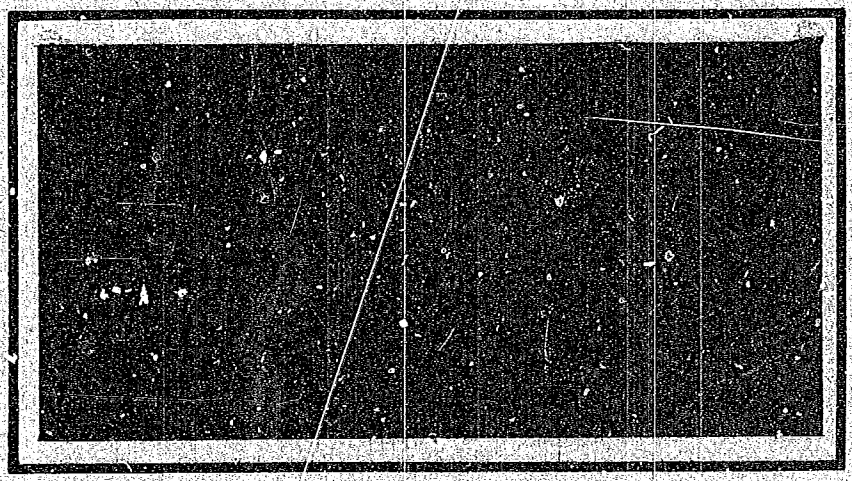

AMERICAN PUBLIC HEALTH ASSOCIATION
International Health Programs
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AMERICAN PUBLIC HEALTH ASSOCIATION

FINAL REPORT

ENVIRONMENTAL ASSESSMENT
and
HEALTH COMPONENT DESIGN
BAKEL IRRIGATED PERIMETER PROJECT

SENEGAL

June 15, 1977

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I INTRODUCTION

The following is the final Report of the Team which carried out an Environmental Assessment of the Bakel Irrigated Perimeter Project between April 11 and May 6, 1977. The Assessment was undertaken on behalf of the American Public Health Association (APHA) in accordance with the terms of its contract with the Agency for International Development (AID), Contract No. APHA/AID-AFR-C-1253.

The Team was comprised as follows:
Ulric P. Gibson, Ph. D., Environmental Specialist-Team Leader
Swailen S. Hennein, Ph.D, Sociologist.
Kevin L. Palmer, M.S., M.P.H., Malariologist.
Sheldon A. Miller, M.H.A., Health Administrator/Planner.
Frank P. Carroll, M.S., Environmental Health Engineer.

A. Objectives and Scope of Work

The Team's Scope of Work as defined by AID is shown in Appendix A. As stated therein:

> The objective of the contract team will be to make an environmental assessment (EA) of the project, focussing on Public Health related aspects. This assessment will also produce a recommended design for the incorporation of an appropriate health component in the project to protect villagers in the activity area from any potential adverse health effects of a new water impoundment and provide cost estimates for such a program. The EA team should study as many possible alternatives and or internal modifications of the project as possible and make recommendations to USAID and the Government of Senegal (GOS) concerning the various options weighed.

B. Background Information

1. Previous Environmental Examinations

A preliminary environmental examination was conducted during the development of the AID Project Paper (PP)[1] and forms a part of it. The Executive Committee for Project Review (ECPR), however, found that examination to have dealt inadequately with the potential negative health impacts.

Subsequently, another environmental assessment[2] was undertaken by Dr. John H. Nebiker during October/November 1976. That assessment concluded that an increased period (year round instead of the rainy season only) of high malaria incidence is the most serious and immediate negative impact. It recommended free prophylaxis for all residents of the project area as the main controlling measure. The ECPR, however, disapproved of this proposal - see the Scope of Work, Appendix A.

That assessment also pointed to much less significant potential impacts of increased schistosomiasis, and ecological changes due to the use of fertilizers and pesticides. These, it pointed out, should not be totally ignored but should be carefully and regularly assessed in the future.

2. Project Description

A full description of the Bakel Irrigated Perimeter Project, as provided in the AID Project Paper (PP)[1], is to be found in Appendix C. It is therefore not intended to repeat that description here, but to emphasize those aspects of the Project that are of particular relevance to this environmental assessment.

The Project is located in the far eastern region of Sénégal around Bakel on the Sénégal River and the lower reaches of its tributary, the Faléme River. It proposes to introduce farmer managed irrigated crop production in an area previously characterized by dry land and flood recession farming.

The irrigated perimeters will be worked on a village level cooperative basis in 23 villages with a total population of about 31,000. The Project is concerned only with the first of the proposed three-phased development which will consist of small perimeters varying in size from 20 to 300 hectares with most being in the range of 30 to 50 hectares each. The total area of the perimeters will be 1896 ha. Small pumps of 15 hp and 32 hp and of capacity 150 and 300 m^3/hr, respectively, will be used to pump water mainly from the Senégal and Falémé Rivers, and from marigots (swamps) in a few cases, for irrigation.

The Project will introduce farmers to double cropping consisting of a first crop of rice during the rainy season of July to October followed by a crop of maize, sorghum and cowpeas during the dry season of November to June. It is also intended to demonstrate to the farmers the benefits of irrigated agriculture such as protection against periodic droughts.

This project is not to be confused with the larger irrigation development projects planned in relation to the construction of 2 major dams on the Senegal River and for which another environmental assessment is in progress.

The total cost of the Project is estimated at $8.556 million with AID providing $6.149 million for pumps, equipment etc., and the Government of Senegal (GOS) providing the remaining $2.407 million. The Project period is planned for FY 1977 through FY 1982.

The Project has already been in progress with the harvesting of the first year's crops currently being completed.

Visits to the eleven (11) functioning perimeters extending from Gande in the North to Ballou in the South have served to emphasize the following:

1. The relatively small scale of the Project.

2. The relatively small contribution of the perimeters to the total flooded areas during the rainy season.

3. That contrary to the claims of the earlier Environmental Assessment[2], water applied to the perimeters for the dry season crops does not result in sustained ponding. No ponding was seen in the fields on the day following irrigation. The only bodies of water seen were the very insignificant quantities trapped in the distribution boxes (area approximately 3m x 2 m) and in some cases used for hand application to nearby kitchen gardens. No anopheline breeding was found in the perimeters and the dry season irrigation poses no threat of an increased incidence of malaria approaching "a uniform high rate throughout the year," as claimed in the earlier assessment.[2]

4. Several of the perimeters are in excess of a kilometer (in many cases 3.5 Km) from the villages - see Table I . At these distances, the effects of insect vectors from the perimeters on the villages will generally be minimal.

TABLE I

CURRENT STATUS OF PROJECT DEVELOPMENT

VILLAGES	POPULATION		AREA (ha)		DISTANCE (km)
	PROJECT FARMERS	TOTAL VILLAGE	PREPARED (DIKED)	PLANTED	PERIMETER-VILLAGE
BALLOU	515	1835	25	15	0.25
AROUNDOU	36	951	2	2	3.50
YAFERA	257	996	5	5	0.25
GOLMY	150	1617	-	-	-
KOUNGHANI	350	1095	15	7	1.50
BAKEL	326	5500	12	6.5	3.00
TUABOU'	95	1067	8	4	1.50
MANAEL	170	970	5	2.5	0.30
YELINGARA	30	538	5	2.4	0.20
DIAWARA	512	2865	15	6.5	3.50
MANDERY	80	2104	7	4.5	3.50
GALADE	68	574	-	-	-
GANDE	75	445	5	3.5	0.20

C. Team Activities

The Team was assembled in Washington D.C. commencing April 6, 1977 for briefings by APHA and AID.

Three members of the Team (Drs. Gibson and Hennein, and Mr. Palmer) travelled to Dakar on April 11, 1977 and were followed by the remaining two on April 19, 1977.

The Team was briefed by the AID Mission, Dakar, following which it proceeded on a trip by road to the project area. This included visits with the Société d'Aménagement et d'Exploitation du Delta (SAED) and the Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS) Documentation Center in Saint Louis, the irrigated perimeters at Dagana and Matam, SAED's management at Bakel, all of the eleven (11) functioning perimeters in the project area, and Selliny, the southern-most village for which a perimeter is planned in the project.

During the approximately two week period spent in Bakel, epidemiological, water quality and sociological surveys were carried out.

Several agencies cooperated in providing the Team

with available information. A list of these agencies and the contacts in them are to be found in Appendix B. The Team wishes to express its sincerest gratitude to all of its contacts and the agencies they represent.

In particular the Team wishes to thank Dr. Marc Vincent and Mr. Frank Casey of AID for their yeoman services in accompanying the Team and providing excellent translations throughout the trip; Mr. Sy Abdourahmane of SAED for similiar services throughout the field trip in Bakel; and those village chiefs and officials who greatly facilitated our field surveys.

II ENVIRONMENTAL ASSESSMENT

The environmental assessment of this project has been undertaken in three main segments, viz.,

1. A Preliminary Environmental Assessment by the Project Development Team. This assessment which preceded the operative date of AID Regulation 16, Part 216 Environmental Procedures was considered inadequate with respect to its analysis of the potential environmental health impacts.
2. An Environmental Assessment by Dr. John Nebiker aimed at correcting the deficiency of the preliminary assessment was then undertaken. The Executive Committee for Project Review (ECPR) found the recommendations of this assessment unsatisfactory and ordered a further assessment of the project.
3. An Environmental Assessment and Health Component Design was thus undertaken by the APHA Team.

These three assessments are synthesized in logical sequence in the sections that follow. Also incorporated are responses by AID/SER/Eng. to a number of issues raised by the Soil Conservation Service and the Department of Health, Education and Welfare.

A. Preliminary Environmental Assessment - Project Development Team

The reduced matrix of numerically rated environmental aspects is shown in Table 2. Analysis of the rating

Table 2

Environmental Impact Assessment Matrix

Significant Impact

Relative magnitude of the interaction

Relative importance of the interaction

10 is the greatest magnitude

	A. Modification of regime	b. Biological controls	c. Modification of habitat	d. Alteration of ground cover	e. Alteration of ground water hydrology	f. Alteration of drainage	g. River control & Flow modification	h. Canalization	i. Irrigation	B. Land transformation & construction	i. Canals	C. Resource extraction	f. Clear cutting & other lumbering	D. Processing	a. Farming	f. Food	E. Land alteration	a. Erosion control terracing	F. Resource renewal	c. Ground water recharge	d. Fertilization applicate	I. Chemical treatment	a. Fertilization	d. Weed control	e. Insect control (pesticides)	J. Accidents	c. Operational failure
A. Physical & Chemical characteristics																											
1. Earth																											
c. Soils									6/6									7/7		6/3							
d. Landform															7/6	7/7		7/7									
2. Water																											
a. Surface									6/5		7/3				7/7	8/7		7/7									
d. Quality									2/7		7/7				7/7												
4. Process																											
a. Floods							1/3									7/7		7/4									
b. Erosion									4/6		4/6				5/7			7/7									
B. Biological conditions																											
1. Flora																											
a. Trees			5/7	7/7									7/7														
d. Crops	6/4	7/4							7/7						7/7	7/7					7/5		7/5	7/5	7/5		7/5
f. Aquatic plants				3/6					5/6		5/6				6/6	7/7					5/5			6/6			
2. Fauna																											
a. Birds															6/4												
e. Insects															7/6	7/6									7/6		
C. Cultural factors																											
1. Land use																											
d. Grazing				6/3					6/3						6/3												
e. Agriculture				7/7		6/5		6/5	7/5		7/6		7/6		7/6	7/7		7/6			7/4		7/6	7/6	7/6		7/6
4. Cultural status									7/6																		
c. Employment															7/6												
D. Ecological relationships such as																											
4. Food chains									6/6						6/5						7/6		7/6		6/6		

matrix indicates the following:

1. Resource Linkage: No significant changes are anticipated in the total ecosystem of the Bakel region. The land use pattern of the area irrigated will be altered, but the total area irrigated will be relatively small. Initially a total area of 200 - 300 hectares increasing to about 1800 hectares widely spread among 24 villages is being proposed for irrigation development. Most of the lands being proposed for irrigation development are presently virgin or devoted to dry land crops of largely millet and maize. The PP team observed that only a very small portion of the activity was truly virgin land which had not been cultivated sometime in the past showing natural regrowth.

The present labor force of villagers will not be significantly altered, as the labor analysis shows that adequate labor is available to implement off-season activity as an adjunct to traditional cultivation. The villagers regard irrigated culture as a supplement to traditional farming, which will continue to remain the mainstay agricultural activity. Thus, the population distribution will be altered but slightly. If the irrigation culture area grows to larger proportions, say to 3,000 - 4,000 hectares or more perimeters in the 10-20 year future (if the initial irrigation activity efforts prove successful) there may be

population shifts and immigration to support expanded irrigation and other related activities. No new villages are predicted, but population in some villages near irrigated perimeters may increase.

Fish and wildlife ecosystems will be altered significantly on those areas to be irrigated. However, the total area affected is very small and will not significantly affect the total fish and wildlife ecosystem. Water withdrawals, largely from the Senegal River, are relatively small and will not affect fish life systems to any significant extent. In some rice paddy areas of Southeast Asia, fish for human consumption are propagated in the paddy ponds and add important protein to the diet. This practice is unknown in the Senegal River Valley. Since the paddy areas in the Bakel region will be permitted to dry up intermittently during the growing season, paddy fish culture will not be feasible.

The increased produce of rice and maize may generate additional transportation requirements. During the third year of the activity, surpluses of products (rice and maize) may begin to appear and will need to be exported to other regions of Senegal for sale. Both road and river transport will need to expand to provide the required increased service. Railroad shipping facilities are only 30 kilometers from Bakel connected by a fair road. The crops to be produced (rice and maize) are readily storable for railroad transport. No great transport constraints are envisaged. Transport can grow gradually to provide the demands that may generate from the activity. The environmental effects of improved roads, etc. will have to be addressed as the roads are developed.

The marketing train will have to be expanded. During the initial phases (2 - 3 years period) produce (rice and maize) will be absorbed into the local village markets and Bakel. As surpluses begin to appear, traders will gain experience over prolonged time as the surpluses will generate slowly and no great constraints are predicted in the marketing train and/or required facilities. No major milling facilities are planned under the project, therefore effects caused by the mill or by-products are not considered.

2. Physical Aspects:

Sedimentation and erosion were considered on the canals and drainage. Since the river flow carries a small bed load, water borne sediment will be very small and no significant problems are anticipated with silt from the river water. The irrigation systems will be served by relatively small capacity pumps and adequate structural erosion controls are being emplaced in the main canals (which are relatively small) and in the laterals, so minimal erosion is expected in the channel ways. Since pumped water is being utilized on ponding rice fields, a relatively low runoff waste will be developed and drainage will not be a problem. Drainage ways are provided but will not be required extensively, as the pumps will be shut off during periods of non-water demands.

The activity intends to irrigate land areas formerly in rainfed crops or not being cropped. Through necessity, only the higher lying lands or those most flood free will be developed for irrigation. The soils in those areas are the most recent alluvium, relatively deep and fertile.

The predominant soil types on the perimeters are fonde soils which constitute about 65% percent of the surface project area. These soils have up to a 44 percent clay content. They are well aerated with good capillary action, permeability and drainage. They are irrigable and usually suitable for wheat, sorghum, peanuts, corn, cowpeas and vegetables. About 35 percent of the area is of the Faux Hollaldes soil type, a medium heavy soil with up to 50 percent clay content. These soils are irrigable and suitable for rice, sorghum and other cereal grain crops. The soils, since they are recent alluvium and not heavily stratified are well drained, particularly in the higher lying zones. No drainage problems are anticipated in the proposed irrigation areas.

On the other hand, the best rice paddy soils are those that have or can be developed over an impermeable clay pan about 30 - 40 cm below the ground surface that will reach the water table, thus providing conditions for efficient

water utilization. An impermeable soil layer is usually accomplished by "puddling" the soil or disturbing the soil texture until a compact layer is developed producing an ideal rice growing ponding water environment. If the area is expanded greatly, the long term effects on the soils of this rice growing culture will need to be assessed by an irrigation land classifier well versed in tropical rice cultures. However, initially, with a total area being proposed for development of less than 2,000 ha. spread over a large area, the project will not have a significant overall effect on the soil environment. With the project developing slowly, as planned, those effects can be assessed before widespread rice development occurs.

Water withdrawals from the Senegal River are relatively insignificant and will have little effect on River flows due to limited project demands. Water use for rice will become more efficient and reduced as the farmers become aware of the relation of diesel costs to water volumes pumped.

The types of irrigation facilities being planned would not cause much area to be continuously wet for long periods. Because the plan has a separate system for each village, the pumping of water will be intermittent. The pumps will be run and the canals filled only for so long as needed to deliver water to the fields. Then they will stop and dry

out. In general, the fields will have a dry surface for a period before the next irrigation is applied. The soils have excellent moisture retention characteristics so that frequent irrigation is not necessary. Even the surface of a rice field can be dried without harm to the crop and the cloudy water requires lowering of the water surface to allow sun to reach the lower stalks during the early stage. Later the deeper roots extend the period before added water is required, also assuring against constantly standing water.

There is a likelihood that in the first few years, poor land leveling might result in spots in the fields that will not fully drain and thus remain inundated between irrigations, but in time such spots will be eliminated because the crops do not produce well in such wet spots, so the farmer will fill them in.

Waste water going into the natural watercourses and drains will tend to extend the life of swamps and pools in nature. However, due to the fact that the villagers and farmers must pay for the cost of pumping water, they will try to reduce water wastage. Thus the area of such natural ponds or swamps should not be greatly increased.

It is desirable to emphasize that in this area of single village systems, irrigation canals, etc. will be used intermittently, not constantly as in larger project areas.

Aquatic plant vegetative growth will not be encouraged in the rice paddies. The ponding water, as it is designed to do, will inhibit much of the weed growth. To produce a good rice crop the farmers will intensively eliminate all undesirable growth. Since water deliveries are limited to the requirements of the paddy fields and are shut off, there will be little waste water to promote swamps and wet areas adjacent to the irrigated areas. And since the water deliveries will be intermittent, those areas and ditches and laterals will dry up, thus preventing excessive ponding and unwanted aquatic growth.

The Senegal River water has a very low salt content and no salt buildup in the paddy areas is predicted. Chemical fertilizer use is relatively low (250 kg ha) on rice and will have minimal effect on the salt content of the groundwater. Although it is anticipated, due to the high permeability of the soils that a portion of the applied chemical fertilizer will be leached into the groundwater reservoirs and will find its way back into the river, the buildup of groundwater saline conditions will be very slow and will pose no problem in the predictable future.

No impact is anticipated from construction activities. The irrigation systems are largely village hand labor construction facilities and will be relatively very small

construction features. No major field construction activities are planned. The perimeter dikes are also small construction facilities and will have low impact. Since the rice culture will be practiced during the rainy season, excess ponding may occur inside the dikes, if constructed on some perimeters, and a means of draining those possible ponded areas will be provided.

Climate will not be discernably affected as the total area of the activity is small and scattered.

3. Socio-cultural Aspects:

As noted above, there will be little population relocation or resettlement as the activity is included into the existing village social structure. The utilization of a single village water system in this proposal is good because it uses an existing social organization and does not complicate the existing social structure by a new entity. The responsibility and authority remain within the village. The suggested size of the perimeters permits this type of irrigation system.

Population growth may occur in the long run if the activity grows to massive proportions, but the growth if any, as a result of the activity will be very slow and problems if any develop, can be resolved within the normal village struct

Aesthetically, the general environment will be improved by the presence of green growing fields of rice during the season in an otherwise very drab-appearing environment.

4. Public Health Aspects:

The population growth will not be accelerated significantly above normal growth due to the activity; therefore health and disease aspects will be aggravated very little beyond that already existing.

Disease vector mosquitoes may be increased due to prolonged ponding of water in the paddies. But since the water will be delivered intermittently and the paddy fields will be permitted to dry out occasionally, the vector producing environment will be disturbed and it is anticipated this will be no greater problem than now exists in the area. Similarly bilharziasis (schistosomiasis) may increase to a limited extent, but the area ponded is relatively small compared to the existing areas of swamps and ponded marigot zones in the region. If schistosomiasis were to be promoted by the activity, it would have minimal effect on the total occurence of the disease.

Pesticide/herbicide usage will be very limited in the initial stages of the activity. However when the activity expands, as it may, and the farmers learn the benefits of pesticides/herbicides, storage and use of these chemicals become widespread, normal precautions will be exercised.

The villagers obtain their domestic water largely from the Sénégal River and some shallow village wells. The activity may augment the groundwater supply in the upper acquifers. The

water thus added is as good in quality as that now utilized by the villagers and will not significantly alter the health hazard.

Increased food storage requirements as a result of the activity will generate an increased rat and rodent population. The villagers now store the crop in elevated bins on stilts, and frequently install "rat shields" on the stilts to prevent invasion of rats and rodents into the stored crop. Improved storage facilities and rat prevention will need to be developed over time and the problem will be appropriately resolved by the villagers.

5. Review by the Project Committee

In a memorandum dated October 26, 1976, to the Africa Executive Committee for Project Review, Dr. John Withers, AFR/DR reported on the findings of the second review of the project as follows:

> The project committee reviewed the subject project for the second time on October 13,1976. (The first review was held Aug. 19, 1976.) The general finding was that the project, in its latest revision, is sound and should move forward to approval, subject to resolution of the few remaining issues detailed below. The primary pending issue relates to environmental health....
>
> Environmental Health
>
> The potential health implications of the project were singled out for special concern as other environmental areas (physical, biological, cultural, etc.) appeared to be adequately treated in the PP.
>
> Discussion: The health problem relates primarily to the increased exposure of the target population to ponded water resulting from the irrigation measures to be implemented. (The absolute increase in stagnant water will be relatively minor compared to quantities

already in existence in the region. In addition, there will be greater use of pesticides and herbicides, as well as increased food storage over the life of the project.

In view of the fact that this will be one of the first projects of the irrigated perimeter type in the Sahel and will probably be looked to as something of a model, and due to increasing exposure of AID projects to public scrutiny in the environmental area, it was felt that further examination of the potential problem should be carried out prior to final project approval. It is also necessary to determine who will be responsible for monitoring, control and action if an environmental factor becomes a problem.

Fortunately, it was possible to immediately identify a highly qualified expert through the AFR/DR contract with the American Public Health Association, John Nebiker, who left for two weeks in Senegal on October 21. We should have his findings prior to finalization of the action memorandum requesting the project approval from the Administrator. It is not expected that any new elements will be uncovered which would require a further delay in project execution.

Recommendation: That the ECPR recommend approval of the project pending basically positive findings from the environmental examination in progress, the report of which may be added to the PP as an annex. Recommended remedial or control measures should be built into the project agreement during final negotiation. (In the unlikely event that Nebiker's findings are negative, the entire project will be re-examined by the project committee.)

B. Environmental Assessment by John Nebiker

1. Introduction

a. Project Description

The Bakel Crop Production is located in eastern Senegal, along a 15 mile stretch of the western bank of the Senegal River near the town of Bakel. As planned, the project will provide for development of irrigated cultivation through the construction of small flood-control dikes and canals, the emplacement of diesel powered pumps and pipe, and the clearing and tilling of land.

Two annual crops are envisioned: rice, followed primarily by corn or millet. A total of 1900 hectares is included in this project stage, although later stages may encompass much more, particularly if the Senegal River is controlled by proposed dams upstream and downstream of Bakel.

The purpose of the Bakel Crop Production project is to introduce irrigated farming to the area, on a gradual level in accordance with the technical and socio-economic capabilities of the area. Crop production from irrigation is to combat malnutrition in the area, although it is expected that eventually surplus crops will be generated that can be sold to other areas of Senegal.

b. Prior and Related Planning

This project is the further development of a number of small irrigated areas developed by SAED (the Senegalese agricultural extension agency operating in the area) and CIDR, a Paris-based non-profit international service organization. USAID financial assistance is provided to strengthen and accelerate SAED-CIDR and local village efforts. The Project Paper for this Bakel Crop Production project includes a special report by a hydrologist and sociologist. On a more general level there are a number of reports prepared by or for various international agencies and multilateral donors which address the feasibility of various development projects in the Senegal River valley.

In total some 400,000 hectares are being considered for irrigation, of which several thousand would be in the Bakel area. Many other projects are contemplated as well, such as reforest-

ation, year-round navigation, and hydroelectric power. USAID is funding a major two-year study which will be initiated soon to assess the overall environmental effects of these projects and to propose mitigating measures.

c. Assessment Methodology

Concern that the project may create unfavorable environmental impacts, particularly in the sphere of public health, has resulted in the writer's assignment to assess environmental impacts of the project. Many of the possible impacts have been reviewed in the Project Paper and were therefore not addressed in depth here. Public health aspects were studied through literature reviews, interviews, and three-day field visit including air and boat reconnaissance. All eleven irrigation fields at present in operation were visited and the proposed sites of the irrigated perimeters studied. Four dispensaries and the Bakel health center were also visited, and those in charge were interviewed.

In the analysis that follows, repetition of the Project Paper is avoided as much as possible.

2. Analysis of Impacts

a. Land-use

The 23 villages in the project area housing some 25,000 people are all located on river banks elevated above historic floods. The river serves as a focal point of village life for washing, bathing and water supply, as well as fishing, some recreation, navigation and livestock watering. Along the banks, recession agriculture provides much of the vegetables eaten locally.

Bakel, with a population of 6500, differs from the villages primarily in its municipal water supply system. The land generally grades slowly away from the river bank and villages down to various interconnected flood-plain depressions (marigots). This land is dry farmed in patches, with the remainder grasslands interspersed with acacia and other trees and bushes which are used extensively for fuel and construction (bush fencing, for example).

The 1900 hectares of irrigation of the Bakel Crop Production project will primarily utilize lands dry-farmed now or in the recent past. In comparision to the total flood plain and adjacent areas, the extent of the irrigated areas will not significantly affect land-use, although obviously as more irrigation projects are added, the impacts will become more noticeable. Perhaps most affected would be herdsmen who would find progressively more difficulty in routing the herds of cattle, sheep and goats through the area or to water. Bakel is a major transit point for cattle moving southward to railheads.

In time it may be expected that improved roads and other developments together with population increases will intensify land uses to the extent of creating new villages, or at least, new housing areas, away from the river and possibly within the irrigated perimeters where water could be made available year round. Present local attitudes are probably adverse to such development outside the village. This is a good attitude, for the irrigated perimeters should be free of settlement and the attendent problems of waste disposal within, as much as possible.

Overall land-use will not be notably affected by the project. The equivalent area of irrigated perimeter is only 700 square meters per village resident, equivalent to a plot of land some 80 feet square. Presumably more grandiose schemes following will be analyzed for land-use impacts as details become available.

b. Water Resources

The project impacts on water resources have been analyzed in the Project Paper, particularly as regards hydrology. Unfortunately, as with so many aspects of the Senegal River and its proposed projects, little data exist which can be analyzed. And what data do exist are frequently temporally or spatially irrelevant to the question at hand.

An example of this difficulty is shown by the Project Paper (Annex G, hydrology report) wherein low flows were analyzed to determine availability of irrigation water in the dry months of March and April. It was concluded that shortages for a 3000 hectare development would occur only about 3 years out of 100 years. The period of record analysis available, however, only included up to 1974. Including the 1975 and 1976 low flows (the groundwater of the region which augments the low flow is still depleted) in the analysis would suggest considerably higher frequencies of over-withdrawal.

In fact, in April 1976, the river had been observed by the writer to have no flow at all, being a series of elongated pools separated by shoals and sandbanks. This does not mean that inadequate supplies for irrigation exist, however, as the river banks probably store considerable waters which would be released as

pumping of the river pools lowers the water elevation. What is meant is that river water, algae-infested and undoubtedly seriously polluted in low flow, will be more so in the future, due to irrigation withdrawals which will leave less water behind for diluting the effects of washing, bathing and other uses.

There will be some return flow from irrigation which will supplement water supplies. Judging from present practice in the Bakel area, such return will be exclusively subterranean, and possibly directed away from the river toward marigots. Some concern may be expressed over the quality of return flows as well, being higher in salinity, nutrients (fertilizer) and pesticides than the applied water. It follows that water quality will be increasingly degraded with distance downstream and in future years, but perhaps before a serious level is reached the upstream Manantali Dam will be completed, thus providing low flows of both higher quantity and quality.

c. Biology

The general appearance of the vegetative cover in the project area has been that it has been overtaxed, particularly by overgrazing. Significant wildlife species were not observed. The writer was told that some lions and antelopes were in the area occasionally. A relatively large number of warthogs (macrocephalus) are reputed to be in the area due to the Moslem prohibition on eating of pork.

A few marsh areas exist at the low points of marigots and other depressions, but most low areas dry out during the year and do not provide a true marsh environment. North of Bakel the writer observed two irrigation pumps withdrawing waters from the

local marigot. It was said that the marigot is an important source of fish. It is clearly heavily fertilized by large herds of livestock watering there.

The Senegal River itself, due to the steepness of its banks, has little marsh-type vegetation. As with marigot shorelines, those areas where seasonal marshes or shoreline vegetation would be expected to grow are used for recession agriculture or livestock watering. Fishing is a significant activity, particularly during the late spring when the river is smallest. Four methods to catch fish were observed: 1) traps, 2) line and hooks, 3) thrown nets, and 4) seining.

