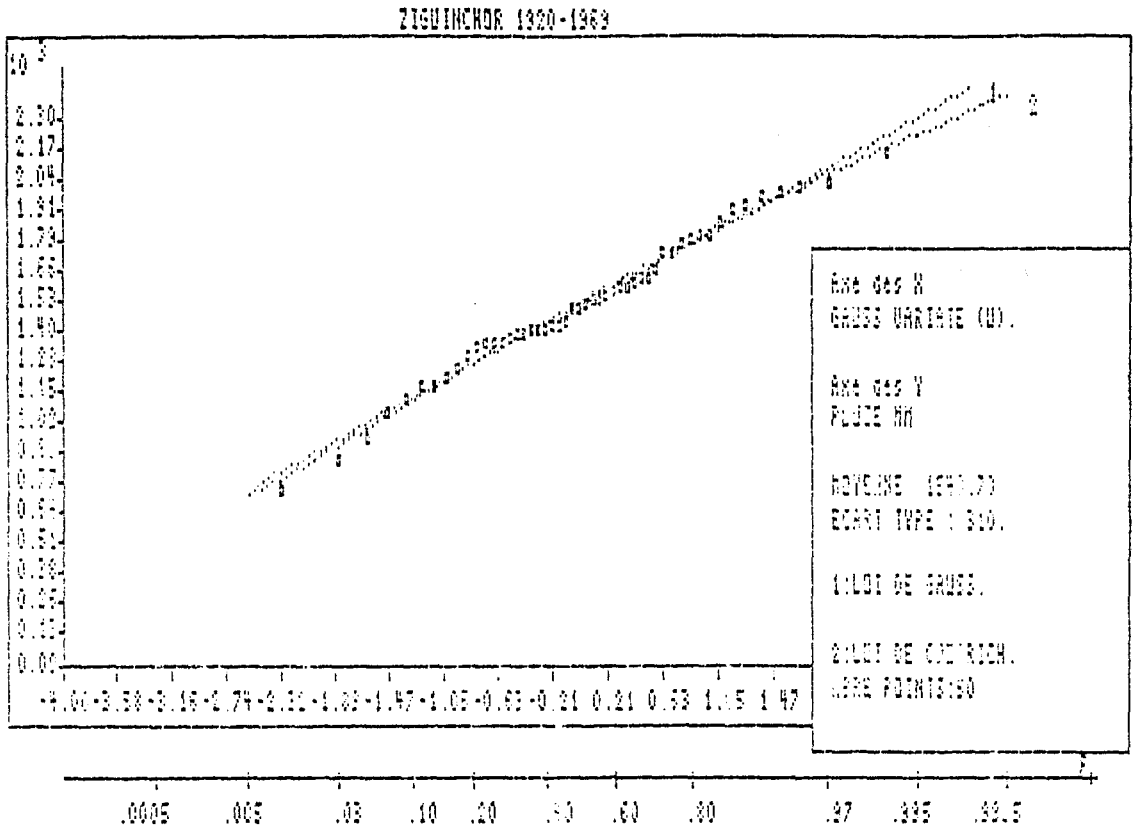
Annexe 2 : CARTE DES ISOHYETES SUR LA BASSE ET MOYENNE CASAMANCE (OLIVRY et DACOSTA, 1983)

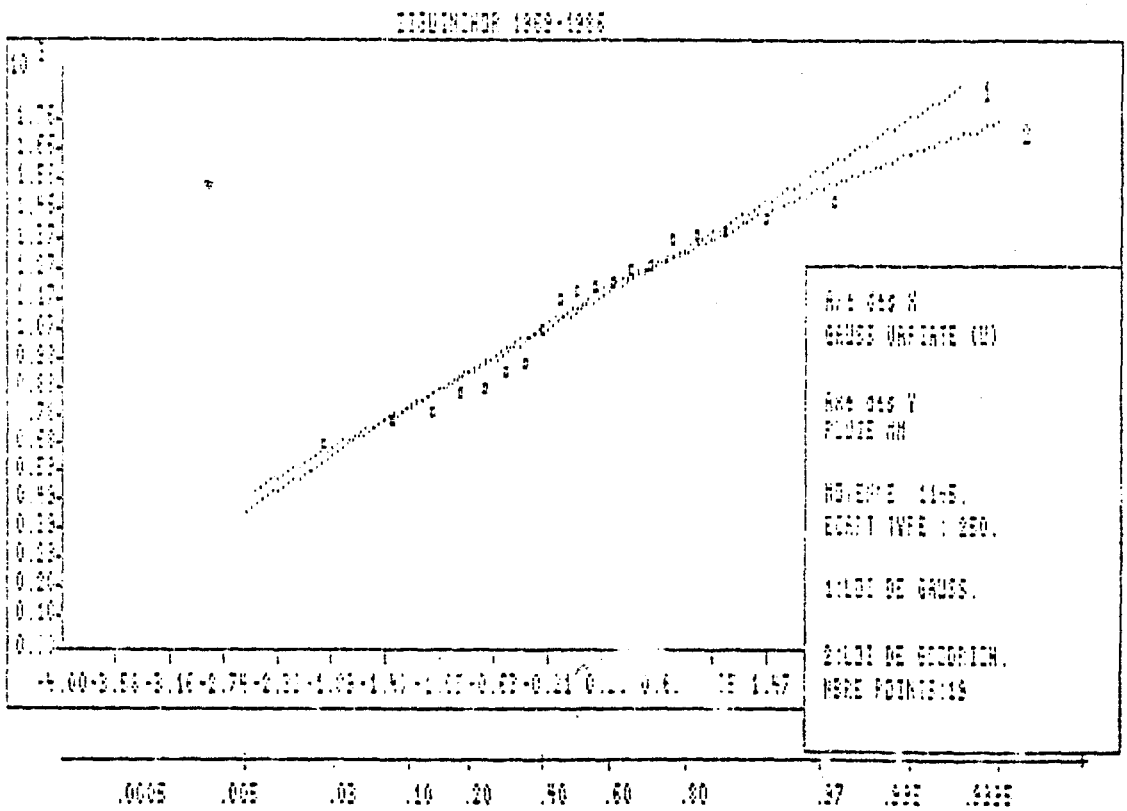
Annexe 2: YSOHYETAL LINE MAP OF THE LOWER AND MIDDLE CASAMANCE (OLIVRY AND DACOSTA, 1983)



Annexe 3 : Ajustement statistique sur les pluviometries annuelles à ZIGUINCHOR.

Annex 3: Statistical adjustment on the Ziguinchor annual rainfall.





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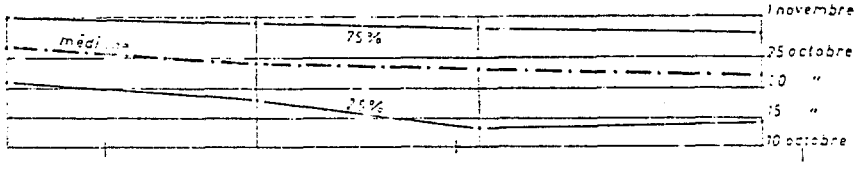
Annexe 4 : Début, fin, et durée de la saison des pluies (BRUNNET MORET, 1970).

Annex 4 : Beginning, end and duration of the rainy season (Brunnet moret, 1970)

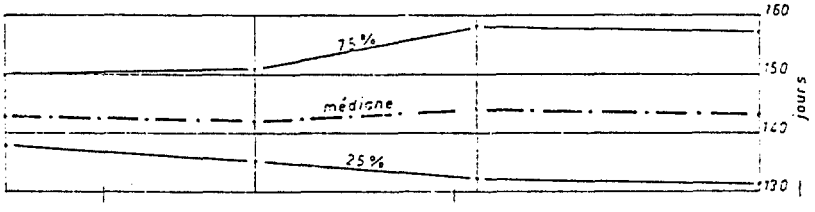
- Date of the end of the rainy season.

Date de la fin de la saison des pluies



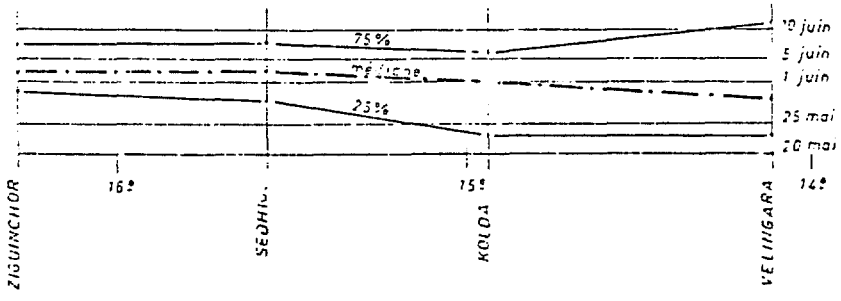
- Duration of the rainy season.

Durée de la saison des pluies



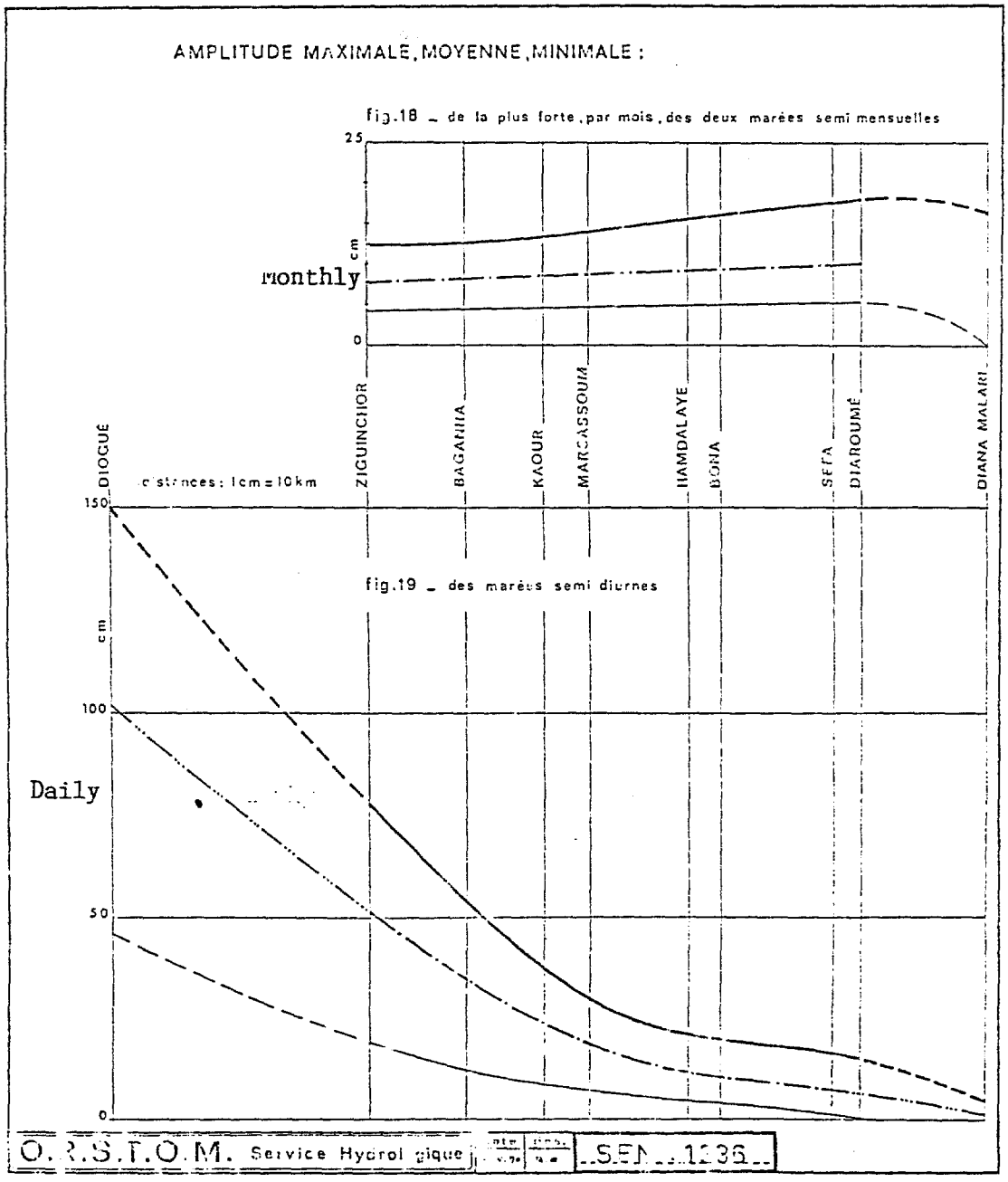
- Date of the beginning of the rainy season.

Date du début de la saison des pluies



Annexe 5 : Amplitudes des marées (BRUNNET MORET, 1970)

Annex 5 : Amplitudes of the tides (Brunnet Moret, 1970)



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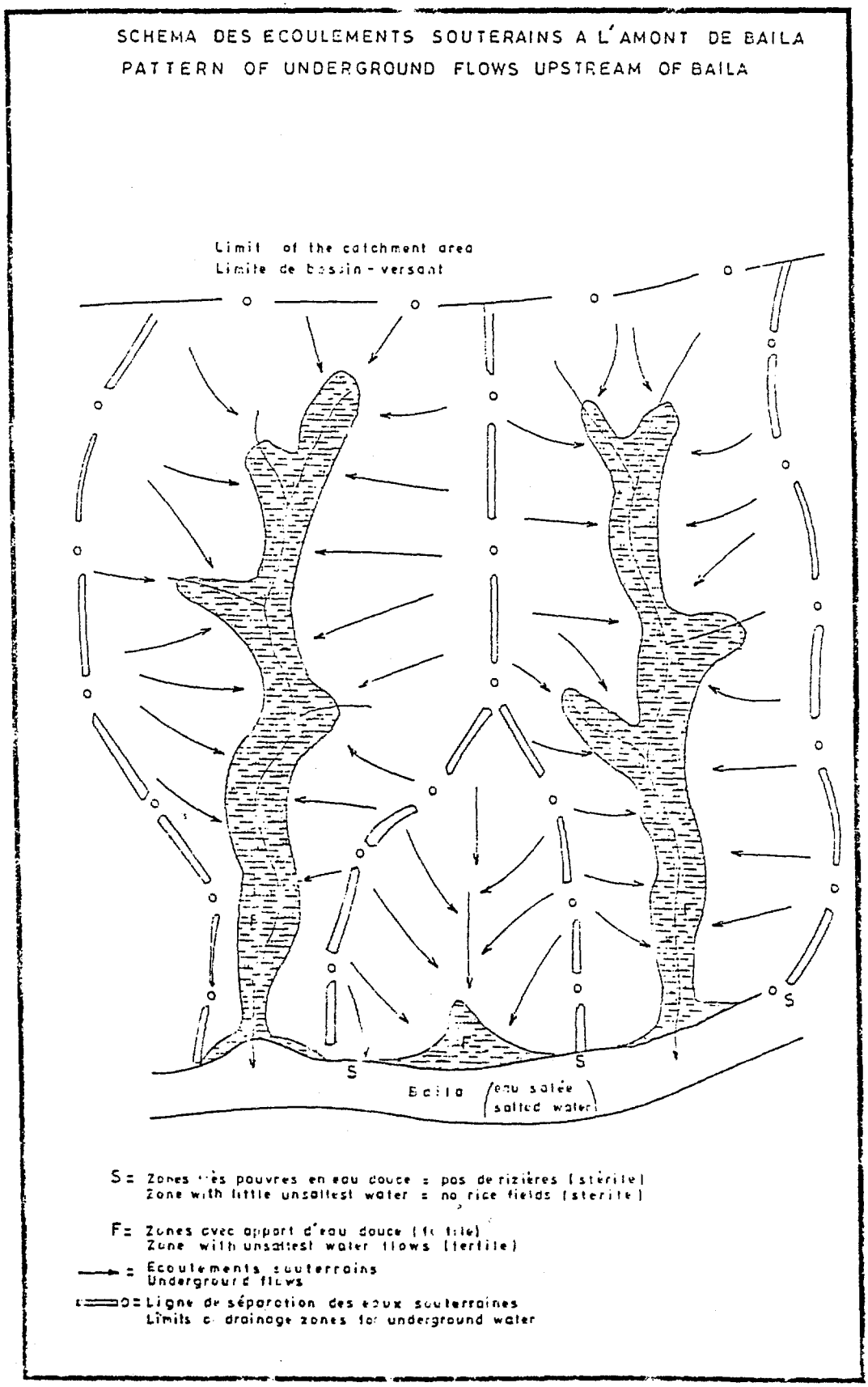
Annexe 6 : Schéma de fonctionnement de l'aquifère superficiel. (LOUIS BERGER, 1981)

Annex 6 : Diagram of the shallow aquifer operation (Louis Berger, 1981)



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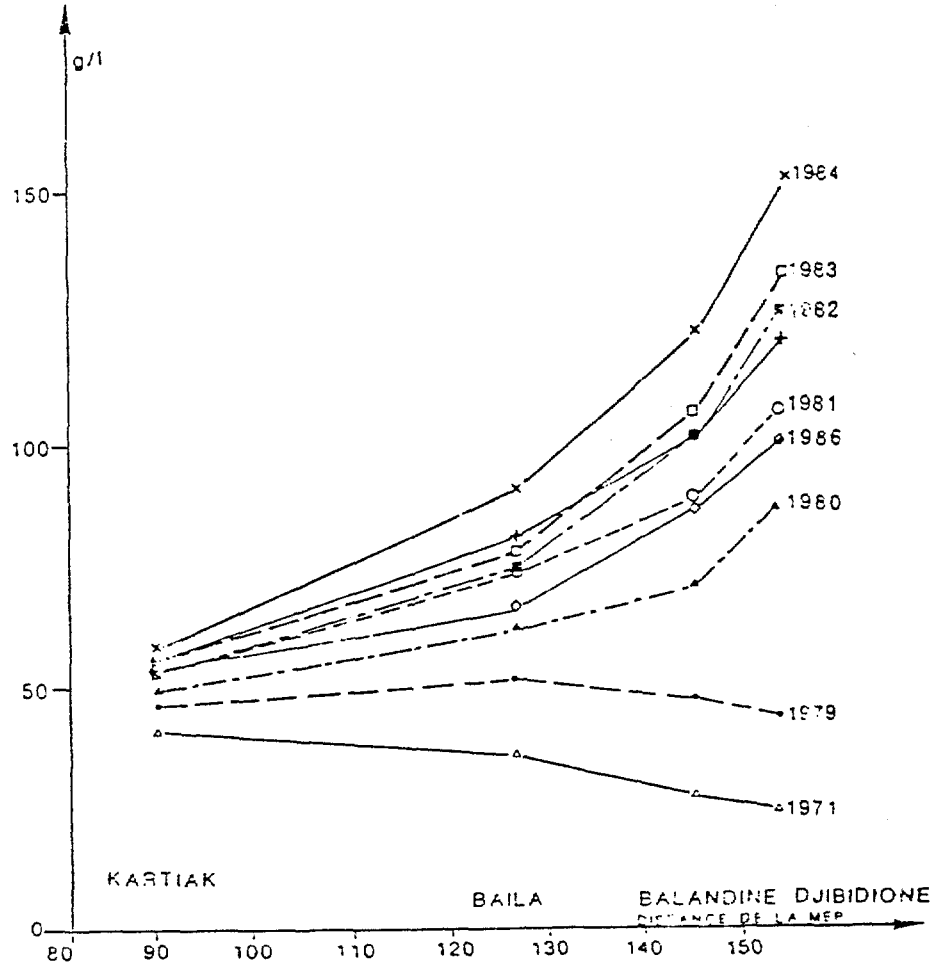
Annexe 7 : Concentration saline en fin de saison sèche pour des années où la recharge des nappes a été plus ou moins bonne (OLVRY, 1987)

Annex 7 : Salt concentration at the end of the dry season for years when water table recharge has been more or less adequate (Olvry, 1987).



EVOLUTION DES CONCENTRATIONS MAXIMALES OBSERVEES

EN FIN DE SAISON SECHE SUR LE MARIGOT DE BAILA

Evolution of maximum salt concentration observed at the end of the dry season on the Baila Marigot.

SOUTHERN ZONE WATER MANAGEMENT

PROJECT PAPER

ECONOMIC ANALYSES

ANNEX G2

Frans J.J. van Eysinga M.Sc.
Associate

Development Alternatives, Inc.

USAID/DAKAR
THE REPUBLIC OF SENEGAL

December 15, 1987

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ECONOMIC ANALYSIS

I. ECONOMIC VIABILITY OF PROPOSED PROJECT

A. Over the Life of the Project

The SZWM project can be considered to be economically feasible. The economic internal rate of return (IRR) of the project is 22%. With a reduction of benefits by 30% the project shows an IRR of 17%, whilst a 50% decrease in benefits still shows an IRR of 12%. It shows that the project design is robust and makes economic sense even at greatly reduced benefit flows.

These calculations do not take into account the spread effects that can be expected as a result of the project. Although the technical assistance, training, research, monitoring and evaluation costs are substantial, the economic viability of the project does not rest on the calculation of post-project spread effects, notably the further reclamation and improvement of land and the value of the creation of institutional capability. Appendices 1 and 2 show the details of the IRR calculations.

Four project scenarios and their consequences for the IRR are presented in the table below.

Table 1. Sensitivity of project IRR to decreased surface area and yield levels.

Improved Surface Area under Cultivation	Expected Increased Yield: 1800 kg/ha	Expected Increased Yield Reduced by 30%: 1260 kg/ha
Expected: 15,000 ha	IRR = 22%	IRR = 17%
Reduced by 30%: 10,500 ha	IRR = 17%	IRR = 9%

Note: Estimated economic Casamance farm gate price for paddy in 1990 is $243/t.

The financial contribution of the Senegalese government over the eight years of the project's life is over $1.6 million. The contribution of the villagers, in the form of labor has been valued at $1.1 million. The total USAID contribution is estimated at $18 million.

During the project's life, the 8 years to be financed by USAID, it is estimated that 15,000 ha will be reclaimed or rendered more productive as a result of better water control techniques and the construction of the required infrastructure to achieve this. The total economic cost, expressed in 1987 prices, for the reclamation of the 15,000 ha is estimated at $14,138,000 which means an investment of $942/ha. In the pre-feasibility study it was pointed out that in order to meet the target IRR of 12%, an additional production of approximately 700 kg of paddy rice would be required to justify this level of investment. The expectation is that, as a result of the project, additional net production levels of 1.8 tons of paddy rice per ha will be achieved on the 15,000 ha because of the better water availability and the possibility of putting the fertile valley soils, lost due to salt water intrusion, back under cultivation.

At present production levels, a maximum of 500 kg of paddy per ha are achieved on the uplands in the areas where the farmers had to abandon their fertile valley lands because of salt water intrusion.

The net production figure of 1.8 tons of paddy rice per ha takes into consideration the existing rice production on the uplands, the expected decrease in production of other (cash) crops and the village labor required for the maintenance of the infrastructure, which is deducted from the gross production expected to be 2.5 t/ha. It is expected that the private sector will become more active in supplying the necessary inputs as a result of the NAP of the government. On 15,000 ha the annual production would be the equivalent of 19,500 tons of white rice. This production would have a value of $4,739,000 and represent approximately 6% of the present annual level of national rice imports.

B. Analysis of Potential Spread Effects

The project will reclaim soils that were lost as a result of salt water intrusion and improve the use of available water, land and labor resources by introducing better water management techniques. At the same time, it will reinforce the existing institutions with the expectation that these institutions will take over the land reclamation and water management activities by the end of the project in year 8. Based on the field studies carried out, it is estimated that about 40,000 ha of potentially fertile soils can be reclaimed and/or improved in the Kolda and Ziguinchor regions. If the strengthened local institutions are able to maintain the rate of reclamation of 2,300 ha per year after the project has come to an end, it will take 11 more years to complete the recuperation of the remaining 25,000 ha.

An alternative IRR calculation that includes the spread effects of the project and assumes that 40,000 ha will be reclaimed and/or improved shows an IRR of 26%. If benefits decrease by 30% the IRR would be 21%.

If project spread effects take place and a total of 40,000 ha are reclaimed and/or improved and brought under rice cultivation, and the majority of the farmers have access to inputs, the net additional production per hectare is conservatively estimated at 2 tons of paddy rice per hectare. Based on the World Bank estimated farm gate price in the Casamance for 1990 of

$243/t of paddy rice, the additional value of production will amount to over $19 million per year. The present economic farm gate price in the Casamance is $205/t of paddy rice, while the government fixed farm gate price is $300/t.

The annual production that can be realized on these 40,000 ha per year is the equivalent of 52,000 tons of white rice. This represents approximately 15% of the amount of rice presently imported into Senegal (340,000 t/year). The foreign exchange savings to the Senegalese economy will be substantial, over $19 million per year.

C. Assumptions Used in IRR Calculations

IRR calculations and price breakdowns are presented in the appendices of this annex.

The exchange rate used in the calculations was 1 U.S.$= 283 FCFA.

USAID/Dakar supplied the costs of experts, consultants and support staff as well as the levels of incentive payments for Senegalese civil servants and payment of their per diem until Year Three of the project.

The costs of salaries and per diem (from Year Four, onwards) of Government of Senegal staff were provided by the Government.

For the civil works, unit prices were used which excluded taxes.

The opportunity cost of village labor that will be used to construct the infrastructure during the dry season was estimated at 50% of the financial daily wage rate of $3.

For the cost of equipment, best estimates of tax free C.I.F. Dakar prices were used.

For training and research, best estimates were used based on USAID's experience in Senegal and the cost of U.S. training.

For other costs, best estimates were used. When necessary, taxes were deducted.

Operation and maintenance of the infrastructure will be carried out by the concerned farmers who will be trained to do so. The costs are estimated to be about two percent of the capital cost of the infrastructure, or about $ 3.20 per hectare cultivated behind the dikes per year.

The value of foregone production as a result of the project was deducted from the gross value of paddy production that will be achieved in the with-project situation.

