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The Sahel Epidemiological and
Environmental Assessments Project

Section I Part D
VOLUME THREE

Environmental Assessment for
Lampsar/Diagambal Irrigated
Perimeter Project - Senegal

Environmental Assessment for Lampsar/Diagambal Irrigated Perimeter Project - Senegal

AID Project No. 628-0702

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Authorized Under Contract No. AID/Afr-C-1253
SAHEL EPIDEMIOLOGICAL AND ENVIRONMENTAL ASSESSMENT PROJECT

March 1, 1977

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ENVIRONMENTAL ASSESSMENT

Lampsar/Diagambal Irrigated Perimeter Project -- SENEGAL

by

Charles C. Johnson, Jr., P.E.
Vice President
MALCOLM PIRNIE, INC.

Introduction

The Agency for International Development and the International Bank for Reconstruction and Development assembled a design team to evaluate the irrigation projects designed for three perimeters in the Delta area of the Senegal River. One aspect of the evaluation involved an environmental assessment and accompanying recommendations of the Lampsar and Diagambal perimeters. Particular attention was to be given to the Diagambal perimeter with sufficient consideration of the project as a whole to assure that any major environmental health issues were identified. The specific scope of work and terms of reference are included as Appendix I. Composition of the design team, itinerary, officials contacted are included in Appendix II.

The Lampsar-Diagambal perimeters are located northeast of St. Louis, Senegal, along the St. Louis-Rosso Road, between the townships of Lampsar and Ross-Bethio. The Lampsar perimeter, located on the north side of this road is traversed by the Lampsar river or marigot. It includes approximately 1500 ha to be developed at this time. The Diagambal perimeter is south of the road and includes 1,000 ha to be developed. A map which illustrates these locations and identifies many of the villages in the project is included as Appendix III.

As designed, the Lampsar perimeter will be irrigated by surface flooding and controlled drainage. The Diagambal perimeter will use sprinkler irrigation. The project is the further implementation of the plan by SAED to develop approximately 44,000 ha in the delta area by 1975.

Information in the report results from a review of selected previous reports, field trips to some existing projects and to the project sites, visits to villages and health facilities in the area, and discussions with GOS officials and others knowledgeable about the proposed project and the region. The report that follows is an analysis and synthesis of the data and information resulting from these contacts. The basic data and information is included as Appendix IV. A bibliography which served as the primary reference source is included in Appendix VII.

Analysis and synthesis of data and information:

Information and data presented as Appendix IV provide the basis for a discussion of the project impact on land use, water resources, ecology, and biology, and public health in the river region. Each of these subjects is discussed in the paragraphs that follow.

1. Land Use

There are 17 villages adjacent to the Lampsar perimeter and 11 villages adjacent to the Diagambal perimeter which are said to be affected by the project. Another 3 villages in the Lampsar area could be affected. The population of these 31 villages is estimated to be 8,200. In the general area there are an estimated 1,000 nomads that also will be affected. To be affected means that the labor to

work the perimeters can and will possibly come from these villages. An additional 10 villages in the general area of the project having an estimated total population of 3,000 are said not to be concerned with the project. An estimated 1,600 villagers are needed to provide the labor for the fields.

It is not anticipated that any of the villages will have to be relocated to implement the project. It should be possible in most instances to assign groups to lands near their villages. Further it should stabilize the villages of the nomads that are affected by the project. Most of the land in the perimeters is either unused, devoted to dry farming, recession farming or grazing. In terms of the project perimeters there will not be any noticeable change in land use, i.e., farming will still be the predominant use. Any relative effect will be felt by the herdsmen who reportedly already feel cramped as more and more pasture land is converted to irrigation farming.

The ready availability of water near the villages may give rise to the development of small multicrop gardens as the villagers are exposed to new farming techniques and new crops. This change was observed to occur in villages adjacent to other operating perimeters in the Delta.

2. Water resources

The existing quality of water resources in the Delta will not be significantly affected by either the Lampsar or the Diagambal projects. This statement is predicated on the basis that the project perimeters represent only a small percentage of the lands already under irrigation or programmed to be placed under irrigation in the river region. Table 1 that follows indicates this relationship.

Table 1

PROGRAM FOR IRRIGATED LANDS

DELTA AREA-HECTARES

Location/year	1977	1978	1979	1985
Lower Delta	8,600	11,700	13,400	13,400
Upper Delta	4,600	4,600	7,500	8,500
Lower Valley	1,800	1,800	2,600	21,800
Total	15,000	18,100	23,500	43,700
Project Area				
Diagambal			1,000	1,000
Lampsar		1,500	2,200	2,200
		1,500	3,200	3,200

It is suspected that the ground waters are already contaminated by fertilizer, herbicides, fungicides, and pesticides used extensively on the other developed perimeters throughout the Delta. The only question is one of degree. A complete chemical analysis should be undertaken to determine the nature and quantities of chemicals in the ground water.

Surface flooding is the primary method of irrigation in the Delta and this has been practiced without water control. The introduction of the water control flood irrigation to the Lampsar perimeter should reduce the volume of irrigation water that percolates to the ground water within the perimeter. To avoid discharge of drainage water to the Lampsar marigot, which is a raw water source for the city of St. Louis, the drainage water from the Lampsar perimeter is discharged to 3 other depressions adjoining the project to be dissipated through evapo-transpiration and percolation. Thus the advantage of using controlled water technology which reduces possible groundwater pollution is lost, to the Lampsar project.