The Bakel Crop Production project will influence water resources as indicated in the previous section, and accordingly some impact on aquatic biota may be expected. Increased nutrient loads will increase algae and plankton growth, but probably not measurably due to the already heavy fertilization from livestock. Fish could be adversely affected by pesticides particularly in those marigots to which irrigated fields may drain and wherein the pesticide concentration would increase through evaporation.

During the writer's visit, no snails were found, and local people claimed that snails were rarely found. Snails, of the family Bulinus are the intermediate hosts of schistosomiasis. Possibly the lack of snails is due the infrequency of marshes in the region. More likely the annual floods disperse the snails, and the rapid succeeding drop in water level leaves the snails subject to dessication and predators.

The effect of flood protection dikes will increase the

amount of land available to which wildlife and insects may flee in time of flood. It is thus possible that heavy concentrations of pests will congregate including various rodents (gerbils, rats, etc.), and insects. Conversely, during the dry season these pests will be attracted to the irrigated fields, as will birds. Rodent, insect and bird infestation of crops have been projected in the Project Paper at 15%, which is only possible with extensive bird chasing and use of pesticides. At present the irrigated rice fields in the project area are dusted against locusts and spanish fly with hexachlorocyclohexane at a rate of 12 kg/hectare at 25% purity. This is a persistent pesticide and reportedly prohibited for use in France where it is manufactured.

The biology of the project area, in general, is subject to severe stresses from the amplitudes of natural phenomena: drought, floods, temperature, etc., and thus the Bakel irrigated perimeters can hardly be expected to upset the ecology of the general area. Such a statement is invalid, however, if pesticides are haphazardly introduced into the environment. Further, the huge eventual irrigation schemes of the entire Senegal Valley with their specialization in dense cropping will introduce a new ecology.

E. Social, Cultural and Economic Considerations

The sociology and culture of the project area has been the subject of a special study under AID and annexed to the Project Paper. Economic analyses of the project are integrated into most of the Project Paper as well. In the interests of brevity only a few comments salient to public health are presented in this section.

The harshness of the climate and the historic limited defenses of the people to human marauders and disease vectors alike have created a fatalistic society of delicate self-reliance to which changes must be introduced gradually if they are to succeed. The Bakel Crop Production project is accordingly designed around gradual acceptance of irrigation, evolving from SAED/CIDR experiences of the last few years. Another foundation of the project are village cooperatives, voluntary groupings of neighbors and families who will develop, operate and farm the irrigated fields. Cooperation is an essential feature of most societies living under difficult circumstances.

The project, if successful, will undoubtedly improve local nutrition, and eventually provide excess grain for sale elsewhere, leading to a possibility of higher standard of living for the people, reversing a disturbing trend of the recent years of the Sahelian drought. Obviously a rise in the standard of living is an impact, the extent and quality of which will depend on the individual. There is some basis to judge the possible impact.

The dominant ethnic group in the area is the Sarakolle, who have a unique tradition amongst their males. Those 15-40 years old and able-bodied emigrate to France remitting a substantial part of their earnings back to their families. These funds are seen to be applied in many ways, including improved housing, substantial mosques, better clothing and implements, etc. It is difficult to claim that such impacts are deleterious to the environment or to social well-being and public health.

The writer did observe, however, that no significant public

health consciousness existed amongst villagers or the populace of Bakel. An awareness of curative medicine was slightly more evident as visits to four local dispensaries indicated. In fact one, in Balou, was said to be built by local volunteer funds.

These dispensaries, operated by employees of the Ministry of Public Health, dispense few drugs. Their staff all stressed the lack of interest in preventive public health measures as well as the present inability of many families to pay for medicines, many of which are sold at 1000 to 2000 CFA (approximately $4 to $8). The dispensers themselves demonstrated the problem of sanitation attitudes in the filthy conditions which they tolerated within their dispensaries.

Overall, the project should improve the ability of local families to pay for medicine. It may be hoped that eventually through education a desire to improve sanitation significantly will result. It is truly doubtful that any impoverished society can improve its sanitation without concommitant improvements in education and standard of living.

e. Public Health

A wide range of diseases is found in the Sénégal River Valley according to a variety of reports. Discussions with the Bakel health center director and others indicated that only some of these are at present reported within the project area.

Records at the health center as well as the dispensaries indicate that the major disease is malaria by far, followed by gastrointestinal illnesses, ascariasis, conjunctivitis, venereal diseases, typhoid and dracunculiasis. Bronchitis was also fre-

quently cited, which may be actually tuberculosis. As is to be expected, other diseases mentioned included leprosy, hepatitis and measles. Of great interest was that only 28 cases of schistosomiasis were recorded in 1975 for Bakel, all being haematobium (urinary bilharzia). Also, no onchocerciasis nor human trypanosomiasis was reported. A statistic cited was that half of the children in the area died by the age of four. Malnutrition is certainly a causative factor although malaria or other diseases are generally blamed.

Malaria in the area, almost exclusively of the falciparum variety, is a major obstacle to the modern development of Bakel and much of the Sénégal River Valley. As of now the incidence rates are highest in the rainy season, June to September, and are low in the remainder of the year, due to the drying out of breeding grounds for the anopheles mosquito. Some marigots retain water year round, but presumably surface disturbance by man and cattle create less than fully favorable conditions for the mosquito. The same is true for the river. During his visit to the area in late October, the writer noted few mosquitos, but of the five identified, two were anopheline.

Clearly the addition of irrigated lands to the Bakel area will increase the mosquito population, particularly during the dry season. As a result the incidence of malaria could approach a uniform high rate throughout the year, causing significant additional disability if not death.

The irrigated fields need not be perpetually inundated,

thereby providing breeding grounds. Nonetheless only 8-10 days are required for a mosquito life cycle in warm water, and it was apparent by the writer's field visit that periods of continuous inundation in excess of this were frequent in many ditches, low spots and in some patches as well. Although the farmers have an incentive to conserve water (and hence save on diesel fuel), it is also true that the farmer has an incentive to avoid work, such as filling low spots, repairing leaky canals, and weeding (inundation reduces weed growth). The use of larvicides faces similar dichotomies, and introduces another potential health hazard. A more detailed discussion of mitigating measures is to be found in Section 3.2.

Irrigation also threatens to increase schistosomiasis from its present reported low incidence to possibly an endemic level found in many irrigation projects elsewhere in Africa. Certainly a reported infection rate of over 40% of the population in upstream Mali is a grim indication of the threat. As earlier discussed (Section 2.3) a low incidence today may be due to the destruction of snails during flood recession. Also, the lack of water bodies other than the Senegal River and a few marigots during the dry season hinders spread of schistosomiasis. In this writer's view, the small-scale irrigation projects of the Bakel project by themselves are not likely to increase schistosomiasis markedly due to the fact that the creation of a flourishing snail colony capable of transmitting schistosomiasis requires about 60 days. It is doubtful that favorable conditions

(for snails) of such duration will exist in general. Also, it should be noted that the villages of the area are generally several hundred meters from the fields, thus the river will continue to serve as the focus of much of the water oriented activities. This situation would change if large scale irrigation projects were constructed where the spread of schistosomiasis would be favored by large return flows and large population contact.

Onchocerciasis is yet another disease threat from irrigation due to the possible creation of turbulent flow regimes favoring the breeding of the vector, similium flies. The writer did not observe such turbulence in present projects in the Bakel area except at the pipe discharges. Under full development of 1,900 hectares some 70 pumps may create like points of turbulence. Yet it must be said that the project intent is that the pumps operate only during the day, and of course, the irrigated areas are not a continuous entity along the river. Concern is warranted through an eventual spread of the disease as it is present upstream of Bakel along both the Faleme and Senegal Rivers.

The human form of trypanosomiasis is carried by the tsetse fly which favors vegetation on banks and flood plains of rivers and streams. As it is not now reported in the area, there is little basis to fear its immediate spread: moist areas in the irrigated lands will not be shaded by trees or bushes initially. It might be mentioned that bovine and equine trypanosomiases are in areas not too distant from Bakel, such as upstream in Kayes, Mali. The large and extensive cattle migration in this part of

Africa can spread the animal forms of trypanosomiasis quickly as opposed to the possible rate of spread of the human form.

The other diseases reported in the Bakel area are primarily related to sanitation (drinking water, excreta disposal) and are not related to irrigation projects directly. It has been previously shown in Section 2.2 that the water demands of the irrigation projects will stress the availability of water resources in dry periods, and hence create lowered water quality to some. Here then is a possible impact of irrigation in enhancing water borne disease transmission. The water supply of Bakel, pumped from the Senegal River and distributed without treatment comes to mind. It may also be noted that the annual extended dessication of the soil is inimical to the spread of many helminthal infections, but that irrigation will enhance the possibilities for year-round soil contamination.

In sum, the threats on public health from irrigation are many, but those specifically posed by the limited extent and complexity of the Bakel Crop Production project are few. Of these few, the increased period of high malaria incidence is the most serious and immediate. Others, particularly schistosomiasis, may not be ignored, but should be carefully and regularly assessed under future basinwide and local environmental/public health studies.

3. Project Evaluation

a. Alternatives

An analysis of the Project Paper as well as documents for other irrigation projects indicates that several alternatives to

to the proposed project may be possible. This section describes and briefly analyzes these possibilities in conformance with the intent of the Environmental Procedures of A.I.D. and the U.S. National Environmental Policy Act of 1969.

- No action Alternative: This alternative would represent a basic continuation of present agriculture in the Bakel area, without external funds or technical assistance to promulgate irrigation systems.
- Integrated Development Alternative: This alternative would initiate the Bakel Crop Production project simultaneously with a comprehensive development scheme including public health improvements, education, transportation, etc.
- Improved Agriculture Alternative: With this alternative external funding and technical assistance would be used to improve present agricultural practices through introduction of fertilizer, improved seed, etc.
- Advanced Agriculture Alternative: This would be a capital intensive irrigation system emphasizing mechanization to reduce health problems.

This list of alternatives is not mutually inclusive nor individually exclusive.

Briefly the No Action Alternative has been dismissed as unresponsive to local or Senegalese national needs, which are to improve nutrition and reduce reliance on import of rice and other grains. It is to be recognized that the failure to increase crops in the Bakel area must place additional stresses elsewhere in the world for crops to be provided. Local production will

avoid transportation and other energy intensive costs required of imports.

The Integrated Development Alternative is meritorious à priori. However, delays in implementing irrigation to coincide with future developments in other sectors is thought to be unjustified, for the results of experience in developing and operating, the small scale Bakel irrigation project is to be an important input to finalized basinwide development planning. Also it is believed that an urgency for implementation of irrigation to meet present shortages exists.

The Improved Agriculture Alternative is in fact a variant of the Bakel Crop Production project in that rice is pres ntly grown in limited areas. The project purpose is in part to reduce the undependability of present rice farming due to droughts. Present recession farming, is also related to proposed irrigation farming (second crop). In general it is felt that farmers will not invest in improved techniques unless crop dependance on weather variations can be reduced to predictable dimensions through irrigation.

Lastly, the Advanced Agriculture Alternative would introduce sophisticated irrigation agriculture to the region to maximize economic return through high yields with intensive application of fertilizer and pesticides on lands irrigated by possibly sprinklers. Studies for such alternatives elsewhere in the Sénégal River Basin have been undertaken and have been reportedly rejected by the Senegal government as being too sophisticated and demanding of specialized agriculturists. An advantage of minimizing certain water transmitted diseases by sprinkler irri-

gation may be obviated by the negative impact of high energy costs, although the use of water is efficient. Large fertilizer and pesticide application is of concern, of course.

b. Mitigating Measures

This section presents measures to prevent or mitigate undesirable significant impacts of the Bakel Crop Production project, as well as measures to increase positive impacts.

The major negative impact identified by the writer is the extension of the annual period of high malarial incidence. There are several mitigating measures possible, including; residual spraying (room walls, etc.), larviciding, the rapid variation in water application, elimination of stagnant pools by filling or draining, clearing of vegetation and prophylaxis. As it now appears, malaria elimination in Africa is impossible, and certainly the Bakel area is not an exception, and therefore prophylaxis will be needed indefinitely. Certainly, mosquito control measures should not be ignored, but their effectiveness should not be overstressed as they will inevitably be carried incompletely as described in Section 2.5. Also, one should note that neighbouring Mali and Mauritania should join in efforts to control malaria. The writer would also mention again that any massive intervention with pesticides may produce undesirable environmental impacts.

Similarly, schistosomiasis can only be controlled by a variety of measures applied regularly and concurrently. These measures include avoidance of human-water contact, prevention of human excretion into water, destruction of snails by molluski-

cides and dessication, and avoidance of stagnant water conditions. One notes that these measures are not contradictory to malaria control, and again, reliance on any measure should be avoided. We may now specify two policy measures:

1) the irrigated fields and adjacent areas should be kept free of trees and bushes. Although shade is desired by farmers for resting, this vegetation serves as roosts for birds and wastes irrigation water. More importantly, trees and bushes issue debris to clog canals and provide privacy to encourage defecation and urination.
2) dwellings should be kept distant from the irrigated fields. Such a policy reduces human-water contact, excreta discharge in water and, conceivably, mosquito density in dwellings. Further, it is desirable to keep the dwellings away from the fields to avoid flood dangers less likely to occur near higher established villages.

Any overall improvements in sanitation will tend to mitigate the undesirable impact of reduced water availability and hence reduced water quality in the river due to irrigation. A dramatic improvement would be the installation of wells to provide higher quality water. Certainly a protected well supply for the Bakel village system would be beneficial, although the need does not seem to be clearly dictated as a mitigating measure for impacts of irrigation on water supply. In villages, well supplies would probably offer little benefit as river use for sanitary purposes is difficult to discourage. The strength of established

customs was seen to discourage the use of the few latrines found in the villages at dispensaries and schools.

A reduction in water quality for water supply and other purposes due to irrigation demands pesticide and fertilizer application can be minimized by economic use through good management and supervision. SAED/CIDR should be certain in particular that farmers understand the dangers of pesticides, in or to protect the health of those applying the pesticides as well as the general public and the environment. Record keeping, proper storage, controlled supply and other measures are needed.

c. Replicability

It has been stressed that the Bakel Crop Production project in relation to the population involved and the large land areas would have chiefly minor impacts except in the public health sphere. However, it does not follow that the project may be enlarged manifold or that it may be duplicated elsewhere without significant impacts of the types previously described or of additional ones.

Each irrigated field both reduces downstream flow and degrades water quality. Each field reduces the availability of land for grazing and for wood gathering, for example. Clearly, indiscriminate replication of small irrigated projects such as this in the Senegal River Valley can be synergistic with far more serious environmental impacts in total than a simple multiplication would indicate. We must note that environmental concerns, particularly public health, are subject to many threshold definitions (toxicity, for example). The limit of replicability can thus not be evaluated.

d. Irreversible Commitment

The minimal irreversible commitment of resources in this project is certainly one of its most attractive features. Were the project to be abandoned after initiation one would find few immovable structures or permanent land commitments that would prevent future productive use of resources. The irrigated lands could be readily returned to dry farming and pumps and pipe could be relocated elsewhere.

Trees, due to their slow growth rate in this dry region, can be considered an irrevocable loss during the lifetime of the local residents. The effects of diking may also be considered semi-permanent, but eventually dikes will be breached by animals, man and erosion. Hydrologic studies in the Project Paper indicate that the dikes would not affect flood heights due to the limited area of land protected in comparison to the total flood plain area.

e. Countervalent Benefits

The countervalent benefits which are believed to outweigh negative Project impacts by a considerable margin if mitigating measures are instituded, may be summarized as follows:

1) improvement in local diet and attendant reduction in mortality and morbidity rates, possibly particularly among infants.
2) improvement in the local standard of living, critical to education, sanitation and other improvements of life.
3) introduction of assimilable technology fulfilling

psychological desires of influential younger residents for improvement and changes. This could be partilarly important if villagers now working in France were sent home.

4) eventual reduction in import needs of Senegal for grain.

5) encouragement to the establishment of infrastructure such as improved transportation.

6) provision of training opportunities for SAED staff for use elsewhere.

7) opportunities for detailed analysis of the feasibility of small-scale irrigation projects in the Senegal River Valley.

4. Recommendations

a. Project Modifications

After deliberation with national, CIDR and USAID officials, it was deemed both essential and implementable that the Bakel Crop Production project should provide free malaria prophylaxis to all residents of the project area, the distribution of which should begin at the beginning of project implementation.

Details must remain to be worked, but is believed that the distribution should be through SAED and the village cooperatives The suspicion of some villagers to pills, particularly of a preventive type, can only be overcome with the influence of those influential elders and others (including SAED cadres) who are for the most part to be involved heavily in the irrigation

projects themselves. Local dispensers lack the influences. They are also immobile, remaining mainly in the dispensaries. Successful mass prophylaxis requires a management/distribution/accountability structure which only the cooperatives will possess.

It may be thought that dependency of malaria control on prophylaxis is dangerous. But all control alternatives described in Section 3.2 are potentially somewhat dangerous or are probably ineffective. The dangers of prophylaxis, of course, are overdoses and the prevention of acquiring natural resistance to malaria among villagers. With the latter, it may be feared that a cessation of prophylaxis leaves the individual defenseless. Such specious argumentation would lead one to recommend against public health and other interventions in general. A more realistic objection is the probability that prophylaxis may lead to neglect of other malaria control measures.

The need for free prophylaxis is clear, recognizing the poverty of the area, but eventually the farmers cooperatives should provide for the purchase of prophylaxis. This is justified as an irrigation operating cost as prophylaxis can be said to be necessitated by the irrigation project. It may be hoped that prophylaxis will also improve efficiency.

Other project modifications would center on assuring that the importance of sanitation and vector control be taught both to farmers and SAED cadre in order that mitigating measures such as described in Section 3.2 are understood and have some possibility of being implemented. Such additional training requires educa-

tional materials and other supportive services which could be made available from health projects of A.I.D., for example.

b. Future Studies

The lack of public health data and other information for th Bakel area must be alleviated if the project and its impacts can be intelligently assessed. At a minimum it is recommended that an entomologist and a public health specialist/physician should be included in the annual project evaluation teams. Also all progress reports prepared for the project should specifically include information on public health such as number of prophylaxis issued, quantity and type of pesticides applied, etc.

It must be stressed that a major value of the project is in the opportunity to learn. Certainly the large environmental study funded by A.I.D of the entire Senegal River Valley will benefit from any data and the experience of the Bakel project.

5. Review by Africa Executive Committee for Project Review

The Nebiker assessment was among the matters reviewed by the Executive Committee on Project Review at their meeting of Novenber 9, 1976. Their findings as reported in a telegram (State 280888) of Novenber 16,1976, from the Secretary of State, Wash. D.C., to the Regional Development Officer, Dakar, were as follows:

> Subject: Bakel Irrigated Perimeters, ECPR Review
>
> Ref: (a) State 257903, (b) Dakar 7139, (c) Dakar 7200
>
> 1. ECPR review held Nov 9 accepted project committee recommendations on all issues except following:

A. Environmental health: ECPR was satisfied with Nebiker's findings in terms of problem definition. Not persuaded, however, that prophylaxis distribution and education program proposal are only possible response to potential increased health hazard, especially malaria. Additional study proposal now being prepared by AFR/DR/H which will further analyze problem and protective measure recommendations re project per se and replicability. Study proposal must at a minimum be cleared by AA as adequate prior to project authorization.

c. Environmental Issues on the Project Review Paper

Following the circulation of the Project Review Paper during February 1977, a number of environmental issues were raised by the Soil Conservation Service and the Department of Health, Education and Welfare.

The issues pertaining to public health are dealt with in the assessment by the APHA Team (See Section II D). The following replies to the remaining issues have been supplied by Ms. C. Palesh, AID/SER/ENGR partly in a memorandum to Mr. John Heard, AFR/DR/SFWAP dated May 25, 1977 and partly by verbal communication on June 7, 1977.

1. Issues of the Soil Conservation Service

Mr. Roy H. Gray, Acting Assistant Administrator, Soil Conservation Service, in a letter to Mr. Albert C. Printz, Jr., Environmental Coordinator, AID, raised the following issues:

a. We feel that the review would be improved if a discussion were included to outline how the dikes and irrigation canals would be repaired if damaged by a flood. Subsistence farmers such as these might be reluctant to expend the time and labor to repair these structures if they were damaged by a flood soon after initiation of the project.

b. The discussion of drainage during a flood might consider possible additional water from flood activated springs within the perimeter. If there are no sandy strata underground this would not be a problem.

c. Additional consideration should be given to the fact that the planned pumping capacity is equal to 80% of the average flow in April for 10% of the years. This would be a major alteration of the aquatic habitat.

The replies are as follows:

a. Only negligible damage to dikes will occur to these structures if properly constructed during the projected serious flood once every ten (10) years. Serious damage would probably only be caused by the one-in-100 years flood when a truly cataclysmic flood might occur. In such a case, all interested parties would pull together for the reconstruction.

b. Conditions are not such as to cause the activation of springs by floods.

c. The Senegal River, on rare occassions, has no flow in the Bakel area. When this occurs water usually remains ponded in areas of the river with no surface inflows or outflows from these ponds. This condition exists upstream of the Boghe area where the river becomes tidal and subject to salt water intrusion. Such dry periods usually occur in April and May after irrigation for the season has been completed.

However, when such conditions occur, with irrigation still in progress, the Bakel Project would decrease surface flow water downstream of the project as well as speed the annual movement of salt water upstream to Boghe. Based on the hydrologic studies completed for this project, a low flow or zero flow condition is expected to occur on the overage of about 2 years out of every 100 in the month of April. Adequate flows are available for other months during the irrigation season and for those months the project's water demand would have minimal impact on river flows. For the shortage months, generally speaking, the project could cause river flows to dry up a week or so earlier than could be expected without the project. Salt water movement upstream would probably only vary a day or two when compared with project and without project conditions. Such conditions could result from the Bakel project without control of pumping, assuming that other demands for water upstream of the project are minimal. In turn a shortage of water may mean a reduction in irrigation of Bakel crops toward the end of the season, therefore resulting in reduced yields.

However, as the Senegal River Basin develops (increasing) the demand for water, storage facilities will undoubtably be developed to augment low flow condition as will regulations for the use of water in the basin. Relatively, the Bakel Project is small as in the water demand. It only appears to be significant at times when the River approaches dryness. Environmentally the river drying is a condition that occurs naturally. The Bakel project would speed the process on rare occasions.

2. Issues of the Department of Health, Education, and Welfare

Mr. Charles Custard, Director, Office of Environmental Affairs, Department of Health, Education, and Welfare (DHEW) in a letter dated April 5, 1977 to Mr. Prinz, Jr., submitted the following issues among others raised by Mr. Boris J. Asheroff, Director, Office of Environmental Affairs/DHEW in a memorandum of March 30, 1977:

> These projects seldom take into account possible occupational health problems. Will the heavy equipment be operated by local peoples? Will training and safety precautions be adequate? Will new technology--e.g., operating the diesel powered pumps--introduce hazards not present in existing agricultural technology? The document should have addressed this issue.

The reply provided is as follows:

> All heavy equipment used on the project will be operated by employees of the Société d'Amenagement et d'Exploitation du Delta (SAED) who are trained and have considerable experienc in handling such equipment on the larger irrigation projects in the Senegal River basin. SAED's personnel have also trained and supervised local farmers in the operation and maintenance of the small diesel pumps already being successfully used in the eleven (11) operating perimeters.

D. Environmental Assessment by APHA Team

This assessment has been undertaken in accordance with the Scope of Work shown in Appendix A. This section is concerned with the assessment of those issues left unresolved by the preceeding Preliminary Environmental Assessment and that of Dr. Nebiker. The supporting data of this assessment and the

remaining requirements of the Scope of Work are to be found in Appendices D to G.

The issues of concern relate to the potential adverse impacts of the project with respect to:

1. The transmission of the water related diseases of malaria and schistosomiasis.

2. The ecology of the area resulting from the use of agricultural chemicals, mainly pesticides and, to a much lesser extent, fertilizers.

1. Water Related Diseases

The disease situation in the project area has been discussed in Appendix E. The findings confirm that, as far as potential adverse health impacts of the project are concerned, consideration need only be given to malaria and schistosomiasis.

a. Malaria

The major premise of concern of Dr. Nebiker in his assessment is to be found in his statement:

> "Clearly the addition of irrigated lands to the Bakel area will increase the mosquito population, particularly during the dry season. As a result the incidence of Malaria could approach a uniform high rate throughout the year..."

i) Observations during this dry season and discussions with SAED officials have proven this statement to be without validity. Any ponding of water in the perimeters following the irrigation of the dry season crops disappears by percolation and evaporation within two (2) days. Irrigation intervals are 7 to 8 days during

early growth and 15 days just prior to harvesting. Hence the perimeters are without ponded water and the land surface therefore is dry for the vast majority of time during the dry season. The 4 to 7 day interval of ponded water required for the complete cycle of mosquito development is not attained.

ii) Spot checks made in a number of perimeters and repeated intensive search in one perimeter have failed to produce a single anopheline larva.

iii) The extent of ponded water in these small perimeters during the rainy season will be minimal in comparison with the existing sum total of naturally occurring bodies of standing water, particularly in the marigots. As stressed in the Project Paper:

> The types of irrigation facilities being planned would not cause much area to be continuosly wet for long periods. Because the plan has a separate system for each village, the pumping of water will be intermittent. The pumps will be run and the canals filled only for so long as needed to deliver water to the fields. Then they will stop and (the fields) dry out. In general the fields will have a dry surface for a period before the next irrigation is applied. The soils have excellent moisture retention characteristics so that frequent irrigation is not necessary. Even the surface of a rice field can be dried without harm to the crop and the cloudy water requires lowering of the water surface to allow to reach the lower stalks during the early stage. Later the deeper roots extend the period before added water is required, also assuring against constantly standing water.

Interviews with the SAED Project Director and his Deputy have confirmed the above intermittent nature of irrigation in the eleven (11) perimeters that are already operational. The periods of standing water in the fields during the rainy season have been usually less than a week with dry periods in between them.

The contribution of the perimeters to the proliferation of mosquito vectors is therefore expected to be minimal.

iv) Since the primary vectors in the area are A gambiae which bite only at night, workers will not be at increased risk as no work takes place in the field at night.

v) Perimeters are generally located at distances from villages approximating the reported limit of the effective flight range of A gambiae. Very few mosquitoes from the perimeters are therefore expected to reach the villages. The effects on the disease problem will be minimal.

vi) For the above reasons the effect of the project area is likely to be insignificant.

b. Schistosomiasis

i) The available existing information points to the Sénégal and Faléme rivers as the main source of S. haematobium in the region.

ii) This being the case, essentially all of the villagers in the project area are continually being exposed to the disease because of their customary extensive use of the river on a daily basis for bathing, washing, fishing and other human contact functions.

iii) The statement made by the Department of Health, Education and Welfare's Principal Environmental Officer/H in his memorandum of March 30, 1977 to the Director, Office of Environmental Affairs/DHEW that "because of increased irrigation, exposure of previously unexposed workers may be markedly increased by the project" is therefore without foundation.

iv) The repeated drying out of the fields at short intervals because of the intermittent irrigation practices (see the Project Paper) and the nature of the soils will discourage the proliferation of the intermediate host snails of schistosomiasis. These snails require about forty (40) days of favorable water conditions for the development of a colony and sixty (60) days for transmission of the disease.

v) Repeated weeding of the irrigation ditches and the lining of the walls of these ditches with burnt clay bricks, as is already in progress in one perimeter, should further discourage the proliferation of snails.

vi) It is therefore expected that the potential of the project for increasing the incidence and prevalence of schistosomiasis will not be significant enough to justify delaying the implementation of this project.

2. Agricultural Chemicals

a. Pesticides

A somewhat confusing situation with respect to the use of pesticides on the project has recently been clarified. The original Project Paper dated July 30, 1976 made many references to the likely use of pesticides on the project. Dr. Nebiker in his assessment specifically referred to the use of hexachloracyclohexane in the rice fields against locust and spanish fly infestations.

SAED officials managing the project have, however, adamantly insisted that no pesticides have been used on the project and it is not intended to use any. They stress that the project's objective is not the achievement of optimum crop production rates but mainly subsistence farming. Thus they are prepared to accept some losses due to crop pests without resorting to the use of pesticides.

The revised Project Paper of May 15, 1977 confirms this position. It goes on further to state:

> If a serious insect or pest outbreak occurs, SAED will consult with the Crop Protection Service which is being supported through the AID financed Sahel Crop Protection Project (629-0916). Two AID entomologists are based in Dakar for that project and would be available for consultation.

It is therefore concluded that the project will not normally contribute to pesticide related adverse environmental impacts. Adequate precautions have been proposed for unusual circumstances necessitating the use of pesticides.

b. Fertilizers

The opinion of Dr. Nebiker is supported that the level of fertilizer use is unlikely to produce measurable increases of algae and plankton growth because of the considerably greater fertilization from livestock manure.

E. Conclusion

It is concluded that the implementation of the project will result in no foreseeable significant adverse impacts. It is recommended that the project proceed in the manner planned.

III HEALTH COMPONENT

A. Objective

A health component of the project is considered necessary, not because of any potential adverse health impacts (already deemed insignificant), but because of concern that the existing poor health conditions in the villages are serious enough to have an adverse effect on the contribution of the villagers to the project.

On the other hand, the health component is not to be considered as a proposal for solving all of the health problems of the project area. Furthermore, it is not to be seen as the component of an "integrated rural development project" which is usually broader in scope than the Bakel Irrigated Perimeter Project.