On the benefit side it was conservatively estimated that a net increase of 1.8 tons of paddy rice per hectare can be achieved.

The economic farm gate price for paddy rice in the Casamance of $243/t used in the IRR calculations has been calculated using long term World Bank projections for the world market price of rice in 1990.

The spread effects for the project were calculated based on additional reclamation or improvement of land. Due to insufficient data no attempt was made to quantify other benefits accruing from the project, although positive environmental effects will be substantial.

Sensitivity analyses were carried out, reducing the benefits by 30%, 50% and 60%.

The calculations have been done using constant 1987 prices for costs.

II. ECONOMIC IMPACT OF PROJECT ON ENVIRONMENT

A. Soils

It is hoped that the spread effects of the project will allow the reclamation and protection of an estimated 40.000 ha of land. This land is currently lost to agricultural production, or is of very low productivity due to salt water intrusion and other water-related problems.

These lands will primarily be used for the production of rice, the main staple food in Senegal. The Casamance area, where these lands are situated, has a comparative advantage for rice production over the rest of Senegal. Due to more favorable rainfall, rice production can be achieved on appropriate soils without the need for sophisticated irrigation systems, but protection from salt and proper water management is required.

As is pointed out above, the total potential value of production of these valley lands at 1990 economic Casamance farm gate paddy rice prices of $243 per ton would be nearly $20 million per year.

These valley lands would replace the less productive slope and upland rice fields, where a maximum of 500 kg of paddy per ha are grown. In turn these areas could be used for the production of other cereal crops.

The reclamation of these soils would therefor mean a considerable savings to the Senegalese economy due to the fact that at present approximately 340,000 MT of rice per year are imported.

The pressure on the slopes and uplands would diminish somewhat initially, but as farming becomes more attractive as a result of the reclamation of the valley lands, it is assumed that some young people will return and become farmers. Also improved agricultural techniques and an increase of the present population levels will put more pressure on the available land.

Provided that the inputs are available, these slope and upland soils can be very productive for corn and groundnuts.

B. Fisheries

Within the protected valleys, fishing activities should be improved. This would provide the farmers with an additional source of income and/or improve their diet. Due to the abundance of fish already available on the urban markets at present, it is doubted whether the marketing of fish from the valleys outside the areas where the fish will be caught will be profitable. Already, fish are harvested behind some existing dikes in the Casamance.

C. Trees

Trees growing on the lower slopes of the valleys are threatened due to salt water intrusion at the root level. Particularly, palm oil and Borassus provide women with additional sources of income. The value of production of these activities is difficult to estimate. Palm trees are also used for the production of palm wine. The project will have a major impact on the trees and plants which line the lower valleys in areas where anti-salt dikes are built.

D. Erosion

Contour dikes will slow down erosion on the sloped lands, and water infiltration will improve as a result of these contour berms. Although on the whole erosion is not considered to be a significant problem in the Casamance area, the sloped lands between the valleys and the uplands are prone to erosion when under intensive cultivation.

E. Soil fertility

Due to a shift of agricultural production away from the uplands, it will be possible to allow longer fallow periods, and thus the fertility of the soils on the uplands will improve. Due to population increases in the Casamance and an intensification of agricultural production, it is doubtful whether this will be a long lasting advantage.

III. ECONOMIC CONSTRAINTS TO INCREASED AGRICULTURAL PRODUCTION

A. Input Supply and Credit

The field work of the PP Team confirmed the fact that supply of modern inputs for agricultural production is very irregular. Most inputs appeared to have been supplied in the past by agricultural development projects. During the mission's visits to the 10 pre-selected sites, it was noted that only SODEFITEX had supplied farmers with the necessary inputs to grow cotton. Farmers were aware of the advantages of the use of modern inputs such as fertilizer and improved seed varieties.

No planning with regard to the supply of inputs exists, although various projects (DERBAC, PRIMOCA) intend to supply these services. As a result of the NAP, it is expected that the private sector will also start supplying inputs.

Another limiting factor to the expansion of agricultural production is the lack of access to credit for most farmers. Again, in the past, various projects supplied credit. At present the CNCAS is starting its activities with the aim to cover the Casamance region. CNCAS is financed by various donors, and eventually could become an important source of credit. During the field work, no evidence was found concerning CNCAS activities since they just opened an office in Ziguinchor in 1987.

Past credit schemes were often poorly designed and resulted in poor repayment rates, with the result that these schemes had to be closed down. Farmers themselves are also to blame for the fact that credit is no longer available due to poor repayment performance.

As yet, incentives for the private sector are insufficient for it to set up an input supply system. It is expected that as a result of the NAP and projects such as the USAID-financed Agricultural Production Support project this situation will change.

B. Marketing Channels

Agricultural production for fruits and vegetables is constrained due to the fact that there is no efficient marketing system in operation. Transport for perishables is extremely expensive. Productivity is dispersed. Supporting structures are nearly non-existent. Local markets are small and provided with good quality produce from overseas. Local vegetable species are generally produced all at the same time causing local market gluts.

C. Agricultural Services

Activities of the Agricultural services are very limited, due to financial and logistical problems. They receive operating funds sufficient to carry out annual production and yield surveys and administrative duties. They also receive special funds for emergency plant protection campaigns.

D. Pricing and Trading Policies

The GOS has liberalized trade in agricultural commodities. The private sector is now allowed to deal in most agricultural commodities. Minimum farm gate prices are fixed by the GOS.

The farm gate price for rice is also fixed by the government and is currently $300/t of paddy. Allowing for transport from the rice production areas to Dakar and the fact that the rice produced in the Casamance region is of a better quality than the 100% broken rice normally imported, the farm gate price in the Casamance is approximately 30% higher than the CIF Dakar price for 100% broken rice from Thailand .

In the Casamance region all produced cereals are consumed on the farm. The area has a cereals deficit and imports approximately 50% of its cereals. It is not expected that farmers benefitting from this project will export rice outside of the Casamance area.

Cotton and groundnuts are still primarily sold to state organizations.

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At the present depressed World market prices for groundnuts, production of groundnuts is no longer economically justified. SONACOS pays, at present, more than three times the World market price for groundnuts. It is heavily subsidizing the farmers in the Casamance who grow peanuts and who depend on the proceeds of peanuts to supplement their diet.

NOTE: Appendices regarding economic analysis are attached to the Financial Analysis Annex (G.3.).

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FINANCIAL ANALYSIS

ANNEX G.3.

Frans J.J. van Eysinga M.Sc.
Associate

Development Alternatives, Inc.

USAID/DAKAR
THE REPUBLIC OF SENEGAL

December 15, 1987

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FINANCIAL ANALYSIS

I. METHODOLOGY

The team visited 10 pre-selected sites chosen on the basis of the findings of the pre-feasibility study. On each site interviews were conducted with farmers in the principal villages. The aim was to establish typical farm budgets for each of the villages, or for a group of villages with similar conditions. The major production constraints facing the farmers were identified. Data covering the past two years of production were gathered. Of the 10 villages, eight had lost considerable surfaces of valley rice lands as a result of salt-water intrusion.

The findings of this section were discussed with the head of the farming systems research team of ISRA, and his comments and suggestions have been incorporated.

Due to time constraints it was only possible to interview a limited number of farmers, and the sample size is considered to be too small to be representative. However, based on the comments received from ISRA and other people familiar with agricultural production in the Casamance, it is judged that the collected data is sufficiently reliable to illustrate the financial gains to the farmers and their families as a result of project intervention.

SOMIVAC and ISRA have carried out farming systems research in the Casamance basin covering several farming seasons. These studies supply a more complete picture of the agricultural activities in the Casamance area. These studies concentrated on villages that had not lost land as a result of salt-water intrusion.

II. PRINCIPAL CONCLUSIONS

The farm budget data presented clearly show the interest of concerned families in the successful implementation of the project, and notably the recuperation of the lands lost to salt-water intrusion.

The revenues per person-day on recuperated valley lands from rice production will go up by an average factor of six compared with revenues per person-day worked on the slope and uplands producing the same crop.

Revenue per person-day worked for all crops will go up by a factor of 1.5 once the recuperated areas can be brought under rice cultivation.

The farm budget for Djimande shows that the farmers had considerably reduced the cultivation of other crops as a result of the construction of the water-retention dam, a scenario which is likely to be repeated in other areas if sufficient water is available because of better water management.

However, the most important aspect is that the families will again be self-sufficient in food and that the crop of choice (rice) has a relatively high economic value. Rice production will increase from 5 to 10 times in the areas that had lost rice lands because of salt-water intrusion.

III. MAIN FINDINGS

In the 10 principal villages visited, eight had lost considerable valley land surface area as a result of salt-water intrusion.

All villages visited were unanimous about the fact that their primary objective was to produce enough rice to meet the subsistence levels, a level which in most of the villages had not been achieved during the past 10 - 15 years. In the villages with the Diola farming system (men and women working together) it was indicated that the cultivation of other crops, notably peanuts, would be sacrificed if more suitable land becomes available for the successful cultivation of rice and where yields of around 2 t/ha could be expected. At present, proceeds of the sales of peanuts are used for the purchase of additional rice, repayment of loans, payment of taxes, clothing, school fees, etc.

Farmers use the proceeds from the sale of peanuts (sold at 90 FCFA per kg) primarily to purchase rice. Effectively the sale of 1 kg of peanuts allows the purchase of 0.56 kg of white rice at the official price of 160 FCFA/kg. This means that the production of one hectare of peanuts allows the farmer to purchase approximately twice as much rice as he presently produces himself on that hectare, which at best yields 500 kg of paddy rice. The time needed to cultivate one hectare of peanuts is more or less the same as that required to cultivate one hectare of upland rice.

It is claimed that most of the rice sold in the Casamance is (illegally) imported from the Gambia and sells at about half the official Senegalese price. This means that one hectare of peanuts would allow the purchase of four times the amount of white rice that could be produced on that hectare, at the present high peanut prices.

From a farmer's viewpoint, it would therefore make sense in the present situation to abandon the cultivation of rice altogether and concentrate upon the production of peanuts.

In the with-project situation this will be reversed since it is expected that gross rice yields will be around 2.5 tons of paddy per hectare. This equals 1.6 tons of white rice. The break even production level would be 1.2 tons of paddy per hectare. This takes into consideration that the required amount of labor to cultivate one hectare of aquatic rice is 180 days versus 110 days needed to cultivate one hectare of peanuts.

The farm budgets presented below illustrate this point quite clearly. The calculated revenues per person-day worked on the cultivation of rice will be around FCFA 1100 per day compared to FCFA 700 for the cultivation of peanuts.

Because the present peanut prices are more than three times the World market price, it is not expected that the farm gate price of 90 FCFA/kg will be maintained in the next year, if the World market price remains at their present levels.

A lowering of the price paid for peanuts to present World market levels would have strong repercussions for the farming families in the Casamance. A shift away from groundnuts to other upland cereal crops would be the likely result.

As pointed out above, farmers are primarily subsistence farmers, and they attach a high value to feeding their own families first.

SONACOS is the state organization responsible for the purchasing, processing and marketing of groundnuts and the products derived from groundnuts. Until recently SONACOS supplied the farmers with seeds. As a consequence of the NAP this activity was stopped this year. The result was that some farmers were not able to produce peanuts because they had not saved any seeds from their previous harvest.

Few of the families interviewed were able to produce or purchase enough food for a whole year. Although remittance payments in a number of cases were used to purchase additional food it appeared that most families suffered from food shortages at certain times during the year.

Fish are an important source of protein in the villages visited. For the men who practice it, fishing provides a significant additional source of monetary income.

Women practiced vegetable gardening on a limited scale. Due to the lack of access to urban markets, production was mainly consumed at the village level and did not form a substantial source of revenue. Transformation of food, and the production of palm oil provided other sources of monetary revenue for the women.

All of the villages visited have had a strong reduction in their work force. As a result of the diminishing rainfall over the past 15 years, agricultural production declined and not enough food could be produced to feed the entire population in the villages. As a result, many young people left their villages for the urban centers in search of more remunerative work.

IV. DESCRIPTION OF FINDINGS FOR EACH TYPICAL SITUATION

A. Djimande

This village has a functioning water retention dike. The first dike had been constructed under ILACO supervision approximately 10 years ago. It broke twice in the two years following its construction and was not repaired after the second year. In 1985 PIDAC rebuilt the dike, and it appears now to be functioning in a satisfactory manner. It was evident that maintenance of the infrastructure deserved more attention in order to prevent a repeat of the previous disasters.

This village provided the mission with an opportunity to study the effects of a functioning water retention dike.

The work for the upland and valley crops is shared by the men and the women of the village (Diola farming system).

No problems with salt-water intrusion were encountered by this village. For the upland crops, land was not a constraining factor to agricultural production. However, an increase in valley land for the cultivation of rice would be welcomed. Agricultural production could be increased if one or two upstream dams would be constructed. This would increase the productivity of the areas in between the valleys and the upland areas.

The farmers indicated that by constructing a water diversion canal, which would channel surplus water collected by the water-retention dike to another lower lying valley, a further 100 ha could be brought under cultivation.

The major constraints to increasing agricultural production cited were the lack of labor, the lack of credit and the lack of fertilizer. During school holidays, young people return to the village to help out with the farm work.

The villagers interviewed thought that people would return to the village if the opportunities to make a decent living would improve.

This village benefitted from PIDAC assistance in 1985, notably with regard to the supply of inputs on a credit basis. Since not all farmers had reimbursed their loans to PIDAC, no inputs had been made available since. For the farmers there were no other forms of credit available, and it was therefore not possible for them to obtain modern inputs. The farmers interviewed indicated that they could double their rice yields if they had access to fertilizer and improved seeds.

This year's rice harvest in this valley which benefitted from the water-retention dam was 2 t/ha. The lower part of the valley could support a second or ratoon crop. However, since the animals are not properly herded after the main harvest, it is not possible to get additional production in this part of the valley.

According to the farmers interviewed, groundnut production was minimal in the village. Corn and millet grown respectively were one half and one hectares yielding 500 kg of corn and 500 kg of millet.

The sale of oranges provided an additional source of income. The farmer interviewed had sold 700 kg for 50 FCFA/kg.

The women had organized themselves in groups that produced vegetables. Due to the difficulty of finding outlets, the production was limited. It was indicated that if the area available for rice cultivation could be expanded, the cultivation of vegetables would no longer be possible due to the conflicting labor demands.

In conclusion, it can be said that this village provided the team with an encouraging example of what can be expected as a result of proper water management and productive rice lands.

B. Essoum

Essoum is another village that has not suffered from salt-water intrusion. However, the production of rice has suffered considerably from the irregular supply of water. In recent years, grasshoppers have had a negative impact on the rice harvests. PIDAC sprayed the area this year to combat the grasshoppers, but the women indicated that a lot of damage had already been done prior to the spraying. In 1986, the rice harvest was minimal and many women did not have seed left for this year's rice crop. The women grow rice with the assistance of the men who prepare the soil (the Diola farming system).

The upland crops are grown by men and women. Animal traction is used. The village has 15 pairs of oxen.

The farmer interviewed, who used animal traction, grew three hectares of groundnuts and three hectares of sorghum. He also had seeded corn, but the harvest was strongly reduced as a result of pest problems.

This village demonstrates the need for improved water management which would allow a substantial increase in rice production. Also it is evident that the lack of access to agro-chemicals has done a lot of damage to crops. The use of animal traction allows the cultivation of substantially larger areas.

C. Balingor, Diatok, Samine-Escale, Mayor, Bounkilling, Tanaff, Kinndiri-Madina, Ndiama-Amont

These villages are similar because they all have suffered from salt-water intrusion. They have had to abandon the majority of their valley rice fields resulting in a severe shortage of suitable land for rice cultivation. As a result, rice production has shifted away from the valleys to the areas in between the valleys and the uplands, and to the uplands.

In Balingor and Diatok, men and women jointly cultivate their fields (Diola system).

In Kinndiri-Madina a small number of families practice the Diola system. However the Mandinka system (women are responsible for the rice crop and the men for the upland crops) is used by the majority of the village. This is also the case for the remainder of the villages covered in this section.

In none of these villages did the families grow enough rice for their own needs. Rice yields varied considerably from year to year and from village to village. It was found that the maximum production of rice in these villages this year was 600 kg/ha (Samine-Escale and Balingor), which was considerably higher than last year's crop. The level of production in the other villages was around 300 kg/ha However, it was difficult to obtain reliable data on the surface area of rice cultivated and the quantities harvested, since in many cases rice was consumed immediately after it was harvested.

On average rice production seemed to be sufficient for three month's consumption, after which rice had to be bought, and/or other cereals had to be consumed. Corn is harvested before the rice, and is therefore an important crop. On the whole, there is a net food deficit.

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In Samine-Escale approximately 25% of the women had in recent years started to grow groundnuts. In N'diama-Amont 10% of the women had started to do the same. In order to do so they had to reduce the surface of rice cultivated. For each unit of abandoned rice surface, sufficient labor was freed to cultivate two units of groundnuts. The women who grew groundnuts found that by selling their groundnuts they could purchase more rice than their own foregone rice production (see also section 3). With the exception of a few individual cases, the practice of women growing groundnuts in other villages was not recorded.

Of the upland crops grown by the men, groundnuts appeared to do best.

Corn on the whole was less successful, either because of the lack of fertilizer, or because of insects and other pests. Yields varied from 0 - 500 kg/ha.

Millet as well as sorghum also seemed to have suffered from insect damage in several of the villages visited, although to a lesser extent.

Only in Kinndiri-Madina had all the upland crops shown satisfactory yields, considering that fertilizer had not been available for corn. The other villages either had problems with the corn production, due to insects and birds, or with their millet and sorghum crops due to problems with insects.

Animal traction was partially practiced in a number of villages visited. The highest concentration of pairs of oxen suitable for cultivating the fields was found in Essoum. The farmers using animal traction were able to cultivate approximately twice the surface area as the farmers who did not have access to animal traction. The soil tilling implements purchased on a credit basis for use with oxen had to be repaid over a period of four to five years. Annual payments for these implements ranged from 17,500 - 22,250 FCFA/year.

These villages demonstrate clearly the effects that salt-water intrusion has had on their rice production. Also the need for better agricultural services is clear.

V. FARM BUDGETS FOR THE WITHOUT AND WITH PROJECT SITUATION

A. General

As stated above, it will be difficult to establish typical representative farm budgets. The irregular rainfall pattern over the past 15 years, the irregular availability of modern inputs and the occurrence of pests, have resulted in yields for the agricultural commodities that change considerably from year to year, and from village to village. However, the interviews at village level have provided sufficient data to draw up indicative farm budgets.

Based on the results of the interviews conducted, farm budgets were prepared for the four following situations:

1. Functioning water retention dam, no salt-water intrusion;

2. No water retention dam, no salt-water intrusion, use of animal traction;

3. Heavy salt-water intrusion, men and women sharing work; and

4. Heavy salt-water intrusion, women responsible for rice production, men responsible for upland crops.

Revenues earned from activities other than the cultivation of principal cereal and groundnut crops have not been included in the farm budgets presented since extra agricultural activities differ considerably from family to family. However, they can form important additional sources of cash revenue.

B. Assumptions Used for the Farm Budgets

Each person-day used in the farm budget equals five hours of work.

The farm gate price for rice was derived from the price the farmers have to pay for white rice imported (illegally) from the Gambia and for which they have to pay 80 FCFA/kg. Using the conversion factor for 1 kg of paddy equal to 0.65 kg of white rice, the calculated value of paddy rice to the farmer is 123 FCFA/kg. The official farm gate price as set by the GOS is 85 FCFA/kg. Since the farmers in the Casamance produce only 50% of their families' cereals needs and therefore never sell any rice, it is judged that the GOS set price understates the value of the rice to the farmers and that it is more realistic to use the price that equals the cost of white rice to the farmer.

The average family size is 13, with six active people.

Appendix 9 presents the various investment scenarios. One scenario assumes that the infrastructure will be built using contractors, while the second scenario presents the investment costs using some village labor. The surface area of land that can be recuperated per farming family is also presented in this Appendix. The recuperable surface area per family differs considerably from site to site, and ranges from 4.6 hectares in Essoum to 0.35 hectares in Mayor.

The seed costs have been calculated using the farm gate prices of the crops, since farmers did not have access to improved seed varieties.

The population figures used to calculate the number of hectares that can be reclaimed per farm family were obtained from the Inspectorates of Agriculture in Ziguinchor and Kolda.

For Balingor and Diatok the average calculated surface area per family that could be recuperated is 0.7 hectares.

For Essoum this figure is much higher, 4.7 hectares. It is likely that in the long run, other crops will be sacrificed in this area in order to grow more rice, particularly if peanut prices are substantially lowered. This study assumes that a maximum of two hectares of rice can be cultivated per family, which should yield enough rice to cover the needs of a family of 13 people, without the need to substantially reduce the cultivation of other crops.

A with-project farm budget has been presented for Djimande. The water diversion canal would double the available surface of rice land available for each family. The risk at Djimande is that the present dike may break if proper maintenance is not carried out. Rice production would then probably drop below the 1 t/ha in the area benefitting from the present dike, and to zero in the area below the water-retention dike. Based on the potential foregone production in case of poor maintenance it seems obvious that a maintenance program is justified. The proposed contour berms are likely to have a positive impact on the areas further upstream.

For the remaining six sites it was assumed that an average of 1.5 hectares per family can be reclaimed although there are considerably differences on a site by site basis.

The farm budgets presented for the with-project situation assume a yield of two tons of rice per hectare. This is based on the findings in Djimande, and is considered to be a realistic figure by experts familiar with the Casamance area. These yields can be obtained without using modern inputs. The use of fertilizer, improved seed varieties and better farming techniques should allow a doubling of the rice production.

Table 1; FARM BUDGET, SITUATION WITH EXISTING AND FUNCTIONING DAM

Farm budget; Djimande, Diola farming system functioning water-retention dam, no salt-water intrusion

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	1	2000	200	2	246000	8680	237320	1187
millet/ sorghum	1	500	120	0.5	35000	420	34580	288
corn	0.3	300	35	1	21000	360	20640	590
peanut	-	-	-	-	-	-	-	-
Total	2.3	-	355	-	302000	9460	292540	824

Table 2; FARM BUDGET, SITUATION WITH EXISTING DAM AND WATER DIVERSION CANAL

Farm budget; Djimande, Diola farming system, functioning water-retention dam, water diversion canal, no salt-water intrusion

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	2	4000	400	2	492000	17365	474635	1188
millet/ sorghum	1	500	120	0.5	35000	420	34580	288
corn	0.3	300	35	1	21000	360	20640	590
peanut	-	-	-	-	-	-	-	-
Total	3.3	-	555	-	548000	18145	529855	955

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Table 3; FARM BUDGET, WITHOUT PROJECT SITUATION

Farm budget; Essoum, Diola farming system no salt-water intrusion, use of animal traction

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	0.5	150	65	0.3	18450	3690	14760	227
millet/ sorghum	3	1800	300	0.6	126000	1260	124740	416
corn	2	800	160	0.4	56000	2890	53110	332
peanut	3	2700	250	0.9	243000	22140	220860	883
Total	8.5	-	775	-	443450	29980	413470	534

Table 4; FARM BUDGET, WITH WATER RETENTION DAM

Farm budget; Essoum, Diola farming system no salt-water intrusion, use of animal traction, water-retention dam.

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	2	4000	400	2	492000	17220	474780	1187
millet/ sorghum	2.5	1500	250	0.6	105000	1050	103950	416
corn	2	800	160	0.4	56000	2890	53110	332
peanut	2.5	2250	210	0.9	202500	18450	184050	876
Total	9	-	1020	-	855500	39610	816390	800

Table 5; FARM BUDGET WITHOUT PROJECT SITUATION

Farm budget; Balingor and Djatok, Diola farming system heavy salt-water intrusion

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	0.8	320	200	0.4	39360	5905	33455	167
millet/ sorghum	1.2	720	145	0.6	50400	500	49900	344
corn	0.7	420	70	0.6	29400	830	28570	408
peanut	1.2	1200	132	1	90000	8856	81144	615
Total	3.9		547		209160	16091	193069	353

Table 6; FARM BUDGET FOR SITUATION WITH ANTI SALT DAM SITUATION

Farm budget; Balingor and Djatok, Diola farming system anti-salt/water retention dam

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice*	1	1570	185	1.6	193110	8610	184500	997
millet/ sorghum	1.2	720	145	0.6	50400	500	49900	344
corn	0.7	420	70	0.6	29400	830	28570	408
peanut	1.2	1200	132	1	90000	8856	81144	615
Total	4.1		532		362910	18796	344114	647

* 0.7 ha cultivated on recuperated valley land, 0.3 ha on upland.

Table 7; FARM BUDGET WITHOUT PROJECT SITUATION

Farm budget; Samine-Escale, Mayor, Bounkilling, Tanaff, Ndiama Kinndiri-Madina. Mandinka farming system. Heavy salt-water intrusion.

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	1	350	200	0.35	43050	7380	35670	178
millet/ sorghum	1.5	600	180	0.4	42000	630	41370	230
corn	1.5	975	150	0.65	68250	1785	66465	443
peanut	1.5	1500	165	1	135000	11070	123930	751
Total	5.5		695		288300	20865	267435	385

Table 8; FARM BUDGET WITH ANTI-SALT DAM SITUATION

Farm budget; Samine-Escale, Mayor, Bounkilling, Tanaff, Kinndiri-Madina. Mandinka farming system. With anti-salt dam.

crop	ha	yield kg	p/days worked	yield t/ha	value FCFA	seed cost	net value	revenue /p/day
rice	1.5	3000	270	2	369000	12880	356120	1319
millet/ sorghum	1.5	600	180	0.4	42000	630	41370	230
corn	1.5	975	150	0.65	68250	1785	66465	443
peanut	1.5	1500	165	1	135000	11070	123930	751
Total	6		765		614250	26365	587885	769

VI. CONSTRAINTS FOR FARMERS TO INCREASE PRODUCTION

A. Input Supply

It was found during the fieldwork that, except for the farmers who grow cotton, few, if any, farmers had access to modern inputs such as improved seeds, fertilizer and agro-chemicals.