The introduction of sprinkler irrigation, which has been designed for the Diagambal project, provides the least, and practically a negligible impact on water sources. Since the design of the system discharges water only in the amount required to meet the moisture needs of the plant little or no surplus water is available for surface run-off or percolation into the ground.

Because of the relatively high ground water table that exists throughout the Delta, the reliance of the villagers on shallow, dug, open bucket type wells, and the extensive use of chemicals for

farming, the quality of water for domestic use is not bacteriologically and may not be chemically safe for human consumption. These are conditions that exist now and they will continue to exist regardless of the pending project.

3. Ecology and biology

The ecology and biology in the river region are not likely to be influenced in any measurable degree by the proposed projects. The two perimeters border both sides of a main highway connecting the communities of St. Louis and Richard Toll. Because of the human activities in the area no wildlife of any substance exists near these perimeters. A few marsh areas exist at low points in the terramin, but most of these dry up during the dry season. No true marsh environments were observed to exist in the project area. Such an environment may be created in the future if a second and third crop are introduced to the perimeters as more irrigation water is made available. The possibility of creating marshes exists because of the planned disposal of drainage water from the Lampsar perimeter by surface spreading to depressions adjoining the two perimeters. If this occurs, the year around availability of fresh water may encourage the increased propagation of snails in the area. A surveillance system should be established and maintained to see if snails are introduced into the area.

At the present time it does not appear that snails of the family Bulinus, the intermediate host of schistosomiasis are prevalent in the area. The local people claim that snails are rarely seen. The Yale epidemiological study team found a few specimens in the raw water canal to the water treatment plant during the

course of this visit by the writer (February 1977). At least this confirms their presence in the area.

The growing of a single crop, which occurs during the wet season should not be an additional problem in the area. During the wet season, because of rain, run-off, and flooding of the Delta, water is plentiful and mosquito breeding is prolific.

If, and when, a second crop is introduced to the Lampsar Perimeter during the dry season, there is a real possibility that the mosquito breeding season, and consequently the malaria transmission season, for the area could be extended. The probability of this happening and the duration of the extension will depend on the length of time it takes the depressions, to which the irrigation drainage water is discharged, to dry up. Any continuous availability of moisture in these depressions can also be expected to support mosquito breeding, and a growth of cattails and other moisture loving plants indigenous to the area.

The Diagambla project does not add to either the anticipated snail or mosquito breeding problems in either the wet or dry cropping seasons. As has been noted, the use of sprinkler irrigation allows a minimum application of water to the plants, without run-off or drainage as is the case with surface flooding.

Pesticides are reported to be used frequently and in substantial doses throughout the region. Reports of DDT resistant mosquitoes were made by the Yale team and others. If this is true the effective use of DDT for mosquito control and the subsequent control of malaria has been reduced. The ecological impact of the use of other insecticides (HCH, Basudine), the herbicides (propanine, glyphosate,

molinate), and the fungicides (zinebe, difolatan, mancozan) was not determined. Based on the chemical physical characteristics of all but DDT and HCH, their environmental impact should not be significant. (See Table A4-5 Appendix 4)

4. Public Health

It is not possible to separate the health problems of the villager in the project areas from those of the inhabitants in the River Region. No specific statistics exist that would make such a distinction possible. Malaria and intestinal parasites were the primary health problems reported by the laboratory, clinics, and dispensaries in the region. The role of viral diseases in the health of the population has not been defined. It is suspected that hepatitis may be an important problem.

Very little is being done or planned to alleviate these diseases in the region. There does not now exist any visible effort to control malaria by spraying, larviciding, canal maintenance, or administering of anti-malaria drugs to the population in general. In some situations pregnant mothers are given an anti-malarial prophylaxis, as are some workers in larger industrial complexes. It is estimated that one can expect better than 5% down time in the labor force to be associated with illness from malaria.

Similarly, little if anything is being done to reduce the incidence of diarrheas, dysenteries, and intestinal parasites in the region. Such an effort will require the introduction into each village of (1) a safe source of water supply for domestic use, (2) an effective means of disposing body and household waste, (3) some minimal improvements in housing and an educational program

that helps the villagers appreciate why such changes are beneficial to their well being.

The absence of the transmission of schistosomiasis in the River Region continues to be a mystery to researchers and practitioners in tropical medicine that visit the region. All the conditions necessary to its transmission are believed to exist. Infected persons, the intermediate host, the snail, and fresh water required for transmission of the disease are found in the region. The continued development of irrigated lands and the ultimate provision of fresh water for year round farming may enhance the possible introduction of schistosomiasis to the region.

The mounting of a sound preventive public health program in the River Region is believed to be essential to the ultimate and long range success of agricultural exploitation of the region. While the institutional framework for such a program exists on paper, in reality the funds, staff, facilities, and programs are not now available for such an undertaking.

Regardless of the foregoing discussion it can be concluded that the Diagambal project will not cause a further deterioration in the health of the villager in the Delta. It is possible that the Lampsar project could have a detrimental effect when two crop farming is practiced and should the drainage water from the perimeter result in an extension of the mosquito breeding season or the propagation of large colonies of snails associated with schistosomiasis.

Recommendations

Development of the irrigated perimeters at Lampsar and Diagambal

represents but a small percentage of the actual, and total proposed perimeters to be developed in the river region. Consideration of the public health and/or water pollution concerns resulting from their development cannot readily be separated from the impact of what is happening in the region as a whole.

As noted previously, the Diagambal project with sprinkler irrigation does not present any harmful impacts on either the public health or the environment. One possible problem may be associated with the location of water under pressure in the close vicinity of villages. There will be a temptation to use this unsafe water for domestic purposes. The provision of safe water in the villages of the region would eliminate this hazard.