The health component in this context should be a somewhat limited one aimed at improving village health to the extent necessary for the successful implementation of the project. It should not be out of proportion to the project itself. Additional health improvement measures should be undertaken within the context of an appropriate comprehensive health plan.

B. Project Paper's Health Component

The Project Paper's Health Component basically meets the requirements discussed. The following recommendations are made for its improvement at little additional cost.

1. The surveillance program should be used not merely as

a means of evaluating the project during its final year but also to provide valuable information to the Government of Senegal in the development of suitable disease control programs.

Such information would include the prevalence, incidence, distribution and transmission of malaria, as well as the identification of the vectors, their resting and biting habits, flight ranges, susceptibility to insecticides and the distribution of breeding sites. Similar epidemiological and entomological information with respect to schistosomiasis and the intermediate host snails would also be relevant.

2. The health services plan should be strengthened by the provision of:

a. Two-way radio communication between the Bakel Health Center and each of the twelve (12) Health Posts. This would result in much better supervision of the Health Posts by the Doctor at Bakel as well as facilitate the necessary communication between him and the Dispensers on technical and other matters.

Costs:

Investment	
Purchase and installation of 13 radio sets	20,000.00
Annual Recurrent	
Operation and Maintenance	2,000.00
Wages of Operator--Bakel Health Center	3,000.00
	$5,000.00

b. The provision of malaria prophylaxis for all residents of the project area during the main 3-month transmission period of the disease in July to September.

Mass prophylaxis has been recommended by the World Health Organization[3] as the method of choice for immediate control programs in semi-arid areas of Africa where A gambiae thrive in water bodies exposed to sunlight and control by larviciding is thus very difficult, if not impossible.

Such prophylaxis is currently the policy of the Government of Senegal. The program is administered by the Service de Lutte Antipaludique (the Antimalarial Services) of the Ministry of Public Health and Social Affairs using chloroquine tablets. It has, however, been unsuccessful mainly because of inadequate financing and, to a lesser extent, a lack of close supervision.

This proposal would provide the necessary financial and other support for the successful execution of such a program in the Project Area under the continued administration of SLA working through the district health services. Two alternatives are proposed based on the use of a) Chloroquine tablets and b) Chloroquine salt.

a) Chloroquine Tablets

The tablets will be distributed on a weekly or fortnightly basis through the system already provided for drug distribution in the health component. The overall super-

vision of the program will be the responsibility of the Service de Lutte Antipaludique (SLA) under Dr. Samba Diallo who also heads the Parasitology Department of University of Dakar. These two organizations have all of the top level staff required for such a program, including four physicians, specialists in parasitology, an entomologist, 34 technicians including laboratory technicians, nurses and sanitary agents.

To ensure the success of the program, it is proposed that the tablets be distributed free of cost to all villagers.

The program must be preceded by a careful census of persons and dwellings in the area.

b) Chloroquinized Salt

The use of chloroquinized salt is particularly suited to isolated communities where it is possible to ensure the use of only this medicated form. The World Health Organization reports its use in many ocuntries in Africa, and in Guyana and Surinam in South America. That Organizaiton[3] reports its use (0.3% chloroquinized salt) in the reduction of the parasite rate in the 6 - 10 years age group in isolated communities of Tanzania from 71.7% to 2.7% and in the group above 16 years, from 27% to 1.2% over a period of three years.

The implementation of this program must be preceded by a survey to determine the salt intake of the villagers in order to establish the chloroquine concentration to be

used in the salt.

A check of the foodstuff distribution system to the villages would also be needed to confirm the feasibility of excluding all but the medicated salt during the malaria transmission season.

The SLA would be the designated agency to determine the required dosage in the salt and also to supervise its availability and distribution.

Comparison of Alternatives

The use of tablets has the advantage of already being the accepted policy of the Senagalese Government. The program has, however, not been a successful one. The logistics of providing, distributing and ensuring the use of tablets in correct doses for all age groups would be much more complex than required for a medicated salt program.

There is always a dendency either to reject entirely or simply not to sustain a protracted course of tablets. By fixing the dosage in the salt, the need for the consumer to be involved in the process of ensuring the use of correct doses for adults and children is totally obviated. This is very important in rural populations such as these. The use of salt would also be a much less obvious or visible measure to villagers.

The slightly bitter taste of chloroquinized salt is sometimes presented as a disadvantage. The taste is more noticeable when salt intake is low and corresponding chlo-

roquine concentration proportionately high. However, Dr. Jose Najera, head of the PAHO/WHO Division of Malaria and Parasitic Diseases (Washington D.C.) has stated that taste has never been great enough to be considered a problem.

The choice of an alternative should not be made until the feasibility of the salt proposal is examined in detail and comparable costs available.

The estimated cost of supplying one tablet per week to approximately 40,000 persons for 15 weeks, i.e. 600,000 tablets per annum is $7,200.00.

REFERENCES

1. Agency for International Development, "Project Paper-Bakel Crop Production" July 30, 1976.

2. Nebiker, John H., "Environmental Assessment for Bakel Crop Production Project, Senegal", November, 1976.

3. World Health Organization, Manual on Personal and Community Protection Against Malaria. WHO Offset Publication No. 10. Geneva: World Health Organization, 1974.

V APPENDICES

APPENDIX A

SCOPE OF WORK FOR ENVIRONMENTAL ASSESSMENT AND HEALTH COMPONENT DESIGN FOR BAKEL CROP PRODUCTION PROJECT - SENEGAL -

I. Introduction

The Bakel Crop Production Project proposes to introduce farmer managed irrigated crop production in the Bakel area of Senegal which is presently characterized by dryland and flood recession agriculture. Rice, millet and maize are the primary crops cultivated in the area. The project will serve to acquaint farmers with the advantages of irrigated agriculture as well as permit increases in yield through greater protection against periodic droughts, and by double-cropping. Initially, the project will establish around 1,900 hectares of irrigated areas. However, if the project is successful expansion in the region is planned for an area comprising around 10,000 hectares.

From an environmental perspective, this project is a "test case" for AID's development strategy in the Sahel, which gives priority to river basin development. A preliminary environmental examination was conducted as part of PP development, before AID Regulation 16 was issued, concerning criteria and procedures for addressing environmental concerns in the project. The Executive Committee for Project Review (ECPR), found that most major environmental areas were adequately treated in the Bakel PP, with the principal exception of the potential negative impact of the project on human health.

The health problem relates primarily to the possibility of increased exposure of the target population to ponded water resulting from the irrigation measures proposed in the PP. In addition, there will be greater use of pesticides, herbicides and fertilizer. An initial environmental health study of likely effects of the Bakel project found that a greater incidence of water-related diseases, particularly Malaria is likely to result. In addition, the use of pesticides could have detrimental effects if proper safeguards are not established.

II. Objectives

The objective of the contract team will be to make an environmental assessment (EA) of the project, focussing on public health related aspects. This assessment will also produce a recommended design for the incorporation of an appropriate health component in the project to protect villagers in the activity area from any potential adverse health effects of a new water impoundment and provide cost estimates for such a program. The EA team should study as many possible alternative and or internal modifications of the project as possible and make recommendations to USAID and the Governement of Senegal (GOS) concerning the various options weighed.

III. Scope of Work

The contract team will work closely in conjunction with officials of USAID/Washington, RDO/Dakar, SAED and the GOS Public Health Service. The contract team will:

A. Collect and assemble available baseline data relating to public health in the project area and peripheral areas to determine:

1) The magnitude of present tropical disease problems with particular attention to malaria and shistosomiasis;

2) The magnitude of present diseases emanating from poor sanitation standards;

3) The nature and extent of public health services presently operating in the project area;

4) The nature of preventive medicine and sanitation infrastructure presently in place including methods, types, prevalence of and uses of household water supply, human waste disposal, and solid waste disposal;

5) Water quality both upstream and downstream from the project; and

6) Social habits and attitudes among villagers in the project area relating to health and sanitation.

7) A frame of reference (base line profile) against which can be measured the effects over time of the proposed project on public health in the project area and peripheral areas within the framework of the six categories above. The use of pesticides should be analyzed in addition to introduction of irrigation systems.

B. Propose and evaluate options for alleviating the potentially adverse environmental impact of the proposed project on public health. This analysis should include considerations of:

1) Investment and recurring cost, taking into account the potential effect of such costs on the overall vialability of project design.

2) GOS institutional support required during and after AID participation in the project, particularly through the public health service and Promotion Humaine and its capacity and willingness to provide this support;

3) Likelihood of change in villagers perceptions and attitudes in their health and sanitation practices, and extent of cooperation called for on their part;

4) Replicability of project design in other river basin areas where irrigated perimeter development is contemplated.

C. Furnish recommendations concerning:

1) Whether the overall project may proceed in a manner which will not adversely affect health conditions, if so;

2) Which of the health component design options identified in section B is the most technically , financially and socially feasible and should be adopted, and provide project design for that option.

3) Means of monitoring and evaluating the environmental impact of the proposed project on public health during implementation and expansion phases of the project

Note : the ECPR was not able to approve a proposal to develop a free distribution program of malaria prophylaxis as a means of addressing possible adverse effects of the project on villagers health. This option is not ruled and for future consideration, however, depending on village attitudes and other factors which will be analyzed in the E.A.

IV. Briefings and Reports

A. Prior to departure for Senegal, the entire contact team will assemble in Washington D.C. for one day briefing by AID/W Africa Bureau personnel and SER/ENGR.

B. The contract team will not be required to submit routine, periodic progress reports. Reports of any significant findings, problems, serious delays, or unforseen circumstances which may seriously hinder or effect the outcome of the team's activities or of the total project must be reported to the responsible AID offices/bureaus when and if they occur. Such reports will be submitted in quintuplicate and distributed in the following manner:

1) Two (2) copies to RDO/Dakar Mission.

2) Two (2) copies to AFR/DR, AID/Wahsington; and

3) One (1) copy to SER/ENGR, AID/Washington.

C. Prior to departure from Senegal the contract team will brief RDO/Senegal and others designated, such as CIDR and SAED officials.

D. Immediately upon return to the U.S. the team will again assemble in Washington for debriefing by Africa Bureau and SER/ENGR personnel.

E. A draft of the final report shall be prepared and submitted in quintuplicate (with the same distribution as above) no later than fifteen (15) days after completion of field work in Senegal. This report shall contain all findings, pertinent data, recommendations and project designs required. The draft report shall be reviewed by the designated AID offices, and, where necessary, commented upon and returned to the contractor. The draft report is to be in a format conforming to sections 1500.7 and 1500.8 of the Council on

Environmental Quality Guidelines described in the Code of Federal Regulations, Title 40, Chapter V, Part 1500 (38 Fed. Reg. 20550-20562, August 1, 1973) and conforming to procedures set forth in AID regulation 16 as published in the Federal Register, Vol. 41, N° 127, Wednesday, June 30, 1976.

F. The final report is to be submitted to AID/W within twenty (20) days after the Contractor receives comments and suggests modifications of the draft final report. The final report is to be prepared in a format which may be presented to and accepted by the Council of Environmental Quality. The final report shall incorporate all data, maps, findings, recommendations and project design resulting from the team effort, as well as AID review comments and/or modifications of the draft report. Twenty-five (25) copies of the final report shall be submitted to AFR/DR and five (5) copies submitted to SER/ENGR.

V. Time Schedule and Personnel Requirements

The contract team shall consist of the following personnel:

1. Malariologist : Expert knowledge of malarial diseases in West Africa is required. This person will focus on the incidence of malaria in the project area, effects of the proposed project in relation to the disease, and viable means of counteracting these effects.

2. Environmental Health Specialist: Required to have background in epidemiology with knowledge of tropical bourne diseases especially shistosomiosis. Expert knowledge and analytical capability with respect to public health statistics, finance and institutional support capacity will also be essential. African experience is desirable. This person will be responsible for analyzing the effects of the project for other vector bourne diseases, especially shistosomiasis, along with effects of pesticides and fertilizers on natural and human environments. He will also be responsible for costing out options identified in minimizing adverse environmental impact and analyzing the institutional implications of these options for the GOS public health service, SAED and possibly for Promotion Humaine.

3. Environmental Health Engineer: Background in civil and sanitary engineering in Africa is essential. Required to have expert knowledge or irrigation and sanitation systems and their various environmental impacts under African conditions. This person will help identify and evaluate options for the health component from an engineering standpoint. He will certify as to the satisfaction of cost and planning criteria of section 611 a. of the Foreign Assistance Act with respect to the health component option selected.

4. Sociologist: Background in traditional African health practices in rural communities is essential. This specialist will be responsible for ascertaining and assessing farmer's perceptions and attitudes concerning health and sanitation and the extent to which villagers are conscious of and will cooperate in combating potential health hazards generated by the potential project. Leadership structures which have influence over local practices and attitudes such as village councils or local cooperatives should also be identified and analyzed from the perspective of their role in modifying or controlling behavior which would contribute to adverse effects of the proposed project on health.

It is highly desirable that all members of the contract team speak French and have previous work experience in Francophone, West Africa. One member of the contract team will be required to act as team leader/manager (the environmental health specialist might most usually serve in this role). This person shall be available to work full time for the duration of the contract (estimated at two months).

The team will be posted for field work in Bakel, Senegal. Team members may make periodic trips to Dakar for consultations with appropriate officials, data-gathering, and administrative support. Field efforts in the study are expected to require thirty (30) man days per specialist. An additional ten(10 man days per specialist is projected for consultations with AID/Washington and preparing reports.

VI. Relationships and Responsibilities

While the contract team is in Senegal, the team through the team leader, will be responsible to the RDO/Dakar, or his duly authorized representative. The contractor shall work in full cooperation with SAED and other Senegalese government offices and officials. The contractor shall have necessary support from RDO/Dakar and SAED personnel in making arrangements for contact with GOS officers required for information, interviews, observations etc.

VII. Personnel and Facilities to be Made Available to the Contractor

All applicable data regarding the proposed project shall be made available to the cont'act team from RDO/Dakar and SAED.

RDO/Dakar will assist the contract team in obtaining quarters; office space; secretarial help; etc., while the team is in Senegal. RDO/Dakar and SAED will arrange for necessary air and ground transport within Senegal. If Government leased quarters are available in Dakar, these may be furnished at the discretion of RDO/Dakar during visits by team members at a reduced rate.

The contractor will be responsible for providing transprotation to and from home office; Washington, D.C. and Dakar Senegal: Pay,ent for ground transportation, housing and subsistence; administrative support costs (such as secretarial, reproduction,etc.), miscellaneous fees and gratuities (e.g., baggage handling; passport fees and medical fees), and other support costs also will be provided in the contract.

APPENDIX B

List of Contacts

U.S. Agency for International Development, Senegal

Mr Norman Schoonvoer, Regional Development Officer.

Mr Arthur Fell, Deputy Regional Development Officer.

Dr Marc Vincent, Regional Health Officer.

Mr Frank Casey, Deputy Project Manager - Livestock.

Mr James Procopis, Deputy Program Officer

Ms Viola Dia, Health Planner

Mr F.M. Philips, Country Project Manager for Sahel Food Crop Protection

Agency for International Development, Washington D.C.

Mr. John Heard, Desk Officer.

US Agency for International Development, Abidjan

Mr Gary Nelson, Capital Projects Officer.

Institute de Pasteur

Dr. John Ridet. Team Leader - Epidemiology.

Institute Technologie Alimentaire

Mme Therese Basse - Director

M. Ibrahima Camara, Technical Director

M. Abdul Aziz Thiam, General Secretary

Société d'Amenagement et d'Exploitation du Delta

M. Amadou M. Fall, Secretary General Adjoint

M. Jean L. Neumann, Ingenieur Agronome - BEP

M. I. Jean-Jacques, Genie Rural - BEP

M'selle Soukeyna N'Diaye, Sociologue Etude du Milieu.

M. Sy Abdurahmane, Adjoint Chef Cellule Evaluation et Enquettes Socio-economiques

M. Diallo, Comptable - Matam

M. Bâ, Ingénieur des Travaux Agricoles - Matam

M. Natta, Ingenieur des travaux Agricoles - Matam

M. Robert Aprain, Director, Perimeter Project - Bakel

M. M. Niang, Adjunct Director, Perimeter Project - Bakel

University of Dakar

Dr Samba Diallo, Professor of Parasitology and Head of National Malaria Service

.../...

Regional Laboratory of Clinical Biology, Fleuve Region

Dr. Jean Marie Le Masson, Medecin Chef

Organisation de Mise en Valeur du Fleuve Senegal - Documentation Center

M. Y. Sow. Analyste-Indesceur

M. N. Connayer, Informaticien

Matam Village

M. Diaw, Village Chief and President of the Perimeter Production Group.

Matam Hospital

M. Famakan Sissoko, Medical Interne

The Prefecture, Bakel

M. Mbaye Niang, Administrateur Civil, Préfet

M. Seko Sonko, Préfet Adjoint

Tuabou Village

M. Silly Tapa Bathily, President, Perimeter Group.

M. Boubacar Bathily, Secretaire Generale Perimeter Group

Mondery Dispensary

M. Dahaba Tounkara, chef de Poste Medical

Grande Village

M. Sissoko, President, Perimeter Group

Departmental Des Grandes Endemies - Bakel

M, Fara N'Diaye, Infirmier

Bakel Hospital

Dr. Moussa Ly, Chef de la Circonscription Medicale

Golmy Village

M. Dramane Camara, Chef de Village

M. Alassane Pouye, Chef Poste Medical

Kounghani Village

M. Mamadou Gueye, Chef du Village

M. M. Camara, School Teacher

Société Nationale D'Exploitation Des Eaux Du Sénégal

M. Edmond Latrilhe, Director General

M. Babacar Diéye, Mechanicien - Bakel

Departmental des Grandes Endemies - Tambacounda

Dr Alain Junod, Medecin Chef

Fonds Des Nations Unies Pour L'Enfance (UNICEF)

Mr. Knud Christensen, Représentant Bureau Pour L'Afrique Occidentale, Dakar.

APPENDIX C

PROJECT DESCRIPTION

Part I. - Project Background

A. Background

1. General

If on the African continent a stand is to be made against further encroachment of the Sahara into the region of the sub-Sahara, the first line of defense will be the river basins of that region. There are three such major basins in the Sahel area revaged by the unprecedented drought of 1972 - 1973: the Senegal River Basin, the Niger River Basin, and Lake Chad Basin. Of these three, the Senegal River Basin on the westernmost periphery of the Sahel area most readily lends itself to schemes to stabilize its ecology and increase local production of staple food crops.

The three riparian nations of the Senegal River: Mali, Mauritania and Senegal, formed, in 1971, a cooperative organization to plan and carry out the coordinated development of the Senegal River Basin under an agreed plan. This is the Organisation de Mise en Valeur du Fleuve Sénégal.

Under the O.M.V.S. auspices, various studies and projects are now underway to realize this river basin's fullest potential as an integrated river system. The principal mainstream components of this system will be two dams operating in concert: one low-level dam in the river Delta to arrest salt water intrusion during the low water season, and a major storage dam on one of the principal tributaries of the river in Mali to assure sufficient flow for irrigation and navigation on a year-round basis. The $30 million low-level Delta will be financed by France and Iran. It is now in a final design stage and could be constructed in 2-3 years. The $230 million upper basin regulatory dam is under study. Its construction will probably require 10 years from design through completion, once financing is assured.

In the meantime various food production schemes are being initiated to prepare the villagers of the Senegal River Basin for their eventual participation in irrigated farming in place of the low-yield and uncertain post-flood recession cropping on the river banks. In the 40-year projection of the coordinated development of this basin, some 420,000 hectares will eventually be brought into an irrigated double-cropping system. Only a few thousand hectares within this vast potential area have been developed to date, mostly through joint funding of large schemes by the Governments of Senegal and France.

In accordance with the O.M.V.S. policy, agricultural projects totally within the boundaries of any of its riparian members are to be negotiated on a bilateral basis between that riparian and the prospective donor. To provide much needed capital to accelerate this process, the European Development Fund (F.E.D.) and the World Bank (I.B.R.D.) have agreed to finance the development of large irrigated perimeters adjacent to the mainstream, and the United States has been asked to join in this effort.

Prior to the severe drought of 1972-1973 in the Sahel, most of the agricultural development efforts in the Senegal River Basin were concentrated in the Delta in sizeable, highly capital-intensive schemes where assurance of water and proximity to markets and transport systems minimized risks. More recently emphasis has shifted to projects in the middle and upper reaches of the river basin, and more account is being taken of traditional family and village social and economic structures. Two approaches are being developed: (1) large-scale perimeters divided into small, family-sized plots such that all inputs can be provided by the traditional family unit, (eight to ten persons), living and working on its own land; and (2) an evolutionary approach of small-scale perimeters developed and cultivated by a cooperative grouping of all families in one village to increase their food production and introduce the improved

technology. An example of the first type is a 7,250 hectare perimeter in Matam, which was studied by the Bechtel feasibility team under A.I.D. contract. The present project deals with the second approach, small scale, village level irrigation in the vicinity of Bakel while at the same time working to improve traditional culture to increase food production in the region.

Both the lower and upper portions of the Senegal side of the River Basin historically have been largely neglected in pre-independence colonial and post-independence national development schemes. The result has been a traditional exodus of young people from the basin due to the lack of the wherewithal to earn a livelihood and the consequent lack of growth within the region. At present, the prime market for laborers from the villages involved in the project area is France. However, severe unemployment in France has put the future of this labor market in doubt. This project, which will increase local production of foodstuffs on both irrigated and dry land farms, will provide an alternative livelihood for those persons who, in the past, would have immigrated to France as laborers.

The GOS, which historically has attached greater importance to the agricultural development of other areas, now accords priority to this river basin within its development planning. The villages which the A.I.D. team has selected for detailed investigation have climatic, soil and

water conditions which will allow cultivation of rice, sorghum, wheat, millet, corn, cowpeas and vegetables. All of these crops are elements of the local diet, and none is being produced locally in adequate supply.

2. Project in Bakel

This project is unique in two ways. First, it is already underway and the development potential has been identified and demonstrated in both the human and technical realms. Second, and even more important, the project is a direct result of actions initiated and requested by a resident farmer of the area. At the risk of sounding like a fairy tale we would like to present the story of the Kounghani development and how this moved into an area development program following a truly grassroots developmental process.

The project was begun at the initiative of one farmer from Koughani village During the time he was working in France and travelling in Europe, he noted the improved agricultural methods applied there and upon his return to Koughani he bought a pump and a rotatiller to use on his land. Because of insurmountable technical and logistical problems (no mechanics, lack of fuel, no spare parts available, etc.) his equipment was not useable. Realizing the need for expert assistance he wrote to the Director of CIDR, whom he knew because he used to work in the same building in France that CIDR has its offices, requesting assistance.

CIDR was happy to assist but did not have financing. Therefore, CIDR contacted various donors and private voluntary organizations and eventually OXFAM and "War on Want" in Britain agreed to provide initial financing for the project.

CIDR sent its first man to Koughani in 1974. He and his wife lived in Koughani for several months learning the way of life and organizing the first farmer group. He then moved to Bakel to begin activities in other villages. Two other CIDR volunteers arrived in 1975 to assist with the extension effort and SAED began contributing some assistance in the form of pumps and technical advice. The CIDR group moved into irrigation work in addition to traditional culture in 1975. As a result of this move to a more advanced technology, War on Want withdrew its support. In the meantime AID had begun to support the project with R&R funds, providing additional pumps and tools. The following table shows how the project developed and the inputs of various groups from 1974 to the present.

YEAR	VILLAGE No.	HA TOTAL	HA TRADITIONAL	HA IRRIGATED	FINANCING
1974	9	32	32	-0-	War on Want
1975	15	76	54	22	War on Want/ SAED
1976	19	210	95	115	USAID/SAED

AID through the R&R program assisted with financing the 1976 program and in 1977 provided preproject funding of $124,000 to keep the SERDA/team in the field thus avoiding a complete loss of momentum. The total AID contribution to date is $294,000 and financed pumps, tools, studies and costs of the CIDR/SERDA

staff in 1976 and 1977. In 1975, 1976 and 1977 SAED financed dikes and clearing, pumps, farm inputs and staff having a value of approximately $225,000. OXFAM and War on Want assisted with staff, tools and studies having a value of approximately $50,000. The total investment for the first three years was $569,000 from all sources plus considerable farmer labor.

The SERDA group (formerly CIDR) has overcome the ever-present "start-up" problems inherent with the introduction of a new technology and has established a working relationship with the farmers of the area. This process, which is time consuming and not very spectacular took over three years to accomplish. A.I.D.'s entry into the project now, when project needs are higher and the program is accelerating after having proven itself, is very sensible,

The villages in the Bakel area receive a sizeable income from laborers in France. Based on the best estimates available at the present time approximately 20% of the 5,000 farm families have one worker in France. This one worker sends back approximately $1,000 per year making a total of some $1,000,000 per year flowing into those villages. The PP team has not programmed these funds as a local contribution because: 1. The risk factor of investing in a totally unknown agriculture is too high to be acceptable to the villages; 2. This money is used in other community and private projects such as pharmacies, schools, houses, etc.; and 3. If the farmers were to rely on this money, financila control would lie in the hands of the select 20% of the village which is most wealthy thus raising serious equity problems.

Therefore, the PP team finds that the project offers an opportunity for AID to provide the needed capital inputs on an equitable basis in a time frame which meets AID's criteria.

When the PRP team studied the project in October, 1975, it was planned that the project would develop very slowly from its modest beginnings. However, due to the strong interest of the people and a push by SAED the program greatly accelerated. SAED, from its own budget provided bulldozers to clear stumps from fields and to build a nine km dike around the Bakel perimeter and a tractor and disk to break ground on 115 ha as a stimulus to the farmer groups. The farmers responded admirably to this stimulus and the PP team noted that their portion of the work: canals, bunds and leveling on 115 ha proceeded well. It was obvious that by utilizing a blend of mechanized and hand construction, an accelerated development schedule can be undertaken. The PP team carefully analyzed the labor requirements and availability (see section 3-A.(1) for construction and 3-A.(2) for agricultura') and reached the conclusion that an accelerated program is possible.

Request for Financing

The request for financing for the project in Bakel was received in July, 1975, from SAED. Conceptually there is no difference between the present project and the project as envisioned in July, 1975. Both this and the project request deal with the idea of small, village level, communally operated and managed perimeters.

However, over time, the scale of the project has changed considerably from a level of $3,100,000 for a 1,320 ha project defined in the PID of Spring 1975, to $2,600,000 for a 915 ha project in the July 1975 request from SAED to $1,345,000 for a 200 ha pilot project in the PRP of October 1975 to the present project of $6,671,000 for 1,800 ha. The evolution of thinking behind these changes is as follows:

1. 1975 PID - This was basically an identification of a potential project without a firm idea of what was feasible or likely but served to stimulate thinking about the project.
2. 1975 request - This request was submitted as a result of the PID team investigations. Costing and technical details were not precisely worked out and there was a very high investment in central infrastructure.
3. 1975 PRP - This team, while in the field discovered a potential flooding problem on several of the identified perimeters. Without any data on topography in the area the team was forced to consider a smaller project on areas where the farmers were able to say that floods rarely occurred.
4. 1976 PP - During the interim between the PRP and the PP, SAED got down to serious work on the project. They sent topographic teams to the field to determine diking needs and to perform detailed topographic surveys and mapping of areas being planned for the

1976 season. SAED contracted for bulldozers to construct one protection dike and to clear stumps from the lands to be farmed in 1976. It provided tractors with discs to break up the new lands. These activities allowed the PP team to judge the feasibility first, of providing flood protection with a reasonable chance of success at a reasonable cost, and secondly, of utilizing a mixture of heavy equipment and hand labor to accelerate the development process. As aresult of their review of the engineering, economic and human aspects of this accelerated development the recommendation to proceed with the 1896 hectares identified by SAED was made.

This evolutionary process took place both within SAED and A.I.D. and both are in agreement that the present project reflects the proper approach now. The current plans are backed by enough data and experience to allow confidence on both sides in the ultimate success of the project.

B. Detailed Project Description

1. Sector Goal - The development problem which this project addresses is how to maximize utilization of water resources, the scarcest resource in the Sahelian region, in order to increase food production. At the same time the project addresses a local development problem, that of immigration.

Better use of water resources is essential if food production in the Sahel is to be increased and agricultural development is to proceed. The rational and proper development of the resources of the Senegal River Basin is one of the highest priority items of the GOS, which views this development as a step toward alleviating a chronic cereal deficit situation while at the same time providing an attractive alternative to immigration. The problems associated with immigration are well understood by both the GOS and the people who are immigrating. Both can foresee in the future that this labor market may be closed to them and they are interested in developing an alternative to replace migration to France as a source of income for the area. They feel that agricultural development based upon a more technologically advanced methodology will provide a suitable alternative.

In order to reach the goal of maximizing utilization of water resources, considerable investment will be required beyond the present project. Larger scale projects keyed to the total development of the River Basin will be installed. The O.M.V.S. and the GOS plan future ventures in the Bakel area and the present project's impact upon the population in terms of introducing irrigation technology is extremely important to future development activities.