SODEFITEX was supplying inputs to the farmers growing cotton in the Kinndiri-Madina area on a credit basis. Also, soil tilling equipment for use with oxen had been supplied on a credit basis by the same organization.

In the past, SONACOS had supplied farmers with seeds for peanut production. However, due to the changes brought about by the NAP, SONACOS will as from this year no longer supply the farmers with seed. The farmers who had not saved any seeds from the previous harvest were not able to grow any peanuts this year.

Even if farmers had sufficient cash on hand they were not able to purchase these inputs because of the non-existence of services that supply these inputs.

A number of farmers/villages had access to modern inputs in the past, but for a variety of reasons they were no longer able to obtain these inputs. Inputs were usually supplied by the various projects, from special production campaigns or from the RDAs. The RDAs were usually supported by projects.

Most farmers appeared to be aware of the advantages of the use of these inputs, particularly for corn and rice.

B. Credit

At the time of the mission, credit facilities were limited to the farmers who were growing cotton.

The CNCAS is still in its start-up phase. None of the villages visited had had access to credit supplied by the CNCAS. In the past, several of the villages had obtained credit from various projects. Due to the non-repayment of loans by a small number of farmers, whole villages had to forego credit facilities.

C. Markets

Access to urban markets is difficult due to the lack of an efficient marketing system. Activities that are potentially very remunerative are therefore limited. Although vegetable gardening is often mentioned as suffering from this lack of access to urban markets it should not be forgotten that vegetables have a high price elasticity, i.e. prices would drop rapidly on the urban markets with an increased supply. However, other activities could benefit from improved market access.

D. Labor

In Djimande, labor appeared to be a limit to expanding agricultural production. Seasonal migration makes this less of a problem during the wet season but for the dry season this poses problems.

This problem may limit the capacity to construct dikes during the dry season in a number of villages. The SZWM project proposes to solve these problems by providing additional equipment (tractors and trailers) as well as contractor services.

E. Land

Almost all of the villages visited lacked sufficient land suitable for the production of rice.

F. Climatological

Irregular and decreased rainfall have been a major constraint to rice production.

G. Animal Traction

Animal traction was not widely used in the villages visited, although the advantages are obvious if properly used.

ECONOMIC AND FINANCIAL APPENDICES

TO ANNEXES G2 AND G3

APPENDIX 1.

SOUTHERN ZONE WATER MANAGEMENT PROJECT ECONOMIC ANALYSIS

Calculation of Economic Internal Rate of Return, without spread effects (15,000 has)

Amounts in U.S. $000

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
TECH ASST.	0	660	660	480	660	660	660	660																	
CONSULTANTS	180	150	150	165	120	105	90	90																	
GOV STAFF	0	94	101	101	94	94	94	94																	
SUPPORT STAFF	50	132	132	132	132	132	132	132																	
INFRASTRUCTURES	174	236	416	456	662	553	602	661																	
TRAINING	0	266	276	126	102	70	50	10																	
RESEARCH	0	325	240	200	170	160	0	0																	
EQUIPMENT	530	100	80	45	389	45	45	45																	
LOG. SUPP	110	192	177	205	146	122	122	122																	
EVAL & AUDIT	0	55	75	0	135	0	75	60																	
O&M	0	0	0	1	6	12	19	26	34	41	45	48	48	48	48	48	48	48	48	48	48	48	48	48	48
TOTAL COSTS	1044	2210	2307	1911.4	2595.8	1953.1	1889.1	1900.4	33.796	41.110	45.491	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
BENEFITS	0	0	0	197	809	1672	2637	3643	4649	5251	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555	5555
CASH FLOW	-1044	-2210	-2307	-1714.	-1786.	-281.1	747.83	1742.5	4615.2	5209.8	5509.5	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3	5507.3
IRR=22%																									
BENEFITS -30%	0	0	0	137.9	566.3	1170.4	1845.9	2550.1	3254.3	3675.7	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5	3888.5
CASH FLOW -30%	-1044	-2210	-2307	-1773.	-2029.	-782.7	-43.26	649.61	3220.5	3634.5	3843.0	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8	3840.8
IRR=17%																									
BENEFITS -50%	0	0	0	98.5	404.5	836	1318.5	1821.5	2324.5	2625.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5	2777.5
CASH FLOW -50%	-1044	-2210	-2307	-1812.	-2191.	-1117.	-570.6	-78.98	2290.7	2584.3	2732.0	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8	2729.8
IRR=12%																									

APPENDIX 2

SOUTHERN ZONE WATER MANAGEMENT PROJECT ECONOMIC ANALYSIS

Calculation of Economic Internal Rate of Return, including all spread effects (assuming 40,000 ha rehabilitated)

Amounts in U.S. $000

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
TECH ASST.	0	660	660	480	660	660	660	660																	
CONSULTANTS	180	150	150	165	120	105	90	90																	
GOV STAFF	0	94	101	101	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94						
SUPPORT STAFF	50	132	132	132	132	132	132	132																	
INFRASTRUCTURES	174	236	416	456	662	553	602	661	661	661	661	661	661	661	661	661	661	661	661						
TRAINING	0	266	276	126	102	70	50	10																	
RESEARCH	0	325	240	200	170	160	0	0																	
EQUIPMENT	530	100	60	45	369	45	45	45	5	5	25	95	5	15	5	95	5	15	5						
LOG. SUPP	110	192	177	205	146	122	122	122	122	122	122	122	122	122	122	122	122	122	122						
EVAL & AUDIT	0	55	75	0	135	0	75	60																	
O&M	0	0	0	1	6	12	19	26	34	41	45	48	64	95	111	114	118	121	124	127	127	127	127	127	127
TOTAL COSTS	1044	2210	2307	1911	2596	1953	1889	1900	916	923	947	1020	946	997	993	1086	1000	1013	1006	127	127	127	127	127	127
BENEFITS	0	0	0	197	809	1672	2637	3643	4649	5655	6661	7667	8673	9679	10685	11690	12696	13702	14708	15714	16720	17323	17627	17627	17627
CASH FLOW	-1044	-2210	-2307	-1714	-1787	-281	748	1743	3733	4732	5714	6647	7727	8692	9692	10604	11696	12689	13702	15587	16593	17196	17500	17500	17500
IRR=26%																									
BENEFITS -30%	0	0	0	138	566	1170	1846	2550	3254	3959	4663	5367	6071	6775	7480	8183	8887	9591	10296	11000	11704	12126	12339	12339	12339
CASH FLOW -30%	-1044	-2210	-2307	-1774	-2030	-783	-43	650	2339	3035	3715	4347	5126	5788	6486	7097	7888	8579	9290	10873	11577	11999	12212	12212	12212
IRR=21%																									
BENEFITS -50%	0	0	0	99	405	836	1319	1822	2325	2828	3331	3834	4337	4840	5343	5845	6348	6851	7354	7857	8360	8662	8814	8814	8814
CASH FLOW -50%	-1044	-2210	-2307	-1813	-2191	-1117	-571	-79	1409	1904	2383	2814	3391	3852	4349	4759	5348	5838	6348	7730	8233	8534	8686	8686	8686
IRR=16%																									

APPENDIX E3

PRODUCTION BUILD UP OF TONS OF PADDY

ha / year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0														
1500					810	1890	2700	2700	2700	2700	2700	2700	2700	2700
2000						1440	2520	3600	3600	3600	3600	3600	3600	3600
2300							1660	2890	4140	4140	4140	4140	4140	4140
2300								1660	2890	4140	4140	4140	4140	4140
2300									1660	2890	4140	4140	4140	4140
2300										1660	2890	4140	4140	4140
2300											1660	2890	4140	4140
15,000	0	0	0	0	810	3330	6880	10850	14990	19130	23270	25750	27000	27000

APPENDIX E4

SOUTHERN ZONE WATER MANAGEMENT PROJECT
Economic Internal Rate calculation (based on project without spread effects, 15,000 ha)

IRR calculation for a typical site; KINNDIRI-MADINA
Irrigable surface; 446 ha
Surface per family; 2.3 ha

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TA	60	10	10																	
CONSULT.	20	5	5																	
GOS PERS	10	5	3	2																
SUP.STAFF	30	8	4	2																
CIVIL W	117																			
EQUIPMENT	33																			
TRAINING	21																			
RESEARCH	7	8	7	7																
LOG.SUP.	66																			
EVAL/AUD	0			10																
TOTAL	364	36	29	21																
BENEFITS	0	0	78	137	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195
CASH FLOW	-364	-36	49	116	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195

IRR ; 29 %

APPENDIX E5

BREAKDOWN OF COSTS OF CIVIL WORKS PER SOURCE OF FINANCE, USING VILLAGE LABOR

Specification of USAID financed component and village contribution
Village labor is valued at $ 1.50 per day

site	dike fill		laterite	concrete	berm fill		total	
	USAID	village	USAID	USAID	USAID	village	USAID	VILLAGE
Tanaff	$1,520	$2,280	$11,900	$4,900	$12,240	$18,360	$30,560	$20,640
Sam.-Esc.	$1,520	$2,280	$25,600	$4,900	$26,160	$39,240	$58,180	$41,520
Kinn.-Mad.	$5,120	$7,680	$65,500	$3,700	$13,920	$20,880	$88,240	$28,560
Bounkilling	$2,760	$4,140	$15,800	$10,400	$9,600	$14,400	$38,560	$18,540
Ndiama	$3,560	$5,340	$15,800	$9,300	$6,720	$10,080	$35,380	$15,420
Mayor	$1,440	$2,160	-	$5,300	$2,880	$4,320	$9,620	$6,480
Diatok	$3,640	$5,460	$23,100	$4,900	$3,120	$4,680	$34,760	$10,140
Balingore	$25,120	$37,680	$102,400	$3,400	$8,880	$13,320	$139,800	$51,000
Djimande	$4,080	$6,120	-	$2,800	$1,920	$2,880	$8,800	$9,000
Essoum	$2,880	$4,320	-	$10,600	$5,040	$7,560	$18,520	$11,880
Total	$51,640	$77,460	$260,100	$60,200	$90,480	$135,720	$462,420	$213,180

Village contribution ; 31 %
USAID contribution ; 69 %

APPENDIX E6

Official farm gate prices

Rice (paddy)	85 FCFA/kg
Peanuts	90 FCFA/kg
Corn	70 FCFA/kg
Millet	70 FCFA/kg
Sorghum	70 FCFA/kg

source: Ministry of Rural Development

APPENDIX E7

Person days (5 hours) required per crop per ha

Rice	submerged: 180	groundwater: 240	rainfed: 125
Peanuts	with animal traction: 85	without : 110	
Corn	with animal traction: 85	without : 105	
Millet/ Sorghum	with animal traction: 100	without : 120	

source: Recherche sur les systemes de production en Basse Casamance, 1983/1984, ISRA.

APPENDIX E8

Seed requirements per crop per ha

Rice	submerged: 70 kg	groundwater: 52 kg	rainfed: 63 kg
Peanuts	82 kg		
Corn	17 kg		
Millet/ Sorghum	6 kg		

source: Recherche sur les systemes de production en Basse Casamance, 1983/1984, ISRA

APPENDIX E9

SOUTHERN ZONE WATER MANAGEMENT, 10 PRE-SELECTED SITES

- Investment scenarios using contractor prices and construction of infrastructures with a strong village participation
- Gained surface per family farm

	ha gained	investment contractor executed	$/ha	investment village executed	$/ha	farms per site	ha per farm
Tanaff	424	105100	248	51200	121	182	2.33
Sam-Esc	822	207000	252	99700	121	440	1.87
Kinn-Man	446	190700	428	116800	262	193	2.31
Bounkill	335	105100	314	57100	170	239	1.40
Ndiama	230	90400	393	50800	221	232	0.99
Mayor	83	38300	461	16000	193	240	0.35
Diatok	80	70400	880	44900	561	140	0.57
Balingor	245	322500	1316	190800	779	275	0.89
Djimande	64	41000	641	17800	278	90	0.71
Essoum	186	61300	330	30400	163	40	4.65
Total	2915	$1,231,800	$423	$675,500	$232	2071	1.41

APPENDIX E10

BREAKDOWN OF ECONOMIC COST ON A PER HECTARE BASIS
(1987 costs)

Scenarios for recuperation of 40,000 ha and 15,000 ha

Total economic cost for 40,000 ha ; $23,294,000
Total economic cost for 15,000 ha ; $14,138,000

	15,000 ha	40,000 ha
Technical Assistance	$204/ha	$ 68/ha
Consultants	$ 61/ha	$ 25/ha
Government Staff	$ 45/ha	$ 43/ha
Support Staff	$ 45/ha	$ 22/ha
Infrastructures	$232/ha	$234/ha
Training	$ 47/ha	$ 17/ha
Research	$ 64/ha	$ 24/ha
Equipment	$ 73/ha	$ 36/ha
Logistical Supp/O&M	$147/ha	$ 83/ha
Evaluation/Audit	$ 24/ha	$ 10/ha
Total	$942/ha	$582/ha

APPENDIX E1

CALCULATION OF ECONOMIC FARM GATE PRICE OF PADDY IN THE CASAMANCE

	F.CFA/ton
Rice f.o.b. Bangkok, 5 % broken $333/ton	93,900
Reduction of 20 % for 100 % broken	75,120
Transport Bangkok - Dakar	19,000
Port handling charges	7,000
C.I.F. 100 % broken rice Dakar	101,120
Transport Dakar - Casamance	21,000
*Economic farm gate price milled rice Casamance	122,120
Conversion to paddy X.65	79,378
Milling costs	11,000
Economic farm gate price for paddy rice, Casamance	68,378 ($243)

$1US = FCFA 282.

N.B. this calculation follows the format used in the Harza study, among others. This calculation of the economic farm gate price of rice produced in the Casamance incorporates the fact that the rice produced in the Casamance is of a better quality than the 100% broken rice, the type of rice imported in Senegal. Using this formula, the calculated economic farm gate price for the Casamance is higher than if the world market price for 100 % broken would have been used.

Source: World Bank estimates of world market prices for basic commodities, January 1986.

APPENDIX E13

CALCULATION OF ECONOMIC PRICE OF GROUNDNUTS PRODUCED IN THE CASAMANCE

	F.CFA
Price C.I.F. Rotterdam per ton of groundnut oil $529	149,178
Less transport Dakar - Rotterdam	39,000
1. Value of oil per ton f.o.b. Dakar	110,178
2. Conversion to groundnuts X 0.33	36,360
3. Groundnut cake value f.o.b. Dakar $195 Converted to groundnuts X 0.44	24,195
Total value (2+3) per ton groundnuts Dakar	60,555
Less inland transport and handling	25,000
Less conversion costs	10,000
Economic farm gate price unshelled groundnuts in the Casamance	25,555

$1US = FCFA 282

Source: Ministry of Rural Development

SOUTHERN ZONE WATER MANAGEMENT

PROJECT PAPER

SOCIAL SOUNDNESS ANALYSIS

CHRISTINE ELIAS
Rural Sociologist

FOR USAID/DAKAR
THE REPUBLIC OF SENEGAL

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I. FARMING SYSTEMS IN THE PROJECT ZONE

Two major ethnic groups, and their respective farming systems, predomoninate in the project zone. Both groups, Diola and Mandinka, grow rice, millet, sorghum, maize, and groundnuts. Among the Diola, farming tasks for all crops are shared between men and women. Men are responsible for land clearing and tilling, while women do the planting. Both sexes participate in weeding and harvesting all crops. Agricultural tasks among the Mandinka are divided between men and women by crop. Women are entirely responsible for rice production while men cultivate maize, millet, sorghum, and groundnuts.

In both farming systems, producers have been forced to shift their rice fields from the increasingly saline valley floors to the higher slopes. Although not salt-affected, the soils on the slopes have a poorer water retention capacity than the valleys, and consequently a lower yield potential. The cultivation of upland cereal crops among the Diola intensified only as a response to declining rice yields. Although these crops have long been a part of the Mandinka farming system, women are gradually including groundnut cultivation in their farming calendar to compensate for poor rice yields.

Rice is the preferred staple food in the project zone. In the past, farm families grew sufficient quantities of rice each year to subsist at least until the following harvest. Surpluses were common, and their sale allowed farmers to invest in cattle or other personal needs. Recently, however, most families have been faced with deficit rice production levels. With declining rainfall levels and the rapid intrusion of salt water into the river and tributary valleys, the surface area of productive rice land is continuously shrinking. It is not uncommon for families to begin purchasing rice only three months after the harvest. Furthermore, since yields from upland food and cash crops have not increased, many households have been forced to borrow on subsequent harvests. The incidence of families living in continuous debt is becoming more and more frequent.

The land tenure systems of both ethnic groups are based on familial usufructory rights. The primary basis for claim to tenurial rights over land is by first clearing and working of virgin land. Generally, the founding family in a village tended to acquire larger blocks of contiguous land in the most desirable locations. These families have generally retained this advantage over time. Under traditional law, one can borrow land, sometimes for generations, but the "owner" can recall it at any time with one year's notice.

II. SOCIO-CULTURAL FEASIBILITY OF PROJECT

From a sociological point of view, the success of achieving project objectives is based on a number of key assumptions, namely that:

i. demand for the water-control structures exists;

ii. labor is available for construction and exploitation of the improved land;

iii. village participation can be achieved given traditional village organization patterns; and

iv. project objectives are compatible with the land tenure system.

In this section, the validity of each of these assumptions is discussed as well as the constraints to achieving project objectives vis a vis each assumption.

Lessons from past experience with water management efforts in the project zone have served as guidelines for project design. The most important lesson learned is that many of the problems encountered in project implementation could have been averted with better village-project communication before beginning construction. Throughout this analysis, the importance of this process emerges as critical to project success. To facilitate this stage of project implementation, the project design places strong emphasis on the pivotal role of the Regional Water Management Teams and Village Water Management Committees.

A. Demand for Water-Control Structures

The importance of rice in the project area has already been discussed as has the dramatic decline in production levels. But, to what extent do farmers consider the construction of water-control structures as a solution for increasing production? The project assumes there is indeed a strong demand for such structures.

1. Validity of Assumption

Two types of demand exist for water-control structures: explicit and implicit. Furthermore, the type and magnitude of demand for particular kinds of structures -- anti-salinity, water retention, and upland contour berms -- vary between the Ziguinchor and Kolda regions.

a. Anti-salinity Dikes

The tradition of anti-salinity dike construction among the Diola in the Ziguinchor region has been well-established for decades. Rice farmers, particularly in the southwestern areas, have always had to find ways to keep salt out of their fields and over the years have developed a sophisticated system of water management and crop husbandry. With the trend of declining rainfall, however, the traditional dikes and "one-way sluice gates" are no longer as effective as they once were in stabilizing the environment. When PIDAC began to construct improved gates which could regulate the water level upstream of the dikes, farmers immediately recognized their potential benefit. PIDAC was flooded with more requests from villages for improved dikes and sluice gates than they could handle. The demand for anti-salinity dikes in the Ziguinchor region can therefore be described as explicit. For the most part, rice farmers in this area clearly understand the function of

the dikes, have years of experience with them, and see them as important in protecting rice land from salt water degradation.

As one moves further east along the Casamance River and up its main tributaries, saline intrusion is a relatively new phenomenon. In the Sedhiou department, some farmers have been faced with the problem only in the last 15 years. Farmers in the upstream portions of some Sedhiou valleys have been confronted with salt intrusion for the first time this year. Farmers in these areas are indeed worried about the rapid degradation of their rice fields. Each year, rice production is declining as more fields are lost to salt.

Examples of anti-salt dikes are scattered around the Sedhiou department. Some were constructed with PRS technical assistance, while others were completed by the villagers with no outside intervention. At these sites, the demand for anti-salinity dikes was clearly explicit. For the most part, however, demand in the Sedhiou department appears to be more implicit in nature. That is, the need to arrest saline intrusion is clear, but the solution of constructing anti-salinity dikes is not as evident to farmers as it is in western Ziguinchor region.

The Tanaf Valley in Sedhiou is a case in point of implicit demand. Within the last few years, women in villages at the upstream limit of saline intrusion into this watershed have been forced to abandon their rice fields on the valley floor and shift to the higher sloping land. Asked if they had considered constructing an anti-salt barrier, they said they had heard of this option but had never seen such a dike; they would not know where to place a dike nor how to go about constructing it. On the other hand, villages at the bottom of the watershed have been faced with saline intrusion since the early 1970's. They organized an inter-village meeting to discuss solutions to the problem but have yet to take any action. These villages have made the transition from implicit to explicit demand.

b. Water Retention Dikes

In both Ziguinchor and Sedhiou, the demand for water retention dikes is more implicit than explicit. In Ziguinchor, 75% of the more than 100 outstanding requests for assistance submitted to PIDAC are for anti-salinity dikes, not water retention structures. Only six retention dikes have thus far been constructed under PIDAC supervision. In Sedhiou, retention dikes are even more scarce.

The implicit demand is clearly illustrated by farmers' own efforts at developing water retention strategies. For example, a labor intensive system of digging small holes to trap rainwater in rice fields is being practiced in both regions. Farmers dig ponds roughly 75 cm in diameter and 25 cm deep, piling the soil onto ridges around the rim of each hole to create a honeycomb effect. Rice is then planted on the ridges and rainwater collecting in the holes seeps into the root zone of the plants. This system produces very low yields because the plant density per unit area is low.

A further indicator of the implicit demand for retention dikes is the manner in which many villages choose to operate the sluice gates on their anti-salinity dikes. These dikes are often sited downstream of an area which has been lost to salt. The timing of opening and closing the gates recommended by PIDAC is designed to facilitate the flushing of salt from this area and the eventual recuperation of the land for rice production. However, farmers give priority to securing yields on present rice fields rather than to recovering fields for future use. In practice, this means using the dike as a retention structure. Farmers keep the gate closed to allow the impounded water level to reach beyond the abandoned area to higher ground, the location of their present fields. As a result, saline water remains standing on the abandoned area and the recuperation of the land is hampered. This is accepted by farmers in the interest of securing the present crop.

c. Plateau Structures

Farmers have little, if any, experience with soil and water conservation structures (contour berms, water diversions, etc.) on the plateaus. No evidence was found of any attempts by private or governmental organizations to introduce such structures.

Given this situation of explicit and implicit farmer demand for anti-salt and water retention dikes in the valleys, the PP implementation strategy focuses on water management in these zones.

The project design requires villages to initiate the process of water management by making a formal request for assistance to the project. In assessing the validity of these requests, two issues are of concern: (1) whether the problem identified by the village can be solved by constructing the type of water-control dikes proposed by the project; and (2) whether the request is based on a commitment to provide all requisite construction and maintenance labor.

The technical viability of village requests is the subject of the technical analysis (Annex G.1).

Past experience is an indicator of the varying validity of the requests vis-a-vis the village's commitment to provide all requisite construction labor. Some villages made requests expecting projects to provide all labor --they have yet to be constructed. On the other hand, the many PIDAC sites completed with village labor attest to the validity of these demands. Clearly, the validity of requests cannot be assessed simply by the village's written letters. One role of the Regional Water Management Teams is to systematically evaluate each village request through a series of pre-construction meetings with the village(s) concerned.

2. Constraints

Where implicit demand exists, the project will have to strike a balance between waiting for village initiated requests for assistance and developing farmer awareness of the options available for solving their water management problems.

The PID proposed a strategy of coordinated watershed management. However, since not even an implicit demand exists for upland soil and water conservation structures, any demand for these structures will have to be generated through an intensive program of farmer education and extension. The PP strategy is to introduce soil and water conservation on a pilot basis after the first years of the project. One approach might be to begin in one watershed where more than one water-control structure already exists. After formalizing the Village Water Management Committee for each structure, the project could facilitate communication between the committees and ultimately promote cooperative activities between them. Again, in achieving this objective, a delicate balance must be struck between promoting new technologies and allowing Village Water Management Committees to initiate their own programs.

B. Labor Availability

The project strategy of requiring villages to provide all non-specialized construction labor assumes that this labor is indeed available. Furthermore, for the project to achieve the objective of increased agricultural production, labor must be available to exploit the improved land.

1. Validity of Assumption

As demonstrated by the completion of numerous anti-salinity dikes by villagers in the project zone, labor availability for construction need not necessarily be a constraint to project implementation. However, the exodus of able-bodied adults from the rural areas is a well-documented phenomenon in recent master plans (i.e. Harza, 1984) and ISRA reports and a factor in the cycle of declining agricultural production. As rainfall levels decline, production yields decrease. With diminished opportunities for earning cash from agriculture, farmers leave in search of alternative sources of income. Production declines further, prompting even more farmers to leave the villages.

The Harza Master Plan presents a comprehensive discussion of issues related to Diola and Mandinka migration. Some of Harza's conclusions have a direct bearing on the availability of dry-season labor for dike construction:

i. The objectives and destination of seasonal migrants have shifted away from rural-rural migration for fishing, palm wine/oil trade, etc., to rural-urban migration in search of wage-labor opportunities.

ii. Seasonal migrants are staying away from the villages for longer periods of time, i.e. leaving earlier and returning later.

iii. Permanent rural-rural migration appears to be increasing. Families are moving away from rice-growing areas to plateau areas, not for reasons of land scarcity, but to grow cash crops and gain access to what they perceive as better markets in The Gambia.

iv. With the trend towards smaller production units, agricultural labor must be hired from outside the unit. The primary source of cash to pay this labor is from remittances made by the unit's out-migrants. This reinforces the attractiveness of migration.

v. There is a decreasing interest in rice production due to increasing salinization and lower labor availability, since the returns from out-migration are higher than those from rice production.

Clearly, these conclusions suggest that the project can expect to be confronted with a limited availability of construction labor in some villages. Experiences of water management projects confirm this limited labor availability, particularly during the dry season when seasonal migrants leave the village in search of wage labor.