The potential public health problem associated with the drainage water from the Lampsar perimeter can be modified by concerted action on the part of the SAED and Regional Health Authority. Basic to the development of irrigation perimeters throughout the river region (and elsewhere in Senegal) is the establishment of effective vector control programs. In the river region, as a minimum, such programs should be considered as an integral element of the normal operations of the SAED. It should include as necessary, and as determined by routine monitoring and surveillance techniques, programs for malaria control and schistosomiasis prevention. A malaria control program may include any and all of the following: routine clearing and maintenance of irrigation canals to reduce mosquito breeding in the canals, and water seepage from the canals; larviciding of mosquito breeding areas in and adjacent to the perimeters; residual spraying of living areas, particularly sleeping

quarters of villagers and others in the region; distribution and use of anti-malarial prophylaxis as recommended by medical authority for the area. While malaria may not be eradicable from the region, its incidence can be reduced and the severity of its illness impact lessened. A suggested scope of work for a demonstration vector control project in the Lampsar/Diagambal perimeters is included as Appendix V.

The schistosomiasis prevention program should include a baseline study to determine (1) the location, prevalence, and infection rate of the snail (Bulinus) in the region; (2) the reservoir of and infection rate of the permanent population and migrants to the region, and (3) the subsequent establishment of a continuing surveillance program to alert the government to any increase in schistosomiasis in the region. While such a program should be incorporated into the operating responsibility of the SAED, the technical implementation probably would best be handled by the Regional Medical Authority.

The development of irrigated perimeters in the River Region may have contaminated the shallow ground water with fertilizer and pesticides. The health impact associated with the intake of water containing such agents is not specifically known. When chemical analysis reveals their presence, preventive health practice recommends that other known safe sources of water be used if such sources are available. Since the water sources of the villagers also can be considered unsafe from bacteriological and probably virological contamination, it is recommended that plans be developed and implemented that assure a safe water supply source to each village in the region. A suggested scope of work for a demonstration project for a village water supply system is included as Appendix VI.

Alternatives to the planned irrigation techniques that could reduce the project impacts on public health and/or water pollution include the following:

1. Do not implement the project. Such an action would continue the present practices as they now exist. It does not fit the national program being implemented in the region. The potential for improved income and nutritional levels would be lost. The public health in the villages would not be improved. This alternative is not recommended.

2. Convert the Lampsar perimeter to a sprinkler irrigation system. This would enable irrigation to be practiced, eliminate the problem associated with the discharge of drainage water, and reduce the percolation of contaminated water to the ground water table. It would require substantial time for redesign, increase the capital and operating costs substantially, and cause serious delays in the GOS plan for development of the river basin and production of foodstuffs to help it gain self-sufficiency. The improvement in the public health and reduction in water pollution would not be of equal importance. This alternative is not recommended.

3. Recirculate all of the drainage water in the Lampsar perimeter. This would eliminate the problems associated with discharge of the drainage water to depressions adjacent to the perimeters. However, it could also limit the useful life of the perimeter for food production if recirculation results in a salts build-up in the soil. The primary purpose of these projects is long-

term food production to help meet the requirement of the country. This alternative is not recommended.

The OMVS environmental assessment of the Senegal River Basin that is being implemented as AID Project 625-0617 will produce a more definitive picture of the overall impact of introducing irrigation to the basin in general and the river region of Senegal in particular. The recommendations resulting from that study will produce the best basis for developing a major preventive health program by the GOS, AID, and other donors.

Nothing under this discussion of recommendations should be construed as a reason for delay of these projects pending further study or implementation of activities associated with recognized environmental improvements or health protection. Neither should consideration of the health needs be unduly delayed. It must be accepted that healthy villagers are essential to the continuing success of the SAED development of the river region.

APPENDIX I

SCOPE OF WORK AND TERMS OF REFERENCE

Environmental Assessment
Lampsar/Diagambal Perimeters
Senegal

Mr. John Eason
APHA

AKR/DR/HN: Edward B. Cross, M.D.

Request for an Environmental Health Specialist for Senegal (Lampsar-Diagambal)

We are herewith requesting your service to supply an Environmental Health Specialist to participate in a design team, with IBRD, as required to conduct an environmental health assessment and make recommendation for the Lampsar - Diagambal irrigated perimeters in the Delta area of Senegal as follows:

Scope of Work and Terms of Reference

I. Introduction

The contractor is to participate in a design team led by the IBRD to design the Lampsar-Diagambal irrigated perimeters project in the Delta area of Senegal. As AID financing will be directed exclusively to Diagambal, a 1,000 hectare perimeter to be irrigated using sprinkler systems, the contractor is to direct his attention primarily to the tasks outlined below as they relate to Diagambal. It is, however, important that sufficient attention be given to the project as a whole to assure that any major environmental health issues are identified.

II. Duration of Services

January 25, 1977 - Washington, D. C. (AID) for briefing on assignment
February 1, 1977 - In Senegal conducting assessment
to
February 18, 1977

3 days, TDY Washington, D.C., for debriefing when requested.

III. Personnel Required

An Environmental Health Specialist with knowledge of tropical vector-borne diseases, especially schistosomiasis.

IV. Scope of Work

The contractor, working with the administrative and technical personnel, of the AID mission and IBRD designation and other necessary Senegal governmental officers shall:

A. Collect and organize all necessary data pertaining to public health in target area particularly and Senegal in general. Data on vector-borne diseases where irrigation provides or may provide breeding habitats for disease vectors (schistosomiasis, malaria, dengue/hemorrahagic fever, etc.) should be collected to the maximum detail available.