There are numerous improvements in the quality of life which will be necessary if agriculture, no matter how

advanced its technology is to be an attractive alternative to immigration. Health facilities, education facilities, access to the social and economic life of the rest of the country, etc., must be improved if the Bakel area is to be a more attractive place to live. The PP team did not contain the skills nor have the time to precisely identify all the activities needed on a priority basis to complement the agricultural activities. However, in discussions with farmers and officials in Bakel the following priorities appeared evident:

1. Transport and communications,
2. Education,
3. Health.

FAC is presently addressing the first priority and is considering an improved all weather road to Bakel from Matam. Further small investments in rural roads to improve dry season access to villages are also necessary but require close investigation to evaluate economic and social impact and define proper standards of improvement.

Education interventions, both formal and nonformal, are crucial to accelerated development in the area. At the present time any formal education beyond primary level is available only in St. Louis or Tambacounda. In order to encourage more advanced education for the youth of the region, a secondary and technical school should be considered. In the nonformal education areas, adult literacy,

hygiene, agricultural development and how the people relate to development need to be addressed. Promotion Humaine can provide the human resources to begin this nonformal education.

The health component of this project will serve as a pilot to indicate the potential for a widespread health intervention in the future.

¶2 .Purpose - The purpose of the project is to introduce the technologies of irrigated culture in 23 villages along the river in the Bakel area and to demonstrate the feasibility, both technically and economically, of irrigation in the area.

Small village-level perimeters of the type included in this project are considered to be phase I of the three phase development process. The process is based on an evolutionary approach to introducing improved technologies so that the farmers can understand and participate in the development process. The three phases are as detailed below:

I. Development of small perimeters (20-300 ha) based on village cooperative groups. These small perimeters will demonstrate the feasibility of irrigation and train the farmers in the management of the irrigation enterprise. The small perimeters are replicable with minimal outside assistance once the techniques are entrenched.

II. Development of middle sized perimeters (800-1,500 ha) based on inter-village groupings with each village having their own lands but with the need for some central management. These perimeters will provide the opportunity for villages not having suitable lands of their own to participate but will not require major resettlement of populations. Due to increased investment costs and more intricate organizational requirements these perimeters will require some outside assistance for replication.

III. Development of large (10,000 ha) perimeters utilizing advanced technologies and central management. These large perimeters may require some relocation of populations and will require intricate management organizations. Due to the advanced technological and managerial characteristics of these perimeters, they will require extensive outside assistance for implementation and management.

Present plans for the Bakel Area call for supplementing phase I actions which are underway now with possibly a medium sized perimeter within four to five years leading to a large perimeter ten years or more thereafter.

In the past SAED has concentrated on phase III developments and very large scale operations. However, during the past two years SAED has shown increased interest in the evolutionary approach. The Bakel region shows great promise as a testing ground for this concept as the social

organization and worldliness of the people lends itself to rapid adaption of the technology at village level. Also, the likelihood of village investments in replication and expansion of the phase I perimeters is high due to the availability of investment capital in the area. It is expected that the 1,800 hectares developed under the phase I program will be adequate to demonstrate the technology and its feasibility on a large enough scale over a big enough area to thoroughly acquaint some 20,000 persons with the potential.

3. Outputs - Three outputs are necessary to achieve the purpose of the project:

1. Introduction of improved practices for dry land crops,
2. Development of 1,800 ha of irrigated small perimeters in 23 villages, and
3. Improved understanding of the health situation in the area.

The first output is crucial, not only for achieving the purpose but also for achieving the second output. SAED is well aware that the people involved in the project put primary emphasis on their traditional subsistence crops and that, in the medium term, any irrigation works will be supplementary to traditional culture, not a replacement for traditional culture. Therefore, SAED wisely decided to work with the traditional culture as well as with the

village level irrigation system. Until such time as the people have faith in the irrigation system as having a lesser risk factor than traditional culture, they will not give up traditional culture for irrigation. Therefore steps to reduce the labor requirements and increase the yields of traditional crops are a necessary complement to irrigation activities.

The second output is a direct step to the project purpose. The creation of small village-level irrigated perimeters as a basis for developing the management capabilities within the village group is essential if the farmers are to be able to manage their own activities in the future.

4. Inputs - A) The major inputs for the agricultural portion of the project are as follows:

1. Technical assistance,
2. Land clearing and conditioning,
3. Village labor,
4. Pumps and hand tools,
5. Agricultural supplies,
6. Animal traction equipment,
7. Administrative infrastructure,
8. Administrative operating costs.

The detailed description of what is included in each of these headings is given in section 3.F of this paper dealing with the financial plan. The PP team agrees with SAED that these are the minimum inputs necessary in order to achieve the desired outputs.

5. Health Component:

Despite the American Public Health Association and AID PP Team's findings that no serious impact on the health or the environment is likely to occur due to the project, it is proposed to include two activities parallel with the production project, namely a health surveillance program and a village health program.

The health surveillance program can be conducted by the combined services of the Department of Parasitology at the University of Dakar and the Anti-malarial Service (Service de lutte anti-apaludique) based in Thies. Both of these services are under the direction of the Chief of the Department of Parisitology, Professor Samba Diallo, who is responsible to the Director of Health in the Ministry of Health. Thus, the surveillance portion of the project will be well integrated into the official ministerial and academic Senegalese system and the project will tend towards an institutionalization of such a health monitoring capability within Senegalese development projects. It is also proposed that an institution in the U.S. provide back-up assistance through periodic consultation to check field results and make statistical and other types of analysis of them.

The village health services program will be built upon the basic health structure now in place and will receive technical assistance from the AID Regional Health Office in ADO/Dakar.

a.) Description of Surveillance Program

The Parasitology Department is headed by Dr. Samba Diallo, a Senegalese parasitologist, who has within his Department which is part of the University of Dakar four physicians, specialists in parasitology, and four laboratory technicians plus secretarial support. This Department has all equipment and expertise necessary to monitor intestinal parasites, schistosomiasis and onchocerciasis. The Anti-malarial Service in Thies, which is part of the Senegalese Ministry of Health, is also headed by Dr. Samba Diallo. It has 40 personnel, 30 of which are technicians of various kinds, an entomologist, senior nurses, nurses, sanitary agents, laboratory technicians, etc. and has the capability of carrying on a malarial surveillance program. Indeed the service was created for that very purpose with a mandate to work on development projects, but is hampered by a lack of operational resources. Thus, the AID assistance for this program will be a happy marriage between the needs and capabilities of the anti-malarial service and the Bakel agricultural production project.

Both services under Dr. Diallo can provide surveillance teams which would make surveys for schistosomiasis, maleria, onchocerciasis and intestinal parasites in some 25 villages (23 villages in the project plus two other villages for control purposes). Out of some 12,000 people in the main villages,

a sample of 2,000 persons would be selected after making an initial census of the populations family by family. This will allow the surveillance regularly of the same persons and considering an average of 25 persons per carré, the team would take a sample of some 80 to 100 carrés, some participating in the irrigated field coops and some not.

After the initial survey, two surveys would be made each year, one at the end of the rainy season and one during the dry season. An institutional contract will be established with a U.S. institute or university to provide:

1) consulting assistance to set up the surveillance program;
2) yearly consultation to monitor field surveys, and analyze results; and
3) at the end of the fifth year to make a health evaluation of the project.

b.) Description of village health services program:

The village health services program will build upon existing Ministry of Health services in the Bakel area and will be implemented in the project villages.

At the present time there are about 10 dispensaries in these villages and a Health Center in Bakel. The distance between a village having no dispensary and a village with a dispensary rarely exceeds 5-6 km.

The program to be implemented under this project will aim at strengthening existing medical services to improve diagnosis and treatment of endemic diseases and to provide health and sanitation training in the villages.

In order to accomplish this the following activities are called for:

1. Retraining dispensary nurses in microscopy,
2. Purchase of 12 microscopes,
3. Training of 23 village sanitarians and 23 Maternal/Child Health Workers,
4. Training of village health workers for those villages lacking dispensaries,
5. Provision of basic drugs and medicines for each of the 23 villages.

c. Funding of Health Component

Funding for the health and surveillance activities are provided in the project budget (p 89). These activities will be managed by the ADO/Dakar Regional Health Officer (Dr. Vincent) and training of health workers can be coordinated with the Sine Saloum Rural Health Project which has a similar village level health delivery services emphasis. ADO/Dakar and the Regional Health Officer believe that GOS services under Dr. Diallo have the capability of carrying out the surveillance program outlined. Project implementation plans for these activities will be finalized on receipt of the final APHA Team Report, and funding adjustments will be made as necessary.

6. Peace Corps Involvement

ADO/Dakar has discussed with the Peace Corps Director in Dakar the provision of one Peace Corps Volunteer (PCV) for the project. His role would be coordination between the SAED activities and health activities. He will assist in making arrangements for the health surveillance and health services program, helping Senegalese counterparts to explain the purpose of these activities to the villagers and to popularize the recommendations of the health workers. For example, the PCV will promote canal clearing and lining as a preventive health measure. In cooperation with SAED he would attempt to identify and reduce ponding. Through regular contacts with villagers he can provide background helpful for the surveillance activity and follow up on items such as: setting traps for mosquitoes which the entomologist from the Thies based anti-malarial service under Dr. Samba Diallo will be programming; promoting improved sanitation practices; and helping villagers to budget for amortization of equipment. Both ADO/Dakar and the Peace Corps/Dakar are in agreement in principle to recruiting a PCV for this kind or role in the project.

Part 3 - Project Analysis

A. Engineering Analysis

1. General: The irrigation possibilities for the Bakel area are divided into three phases:

- Phase I : Small village-level perimeters 20-300 ha each,
- Phase II : Medium perimeters 800-1,500 ha each
- Phase III: Large perimeters 4,000-10,000 ha each.

The present project deals only with Phase I of the SAED program, small perimeters of 20-300 ha each based on

village management. The Phase I activities can in turn be divided into two parts:

a) Perimeters where no flood protection is needed,

b) Perimeters where flood protection is needed.

Several perimeters (290 ha) have been surveyed which do not require flood protection to meet the "threshold feasibility" standard established by SAED of flood free four years in five. 100 ha of these perimeters are planned for development in 1976. SAED has also surveyed a number of perimeters together totalling 700 ha which could meet "threshold feasibility" if protected by low dikes (less than 2 meters). These perimeters needing diking plus more of the ones not needing diking are planned for development in 1978.

At the same time SAED has identified another 910 ha in parcels located in other villages which show potential for irrigation either with no dikes at all or with low dikes. A detailed survey will be made of these perimeters to determine dike requirements in late 1977.

The present project plans to include about 1,800 ha of land in small village-level perimeters. The details of the status of plans for these hectares is shown in Table 1, Annex H. 986 hectares located around several villages have been surveyed for diking of which nearly 700 ha require less than 2 meter dikes and 290 hectares do not require dikes.

The remaining 910 hectares located around other villages will probably require about the same proportion of diking so for planning purposes we have used 700 ha to be diked and 210 hectares not requiring dikes.

2. Hydrology

Since the height of the flood and the amount, duration and extent of inundation is the basis for identifying areas for perimeters, and determining need for and determining the height of dikes, the methodology of determining the effects of the river flow hydrology on the land is of interest. The only stage recorder for the river in the Bakel region is the ORSTOM maintained stage located at Bakel. The topographic surveys are tied to that flood stage record. During the topographic surveys, SAED engineers interviewed farmers to determine probable flood heights and correlated the farmer opinions with the known flow elevations at the Bakel stage. The correlation of the Bakel perimeter farmer data, which lies close (about 5 km) to the Bakel flood stage guage, were very good. This generally confirmed that the farmers' memories were approximately correct. For those perimeter irrigation areas lying some distance from Bakel, it was assumed that the farmer memory data was similarly correct. The farmer experiences also indicated that the flood height elevations in the flood plains lying inland from the river were about one meter

lower than the flood flow elevations on the river. This is explained in part by the assertion of SAED engineers that the river crests for a short period, 3 or 4 days, after a precipitous rise, and the amount of flood flow up the marigot channels would not permit filling up the lower lying areas to flood crest height before the maximum flood crest elevation had receded. Thus a lesser flood level elevation would occur in the inland flooded areas. SAED engineers indicated that the main river would crest for about 3 to 5 days and thus confirming that the crest period may be too short to permit filling up of the inland flood plains. The flood flow hydrologist working for S.I.D. felt that a differential of one-half meter between flood height in the river and flood height in the marigots was more reasonable. (See Annex E.)

During an interview with Mr. Mohammed Curtin, a 40 year resident in Bakel, it was stated that up to 1966 the Bakel flood stage reading was about 13.5 meters and from 1967 to 74 or since the drought, the flood stage reading has been 7 or 8 meters. This indic tes that during the drought period and up to present the river may be flooding at lower elevations than would occur during a normal flood flow year. Mr. Curtin also stated that a similar drought and lower water stage elevation had occurred in 1939-45.

The discrepancy between SAED theories and the farmer interview data indicated that the PP team needed more

firm information before determining that the chances are good that the irrigation perimeters to be selected can be adequately protected from floods at a cost which is economically feasible.

The success of expanding the activity depends largely upon the probability that at least four years out of five the proposed irrigation areas will be free of inundation and damaging floods, or can be diked with low (2 meter) dikes. Therefore, AID contracted a hydrologist whose report is attached as Annex K. As a result of the hydrologist's findings and discussions with the SAED engineers and the economist on the PP team, it was decided that designing the dikes to a one year in ten flood level would be preferable in order to reduce the risks. Since the dikes are only a small part of the project, the increase in total cost was minimal and helps assure proper use of the remainder of the investment.

3. Plans and Specifications

The PP team visited the SAED headquarters engineering office in St. Louis where detailed topographic surveys for 12 perimeters totaling about 227 hectares have been completed. The topographic surveys were made to 10 cm contour intervals and are correlated to mean sea level elevations and the Bakel flood stage guage records. This permits a determination of the areas that may be free of floods based on the known hydrological flood level data.

The 10 cm contour intervals provide a suitable topographic map on which to plan and design the rice paddy irrigation systems. The SAED engineers are designing the individual paddies so that there is a maximum of 10 cm (4 inches) difference in elevation between field dikes. Under this design criteria, very little field leveling will be required. A 10 cm difference in levels of an individual rice paddy is tolerable to rice even at the maximum water depths. The field paddy design is an acceptable practice.

The SERDA (former CIDR) staff, as a result of experience in growing rice on these soils, determined that a 300 square meter paddy size is optimum and will adequately permit hand or animal traction cultivation (just being introduced). If mechanical tillage should be utilized, the paddy areas may need to be enlarged to permit efficient mechanical cultivation. For the present, the relatively small paddies will tend to reduce the amount of required field leveling. Since the soils are good, but more permeable than desirable for ideal rice lands, the small plots will help promote more efficient irrigation water application practices.

SAED engineers have planned and designed the main ditches and laterals to take advantage of the natural topography. The main canals are aligned along the general level of the contours and will require few major drop structures. The laterals cut across the contours and small

drop-turnout structures will be required in the laterals to prevent channel erosion and to provide water control. The water flow in the laterals will be relatively small. The SAED engineers will need to develop a small standard precast concrete drop and turnout structure that can be readily installed as required in the laterals. SAED is conducting a credible engineering job.

4. Pumping Stations

The majority of the irrigation systems will be supplied water from the Senegal River. Pumps will be installed on small rafts. This set-up has been tested for two years in the Bakel area and is operating satisfactorily. SERDA staff have recommended that two standard size Lister Diesel powered pumps (15 hp and 32 hp delivering about 150 and 300 M 3/h4 respectively) be used. As the areas to be irrigated expand or are adjusted, an appropriate sized pump or pumps may be used. A 15 hp pump will serve about 15-20 hectares and similarly a 32 hp pump will serve about 30-40 hectares. It is recognized that a specific pump should be designed to serve a specific sized area, but due to the flexible nature of the expanding activity, an exact sized pump cannot be fixed. Experience over two years indicates that the two sizes of pumps noted above will provide for most anticipated conditions. Under operation, this means that for smaller than ideal areas, the pump will not be operated for a normal period; for larger than optimal areas, the pump will need to

operated overtime. The systems are designed to be operated daytime hours only; thus there is reserve time for pumping additional water. When the irrigated areas expand beyond the largest optimal pump capacity, two pumps may be operated in tandem. The activity will have sufficient flexibility and spare equipment to provide for this "modus operandi."

5. Construction Methodology

The villagers are constructing all the facilities (canals, laterals, field bunds, drains and small perimeter dikes) by hand. Table 2, 3 and 4 Annex H show labor requirements and compare labor availability and requirements during maximum development. The villagers usually turn out in labor gangs of 35 to 100 about 5 or 6 o'clock in the morning and usually work for three or four hours. SAED recently provided two rented D-8 bulldozers which were employed to stump 115 hectares of proposed perimeters areas. The SAED equipment was utilized to remove the heavy stumps remaining after the villagers had conducted the light clearing and burned the small brush. The SAED stumping activity has encouraged the villagers to increase their irrigated hectarage.

It is planned that the dikes for the project will be constructed by a contractor arranged through SAED. SAED is experienced in contracting procedures and has demonstrated its ability to supervise construction activities in other projects in the Basin. The dikes will be constructed as "semi-compacted" dikes. Special compaction equipment will not be brought in to compact the dikes but

work will be done in such a way that the dike will be constantly traversed by the dozer. Since it is not expected that the dikes will be in serious danger from current erosion, rip-rap will not be used. The dikes will be made one meter wide with 2:1 slopes on the sides. The height of the dikes will vary from one meter to 2.5 meters depending on the contours of the land. Plans have been developed by SAED which are sufficient for construction.

SAED has three engineering technicians assisting the villagers with the field engineering layout of ditches, laterals and field bunds. The field engineering is adequate. The water delivery systems are being staked out and constructed according to the planned designs in eleven perimeters inspected by the team. The villagers, under SAED field technical supervision, were monitoring construction progress on schedule and it was asserted that the targeted planned hectarage for cultivation will be achieved. The villagers are conducting a satisfactory ditching and field bunding job. Experience will teach them that good initial ditching and bunding will significantly reduce maintenance.

6. Cost Estimates

Cost estimates are dealt with in detail in the financial section of this paper. The PP team determined the amount and labor requirements of construction of the main canal, laterals, field bunds, and drainage ways and the results are shown in Tables 2 and 3, Annex H.

It is noted that the amount of field work as estimated in SAED plans and designs are less than those estimated by SERDA staff. This confirms the statement of the SERDA staff that extra field bunding work will be conducted. The team believes that SERDA estimates are a bit high, but have weighed the average amount of work in their favor.

The average labor requirements data as collected from villages by the team correlates very closely with SERDA estimates as shown in Table 2, Annex H.

7. 611A Certification

SAED has developed plans and specifications for housing, warehouses and shop and has surveyed and designed over half of the irrigated perimeters in a very professional way. Based on this, a 611A certification can be given from both an engineering and management standpoint.

8. Detailed Analysis of Capability of SAED to Implement Activity from Planning, Design and Supervision Standpoint

SAED as noted above is carrying on adequate engineering plans and design program for the activity. SAED's chief designer is an expatriate Frenchman. He is overworked and has a small Senegalese staff. However, they are getting the assigned tasks completed. Management studies of SAED have been undertaken by Bureau d'Etudes et methodes (BOM - part of the GOS Presidency) and SATEC. These studies will indentify SAED's management strengths and weaknesses and develop recommendations for strengthening the management aspects. A Project Paper for an AID training project in SAED is being prepared.

In the Bakel area, SAED is sponsoring three SERDA technicians, a SAED representative, a field supervisor and three technical assistants. It is planned to increase the staff to provide a technical assistant to each village. For the moment, the staff is able to adequately stake out and supervise the initial construction work. Later, the technical assistant workload will increase as they are expected to assist with agronomic as well as irrigation practices. In addition to the supervising engineering staff, SAED has two mechanics in Bakel that have been trained by MATFORCE in Lister Diesel Motor maintenance and operation. The mechanics are training village employed pump drivers, who will be running the pumps. The SERDA staff is of the opinion that SAED staff will be adequate. This aspect will need to be evaluated as the activity is expanded this season and the next, to determine if in fact they can adequately conduct the necessary work. An initial small SAED staff will promote the villagers to do more of the necessary work and this will be good. The villagers must eventually be in full control and

and manage and run their irrigation systems without too much technical assistance from SAED if the activity is to be fully successfully installed and running.

9. Detailed Analysis of Capability of People to Implement Construction Portions of Activity

The field operations have been dealt with in detail above. The villagers are demonstrating the capability and will to conduct all necessary field construction activities except the larger dike construction which is beyond their capability and will need to be constructed with heavy equipment. Farmer construction activities are engineered and supervised by SAED staff. The PP team's analysis of the labor requirements indicates that adequate village labor is available to conduct all the construction activities envisaged in the initial years of the activity. (See table 4, Annex H).

10. Timetable for Implementation of Construction and Analysis of Whether Time is Reasonable

The timetable for implementation of the construction activities appears reasonable particularly in view of the adequate village labor supply. Two to three months is adequate time to implement the planned construction activity during the initial beginning years. These estimates are predicated on the basis that SAED will continue to provide heavy stumping and construct the major dikes. It is assumed that SAED's management capability will expand with progress of the activity.

11. SAED Phase II - Medium Sized Perimeters

The project under consideration only concerns Phase I. However, for purposes of future planning it is noted that SAED has identified for future irrigation perimeter development about 2,000 ha or more area of land lying along the river

adjacent the bridge about 1.5 kilometers north of Diawara. The land appears to be suitable for irrigation development. Land elevations determined near the area indicate that relatively low dikes would be required to adequately protect the area from flooding. The dikes constructed for the Phase I small perimeters would be utilized as a portion of the dikes for the larger perimeter. They would probably be made higher and strengthened to provide protection for the more entensive Phase II operation, but would not be rendered useless.

Further discussion concerning the suitability of area this large for irrigation is speculative until three steps are taken :

1) The results of the flood hydrologist findings regarding floods from the marigots to indicate the precise height and extent of the diking effort required to protect the area,

2) If the report of the flood hydrologist is favorable (i.e. indications of only minimal dike requirements) then SAED or an engineering firm will conduct a detailed topographic survey of the entire area proposed for irrigation and include enough of the surrounding zones to be able to plan and design the required dikes,

3) Utilizing the detailed topographic maps, a detailed irrigation land classification survey must be made determine the economic possibilities of those irrigable soils.

When the above steps are completed SAED will be able to determine if it has the capability to plan, design and prepare specifications for the entire job. There are no particularly significant problems envisaged when the above items are determined. The implementation and operational experience now being gained by SAED with its smaller perimeters in the region

will provide invaluable base data for planning, design and cost of the larger perimeter. If AID decides to consider funding Phase II activity, documentation for it might begin after the evaluation of Phase I in 1979.

B. Agronomic Analysis

1. General

The population of the area is almost totally subsistence farmers. They have survived on this marginal existence since time immemorial by planting dry season sorghum and millet and a sorghum crop under recession agriculture following the annual Senegal River overflow in September and recession in November. During this period sedimentation is deposited on land adjacent to the river banks and sufficient moisture is retained by the soil to support an average sorghum yield of 500 kilograms per hectare. Cultivator's inputs are limited to labor and seeds.

Sorghum and millet are planted under rainfed conditions on the sandy soil (dieri), further away from the river banks in June and harvested in October/November with average yields of 350 kilograms obtained under traditional methods of cultivation.

Traditionally, some rice was grown by the women in the swampy areas but suffers a total loss four years in five due to the vagaries of the climate. Some peanuts are also grown by the women of the area on the lightest inland soils. An average rainfall of 625mm (25 inches) may be reduced in certain years to less than 400 mm (16 inches) for long periods of time such as occurred during the drought years of 1965-1972. These often result in hardship to the population and loss in crops and livestock.

The climate is strongly influenced by the desert. Great variations may occur between peak day and night temperatures. An average temperature of 45° C in April, which is the hottest time of the year, will drop to 25° in January.

2. Soils:

The predominant soil types on the perimeters are fondé soils which constitute about 65% of the surface project area. These soils have up to a 44 % clay content. They are well aerated with good capillary action, permeability and drainage. They are irrigable and suitable for wheat, sorghum, peanuts, corn, cowpeas and vegetables. They have about 35% clay content.

The following summary is drawn from an OXFAM report on soils of the region. (Attached as Annex G.)

The soil types of the perimeters are as follows:

1. Heavy alluvial soils (51-60% clay), known as Hollaldés. They are found in perimeters along the river and in low-laying areas. They have fine-textured particles of low permeability and a PH of 6 to 8. About 10% of the perimeters are of this soil type which is irrigable and has slow drainage characteristics which makes it suitable for rice production.
2. Medium heavy soils (45-50% clay) content, known as (Faux Hollaldés). They are found adjacent to Hollaldés soil type. These soils are irrigable and suitable for rice, sorghum and cereal crop cultivation. About 30% of these perimeters are of this soil type.
3. Medium soils with (30-40% clay) content, known as Fondés. These soils are well aerated and have good capillary action, permeability and drainage. They are irrigable and best suited for wheat, sorghum, millet, peanuts, tomatoes and other vegetables but rice production is possible. About 60% of the perimeters are of this soil type.

Random borings of more than one meter depth made at these perimeters by pedologists of the Société d'Aménagement et d'Exploitation des Terres du Delta "S.A.E.D." and technicians of the Compagnie Internationale pour le Développement Rural "C.I.D.R." indicate the absence of hardpan at these depths. Also there are no salinity problems or salt formations at this time.

No detailed soil surveys have been reported made of the perimeters. However, the soils are fine textured with fair tilth, low to fair permeability and capillary action which are suitable for cereal crops production. They are probably deficient in nitrogen, phosphates and other minerals such as potash, magnesium and trace elements. Soil erosion due to lack of cover crops is evident in several places but not serious. Much of this erosion is caused by the heavy harmattan winds in March/April, the uncontrolled grazing by livestock and the Senegal River overflow and inundation.

Predominant use of primitive agricultural tools (daba) have been responsible for the conservation of the soil crust and limited disturbance of the soil surface with subsequent minimum serious erosion.

3. Crop Research Work:

Crop research has been carried out in the Upper Senegal River Valley since 1965. The Institut Sénégalais de Recherches Agricoles (ISRA) has an experiment station at Richard Toll where research work is carried out on rice, wheat, sorghum, millet, sugarcane and vegetables. Also OMVS/FAO/UNDP have three experiment stations at Guede (Senegal), Daedi (Mauritania) and Kayes (Mali). Research work at Guede which has Fondes type soils include wheat, corn, sorghum, millet and cowpeas. The Kaedi station at Vandam has a Faux Hollaldes soil type. Research is performed

there on wheat, rice, sorghum, millet,corn, forage crops and sugarcane. The Kayes station in Mali has a research program that includes wheat, rice, corn, sorghum, millet and vegetable crops.

The Institut de Recherches Agronomique et Tropicale (IRAT) and the Office de la Recherche Scientifique et Technique Out. -Mer (ORSTOM) collaborate with these stations in different phases of their research activities. Also the West Africa Rice Development Association and the West Africa Major Cereals Project work with these stations in developing, breeding and testing rice, wheat and sorghum varieties respectively.

Several semi-dwarf rice varieties including the I.R. line with a short maturity of 90 to 110 days have been identified and tested at these stations. These varieties have shown disease resistance, adaptability to the local climate and soils and high yields in excess of eight metric tons per hectare.

Semi-dwarf wheat varieties with a maturity of 110 to 120 days have been tested and have shown good adaptability, disease resistance, high yields and acceptability by the local population. Further testing for planting density, planting dates, fertilizer application, irrigation frequency, weeding, insecticide, pesticide and herbicide use and harvesting date experimentation are required. The Mexipak variety was reported to have given yields in excess of four tones per hectare at the Kaedi Experiment Station. Also semi-dwarf sorghum varieties tested at the OMVS Experiment Stations have given yields of three tons per hectare and Niebe varieties produced 2.5 tons per hectare while composite corn varieties of IITA (A and B strains) have given yields in excess of five tons per hectare. Crop rotation experiments with double and trible cropping patterns were successfully performed on the principal soil types at these stations as follows:

On Hollalde and Faux Hollalde Soil Types:

Wheat planted under irrigation in November and harvested in March. Upland rice planted under dryfarming conditions in June and harvested in October.

Rice planted under irrigation in November and harvested in March. Rice planted under dryfarming conditions in June and harvested in October.

Rice planted under irrigation in November and harvested in March. Sorghum planted under dryfarming conditions in June and harvested in October.

Rice planted in November under irrigation in November and harvested in March. Corn planted under dryfarming conditions in June and harvested in October.

On Fonde Soil Types:

Wheat planted under irrigation in November and harvested in March. Niebe (cowpeas) planted under irrigation in March and harvested in May. Sorghum planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Niebe planted under irrigation in March and harvested in May. Corn planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Sorghum planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Corn planted in June under dryfarmed condition and harvested in October.

A wide range of vegetable crops including okra, tomatoes, cabbage, Irish potatoes, sweet potatoes, eggplants, onions, carrots, garlic and salads are suitable in rotations between October and March.

4. Crop Varieties Planted at Perimeters:

At present, the following crop varieties and lines are planted at some of the perimeters, under dryfarming conditions:

Rice :	D 5237 (upland)
Millet :	Souna III
	Souna Gam
Sorghum :	CE 90
	CE 67
	Mali
	Soudan
Corn :	BDS
	JDS
	2 M 10

Also the following paddy rice varieties are grown by transplantation:

IKONG PAO

TAICHUNG

Fertilizer application is confined to rice with 150 kilograms of 18-54-0 applied per hectare. None is applied to sorghum and millet. However, animal manure is used when available.