To compensate for construction labor shortages, the project will provide basic machinery to lighten the workload; for example, a tractor-drawn plow to loosen the soil and a trailer to haul soil to the dike site. Furthermore, project assistance with dike compaction and stabilization (with laterite) will reduce the need for maintenance labor during the life of the dike.

Supplemental construction labor could also be hired by the village using the local tax rebate (fonds de concours). These funds are returned to the village through the sous-prefet and are intended for use on village-based development projects.

Before discussing sources of labor for exploiting improved land, a brief review of the changes in rice cultivation patterns over the last 15-20 years is helpful. In some valleys, declining rainfall levels have lead to progressively deeper intrusion of saline water. Each year more rice fields were lost to salt and farmers were forced onto the higher slopes of the valley. These new rice fields were either on previously cultivated cereal fields or on land cleared to accommodate the shifted rice cultivation. The use of these topographically higher fields was clearly a second choice for the rice farmers given their lower organic matter content and poor water-retention capacity. Furthermore, because the higher fields do not flood, rice farmers are faced with more weeding as well. In valleys where salt intrusion is not a problem, rice farmers have generally stayed on the topographically lower sites although yields declined as rainfall levels fell.

At sites where anti-salt dikes have been constructed and previously saline soils recovered, the original owners have tended to shift back to the valley floor. No instances have been cited where this land was left uncultivated, since rice farmers consider it to be the superior land. Since the original owners of any newly reclaimed land are likely to be the ones who have remained in the village (because they have access to the best land), they will eagerly move back to their superior fields. In Diola areas, both men and women would shift from the uplands (i.e. crops they took on only since rainfall levels began to decline) to the newly productive rice fields. In Mandinka areas, women would expand their areas of rice cultivation and/or abandon groundnut cultivation after yields of rice become proven. Any of the higher land which they cannot continue to cultivate will be made available to potential borrowers.

With the construction of water-retention dikes, the issue of exploiting the improved land does not arise because this land had not been abandoned in the first place. The issue is one of stabilizing and improving yields on already cultivated rice land.

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Although the Harza Master Plan concluded that farmer interest in rice production is declining, this statement should be examined in light of the discussion of the preceding paragraphs. Firstly, the land to be affected by the project is the most desirable rice land in the watershed and will therefore be the first to be exploited. Secondly, although the project may have little immediate impact on slowing the rate of seasonal migration, it may gradually have an effect on slowing the exodus of permanent migrants. Families with access to rice land on the valley floor, for example, may consider remaining behind if they anticipate improved yields. However, it must be stressed that although rice farmers in the saline zone have had years of experience with traditional dikes, the introduction of improved sluice gates and better dike construction techniques are relatively new phenomena. The impact of the project on migration patterns can only be realistically assessed well into the implementation phase.

2. Constraints

The amount of available labor varies from village to village. Therefore, it is impossible to have project-wide standards concerning numbers of participants or length of construction time. Work schedules must be determined on a site-by-site basis taking full account of the labor available to each village. This implies that the speed of development may be slower than what may be considered ideal. Some dikes will be over one kilometer long and require massive mobilization. On such dikes, progress will be slow. What is important is for the project Regional Water Management Teams and the Village Water Management Committees to agree upon a work schedule and to stick to it. There will be delays which cannot be scheduled but can be predicted, such as baptisms, funerals and weddings.

In spite of farmers' genuine efforts to provide all requisite labor for dike construction, there will be some villages which lack a large enough work force. In such cases, the project will adopt an implementation strategy whereby village labor capability is assessed and agreement reached on what the village will provide. This leaves open the possibility of villages "hiding" their true labor force if they know the project will meet the deficit. The implementation team will have to assess this situation. One possibility is to work first with those villages that can indeed provide the requisite labor. Requests from labor-poor villages could be monitored to verify a genuine shortage, then assisted with the deficit in later years of the project. Without dike construction, more land will be lost to salt forcing more people to leave the village, thereby further reducing labor supply. If the project were to assist with supplemental labor, the project could make a contribution to breaking the cycle of rural-urban drift.

Although the project will minimize the amount of labor required for dike maintenance, emergency repairs will sometimes be required. Most likely, such repairs will become necessary during the rainy season when cropping activities are given priority. With past projects, the organization of dike maintenance has been difficult to achieve because discussions with farmers on the topic usually began only after construction was completed. The SZWMP will have few precedents on which to base the development of successful maintenance plans. The project will encourage the village to create a maintenance fund with contributions from land users. This practice has worked in Asia where cash is

regularly required to operate and maintain irrigation works. Such plans will be worked out with villagers and tested as the project progresses.

A final constraint to exploiting improved rice land will appear if any attempt is made to promote ratoon or double cropping. Cattle are herded during the rainy season, but are allowed to roam freely after the first harvest. Herding practices would have to be modified and an appropriate watering source located to keep cattle from destroying the second crop.

C. Village Participation

The fundamental strategy of the project is to actively involve villagers at all stages of project implementation, i.e. in the identification of an appropriate water-control strategy, site selection, construction, and resource management for operation and management. How feasible is this strategy? How realistic are project expectations in terms of village participation? Through which village organizations will the project work to ensure village participation?

1. Validity of Assumption

There are a number of traditional village institutions which are common to nearly all ethnic groups in Ziguinchor and Sedhiou. Their existence has been well documented elsewhere and include the village chief, council of elders, men's and women's groups of age peers, and agricultural work groups. What is important to note is that the strength, cohesion, dynamism, and role of these units vary widely from village to village. In some villages, for example, the chief may be the driving force behind all activities, while in others he is little more than a nominal and weak figure head. In the latter case, another charismatic individual (religious leader, progressive farmer, village sage, etc.) may take the de facto leadership role.

Some villages are more fragmented than others. In more cohesive villages, the council of elders, with representatives from all quarters of the village, may indeed speak for the entire population. Often, however, extended family units, or wards, within a village act independently of each other and have separate groups of elders. These villages essentially have a multiple leadership, although there is almost invariably one nominal village chief.

The cohesion and role of the traditional age peer groups and agricultural work groups also vary between villages. Age groups, for example, may consist of members from all village quarters or, alternatively, represent one single extended family ward. Their roles also differ. At one extreme, the male young adult group may be a loosely organized social club which sporadically convenes a wrestling match; or, it can be a well-structured group with a large collective cash fund generated from regularly hiring out the group's labor.

Memberships of the diverse traditional village groups frequently overlap. For example, agricultural work groups are often subgroups of the larger age peer groups or can be comprised of males or females from different age groups. Rarely are men and women members of the same group, but groups of different sexes do work together on projects of mutual interest.

Organizational structures linking two or more villages have traditionally been somewhat informal. In pre-colonial times, the village was an autonomous unit, being self-sufficient in land, labor, and food. Links with other villages were established on an as-needed-basis; for example, to clear a road linking two villages or to settle land disputes. Inter-village marriages also facilitated communication. In general, this underlying organizational system still holds. However, as villages are no longer self-sufficient in food, and as the traditional economy becomes ever more market oriented, inter-village links become more essential and more frequent.

Superimposed on this structure of traditional village groups is a plethora of more modern organizations. Some are formal institutions set up under the auspices of national government agencies while others have been organized by PVOs around particular development activities. The most predominant of these structures are the Rural Communities, rural councils, Centers for Rural Extension (CER), women's groups organized by the Social Development Ministry, producer groups organized by PIDAC, and the Young Farmers Association of Casamance (AJAC). These groups are described in the Institutional Analysis (Annex G.5).

The strategy adopted by the project for working effectively with villagers is designed to build on the strengths of existing traditional and modern village organizations. Before honoring a village's request for assistance, the Regional Water Management Team will convene a series of general village orientation meetings -- men and women and listen to the villagers speak. The local president of the "Communauté Rurale" and the sous-prefet will be invited both as a courtesy and to officially sanction the proceedings and outcome of the meetings. At these meetings, the team will attempt to assess a number of factors: village's clarity of problem identification; the presence of a felt need for a particular water control intervention; an understanding of the proposed intervention; the solidity of the villagers commitment to see the project through; their unity in this objective; and their ability to mobilize themselves to complete the task. This will often be a long and painstaking process through which agreements are reached on the type and location of the proposed dike (if not already started by the village), and the expected contributions of the village and the project. This pre-construction site preparation and sensitization process ("sensibilisation") will be vital in establishing an effective working relationship with the village.

Once the project and village agree to work together towards a water management goal, the village will be required to form a water management committee. This group will become the mobilizing force of the village and the link between villagers and the project Water Management Team. During the construction phase, the committee's most important task will be to set up the construction work schedule and ensure the proper execution of the project's technical instructions. Because of the importance of having a dynamic committee, project staff may sometimes recommend that certain individuals who demonstrate exemplary leadership skills be considered as members. The final selection of the committee members, however, should be left entirely with the village.

Given the project strategy of coordinated watershed management, the importance of involving all concerned villages from the onset cannot be overemphasized. Although one village may initiate the request for assistance, often a given intervention would affect the land of a number of villages. Unfortunate conflicts have resulted in cases where a project worked exclusively with one village only to find itself in the crossfire of an inter-village dispute. To avoid this problem, the project must establish during the first village meetings whether or not the land of any other villages would be affected by the proposed intervention. If so, those villages are called to participate in all subsequent meetings. All villages are then represented on the Water Management Committee.

2. Constraints

A common constraint to working with village groups, already touched upon in the previous paragraphs, is the varying degree of effectiveness and strength among the groups concerned. Furthermore, some villages are more difficult to work with than others. For example, villages which, in the past, have benefitted from "free" donor assistance are not interested in collaborating on projects contingent on village participation. Also, difficulties have been encountered in reaching a village consensus in fragmented or very large villages.

No system has yet been introduced to quantify village labor contributions. Developing such a system will be an important task of the project implementation team.

Experience has shown that a written contract between the project and a village leader carries little weight as far as villagers are concerned. The SZWMP will first negotiate the agreements between the project Water Management Team and the Village Water Management Committee. Then, to ensure that all concerned villagers are behind the agreement, a general meeting can be convened at which the agreements are communally witnessed. Past experience shows that if individual names of participants are read aloud at a communal gathering and each individual acknowledges concurrence with the agreements presented, there is a strong motivation for villagers to abide by the terms.

The definition of sanctions against villagers who do not abide by the terms of the contract should be left entirely with the village committee. With past projects, village-instituted sanctions have varied from a system of fines to no sanctions at all. Villagers know best how to mobilize their numbers and how to do so fairly. Once the Water Management Team has established village readiness to embark on the project and the work schedule has been agreed upon, the methods of dealing with individual villagers should be left to the village committee.

A number of pitfalls may lead to the breaking of agreements between village and project:

Villager discouragement -- Despite the strong motivation and commitment of villagers to complete a water-control project, there are factors which may lead to their discouragement along the way. For example, the construction of

long and difficult dikes may seem an impossible task. The Regional Water Management Teams can attempt to avoid this problem by suggesting sites which require the minimum amount of work and the shortest distance. Also, the project will provide labor-saving equipment, such as a tractor to haul soil and a plow to make digging easier, to simplify the work and encourage villagers to persevere.

Technical problems encountered during construction serve as a disincentive to villagers and give rise to a lack of confidence in the project. For example, siting a dike on unstable ground may require relocating the dike after village labor has already been invested. The importance of having a competent engineer on the Water Management Team is clear.

Cultural beliefs have, in the past, caused villagers to back out of a project. For example, fear of the mystical (and physical) powers of flowing water could bring construction work to a standstill.

Conflicting or false information regarding the project or the dike may also lead to breaking construction agreements. For example, a technician from another project may have different ideas as to the right approach to water-control. Although there may be more than one solution to the same problem, instilling doubt in the villagers may lead to breaking project agreements. Continuous dialog between project and village can avert this problem.

Lack of coordination -- Finally, many village development projects may simultaneously compete for village labor. If all intervening projects can coordinate their implementation plans, all work can be efficiently completed with less confusion in the village concerned.

Solutions to ensuring effective operation and maintenance of completed structures are still evolving. However, two elements emerge as critical. Firstly, it is much easier to set up a maintenance and operation system if done gradually throughout the planning and construction phase rather than waiting until after construction is complete. Experience shows that villages take responsibility for operation and maintenance more readily if introduced in this manner. Secondly, villages need information on how to go about operating the sluice gates and maintaining the dikes. The project entrusts this responsibility to the same Village Committee charged with overseeing the construction phase. In this way, not only are the problems of operation and maintenance dealt with from the onset, but continuity is insured between construction and operation. In support of this strategy, the project team will work weekly with the Water Management Committee during the year following construction. Gradually, the Committee comes to understand the consequences of opening and closing the gates at particular times. Although the Committee and the project will not always agree on when to open and close the gates, the Committee will learn to judge operation timing to suit their needs.

D. Land Tenure System

The project land improvement strategy calls for the construction of water-control dikes which will at once affect the land of more than one family

and even more than one village. The implicit assumption is that the project objective is compatible with the prevailing land tenure system.

1. Validity of Assumption

The land tenure system is based on usufructory rights with all villagers having the implicit right to the use of land for subsistence. The founding families generally have permanent tenurial rights over the best land by virtue of their early settlement in the area and their choice of the most productive land for clearing. Nevertheless, collective concerns are fundamental and any villager can at least borrow land for cultivation.

Despite these basic rights, numerous land-related conflicts have emerged in the course of water-control project implementation. These conflicts have been of two basic types:

- Between borrowers and original land holders -- By traditional land tenure law, eternal rights over land rest with the original tillers. With the introduction of the national land law (Loi sur le Domaine National), primary rights are theoretically extended to the current users. Although the traditional laws are still respected in the villages, borrowers will always wish to "own" land of their own. A common source of land conflict, therefore, is when borrowers attempt to override the traditional laws and stake land claims of their own. By constructing improvements such as water-control dikes, their status as current user is enhanced.

- Between two villages with conflicting claims -- Often, two villages claim tenurial rights over the same plot of land. In cases of long-standing conflicts, the two villages tend to come to some sort of temporary settlement in the interest of peaceful co-existence; for example, leaving disputed land uncultivated or letting the conflict lie dormant. With the initiation of dike construction, these conflicts often resurface.

Many of these inter- and intra-village land conflicts will be averted in the initial stages of implementation by the Regional Water Management Team. A key task for this Team is to prepare a land use and land tenure map of the area to be affected by the water control structure. Any land-related constraints to fully utilizing improved lands will also emerge and can be addressed from the onset of the project. Before construction begins, agreements will be reached among land "owners" and borrowers as to the post-construction use of the land. This will be a difficult process, but vital to project success. Although the project will not attempt to affect the distribution of land within watersheds, the Water Management Teams can facilitate discussions amongst villagers to ensure that all participants decide upon, understand and agree to the planned use of the land after construction.

2. Constraints

Despite the precautions taken by the project to avert land conflicts, uncertainties remain about the implications of the national land law and the extent to which, in practice, it will override traditional law. Under this law, tenurial rights are based on possession of the land and on productive use of the land. Conflicts result when units which have long used such land resist their return to the traditional owners. Family units borrowing land also have a chance, under the same law, to be able to claim the land.

Traditionally, land disputes have been resolved by the village council of elders. According to the law, civil authorities are given juridiction over land-related matters. With the approval of state authorities, the "Communauté Rurale" and its "Conseil Rural" could settle disputes and expropriate land. However, the viability of the "Conseil Rural" as a dispute-settling mechanism is dubious. Village chiefs and other elders who make up most of the membership are often not perceived as legitimate representatives of either production unit or village interests. The extent to which rulings by these bodies are respected in the villages remains to be seen. It is clear, however, that the threat of imposition of the national land law has resulted in a decreasing flexibility of loaning and pledging of land as original land holders become leery of losing their tenure rights. Again, the vital role of the project Water Management Teams in averting land tenure disputes cannot be overemphasized.

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INSTITUTIONAL AND ADMINISTRATIVE ANNEX

I. INTRODUCTION

Two key GOS policy decisions, contained in the New Agricultural Policy (NAP), have direct implications for the institutional framework of the SZWM Project:

- The roles of Rural Development Agencies (RDAs) are being changed whereby most direct farmer services and activities are to be taken over by the traditional technical services, to be revitalized for this purpose.

- Responsibility for rural development activities is to be transfered to the local communities with the assistance of the revitalized technical services, the private sector and voluntary organizations.

USAID/Senegal is incorporating the NAP directives into the SZWM Project because:

- working with farmers through the traditional services can pave the way for institutionalization and sustainability of project water management activities; USAID can assist the traditional technical services in shifting their focus from their present regulatory and monitoring functions towards providing appropriate services to rural communities;

- the nature of the problem, protection and reclamation of salinized areas, has a strong element of national interest justifying public investment to protect an important natural resource base; and

- private sector activities, including PVOs, in support of water management are not sufficiently established in the Casamance basin, but could become involved with the right technical support and incentives.

The purpose of this analysis is to define a viable institutional framework for project implementation. Several decisions on the components of the institutional structure have already been taken. Firstly, funding for the project will be provided as a direct A.I.D. contract to an implementing U.S. contractor. Secondly, the GOS named the Ministry of Rural Development (MRD) as the lead institution with its Directorate of Agriculture (DA) as the lead implementing organization. These organizations were selected because (1) the goal of the project is increased agricultural production, and (2) a key phase of the implementation process will be agricultural extension follow-up to maximize the benefits from the water-control works. GOS has also appointed the Directorate of Irrigation and Water-Control Works (DAIH) of the Ministry of Hydraulics to take responsibility for construction of water-control works and coordinate closely in all activities.

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This analysis describes the present roles and organizational structures of these technical services and discusses their strengths and weaknesses vis a vis project implementation. This is followed by a similar discussion on other formal and informal organizations operating in the project area. The analysis then proposes an institutional framework for the project and describes the structural support for the technical services needed to implement the project. Finally, a strategy for ensuring post-project sustainability of water management activities is presented.

II. ORGANIZATION, MANDATES AND STAFFING OF THE CORE TECHNICAL SERVICES WITH PRIMARY IMPLEMENTATION RESPONSIBILITIES

A. The Regional Inspectorates of Agriculture (RIA)

1. Organizational structure

Each regional inspectorate in Senegal is divided into three sections:

- Office of Program Implementation
- Office of Studies
- Office of Personnel and Administration

At the department level there are Agricultural Sectors headed by Sector Heads. There are three departments in the Ziguinchor region (Ziguinchor, Bignona and Oussouye) and an equal number in the region of Kolda (Kolda, Velingara, and Sedhiou).

The arrondissements are headed by the chiefs of the Centres d'Expansion Rurale (CER). Until recently the CERs, which regroup extension agents of the technical ministries, were under the authority of the Secretariat of Decentralization which has now become part of the Ministry of Interior.

2. Mandates

The Regional Inspectorates of Agriculture are responsible for:

- preparing and following up agricultural campaigns and surveys;
- collecting rainfall data;
- providing extension services to truck farmers and fruit producers;
- coupling research results to development;
- collecting agricultural statistics;
- conducting agricultural socio-economic surveys; and
- training farmer groups in farming techniques and crop protection.

Although the Agricultural services' staff are not charged with water-related infrastructure development, their training includes some basics

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in this field. In addition, staff trained in water-control works are now found in the MRD because of the freeze on hiring in the MH.

3. Staffing and Qualifications of Personnel

Over the past seven years, the level of education of the DA personnel has been of high quality and diversity. Senior agronomists, agro-economists and soil scientists trained in the U.S., USSR, Eastern and Western Europe, and China exist in sufficient numbers to staff leadership positions in the national, regional and departmental level of the Agricultural Services. The following table gives the number of DA staff at the national level.

CATEGORY

TECHNICAL DISCIPLINE	SENIOR PROFESSIONALS	MID-LEVEL PROFESSIONALS	EXTENSION AGENTS
Agriculture/ Soil Science	76		
Ag. Economics	5		
Hydro-technician	6		
Other		109	323

a. Ziguinchor Region

Thirty of the region's staff menbers have the potential for participating in this project:

* Two senior professionals (Ingenieurs de Conception) (Baccalaureate plus six years of vocational training):

  - Agricultural Economist (Regional Inspector)
  - Hydrotechnician, Head of Program Office

* Six mid-level professionals who are heads of offices and sectors (Ingenieurs des Travaux Agricoles--ITA) (Baccalaureate plus three years of vocational training); and

* Twenty-two extension agents (Agents Techniques d'Agricultures, ATA) (Brevet plus three years of vocational training)

Extension agents are found at all administrative levels, although the bulk is found at the arrondissement level, the closest level to the rural population. There are ten arrondissements in the region.

b. Kolda Region

With its twenty arrondissements, the region of Kolda totals sixty people in the Agricultural service. This number is divided as follows:

* Three senior professionals (Ingenieurs de Conception)

  - Two Agronomists (including current Regional Inspector)
  - One Hydrotechnician;

* Six mid-level professionals (Ingenieurs des Travaux Agricoles);

* Fifty-one extension agents (Agents Techniques d'Agriculture and Techniciens Horticoles).

B. The Regional Hydraulic Divisions (RHD)

1. Organizational structure

As in the case of the Agriculture services, the Regional Hydraulic Divisions throughout Senegal are all structured along the same pattern, each comprised of:

- Regional Office of Rural Hydraulics
- Regional Office of Hydraulic Studies
- Regional Office of Irrigation and Water-Control Works
- Regional Office of Urban Water Management and Sanitation
- Regional Office of Personnel and Administration

The Hydraulic Divisions are not staffed at the department or arrondissement levels, in contrast to Agriculture and many other GOS technical services.

2. Mandates

The Regional Hydraulics Divisions are charged with:

- constructing wells and boreholes;
- monitoring surface and ground water levels and water quality;
- constructing irrigation and water-control works as well as rural infrastructure (schools, maternity facilities, storage facilities); and
- controlling water quality for domestic use and standards for construction of drainage and sewerage systems.

3. Staffing and Qualifications of Personnel

As in the case of Agriculture, the educational background of Hydraulics personnel has greatly improved, although in smaller numbers, and its sources and experience have diversified. Masters and PhD degree holders

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are found throughout the country. The following table gives the disciplines of MH staff for the entire country.

CATEGORY

TECHNICAL DISCIPLINE	Senior Professionals	Professionals and Mid-level Professionals
Hydro-geology	1	
Rural Dev. Engineer	33	
Civil Engineer	4	61
Hydraulics Specialist	7	
Irrig. Planning Engineer	2	

a. Ziguinchor Region

The entire regional staff (including drivers and messengers) number eleven men:

- No senior professionals (Ingenieurs de Conception)
- Seven mid-level professionals (Techn. Superieurs--TS) (Baccalaureate plus three years) (the Inspector and the office heads)
- Four support staff (one skilled worker, two drivers, one messenger).

Personnel potentially pertinent to the project are missing: senior hydrotechnicians and topographers.

b. Kolda Region

Compared to the rest of Senegal, Kolda is perhaps the least staffed region, with only two mid-level professionals currently at post.

C. Strengths and Weaknesses of the RIAs and RHDs

1. Qualifications and work experience of staff

The present staff of the RIAs have the requisite formal training to provide assistance during the construction phase and to carry out the required extension services. The two hydrotechnicians (one in each RIA) are trained

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civil engineers and the agricultural agents (posted to the CERs) have relevant agricultural vocational training. However, there are serious constraints to relying on these personnel for project activities:

- The present workload of RIA personnel, if actually executed in its entirety, leaves little time for project activities. The available agricultural agents are already fully engaged in data collection and agriculture campaigns for the RIA during the cropping season. The mid-level professional staff have heavy administrative responsibilities. Since adding project-related activities to this workload is not feasible, more personnel will be needed to absorb either the new project activities or the existing RIA tasks.

- Neither the hydrotechnicians nor the agriculture agents have substantial work experience relevant to water management or the operation and maintenance of water-control structures.

- Some of the skills vital to project implementation -- for example, soil and water management, land reclamation, and rural sociology -- are not represented at the RIAs.

The Hydraulic Divisions are weaker than the RIAs in field experience and level of staffing. Neither regional service has any practical experience in constructing and operating water-control structures. Furthermore, the two services are currently staffed with mid-level professionals who do not have the expertise needed for watershed planning (the TS can only execute planned construction activities). Surveyors and construction engineers are not presently posted to either regional services.

Despite the staffing weaknesses of the RIAs and RHDs, the team believes that there are workable solutions for overcoming these shortcomings. For example, some of the qualified personnel employed within these national services are presently underemployed. Given GOS commitment to this project, it should be quite feasible to redeploy some of this staff to the regional services at Ziguinchor and Kolda.

2. Logistics and Operational Budgets

Inadequate logistical support and operating budgets are two of the major constraints of the GOS technical services. Rather than presenting the logistical and budgetary problems of all the services, a review of the situation at the Ziguinchor RIA will serve to illustrate the constraints.

The entire RIA of Ziguinchor has only four vehicles: one pick-up (1984), two four-wheel drive (1985), and one station wagon. The operational budget of the RIA is below minimum requirements. Fuel allocation amount to CFA 4,198,000/year while only CFA 50,000/year is allocated for travel expenses.

To complicate matters even further, current GOS procedures do not permit transfer of money from one line item to another. Some line items are

over-budgeted (electricity, water, and telephone) and others are in chronic deficit. The RIAs have no control over their budgeting process, since their budgets are prepared by the National Directorate in Dakar and the input from RIA staff seems to be ignored.

The project cannot count on the current logistical and financial resources of the traditional services to function. The project will have to provide logistical support as well as fuel for at least three years of the project life, and USAID will insure that the GOS will take over operational costs from year four and throughout.

III. OTHER FORMAL AND INFORMAL ORGANIZATIONS IN THE PROJECT ZONE

There are a number of formal and informal organizations and structures with which the project can work to reach the local population.