B. Collect and organize data on fertilizer and pesticide use, and proposed use (especially nitrogen and phosphorous), both in the project area and in other on-going projects of a similar nature meteorologically, geographically, and developmentally.

C. Collect and organize data on run-off and drainage, both real and potential from the project area, downstream uses of the water, etc.

D. Through interview and observation, make an assessment of the present Senegal institutional capabilities, especially in the target area in public health and communicable disease control programs.

1. Detailed assessments must be made of capabilities for the control and the possibility of further extension of schistosomiasis and other vector bourne diseases associated with wetland crop production which are peculiar to Senegal in general and the target area in particular. This would involve collaboration with team members for environmental health assessment, such as at St. Louis lab.

E. Through interviews with GOS representatives and other observation, make an assessment of theGOS and target area capabilities for monitoring and controlling down-stream and in-project water pollution from fertilizers and pesticides which might result from the project.

F. Analyze and synthesize data and information collected to satisfy items (A through E) above in order to present a comprehensive picture of the present situation and institutional adaptabilities regarding the project area and any other areas which may be affected by the project and its activities.

G. Based on the above synthesis and analysis, make necessary recommendations for the following:

1. Possible or potential project modification requirements which may be required to eliminate or lessen deleterious effects which the project may produce in the public health and/or water pollution environments.

2. Possible or potential institutional modifications which may be required to monitor, lessen, and/or eliminate deleterious public health and/or water pollution hazards which may result from or be increased due to project activities.

3. Examine alternatives as they might affect public health and/or water pollution, with recommendations.

4. Recommendations for further studies to be taken for satisfaction of AID's environmental assessment requirements.

V. Reports

A final draft report must be submitted to AID no later than 30 days after completion of field operation.

Appendix II - 1

Composition of the AID/IBRD Design Team
DEBI - Lampsar/Diagambal Irrigation Project

From IBRD:

Jean-Louis Ginnsz, Group leader
Gois, irrigation engineer
Weinberg, agronomist
Brown, loan officer
Dialanas, hydraulic engineer
Dubois, agronomist
Daher, economist

From AID:

Jay M. Bagley, Ph.D., irrigation engineer
Peter B. Hammond, Ph.D., anthropologist
Charles C. Johnson, Jr., environmental engineer

From AID/Dakar

Glenn Slocum, coordinator

Appendix II - 2

Itinerary and Schedule

Jan. 25: Briefing AID and World Bank, Washington, D.C.

Jan. 31: Depart Washington, D.C., for Dakar

Feb. 1: Briefing AID/Dakar - Depart for St. Louis

Feb. 2: Briefing SAED - Journey to Debi, Lampsar and Diagambal perimeter sites

Feb. 3: Journey to Nianga and Dagana perimeters. Discussions with perimeter officials, review of operations, and village relationships.

Feb. 4: Literature and reference review session.

Feb. 5: Visit with Yale University study team, Director Regional Laboratory, and Dr. Vincent (in St. Louis) Journey to village of Savoigne

Feb. 6: Literature and reference review session

Feb. 7: Journey to Socas, commercially developed perimeter - pivot sprinkler system

Feb. 8: Visit three field dispensaries and adjacent villages - Ross-Bethio, Kassad Sud, and Savoigne - also village of Diagambal

Feb. 9: Visited all day with Dr. LeMasson, Director Regional Laboratory

Feb. 10: Report preparation

Feb. 11: Debriefing, SAED officials, travel to Daka Briefing AID/Dakar

Feb. 12: Report preparation

Feb. 13: Report preparation

Feb. 14: Report preparation

Feb. 15: Depart Dakar

Officials contacted

AID/Washington

Mr. James Graham, Design Research Officer
Mr. Steven Edleman, Consultant
Mr. Joseph Howe, Engineering Branch
Mr. Dennis Baker, Desk Officer/policy arm
Mr. Harold Gray

AID/Dakar

Mr. Norman Schoonover, Regional Development Officer
Mr. Arthur Fell, Deputy Regional Development Officer
Dr. Mark Vincent, M.D.
Mr. Glenn Slocum, Project Coordinator

SAED

Mr. Cheikh Cissokho, Director General
Mr. Papa Syi Diagne, Deputy Director
Mr. Robelin, Irrigation Engineer (French tech. assist.)
Mr. Villocel, Irrigation Engineer to replace Mr. Robelin
Mr. Fall, Deputy Director
Mr. George Zaballone, Coordinator de Perimeter
Mr. Sy Oeismane, Nianga Perimeter, Senior Official
Mr. M. Fediore, Director de Perimeter, Dagana
Mr. Flinois, Irrigation Engineer, Socas