Experience with the 1975 crop in Bakel and the 1974-75 crops in Matam indicated that the best results were obtained from Ikong Pao (4 T/ha average versus 2 - 2.5 T/ha for Taichung Native). Therefore, in the future it is planned to utilize Ikong Pao on a much larger percentage of the area.

To maintain conservatism in yield estimates the team has decided to make the following assumptions regarding yields:

	Beginning	Increasing to in 8 years
Rice	2.5	4.0
Corn (irrigated)	1.5	3.0
Sorghum (irrigated)	1.0	2.5
Niebe (irrigated)	.5	1.5

A changing yield is assumed because as farmers become more experienced with irrigation and irrigated culture and as improved varieties are identified tested and adapted the yields are certain to be increased. Past experience in the Guede and Matam perimeters conforms these assumptions.

Due to the uncertainty of acceptance of improved technologies absolute yield increases are not the goal of this project. Rather the emphasis of this project is to improve traditional culture in order to release additional labor for irrigated culture. The introduction of animal traction on the drylands as well as on the irrigated lands will do much to release labor. A small increase in yields on dryland farms is likely due to the efforts of CIDR and SAED. However, it is assumed that these increases will not result in increased total sorghum and millet production but rather in less hectares planted and more time spent in the more profitable and less risky irrigated farming.

A field trials station is recommended for the Bakel area, at a site tentatively selected by the CIDR personnel, four kilometers west of Bakel. An area of ten hectares earmarked for adaptive research experiments is suggested. This station will perform crop adaptability test, varietal trials, seed density tests, crop management experiments, fertilizer treatments, irrigation method applications, insect and disease identification and control, introduction of new crops such as wheat, lentils, chickpeas and other high protein pulses and cereals and their management. Research

and extension efforts should be coordinated to make maximum utilization of the station for farmer field days and demonstrations for villagers in the region.

5. Dry Land Interventions

The dry land interventions are planned to encourage improvement of traditional cultivation methods. The methodology of approach which has been used in the past and will continue is one of planting community demonstration plots based on the farmers groups in each of the villages. On these plots improved varieties of sorghum and maize will be demonstrated along with use of fertilizers, improved cultural practices and animal traction. This component of the overall project is essentially a technical assistance project with nearly all the costs being for the staff and technical experts. The PP team estimates funding of approximately $220,000 attributable to the dry land component. This cost is broken down as follows:

T.A.	$ 62,000
GOS staff	30,000
Vehicles	17,000
Housing	60,000
Operations	27,000
Equipment	15,000
Ag Inputs	7,000
	$218,000

Dry land demonstration plots will be undertaken in each of the 23 villages utilizing ag inputs provided free of charge by the project. Farmers will be trained in use of the improved technologies and encouraged to utilize these technologies on their own fields. The farmers showed great interest in possible improvement in their traditional farming methods as a complement to the irrigation activity.

6. Pesticides

The small, village level irrigated perimeter project under consideration is not viewed by SAED as a maximum production effort. It is aimed at increasing local food resources but unlike the major, large scale irrigated perimeters like Dagana and Nianga, is not a maximum production project. The systematic use of pesticides is therefore not contemplated in this project. If a serious insect or pest outbreak occurs, SAED will consult with the Crop Protection Service which is being supported through the AID financed Sahel Crop Protection Project (629-0916). Two AID entomologists are based in Dakar for that project and would be available for consultation.

C. Sociological Analysis (detailed report attached as Annex K)

1. Introduction

Social analysis of the project shows that it can integrate into the society of the Sarakolle who inhabit the project area and can respond to essential needs of the population. There is a common will evident among the farmers to organize themselves on the basis of village communities to make their region an example of modern agriculture. Already the local farmers have come to understand the need for joint organized action. The sedentary villagers involved in the project speak a common language and share a common ethnic identity. Thus, the project area constitutes a homogeneous region for development.

The SERDA technicians are well integrated into the local society and into SAED's operations. SAED itself, whose Director General comes from Bakel, is well motivated. The villagers place great hope and trust in the Director General as a "son" from Bakel. There is no question that the project already has had some impact on this traditional society and in the future its impact will become progressively greater. The villagers ability to adapt and to accept the changes progressively appears to be positive. The potential for a positive impact on women is present since for the first time women are working on a project on an equal footing with men within the cooperatives.

2. Operation of Cooperative Groups

A. Membership

All farmers and individuals can join the Cooperative groups which operate the village level perimeters. There is no distinction made with respect to sex, age or caste for admission into the groups. Each member brings his own work-capital (human investment). Every family in the village has at least one representative in the cooperative group. All castes work together and the group itself sets up its management

regulations and divides the group up into teams.

In many of the villages collective gardens have already been established. Members are satisfied with the workings of these collectives. Profits from these collective gardens are used as village funds to set up pharmacies, build dispensaries and schools and other village community projects.

What is remarkable in the village cooperative system as it operates so far is that the leaders are willing to keep village level rules flexible. They demonstrate a strong interest and desire in preventing cooperation itself from becoming an apple of discord. There is a strong feeling among the Sarakolle that investments derived from community undertakings will be used for the community as a whole and not for some privileged groups. Thus, the cooperative concept envisioned by the project fits into the community concept of the Sarakolle.

B. Motivating Future Members

There is motivation at several levels for future members. Dynamic individuals, who are aware of the economic advantages of modern agriculture, have been observed in the village groups. These individuals recognize the need for collective efforts, and understand the economic advantages irrigated agriculture will provide.

A second group of active participants is made up of those who are close relatives of the natural leaders. Other participants join because the cooperative group becomes "a village undertaking". Thus, one would be marginal in relation to the community if one did not participate in the work which elders had come to view as worthwhile. Thus, for most members the determining factors are of a psycho-sociological nature.

What might be termed creative competition between various villages has also taken root. Sarakolle villages tend to watch and rival one another. The construction of sumptuous mosques is an example. Working fields cooperatively benefits from this spirit.

Another motivation observed is the desire of cooperative members to apply new techniques on individually worked fields. In fact cooperative members seem to see their main advantage in applying new technology gained in the cooperative on their individual fields.

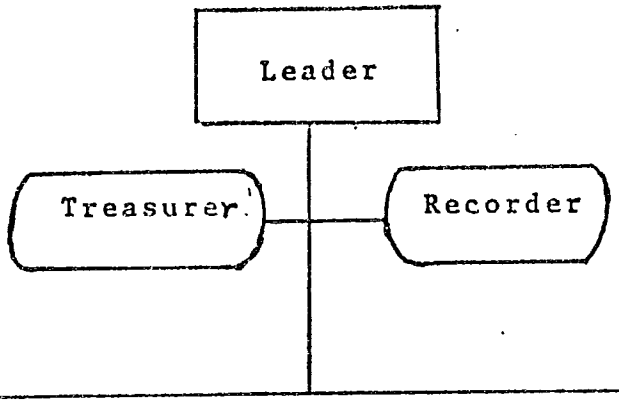
C. The Village Group Leaders

In six villages observed at random, four group heads were sons of chiefs. One group is headed by the nephew of a village chief and the sixth group is led by a member of the second most important family. Thus there is a reflection of traditional leadership pattern among the cooperatives. However, there is some innovation at the work team level. Work teams (averaging 5-7 in number) were observed both with an individual of slave ancestry (Thioubalo) and a member of the ruling family as heads. Most team leaders had travelled abroad (mainly Europe) and were chosen based on technical competence and education. This is somewhat of a departure from traditional authority structure among the Sarakolle. There appears to be a strong self-imposed discipline and team leaders are generally obeyed.

3. Project Impact on the Social Structure and Impact on Women

The project is an innovation in the Sarakolle environment. It is the first time that families of all social conditions and castes come together in a project for the whole community. New structures of authority departing from village tradition are appearing. These will be based on technical competency and ability as a team leader

1.



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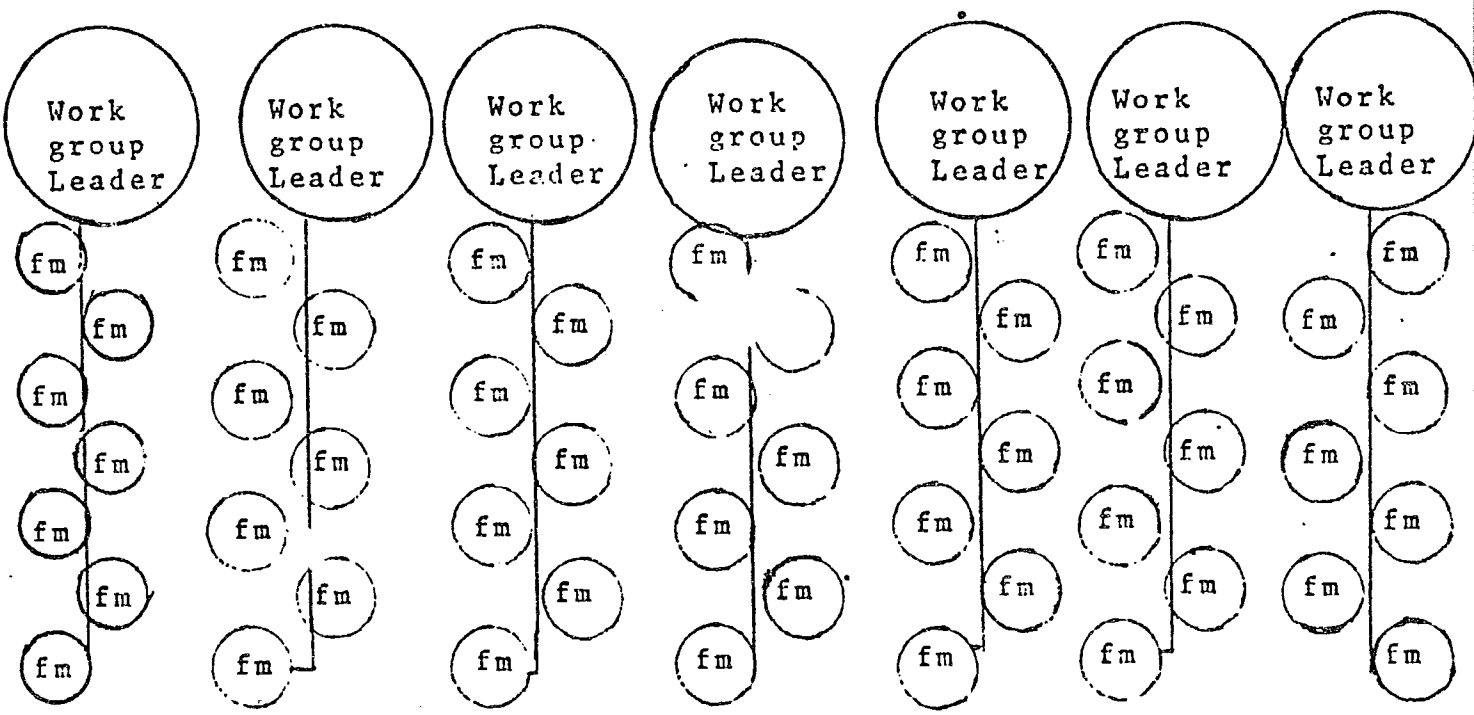


1. Leader - Liaison with Gov't
   Traditional Leader

2. Work group leader - advisory council
   - from all social classes
   - real control

fm = farmer

FARMER GROUP ORGANIZATION

and manager; factors not necessarily linked to the individual's birth status. Thus, working collective fields will become a matrix for experience which will evolve towards transformation of the societal structure.

Also, for the first time in the history of the region a project overlooking the sexual division of work is being undertaken. Women traditionally have been under the absolute authority of the men. However, the presence of women working alongside male heads of households will have long-term remifications on the structure of authority. The women will gradually realize that they play an equal role in the project and will formulate judgments on the overall society. The germ for a positive improvement of the conditions of women is present. This will be a gradual process. The women in the Sakaolle society bear a large labor burden with their days full of heavy labor such as water drawing, grinding millet, etc. The introduction of mechanical pumps under the project will illustrate their efficiency at moving water and the farmer groups will be encouraged to invest some of their returns in pumps for wells. Animal traction will also help to encourage practices which save labor for women.

Emigration from the project area to France, which has been the characteristic and traditional pattern, may not change in the near future because of the project. Almost all young men leave the Bakel area at age 14-16 to replace a brother or cousin in Europe. The relatively large amount of money which can be earned by emigration has been the impetus for this movement. Income from collective fields is too low up to now to rival the enticement of earning money in France or Dakar. After a

period of 4-5 years, however, there may be some slowdown in emigration.

4. Summary

Transformations of a sociological nature are extremely slow; almost unperceptable in the short term. Present day Sakarolle society gives a minimum of security to the individual at the least cost. The project can provide an extra margin of security. Sociologically speaking, deviant individuals are generally looked down upon in rural communities when they experiment with innovations that go wrong. Negative group feedback devices (ostracism, malicious gossip and loss of prestige and influence over other) come into operation. When an innovation is successful the imitative response of others in the community leads to broad-scale acceptance. Thus, positive and negative feedback mechanisms are critical. The present project already has begun this process and has the benefit of a gradual but successful initiation over the past two years. Sociologically, this bodes well for the project.

APPENDIX D

HEALTH INFRASTRUCTURE

I INSTITUTIONAL FRAMEWORK - GoS - ADMINISTRATIVE REFORM MODEL[1]

Admimistrative Structure and Technical Cadre

The structure of the Government of Senegal is shown in shown in Charts Nos. 1 and 2.

National Level: The Planning Council defines planning policy, options and objectives of the Plan.

Regional Level: The creativity in the model is the existence of the function for development within the territorial administration. This authority has been modified and reinforced by the law of February 1, 1972, called the "Administrative Reform."

Senegal is divided into eight regions: Cap Vert, Casamance, Diourbel, Fleuve, Louga, Senegal-Oriental, Sine-Saloum and Thies. Each region has a Governor who represents all ministries and acts as head of all Government officials employed in the region. However, technical ministries have their own regional inspectors.

Each region is divided into "Departments", each of which is administered by a "Prefect", placed under the authority of the Governor. Prefects have a role of departmental coordination, technical transmission and assistance to both rural and urban communities under its juridiction. The role of the prefect is well described thus:

> Almost all local administrative activities take place at the department level or lower. The head of the department, the prefect, is appointed by the president. He is the depository in his area of the

Chart No. 1

GOVERNMENT OF SENEGAL
INFRASTRUCTURE

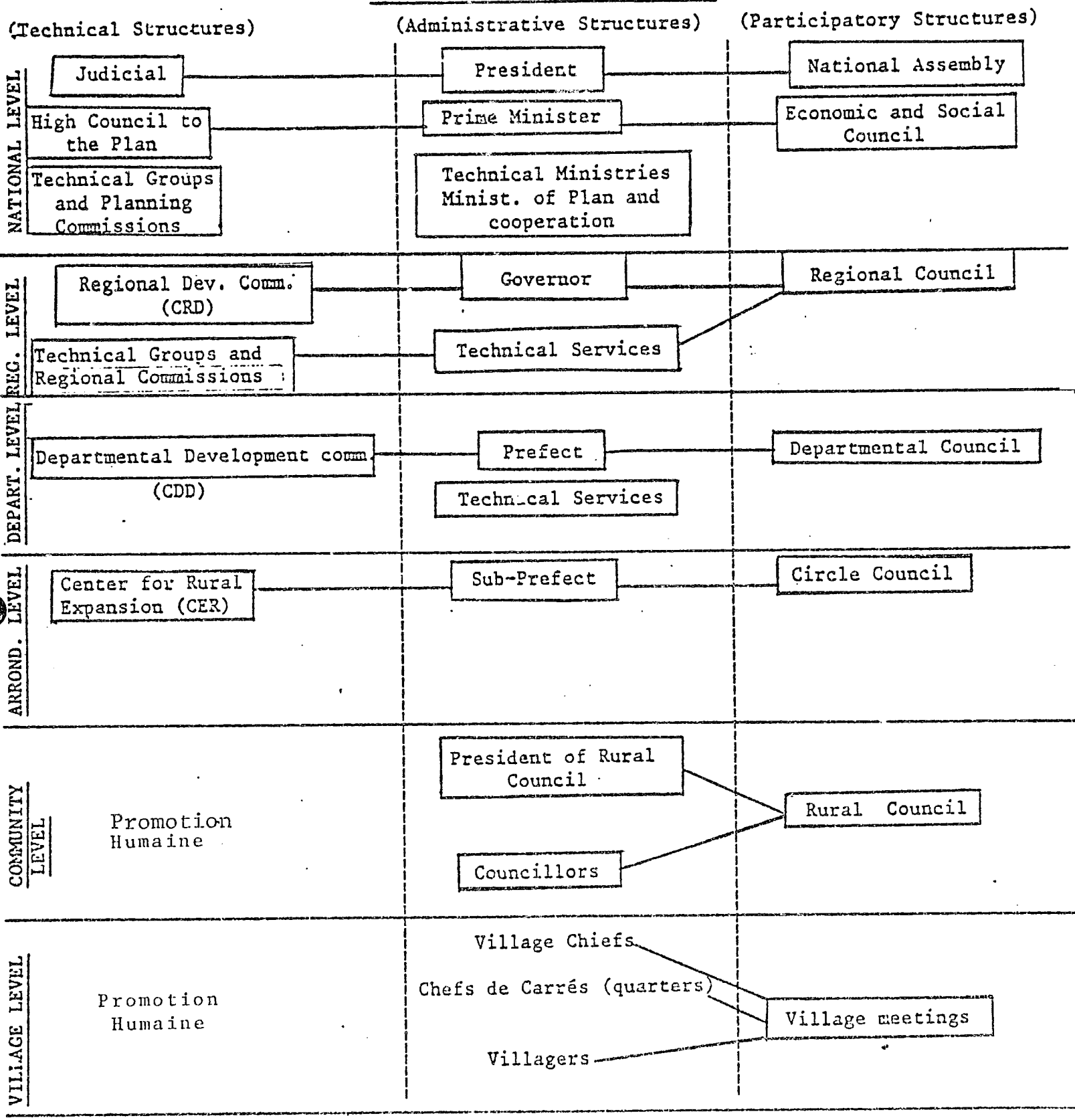


CHART NO. 2

REGION

Technical Structure	Territory Administrative Structure	Participation Structure
Regional Committee Development	Governor	Regional Council
-Technical Study of Projects -Assist in Regional Development Plan -Assist in Implementation of Regional Development Plan	Coordinates and controls Regional services re: economic and social development	Consultation for advice re: design & Regional Development Plan special requests

DEPARTMENT

Department Committee Development	Prefect	Department Council
Technical study projects Assists design department in programs Exam programs of the C.E.R.'s	Coordination and control of Services and Organisms in Department. eg. re: economic development. Coordination and control of Government employees in the Department	Consulted in practice eg. for setting up Department and Regional Development Program - special request - sets level of rural taxes

CIRCLE

Center for Rural Expansion	Subprefect	Arrondissement Council
-Technical study of projects -Assistance 1. Implementation of projects 2. Design and implementation of local projects with rural councils	Coordination; control of civil services in social and economic Development sectors. Assists rural Communities and controls Development activities in Regional and local planning	Consulted for advice on all actions dealing with investments and development concerning the circle- Special request

RURAL COMMUNITY

Promotion Humaine

1. Technical agr./ Production
2. Literacy training
3. Youth training
4. Environmental improvement of villages

President of Rural Council

Implementation of decisions of Rural Council

Village Chief

Implements Administrative decisions of Rural Councils. Support of development action decided by Rural Council. Collects rural tax and animal tax.

Rural Population

Rural Council

-Makes decisions re: management of rural communities

-Voices opinions on all development projects concerning the Rural Communities

> powers of the national government and again represents each of the ministers.'
>
> The prefect is the figure to whom local leaders look as the voice of the government. His is therefore the key post in the government's link with the people--the one upon whose success or failure any effort to introduce new ideas and progressive changes most heavily depends.

Departments are divided into arrondissements (circles). The head of an arrondissement is a subprefect. He is placed under authority of a prefect. He has the responsibility for promoting development in his circle and obtaining participation of the population. He exercises a monitoring and control function over the Rural Councils which are the representative organs of the Rural Communities. The subprefect controls financial management of the Rural Communities but, as budget officer for the Rural Communities, he is under management of the Rural Councils.

The Administrative Reform has created the Rural Communities which bring together several villages and are the basic organizational level of populations of rural areas.

Villages, i.e., several families or carrés close to each other are the smallest administrative cell. The "village chief" is appointed by the subprefect, and is under the joint authority of the subprefect and of the president of the Rural Council.

Content of the Administrative Reform

Deconcentration : administration structure

These measures increase the power of the heads of ad-

ministrative units. At the level of the arrondissement, the subprefect, with the Center for Rural Expansion (CER) over which he has authority, promotes rural development. The Department is a transmission organ (between the Region and Rural Communities) where the prefect has a team of trainers, whose task is to sensitize, to assist and train rural councillors.

Decentralization : participatory structure.

The Rural Community has "moral personality" and financial autonomy. Each Rural Community elects the Rural Council, of which two-thirds of the members are elected by the people and one-third are representatives of the cooperatives. This Council manages Community affairs. Financial resources come from rural tax (paid by each person) and from other taxes. The income from rural tax is allocated to the financing of local development projects, which are approved and voted for by the Rural Councils.

Technical Structure : the CER

Available to the administrative authorities (governor, prefect, subprefect) are Regional and Departmental technical services, the Representatives meet once a month. The CER is at the level of the arrondissement.

The Center for Rural Expansion is a service which contributes to the economic and social development of the Rural Communities; it is under the technical supervision of the Minister of Rural Development.

It provides technical assistance to the rural populations

for the implementation of local development projects. The CER has a budget provided by the national treasury for the implementation of specific projects.

The ideal staff of technicians in the CER is as follows: agriculture, livestock, forests, water resources, cooperation, sanitation, youth and sports, fisheries, and technical education. There are also women who teach home economics. Onee a month the head of the CER devises with the members of the team a plan of action.

Finally, the Services of the State Secretariat to "Promotion Humaine" are the vehicle that allows for interpreting the Village Health Program, suggested by villagers.

II MINISTRY OF PUBLIC HEALTH AND SOCIAL AFFAIRS

The organization of the Ministry of Public Health and Social Affairs is shown in Chart No. 3.

Regional Level

In each of the eight Regions, except the Senegal Oriental Region and the newly-created Louga Region, one finds a Regional Hospital which serves as a referral center for the Region and allows for treatment of the serious cases referred by the health facilities of the rural areas.

A study of the role played by The Bakel Hospital in the Senegal Oriental Region shows that the hospital treats only a very few of the cases that they normally might treat: the other cases stay at home without receiving vitally needed care.

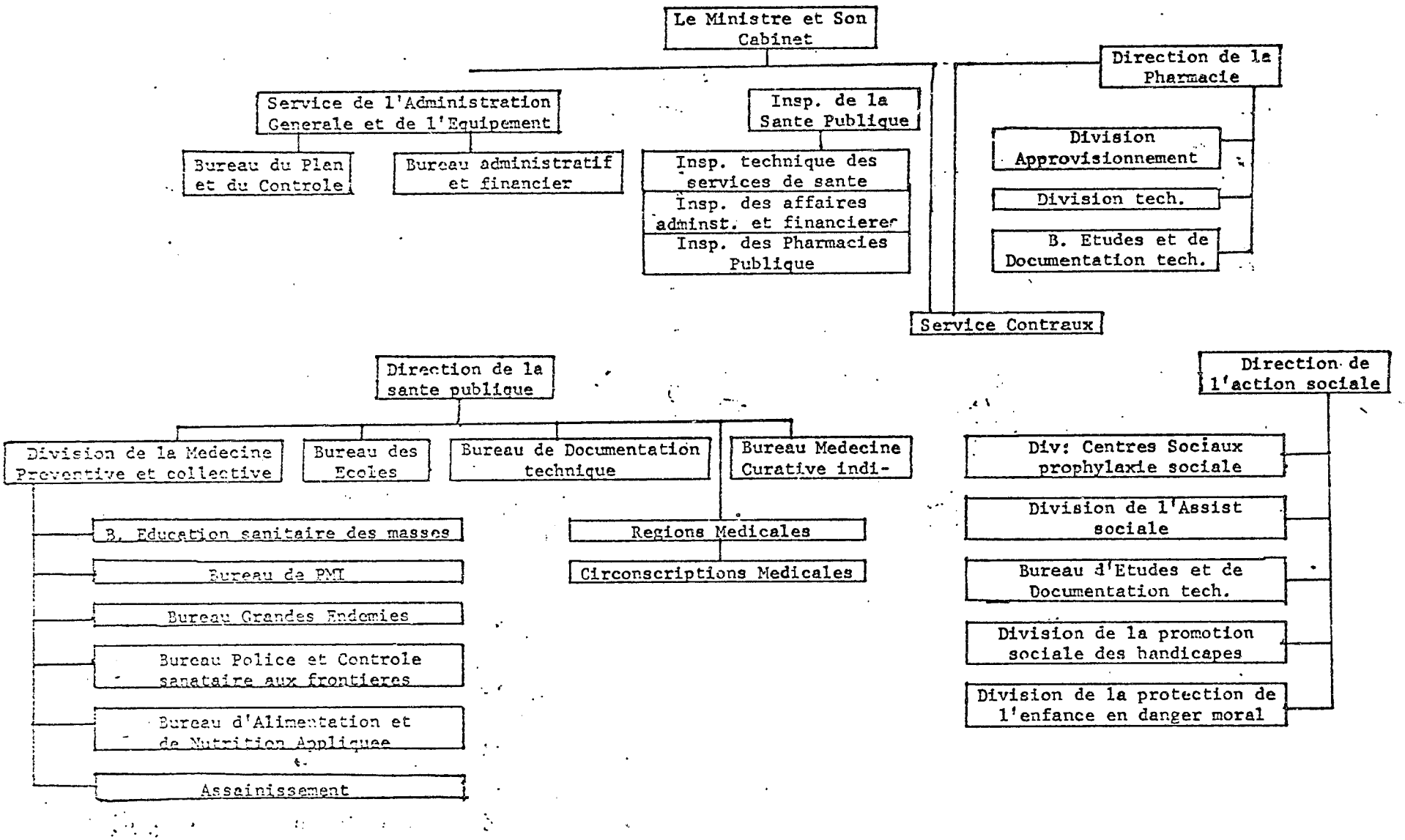
There is (on paper) in each Region a "Communicable Disease Control Service" (Service des Grandes Endemies) which carries out immunization programs. This Service does not provide total coverage of the population. It also does not seem to possess a well defined communicable disease control policy. Vaccine stocks in Bakel did not exist. Responsibility, in principle, covers prevention and surveillance of yellow fever, smallpox, measles, cholera and malaria. In the countryside, including the Bakel area, immunization reaches only a small number of children.

Rural medicine is the responsibility of a Regional Chief Medical Officer, who supervises health Services in the Departments (called "Circonscriptions Medicales" in the Health Services.)

Senegal Oriental's Chief Medical Officer has, in fact, lit-

CHART NO. 3

ORGANIZATION CHART OF THE MINISTRY OF PUBLIC HEALTH AND SOCIAL AFFAIRS (1975)



tle time for supervision since he is directly responsible for the Circonscription Medicale covering the neighborhood of the Region's main town, Tambacounda, and has clinical work in the Health Center (Centre de Sante) of Tambacounda as well.

Departmental Level

Each Circonscription Medicale (Depa tment) is equipped with one Health Center (Centre de Sante): a small hospital with 20 to 30 beds of which ten are maternity beds. It is directed by a physician, assisted by one or two midwives, and nursing personnel (Really only a small hospital.).

The Bakel Health Center which the Team visited has deteriorated and is very inadequately equipped.

Rural Community Level - Arrondissement

Health Posts are rural dispensaries located in the main villages of Rural Communities; in principle, each Rural Community should have one Health Post. These are two or three-room buildings with a covered terrace in front, with a total surface area of between 60 and 70 m^2. Those we saw were in a poor state of repair and badly deteriorated. None have running water and electricity. Water for cleaning and other uses comes from hand-dug wells, ten to twenty meters deep. Some health posts have a well on the premises, others are close to a well, and to others water has to be fetched from a distance.

Ministry of Health plans require staffing patterns in each of these Health Posts as follows:

1. One Infirmier d'Etat, i.e. a professional male nurse;
2. One auxiliary nurse, called an "itinerant worker" (agent itinerant) when working in the Health Post because his task is, besides assisting the nurse, to visit the villages of the Community once a month, note all epidemiological problems and report them to the nurse, to teach health education in order to prepare the population for vaccination campaigns, and to advise the population on hygiene matters; and
3. One laborer for cleaning and other heavy tasks.

In fact, in most Health Posts there is only a nurse. Because of the inadequate medicine supply, the Health Post lacks essential drugs 8 to 9 months of the year. Patients cease to come to the Health Posts as soon as they are aware of the lack of drugs.

It is interesting to note that in the informal morning meeting with the prefect, he mentioned the existence of a small but effective hospital operated in Mauritania across the river, staffed by Republic of China physicians, with ample stocks of drugs which they freely dispensed to all comers, including those who go there from the Bakel area. He emphasized that the availability of such quantities of drugs for distribution was quite a mystery, considering the difficulties of transport, crossing national borders, etc.

He was very concerned that sorely needed medical supplies and the most essential drugs are received in Bakel only twice a year and then in quantities estimated to be two-fifths of the minimal requirement.