Both formal and informal organizations can be partners in the project's objective to mobilize, organize, and train the local communities in water management techniques (including operation and maintenance of water-control structures). However, no one organization can be drawn upon to meet all the project's needs in these areas. In some cases, project efficiency may be enhanced by working with organizations which have established productive links with villages participating in project water management activities. On the other hand, where villages have had unsuccessful experiences with particular organizations, involving those organizations in project activities would have detrimental consequences. Furthermore, many of the organizations cited above are faced, to varying degrees, with the same logistical and financial problems as the RIAs and RHDs. For the project to have productive working relationships with such organizations, some resources may have to be provided.

Among the formal organizations there are: the Regional Services of the Ministry of Social Development; Centres d'Expansion Rurale (CER); and the Local Development Committees (LDC). The major non-GOS structures include: the private sector; CADEF; AJAC; ALUCER; Women's Group; and the Peace Corps.

A. GOS Organizations and Structures

1. Social Development Service

The Ministry of Social Development is represented throughout the administrative divisions of each region. It has over 42 staff in the region of Ziguinchor and about 50 in the Kolda region. Although all staff from the Social Development Ministry are familiar with village extension methods, the most qualified personnel for project purposes are the group and village organizers as well as coordinators for women's activities. They have been able to organize about 500 women's groups and youths in the Ziguinchor region and more than 200 in Kolda. Discussions with local authorities and PVOs (ENDA, CARITAS) attest to the aggressive campaigning and mobilizing approach of the women's group organizers.

2. Centres d'Expansion Rurale

This GOS structure was under the Secretariat for Decentralization, which has been incorporated into the Ministry of Interior.

The CERs are multidisciplinary teams representing the technical services at the arrondissement level. They have two major roles: (1) providing technical assistance and follow-up to development actions of the local communities, (2) organizing consciousness-raising campaigns (reforestation, vaccination campaigns, etc.) and training villagers in agricultural and crop protection techniques, health, literacy, truck-farming, etc. They also help villagers prepare projects of communal interest and value, and provide guidance in Rural Council budget formulation.

The CERs are under the line authority of the sous-prefects. Formal approval of these authorities have to be obtained prior to CER participation in any activity in the arrondissement. The team feels that this will not be a major problem after sous-prefects' cooperation is obtained by decision-makers in Dakar through the regional governors. Furthermore, when the project works in a given area, the local sous-prefect and CERs will be invited to participate in planning with village organizations.

3. Comités Locaux de Développement (CLD)

These committees are headed by the sub-prefects and are comprised of the heads of the CERs and the elected Presidents of the Rural Councils.

The CLDs will facilitate contacts with the villagers and canvas for effective organization of the local communities.

B. Non-GOS Structures

1. The Private Sector

There are no private enterprises in the two regions that could provide technical services or logistical support to the project. Such enterprises exist only in Dakar, but can be utilized to work throughout the country. The project will stimulate the interest of local intitiatives in offering construction and/or other services applicable to project activities.

2. Comité d'Action pour le Développement du Fogny (CADEF)

Created in 1983, CADEF, a former association, has a membership of over 3,000 individual farmers, men and women. Its areas of influence cover all the villages in the arrondissement of Sindian in the Bignona Department and some villages in the Tenghory arrondissement, also in the same department. Its activities include anti-salt dike construction with assistance from PIDAC (Suel and Bougoutoup), well-digging, agriculture/truck farming, artisanal metal works and training (literacy, ironworks, health care, etc.). CADEF relies, first and foremost, on the labor of its members and their financial contributions; membership fees of CFA 1,000 per person were collected at its founding.

CADEF also receives assistance from PVOs. It received financial and material help from a French voluntary organization, CIEPAC (for spades, wheelbarrows, cement and mason's fees) during the construction of the anti-salt dikes. CADEF had already mobilized, organized and started construction before receiving this assistance. CADEF also received technical assistance from Church World Service in well-digging and from ENEA in literacy, marketing, accounting and health care training programs.

This association of farmers can be a real moving force for projects and offers a basis for sustainability of project activities which may be initiated in Sindian or Tenghory.

3. Association des Jeunes Agricultuers de la Casamance (AJAC)

AJAC was created in 1974. It has about 50,000 individual members (all active farmers) in 722 separate groups throughout the Ziguinchor region and in the Sedhiou department of the Kolda region. AJAC is now divided in two rival groups both maintaining the same name. Both are active. Their activities are varied but are generally concerned with improving the living conditions of their farmer communities.

AJAC members have interest and some experience in anti-salt dike construction in Bona, Djiragone, Djidjipoune and Bacoundine. Members provided labor and bought the services of a private constructor to do the engineering works.

4. Association pour la Lutte Contre l'Exode Rural (ALUCER)

The Association, based in Madina-Faracounda (arrondissement of Marsassoum, department of Sedhiou), has more than 2,000 members in 34 farmer groups. ALUCER has a high level of organizational and mobilization capacity. It is supported by the French PVO, Association Française des Volontaires du Progrès (AFVP) which provided (and continues to provide) technical assistance for construction of anti-salt dikes and sluice gates. Discussions with the President of ALUCER and a member of AFVP indicate that the project may be able to work closely with this group.

5. Women's Groups and Associations

There is widespread recognition that women's groups are the most dynamic organized force in both regions. They are present in all development activities and participate in the most difficult infrastructure works. As mentioned earlier, they form a network throughout the Lower, Middle and Upper Casamance.

6. Peace Corps (PC)

The Peace Corps is now finalizing its Africa Food System Initiative Program. Two regions in Senegal, Ziguinchor and Kaolack, will benefit from it. This program will place Peace Corps Volunteers in the Bignona department. PC will recruit volunteers with training and skills in

construction and agriculture. Conditions to having PC collaboration in this project are being discussed between the three concerned parties: GOS, USAID and Peace Corps. The Peace Corps is also planning to place up to four volunteers, beginning at the end of 1988, in the Sedhiou department which is a project zone.

IV. INSTITUTIONAL FRAMEWORK OF THE PROJECT

The institutional framework chosen for the project must facilitate the realization of the project purpose.

A key strategy for implementing the project is to work closely with villagers on planning, siting, and constructing water control works as well as having villagers take full responsibility of the operation and maintenance of these structures. Project success will greatly depend on the capability of its institutional structure to facilitate productive project-village dialogue.

In addition to building village capability for water management, the institutional structure must strengthen the traditional technical services in this area. In particular, the organizational structure must include appropriate decision-making procedures, clearly defined roles, responsibilities, and lines of authority within the project, adequate logistical support, and appropriate training of personnel.

The core structure of the project must be kept streamlined. A number of administrative and logistical constraints exist which need to be resolved if the project is to perform well. The sustainability of project activities after project completion depends on this performance.

A. Project Institutional Organization, Management and Administration, Staffing and Major Roles of Staff

The Directorate of Agriculture and the Regional Inspectorates are key elements in the project institutional structure. The DA and the RIAs will work closely and collaboratively with the DAIH and the RHD of the Ministry of Hydraulics (MH). At the national level, a Technical Committee which will comprise the DA, DAIH, and USAID, will be set up. This National Technical Committee will meet twice a year to address policies and implementation issues. In each region, the RIAs and RHDs will form a Regional Technical Committee (CTR). In addition, two new structures will be created for project implementation:

- Project Management Unit (PMU)
- Regional Water Management Teams (RWMT)

The project organizational chart is found on page seven of the PP.

The selection of the regional organizational structure described above was made after careful weighing of the strengths and weaknesses of four possible models for project implementation:

Model 1: the selected model appears to be a workable trade-off to Model 3, even if it entails higher operational costs than Model 2, with the creation of two teams in lieu of one. It has the following advantages:

- reflects administrative realities;
- limits implementation problems and personal conflicts;
- creates teams which are more integrated in their regional services as they would be more likely to continue to operate after the project terminates, given the appropriate means; and
- gives more participatory role to the Heads of RHDs.

Model 2: establishment of a similar PMU structure as in Model 1, with only one inter-regional team and one Inter-regional Special Technical Committee. While it has the major comparative advantage of reducing the overhead costs with the creation of one team, it turned out to be the least viable of the four because:

- an inter-regional team and an inter-regional committee would not reflect administrative realities; Kolda and Ziguinchor are two separate administrative divisions with their own budget cycles and control mechanisms.

- an inter-regional committee would: a) be costly because of expenses incurred during various committee sessions; b) waste time in long debates; and c) result in "regionalist" tendencies that could deflect from real implementation issues.

Model 3: the same structure as in Model 1, but with only the RIAs having implementation and coordination responsibilities. This model seems to conceptually be more workable than the selected model in that (1) it assigns program coordination and implementation responsibilies to one person rather than two, and (2) it reduces the risk of conflicts between two individuals who have so far had equal status. Such model was abandoned because of the necessity to have the RHD heads participate more effectively in the project.

Model 4: the same as Model 1, except the position of the Project Manager is assigned to the RIAs. This model cannot accommodate the intensive coordination required for start-up, which would require 100% of the two RIA's time.

1. The Office of the Director of Agriculture

The Director of Agriculture will be the principal coordinator at the national level, coordinating project activities requiring central Ministry attention. He will negotiate the reassignment of require staff from DA, negotiate the provision of services (through covenants/contract) by GOS services such as ISRA and the private sector, and work closely with the USAID officials. Before project start-up, DA will obtain official recognition of, and support for, project activities by the regional administrative authorities (Governors, Prefects and Sous-Prefects).

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To avoid implementation delays, full delegation of authority will be given to the Project Management Unit. The Director of Agriculture and USAID will be kept current of project activities and progress through periodic reports, and will be advised of implementation problems which are to be resolved at higher levels.

2. Regional Technical Committees (RTC)

Each region's RTC will be composed of: the Regional Agriculture Inspector and the Regional Head of Hydraulic Division. The RTCs will be chaired by the Project Director.

The Regional Agriculture Inspectors and RHD Heads will participate in implementation planning. They will be directly responsible for the execution of planned programs, supervision of the technical teams and coordination with counterparts in Social Development and Public Works. The RTCs will also liaise with the Comités Régionaux de Développement (CRDs) to obtain administrative support as well as assistance in resolving implementation problems. The RTCs will keep the CRDs informed of project progress.

3. Project Management Unit (PMU)

The PMU will be responsible for planning, contracting, administrative supervision, monitoring, research, evaluation and financial activities.

The PMU will be comprised of a Project Director (PD), appointed by the Director of Agriculture, and the U.S. contractors, representing the firm awarded the direct USAID contract.

The Project Director will be a senior agronomist from the DA who will work with the project for two to four years, then hand over responsibility to the Regional Inspectors of Agriculture and RHD chiefs. The team believes that the presence of the PD is needed at the onset of the project, when coordination activities are most intense, to (1) coordinate between the regions and with Dakar; (2) facilitate financial disbursement; (3) manage contracts with other institutions; (4) establish operating policy and management practices; (5) build the regional teams; and (6) help shield the project from outside direct intervention. However, it is quite clear that the PD's presence will initially limit the role and responsibilities of the Regional Agriculture Inspectors and RHD chiefs, in taking initiatives on management and administrative coordination. To lay the foundation for smooth continuation of activities after the project is completed, it is essential that the Regional Inspectors and RHD chiefs be involved in PMU activities from project inception.

The Chief of Party will be responsible for contract administrative, financial and procurement matters. All long-term advisors will report to the COP.

S/He will receive backstopping from the USAID controller and the Supply Management Office (SMO) when necessary. The GOS Project Director will be associated in all the management aspects of the project. Local support staff will be recruited for administrative tasks.

4. Water-Management Teams

A permanent Water Management Team will be established in each region. Each team will be comprised of a Hydrotechnician, Agronomist/Soil Scientist, Topographer, and a Village-Project Liaison Officer. All team members will be professional and mid-professional civil servants posted in the regions and paid by the MRD and MH, and assigned to the project activities on a full time basis.

The role of regional Water Management Teams as the link between the project and villagers is essential. Recognizing the vital importance of the preliminary village-project dialogue, each team will enlist the participation of dynamic extension workers and members of village associations in establishing village water management committees. The team's Village Liaison Officer will take the lead role in this effort. To be effective in their roles, the Liaison Officers must be fluent in the Casamance languages and preferably be natives of the region.

The teams will be charged with a number of specific tasks, namely to:

- organize villagers to plan and implement water management interventions;
- assist villagers to clarify their needs and determine the village's readiness to embark on a water management project;
- work with the village to select a construction site which is both acceptable to the village and technically feasible;
- collect baseline data needed to determine land tenure arrangements, quantify the villages contribution to the project, anticipate any constraints to the effective completion of the water-control structures, and to ensure the productive use of the scheme after completion;
- supervise the construction of the water-control works;
- work with the village on post-construction operations and maintenance of the structures; and
- help integrate production technologies with improved water control.

Both teams will be assisted by the Water Resources Engineer and other technical advisors.

The technical assistance effort will be oriented toward training the Senegalese Water Management Teams in watershed planning, construction of water-control structures, post-construction water utilization, and techniques for effective formation of Village Water Management Committees.

5. Village Water Management Committees

Each project village will be charged with setting up a Water Management Committee. It is this group that will be the mobilizing force of the village and the link between the villagers and project Water Management Teams. During the construction phase, the Committee's most important task will be to set up the construction work schedule and ensure the proper execution of the project's technical instructions. The success of the project will hinge on these Committees and the effective leadership of the Committee members.

Some of the project sites will undoubtedly involve more than one village. Therefore, it is essential to ensure that each village concerned is represented on the committee.

B. Project Location

The project Management Unit's main office will be in Ziguinchor. It will rent office space near the RIA and the RHD headquarters (both share the same premises). The Water Management Teams will be based at their respective RIA and RHD headquarters. This will entail extension and rehabilitation of the RIA and RHD office facilities.

The choice of Ziguinchor is based on logistical convenience: frequency of air travel; communications availability and reliability; more housing facilities for TAs; office space; educational facilities for GOS staff families, and; travel distance of less than two hours between Ziguinchor and most proposed early project activities. It will also permit better communication and coordination with ISRA on applied research and environmental monitoring.

The team has anticipated the potential inbalance such a location may create in favor of Ziguinchor. With the proximity of the Project Management Unit, there is a fear of allocating more of the project attention and resources to the team in Ziguinchor, with quicker resolutions of their implementation problems.

A second fear is that the Agricultural Inspector of Kolda may be less involved in the decision-making process and gain less practical experience in coordination than his counterpart in Ziguinchor through the on-going supervision and support of the Project Management Unit.

The team is confident that these difficulties can be alleviated by: (a) establishing weekly coordination meetings between the Project Management Unit and the two Inspectors during the first six months to one year from project-start, to better involve the Inspector of Kolda; (b) programming periodic visits of the Project Director and Financial Controller to Kolda; and (c) organizing interregional training sessions to address technical and implementation issues.

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CONSTRAINTS TO PROJECT IMPLEMENTATION

A. Personnel Management-Related Issues

There are three major personnel management issues that may have detrimental impact on project efficiency if not addressed before project start: (a) GOS policy on travel authorization; (b) inconsistency between project staffing needs and the GOS policy on civil servant posting; and (c) GOS policy on salary supplements.

1. GOS Travel Authorization Policy

This policy requires all civil servants travelling outside their administrative boundaries, or with SO-registered vehicles, to have a travel authorization (ordre de mission). This must be approved by Service Heads and their lead ministers or designees, if concerning civil servants posted in Dakar, or by the Governor for personnel serving in a region.

Conformance to this policy by the Water Management Teams, Regional Agriculture Inspectors and Hydraulic Division chiefs implementing the project, will undoubtedly inhibit project activities.

The team suggests that (1) arrangements be made to delegate authority for signing travel authorization for the Water Management Teams to the Project Director or RIAs and RHD chiefs and (2) the Regional Inspectors have blanket authority from the Governors to travel for project activities.

2. GOS Policy of Staff Reassignment

GOS policy usually grants a request for reassignment to any civil servant who has served two years at post. Although not strictly adhered to, this policy may affect project continuity and efficiency if team members are to be transferred simultaneously, one or two years after project start-up. This may cause problems since there is no guarantee that the reassigned person(s) will be replaced and on time.

It is, therefore, important for the project to ensure that: (1) assigned personnel will remain for at least two years; and (2) a maximum of one-third of the team will be reassigned at a time. The project must see to it that training of the new-comers is efficiently integrated into project activities, and that a core group will remain to facilitate the training of new arrivals.

3. GOS Indemnity Policy

Projects have customarily paid salary supplements and/or allowances to civil servants, to bring their salaries closer to those paid to their counterpart contractors.

The current USAID policy forbids salary supplements and allowances on all its projects. USAID considers civil servants assigned to a project as

performing their regular duties. The only type of monetary rewards permitted under this policy are performance awards for outstanding administrative or technical accomplishments. This could represent up to 25% of the annual salary of the recipient.

The GOS policy poses a problem of motivation for the "personnel affecté" of the technical ministries since other projects in the region offer considerable salary supplements.

The coexistence of the project with three other projects -- DERBAC, PRIMOCA, and the BOAD-financed project at Tendouck -- all of which offer substantial salary supplements, allowances and fringe benefits, will make staffing of this project more difficult. The table below gives an indication of the salary supplements and per diem rates of DERBAC and the Tendouck project. PRIMOCA has not officially announced its rates, but has a committed policy of salary supplements.

	SALARY SUPPLEMENTS (CFA/month)	PER DIEM (CFA/day)
DERBAC		
Professionals	up to 100,000	10,000
Drivers	10,000	
TENDOUCK PROJECT		
Professionals	100,000 + 10%/yr	15,000
Drivers	10,000	2,500
CERs	8,000	2,500 + transportation

There is no easy solution, given the GOS policy, and the Senegalese civil servants' attempts to find ways to supplement their relatively low salaries compared to the current cost of living. The team can only suggest ways to alleviate implementation problems. One suggestion is that assignment to the project technical teams be fairly and thoroughly discussed with proposed incumbents. They must be informed of conditions of assignment and accept it without being forced. The second suggestion relates to the performance awards scheme. If awards are 25% of present GOS salaries, it becomes clear that awards will be low. For instance, a GOS professional at CFA 110,000/month (realistic salary of project staff) would be awarded 330,000/year. His counterpart in DERBAC, earning 158,000/month, will receive 900,000 to 1,200,000 per year in salary supplements. The team suggests that the Mission review its performance awards system to make it more attractive while remaining within its regulations.

B. Logistics

The lack of logistical support to GOS technical services is common knowledge and does not need to be documented further. The very scarce logistical resources are managed in pools. Fuel, if at all available, is rationed by the Governors, Prefects, Sous-Prefects or their designees.

The project will have to be logistically self-sufficient, both in terms of transportation of project staff and in assisting villages in obtaining construction equipment and transporting building material.

Theoretically, the project should be able to borrow and/or rent construction and transportation equipment from two existing sources: SOMIVAC, which rents out heavy and light equipment (bulldozers, graders, trucks, pneumatic compactors, caterpillars etc.), and the GOS regional services of Public Works which provides assistance, though rarely, to the local communities.

Reliance on these local sources may pose serious problems. With the DERBAC project in place, demand on SOMIVAC will be high. As for the Public Works, the project can hardly rely on their equipment because of their normal workloads and, in the case of Kolda, their future involvement with the PRIMOCA project construction activities in the Sedhiou department.

Although these sources are not entirely eliminated, the project will rely on private sources at the national level for earth moving, transport, and construction of sluice gates.

The project will purchase tractors and trailers to assist farmers to move dike material.

It is vital that the PMU has control over use of its vehicles and other equipment. The USAID vehicle policy makes it mandatory to register project vehicles (TA vehicles excepted) in the SO category. This will pose dangers for project effectiveness unless USAID negotiations for a protocol agreement, placing these vehicles exclusively under project control, is concluded. A condition precedent has been included in the grant agreement concerning this problem. Failure to reach agreement leaves no alternative but to register project vehicles and material under TT category to prevent the vehicles from falling in the GOS motorpool and being used for purposes unrelated to the project.

PROJECT SUSTAINABILITY; PROPOSED COVENANTS, CONDITIONS, AND POLICY DIALOGUE

The sustainability of project activities is predicated on three key assumptions:

- the local population will assume responsibility for maintenance and operations of the constructed works, will use the available water more efficiently, and will have increased rice production;

- the traditional technical services of Hydraulics and Agriculture will be technically experienced in collaboratively planning and executing these activities at new sites in their respective regions after the project terminates;

- The MRD and the MH will continue to provide salaries and operating expenses to watershed management activities.

A. Constraints

Assuming that the project has successfully enlisted village participation through an appropriate "sensibilisation" process, there should not be any technical nor social constraints to the villagers' maintaining and operating constructed works. The structures will be designed such that they will be simple to maintain and operate.

To ensure project sustainability, it will be necessary to institutionalize project activities within the traditional technical services. Two key elements leading to the achievement of this goal concern present GOS personnel and budgetary policies:

- the need to maintain the personnel necessary for the technical teams for a sufficient period of time to allow continuity of water management activities, i.e. to allow newcomers to be trained by experienced team members; and

- resource (vehicles, fuel, operating budget, etc.) management and control must be vested in the technical services, not in an administrative pool.

Hindering the enactment of the first element is the GOS policy, identified earlier in relation to project implementation, of reassignment of civil servants. This policy will, as in the project implementation phase, constitute a stumbling block to the permanent establishment of water management expertise in the technical services of Agriculture and Hydraulics. This source of technical assistance is needed to meet the local population's demand for construction and repair of the water-control structures.

The second element needed to ensure sustainability concerns not only this project, but has implications for the sustainability of all donor-financed projects. It concerns GOS' inability, or perhaps its lack of real commitment to provide for the continuity of project activities after donor support ends.

Better and more flexible administrative regulations to logistically support the Water Management Team's activities, the necessary reallocation of budget line items, and appropriate disbursement procedures, will be required to continue project activities.

B. Condition Precedent (CP), Covenants, and policy Dialogue Proposed

Two covenants and one CP must be negotiated with the GOS. The first covenant would require GOS to ensure that construction, maintenance and operation of water-control works, as well as improved water management servicing, become part of the mandates of the regional services of Agriculture and Hydraulics. Furthermore, GOS must guarantee that quality staff be assigned to these services and remain in place.

The second covenant would ascertain that additional financial resources are made available through the use of the "Fonds de Concours", granted to the qualified Rural Councils, in addition to villages' labor contribution to financing water-control structures. Joint study of other reflows to support water control works should take place in year three of the project.

The CP should ensure that the GOS would take over recurrent operating costs (fuel, repair and per diem) after project year three. This is to prepare the smooth transition from the with-project to without-project situation.

In addition to the above, a policy dialogue with the GOS should begin to ensure that the GOS will commit itself to providing adequate logistical support to the traditional technical services and to transferring managerial and administrative control of logistics from the governors, prefects and sous-prefects to the regional inspectors, service heads and chiefs of CERs. The current motorpool administration and the rationing of fuel do not permit rapid and smooth execution of tasks.

3053-0

Attachment VI

INITIAL ENVIRONMENTAL EXAMINATION

AMENDMENT

Project Country: SENEGAL

Project Titles: SOUTHERN ZONE WATER MANAGEMENT (685-0295)

Funding: FY(s) 1988-1995 US$ 20,000,000

IEE Prepared by: Jeffrey W. Goodson
Regional Environmental Officer, REDSO/WCA

Environmental Action Recommended:

NEGATIVE DETERMINATION

Concurrence: (Bureau Environmental Officer) APPROVED X
Bessie L. Boyd, AFR/TR/ARD
DISAPPROVED
DATE 3/11/88

CLEARANCE: GC/AFR
Gary Bisson
DATE March 14, 1988

MAR 14 1988

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INITIAL ENVIRONMENTAL EXAMINATION AMENDMENT

SOUTHERN ZONE WATER MANAGEMENT PROJECT

685-0295

Jeffrey Wiley Goodson

REDSO/WCA

November 1987

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IEE AMENDMENT

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INITIAL ENVIRONMENTAL EXAMINATION AMENDMENT

SOUTHERN ZONE WATER MANAGEMENT PROJECT

685-0295

1.0 IEE AMENDMENT BACKGROUND

The Initial Environmental Examination (IEE) for the Southern Zone Water Management (SZWM) Project was prepared during May 1987 and submitted to AID/Washington along with the written clearance/concurrence of the Regional Environmental Officer (REO), REDSO/WCA; the USAID/Senegal Project Development Office; the USAID/Senegal Irrigation and Water Management Office; the USAID/Senegal Mission Legal Advisor; and the USAID/Senegal Mission Director. AID/Washington responded on 20 August 1987 (State 260192), stating that a categorical exclusion was approved on 11 July 1987 for the technical assistance (TA), training, studies and commodities components of the project. Additional environmental information, however, was requested in the form of an IEE amendment on infrastructural activities. The information requested included specification of 1) the "environmental characteristics of different regions where infrastructure will be built"; 2) the "mix of specific infrastructure alternatives to be considered for project financing"; and 3) "a list of environmental criteria for construction of each infrastructure type."

The rationale for deferral of infrastructural activities in the original IEE was, pursuant to 22 CFR 216.3(a)(7), that the specific interventions, intervention locations and intervention designs had not yet been either identified or planned. Indeed, a major and integral project component is to appropriately identify and environmentally plan, as well as to construct, the individual infrastructural interventions. This IEE amendment has nonetheless been prepared to provide, to the extent possible at the current time, the information requested in 87 State 260192.

2.0 REGIONAL ENVIRONMENTAL CHARACTERISTICS

Because the infrastructural interventions to be implemented under the SZWM Project will occur throughout much of the "southern zone" or "Casamance" region of Senegal, with most individual sites currently unidentified, environmental characterization in this IEE amendment employs both regional and biophysiographical approaches.

2.1 LOCATION AND GENERAL TOPOGRAPHY

The SZWM Project region is generally bounded on the north by the southern frontier of The Gambia, on the east by the Tambacounda (Senegal) - Koudara (Guinea Bissau) road, on the south by the northern border of Guinea Bissau, and on the west by the Atlantic Ocean. The area lies between approximately 12.2 and 13.5 degrees north latitude, and between approximately 13.0 and 16.8 degrees west longitude.