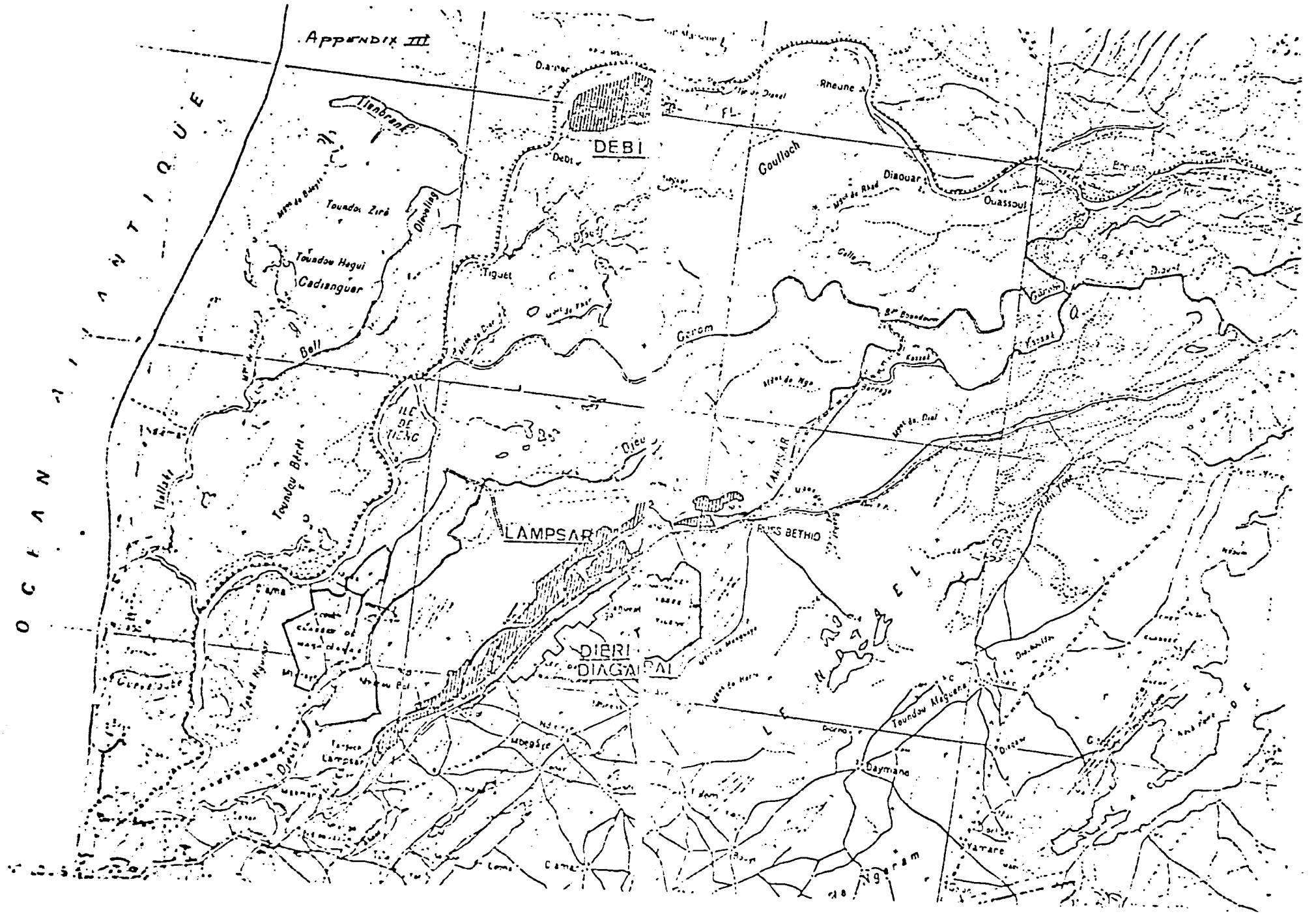
Regional Laboratory - St. Louis

Dr. Jean-Maire LeMasson, M.D., Director

Yale University study team, St. Louis

Dr. Wilbur Downs, M.D., Principal Investigator
Dr. Curtis Patton, M.D., Parasitologist
Mr. Phillip Goldstein, Research Assistant, Parasitology
Dr. Andrew Main, Ph.D., Medical Entomologist
Mr. Kirby Kloter, Research Assistant Entomology

Appendix III



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Feb. 13: Report preparation

Feb. 14: Report preparation

Feb. 15: Depart Dakar

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Yale University study team, St. Louis

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Mr. Phillip Goldstein, Research Assistant, Parasitology
Dr. Andrew Main, Ph.D., Medical Entomologist
Mr. Kirby Kloter, Research Assistant Entomology

Appendix IV

The scope of work and terms of reference (see Appendix I) associated with the Lampsar/Diagambal irrigated perimeter project requires that specific background information be obtained as a basis for evaluating the project. The information requested is found in items A through E of the scope of work. Each of those items is discussed in this appendix.

A. PUBLIC HEALTH PROBLEMS - Collect and organize all necessary data pertaining to public health in target area particularly, and in Senegal in general. Data on vector borne diseases where irrigation provides or may provide breeding habitats for disease vectors (schistosomiasis, malaria, dengue/hemorrahagic fever, etc.) should be collected to the maximum detail.

The public health problems in the target area are similar to those that prevail throughout the Senegal River Basin. These are characterized by endemic tropical diseases that vary in intensity, and when absent from an area often have the potential for establishing themselves if small modification in environmental conditions occur. In addition, the diseases associated with poor sanitation and an unhealthy living environment exist in large measure throughout the basin,

In recent years (1968-1974) these health conditions were further aggravated by a widespread drought that caused a severe reduction in the production of food and heavy losses in the livestock herds. In Senegal in the 1972-73 dry farming year, cereals were down from 28,500 tons per year from previous levels of 95,000 tons per year. Irrigation farming was down to 15,000 ha. and 6,000 tons of rice from 60,000 tons previously. Further, livestock herds, cows, sheep, goats, were reduced by 20 percent. Because of these conditions which were sustained over a period of several years, malnutrition and hunger (sometimes starvation) were added to the already heavy burden of parasitic and bacterial diseases believed to prevail throughout the population. Thus, the growing of food and increasing livestock herds for feeding the population became the number one priority in the country, to prevent malnutrition and hunger from becoming a major health problem and to relieve dependence on outside relief in furnishing of such supplies.