III HEALTH MANPOWER PROBLEMS

Physicians: Most recent statistics (Dec. 1974) show a total of 281 physicians in Senegal 119 of whom (42%) are Senegalese. This means one physicians per 15,000 inhabitants. National averages should be interpreted in view of the concentration of physicians in Dakar: Cap Vert Region has 3,800 persons to a physician while Diourbel has 66,700 to one. Senegal-Oriental is even worse off in its ratio as shown in the Chart No. 4. Senegal-Oriental is the most underserved region. The Medical School at Dakar graduates about 30 students a year, of which ten are Senegalese. Efforts are being made to increase the number of Senegalese students. So far medical positions are limited in the Government budget and no solution is apparent that will soon bring a sufficient number of physicians to staff all the Health Centers in the interior.

Midwives: In 1974 there was a total of 330 midwives in Senegal. Almost two-thirds of these are located in the Cap Vert Region.

CHART NO. 4

HEALTH PERSONNEL OF SENEGAL (1975)

Reg.	Doctors				Pharmacists		Nurses		Midwives		Tech. Pers.	
	Public Health	Private Pract.	Total	Pop. per Doctor	No.	Pop. per Pharm.	No.	Pop. per Nurse	No.	Pop. per Nurse	No.	Pop. per Tech. Pers.
1	97*	33	130	4,276	13	42,753	449	1,238	95	5,850	868	640
	175	50	225	3,732	34	24,697	936	897	212	3,960	1,174	715
2	0	1	10	58,552	-	-	138	4,242	9	65,057	35	16,729
	20	-	20	33,082	1	661,640	330	2,002	16	41,352	116	5,703
3	0	1	11	51,042	-	-	111	5,058	10	56,146	43	13,057
	10	-	10	67,808	1	678,080	249	2,723	17	39,887	113	6,000
4	12	1	13	29,407	1	382,291	196	1,950	11	34,753	117	3,267
	19	3	22	18,884	1	415,448	317	1,310	19	21,865	97	4,282
5	4	-	4	41,397	-	-	60	2,759	2	82,794	16	10,349
	4	-	4	66,885	-	-	128	2,090	6	44,590	28	9,555
6	10	2	12	66,813	-	-	154	5,200	15	53,450	94	8,529
	11	2	13	65,783	-	-	305	2,803	26	35,891	129	6,629
7	11	2	13	37,513	-	-	113	4,315	9	54,185	71	6,868
	11	2	13	45,670	-	-	298	1,992	33	18,082	104	5,737
SEN.	153	39	192	18,341	14	251,533	1,221	2,884	151	23,321	1,244	2,830
	250	57	307	14,004	37	116,527	2,563	1,686	329	13,104	1,761	2,448

Regions: 1 = Cap-Vert; 2 = Casamance; 3 = Diourbel; 4 = Fleuve; 5 = Senegal-Oriental; 6 = Sine-Saloum; 7 = Thies
* First figure for year 1966, second for 1975.

Source: Rapport Annuel du Service de Sante, 1974.

The state school for midwives, located in Dakar provides a three-year midwifery course. The graduating class consisted of twenty-five students in 1973 and twenty-seven in 1974, all of whom were Senegalese. If one or two of the students were sent from, and willing to return to work in the Senegal Oriental Region, it would be possible to gradually increase the number of midwives employed there.

Nurses: Training of professional level nurses (Infirmiers d'Etat) is given at the Nurses' School of Dakar and lasts for three years. This school has graduated 40 to 50 nurses a year (of both sexes) during the last several years.

Training of auxiliary nurses is given in two schools:

(a) St. Louis offers a two year training course, mainly clinical, for a diploma of Agent Sanitaire, the equivalent of a "Health Auxiliary".
This school occupies an overcrowded old building, and could not take more students. Sixty students (of both sexes) are recruited in the first year; at the end of this first year ten male students enter the school of Khombole. With normal attrition, St. Louis delivers 40 to 45 diplomas at the end of the second year.

(b) Khombole: receives each year from St. Louis ten students who have completed their first year and provides a one-year course centered around hygienne, nutrition, sanitation, the practice of demographic surveys in villages, and prophylaxis of communicable

diseases. At the end of the year the students receive a diploma of Agent d'Assainissement (i.e. Auxiliary Sanitarian).

These students appear particularly suitable to ensure the needed contact between villages and Health Posts, i.e. the functions of "itinerant workers". It is unfortunate that budgets have limited the number of students in Khombole to ten per year. The functional title of Agent Itinerant is given to graduates of Khombole or St. Louis when they assume their tasks of visiting villages around a rural Health Post. Most national statistics do not distinguish between the professional and the auxiliary. Distribution of nurses in Senegal is better than for physicians. There are nine nurses per physician or one nurse per 1,700 inhabitants, if one includes both professional and auxiliary nurses.

Besides these national-level schools, there is in Dakar a school which trains nurses and midwives for teaching, supervisory and management functions. This school opens its doors to students interested in modern public health perspectives, and has been set up through the communal effort of all francophone countries in West Africa with the WHO's cooperation. It is the Centre d'Etudes Superieures en Soins Infirmiers (CESSI). Studies last two years. Each year about thirty degrees are given, of which several go to Senegalese nationals.

Pharmacies, Drugs and Supplies

The Central Pharmacy Service (PHARMAPRO), located in Dakar, is responsible for the purchase and distribution of drugs and supplies to the entire MoPHSA system. It is also charged with the inspection of pharmacies attached to private and public establishments. In addition, it is expected to implement the international conventions on narcotics . The funding, organization and manpower available to this unit presently do NOT permit it to fulfill ANY of these functions satisfactorily.

The provision of drugs and supplies to the Regions, especially to the rural health system, is particularly weak. The hospitals, which have physicians to speak on their behalf and strong contacts with the Ministry of Health, are able to obtain a larger allocation of the pharmaceutical budget. The Fourth Plan called for the formation of a new regional pharmacy to be located in Tambacounda to serve Senegal Oriental. As far as the Team has been able to ascertain, although the Fifth Four-Year Development Plan was approved in April, 1977, no new Regional pharmacy has been established in Tambacounda, the headquarters of the Senegal Oriental Region in which Bakel is located. Neither was information available as to whether the proposed pharmacy would distribute drugs to indigents -- currently being undertaken directly by the MoPh & SA in Dakar -- and also be authorized to sell them at cost (duty free) to the village cooperatives. If the latter is not the case, the Regional Pharmacy, even if established,

will have a very limited effect.

IV EXTENT OF SENEGAL'S GENERAL HEALTH PROBLEMS

The nature of preventive medicine and sanitation:

A summary sheet of the most current data available on both in- and out-patients' countrywide morbidity and mortality was given to the Team by the WHO Country Representative (see Chart No. 5), together with a copy of his "Country Profile". More time, resources, and contacts would be required to obtain figures that accurately reflect the present health situation than were available to the Team. However, WHO is currently doing just such a refined statistical study of health data for each region and the raw data for one region (which had already been completed but not yet processed) were seen during our visit to the WHO Country Representative's office.

Even more specific and detailed data will become available eventually as the intensive and extensive Senegal River Basin Study is carried out by Gannett Fleming Corddry and Carpenter, Inc. It will be noted that the Team met with Dr. Max Miller, Professor Emeritus of Parasitology and Chief of GFC & C's Public Health Team in Dakar.

Until such time as these more refined and complete data become available, the currently available data give an approximate and generalized picture of prevailing health conditions. This is not true of the organizational patterns provided describing the "Nature and Extent of Public Health

CHART NO. 5

THE TEN LEADING ILLNESSES

Categories: Out-Pt. Visits, Hospitalized, Deaths, Deaths from Communicable Diseases

Total Out-Pt. Visits 1975	1,753,220	100%	Total Hospitalized 1975	135,284	100%
Undiagnosed	191,795	10.94	Undiagnosed	24,828	18.35
Parasitic Diseases	503,409	28.71	Obstetrics	60,521	44.74
Respiratory System	400,282	22.83	Parasitic Infections	16,937	12.52
Digestive System	209,914	11.97	Respiratory System	8,928	6.60
Injuries	122,483	6.99	Digest. System	6,716	4.96
Diseases of Skin Tissue	89,167	5.09	Perinatal Morbidity	6,057	4.48
Nervous Sys.	81,951	4.67	Injuries	3,484	2.57
Obstetrics	64,864	3.70	Endicrin.-Nutritional	2,198	1.62
Orthopedic	25,326	1.44	Circ. System	1,217	0.90
Blood Dyscrasias	14,970	0.85	Genito-Urinary System	1,016	0.75
Genito-Urinary Sys.	14,521	0.83	Blood Dyscrasias	975	0.72
Total of the 10 Leading Ill.	1,526,897	87.09	Total of the 10 Leading Ill.	108,049	79.87

Total Deaths	13,412	100%	Total Deaths from Comm. Dis.			100%
Undiagnosed	2,466	18.39		Cases	Deaths	
Perinatal	2,941	21.93	Malaria	483,773	563	39.23
Parasitic Inf.	2,660	19.83	Measles	26,267	324	22.58
Digest. System	1,684	12.63	Tetanus	1,086	230	16.03
Blood Dysc.	814	6.07	TB-Resp. Sys.	2,691	145	10.10
Circulatory System	786	5.87	Cerebral-Spinal Meningitis	367	56	3.90
Resp. System	725	5.40	Diptheria	399	49	3.41
Endocrin.-Nut.	706	5.26	Whoop. Cough	25,208	23	1.60
Obstetrics	225	1.68	Icterus (Hepatic Malfunct.)	819	16	1.11
Injuries	111	0.83	Amoebiasis	3,926	9	0.63
Genito-Ur. Sys.	101	0.17	Typh.-Paratyph.	140	8	0.56
Total of 10	10,753	80.17	Total of 10	544,976	1423	99.45

Sources: Statistiques Demographiques et Sanitaires du Senegal - 1975

Services Presently Operating". However, charts of organization everywhere do not necessarily reflect the actual day-to-day "informal" workings of the entity described, nor in anyway aptly describe the problems of inevitable political and interpersonal relationships. The difference here is only one of degree; there is evidence from our field observations that there are large discrepancies between what actually exists and what is reported in charts and descriptions. Nevertheless, there is a consensus that the health infrastructure in Senegal is superior to those of other French West African countries. What does exist provides a nucleus around which could be built integrated health services that could be more cost-effective than the present precarious rural health structure.

V HEALTH INVESTMENTS

Both the WHO Country Profile and the USAID/Senegal - Sector Assessment list the Central Reorganization of MoH as the first project of Health Investments Under the Fourth Plan--Senegal 1973 - 77 but show no possible source of funding. The provisions of the Fourth Plan for the Health Budget, national, bilateral, and multilateral funding are shown in Chart No. 6. This same material indicates that careful planning is urgently needed to establish health priorities and thus make the most effective use of the very limited Health Manpower, Financial and Physical Plant resources, coordinating their development with other sectors of the economy in relation to projected population growth.

The recently completed Fifth Four-Year Development Plan was not available.

VI HEALTH SERVICES IN THE BAKEL DEPARTMENT

a. Department Level

Health services in the Department emanate from the Bakel Health Center under Dr. Ly, Chief, Circonscription Medicale. Its staff is comprised as follows;

1 physician

1 midwife

2 registered nurses

1 agent technique medical (trained for specialized task)

CHART. NO. 6

HEALTH INVESTMENTS UNDER THE FOURTH PLAN; Senegal 1973 - 77

TITLE OF PROJECT	POSSIBLE SOURCES OF FUNDING	73-74	74-75	75-76	76-77	TOTAL
Central Reorganization of MoH	--	--	--	--	--	--
Remodeling of Existing Facil.	*BN-UNICEF	50	63	83	13	209
New Facil. - Health Posts and Centers	BN-UNICEF, URSS	47	54	93	123	317
Logistic Support	BN-UNICEF, FAC	38	35	34	32	139
Basic Health Service Development	BN-UNICEF	15	11	13	16	55
Fragile Vaccines	USAID-FR, USSR	14	16	17	16	63
School of Nursing	Unknown	--	250	--	--	250
Fight Against Leading Diseases	FAC	25	35	10	10	80
Nutrition Protection Program	BN-UNICEF	19	6	3	2	30
Central Public Health Lab. Fight Against TB	BN-Canada	121	--	--	86	207
Regional Pharmacies	BN-Unknown	4	4	18	18	44
Regional Public Health Labs.	BN-FAC	--	32	16	22	70
Blood Bank	BN-FAC	17	9	8	--	34
Dental Care	BN	9	2	11	14	36
Psychiatric Assist.	BN-ENAS, Royar Club	20	16	--	--	36
Social Centers	BN-UNICEF	2	55	44	55	156
Cobalt Bomb	FAC	--	16	--	--	16
Environmental Sanitation -Somone and Nougowna	BN-FAC, FAO or FED	5	11	25	14	55
Kaolack Hospital	BN	--	29	--	--	29

Note: Units of Millions of CFA Francs.

*BN = Banque Nationale

CHART NO. 6

(Continued)

TITLE OF PROJECT	POSSIBLE SOURCES OF FUNDING	73-74	74-75	75-76	76-76	TOTAL
Hospital Complex Fleuve Area	FED-BN	490	244	195	122	1040
Tambacounda Hospital	FAC	--	--	--	150	150
Diourbel Hospital	W. Germany	--	--	--	60	60
Zinguinchor Hospital	FAC	--	--	--	150	150
LeDantec Hospital Stomatology	BN	7	--	--	--	7
LeDantec Hospital -Laboratory	BN	32	25	32	25	114
Pediatric Ward at Fann	BN-Can.	261	--	--	--	261
Doctors' Offices, Hospitals at Thies and Diourbel	?	--	20	15	--	35

FUNDING OF SENEGAL'S FOURTH FOUR-YEAR PLAN
(in millions of CFA francs)

SOURCE OF FUNDING	FY 74	FY 75	FY 76	FY 77	TOTAL	IN $
National Budget	280	323	226	150	979	4 mill.
Multilateral Aid	533	254	235	169	1,191	5 "
Bilateral Aid	363	392	156	513	1,424	6.4 "
	1,176	969	817	832	3,594	16.4

3 agents sanitaires

1 auxiliary nurse (female)

2 matrons

The patient load averages 100 patient visits per day (40 new and 60 old) but can be as high as 200 per day in the rainy season. There are about 30 deliveries per month, none being caesareans. Serious and complicated cases are flown to Dakar for treatment.

The annual budget for medicines, supplies, and equipment is reportedly one million CFA francs and has been unchanged for the past 10 years. It is equivalent to a mere 10 CFA francs (4 cents) per person per year.

The budgeted amount for administrative purposes is reportedly 500,000 CFA francs and is used mainly for staff salaries. Because of its gross inadequacy cleaners of the health center and the village health posts have been laid-off and the buildings are in a very poor state of cleanliness and disrepair.

The Services des Grandes Endemies is represented by a single nurse in Bakel. He is in charge of the Arrondissements of Ololdu and the Commune of Bakel. Instead of the car that is the normal provision for the post, he has only recently been provided with a mobylette and a meager gasoline allowance of 20 liters per month.

He has been supplied with an old microscope and a few slides but no stains. Hence he is unable to do microscopic examinations for malaria, tuberculosis or leprosy.

He occasionally examines stools for parasites.

The nurse is in charge of treating 72 lepers in Bakel, and 258 in the Arrondissement. Rifampicin has been recently introduced for the treatment of leprosy but is not available and DDS is the only drug used. Tuberculosis cases are flown to Dakar for diagnosis and prescription. Treatment is carried out in Bakel and in the five village Health Posts of Muderi, Diawara, Golmi, Vafera and Balou, by the nurse.

Syphilis is treated only if patients can afford the $16 cost of the drugs in a pharmacy: Benzathin penicillin plus Bismuth injections, according to French traditions.

There is no evidence that this nurse has any guidance or support on epidemiological surveillance of his region, and problems like malaria, schistosomiasis and onchocerciasis are not given any organized attention.

This situation represents the rule rather than the exception. Remedial measures should include community organization and the use of village health workers. This requires solving the logistics of drug distribution and sale, revising of the Senegalese legislation to remove commonly used safe drugs from the list requiring prescriptions and authorizing them for general sale through commercial channels.

b. Village Level

The villages are served by 12 health posts or rural dispensaries, generally manned by one person as shown below:

Balou: 1 agent sanitaire (auxiliary nurse)

Vafera: 1 auxiliary nurse specialized in surgery

Golmi: 1 infirmier decisionaire--trained on the job

Diawara: 1 registered nurse

Muderi: 1 auxiliary nurse specialized in surgery

Gande: 1 agent sanitaire when trained

The patient load in the Diawara and Golmi health posts averages 30 persons daily and is similar to those of the 30 posts throughout Senegal-Oriental, see Chart No. 7.

The physical facilities are generally in a state of disrepair, furnished with a bench and table. They are provided with no supplies.

VII ASSESSMENT AND FINDINGS

Sustaining the Villagers' Confidence

The importance of sustaining the confidence of the villagers is stressed in the Project Paper. It was the consensus of opinion of all USAID/Senegal authorities interviewed that the essential feature of maintaining confidence is for all involved NOT to be "heavily dependent on governmental support for operating expenses." It cannot be overemphasized that this was concurred in fully by the Prefet du Departement de Bakel when the Team met with him. The Team that developed the PP also stated that most (but not all) activities to be carried out under this project require"...internal self-sufficiency, individual farmer autonomy, and reliance on village cooperatives."

CHART NO. 7

HEALTH/SANITATION INFRASTRUCTURE OF SENEGAL (1974)

Regions	H	HEALTH CENTERS			HEALTH POSTS			MATARNITIES			P.M.I.		
		Accessible Population	NB	R	Access. Pop.	NB	R	Access. Pop.	NB	R	Access. Pop.	NB	R
Cap-Vert	4	843,119	1	13.2	13,599	62	1.7	11,263	17	3.2	5,695	24	2.7
Casamance	1	113,772	6	38.8	7,938	86	10.2	19,379	8	33.6	15,808	7	35.9
Diourbel	1	116,766	6	42.2	15,923	44	15.6	17,679	9	34.5	18,928	6	42.2
Fleuve	1	106,886	4	59.3	6,578	65	14.7	16,183	6	48.4	11,551	6	48.4
Senegal-Oriental	-	89,820	3	79.5	8,982	30	25.2	20,399	3	79.5	14,560	3	79.5
Sine-Saloum	1	99,800	9	29.1	10,822	83	9.6	20,399	10	27.6	14,560	10	27.6
Thies	1	122,875	5	20.5	10,778	57	6.1	19,933	7	17.3	9,959	10	14.5
SENEGAL	9	130,469	34	42.9	10,364	428	12.1	16,790	60	32.31	10,895	66	30.8

R. = Average Radius of Coverage
P.M.I. = Sanitation Programmation Throughout the Country (Programmation Sanitaire pour le Pays)
NB : In 1974, Senegal Contained Only 7 Regions; It Was In 1976 That Diourbel Split Into Two Regions (Diourbel and Louga) to Make a Total of Eight.

Sources : Rapport Annuel du Service du Sante, 1974.

The Region of Senegal-Oriental may be called "the end of the line", and is at the bottom of every list in terms of distance from and communication with the capital (accessibility), population density, health facilities and technical resources as well as GoS financial support. With this in mind and in recognition of the hardships and expense of travel, it is easy to understand the people of Bakel's reluctance to depend very much on their government. Supervision from Tambacounda, shown on the organizational charts, is most inadequate and in practice consists of a brief visit once or twice a year at most. There is no telephone or other means of communicating on a regular basis.

Despite the commendable determination of the Sarakolle people, reflected in their practical insistence on self-sufficiency, there are in addition some needs for better provisions of technical and professional health services from the GoS to supplement the "boot strap", self-help, operational aspects of the irrigation projects.

Intensive and concentrated health education is an absolute requirement in order to gradually achieve confidence in the use of the VHP for broader health services first, and then, through such use, bring about a more judicious and cost-effective distribution of medication. This will come about as a result of the guidance provided by trained health workers. Discussed elsewhere in this report and closely related to this point, is the need for radio communication between these Posts and the Bakel Health Center

and later, the Tambacounda Hospital for continual contact and access to professional advice and direction.

Overview of Health Infrastructure and Related Problems

This selective overview of the health infrastructure reveals several problems which are common to all developing countries (and even the U.S. to a certain extent, since the deficiencies are a matter of degree). In both facilities and manpower there exists a severe maldistribution of resources which favors the capital city and urban areas at the expense of the rural areas where the majority of the population lives. Severe shortages of manpower exist in almost all the health professions. Supervision is either inadequate or lacking entirely in and around the Bakel area of the Senegal Oriental Region.

These conditions will continue to hamper any major expansion of the health delivery system and even if the budget was available, it is not sure that improvements brought forth by remedial work would advance at a faster pace than the rise in demand and population. This is why a solution has to be found that would follow ways different from those of the past and which would use all existing sources and structures, which, though admittedly imperfect, are nevertheless openly oriented towards regional development.

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APPENDIX E

DISEASE SITUATION

1. Review of Existing Situation

Little reliable morbidity and mortality data exist for the Bakel project area. A malaria survey in 1968 is the only epidemiological study reportedly undertaken in the project area. Figures on the disease situation quoted in other reports about the Bakel area must therefore be assumed to be educated guesses based on data from other areas of the country or else they were derived from data of clinical observations made at the Bakel hospital.

There are no laboratory facilities in Bakel. The nurse assigned to the area under the Service des Grandes Endemies at times does some rudimentary laboratory work, mainly stool examinations, at the request of the Doctor in charge but his equipment is limited to an ancient microscope and a few slides, and does not permit him to do any examinations for malaria or schistosomiasis.

This nurse's intended duties are the carrying out of infectious disease surveillance activities in the arrondissement of Ololu and the Commune of Bakel, which together include the entire Bakel project area. His activities in this respect have, however, been nil during the past four years due to the lack of transportation among other reasons. Instead, he has been providing nursing services at the hospital in support of the Doctor, and the treatment of some leprosy patients. This nurse seems to have been totally forgotten by his district headquarters in Tambacounda who have given

him very little guidance or support of any kind.

An examination of the daily case register at the Bakel hospital revealed that approximately 75% of the patients seen were diagnosed as having malaria. The remainder of cases were recorded as diarrhea, schistosomiasis, or some type of injury. From this register and from conversations with medical personnel and villagers, it would seem that the main disease problem in the Bakel area is malaria.

The malaria survey of June 1968 was undertaken by the Service de Lutte Antipaludique (SLA), the malaria control service of the Government of Senegal. Spleen and blood examinations of one to nine year olds were done and the results for the villages of Golmi and Kounghani are shown in Table 1. These results indicate that malaria in the two villages is approaching hyperendemicity. Similar results were obtained by the survey in other villages throughout the project area.

The Senegalese government has a nationwide program of chloroquine distribution which is of two parts, viz. prophylaxis and chemotherapy. Both parts of this system have failed to operate satisfactorily throughout the country due to various economic factors but the situation appears to be even more serious in the Bakel area because of added difficulties with transportation. At the time of our visit we were unable to find a single chloroquine tablet anywhere in the project area; this includes village pharmacies,

TABLE 1

SUMMARY OF MALARIOMETRIC SURVEYS AGES 1 - 9

GOLMI AND KOUNGHANI JUNE 1968

	Golmi	Kounghani
Total no. slides examined	40	40
Total slides positive	24	30
Percentage of pos. slides	60.0%	75.0%
Positive slides by species		
P. falciparum	22	28
P. ovale	4	8
P. malariae	0	1
Mixed infections	2	7
Spleens examined	43	40
Positive spleens	20	25
Spleen rate	46.0%	62.5%
Average enlarged spleen	2.0	1.6

government dispensaries, and even the Bakel hospital. The failure of this system to get the needed chloroquine to the villagers is a major health problem. Evidence shows that if prophylactic supplies reach the villagers during the wet season the number of cases occurring during that peak season will fall markedly. At this point in time prophylaxis remains the most effective method of controlling malaria in Africa.

Schistosomiasis is considered to be of secondary importance in the Bakel area probably because it is usually chronic and is more difficult to diagnose clinically. A program under the direction of Dr. Junod of the Services des Grandes Endemies proposed to do a thorough survey of school children in the Bakel area to determine the level of schistosomiasis prevalence and to locate disease foci. This program has not yet reached the Bakel area but a similar survey conducted by Dr. Junod in Tambacounda showed a 34.9% prevalence rate for S. hematobium among school children.

The consensus among medical personnel in the Bakel area is that only urinary schistosomiasis (S. hematobium) exists there. This view is also supported by Dr. Watson in a WHO report[1] which gives a prevalence rate of 22% in the Bakel area. The source of this information is, however, not identified.

The third disease of concern in the Senegal-Oriental Region is onchocerciasis. Information compiled by Dr. Junod

based on clinical and entomological studies has set the northern limit of distribution of the vector of onchocerciasis, Simuliun damnosum, as Neyes which is about 30 km along the Faleme River from the Southernmost village in the Bakel project area.

Our observations, which were confirmed by Dr. Junod, are that the Sénégal and Faléme Rivers in the Project area provide no suitable breeding sites for S. damnosum and therefore it is unlikely that onchocerciasis will extend into the area from the south. Furthermore, it is most unlikely that the intermittent low rate pumping of water from the river for this project will create a suitable environment for the development of S. damnosum.

Among other diseases of importance mentioned by Dr. Ly, the doctor in charge of Bakel hospital, is Asian flu which apparently caused high mortality in a number of villages when introduced by some pilgrims returning from Mecca. He also identified measles as a problem particularly because it usually appears in the hot season and causes great discomfort. Reference was made to a cholera outbreak that occurred in 1971. However, there has been no further occurrence since.

Another major health concern in the area is the lack of an immunization program. This falls under the responsibility of the Services des Grandes Endemies which has undertaken no programs during the past two years.

Of particular concern is the lack of yellow fever vaccinations in the area since 1965. This indicates that the number of susceptibles in the area is enormous and the possibility exists that a major epidemic of yellow fever could occur at any time. At present Bakel is allocated only 100 doses of yellow fever vaccine per year and these are specifically for the 100 pilgrims who are chosen to go to Mecca.

To any observer it is obvious that the general disease problem in the Bakel area is enormous but that the health infrastructure as it now exists seems totally incapable of dealing with the problem. Hopefully more surveys will be done in the future, similar to those undertaken by Dr. Junod, to define the problem more precisely.

2. Field Studies

Field studies of two types were undertaken by the Team in the Project Area, viz., (a) epidemiological surveys and (b) entomological surveys.

a. Epidemiological Surveys

i) Methodology

The purpose of these surveys was the determination of prevalence rates of malaria and schistosomiasis. These rates were intended to provide comparisons with the previously reported information and serve as baseline data for future surveys.

It was decided to survey two villages, one with an operating irrigation perimeter and the other without. The latter village was intended to serve as a control. Other criteria for the selection of the villages included their similarity in size, geography and relationship to the river. Kounghani (population approx. 1,100) was selected as the village with a perimeter, and Golmi (population approx. 1,600) that without one.

By means of a random selection of carrés (family groups) within each village a potential subject pool of 300 persons per village was selected, using the Chief's tax register. From this pool, those persons to be examined were selected, approximately 200 for malaria including 100 for schistosomiasis in each village. Consultations were held with the Carré Chiefs to identify the selectees, inform them of the surveys and seek their participation. The schistosomiasis selectees were given urine containers and together with the additional malaria selectees asked to report the following day at a selected central point for examination. The urine samples were then collected, and blood smears and spleen palpations undertaken on all in attendance. The attendance of 181 persons in Kounghani and 149 persons in Golmi out of the selected 200 in each case is an indication of the success of the selection procedure.

The malaria slides were stained in the field and brought to Yale University for miscropic analyses.

The urine samples were filtered, stained with ninhydrin and heat dried in the field.[2] The stained filter papers were examined at the San Juan Laboratories of the Center for Disease Control (CDC) for the presence of S. haematobium eggs.

ii) Results

(a) Malaria

The parasite age-sex specific prevalence rates for Kounghani and Golmi are shown in Tables 2 and 3, respectively. The prevalence rates for all ages are seen to be 39.4% and 18.6% for Kounghani and Golmi, respectively. A comparison with the 1968 survey is not possible since that survey was limited to the 1-9 age group. A comparison of the rates of the two surveys in the 1-9 age group is however possible and is shown in Table 4. Such a comparison shows that while the difference in the rates for the villages in 1968 (75% to 60%) is not significant, that of 1977 (52.8% to 22.4%) is indeed significant). However, in the absence of pertinent data in the years immediately preceding 1977, the inference cannot be drawn that the difference is due to the introduction of the irrigated perimeter in Kounghani. Additional studies are required to monitor the differences and the effects of various influence factors other than the perimeter. Indeed the generally intermittent nature of the irrigation practice, the frequent drying out of the fields at relatively short intervals (under 1 week), the distances of the perimeter from the villages and the relatively minimal water retaining areas of the perimeter in comparison with the naturally occuring water bodies all tend to indicate that the effect of the perimeter will be insignificant.