The southern zone region is extremely flat, and slopes from an elevation of approximately 250 feet AMSL on the Tambacounda-Koundara road on the east to sea level on the west. Principal areas of vertical relief occur only in association with streams and rivers dissecting eastern portions of the region, and at some sites associated with unfixed coastal sand dunes.

2.2 CLIMATE

The climate of the southern zone region is strongly influenced by both oceanic and continental climatic influences. Oceanic influences dominate during the rainy season when the monsoon or south Atlantic humid anticyclone brings massive quantities of humid air to West Africa. This results in isolated intense thunderstorms, very intense widespread storms, and occasional continuous rains. Towards the end of the rains, colder air from the north influences Senegal and provides for the atmospheric conditions which result in the harmattan. The harmattan winds originate in the Magrebian region of the Sahara and are responsible for the very hot temperatures and high evaporation rates found in most of the southen zone region during the mid to late dry season.

Precipitation in the region generally decreases from south to north, and near the coast it also decreases with distance from the Atlantic Ocean. Rainfall is highly variable from year to year in quantity, timing of onset, periodicity and termination, but variation is not as great in the southern zone as in more northern portions of Senegal.

Mean annual precipitation in millimeters was calculated in 1982 as follows for six principal towns in the southern zone region: Ziguinchor (1559), Bignona (1408), Sedhiou (1387), Kolda (1194), Velingara (1063) and Tambacounda (886). "Dependable annual precipitation," defined as the amount of precipitation that is normally equalled or exceeded three-fourths of the time (i.e., the 75% statistical probability of occurrence or exceedence) for the same sites is as follows in millimeters: Ziguinchor (1150). Bignona (1035), Sedhiou (1107), Kolda (853), Velingara (727) and Tambacounda (659). Precipitation is highly seasonal throughout the region, with maximum rain falling from June-October and minimum precipitation occuring January-April. (Hargreaves 1982).

Mean annual temperatures in Ziguinchor and Tambacounda are 26.8 and 28.0 degrees C, respectively, with maxima usually occuring in May and minima usually occurring December-January. Relative humidity generally decreases as one moves north and inland from the Atlantic Ocean and with increasing latitude, averaging 1663 mm/yr in Ziguinchor and about 1884 mm/yr in Tambacounda. Most of the southern zone region has a growing season for rainfed agriculture of 100-125 days/yr, with some southern locations averaging greater than 120 days/yr. (RSI 1986).

2.3 REGIONAL HYDROLOGY AND HYDROGRAPHY

Virtually the entire southern zone region drains generally from east to west, with most surface flow ultimately discharging through the Casamance River channel. Limited areas in the northern part of the region fall within

the Gambia River watershed, however, and extremely limited portions of the southeastern part of the zone drain into the Cacheu River system located principally in Guinea Bissau. The Casamance River headwaters occur about 75 km east of Kolda where outflow from a number of small seasonal marigots converge. The river is generally seasonal east of about 15°15' west longitude, and in relatively "normal" rainfall years it is stagnant at Kolda by the month of February. The main tributary of the Casamance River is the Soungrougrou which is also formed by the reunion of several marigots which drain out of woodlands near Pata. The Soungrougrou is considerably smaller than the Casamance, but it can attain a width of up to 1 km. Two other significant tributaries, the Kamongul and Douloulou, find their confluences with the Casamance in its lower reaches where the river system develops into a complex and interconnected system of tidally inundated mangrove swamps and wetlands below the regional capital of Ziguinchor.

Generally speaking, precipitation in the southern zone region results in surface ponding of water which lasts until December or January depending on rainfall quantity (CRSI 1986). Principal aquifers occur at about 5-20, 50-100 and 150-200 meters depth in the region (DAI 1987). Rainfall above the 1000 mm isohyet is normally adequate to provide recharge to near surface and deeper aquifers and to both produce sufficient runoff to contribute significantly to Casamance River floodwater volumes and to cause some surface erosion. (RSI 1986).

2.4 GEOLOGY, SOILS, VEGETATION AND LAND USE

Physiographically, the southern zone region can generally be broken down into 1) tidally inundated lower valley sites, 2) seasonally inundated mid and upper valley sites, and 3) plateaus and surface peneplains.

Tidally Inundated Lower Valley Sites. These sites are found in tidally-inundated portions of the lower and middle Casamance River and its major tributaries. For the most part they are underlain by recent marine deposits, with soils consisting of recent and ancient muds of variable evolution and salinity. Most of these soils are considered to be degraded as a result of increasing salinity, and surface salt efflorescences can be expected to occur under appropriate hydric and edaphic conditions throughout these areas.

In addition to vegetational degradation due to increasing soil salinity, some lower sites are described as moderately to severely degraded due to human activity and the expansion of agricultural production. Most such areas, however, are little used or are used primarily for harvesting of wood and estuarine food resources (e.g., the mangrove formations).

Natural vegetation on these sites consists of mangrove, "tannes" vegetation and swamp prairies, and denuded tidal swamps. The mangroves of the region consist primarily of *Rhizophora racemosa* in deeper waters along estuaries and brackish lagoons, *R. mangle* in somewhat shallower water, and *Avicennia africana* along shorelines reached only by the high tide. A complex of swamp prairies and denuded tidal swamps supporting little or no vegetation also occur in large areas of lower valleys; most such sites were formerly

covered by mangrove formations that have degraded due to decreased freshwater inflows, increasing salinity and in some instances fire. Slightly further upstream are found a mosaic of "tannes" formations, swamp prairies occurring in valley bottoms, and to a lesser extent the mangrove formations that border estuaries and channels. "Tannes" are best described as salt flats whose soils have become increasingly saline during the recent dry cycle. They are characterized by a discontinuous cover of halophytes, including Scirpus littoralis, Paspalum vaginatum, Philoxerus vermicularis and Sesuvium spp. They were and in some cases still are used for rice cultivation. Many have been abandoned due to increasing salinity, but numerous dikes have also been constructed to both prevent salt water from reaching the paddies and to store rainwater. (RSI 1986).

Seasonally Inundated and Mid and Upper Valley Sites. These sites are found for the most part above the reach of normal saltwater intrusion, and include sites seasonally inundated by surface runoff and valley slopes. For the most part they are underlain by alluvial and colluvial materials on continental terminal deposits, and are characterized by acidic, saline, hydromorphic organic soils grading into hydromorphic soils on alluvium, which in turn grade into poorly developed hydromorphic soils on colluvial material. Soil degradation as a result of increasing salinization also occurs on some sites. Natural vegetation on these sites consists, in general order of increasing elevation, cultivated wooded savannahs, palm savannahs, non-cultivated wooded savannahs and gallery "forest".

Three principal types of cultivated wooded savannahs occur in the region. On the lowest sites are found a tree savannah and marsh complex (e.g., in the mid Soungrougrou Valley) on saline, hydromorphic gley soils in the floodplain. Numerous trees have been preserved in the rice fields here and scattered herbaceous species grow in fallow rice paddies. At slightly higher elevations are two types of anthropogenically-induced savannahs. The first type is surrounded by relatively dense woodland and is dominated by Parkia biglobosa, Khaya senegalensis and Ficus glumosa. These are shrub emergents in fallow and old fields as well as forb invaders. Upland fields alternate between groundnuts and millet, with recent introductions of cotton and rainfed rice, while valleys are reserved almost exclusively for rice. Another type of induced savannah deriving from devegetation of upland and valley woodlands is dominated by Pterocarpus erinaceus. Shrub invaders are diverse and grasses dominate the herbaceous cover. Upland crops found here include millet, groundnuts and cotton.

Palm savannahs intermixed with moist woodlands are found on the lower valley slopes. They tend to dominate the riparian vegetation as a result of centuries of human intervention. Elaeis guineensis is the dominant palm and tree canopy in the intermixed woodland covers 40-60% with a relatively heterogeneous understory covering about 10-30%. The dense, herbaceous understory is dominated by grasses, and these narrow bands of riparian vegetation constitute a rich source of vegetational products and provide good year around grazing land.

The principal non-cultivated wooded savannah type of the region occurs where valleys become relatively wide and shallow and seasonal flooding occurs. Gentle upper slopes are generally colonized by a savannah-woodland

mosaic while lower slopes are occupied by moist, evergreen riparian "forest." Aquatic prairies are also found as inclusions within the riparian vegetation and are often cultivated for rice. Riparian associations are distinctively Guinean in character, with trees averaging 15-20 m in height, the presence of oil palm, the presence of a floristically rich, woody understory, and the presence of a herbaceous cover commonly dominated by Pennisetum subangustum, Andropogon guyanus and Vetiveria nigritana. Valley bottoms support aquatic herbs and grasses, with Brachiaria mutica and Echinochloa pyramidalis or Oryza longistaminata dominating depending upon depth of inundation. This general vegetation type primarily supports cultivation of paddy rice on suitable sites, but the prairies provide good forage for livestock during the dry season.

Gallery "forest," relatively rich and diverse in composition, occurs in the deeper valleys where the water table is at or near the surface. The hydrophytic trees can attain heigths of 30 m and provide canopy cover of up to 60%. Numerous evergreen Guinean species occur and year around green biomass occurs in the upper tree strata. Grasses are relatively scarce, but include Panicum spp., Andropogon gayanus and Olyra latifolia. (RSI 1986).

Plateaus and Surface Peneplains. Plateaus and surface peneplains cover most of the southern zone region not consisting of tidally inundated lower valley sites, or seasonably inundated and mid and upper valley sites. North of the Casamance River in the area of Bignona, the geology of these areas is exclusively continental terminal. This gives way quickly to ferruginous cuirasse formation which dominates the uplands of most of the rest of the region, but in the extreme southeast are found limited areas of undifferentiated Eocene deposits, undifferentiated Cambrian deposits of volcanic and sedimentary origin, and acidic intrusive and volcanic Cambrian rocks. Upland soils consist primarily of poorly developed and lightly ferrugenous materials with moderate clay content on plateaus and residual buttes, with hydromorphic soils occurring near the eastern extreme of the southern zone region. Approximately the eastern and northeastern 50% of the region's uplands is characterized by soils that are considered to be undergoing degradation primarily as a result of water erosion. These soils typically have a very shallow useful depth, a high or very high coarse fragment content, and numerous outcrops. Most are regosolic or truncated/indurated soils on hard pan which remain arable; very isolated areas, however, are composed of lithosols which are generally of very low fertility and are not arable. Most upland soils of the region have an agricultural land capability rated at moderate potential. Major limitations influencing productivity occur, and cultivation requires investments in addition to current inputs and conservation practices. Generally, fertilizers and organic inputs are required during the growing season to ensure acceptable yields. These soils are generally rated as fair rangeland, with grazing quality being poor to fair during the dry season and fair to good during the rainy season. Wood production on these soils is also rated as good to fair. On better sites, the natural "forest" stock can be enriched and reforestation for wood production can be attempted. On most other sites stock enrichment and reforestation for wood production are only locally possible.

Natural vegetation on the plateaus and surface peneplains of the southern zone region varies generally from lightly wooded savannah to dense woodland. Three major formations dominate the area north of the Casamance River. The first ranges from a dense savannah woodland to a dry woodland on leached ferruginous soils of sandy to sandy clay texture overlying laterite and gravels. The woody vegetation has a canopy cover ranging from 40-60% with the upper story making up about half the cover. Trees of "excellent" commercial potential occur as well as dense clusters of bamboo in the understory. Grass cover is dominated by Andropogon spp. and Pennisetum subangustum, and while the cover is often eliminated by fire the rangelands can normally be grazed year around.

The second formation ranges from a dense savannah woodland to a dry woodland on gravelly to shallow gravel soils. Tree cover ranges from 30-50%, tree height is typically 10-15m, shrub cover ranges from 20-30% and the understory is dominated by tall grasses. Numerous depressions are also scattered throughout this formation type, with Mitragyna inermis, Saba senegalensis and other hydrophytes growing among them.

The third formation ranges from dense savannah-woodland to dry woodland and is found on poorly evolved, leached tropical ferruginous soils. Rainfall is somewhat higher here, and the upper story is heterogeneous and relatively dense. The woody understory is less dense and the herbaceous cover is dominated by grasses. Considerable devegetation is occurring here, especially on either side of the Sougrougrou River where woodlands are receding as agriculture expands onto the plateau.

Soudano-Guinean woodland dominates the plateaus of western and southern Casamance, stretching from the Atlantic Ocean in a broad, dipping curve almost to the Tambacounda-Koundara road. To the west and northwest, this formation consists of dry woodland on relatively deep, slightly ferralitic soils with clayey to sandy textures. It has a relatively strong Guinean aspect due to the maritime climate and elevated precipitation; the formation is dense with a canopy cover of 70-80% and an average tree height of about 15m. The woody understory is heterogeneous with tall grasses dominating. Much of the herbaceous vegetation is burned every dry season, keeping the formation in a more open state than would be expected for a non-fire climax vegetation. To the south, the Sudano-Guinean woodland occurs on relatively deep and slightly ferralitic soils, with textures ranging from sandy clay to clayey sands. Pre-drought precipitation was approximately 1500 mm/yr, and the vegetation here is significantly denser and taller than most woodlands to the north of the Casamance River. Tree canopy cover ranges from 30-60% at a height of 15-20m, and the woody understory ranges in cover from 20-30%. The formation is considered climax where not seriously exploited.

In a small region to the west and north of Bignona is an area of secondary "forest" derived from the semi-evergreen forest than once covered much of the "Basse" or lower Casamance. Over the last century or so, the native vegetation has been modified by clearing, fire and drought and numerous Sudanian species have invaded into what was at one time primarily a Guinean species composition. The resulting formation is very heterogeneous, with thick pockets being interspersed with more open secondary formations. Canopy cover varies from 30-60% with a woody understory canopy of 5-30% and a

herbaceous stratum dominated by both annuals and perennials. Numerous small clearings occur in the vicinity of villages, and groundnuts, millet and rice are cultivated. Old fields have often developed into nearly impenetrable thickets from which large trees have sometimes emerged.

Another vegetational formation of very restricted distribution occurs on hydromorphic soils which generally overlie lateritic deposits within the Anambe Basin of "Haute" or upper Casamance. This savannah and dense savannah-woodland mosaic has a tree cover which tends to be dense over most of the basin, except for lower areas subject to flooding on which either a savanna or a herbaceous stratum occurs.

In isolated portions of the very southern portion of the region occur two formations of transitional vegetation. The first consists of deciduous woodlands and dense semi-evergreen Guinean "forests" on slightly ferralitic clayey sands to sandy clays. Woodlands occur on higher-sited land where groundwater is too deep to influence the vegetation, and semi-evergreen "forests" occupy lower parts of the plateau where groundwater is shallow enough to be used by many species. Vegetational composition is very heterogeneous, and canopy cover ranges from 60-80% with an understory canopy of 20-40%. The herbaceous understory is not as well developed as that of a savannah, but this is one of the richest formations in Senegal in terms of economic value. The second formation consists of a complex of palm groves and secondary "forest" occurring on low plateaus to the south and west of Ziguinchor. Deciduous woodlands to the east have been almost completely replaced by a dense, semi-evergreen formation which has been degraded by fire over the centuries. Oil palm is no longer restricted to the periphery of valleys as it is to the east, and it dominates the low plateaus. There is some indication that the formation has developed from abandoned fields, as evidenced by the dense population of oil palm and the relatively low density of large trees. (RSI 1986).

2.5 SPECIAL FAUNAL RESOURCES AND CONSERVATION AREAS

The only major protected area in the southern zone region is the National Park of the Basse Casamance located near the coast. This park includes mangrove swamps at its western end and Guinean woodland, savanna and secondary forest throughout the rest of its area. Principal mammals include sitatunga, yellow-backed duiker, patas monkey, red colubus monkey, chimpanzee, Cape clawless otter, genet, spotted hyena, serval, leopard, bush pig, hippopotamus, bushbuck, buffalo, Maxwell's duiker, kob, aardvark, crested porcupine and a number of lesser species. More than 120 species of birds have been recorded in this and other areas of Basse Casamance, and the herpetofauna can be expected to be relatively diverse.

Federally-listed threatened or endangered species whose historic ranges include the southern zone region, and which may still be found there in isolated or protected locations, include the chimpanzee (*Pan troglodytes*), leopard (*Panthera pardus*), West African manatee (*Trichechus senegalensis*), White-collared mangabey (*Cercocebus torquatus*), Diana monkey (*Cercopithecus diana*), pangolin (*Mannis temminki*) African dwarf crocodile (*Osteolaemus tetraspis tetraspis*), slender-snouted crocodile (*Crocodylus cataphractus*) and Nile crocodile (*C. niloticus*). (DOI 1984; Dorst 1969).

2.6 AQUATIC ECOLOGY AND AQUATIC RESOURCES

Introduction. The aquatic ecology of the southern zone region is for all practical purposes that associated with the Casamance River, its tributaries, the freshwater marshes of its upper reaches and the tidal swamps associated with its lower reaches. An understanding of the basic aquatic ecological patterns of this unusual system is essential to grasping the aquatic resource impacts associated with natural and anthropogenic forces in the watershed.

As noted earlier, the Casamance River rises about 75 km east of Kolda where outflow from a number of seasonal marshes converge. The river widens to about 50m at Kolda, where it is associated with upper valley sand deposits, and to about 2km above Sefa. Below Adeane, it widens to about 4km, then narrows to 640m at Ziguinchor; below Ziguinchor, it widens gradually before attaining a width of up to 8km at it's mouth. The river channel also generally deepens as one moves downstream, attaining a maximum depth of about 20m. Average water depth, however, is only about 5m at the mouth declining to less than 50cm at a point 200km upstream.

Runoff in the Casamance River watershed has been estimated at about 0.3 $l/km^2/sec$ vs. about 2.0 for the Senegal River basin and 3.0 $l/km^2/sec$ for the Gambia River basin. Because water depth is generally low in the river, water-atmosphere and water-sediment relations are particularly important to fluctuations in some water chemistry parameters. In chemical interchange between the intertidal soils and surface water of the region, major chemical parameters are Na, K, Ca, Mg, Cl, SO_4 and HCO_3, and minor parameters include PO_4, NO_3 and silica. The most important physical processes are groundwater transfer, inundation and evaporation, and the most important physico-chemical processes are oxygen reduction, acid base reaction and precipitation. (Pages et al. 1986).

Substrates. The Casamance River can generally be divided into four sedimentary zones. In the upper reaches above Adeane, sediments are generally soft anoxic muds characterized by organic contents sometimes exceeding 20% and low to very low sedimentation rates. Below this, from Adeane to Ziguinchor, sediment particle size increases somewhat but sand and gravel content remains generally below 15%. From Ziguinchor to Point St.-Georges, sediments become increasingly more heterogeneous and from Pt. St-Georges to its mouth the river flows over well-sorted sands. Average particle size diameter here is ca. 0.25mm and particles less than 63 microns diameter often comprise less than 20% of the sediment. (Millet et al. 1986).

Water Velocity and Discharge. Water velocity in the upper reaches of the Casamance River, between Sefa and Hakdalaye, tend to be relatively stable (10-20 cm/sec); below this as far as Ziguinchor speeds tend to increase almost linearly attaining values of 70-85 cm/sec. Volumetric discharge of the river tends to increase slowly but exponentially as one moves downstream. Near Sefa discharge is ca. 3-5 x 10^6 m^3/sec, increasing to about 6-13 at Hamdalaye, about 23 at Goundomp and 37-69 x $10^6/m^3/sec$ at Ziguinchor. Discharge can vary considerably, of course, as a function of tidal stage at any given point on the river. (Millet et al. 1986).

Salinity. Salinity patterns are among the more unique features of the Casamance River system. Prior to 1968, there was a dynamic equilibrium between accumulation of tidal and evaporative salts in the dry season and elimination of salts by rains during the rainy season. The result was moderate salinity and agriculture was practicable in mangroves and near the bolon areas. At the current time, however, rainfall has decreased, and with the effect of evaporation salinity has concommitantly increased in both surface and ground waters. At the same time, groundwater levels are lower and saline ground water is now intruding into terrestrial areas adjacent to the bolons. Also, and in addition to heavy mangrove dieback and loss of mangrove swamp rice production systems, there is now both salt contamination of terraced rice and palm dieoff in some locations. (Le Brusq 1986).

Prior to the recent drought years, salinity characteristically decreased with distance from the river mouth. By 1985, however, this trend was reversed: salinity increased from about 30 ppt at the mouth to values as high as 150 ppt at a point 200km inland before dropping rapidly at 200-235km to values near zero. Lowest salinity values are typically found in October at the end of the rainy season, and values tend to increase as the dry season progresses until peaking east of Sedhiou in July and August. This trend of natural but increasing hypersalinity associated with low watershed precipitation, high evapotranspiration and relatively poor system flushing continues to occur, a maximum value of 175 ppt being obtained in mid June 1986. The system's extreme natural hypersalinity has been compared to both Bocana de Virrila lagoon in Peru and Laguna Madre in Texas, the former exhibiting higher and the latter somewhat lower values. (Pages et al. 1986).

With a return to earlier (i.e., ca. 1950-1968 mean) rainfall levels, the considerable levels of salt accumulating in the ground water and on soil surfaces would gradually be reduced. This would occur slowly, however; for example, the 1984/1985 rains were relatively good although marigot salinity still increased from June 1984 to June 1986 (Le Brusq 1986).

Nutrients. Inorganic nutrient parameters of importance in the Casamance River include dissolved inorganic carbon (DIC), potassium and nitrogen. DIC tends to attain maximum values in the uppermost and lower reaches of the river, declining to a nadir approximately 175km upstream from the mouth near Sedhiou. There is a potassium deficit in the lower reaches typically associated with mangrove systems, and inorganic nitrogen, while generally rather high, is low in relation to PO_4. Few good data exist on particulate organic matter, but dissolved organic matter (DOM) levels are high, exhibit a clear increase as one moves upstream, and constitute a significant nutrient reservoir. DOM, along with litter, appear to be the primary nutrient sources in the estuary.

In general, the sea is believed to be a source of relatively little nutrient input to the Casamance River system. Terrestrial sources also appear to be limited in their contribution to the system, since there is weak runoff during the rains and organic material decomposes only poorly during the dry season.

The atmosphere contributes an estimated 250g of material/m^2/yr, mostly during the harmattan season, and about 2-5 gN/m^2/yr via rainfall.

Mangroves are estimated to produce about 7.5 $g/m^2/yr$ of biomass, and upper system reed marshes are estimated to produce about 300 $g/m^2/yr$. (Pages et al. 1986).

Primary Production. Two general chlorophyll(a) regimes have been described, one 180+ km upstream (50-2000 ug/l) and a second 0-180km from the mouth (2-20 ug/l). Phytoplankton biomass (tons carbon/station), however, decreases as one moves upstream. Levels are lowest in the rains and increase throughout the dry season, and chlorophyll(a) and DOM levels tend to fluctuate together, always occurring with salinity maxima. About 30-60% of the river's substrate is in the euphotic zone, and phytobenthic production has been estimated at about 100 $gC/m^2/yr$ or comparable to that of phytoplanktonic production. (Pages et al. 1986).

Marshes consisting primarily of Phragmites cover an area of about 40 km^2 in the uppermost reaches of the watershed. They were far more extensive in 1955 than now, and continue to shrink in areal extent as a function of increasing salinity. Between 1984 and 1986, they receded approximately 20 km upstream, and are now found only above about 200 km upstream from the mouth of the river. Estimated primary production of these systems is ca. 2000 $g/m^2/yr$ dry weight, or about 7 tons C/yr for the whole river system. Biomass production is a major component of their systemic role, but they also provide protection for juvenile fish.

Mangroves, consisting of six species, are concentrated in the lower portions of the Casamance estuary below Ziguinchor. They have suffered a continuous decline from 931.2 km^2 (1973) to 907.5 km^2 (1979) to 887.5 km^2 (1983) to about 800 km^2 (1986). (Recent (1987) indications are that mangroves are declining at a rate of about 4-7 km^2/yr, depending upon rainfall.) Rhizophora has regressed about 70%, Avicenia spp. has regressed somewhat less, and tannes soils are concommitantly spreading. In general, this decline has occurred progressively from upper to lower portions of the estuary and natural regeneration is currently very weak. It should be pointed out, however, that mangroves tend to naturally have a rather precarious existence in the Casamance River system because 1) the watershed area is small, precipitation is marginal and runoff is slight; 2) tides are not very high (about 169 cm at the mouth, about 52 cm at Ziguinchor) and there is therefore little appropriate substrate for mangroves to begin with; and 3) weak sedimentation rates do not favor the establishment of new lands suitable for mangrove colonization. (Badiane 1986).

The recent decline in mangroves is attributable somewhat to anthropogenic sources. It has been estimated, for example, that 50% of all charcoal in Ziguinchor derives from mangrove; that 90% of all housing construction uses mangrove wood; that 35% of all mangrove decline in some areas is due to mangrove swamp rice cultivation; that 1% of overall decline is due to road construction; and that an unknown but perhaps significant percent is due to barrage construction and mangrove stilt root cutting during oyster harvesting in the southern zone region. Generally, however, it is accepted that natural phenomena are the greatest sources of decline. Recent drought has resulted in the marked increase in salinity beyond mangrove tolerance, a reduction in inundated tidal surface area, a decline in diurnal inundation fluctuations

resulting in soil exposure and acidification, and decreases in groundwater levels. North-south channel displacement in some areas and substrate erosion have also been mentioned, as well as declining sedimentation rates, (Badiane 1986).

In general, mangrove systems can be expected to be more vulnerable to periodic or aperiodic decline in small watersheds characterized by 1) low or marginal and generally highly variable precipitation, 2) high evapotranspiration, and 3) low natural runoff conditions. The recent "dieback" in the Casamance and Gambia river is probably therefore a recurrent phemonemon associated with recurrent drought, and the trend can probably be expected to slowly reverse itself during series' of years of higher rainfall and runoff. Such a reversal may, nonetheless, be mitigated by anthropogenic impacts such as freshwater interception and swamp rice cultivation and such impact can be expected to be greatest in upper and mid portions of the system where salinity trends are most marked.