Within the foregoing framework a further discussion of endemic diseases of particular interest in the target area will be pursued. In this instance the target area will be defined as the whole of the delta, from St. Louis to Dagana, as this constitutes the river region, coincides with the medical and public health organization serving the region and makes possible the discussion of the limited health statistics which indicate the prevalence of some diseases in the region. It is important to recognize that the statistics associated with the diseases do not represent levels of infections

existing in the total population, but rates of infections found in patients visiting the several medical facilities existing in the region or special studies conducted in the area. Also, the infection rates indicated are not necessarily specific for the disease entity cited as no laboratory confirmation was undertaken in some instances, i.e., most fevers are reported as malaria. It can be expected that true prevalence rates will be higher as many villagers become ill and recover or die without seeing a physician or visiting a dispensary. Within these limitations a discussion of diseases generally associated with human contact or use of water is presented in three forms - (1) diseases with high prevalence rate, (2) diseases for which prevalence is not well known, but sporadic epidemics have been observed, and (3) diseases not found among inhabitants of the delta, but for which vectors and reservoirs exist.

High prevalence rate

Malaria - Clinical statistics based on 277,000 visits to 10 dispensaries in 1973 (end of drought) indicated 15 percent of the patients had malaria. When the rain started again in 1974 this percentage increased to 20 percent and in 1975 to 30 percent. These increases indicate a relationship in the region between suspected malaria cases and rainfall (water for mosquito breeding). Incidence rates of 56 percent have been reported in the river region and 48 percent in the Ferlo. Also that generally speaking 76 percent of all the population below 30 years provide positive findings for malaria.

Several species of A. Gambia are found in the region - Melas A & B. A. Gambia Melas B is suspected of being DDT resistant. A. Gambia is believed to be the primary vector for malaria transmission although other Anopheles mosquitos common to the area are capable of its transmission.

Prevalence rate not well known

Intestinal parasites - Based on 5,000 stool examinations in 1971, 1973, and 1975 indicated a 1 percent positive for stronglyoidiasis and 3 percent positives for Amaeba (entamoeba histolytica) with a peak in 1973 of 8.8 percent. Ancylostomiasis (hookworm disease) indicated 1 percent in 1971, 1.3 percent in 1973, and 2.9 percent in 1975.

Bacterial diseases - Leptospirosis is known to exist in Dakar-no more specific information was available. Cholera outbreak in Dakar 1970-73; 251 suspect cases, 44 vibrio isolated; August to September 1971, 11 vibrio isolated in Podor region of the valley, nothing in the region since. Salmonellosis and shigella identified in hospital population by Pasteur Institute in Dakar. During a period of nine years (1963-1973) 2,894,000 cases of salmonellosis identified, and 1,610 shigella cases identified. Laboratory specimens were from hospital patients only; patients were from locations throughout Senegal. In Saint Louis in 1975, 25 cases of salmonellosis were identified in the hospital population.

Diseases not found, but vector and reservoirs present

Schistosomiasis is probably the most important of this category of diseases. The snails (intermediate host genus Bulinus) are said to be found in the delta swamps, marigots, and canals. A Yale University epidemiological study team found Bulinus snails

in the canal carrying water to the water treatment plant that served Saint Louis as recently as February 9, 1977. They are very prevalent around Lake Guier in the valley region. While this does not seem to be a problem in the more permanent population in the delta, there is considerable migration of persons from other regions where schistosomiasis is endemic. The examination in 1973-1975 of 3,500 urine specimens from students at the institute in Dakar seen by referral revealed a 5.3% positive for schistosome flukes. A report by experts in 1960 of a study on students at the technical school indicated that 35% of the students were infected with schistosomes. Most of these students were from the southern portion of Senegal. These studies confirm the existence of a reservoir of infection of schistosomiasis in Senegal (See figure A4-1). Further to the north of the delta and on into Mali the prevalence is estimated to increase from 10% to 40%. It is estimated that 60% of the cattle in the area have the disease.

Faciolopsiasis has been recognized by the Pasteur Institute in Dakar three times in the last nine years. Veterinarians believe they are finding a lot of the flukes in cattle in the region. The snail has also been identified as an intermediate host. The snail vector is reported to be widespread in waters of the delta (Lampsar, Djeuss, Njalom). The Yale University epidemiology study and the WHO study in the area are looked to shed more light on this disease.

In the foregoing discussion viral diseases were not included. Apparently there is little information against which to make

Figure A4-1

Distribution of Schistosomiasis
in
Senegal

Bilharziose urinaire au Sénégal

3e journée médicale de Dakar.
C. 1965

estimate of their occurence. Discussions with inhabitants in the regions (expatriates) suggest that viral hepatitis does exist and may be widespread.

B. Fertilizer and Pesticide Use

Collect and organize data on fertilizer and pesticide use, and proposed use (especially nitrogen and phosphorous), both in the project area and in other on-going projects of a similar nature meteorologically, geographically, and developmentally.

Fertilizers and pesticides are used on an organized basis throughout the river region. Chemicals are applied to prevent occurence of unwanted plants and animals (pesticides) and to increase available plant nutrients (fertilizers). After application pesticides persist in the soil until they are degraded to less harmful compounds or are removed from the soil by washoff or leaching. Fertilizers are applied as a supplement to nutrients present in the soil profile. Typically, only 5 to 10% of the applied phosphorous and about 50% of the applied nitrogen is recovered in the crop. The remaining nutrients can be retained in the soil in unavailable forms, or lost by volatilization, leaching, and surface washoff. Excess fertilizer is available for contamination of surface and ground waters. Drinking water containing high nitrate concentration can cause methemoglobinemia in small children. High nitrates in water can result from fertilization of farm lands.