TABLE 2

MALARIA AGE-SEX SPECIFIC PREVALENCE (PARASITE) RATES

KOUNGHANI (POP. 1,095) APRIL 1977

Age Group	MALES			FEMALES			BOTH SEXES		
	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive
< 1	0	0	0	1	1	100.0	1	1	100.0
1-4	16	9	56.3	12	6	50.0	28	15	53.5
5-9	23	11	47.8	21	12	57.1	44	23	52.3
10-14	10	3	30.0	13	8	61.7	23	11	47.8
15-19	8	6	75.0	7	2	28.6	15	8	53.3
20-29	7	1	14.3	15	3	20.0	22	4	18.2
30 +	9	1	11.1	33	6	18.2	42	7	16.7
All Ages	73	31	42.5	102	38	37.3	175	69	39.4

TABLE 3

MALARIA AGE-SEX SPECIFIC PREVALENCE (PARASITE) RATES

GOLMI (POP. 1,617) APRIL 1977

Age Group	MALES			FEMALES			BOTH SEXES		
	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive
< 1	0	0	0	0	0	0	0	0	0
1-4	17	7	41.3	4	0	0	21	7	33.3
5-9	26	3	11.6	11	3	27.3	37	6	16.2
10-14	30	4	13.4	13	4	30.8	43	8	18.6
15-19	6	1	16.7	6	2	33.3	12	3	25.0
20-29	1	0	0	10	1	10.0	11	1	9.1
30 +	7	1	14.3	9	0	0	16	1	6.2
All Ages	87	16	18.4	53	10	18.9	140	26	18.6

TABLE 4

COMPARISON OF MALARIA PREVALENCE RATES

MAY 1968 AND JUNE 1977

Village	Prevalence (Parasite) Rates (%)		
	All Ages	Ages 1 - 9 Yrs.	
	1977	1977	1968
Kounghani	39.4	52.8	75.0
Golmi	18.6	22.4	60.0

Tables 2 and 3 show that the prevalence is highest in both villages among the children and young adults under twenty years of age, probably reflecting the higher levels of immunity among adults. It is interesting to note also that the single infant (age two months) examined was positive, indicating that the transmission occured during the dry season.

As in the 1968 survey, Table 5 shows that P falciparum is the major species of infection accounting for 92% and 81% in Kounghani and Golmi, respectively, with P malariae and P ovale accounting for the remainder.

A thorough examination of spleens was done only in Golmi. The results, shown in Table 6, indicate a spleenic rate of 16.7% and that the disease is mesoendemic or in the "high danger zone" according to the classification of the World Health Organization.[3]

(b) Schistosomiasis

The age-sex specific prevalence rates (April 1977) for S. haematobium in Kounghani and Golmi are shown in Tables 7 and 8. There is no significant difference in the prevalence rates of all ages, 11.6 percent in Kounghani and 12.8 percent in Golmi. While a number of cases have been found in the adult age groups above 24 years in Kounghani, none were found in Golmi. This may be a reflection of the fact that mostly children and young adults were examined in Golmi.

TABLE 5

SUMMARY OF MALARIOMETRIC SURVEYS

GOLMI AND KOUNGHANI, APRIL 1977

	Golmi	Kunghani
Total Slides Examined	140	175
Total Slides Positive	26	69
Positive by Species		
P. falciparum	21	63
P. malariae	4	8
P. ovale	1	1
Mixed infections	0	3
Percentage Positive	18.6	39.4

TABLE 6

SPLEENIC RATES, GOLMI, APRIL 1977

Age Group	No. Examined	No. Positive	Size of Spleens 1	2	3	4	Spleen Rate (%)
1-4	16	2	0	2	0	0	12.5
5-9	32	6	3	1	1	1	18.7
Ages 1-9	48	8	3	3	1	1	16.7

The intensity of infection in both villages is low, ranging from 1 - 27 with a mean of 6 eggs per 10 ml. of urine in Kounghani and from 1 - 61 with a mean of 3 eggs per 10 ml. in Golmi. This indicates that the infections are perhaps mild without much evidence of morbidity and that transmission is intermittent. The absence of cases among the under five age group is perhaps worthy of note for comparison in future surveys.

b. Entomological Surveys

Entomological investigations were limited to surveys of houses for mosquitoes using pyrethrum spray, and surveys around the irrigation perimeters for mosquito larvae because of the time constraints.

Six houses each in Kounghani and Golmi were surveyed. Of the 42 mosquitoes found, 24 in Kounghani and 18 in Golmi, only one was anopheline. Its somewhat battered condition made its species identification impossible.

Larval searches consisted of spot checks in most perimeters visited plus intensive searches in the perimeter at Kounghani during two different visits. During both visits to the Kounghani perimeter every area of the perimeter was checked for the presence of mosquito breeding. Areas examined included ditches, foot prints, general low spots, and areas under plants. No breeding of any kind was found except in a large holding tank which was being used as a source of water for hand watering of small plots. Larvae found in the tank, however, were non-anopheline.

TABLE 7

SCHISTOSOMIASIS HAEMATOBIUM AGE-SEX SPECIFIC PREVALENCE RATES

KOUNGHANI (POP. 1,095) APRIL 1977

Age Group	MALES			FEMALES			BOTH SEXES		
	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive
≤ 4	5	0	0	0	0	0	5	0	0
5-9	7	1	14.3	10	0	0	17	1	5.9
10-14	7	0	0	4	0	0	11	0	0
15-19	6	3	50	3	2	66.7	9	5	55.6
20-24	1	0	0	8	0	0	9	0	0
25-29	3	0	0	3	0	0	6	0	0
30-39	0	0	0	10	2	20	10	2	20
40-49	1	0	0	5	0	0	6	0	0
50-59	3	1	33.3	1	0	0	4	1	25
60 +	5	1	20	4	0	0	9	1	11.1
All Ages	38	6	15.8	48	4	8.3	86	10	11.6

Egg Counts: Range 1-27 eggs/10 ml urine; Geometric Mean 3 eggs/10 ml urine.

TABLE 8

SCHISTOSOMIASIS HAEMATOBIUM AGE-SEX SPECIFIC PREVALENCE RATES

GOLMI (POP. 1,617) APRIL 1977

Age Group	MALES			FEMALES			BOTH SEXES		
	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive	Number Examined	Number Positive	Percent Positive
≤ 4	4	0	0	0	0	0	4	0	0
5-9	17	2	11.8	3	0	0	20	2	10.0
10-14	22	5	22.8	9	1	11.1	31	6	19.4
15-19	5	0	0	8	3	37.5	13	3	23.2
20-24	1	0	0	2	1	50.0	3	1	33.3
25-29	0	0	0	5	0	0	5	0	0
30-39	1	0	0	4	0	0	5	0	0
40-49	2	0	0	4	0	0	6	0	0
50-59	2	0	0	3	0	0	5	0	0
60 +	2	0	0	0	0	0	2	0	0
All Ages	56	7	12.5	38	5	13.2	94	12	12.8

Egg Counts: Range 1-61 eggs/10 ml urine; Geometric Mean 6 eggs/10 ml urine.

c. Conclusion

Further surveys of a long-term nature on an annual and seasonal basis (rainy and dry seasons) are needed to determine the incidence and transmission seasons of these diseases as well as monitor any changes that occur.

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APPENDIX F

ENVIRONMENTAL ENGINEERING AND SANITATION

1. SANITATION

In Senegal, the current magnitude of diseases associated with poor sanitation rates high among the country's health problems. Data of 1975 indicate that parasitic and enteric disorders rank first and third, respectively, of all cases referred on an outpatient basis, amounting to more than 47% of the total of the "top ten" maladies.[1] Previous investigators have commented on the major role which sanitation plays in public health in the project area and nearby locations in Senegal.[2,3] The observations of the Bakel assessment team support and underscore these findings.

The status of rural sanitation in the Bakel vicinity reflects traditional attitudes regarding personal cleanliness, a lack of concern for public places (central meeting points in villages) and unfamiliarity with the modes of disease transmission. Most commonly, disease occurrences are viewed to be of divine design. These concepts are reflected in the generally diligent care of pit privies and family dwelling areas, juxtaposed with the proliferation of garbage and non-degradable solid wastes (especially metal cans) in alleys and streets. These latter items, together with other water receptacles such as old tires and broken clay pots and calabash, provide convenient and proliferous breeding grounds within the villages for the malaria vector during the wet season. The excavations for clay to make adobe bricks for building construction (borrow pits) also create substantial breeding sites for mosquitos within and around the villages.

Some burning of trash was evidenced in alleys in the town of Bakel, but this activity is not undertaken in an organized fashion, nor could it be considered a normal practice in local villages. No community solid waste disposal mechanism currently exists in the project area.

As mentioned above, pit privies are generally well-maintained. There is usually one privy per married woman in a family. It is normally located at the rear of the living quarters, often open to the air. This condition most likely presents maintenance problems during the wet season. The privy area also serves as a bathing place mainly for men, who do not normally bathe in the river. Effluent from this activity, as well as urination, however, is directed out the rear of the compound to the surface of the common street or to shallow (approximately one meter deep) and crudely constructed soak-away pits.

The privy itself is of the dry type, averaging approximately two meters in diameter and, we are told, six meters in depth. They are unlined with rough-hewn log bases and cement floors. The round oepning of 15 cm. diameter could obviously be improved upon. A depth of one-half to one meter of charcoal is provided at the bottom for odor control and to improve percolation. Odor control and waste reduction through liquefaction by the addition of caustic soda is effected on the order of every ten years. (At an approximate pit volume of 15 cu.m., therefore, a conservative estimate of 15 individuals could be adequately served over this period of time.) After percolation of the resultant

liquified mixture, the pit is reused. It is expected that this procedure would cause organic clogging of the immediate soil structure over time and require the construction of a new pit. No feuillées (trench latrines) were observed in the project area.

In addition to individually maintained privies, urination and defecation occur in public places (streets and back lots) and fringe areas, as well as in and by the river. Unused buildings also provide convenient waste disposal facilities. Ironically, it was noted in more than one instance that simple school shower and wash facilities (standard design using rotary hand pumps and gravity delivery) constructed in some villages about ten years ago by the Fonds Européens du Développement (F.E.D.) have fallen into disuse (mainly because of valve breakage and unavailability of repairs), and are now used for excreta disposal.

These conditions do not seem to suggest that public toilets would find ready acceptance among villagers of the region. Custom, rather, would seem to indicate that great difficulty would be encountered in ensuring the proper use and maintenance of such facilities.

Food handling and storage are complicated by the high local temperatures and the lack of adequate refrigeration. The few propane-operated refrigerators in Bakel can barely keep food at 20°C. No such devices exist in the villages, even at health dispensaries. Butchered meat is sold at a central location in the Bakel bazaar which is far from well-kept and supports its own colony of flies. The unavailability of an adequate safe

water supply contributes to the low standard of cleanliness on the part of food handlers.

The Team was informed that rats are not considered to be a problem presently, the last infestation having occurred following the 1972-74 drought. The potential certainly exists, however, and rodenticides were observed to be in use in family vegetable gardens outside the villages.

In summary, the traditional lack of community (vis-a-vis individual) sanitation contributes significantly to the endemic parasitic and enteric disease problems among the villagers in the project area. Insanitary conditions have been accepted as the way of life. This signals that the necessary public health improvements will come slowly with changes in attitudes brought about by health education. Furthermore, the relatively basic and extensive nature of these conditions dwarfs any potential adverse health impacts of small-scale irrigation. Inroads on the public health problems, however, will be made only when concerted effort towards sanitation and water supply improvements is made in addition to increased food production programs.

II. WATER SUPPLY

Water supply for the small perimeters irrigation project has been analyzed in the Project Paper from the standpoints of:

(1) The availability of water for crop production during the low flow season,

(2) Maximum flood-stage elevations for the determination of diking requirements.

Additional discussion has been provided in the Nebiker environmental assessment, which focuses on general aspects of water quality implications as well.[3] The present treatment does not intend to duplicate these prior presentations.

General climatological data affecting the water supply regime are summarized below. Kayes (Mali) and Matam are approximately equidistant upstream and downstream of Bakel. The underlined values for Bakel have therefore been interpolated at 50% in cases where Bakel data were not readily available.

TABLE 1

MEAN ANNUAL CLIMATOLOGICAL DATA
AT VARIOUS POINTS ON THE SENEGAL RIVER[4]

Location	D. (km)	Tmax (°C)	Tmin (°C)	Ave. (°C)	"Piche" Evap. (mm)	Rain-fall (mm)	Rel. Hum. (%)	Total Sunlight (hrs)
Matam	625	37.0	21.6	29.3	3218	526	48	3325
Bakel	784	36.8	22.0	29.4	3081	683	46	3106
Kayes (Mali)	914	36.6	22.3	29.4	2944	754	45	2888

As far as can be presently determined, no detailed groundwater study has been performed in the Bakel region. The Ministry of Rural Development and Hydraulics has recently submitted to AID/Dakar a preliminary 3-year/$1.35 million proposal for a hydrogeological study of the Senegal River basin from Boghe to Bakel.[5] This study would investigate the extent and dynamics of basin groundwaters, paying particular attention to hydraulic interaction with the Senegal River itself.

Preliminary groundwater investigations done in conjunction with the Matam irrigation project[6] have unearthed information regarding two aquifers in that region:

1) An upper lens commencing from 7 to 15 meters in depth and extending 46 to 66 meters in thickness; and
2) A lower layer, beginning 30 meters below the lower limit of the upper one, and extending over 50 meters in thickness.

The studies suggested, furthermore, a hydraulic connection between the upper aquifer and the river, the aquifer being recharged at flood stage and subsequently discharging to the river during recession. The actual thickness of the lower aquifer, as well as its possible hydraulic connections, remains to be determined. The transmissivity of both aquifers is high, and they can readily yield large quantities of water to wells, possibly effecting recharge from the river (Upper aquifer: T = 1800 sq.m./day, S = .001; Lower aquifer: T = 1050 sq.m./day, S = .0003). It is believed that this general condition operates in the Bakel area as well. The study has recommended more extensive groundwater investigations. It is expected that the OMVS -

commissioned two-year environmental assessment of the entire basin will provide some of the needed information regarding the groundwater relationship to the Bakel small perimeters during the implementation of the project.

During the low-flow period field investigation by the assessment team, the Senegal River was observed to be at a noncritical stage. Rough flow studies using floats and cross-sectional measurements at Bakel and Kounghani indicated that the river was well above the 10% frequency minimum (9 cu.m./sec. at Bakel) for April.[7] Unlike the situation of pooled water reported during the same month of 1976 by Dr. Nebiker, the Senegal river was viewed to have a continuous flow through the project area. The Faléme tributary, at the southern limit of the project, however, did exist as a chain of ponded reservoirs.

Agriculture places the greatest demands on the water resources of the Senegal River. While it is impossible to estimate the use for traditional cultivation practices, the specific requirements for the proposed project are dealt with in detail in Annex I of the Project Paper. It may simply be added that that analysis does not consider the potential availability of groundwater.

Water supply for the town of Bakel (pop. 6100) is provided through a system constructed and maintained by SONEES (Société Nationale d'Exploitation des Eaux du Senegal). Contrary to the report of the preliminary environmental assessment, river water

supplied to the inhabitants of Bakel undergoes a three-stage treatment process before delivery (flocculation/sedimentation, rapid gravity sand filtration, and disinfection). The operation of the system is somewhat unsatisfactory, however. Annual billed consumption approximates 45,000 cu.m./year to 20 public standpipes/municipal connections and 49 private connections. A survey in 1973 indicated a pumpage of about 33% in excess of billed consumption and attributed the difference primarily to distribution system loss due to the condition of the conduits.[8] This analysis could not be verified during the present investigation, although inspection of the pumping facility did suggest the high supply-rate. At a delivery cost of $0.40/cu.m. ($1.50/1000gal.), reduction of the high system loss is worth pursuing.

Rural water supply for drinking, cooking, and men's bathing is fetched from the river in buckets by women and children as often as three times per day. Other activities requiring the use of water are carried out at the river's edge. Conversations and observations led to an estimate of 25-40 l/day per capita consumption in the study region. This would lead to an approximate total annual domestic demand among the 23 villages of the project area of 280,000 - 450,000 cu.m. Stated another way, the total domestic requirement would vary between 9 and 15 l/sec., which can be compared to the one percent low-flow frequency of the Senegal River at Bakel in April of 3000 l/sec. As previously stated, the additional magnitude of available groundwater in this sector remains to be determined. Initial signs are encouraging.

No industrial demands on the local water resources were identified during the Team's field investigation.

In summary, the combined availability of surface and groundwater resources in the Bakel area for regional development schemes has not yet been adequately determined. While a long period of record is afforded for surface flows, relatively little information exists regarding aquifer dimensions and dynamics. It is possible that considerable future demands may be met by exploitation of this undefined resource. At a minimum, it will be necessary to elucidate the recharge relationship between the river and basin groundwaters, so that the effects of proposed hydraulic manipulations on the natural hydrologic cycle and subsequent ramifications may be appropriately assessed.

III. WATER QUALITY

Several aspects of health-related water quality impacts of the small perimeters irrigation project have been considered in the Nebiker environmental assessment.[3] This discussion is intended to amplify on that framework, and, as with the above sections on sanitation and water supply, will attempt to look at the quality question in the context of competing uses and related aspects of local environment. It is impossible to evaluate rationally the impact of a particular development activity without reference to such a total picture, which assigns relative weights (qualitative or quantitative) to the existing situation and the proposed modifications.

Within the general pattern of concentrated utilization of

the Senegal and Faleme Rivers for a multiplicity of purposes, it can be said that the villages in the project area experience varying degrees of water quality problems, depending primarily on the contact population and particular flow regime during the critical period of March-April. It is not believed that irrigation of the present magnitude will significantly alter low-flow water quality. Pesticides are not now employed and fertilizer applications do not coincide with the time period for potential return flows during the dry season. Moreover, the opinion of the preliminary environmental assessment that any such return flows might even be directed away from the river is herein supported. It cannot be said at the present time what effect a ten-fold increase in irrigated areas might have in terms of river quality, particularly salinity, but this is certainly no justification for foregoing the tangible benefits to be derived from increased food production. With a very low salinity currently, the river appears to have ample assimilative capacity.

A. Existing Data

A search of available information at the OMVS and UNDP Documentation Centers, as well as the Ministry of Rural Development and Hydraulics, yielded no data regarding either surface or groundwater quality in the project area. In the lower Senegal basin, however, primarily in the tidal region below Boghe, numerous physical and chemical investigations have been conducted. Essentially, these have revolved around descriptions of the salt water intrusion pattern and the quality of irrigation waters for agri-

cultural projects. The Bureau de Recherches Geologiques et Minieres (BRGM) and Institut Sénégalese de Recherches Agricoles (ISRA) have been in the forefront of such investigations.

Illy (19/3) provides a general description of groundwater characteristics above Boghe, in the vicinity of Salde, Kaedi, and Matam, the latter approximately 150 km. downstream from Bakel.[9] His findings show electroconductivities of phreatic layers in the range from 100-500 umhos/cm. Ions predominate in the following order: Ca > Mg > Na > Cl, with SO_4 practically absent. As expected, low salinity waters are found in regions of high flood infiltration, and the most mineralized in areas of high ground or clay soils.

Similar results were found in the investigation of the deep aquifer (the so-called Maestrichtian layer). East of Nianga, measured salinities decreased from below 300 mg/l (EC <475 µmhos/cm) to less than 100 mg/l (EC < 150 µmhos/ch) at Seme, approximately halfway between Bakel and Matam. The ionic regime reported is similar to that of the upper layer.

As far as could be determined, the only water quality monitoring in the project area to date has been conducted in conjuntion with the Bakel water supply system. Samples are collected monthly for microbiological analysis at the Pasteur Institute, and annually for chemical and physical analysis at the main SONEES laboratory in Dakar. This task separation is not considered to be wholly satisfactory. Results of relevant analyses requested during the Team's stay have not yet been received.

A preliminary review of data, however, indicates that delays of several days between sampling and laboratory analysis severely

compromises the validity of many microbiological results. The SONEES lab was seen to be underutilized during a visit to the facility. Equipped with basic instrumentation for a wide rande of standard parametric observation and maintained by a modest but enthusiastic and capable staff, the SONEES lab could provide valuable support to future activities, should the proper institutional arrangements be effected. Furthermore, the Department of Chemistry in the Institute of Technology at Dakar University possesses both an atomic absorption spectrophotometer and a gas chromatograph, which might become important resources for appropriate GoS programs.

In conjunction with the recently initiated OMVS Environmental Assessment of the Senegal River Basin, a program of surface and groundwater quality monitoring is planned.[10] A review of the revised project proposal indicates that the primary objective of the surface monitoring program will be to provide input to the development of a predictive mathematical model that will incorporate, in addition to water quantity/quality programs, biological, public health, and socio-economic components. Predicted effects would lead in turn to the proposal of mitigating measures. The initial parameters of interest in this task are listed in Table 2.

The groundwater monitoring program, on the other hand, appears to be oriented more towards the establishment of an on-going system for measuring the effects over time of particular development actions. Coupled with this activity would be the

TABLE 2

WATER QUALITY PARAMETERS OF INTEREST IN SENEGAL RIVER BASIN ENVIRONMENTAL ASSESSMENT[10]

WATER QUALITY PARAMETERS	ESTUARY	FRESHWATER RIVER
BOD	X	X
NOD	X	X
COD	X	X
Ammonia-N	X	X
Nitrate-N	X	X
Total-P	X	X
pH	X	X
Total Solids	X	X
Suspended Solids	X	X
Disolved Solids	X	X
Chlorides	X	X
Temperature	X	X
D.O.	X	X
Chlorophyll		X
Total Coliform	X	X
Fecal Coliform		X
BOTTOM MUD PARAMETERS		
Moisture	X	X
Ash	X	X
WATER QUALITY RATES OF RESPONSE		
K_r - (Rate of BOD)		X
K_n - (Rate of NOD)		X
P-R (influence of Algal Systems)		X
B - (Benthal Oxygen Demand)		X
Ka - Reaeration Capacity		X

development of recommendations for pollution control activities, including health education, fertilizer and pesticide application schedules, and institutional arrangements.

B. Field Study

1. Methodology

Physical and chemical analyses were conducted on the waters of the Sénégal and Falémé Rivers during the period 4-23-77 through 4-28-77 using a Hach DR-EL Portable Laboratory. Surface samples were collected from the rivers in most cases within 5 meters of the bank, from one unprotected hand-dug well, from the Tuabo marigot, and from various points in the water supply system of Bakel. The range of river reach investigated totaled approximately 132 km, from Gande (downstream) to Senoudebou (upstream, Faleme) (Figure 1). This distance includes all present perimeters and those planned in the South, but does not extend to the undeveloped areas in the North.

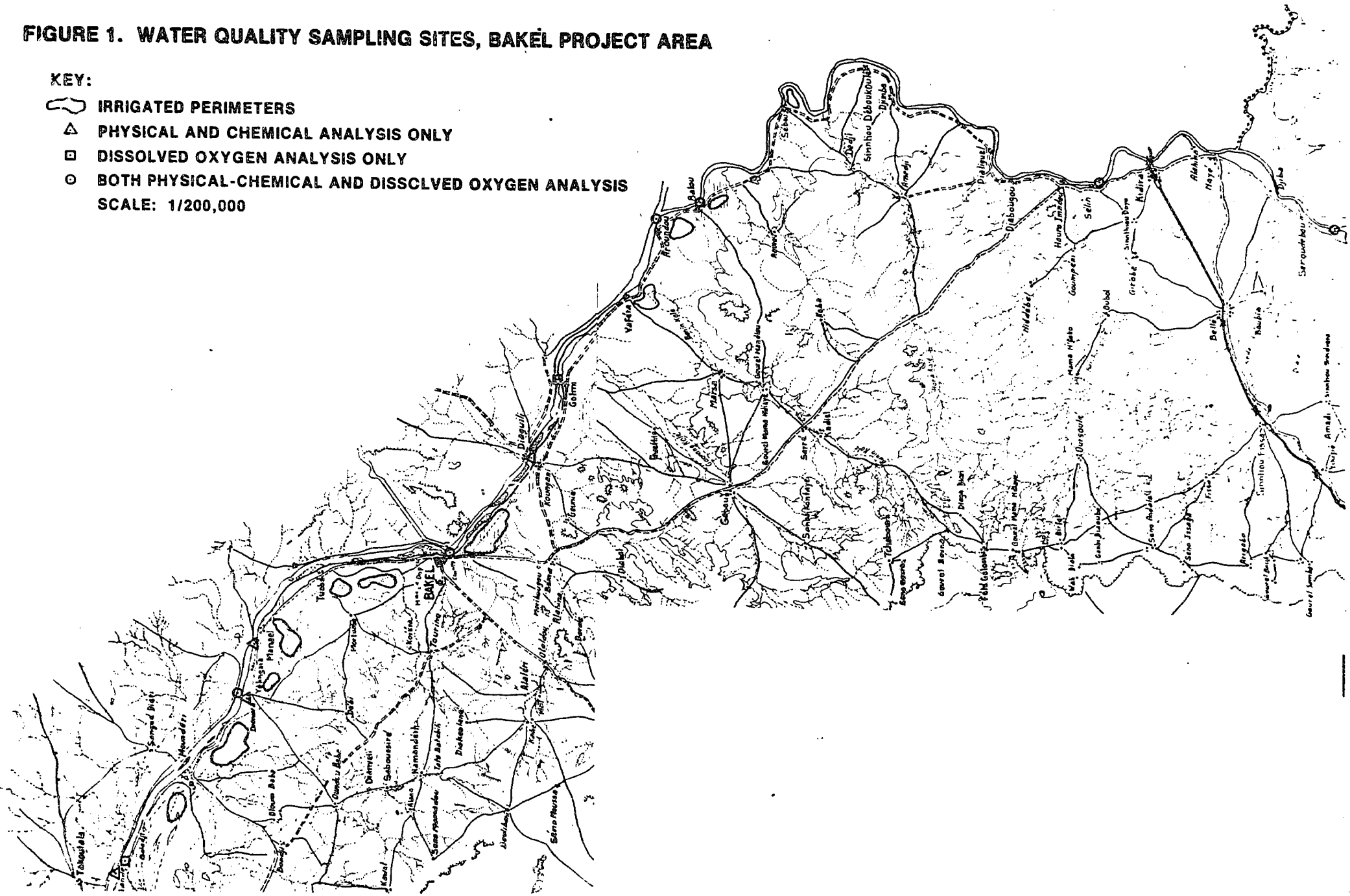
Analyses were conducted for the following constituents: pH, temperature, hardness, akalinity, nitrate, orthophosphate, iron, maganese, chloride, electroconductivity, turbidity, color, and in the case of the Bakel water supply, free residual chlorine. Thirteen of sixteen samples were analyzed within 12 hours of collection; the remaining three were processed within 24 hours. Refrigeration was inadequate for optimal preservation. Turbidity was measured on settled samples, and pH was determined only after storage.

FIGURE 1. WATER QUALITY SAMPLING SITES, BAKEL PROJECT AREA

KEY:

- IRRIGATED PERIMETERS
- △ PHYSICAL AND CHEMICAL ANALYSIS ONLY
- ⊡ DISSOLVED OXYGEN ANALYSIS ONLY
- ⊙ BOTH PHYSICAL-CHEMICAL AND DISSCLVED OXYGEN ANALYSIS

SCALE: 1/200,000



Additionally, surface dissolved oxygen was measured at eight points along the investigated stretch, using a modified Azide-Winkler technique. Where possible, both midstream and bank samples were collected at each location.

The intention of this study has been to highlight important investigative points for the future and to develop a general idea of the riverine background chemistry, rather than to provide a complete characterization during low flow.

2. Water Quality Survey

Water quality sampling was conducted in the course of the Team's field investigation as described in the methodology section above. Results of analyses are presented in Tables 3 - 6.

The waters of the Senegal River along the stretch studied (approximately 63 km) were relatively homogeneous during the study period. In general, they are of acceptable physical and chemical quality for agricultural and domestic purposes. Turbidity, although currently low, would be expected to be objectionable during the rainy season, however. Except for one bank sample (Diawara) obtained from shallow, stagnant water in an area of intensive use, electroconductivities ranged from 61-78 µmhos/cm through the stated distance. Color varied between 0 and 20 units, generally increasing downstream. Additional measurements would be required to determine if this pattern is significant. The waters are soft and contain no noncarbonate hardness. Alkalinity is low and exists totally in the bicarbonate

TABLE

PHYSICAL AND CHEMICAL ANALYSES OF SENEGAL AND FALEME RIVER WATERS, DOWNSTREAM AND UPSTREAM OF PROJECT SITES

Location	Distance Upstream from Gande (km)	Date of Sample/ Analysis (-/4/77)	Temp. Air (°C)	T_{H_2O} Site/Lab (°C)	pH	Color (APHA units)	Turb-idity (FTU)	Total Hardness (mg/l $CaCO_3$)	Total Alkalinity (mg/l $CaCO_3$)	Electro-conductivity (μmhos/cm)	Fe (mg/l)	Mn (mg/l)	NO_3 (mg/l N)	PO_4 (g/l P)	Cl (mg/l)
Senoudebou South (FR)	132	28/28	37	30/35	8.1	10	5	40	50	90	0.25	nil	nil	0.01	1.5
Selin (FR)	108	28/28	42	29/35	8.3	110	40	50	65	110	0.7	nil	nil	0.03	1.5
Balou (FR)	65.0	27/27	37	30/29	7.6	50	15	65	90	150	-	-	nil	nil	-
SR at confluence w/FR	62.5	27/27	33	30/29	8.2	0	0	35	45	61	-	-	nil	nil	-
Kounghani South (SR)	42.8	24/24	30	27/34	8.7	5	0	35	45	68	0.1	0.1	nil	0.02	< 3.5
Kounghani (SR)	42.5	24/24	30	27/32	8.4	15	5	35	45	70	0.15	0.2	nil	0.02	< 3.5
Bakel (SR)	34.3	26/26	34	32/20	8.5	15	10	30	50	69	-	-	nil	nil	-
Manael North (SR)	18.5	23/23	34.5	30/-	6.7	-	15	27	45	70	0.14	0.2	0.2	0.07	< 2.5
d.o.	18.5	24/24	32	30/29.5	7.9	0	0	35	45	68	0.1	0.2	0.1	0.02	< 3.5
Diawara (SR)	14.0	25/26	31	33/21	8.3	15	0	45	50	120	-	-	0.05	nil	-
Gande North (SR)	-0.3	25/26	39	33/20	8.2	20	0	35	50	78	-	-	nil	nil	-

SR = Senegal River; FR = Faleme River

TABLE 4

GROUNDWATER AND MARIGOT ANALYSIS IN PROJECT AREA

Location	Date of Sample/ Analysis (-/4/77)	Temp. Air (°C)	Temp. H_2O Site/Lab (°C)	pH	Color (APHA units)	Turbidity (FTU)	Total Hardness (mg/l $CaCO_3$)	Total Alkalinity (mg/l $CaCO_3$)	Electro-conductivity (μmhos/cm)	NO_3 (mg/l N)	PO_4 (mg/l P)
Diawara Well #1 (app. H_2O depth=6m)	25/26	34	29.5/21	7.3	140	25	550	630	1500	0.5	0.1
d.o.	23/23	29.5	29/-	-	-	-	-	-	1500	-	-
Diawara Borrow Pit (app. H_2O depth=5m)	23/23	29.5	33.5/-	-	-	-	-	-	2300	-	-
Tuabo Marigot (app. 1 km W of Tuabo)	23/23	34.5	27/-	-	-	*	-	-	285	-	-

* Turbidity too high to measure after 12 hr. settling; lack of filter apparatus prevented other measurements.