Primary production of mangroves in the Casamance estuary has been estimated to vary from 2-60 tons of biomass/ha/yr depending on size, density and other factors. Litter production for the system as a whole is estimated at about 13 tons/ha/yr, most of which is transported seaward. Mangrove leaves contain about 1% nitrogen dry weight and while leaf decomposition in the substrate is slow and leads to significant accumulation of detritus, liberation of nitrogen and especially phosphorus probably occurs faster. (Pages et al. 1986).

Secondary Production. Three zooplanktonic zones have been delineated in the Casamance estuary, a "maritime" (ca. 0-40km upstream from the mouth), an "estuarine" (ca. 40-90km upstream) and an "anti-estuarine" (ca. 90-180km upstream) zone. Zooplanktonic biomass typically peaks during the rainy season and highest levels are found in the estuarine zone. Microbenthic biomass (formaminifera), conversely, is highest near the mouth of the river while macrobenthic biomass shows no clear longitudinal trend. Crabs have been noted to still occur at salinity values of 80 ppt, and there is a general increase in mollusc abundance from August to December. (Pages et al. 1986)

Oysters tend to be concentrated in the lower stretches of the estuary in association with mangroves, but no reliable biomass figures for oysters are available. Almost all oysters are harvested at low tide from the mangroves and they are consumed, exchanged and sold in Ziguinchor and Dakar. Oyster harvesting is a dynamic system whose future is affected by drought persistence and rural-urban migration to Dakar. Oyster size has generally decreased with increasing salinity, but there remains a good potential to develop commercial oyster culturing in the region. (Cormier-Salem 1986).

Shrimp appear to reach their maximum size at around 30 ppt, decreasing with salinities either higher or lower than that value. Quantities tend to depend on salinity, seaward migration size, temperature, bottom dissolved oxygen (DO) levels, nutrients and a range of other factors. The first life stage of the predominant shrimp in the region, Penaeus notalis, is in the estuaries. The impact of shrimping in the Casamance River on sea shrimp stocks has probably been low, however, since there is little shrimping below Ziguinchor (an area very rich in juveniles) and sea stocks to a large

extent derive from Guinea Bissau estuaries which are so far poorly exploited. Shrimping began in the Casamance region about 1960, and catch has generally fluctuated directly with salinity. Shrimp are usually captured at night on outgoing tides with fixed nets. The catch generally increased from 1960-1981, then declined significantly; by 1984, shrimp processing plants were closing as the weight of shrimp captured fell dramatically. (Le Reste 1986).

It has been noted that the zone of post-larval and juvenile shrimp corresponds to that of the occurrence of mangroves, but at a fine scale the relationship is not evident. In 1978, for example, maximum concentrations were generally found where there were no mangroves. (Badiane 1986).

Tertiary Production. Fish diversity in the Casamance River generally declines strongly as one moves upstream. Predator communities are concentrated in the lower stretches with detritovores or phytophages occurring in the upper limits of the system. Above salinities of about 130 ppt, virtually all fish disappear. Some species have already disappeared entirely from the estuary, and the continental fish fauna remains only in a few residual marshes near Kolda. A core community of about six fish species dominate higher salinity areas. In general, the decline in species richness in the estuary would be easily reversible in estuarine and maritime areas with a decline in salinity, but it would be more problematical for continental species. (Pages et al. 1986).

Fish catch biomass is approximately equivalent in the three zones of the estuary, although the productivity of surface catch is clearly higher in middle and upper than in the lower reaches. The sea catch constitutes about 27% and the estuarine catch about 73% of total offtake. About 80% of the catch consists of Tilapia, onga shad, senentfish, mullet and cracker. Maximum offtake occurs in the dry season (February-May) and an estimated 94% of local fish consumption derives from the regional artisanal effort. (Diadhiou et al. 1986).

Fishing has occurred on the Casamance River since at least about 1000 A.D. Major changes began occuring after about 1900 and accellerated rapidly after about 1950 with a sharp increase in new fishing methods and the brief flourishment of a Casamance-based smoked fish industry. In 1986, it was estimated that there were 4360 fishing units and 9460 fishermen working the Casamance. About 85% of these units, and 45% of all fishing centers, were described as consisting of "peasant fishermen" still clearly tied to agriculture and other land-based economic strategies. Currently, however, the economic effect of development projects and the effects on fisheries of naturally increasing salinity levels have tended to draw fishing efforts from the mid-estuary bolons towards the sea. (Diaw 1986).

Macrofauna. Water bird diversity on the Casamance is highest (12-14 species) in the Phragmites marshes at the upper extreme of the system, and biomass, density and number of waterbird species generally increased with distance upstream from Ziguinchor in April 1985. Manatees are still hunted along the river, crocodiles are said to still be present, but hippos, which used to be abundant in the Soungrougrou River tributary ca. 1960, are said to be entirely extirpated as a result of hunting and other pressure. Human population, concentrated in Ziguinchor, Sedhiou, Kolda and Marsassorum, is said to appear

to have had little effect on the Casamance estuary with the possible exception of its affect via fishing pressure. (Pages et al. 1986).

General Conclusions. The Casamance River system is characterized by a confined watershed of limited size, highly variable watershed precipitation, generally low to very low freshwater inflows, and consequent hypersalinity increasing in recent years to extreme hypersalinity in the central and upper reaches of the system. As such, the estuarine portion of the river can be viewed largely as an evaporative system. The upper reaches are essentially detritic with exceptional organic reserves, where solar insolation is almost the only source of external energy input. The biological diversity of the system is generally low, with the highly variable central portions of the system selecting for oligo-specific communities which are highly adaptable. Nonetheless, the productivity of the Casamance River remains moderate to high.

2.7 SOIL/WATER PROBLEMS AND LAND RECLAMATION

There are two major and very different soil/water problems currently prevailing in the Southern Zone, i.e., soil acidity and soil salinization. Development of acid sulphate soils normally occurs in the southern zone region in association with mangroves, when groundwater levels drop and oxygenation of pyrite to sulphuric acid occurs. This has resulted in pH values as low as 1.5-2.0 locally, and precipitation of ferric sulphate on tannes soils is typically used as an index to identify areas of potential acidification. A related phenomenon has also been observed in the region where older mangrove systems have liberated large quantities of exchangeable aluminum (fixed on clay) which is both soluble and mobile. This aluminum precipitates at the terrace limits and is washed by rainwater into the marigots, making the water behind some barrages acidic, e.g., 3.2 at Djiguissoum in December 1986 and falling from 6.1 to 3.1 at Guidel following the first rains in June 1986. This is a potential problem because water high in aluminum is not usable for irrigation and is probably also not usable for pisciculture. Low pH water is typically flushed from behind barrages in July-August, however, prior to capturing the late rains for rice production, and both iron and aluminum toxicity are greater problems for fish than for shrimp culture. (Le Brusq 1986).

The key to controlling the phenomenon of soil acidity in such sites worldwide has typically been to maintain soil saturation in the dry season (after crop harvesting is completed) by flushing the cropping site with tidal waters and maintaining soil saturation until tidal waters can be replaced with fresh water after the onset of the rains.

The other major soil/water problem in the southern zone is increasing salinization of cropland as a result of declining precipitation, increasing surface water salinity and saline groundwater intrusion. The best way to manage such areas is through construction of small anti-salt dikes. These dikes stop salt water intrusion and retain fresh water runoff during the rainy and early dry season (June-December) for crop production; after harvesting, they are then opened and flushed with tidal waters.

In essence, the sequence of events which takes place in reclaiming southern zone lands which are both salinated and exhibit potential acidification is as follows. A small anti-salt dike is constructed at an appropriate location upstream of the mouth of the bolon. From about December-June, the dike is left open and saline tidal waters are permitted in to maintain soil saturation and obviate the potential for the oxidation which produces sulphuric acid and, therefore, high soil acidity. With the onset of the rains (ca. June) runoff is trapped behind the dike. Periodically throughout the rainy season, the dike is opened to flush the accumulated and dissolved salts out of the system; this gradually reduces the total bulk of salts which have accumulated on the site over the years. When water levels in the early dry season are reduced to the point where soils begin drying and oxidation and acidification potential rise (ca. December), tidal waters are again permitted to enter to keep the soil saturated. After a few years, sufficient salts have been flushed out of the soils such that a rice crop can be produced. This system only usually changes at that time insofar as the frequency of flushing during the rains occurs. Typically, the dike will be closed in June and opened in July or August to flush out accumulated salts for one to three weeks. It is then closed again to capture the late rains and is opened again only after harvesting is complete.

A summary of typical and principal surface and groundwater physicochemical patterns which result from such management, drawn from the example of the Katoure Barrage in 1986 as analyzed during the USAID-funded ISRA study, is as follows: (It should be noted that this site is located in the lower Casamance, where the greatest surface area of acid sulfate soils exists.) Between closing of the dikes in June and its temporary reopening in August, surface water salinity decreases rapidly above the dike and slowly below the dike. After the August closing, the opposite pattern occurs. Surface water pH above the dike remains low (pH ca. 3.0-4.0) until the August opening, after which it climbs rapidly to ca. 6.0-7.0. Below the dike, surface water acidity remains at levels of pH 6.0-7.0 regardless of dike operation.

Groundwater levels of course increase throughout the rainy season and decrease as the dry season progresses both above and below the dike. Groundwater salinity shows an opposite pattern, decreasing during the rainy season and increasing during the dry season both above and below the dike. Groundwater pH below the dike typically remains at fairly stable high levels (ca. pH 6.0-7.0) throughout the rainy season, while pH above the dike tends to decline to its lowest level between June and the August flushing, at which time it increases gradually to about 6.0 in November.

It is important to reiterate 1) that salinization and acidification are very different phenomena, 2) that they only sometimes occur on the same plot of land, and 3) that currently it is salinization far more than acidification which represents the primary constraint to valley rice development. This is because it affects a great deal more land and occurs far higher in the watersheds where acidification potential is typically low, and it is because of this phenomenon that it is possible to site anti-salt dikes in a large number of areas without running the risk of developing significant levels of acidification.

2.8 BARRAGE IMPACTS AND AQUATIC ECOLOGY

Barrage impacts on aquatic ecology in the southern zone region have been described by a number of authors. The Guidel barrage, enclosing an area of approximately 745 km^2, has been described as having had the effect of decreasing salinity variability and decreasing nutrient levels and fish recruitment below the barrage (especially for fish and ethmoloses). Above the barrage, the effects have been to maintain the fish biomass at about pre-closure levels, to change the species composition of the fish community and apparently to generally improve the regenerative capacity of the area for mangrove reestablishment. Overall, however, the effects of the barrage have been described as 'practically nil.' (Barry and Posner 1986; Badiane 1986).

The aquatic impacts in the Bignona Valley, site of the Affiniam Dam, have been somewhat more intensively studied. Data from eight stations monitored monthly and located both above and below the dam provide an indication of the variability prevailing there (Diaw 1986). This bolon has a watershed of approximately 800 km^2, and a length of about 88 km of which about 68 km was originally under tidal influence. In 1971, the bed of the river was about 150 m wide and 10 m deep at Elora, just above the confluence of the Bignona with the Casamance River, but by the mid 1980's the bed was no deeper than about 6 m at this point. Farther upstream, the channel narrows to about 20 m width and 1.5 m depth at the town of Bignona.

In general, there is little diurnal variation in water temperature in the bolon. Maxima of 31-32°C occur in October and minima of 21-22°C occur in January-February. Salinities tend to reach their maximum at 53-68 ppt during the rainy season as salts are leached out of the soil. They minimize in September due to runoff, direct rainfall and groundwater movement, reaching about 39 ppt below the dam and about 7 ppt above. No salinity levels below 7 ppt were ever observed in the bolon during the course of the study. Salinity gradually increased slowly after September as the rains slowed, groundwater flow decreased and evaporation increased. This phenomenon is said to be typical throughout the Casamance River system except in Soungrougrou Bolon which does not desalinate in the rainy season. In general, tide waters are more saline than those at ebb tide during the rainy season. Here, as in most of the Casamance, it appears that groundwater salinity was previously lower than the river water but that in recent years it has become 2-3 times saltier than the river water.

Values of pH generally maximize in the late dry season and are at their minima during the rains. Seasonal variation increases with distance upstream from the confluence of the bolon with the Casamance River. Minima are generally from 6.5-7.1, maxima are generally about 8.5, and there is little diurnal pH variation. DO values are generally between 2-4 ppm and show little variation either seasonally or diurnally. Higher variations tend to be associated with photosynthetic activity.

Nitrate values are generally highest during the rainy season (August-October) and then decline except for a minor peak in December. Maximum values correspond to low salinity. Values are highest in the rains due to runoff, high nitrogen content of rainwater, washing of iron from the soil, contributions from the mangroves in the lower reaches and farm runoff in

areas where terrestrial farming occurs. Some diurnal variation occurs, but patterns of variation are not particularly clear. Phosphate levels tend to maximize in September, a phenomenon typical of coastal and continental soils due to intensification of soil rejuvenation of phosphorus by the sediments. Minimum values are usually obtained in December-January.

Cholorphyll(a) tends to peak in October and decline throughout the dry season and at the start of the rains. Maximum values obtained were 5.59-13.16 micrograms/l, much lower than the maxima of up to 30 micrograms/l obtained at the Guidel Bolon. There is considerable diurnal variation in values, as would be expected.

In general, temperature, salinity, pH and DO vary little throughout the water column. Nitrogen and phosphorus tend to be much higher at depth as well as chlorphyll(a), supporting the hypothesis of a detrital origin.

In general, longitudinal variation in parameters in relation to the Affiniam Dam can be summarized as follows:

Parameter	Below Dam	Above Dam	Season/Notes
Temperature	Lower higher =	Higher Lower =	October-November March-May Rains; Winter
Salinity	Lower Higher =	Higher Lower =	June August-November December-January
pH	= Higher	= Lower	Most of year August
DO	Lower	Higher	Most of year
Nitrates	Lower	Higher	Generally
Phosphates	Higher	Lower	Generally highest in association with mangroves
Chlorophyl (a)	Lower	Higher	Generally

2.9 INTERVENTION ZONE DESCRIPTIONS

Baila Valley. Long-term rainfall measurements indicate variation from about 1300 mm/yr in the south to about 1000 mm/yr in the north, but these values have declined during the last 10-15 years to approximately 1100 mm and 800 mm, respectively. Most precipitation is currently lost to agricultural production because of the uneven distribution of rainfall over the wet season, high evapotranspiration rates, the intensity of rainfall which leads to overland flow of runoff, and the lack of storage facilities to capture excess runoff during the rainy season. In the salinized valleys, early season rainfall is used to dissolve, leach, and remove salts from the soils to enable rice to be transplanted. A month or more of rainfall may be needed before transplanting can occur.

Groundwater resources in this basin consist of three aquifers, at about 5-20, 50-100 and 150-200 meters depth. The shallow aquifer has been tapped by hand-dug village wells to provide village drinking water, but the medium aquifer is largely unused and the deep aquifer has only been used in a few locations to provide water for town municipal water supply systems and small fruit and vegetable gardens. These aquifers cannot economically provide significant amounts of water for agricultural development, but the resources should perhaps be monitored to determine the relationships between surface water, ground water and water quality with a view towards preservation of the resource for potable water usage.

Soils of the basin appear to be of average fertility and consist of light to medium-grey clays, clay loams and loamy sands. Organic matter is estimated at less than 1%. The red acidic plateau soils fix large quantities of phosphate, but the gray sandy soils lack both nitrogen and phosphorus. When flooded, they tend to show iron toxicity. Loamy sands and clay loams in the bottom lands are subject to drainage problems for all crops except rice. They also have iron and aluminum toxicity problems when first flooded. They generally have low pH but away from the main marigot salt water intrusion does not present a problem. Agriculture in the basin is not very intense and many wooded lands occur, much of which is secondary vegetation now in bush fallow. Most of these are lands formerly cultivated but which have returned to fallow since 1962 when total surface area cultivated began dropping substantially.

The lands proposed for project development are all relatively flat with low rolling hills creased by small valleys formed by non-perennial streams. The land is not ideally suited to gravity irrigation systems which would be supplied by surface storage reservoirs, as the stream valleys have very little relief. In general, salt water intrusion is not believed to be a significant problem here nor is groundwater believed to be a significant agricultural resource. (DAI 1987).

Bignona Valley. This basin is adjacent to the Baila Basin and is located to the southwest of Baila. It is drained by a large marigot which dispenses directly into the Casamance River; this marigot alternately acts as a drain for the basin and as an entry for salt water coming in from the sea via the Casamance River. During the last decade, rainfall has decreased in this basin as it has in the entire region but on average it is slightly higher here than in Baila. The long term rainfall decrease from about 1500 mm to 1200 mm per

year has allowed an increase in saltwater intrusion and increasing salinization. All streams in the valley are intermittent. Groundwater is generally used for village potable water supply and is withdrawn by hand from shallow aquifers. Occasionally deep wells are used to irrigate fruit and vegetable crops but this use is relatively small.

The soils in this basin are more clayey and less sandy than in the Baila basin. More red soils were visible and since there is more saltwater intrusion in this basin than in Baila the acidity of these soils is more of a concern. While wetland agriculture is more evident here, indicating a more firm water supply, there are also more lands left fallow because of a combination of salt water intrusion and acidity. The basin generally slopes gently upwards towards the north and east. Flat and rolling, the terrain drains towards the Casamance River to the south. Saltwater intrusion exists in this basin due to the relatively mild slopes of the streams which connect to the sea. Groundwater levels in September 1987 were at about 5-8 meters below the surface. Diking of the land to prevent the inflow of salty water is possible, and these dikes can also be used to retain fresh water from upstream to flush out soil salts. (DAI 1987).

Sedhiou Region. The long term rainfall in this region has also dropped and, even though the basin is located further upstream than Bignona, there is still a serious salt water intrusion problem although not as severe as at Bignona. The area is dissected by many marigots and drains directly in to the Casamance River. Ground water has been used here for banana plantations, which draw from one of the deeper aquifers. Soils are generally silts and clays which appear to be free draining and relatively fertile. There does not appear to be an abundance of the red soils that were observed in the Baila valley. Along the edges of the water courses of the marigots significant amounts of fallow lands were noted resulting from the soil salinization process.

Land in this region is relatively flat and slopes generally to the north, with marigots flowing into the Casamance from both the right and left banks. In general, groundwater levels are lower than in many other areas of the Casamance, as a result of both reduced rainfall and greater use by human populations. (DAI 1987).

Soungrougrou Valley. This region is extremely similar to that of the Sedhiou Region with respect to water resources, soils, topography and hydraulic features since they lie essentially contiguous to each other. However, the Soungrougrou Valley is significantly drier and the shallow aquifer occurs at a depth of about 4-5 meters in the valleys and 12-18 meters on the plateau during the dry season. (DAI 1987).

3.0 MIX OF SPECIFIC INFRASTRUCTURAL ALTERNATIVES TO BE CONSIDERED FOR PROJECT FINANCING

There are four specific infrastructural alternatives which are under consideration for project financing, i.e., anti-salt dikes, water retention dikes, contour berms and dikes, and a pilot irrigation system. (DAI 1987).

Anti-salt Dikes. Anti-salt dikes will be constructed in lower valley portions of the Soungrougrou Valley, the Sedhiou Department, on the left bank of the

Casamance River between Sedhiou-Tanaf and Ziguinchor, and in the Bignona Valley. They will be sited so as to optimize the area which can be reclaimed from salinization at the same time that exposure to potential soil acidification can be minimized. Approximately 150 ha will be protected by each dike at a cost of approximately US$ 1000/ha. These dikes are expected to be constructed of reasonably impervious clayey materials. Embankment materials will be compacted in place in layers by either hand tampers or by mechanical means after moistening. Dikes will have maximum side slopes of 2:1, top widths of 2-3 meters, heights of 1.5 meters and be protected by either grass or laterite on the slopes. When completed, the systems will consist of a well-compacted earthen dike and a reinforced concrete control structure provided with wooden stop logs. The system can retain rainwater up to a height of 1.5 meters and hold out salty downstream water to the same height.

Control structures for both the anti-salt and water retention dikes will be constructed with 350 kg class reinforced concrete. Stone aggregate will probably be used rather than shells to obtain the specified concrete strength. Deformed reinforcing bars are a preferred option and the concrete should be hand mixed and tamped into place. Wooden stop logs are acceptable, but it is preferable that the stop logs be provided as back up to hand-operated, steel vertical slide gates or flap gates. As an alternative, a low level outlet pipe might be installed in control structures with an overflow weir at a higher level.

Operation of these dikes and control structures is designed to reduce salt water intrusion and reverse the salinization process that has been taking place with the reduced rainfall levels over the last decade. It is also intended to keep potentially acid sulfate soils moist enough to avoid acidification and mineral toxicity problems. The greatest benefits will occur when the desalinization process is rapid. As salinized land is being reclaimed, farmers are likely to have conflicting objectives involving short-term returns from holding runoff behind the salt dike to increase the supply of water to the groundwater rice zone and the medium-term returns to desalting a larger surface area in the valley proper. It may be that on heavily salinized soils and on soils bearing deep sulfur deposits, the short-term production objective should take precedence. On more recently salinized soils, the medium-term land reclamation objective should probably take precedence. (DAI 1987).

Water Retention Dikes. Water retention dikes will be constructed in mid-valley portions of the Baila Valley, Soungrougrou Valley, Casamance River between Sedhiou-Tanaf and Ziguinchor, and the Bignona Valley. Each dike will protect an area of about 150 ha at a cost of approximately US$ 1000/ha. Water retention dikes will be constructed to the same general specifications as anti-salt dikes, but they are designed solely to retain rainfall and surface water runoff upstream of them for agricultural and perhaps other uses. (DAI 1987). Such structures are essentially analogous to small U.S. Soil Conservation Service dikes and dams found throughout much of the western and southwestern United States.

Contour Berms and Dikes. Contour berms and dikes will be constructed in certain upper portions of the Soungrougrou and perhaps other valleys. They

will protect an area of approximately 150 hectares per site at a cost of about US$ 500 per hectare. Typical berms will have a height of 0.6 meters above the ground, a width of 2.7 meters, 1:1 side slopes and a length of about 300 meters. They will typically be laid out at 150 meter intervals alternating in "staggered stepladder" patterns. (DAI 1987).

Pilot Irrigation System. A single pilot irrigation system is under consideration for a portion of the upper Baila Valley. The system will protect an area of about 150 ha at a cost of about US $3000 per hectare. The dam is designed 1) to be constructed of impervious material which is compacted in place mechanically in six-inch layers at optimum moisture content to achieve maximum compaction; 2) to be provided with an ungated, broad-crested weir emergency spillway which is designed to pass at least a 100 year frequency flood event; 3) to have a lined spillway and downstream energy dissipation; 4) to have an upstream slope protected with riprap and having an impervious core; 5) to have a positive impervious cutoff to prevent under seepage under the dam and gated outlet works through the core of the dam; and 6) to have outlet works which should be provided with cut off collars at frequent intervals. If the service area is located upstream from the dam a reinforced concrete side reservoir overflow weir will likely be provided. The irrigation system itself will consist of trapezoidally shaped unlined earth canals, gravity fed and having side slopes of 1:1, or 2:1 if necessary. Standard concrete division/turnout structures will be provided at frequent intervals along the primary canals and these structures will be provided with simple vertical slide gates.

4.0 ENVIRONMENTAL CRITERIA FOR INFRASTRUCTURE CONSTRUCTION

The overwhelming consensus among technical specialists (engineers, soil scientists, agriculturalists, aquatic ecologists and fisheries specialists) familiar with the southern zone region, its naturally changing environmental characteristics, and the mix of engineering infrastructural interventions which have taken place there to date, is that salinization control in the bolons through construction of small anti-salt dikes in the lower valleys and freshwater runoff catchment through construction of water retention structures in the mid and upper valleys are critical to stabilizing the prevailing deterioration of agricultural land and water quality occurring naturally in the region. Far from representing the potential to result in significant adverse environmental impact, these types of infrastructural interventions are designed to result in the environmental protection and/or amelioration of adverse environmental conditions on agricultural and other lands upslope from the structures.

With the possible exception of soil acidification potential, there are few if any environmental threshold criteria for such infrastructure the exceedance of which would result in significant adverse environmental impact at the scale envisioned for project interventions. For example, very high salinity values upslope of the site of a potential anti-salt dike would not represent the potential for significant adverse environmental impact since construction of a dike at such a location would not result in degradation of preexisting conditions; rather, the economic attractiveness and technical soundness of such construction might be rendered questionable by virtue of those high values. Moreover, the environmental issues raised in the original IEE for the

SZWM Project (e.g., estuarine impacts, terrestrial impacts, social and human health impacts) are far more appropriately addressed on a watershed, subregional or regional basis rather than through establishment of intervention- or site- specific environmental threshold criteria. This is because the issues associated with such construction represent very gradual and cumulative impacts potentially occuring due to development of such infrastructure regionally by the GOS and a diverse array of other international donors. This also holds true for non-environmental but related issues such as the efficacy of intervention design and siting alternatives on 1) control of soil salinity, 2) water quantity, quality and distribution, and 3) soil pH and aluminum and iron toxicity.

In spite of this, however, and given the requirements of 87 State 260192, the following environmental criteria are recommended as those to be taken into specific consideration for each of the infrastructural intervention alternatives prior to a decision to proceed with construction:

Anti-salt Dikes and Control Structures. Anti-salt dikes are designed to control salt water intrusion, reverse the salinization process and keep potentially acid sulphate soils moist enough to avoid acidification and mineral toxicity problems. The beneficial effects of such dikes on upslope vegetation and crops are well established. Because there exists a minor potential, however, for mismanagement of such dikes to result in some degree of upslope acidification after the end of the project, the SZWM project will not fund construction of such dikes where a significant potential for upslope acidification under mismanagement exists.