The fertilizers in use in the region include a complex: 16-48-0 (urea 46% NH4) and KCL (potassium chloride). Fungicides were identified by trade names ZINEBE (zinc and sulfur), DIFO-

LATAN (similar to captan) and MANCOZAN (manganese and zinc). The insecticide used is basically DDT, although HCH (hexachlorocyclohexand) is used around the seed beds for tomatoes. Herbicides include STAM (propanil), glyphosate, and molinate.

Fertilizers, fungicides, and pesticides are applied in both dry and liquid form. Irrigation techniques dictate whether a dry or liquid application will be used. For tomatoes the fertilizer is spread on the bottom of the furrows before and after planting. A slow stream of water introduced to the furrow dissolves the fertilizer into the soil where it sinks over 4 to 5 days of irrigation to the root zone of the plants. For wheat, where surface spreading water is practiced, the fertilizer is spread in a liquid form. The following tables (A4-1, A4-2, A4-3, A4-4) illustrate the use of fertilizer, fungicides, and pesticides by the SAED. It can be seen that the total amount of chemicals applied to the soils is dependent on the number of hectares allocated to each crop and the number of crops planted each year. Each of these conditions is subject to change each year.

Table A4 - 1

Fertilization of Tomatoes

Purpose of fertilization	Growth stage	Type of fertilizer	Application rate kg/ha
		Complex 16-48-0	350
1st application	Before transplanting	KCL	350
	Flowering	UREA	100
Subsequent application	Budding	Complex 16-48-0	100

Table A4 - 2

Fertilization of Wheat

Purpose of fertilization	Growth stage	Type of fertilizer	Application rate kg/ha
		Complex 16-48-0	150
1st application	Before planting	KCL	100
	Sucker (buds)	UREA	150
Subsequent application	Wheat forms	UREA	100

Table A4 -3

Field Treatment of Tomatoes Illustrating Periodicity of Chemical Application Crop

Date	Chemical	Dose kg/ha
12/21	Zinebe (zinc, sulphur)	1.6
	UREA (46% nitrogen)	0.5
	DDT	1.5
1/8	ZINEBE	1
	UREA	2
	DDT	2.5
1/28	ZINEBE	3
	MANCOZAN	3
	UREA	2
	DDT	2.5
2/8	DIFOLATAN	3
	DDT	2.5
2/19	ZINEBE	3
	DDT	2.5
3/5	ZINEBE	3
	UREA	2
	DDT	2.5
3/14	MANCOZAN (manganese, zinc)	3
3/21	MANCOZAN	3

Note: Fixan C is added to each treatment at the rate of Ikg/ha.

Table A4 - 4

Annual Application Rate of Fertilizer by Crops

Crop	Season	Fertilizer	Application rate - kg/ha
Rice	wet	Complex 16-38-0	125
		UREA	250
Wheat	dry	Complex 16-48-0	200
		UREA	250
Millet	wet	Complex 8-18-27	200
Tomatoes	dry	Complex 16-48-0	300
		UREA	350
Potatoes	dry	Complex 10-10-20	600
		Potassium sulphate	100
Onions	dry	Complex 16-48-0	250
		Complex 8-18-27	100
		UREA	100
		Super phosphate	150
		Potassium sulphate	100
Green beans	dry	Complex 16-48-0	350
		Complex 8-18-27	100
		UREA	250
		Super phosphate	300
		Potassium chloride	300

An attempt was made to obtain the types and application rates of herbicides, rodenticides, and pesticides applied to the rice crops. Except for one insecticide, Basudine (a phosphorus compound), which was applied at 5 kg/ha at Dagana to control borer worms, this information could not be determined. The following chemicals were used in the rice fields:

Chemical	Purpose
HCH (hexachlorocyclohexane)	Insecticide control - sauterrelles
Basudine (phosphorus base)	Insecticide control - borer worms
DDT	Insecticide control panaises - bed bugs
Ratilan (anti-coagulant)	Rodenticide control - rats
Glyphosphate	Herbicide
Stam (propanine)	Herbicide
Mancozan (manganese, zinc)	Fungicide
Ordram (molinate)	Herbicide
Fixan C	To fix powder on plants

From a general viewpoint, pesticide compounds of particular interest are those that are non volatile and biologically stable. Pesticides that fit this mode present a problem in that they may leave the targeted area on sediment and in the water flowing across or through the soil. The distribution of a pesticide with time within a soil profile depends on its interaction (absorption-desorption) with the soil matrix and the rate and direction of soil water movement. The physical/chemical characteristics of pesticides reported to be used in the River Region are shown in Table A4-5. These characteristics suggest that, except for DDT and HCH, environmental problems associated with their use should be minimal.