TABLE 5

DISSOLVED OXYGEN MEASUREMENTS, SENEGAL AND FALEME RIVERS

Location	Distance Upstream from Gande (km)	Sampling Date/Time (-/4/77)	Temp. Air (°C)	Temp. H_2O (°C)	Electro-conductivity (μmhos/cm)	D.O. (mg/l)	D.O. Saturation (mg/l)	D.O. meas. / D.O. sat. (%)
Senoudebou South	132	28/1015	37	30	90	8.0	7.6	105
Selin	108	28/1215	42	29	110	9.2	7.8	118
Balou (Midstream)	65.0	27/1000	37	30	150	5.6	7.6	74
(Shore)		27/1025	-	30.5	-	7.6	7.55	101
Senegal R. at Confluence w/ Faleme R. (Midstream)	62.5	27/1130	-	30	-	10.4	7.6	137
(Shore)		27/1100	33	30	61	10.2	7.6	134
Golmi (Midstream)	48.5	27/1225	40	33	70	9.8	7.3	134
(Shore)		27/1245	-	30	68	10.6	7.6	139
Bakel (Midstream)	34.3	27/1400	41	31	70	9.4	7.5	125
(Shore)		27/1420		31	70	10.5	7.5	140
Diawara (Midstream)	14.0	27/1700	-	32	83	11.3	7.4	153
(Shore)		27/1715	41.5	34	82	9.2	7.2	128
Gande (Shore)	0	27/1820	36	31	77	10.9	7.5	145
(Shore 40m N)		27/1845	-	31	-	10.4	7.5	139

TABLE 6

ANALYSES AT VARIOUS POINTS IN TOWN OF BAKEL WATER SUPPLY SYSTEM

Location	Sample Date/Time (-/4/77)	Temp. Air (°C)	Temp. H_2O Site/Lab (°C)	pH	Color (APHA units)	Turbidity (FTU)	Total Hardness (mg/l $CaCO_3$)	Total Alkalinity (mg/l $CaCO_3$)	Electro-conductivity (μmhos/cm)	NO_3 (mg/l N)	PO_4 (mg/l P)	Free Residual Cl_2 (mg/l)
Senegal R. at Water Supply Intake	26/1130	34	32/20	8.5	15	10	30	50	69	nil	nil	-
Sedimentation Tank (before filtration)	26/1045	37.5	31/21	7.4	30	15	30	50	69	nil	nil	-
Public Stand-pipe (after filtration)	26/1115	-	32/20	7.5	10	15	30	50	75	0.05	nil	-
d.o.	26/1700	37	32.5/25	7.5	20	15	30	50	73	0.05	0.01	-
Private House Connection	23/2215	-	-	-	-	-	-	-	-	-	-	3.5
d.o.	24/1600	-	-	-	-	-	-	-	-	-	-	0.05
d.o.	24/2215	-	-	-	-	-	-	-	-	-	-	0.01
d.o.	25/1430	-	-	-	-	-	-	-	-	-	-	0.01
d.o.	26/2100	-	-	-	-	-	-	-	-	-	-	0

form. Only one sample did not exhibit an alkaline pH between 7.9 and 8.7. Marganese and iron were somewhat high exhibiting staining potential. Chloride is of minimal importance. Within the limits of the experimental methods employed, nitrate nitrogen and orthophosphate appeared low to average. Daytime dissolved oxygen values considerably in excess of saturation at various points along the river (Table 5) indicate a fairly efficient turnover in production. It is expected that the available nutrients are recycled into algal mass from the immediately available organic forms, and most likely the depressed nitrate levels indicate nitrogen to be the limiting factor in river productivity at this time of year. With the advent of the rainy season, however, increased river velocity, turbidity, and nutrient load from appreciable manures deposited on river banks would tend to reduce the importance of this variable. Fertilizers applied at this time, therefore, would have little impact on surface water quality.

In general, during the study period pollutional effects of intensive river use appeared to be localized, with the river restoring itself to a relatively high physical and chemical quality in areas between population centers. Under ponded conditions, however, the river could not be expected to exercise this self-purification potential.

The greatest public health problems associated with river use would appear to be in the southern area of the project, along the Faleme River. Here, with a flow inferior to that of the Senegal River, water quality was viewed to be comparatively lower. Existing as a chain of ponds not connected to the

Senegal at the time of the field investigations, the Faleme showed increased electroconductivities (90-150 umhos/cm), color, turbidity, hardness, and alkalinity, although only color and turbidity could be considered objectionable (Table 3). While iron is indicated to be higher than in the Senegal River, manganese measured lower to the point of being undetectable. Nutrient levels did not differ significantly from Senegal River samples, but daytime dissolved oxygen measurements were generally lower. In spite of the fact that the Faleme D.O. levels were predominantly morning values, compared to primarily afternoon concentrations for the Senegal River, it appears that some other factor is involved. The data are not complete enough, however, to be conclusive.

The one multi-parameter well analysis conducted (wells are an infrequent source of water in the Bakel region) indicates a significantly poorer quality supply than the Senegal River (Table 4). Indeed, the water sampled is condered unacceptable even for irrigation purposes. Although located in an area not subject to inundation nor a high degree of recharge, this open well most likely reflects a high degree of contamination rather than a low quality groundwater. Such wells are utilized only when access to the river is somewhat inconvenient (approximately one km in this case). Yet under these conditions, even borrow pits serve as sources for all uses except drinking.

Although no microbiological testing was conducted during the survey, it is most assuredly believed that both the river and open hand-dug wells present greater public health problems from this perspective than from that of physical and chemical

quality. A truly meaningful description of the hazard would require an input of resources greater than envisioned under the scope of the present study.

The quality of the Senegal River would indicate that minimal treatment (disinfection) would suffice for potable supply during the dry season. Currently, Javel water (liquid bleach) is added twice daily in batch doses after filtration for disinfection purposes. This procedure has grave shortcomings. There is also a lack of free chlorine monitoring in delivered supplies and in the shortage of chemicals in stock at Bakel. An indication of the resulting variation in free residual chlorine is given from a time-sequence of checks on tap water from 23 April through 26 April (Table 6). The data in Table 6 also suggest that water quality is not significantly improved by the Bakel treatment system as currently operated. Under such conditions, flocculation, sedimentation, and filtration can only be justified during the period of high turbidity. Even then, the system would require improved operation and maintenance, which cannot be presently assured. Attached algae on the sedimentation tank and weir were abundant at the time of inspection. Backwashing of the sand filter at the stated bimonthly rate is also a very questionable practice.

The experience indicates, therefore, that considering the water rates associated with the existing system, other water supply options should be considered in the project area, particularly the exploitation of groundwater.

IV. AGRICULTURAL CHEMICALS

As far as could be determined, no pesticides are currently applied in the Bakel project perimeters. This finding includes HCH, which was specifically mentioned in the Nebiker environmental assessment as being employed.[3] SAED's officials both at the St. Louis Headquarters and at Bakel further insist that it is not intended to use any in the future. They stress that the objective of these perimeters is not the achievement of optimum crop production rates but mainly subsistence farming on a relatively small scale. Thus they are prepared to accept some losses due to crop pests.

The fertilizers now employed in the project area (12 of 23 planned sites) are listed in Table 7, along with the total amounts used during 1976. NPK 16-48-0 and KCl are applied as base nutrients at rates of 120 kg/ha and 100 kg/ha, respectively. Urea (46% N) is utilized as a cover at a dose of 100 kg/ha. NPK 14-7-7 (150 kg/ha), is used only on maize and sorghum. All fertilizers are applied by hand.

The Matam perimeters, which are approximately of the same size as those of Bakel but pursue higher production rates, do use the pesticide Basudin 10 (CIBA-Geigy). It is applied to the rice fields at the rate of 20 kg/ha one week after planting and then repeated 2-3 weeks later. Fertilizers used are the same as in Bakel.

TABLE 7. FERTILIZERS APPLIED IN PROJECT AREA, 1976

PERIMETER	TYPE AND AMOUNT FERTILIZER (kg)			
	NPK 16-48-0	UREA (46%N)	KCI	NPK 14-7-7
Kounghani	2000	2000	2000	500
Golmi	-	-	-	700
Yafera	1300	1600	1000	1850
Aroundou	800	950	600	2400
Ballou	4400	4450	2500	1100
Tuabo	2500	2000	600	-
Manael	1500	1500	400	700
Yelingara	650	1400	500	-
Diawara	1950	2650	1500	-
Moudery	1500	900	800	-
Galade	500	600	400	500
Gandé	800	900	600	150
Bakel	1950	1500	1500	150
TOTAL	19850	20450	12400	8050

Source: S.A.E.D. Field Station, Bakel

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APPENDIX G

SOCIOLOGICAL CONSIDERATIONS

1. The Problem

The following are among the major sociological concerns considered in relation to the environmental health assessment of the Bakel Project.

a. The socio-cultural[1] patterns which have evolved around the river, viz., (i) the various ways in which the Sarakolle of the Bakel area relate to the river, (ii) behavioral implications for personal hygiene and community sanitation[2], (iii) the query whether the irrigation project in its proposed initial stages would conceivably change in any substantial ways those patterns of individual and community behavior to such an extent that they would pose an added health or environmental hazard.

It could be demonstrated that increased food production tends to improve the general level of nutrition, while improved and more secure incomes increase the villagers' capacity to help themselves in improving their health through both preventive measures such as improved housing and sanitation, and remedial measures such as the purchase of necessary medicines.

Yet, development has another face, namely, the strains placed on certain segments of the community (often the women [3, 4] and hence the children) resulting in adverse health conditions. Will such negative experiences take place in Bakel? What can be done so as to minimize the probability of their occurrence? Useful suggestions, though in a different context, are to be found in Afrique Médicale.[5]

c. Any form of "intervention," even when sought after by the villagers themselves, would introduce factors of change in the community. "New" structures are associated with the irrigation project, such as a farmer's cooperative that departs from the traditional hierarchical order and which includes women on its membership, and the division of agricultural labor on principles different to the traditional sex-role categories. These are innovations that might have far-reaching institutional consequences. How will the Sarakolle community structure react to these innovations? Is there any danger of serious disorganization? If these structures lead to an enhanced status for women, will the women be expected to assume more "aggressive" roles in matters of property and goods allocation, personal and community sanitation, family planning, and the education of the children?

d. If the answer to the last set of questions is positive, should health education for community sanitation, preventive medicine, child health, nutrition[6], and self-help in matters of health emphasize the role of the woman[7] and hence aim at educating the women in these matters? What other indigenous groups within the Sarakolle community (such as traditionally designated leaders 8, 9, 10) should be enlisted and trained for community health education and organization?

2. Sociological Survey

a. Methodology

The survey was based on two types of interviews:

i) Spontaneous interviews involving no definite set of questions

ii) Planned interviews using a questionnaire. All interviews were conducted verbally and recorded by the interviewer.

i) Spontaneous

No interview schedule was used for these question-and-answer interviews. The occasion itself determined the sequence of questions, although the general subject about which information was to be sought was determined prior to the interview.

Interviewees included:

a) SAED officers, in charge of technical side of the Dagana Agricultural project--three officers in charge of cultivation and marketing, and two in charge of water supply.

b) Leaders of the village of Gamal, particularly those involved in the Matam project--a large group, but the chief answered most of the questions on behalf of the others.

c) Several officers responsible for various parts of the total agricultural project of the Société d' Aménagement et d' Exploitation des Terres du Delta (SAED). Their spokesman, however, was Mr. Newman, who seemed to be better informed and more outspoken than the other four or five.

d) Three SAED officers, Bakel.

e) The Bakel Préfet and his deputy.

f) Various village groups related to the various perimeters both north and south of Bakel.

g) The leaders of the village of Golmi--the Chief acted as spokesman, although other members of the group occasionally volunteered to add information or clarify a point.

h) Three religious leaders (marabouts) at Kounghani.

i) School teachers at Koughani and the medical assistant with others of the village people at Golmi.

j) Individual interviews with various specialists in Dakar and Bakel.

ii) Planned Interviews

A schedule of interviews was developed and tested prior to its use on a random--one out of ten--sample of household (carré) heads and their wives both at Golmi and Kounghani. Nineteen carré heads and their wives participated. The size of their carrés ranged from 4 to 77 family members with a median of 23. Three of the carré heads were not reached. Answers given were usually supplemented, modified, or assisted by other villagers present at the interview. The level of seriousness in providing answers varied from casual, ambivalent responses to careful consideration of most questions. One of our cases was obviously defiant. The problem of translating from English to French and to the Sarakolle language added a dimension of subjectivity. While the whole process was an approximation of a scientific approach, no such value is claimed beyond that our findings are based on repetitive descriptive statements that show a general pattern of social behavior among the Sarakolle of the Bakel region.

b. Findings

The following generalizations are inferences from interaction with the various groups of the Bakel river region and their situation, and the interviews, dialogues, discussions, and observations over a period of two weeks.

i) A social life built around the river - True to traditional African beliefs, the human and his environment make one ecological entity; they belong to each other. While this is true of the human, the land, and the animal, it is even more so of the Sarakolle people and their river. Social life in its totality seems built around the river. The regularity of its annual rise and fall provides life and a threat to life as well. The people have to guard its banks for fear of floods during high water period.

Close to the river, the young are born, baptized, initiated into adulthood, and it provides the occasion for them to meet, have their youthful experiences, get their entertainment and sex education. Mothers wash their menstrual rags in its water. The baby's soiled clothes, all other clothes, bedding, hides of animals, part of the food they eat are all washed right in the river. It is there too that they empty night pots, urinate, float away dead animals, then drink of the same water, to be sure, only a few feet away from all that other activity. Their animals too, share the same river.

The Sarakolle firmly believe that the river is self-cleansing and its water purifies everything else. Besides, "it tastes far better," declared the medical assistant of a village dispensary. Disease has nothing to do with the river, they assure you. "Disease is natural, and to be expected".

The river provides fish for food. It also provides year-round recreation for young and old. It is a social

location where people gossip, share news, weep over each other's shoulders, unload their emotional strains and, perhaps, experience some form of therapy.

Life from the womb to the grave is so closely integrated with the river that separation is likely to require great concerted effort over a protracted period.

(ii) Value of personal hygiene fairly recognized, but very little awareness of community sanitation

The Islamic religion emphasizes personal hygiene through its elaborate system of daily ablutions for the grown-ups. Babies and children, too, are reported to be bathed quite regularly. The Sarakolle seem to take pride in keeping their clothes clean and the inner walls and the floors of their houses well plastered. But the refuse goes to the commons or public places and bath water into the narrow streets and back alleys. It should be noted, however, that crude soak-away ditches supposedly to receive bath water and all kinds of human waste have been dug next to the outer walls of many houses in the streets or back alleys.

Animals are butchered, skinned, the meat carved and portioned right in the open, unprotected from dirt, sand drifts, and swarming flies. Care was observed in locating kitchens but smoke and pet animals in the cooking area diminished the apparent attempt to be clean. Regarding sanitation, the villagers have a long way to go before a barely acceptable standard is achieved. Sanitation consciousness might be viewed as a concomitant of a further stage of socio-economic development.

Regarding disease, we found very little awareness of "causality". Disease is "natural", the consensus seemed to be. If you pressed the question further "it is from God," we were assured, else a surprised shrug as if it were ridiculous even to ask the question. Like the river, disease is a given part of the ecological whole.

A slight modification of the above generalization is the general recognition of the mosquito as a villain. They smoke it out, but damp dark inner rooms, sometimes with uncovered pots left with water in them indefinitely, provide excellent breeding grounds for the mosquito.

Yet there is the continuous search for health. Perinatal mortality was reported frequently. Several older people in both Kounghani and Golmi could not recall how many children they had lost. In two cases, sudden infant mortality was reported and both asked, "but why?" The villagers do seek protection, a magical form, for themselves and their children through the purchase of amulets. With prolonged illness they seek help at the dispensary or, further on, the Bakel hospital. Almost every Head of Carre we interviewed reported a circumstance that obligated someone of his family to seek medical help as far away as Dakar, almost the only place in Senegal you would hope to find a measure of professional specialization.

Oral hygiene seems to be observed by many. The crushed tip of a twig taken from an indigenous tree serves as a popular form of toothbrush. Numerous cases of what looked like periodontal trouble, however, were observed in each of the villages visited.

Attempts to improve housing conditions through use of concrete rather than mud and wattle plaster over walls and floors were observed being done invariably by villagers with improved incomes from labor earnings and savings in France. The economic variable, at this stage, seemed to be associated with travel abroad, hence being exposed to a technologically more advanced culture, of which improved living conditions seemed to be a consequence. This relationship seemed to hold also in the case of dental work exhibited in gold caps on teeth which probably carried the added value of a status symbol.

A logical inference would indicate that improved means of subsistence through increased irrigated perimeters and improved agricultural technology would result in better capability for self-help in matters of sanitation and public health.

A distinctive feature of the "crop production project in the Bakel Region of Senegal" is its grass-roots, small size, self help character. It builds on the initiative, cooperation, and continued effort of the affected population.

iii.) Irrigation means "greater security from droughts and famines," we were repeatedly told by villagers who have already had an experience of irrigation farming such as at Gamal of the Matam area and the villages near Bakel. Assessing the experience of two years, a Gamal leader summed it up thus: "We have worked much harder, had much more food; we are not less healthy, but we merely broke even. When asked about what needs to be done, he answered, "More irrigated perimeters, enough land for each family to have a plot to farm."

The Sarakolle are basically herdsmen. Their wealth is in the head count of their cattle. Irrigated perimeters would be expected to introduce a factor of change in the means of subsistence, in available diets and, most probably, in basic sense of community. From observations elsewhere in Africa, land tenure tends to individualize people's behavior, and releases it from commitments of interdependence to a greater measure of independence in acquiring and accumulating wealth. Hence, the gradual disappearance of primal systems of dispersion of wealth.

No matter how you earn your wealth, whether through marital alliances, trading of cattle, or even, wages earned in France (as in the case of about one-third of the Sarakolle adult males), you are committed to share that wealth, first, with the immediate members of the extended family, then with "friends" who keep

pressuring you until you grudgingly give away the last franc. This is especially true of cash, less true of cattle, although butchering cattle for elaborate wedding and other feasts is a must. Begging, too, is an accepted form of wealth dispersion. It is not only the poor who beg. Grain supplies follow a dual system of communal and limited individual ownership. Everyone works on the carré's common field; the produce goes to a common granary. Almost every nuclear family, at the same time, is expected to have it's own private field. The crop from the private plot goes into a private granary. But then the head of the carré has the sole right, once the common granary is empty, to make the grain in the private stores available for the consumption of the whole carré. As would be expected, conflicts do take place over which "private" granary should be tapped first, even to the extent of family splits. A basic principle needs to be pointed out in this respect. The Sarakolle system strikes a balance between communality and individuality, between being an asset and being a liability.

With agricultural expansion there tends to be a release of labour from communal obligations leading ultimately to individualized ownership of the means of subsistence. Wealth differential often leads to a feudal-like system of relations. The nucleus of such a system already exists in the hierarchically structured Sarakolle society in which there are privileged classes and slaves. It would not be surprising if expanded agriculture reinforced the present

system until it places large land holdings into fewer hands, assigning a larger proportion of the community to serfdom. We cannot, however, predict with any confidence in what direction will the Sarakolle society change. All that we know is that the system has not changed much structurally, even with the continued one-way interaction with the outside world through the considerable number of men who work in Europe. They carefully conform to the obligations of their community once they return home. The Sarakolle society is far from being an empty shell. It is definitely solid.

Wealth differential entails privilege differential; hence, the probability of greater sanitary and nutritional advantage for a few, but comparatively worse conditions for many, unless the land-reform acts of the Senegalese government are carefully adhered to, and the proclaimed principles on which agricultural cooperatives of the SAED project of Bakel are strictly observed. Mass instruction in sanitation and personal hygiene must accompany all stages of economic development. Provisions of curative health care are long overdue.

iv) The most noticeable evidence of the solidity of the Sarakolle community may be found in the women's year-round schedule of work. The Sociological Survey appended to the Project Paper illustrates the load of work women carry from infancy into old age. During the dry season a contrast between males and females is observable. Men waste the days off dozing, chatting, or playing games under the shade of trees and man-made covered resting places. Women

meanwhile slave, carrying water, preparing food, pounding the grain in wooden mortars, plastering floors and walls as well as looking after their children and husbands. It is clear that irrigated perimeters do increase work for women. About as many women as men were seen preparing land for cultivation. It has also been reported that the wives of absent husbands take, or share with other families, plots of land to cultivate. The Farmers' Cooperatives were reported to have female members on them, one such cooperative having more women than men. The clear demonstrated consequence of irrigation farming means more toil for women in the fields which might mean an adverse health effect on their infants. We have nothing from the Bakel region to support such a conclusion. It is only an inference drawn from elsewhere in West Africa.

Precautionary measures will have to be taken for the sake of maternal and child health.

At this point, educating the villagers in the general benefits of the equitable distribution of labor by sex could be undertaken. Interest in the health of children, to be equally demonstrated by men and women, would be a good starting point of the discussion. Advancement in this respect will be very slow and no real breakthrough should be expected until there are sufficient schools for the education of all school-age children, both boys and girls. In the two villages we studied, the lack of teachers and facilities was a major reason for less than 20% of all school-age boys being actually in school. Far less than that was estimated of school-age girls. In relation to this discussion and all discussions of

health, sanitation, and hygiene the solution must include the education of women.

A hopeful observation in this respect is that class-lines seem to fade a little within the Farmers' Associations. The leadership has gone in many cases not to the recognized heads of villages but to members of much lower traditional status. The reason is that the latter most of whom have had an overseas experience in France, were found more experienced in reading, writing, accounting and machine operating. The knowledge related to the new, more-advanced agricultural technology seems to have been an impelling force resulting in the foregoing of tradition. Yet the Sarakolle community is far from being on the verge of a social revolution. Only feeble experimentations, with new forms of social relations are taking place. How rapidly will they spread? We do not know.

v) In order to estimate the probabilities of social change in the Sarakolle society we must first make an assessment of its present structures. The Sarakolle are a highly regimented stratified people whose various positions in the community have been ascribed by tradition. Humans are born males and females, nobles and slaves and "nothing could change that," not even accumulated wealth. While the Sarakolle recognize social practices for the dispersion of wealth, the practices that accumulated wealth in the hands of notables such as the nobles and the <u>marabouts</u> seemed to be more effective. The notables seem never to lose their advantage.

Among the factors that give the Sarakolle structure such solidity is the fact that they (the Sarakolle) continue to remember that they are themselves immigrants who have a sense of 'conversion' and mission. Hence, they are a people set-aside, whose emphasis is on their own rights as well as their own righteousness. The Sarakolle people are "good-hearted", we were told; "they extend hospitality to strangers, friends and foes." Their living is a religious duty. Fixed is the place of the individual which "does change neither upward nor downward in the community." Immobility is a virtue.

Paradoxically, however, many of the Sarakolle we interviewed expressed a sense of satisfaction with the one-way traffic of villagers to France. There is general recognition of the benefits. The Sarakolle do not starve during the years of drought because of income from overseas relatives. Those benefits also included an exhibition of expensive clothes, radios, bicycles, motorcycles, pots, pictures, photographs, and silverware. Some villagers have also recognized the value of mechanical devices long before SAED appeared on the scene, such as privately owned pumps for lifting water for gardening and brickmaking purposes.

On the surface, Farmers Cooperatives which use mechanical devices assisted by SAED technicians seem as if they are departures from tradition. Assistance and cooperation in matters of livelihood and means of production is an innovation. Yet the way a cooperative is organized very closely follows traditional lines. The notables "conceive" of the idea, and like comrades they discuss

it again and again among themselves smoothing out any differences of opinion until they reach a consensus. Then the whole scheme is discussed in public. But once consensus is publicly noted, the leadership is left to those who are better qualified. The new phenomenon is that technology introduced so far has been slightly ahead of indigenous capabilities--hence, the need to forego traditional lines of stratification. We have only to pose the question: is technology pulling the traditional structures apart? Or are those structures flexible enough to adapt themselves to innovations? We are pursuaded of the latter being the case.

The position with respect to the utilization of foreign expertise is a similar one. At one time all foreigners were suspect, but foreign technicians with SAED have established a place of respect and trust among the villagers. Nevertheless, other strangers such as the male nurse and school teachers will have to be kept "outside" of the village perhaps for many years to come. The difference lies in the fact that the foreigner continues to create a bit of excitement and curiosity and raises their hopes for "better things" to come. In this we observed the dynamics of a society which is open and closed at the same time. Living on hope, it cautiously allows in a little of the new, but still clings strongly to its past. This creates strains, perhaps tensions, to be sure, but this is an integral part of the process of development.

3. The status of the Sarakolle women should be expected to change as a consequence of irrigation farming. Several new factors have been introduced, all of which embody a significant departure from traditional principles and practices. For instance, women are not confined anymore to growing peanuts and working on the small private plots. They work side by side with men, as their equals, on the irrigated perimeters. Moreover, monetary dealings such as paying for technical services provided by SAED, gasoline, chemical fertilizer, seeds. and the selling of the produce for cash tend to remove the traditional sanctity attached to growing food for family consumption about which questions of ownership were not permitted. The end of season balance-sheet showing credits and debits will sooner or later invite questioning by the female members of the Cooperatives who, no doubt, will claim the right to decision-making. So far, the issue has not been raised on account of the newness of the operation and because the farmers just "broke even" at the end of each of the last two years. Already we have heard disgruntled voices from members of one of the older perimeters. People who have made a considerably greater work input will not remain satisfied for too long with only the excitement of the nouveau venture. They will demand sufficient economic returns to make the investment worth it.

Meanwhile the health of mothers and children may suffer. Prospectively, the key to the situation is the women who should become the center of an adult education activity aimed at better hygiene, sanitation, nutrition, maternal and child care, and family planning. Lucrative offers should be made to Sarakolle women in school to mobilize them for such

an important role in the education, not only of mothers and grandmothers, but also a whole generation of younger women who have been wed at a very early age (14 or 15 years) and left behind by husbands who had gone seeking their fortune in Europe.

It should be noted, though, that Sarakolle men do not whole-heartedly endorse a change in the status of women. Of the 19 heads of carré we interviewed, almost all gave a non-enthusiastic recognition of importance of educating young girls. They were split, almost equally, over the issue of employment of girls that would take them away to Dakar, or any city for that matter. Almost all of them, including their wives, would not accept that their daughters choose their marriage partners. "He has to be Moslem," said one. "I must know exactly who he is, of what family, and his character before I consent to marrying my daughter to him," said another. Most of them, though, had a non-qualified, "No, not under any condition would my daughter marry someone I did not choose for her." Of all the questions on the schedule of interviews, those about their daughters and the future generation elicited most controversy.

7. Next to female extension workers and health educators, the marabouts must be viewed as trusted traditional teachers who alone next to close kin have access to homes. Their traditionalism is a characteristic that must be contended with if a number of them were to be recruited as teachers. A starting point would be their own self-interest. In the village of Kounghani, younger marabouts seemed jobless. The income from land, mosque and shrine gifts, charges for Koranic classes for both young and old, charges for amulets were

enough some years ago. But they, too, suffer from the population explosion which increased their number faster than the economic "carrying capacity" of marabout villages.

Nevertheless, the marabout are a great social force in Senegalese society generally, a matter well recognized by the government. If an approach were to be found by which a few of their young may be recruited for health teaching, that by itself, would open doors for a successful adult education campaign.

It should be pointed out that the State Secrétariat de Promotion Humaine could conceivably be a possible channel for health education at the village level.

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