It was originally envisioned that a simple quantitative cutoff point for potential soil acidity as measured by sulfide concentration or by total acidity could be used to site anti-salt dikes above areas of potential acidification, and thereby avoid any potential whatsoever for acidification under a mismanagement scenario following project completion. Subsequent soil sampling and survey work showed, however, that exclusion of all potentially acid sulfate soils from above potential anti-salt dikes was not a practicable approach. This was because potentially acid soils, as well as already acidified soils, occur in thin strips along water courses in vitually all of the basin valleys. The potentially acid soils have remained at or near saturation moisture content during the last fifteen years of dought but, in areas where anti-salt dikes have been constructed and operated, salt concentrations have diminished and mangrove vegetations has begun to naturally reestablish. In areas where significantly acidified soils already occur, salt content and residual acidity prevents their use for agricultural purposes. Reduction in salt concentration through construction and operation of anti-salt dikes may, however, allow revegetation and eventual reclamation to occur. The effect of the anti-salt dikes proposed by the project will be to maintain these soils in their saturated condition, but at reduced salt concentrations favoring mangroves. And, even under a worst case scenario where the reclamation process proves unsuccessful, the hydraulic regime can be expected to return to a pre-dike pattern of alternating fresh and salt water flows. These soils will not, therefore, be any drier than before anti-salt dike construction, i.e., if rainfall and runoff are insufficient for reclamation then the dikes will still allow water (regardless of its salinity) to move upstream of the dike during high tides and maintain maximum or

pre-dike construction soil saturation levels. Therefore, the moisture content of the soils (and thus the potential for acidification of those soils) will remain the same whether or not a dike is constructed. It should be reiterated that drainage of these soils is neither a project objective nor is it an objective of farmers who recognize that these soils are susceptible to sterilization if they dry out. While construction of anti-salt dikes is therefore essentially a "minimum risk" activity from the soils acidification perspective, further minimization of any potential risk during project implementation will be ensured by establishment of the criterion of siting anti-salt dikes such that the total area of high potential soil acidification or pre-existing acidified soils, as defined by occurrence of the taxonomic subgroup of soils described as typic sulfaquents in the USDA Soil Taxonomy system, does not exceed 15% plus or minus 2% of the service area upstream of the anti-salt dikes.

It is important to reiterate here that 1) none of the anti-salt dike sites to be selected require reclamation of high potential soil acidification; 2) that the project will help protect against soil acidification by maintaining low-lying land at saturated or near saturated conditions and/or improving saturation conditions; and 3) that existing anti-salt dikes in the southern zone region have tended to demonstrate a beneficial vegetational effect in the subwatershed, with sedges and mangroves often ultimately reappearing.

Water Retention Dikes. Water retention dikes are designed to retain rainfall and surface water runoff from upstream for agricultural and perhaps other uses. The only recommended environmental criteria is that siting of such structures be such as to avoid submergence and/or precluded use of important (from the target population's perspective) cropland, grazing land, vegetational associations or other important lands, or that the benefits deriving from such construction from the target population's perspective clearly outweigh the adverse implications of precluded use of such lands.

Contour Berms and Dikes. Contour berms and dikes are designed to improve water retention, to improve soil infiltration, to improve crop and other vegetational productivity and to reduce sheet erosion on mid and upper valley slopes. There are no environmental threshold criteria for such structures at the scale envisioned, exceedance of which could result in significant adverse environmental impact.

Pilot Irrigation System. This small scale, gravity flow, pilot irrigation system in the upper Baila Valley is under consideration to service an area of only about 150 ha (the same area as will be affected behind the average anti-salt or water retention dike). The only recommended environmental criteria are 1) that sufficent analysis be performed prior to siting and construction to ensure that salinization and water logging potential in the affected irrigated area will be minimal and that appropriate measures will be available to the target population to mitigate any salinization or water logging which may occur in the future using appropriate and locally available technology; and 2) that sedimentation rates upslope of the primary structure are determined to be sufficently low to permit use of the reservoir for irrigation throughout a reasonably long facility target life.

Because of the very small scale of this structure, other issues typically associated with irrigation facility construction, including potential health impacts, are to be addressed as inherent components of the regional, subregional or watershed management activities as described in the original IEE.

5.0 PROJECT PAPER DESIGN STAGE ENVIRONMENTAL REVIEW

Pursuant to the provision of the original SZWM IEE, additional project environmental review was undertaken during the PP design stage to clarify, amend and elucidate issues and other points raised in that IEE. The findings of that review can generally be broken down into 1) issue revisions, 2) technical monitoring and evaluation, 3) project evaluation requirements and technical assistance, 4) commodity procurement and training, and 5) covenants.

5.1 ISSUE REVISIONS

The first issue raised in the original IEE, that of the effectiveness of anti-salt barrages in controlling upstream soil salinity levels, has been addressed on a continual basis by engineers, hydrologists, pedologists and agronomists since the advent of such infractructural construction in the southern zone region of Senegal. Major reviews of the issue and experiences to date took place at a 1978 "reflection seminar" sponsored by the Ministry of Hydrology and Rural Development in Ziguinchor, at 1980 and 1985 round tables, and in a detailed 1987 study by ISRA financed by USAID/Dakar. Ongoing review of the issue should continue so long as anti-salt dikes continue to be designed, constructed and evaluated in the region since review of variability in effectiveness resulting from different designs and operation and maintenace patterns has and will continue to lead to substantial refinement of intervention approaches. It is appropriate, therefore, that this issue and lessons learned since the last round table again be cohesively reviewed during project implementation. It is recommended, however, 1) that such review occur in Year 3 or Year 4 of the project; 2) that it be restricted primarily to lessons learned from the southern zone region; 3) that the issue of efficacy of such barrages in controlling upstream salinity levels be only one of a range of related issues addressed; 4) that review take the form of a multi-donor and multi institutionel roundtable; 5) that primary responsibility for the organization of the round table fall to the Project Management Unit; and 6) that the roundtable be sponsored by USAID using project funds. Estimated Project Manpower: 6 person-weeks.

The second issue raised in the IEE, that of the effects of upper, mid and lower valley infrastructure on groundwater quantity, quality and distribution; has also been the subject of ongoing review in the southern zone region but at a much less intensive level. Because the effects of such interventions are particularly important from the hydrological, pedological, agronomic, economic and social perspectives, it is recommended that the idea of a regional review of our state of the knowledge in the southern zone to date undertaken using project funds, be retained. It is also recommended, however, 1) that the review occur in Year 2 or Year 3 of the project; 2) that it concentrate almost exclusively on shallow aquifer effects; 3) that it address potential

implications with respect to village garden development and small-scale hand irrigation; 4) that it address effects on the seasonality of water availability at diffirent levels of the toposequence ; 5) that it address critical groundwater physiochemical parameters, including but not restricted to ph, electrical conductivity, depth and recharge, sodium absorption reaction, exchangeable sodium percentage, sulphates and sulphides, and aluminum and iron mobility; and 6) that primary responsibility for the review fall either to the PMU Water Engineer, appropriate ISRA technician or an independent contractor. Estimated Project or Contract Manpower: 3 person-months.

The third issue raised in the IEE, that of infrastructural intervention in areas of potential acid sulphate soils, is addressed here as two subissues. The first subissue, that of siting anti-salt dikes in areas where significant potential for soil acidification exists, is no longer considered appropriate for written review as a direct component of individual Watershed Management Plans since those plans will include pedalogical analysis and exceedance of the 15 $\pm$ 2 % criterion will, a priori, disqualify a specific location from further consideration for anti-salt dike construction on the basis of potential for soil acidification. The second subissue, that of secondary acidification due to intrusion of low pH groundwaters behind the structures, was reviewed with PP team technical personnel. Pedological, hyrological, agronomic and environmental review showed: 1) that intrusion of low ph groundwater is a naturally occuring phenomenon resulting from flooding, saturation and mobilization of acidic cations that will not be significantly altered by project infrustructural development; 2) that hydrographs demonstrate that mass flow of groundwater during most of the rainy season is directed away from the valleys; 3) that the amount of intrusion of low ph groundwater will be small, limited in areal extent, and occuring at a time when anti-salt dikes and retention structures will be flushing water downstream to saltier portions of valleys below the structures where buffering capacity is high; and 4) that if groundwater intrudes from the iron-enriched subsoil and is retained behind the dikes, it will be neutralized in the flooded zone through reduction reactions common to all flooded soils. It is also recommended, therefore, that this subissue be deleted from formal written consideration in either the individual Watershed Management Plans or regional or subregional plans.

The fourth issue raised in the IEE, that of the cumulative regional effects of infrastructural intervention in the southern zone region on estuarine and other aquatic ecosystem resources, was discussed with both PP team and other regional technical personnel. It is the conclusion of the REO that this issue should be addressed regionally by an appropriate and qualified ISRA team with the possible assistance of ORSTOM and completed by Year 5 of the project. The study should 1) take the form of a multi-scenario predictive assessment, 2) focus on agricultural versus aquatic food and other resource trade-offs, and 3) compare inputs given no tributary barrage construction and 30% runoff interuption; 1968-1984 rainfall means versus 1950-1968 rainfall means; best case, worst case and mid-case agricultural production estimates; and high versus moderate freshwater fisheries development scenarios. The assessment should use existing data to the extent possible, limit new data collection to that absolutely necessary to answer critically germane questions, use best professional technical estimates to arrive at conclusions

about estuarine impacts and agricultural/aquatic resource tradeoffs, and document all assumptions. A technical and cost proposal should be solicited from ISRA during Year 1 of the project, and reviewed by one or more competent technical personnel familiar with this issue in West Africa. Estimated Contract Manpower: 6 Person-Months.

The fifth issue raised in the IEE, that of the effects of infrastructural interventions on water-associated disease incidence rates, should be retained for project funding as a single regional assessment due in Year 2 of the project and conducted by an appropriate and qualified GOS, NGO or contract specialist. The assessment should 1) review the status, distribution and incidence rates of water-associated diseases in the southern zone region; 2) assess the potential for infrastructural interventions undertaken by all donor and GOS institutions in the region to affect, both positively and adversely, those distributions and incidence rates; and 3) recommend, if appropriate, integration measures to reduce potential adverse impact. Estimated Contract Manpower: 6 Person-Weeks.

The sixth issue raised in the IEE, that of the social impacts of infrastructural intervention in the southern zone region, was addressed in the prefeasibility social analysis. Social issues are also being addressed as an integral part of PP preparation by a qualified professional familiar with the region, and additional study and analysis is expected to occur during project implementation. For these reasons, and because social considerations are outside of the scope of the provisions of 22 CFR 216, it is recommended that the single regional or subregional analysis described in the IEE be deleted from further consideration for project funding in the form originally conceived.

The seventh issue raised in the IEE, that of the effects of infrastructural interventions on terrestrial ecosystems and endangered, protected or commercially important species, is considered by the REO to be implicity essential to satisfying certain requirements of 22 CFR 216. While the potential for detectable adverse inputs to result is considered very low because of the general geographical separation of most such species from the region of primary project intervention, it is nonetheless recommended that this single regional assessment be completed by year 2 or 3 of the project by a local NGO or local independent contractor. Estimated Contract Manpower: 3 Person-Weeks.

5.2 TECHNICAL MONITORING AND EVALUATION

Discussion of technical monitoring and evaluation of infrastructural interventions, especially anti-salt dikes, was discussed at length with PP and GOS technical personnel during PP development. There remains a broad consensus that additional technical information is necessary to better understand the physiochemical dynamics associated with such dike construction and that collection of such data should focus on answering specific, applied questions which will significantly help donors and the GOS to improve the planning, design, operation and maintenance of the structures. The specific technical approach receiving the greatest support was a paired watersheds study. Paired watersheds would be selected and monitored for one year, infrastructure then placed in one of them, and monitoring continued throughout

the life of the project. General parameters to be monitored include precipitation and evapotranspiration, soil chemistry (micronutrients, sulphur, sulphates and sulphides, aluminium, iron, soil moisture, organic content, pH, salinity and other physiochemical parameters); groundwater hydrology, hydrography and chemistry; surface water quantity and chemistry; surface water-groundwater contact and interactional phenomena (both vertically and horizontally along the toposequence); crop productivity; and plateau versus valley cropping patterns. It was noted that there has been significant but scattered and uncorrelated analysis in the region in both intervention and non-intervention watersheds, but that the extreme variability between sites and the lack of baseline data for correllating pre- and post-intervention fluctuations between sites is largely absent.

This applied technical monitoring and evaluation research program is considered by the REO to be the single most important research or study activity to be funded under the project. Because of its nature, duration and the heterogeneous technical specialties which it will require, however, it will also likely be the most costly. It is recommended 1) that ISRA be the lead organization responsible for its operation; 2) that ISRA be asked to review related research in the southern zone region which has occurred to date and that which is ongoing or projected; 3) that ISRA be asked to prepare a detailed technical and cost proposal for funding such research; and 4) that that proposal be reviewed by competent technical personnel, revised and a turnkey contract accorded to ISRA no later than the end of year 1 of the project. ESTIMATED ACTIVITY COST: US$500,000.

5.3 PROJECT EVALUATION REQUIREMENTS AND TECHNICAL ASSISTANCE

The preliminary findings of the IEE that a mid-term or other appropriately timed technical evaluation of the environmental/natural resource aspects and issues of this project be performed by an experienced applied ecologist, environmental geographer or similarly qualified specialist is, after further consideration during PP development, endorsed. ESTIMATED CONTRACT MANPOWER: 4-6 weeks.

The preliminary findings of the IEE, that six person-months of short-term TA in the form of an applied ecologist or similar specialist should be funded under the project is also endorsed. This short-term TA should be in addition to that required for the mid-term evaluation, and should be phased as follows:

Year 1: 1 person-month to review the ISRA proposal for monitoring and evaluation research; Year 2: 1 person-month; Year 3: 1 person-month; Year 4: 2 person-months; Year 5: 1 person-month.

5.4 PROCUREMENT AND TRAINING

No environmental-specific commodity procurement is envisioned under the project, and none is recommended. However, the technical monitoring and evaluation research program will likely incur potentially significant commodity procurement costs (e.g., piezometers, pH and soil and water salinity meters, associated field and laborartory equipment, and possibily vehicles). Procurement of these items should be the responsibility of the contractor (ISRA) and item specifications should be included in the cost proposal

solicited from them. Under no circumstances should responsibility for procurement of these items rest with either USAID/Dakar or the prime project contractor; both USAID/Dakar and the prime contractor should, however, realize and anticipate that such expenditure for an activity of this nature will be both necessary and perhaps costly. ESTIMATED (INDIRECT) COMMODITY COSTS: US$125,000.

Training plans have yet to be worked out by the PP team, and "environment-specific" training was therefore only cursorily discussed. From the environmental perspective, fields of emphasis for training should include soil chemistry, groundwater hydrology and agronomy with a very strong focus on tropical coastal systems. Short term training provisions should be made for appropriate project and GOS technical personnel to spend at least two weeks on the south coast of Guinea Bissau and at least two weeks at WARDA's Rokupr Rice Research Station in Sierra Leone reviewing experiences with mangrove and similar swamp rice production in those locations.

RECOMMENDED TRAINING:

1 person, B.S. Soil Chemistry
1 person, B.S. Groundwater Hydrology
1 person, B.S. Agronomy
6 persons, 2 person/weeks, Guinea Bissau
6 persons, 2 person/weeks, Rokupr, Sierra Leone

5.5 COVENANTS

Certain covenants are required in association with deferral of environmental review for infrastructure activities pursuant to the provisions of 22 CFR 216. 3(a)(7)(iii). Environmental review for infrastructural activities under ths project shall consist of the findings of the project IEE, as amended, and the findings of the assessments of the five issues retained in the IEE amendment. The Project Grant Agreement shall, therefore, contain the following covenants:

(1) USAID and the Grantee agree that the issues of A) anti-salt barrage effectiveness in controlling upstream salinity; B) the effects of infrastructure on groundwater quantity, quality and distribution; C) the cummulative effects of regional barrage construction on estuarine and other equatic ecosystem resources; D) the effects of regional infrastructural development on water-associated desease incidence rates; and E) the effects of infrastructural development on terrestral ecosystems and endangered, protected or commercially important species, as described in the Project IEE Amendment, shall be addressed as described except insofar as those issues or approaches may be amended or modified by the mutual agreement of both parties.

(2) USAID and the Grantee agree that implementation plans for infrastructural development will be modified in accordance with the findings of the five issue assessments listed in (1) above, as appropriate and practicable.

(3) USAID and the Grantee agree:

(A) that anti-salt dikes shall only be constructed where the area of high potential acid sulfate soils or already acidified soils of the taxonomic subgroup of typic sulfaquents (USDA Soil Taxonomy) does not exceed 15 percent plus or minus 2 percent of the service area upstream of the dike.

(B) that siting of water retention dikes will be undertaken with the full knowledge, advice and consent of the affected village populations; and

(C) that any irrigation system funded under this project shall have had sufficient technical analysis performed to indicate that salinization and waterlogging potential in the affected area will be minimal; that measures will be available to the target population to mitigate any salinization or waterlogging which may occur in the future; and that sedimentation rates upslope of the primary structure are sufficiently low to permit use of the reservoir for irrigation throughout a reasonably long facility target life.

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PROCUREMENT PLAN

I. COMMODITIES

Description	Quantity	$ App. Price	Source Code	Required Delivery Date	Responsibility
Construction Equipment					
- Tractors, 50 hp	5	105,000	Senegal	April 89	IWME/SMO
- Trailor (5 tons; rear tip)	5	27,000	SEN	April 89	
- Spare parts (30% of)		31,000	SEN		IWME/SMO
- Fuel, maintenance and repair		100,000	SEN		" "
- Tractors, 50 hp (replacement)	5	105,000	000/SEN	May 93	US Contractor
- Spare parts; fuel maint. and repair		205,000	SEN	" and ongoing	US Contractor
- Trailor (repl.)	5	27,000	Senegal	May 93	US Contractor
- Hand tamper	200	3,000	SEN	April 89	IWME/SMO
- Shovel	500	4,000	SEN	April 89	IWME/SMO
- Hand pick	300	3,000	SEN		
- Wheelbarrow (rubber wheel)	150	10,000	SEN		
- Replacement		20,000			US Contractor
- Miscellaneous equipment		14,000	000/SEN		IWME/SMO (initial)/US Contractor
2. Project Vehicles					
- 4WD pick-up dble Cabins (initial purchase)	6	127,000	935	January 89	IWME/SMO
- Spare parts 30% of cost of vehicles		28,000	935	" "	" "
- 4WD Station Wagon (initial purchase)	4	108,000	935	" "	" "
- Spare parts (initial)		32,000			
- Fuel, maintenance, repair (initial)		32,000	935	" "	
- 4WD pick up, dble cabin and spare parts (replacement)	6	156,000	935	January 93	US Contractor
- 4WD Station Wagon and spare parts (replacement)	3	105,000	935	January 93	US Contractor
- Fuel, maintenance repair (replacement)		32,000	SEN	January 93 onwards	US Contractor
3. OFFICE SUPPL. & EQUIPMENT					
- AT class IBM compatible computer	2	5,000	000/SEN	April 89	US Contractor
- IBM compatible laptop computer	2	5,000	000/SEN	February 89	US Contractor
- $5^{1/4}$ inch disk drive	1	600	000/SEN	February 89	US Contractor
- Printer	4	2,400	000/SEN	April 89	US Contractor
- Software		8,000	000/SEN	April 89	US Contractor
- Electrical Typewriters IBM	3	6,000	000/SEN	April 89	US Contractor
- Photocopier	3	12,000	000/SEN	April 89	US Contractor
- Office desk and (2 chairs per desk	8	8,000	000	February 89	IWME/SMO
- Computer desk, chairs and covers	8	8,000	000	February 89	IWME/SMO
- Secretarial desk, w/return and chairs (3)	1	1,500	000	February 89	IWME/SMO
- Large filing cabinets + small filing cabinet (1)	2	5,000	000	February 89	IWME/SMO
- Office Suppliers		100,000	000	February 89	IWME/SMO
- Freight and incountry transport.		150,000	000	February 89	IWME/SMO
- Office Equip. and supply (repl.)		100,000	000	February 89	US Contractor
- Office repair and maintenance		135,000	000	February 89	USAID (initial)/Contractor

A. SURVEYING EQUIPMENT

- Survey set comprising of: . 1 automatic level, type WILD NAK2 . 2 leveling rods (4 meters) . 1 Tripod " . 1 Universal compass w/alidade . 1 metalic tape, 50 meters . 1 metalic tape, 30 meters	2	14,000	000/SEN	April	89	US Contractor
- Drafting tables and equipment (80 x 120 cm tables, w/ sliding rulers and drafting equipment and draftsman tools etc.	2	5,000	000/SEN	April	89	US Contractor
Total (rounded-up)		1,900,000				

II. AUTHORIZATION DOCUMENTS

PIO/Cs

III. WAIVERS

No waivers are required.

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SOUTHERN ZONE WATER MANAGEMENT PROJECT

Descriptive List of Planned Training Activities

Training is one of the key elements of the SZWM project. It will assist in establishing the institutional framework required for sustainability after A.I.D. financing has ended. A diverse mix of training programs will be required. All training activities will be approved in advance by the USAID Project Manager. Approvals will be based upon detailed training plans.

On-the-job training for MRD and MH technical personnel will be conducted as required, throughout the project by both short and long-term technical advisors. The project will also support workshops and seminars conducted by technical advisors with specialists from institutions such as ISRA, ORSTOM and CRODT working on related research, short-term technical training, study tours, internships and four MS degree training programs are envisioned in the training schedule. For each training activity, the contract Chief of Party will be responsible for submitting to USAID a detailed training plan which must be approved prior to the start of any training activities. Training activities planned with estimated cost are as follows:

1. **Approx. 12 workshops and seminars:** Short workshops and seminars using technical advisors from the project and local specialists, with additional advisors as required.

2. **Approx. 15 participants for short-term observation tours:** Study tours to Africa and the United States for 14 participants to review local water management programs. Approximately four weeks. To be scheduled as required.

3. **Approx. 5 participants training at the Ecole Inter-Etats d'Ingénieurs de l'Equipement Rural, Burkina Faso,** in planning, design and management of water projects. Nine month program.

4. **Approx. 16 participants training at Institut Agronomique, Rabat, and Ecole du Génie Rural et de Topographie.** Five week programs in irrigation and water management.

5. **Approx. 12 participants study Tours in West Africa:** to visit related programs in the Gambia, Guinea Bissau, Sierra Leone, Burkina Faso and/or Ivory Coast. Up to four weeks each.

6. **Approx. 12 participants for internships, short-term training in the U.S.:** two week course on farm practices, agriculture-related soil conservation techniques, irrigation and water management with the Soil Conservation Services with two weeks of on-site visits. One month courses and study tours with the Bureau of Reclamation examining general operation, design, maintenance, management and administration of water systems.

7. **Approx. 4 participants for MS training in the U.S.:** in civil engineering and soil and water management.

Approx. timing: Masters level training for two participants would begin during the second year of the project. Two more participants would begin training the following year. Workshops, short-term training and study tours would be spaced over the life of the project.

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I. Water Resources Engineer

In consultation with the Project Director and the COP, he/she will provide direction and advice to the Water Management Teams in the two regions as well as detailed and specified on-the-job training. In particular, the Engineer will be responsible for assuring that the following tasks are carried out working with the Senegalese professional staff to:

* develop overall watershed plans with appropriate topographical, soils, hydrologic, agronomic and social inputs;
* site dikes/berms/control structures;
* design dikes/berms/control structures based on overall plan;
* prepare construction contract documents for all proposed facilities;
* select construction mode and contractors;
* supervise construction;
* certify construction from private contractors;
* certify payment to contractors;
* provide detailed and specific on-the-job training to Senegalese; technical staff and present training seminars, designed so that professional Senegalese will take over the above responsibilities by Year 4;
* develop planning and management capabilities within Water Management Teams.

II. Sociologist/Water-User Associations Specialist

The Water-User Associations Specialist will work closely with the Regional Water Management Teams and the Water Resources Engineer to facilitate the development of effective working relationships between villagers and the project. Specifically, the consultant will assist the regional teams set up a methodology to:

* assist villagers to clarify their water management needs and determine village readiness to embark on the proposed project;
* facilitate the organization of Village Water Management Committees;
* choose construction sites which are socially acceptable in terms of the existing land tenure and use patterns;
* collect baseline data needed for effective project implementation (i.e. data for land use/tenure map of land to be affected by project infrastructure; enumeration of households/farmers to quantify village's labor available to exploit improved land;

* help Village Committees to set construction schedules;
* develop with the Village Committees and the Water Resources Engineer appropriate operation and maintenance plans for the structures (such planning will begin during the pre-construction phase);
* facilitate village discussions on post-construction use of improved land;
* liaise between village and other agencies concerned with water management to avoid the communication of conflicting information to them on operation of structures and on follow-up activities;
* facilitate communication between Village Committees to learn from each others experience;

* document project experience and succesful methodologies.

III. Agronomist

The Agronomist will work full time on the project starting the fifth year of the project for a total of four years. By the fifth year, a significant number of hectares of valley land will have been reclaimed or provided with improved water control, research results on earlier water control and water management practices will be available and the project will need to develop specific forms of assistance to farmers on improving their water management practices. The Agronomist will work closely with the Water Management Teams, ISRA, and other extension personnel in the regions to develop a methodology of extending advice and packages to farmers or farmer groups on improved water management practices, to include:

* contour diking of valley terraces
* realignment of rice parcel dikes
* accelerated land reclamation techniques
* land preparation to increase salt leaching and permit earlier transplanting
* land levelling
* management of zones of iron hydroxide interflow
* varietal options for different water management conditions
* soil and water conservation works.

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