Table A4 - 5

Characteristics of Pesticides in Use

Pesticide and use	Solubility ppm of °c	Voltalization kg/ha/yr	Leaching-CM 150 cm/yr rain	Surface runoff water	Surface runoff sed.	Degredation	Persistence	Carryover yr. to yr.
Fungicides *								
Zinebe (zinc & sulfur)(zinc ethylene bisdithiocarbamate)	very slight	Lo.1 kg/ha/yr	10-20 CM/yr	Low	Low	Rapid	Not	0
Difolatan=captafol= foloid, similar to captan	3.3 ppm 25°C	2 kg/ha/yr	L 10 Cm/yr	Low	N.A.	Rapid	0-2 weeks	0
Mancozan - mancozeb (manganese & zinc)	very slight	L0.1 kg/ha.yr	10-20 CM/yr	No	Poss.	Not		0
Herbicides								
Stam-(propanine= propanil) (3',4' dichlorophenyl-propionanilide)	140 ppm 30°c	2 kg/ha/yr	5 CM/yr	Neg.	Neg.	1-2 days	Little	None
Glyphosate = roundup (Nphosphonomethyl glycine)	Very 25°c	Negligible	Low	Low	Low	Moderate	Little	None
Ordram=hydram Molinate (S-Ethyl hexahydro-14-azepine -1-carbothioate)	Insoluble	High	Moderate	Low	Pos.	Moderate	Little	None

Pesticide and use	Solubility ppm of °c	Voltalization Kg/ha/yr	Leaching-CM 150 cm/yr rain	Surface runoff Water	Surface runoff Sed	Degredation	Persistence	Carryover yr. to yr.
Insecticides* HCH=Lindane-BHC (hecachloro-cyclohexane)	10 ppm 20°c	5 kg/ha/yr	L10 cm/yr	Nil	Minor	Very slow	Very persistent	Yes
DDT	Insoluble	L0.1 kg/ha/yr	L10 cm/yr	Low	High	Very slow	Very persistent	Very high
Basudine=Diazinon (0,0-diethyl 10-(2-isopropyl-4-methyl-6-pyrimidinyl phosphorol-hioate)	40 ppm 20°c	5 kg/ha/yr	10-[illegible] cm/yr	Poss.	Poss.	Mod.rapid	4-6 weeks	0
Rodenticide Ratilan-anticoagulant								
Adherent Fixan-C (fix powder on plants)								

* Source: EPA Manual - EPA-600/2-76-151 (app. G-2), May 1976.

C. Runoff and Drainage in the Delta

Collect and organize data on runoff and drainage, both real and potential, from the project area, downstream uses of the water, etc.

The Senegal Basin is drained by the Senegal River. The low flat characteristics of the basin downstream from Bakel, Senegal, causes an extensive but poorly defined flood plain all the way to the mouth of the river near St. Louis. A difference of a few centimeters in the river flood stage can make a great deal of difference in the amount of area that is inundated. The flood plain in the delta is dotted with low depressions that become filled with water during each normal flood season.

The topography varies very little in the lower delta with elevation from 0.2 to 1.9 meters and an average of 1.0 meter. The Dieri (dunes) have elevations from 2 to 15 meters and slopes that vary from 10 to 20%. This area is drained by marigots (Lampsar, Djeuss, and Njalam primary ones) which help drain the area back to the Senegal River.

Rainfall is light, about 250 mm/year, with most of this (95%) occurring between the months of July and November. The accumulated runoff throughout the basin creates the flood waters that inundate the delta. Following the rains, evaporation, transpiration and increased temperatures aid the removal of water from land surfaces. Evaporation increases as you progress inland from four times the annual precipitation near St. Louis to ten times the annual precipitation in the project area. The highest values correspond to the period March to May, the lowest being November to January - see table A4-6.

Table A4-6

Illustration of Evapo/Transpiration by Months

E-T	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total
mm	150	160	230	250	260	240	220	170	160	190	160	140	2,330

The tidal influence of the lower delta is relatively weak, having a mean variation between high and low tides of less than one meter. However, because of the low elevation of the river basin, tidal influence, and salt water intrusion may extend beyond Dagana, a distance of over 200 km. from the coast, during the period of minimum river flow in May or June. Conversely, when the river flow in the lower delta is at its maximum during September and October, fresh water may extend to the mouth of the river near St. Louis. Therefore, the water regime for the lower 200 km. of the river is very dynamic and plays a unique role in that portion of the basin system.

Villagers in the delta obtain their water from shallow wells, marigots, irrigation canals, and other depressions in the delta. The quality level of the water in the shallow wells is influenced by tides (sometimes brackish), the percolation of water from the irrigation canals and the level of water in marigots. Much of the soil in the area is sandy on the dieri ranging to clayey in the delta. Soil conditions are such that percolation of surface water to the ground water table does occur. The average depth to the ground water level in the dieri (higher ground) is 5 to 8 meters, while in the delta it is 2 to 5 meters.

The main marigot that drains the project area (Lampsar/Diagambal) is the Lampsar. The Lampsar marigot is also used to store fresh water from the Senegal River in order to supplement the water supply for the city of St. Louis when the water in the Senegal River is too brackish to use. As a

result it is not planned to discharge the drainage water from the Lampsar perimeter to the Lampsar marigot.

D. Senegal Institutional Capabilities

Through interview and observation, make an assessment of the present Senegal institutional capabilities, especially in the target area in public health and communicable disease control programs.

1. Detailed assessment must be made of capabilities for the control and the possibility of further extension of schistosomiasis and other vector borne diseases associated with wetland crop production which are peculiar to Senegal in general and the target area in particular. This would involve collaboration with team members for environmental health assessment such as at the St. Louis lab.

The medical services provided in St. Louis and in the Delta area are illustrated by Tables A-4-7, and A-4-8. The Chief Medical Officer for the region is responsible for all medical services provided in the region. He reports to the Governor for the region and to the Minister of Health in Dakar. An institutional framework, which has existed for many years, is available to provide health services to the region. It is hampered by inadequate facilities, insufficient supplies and limited trained staff. Given more realistic budgets and technical assistance, each of these areas could be improved and more satisfactory public health and communicable disease control programs could be implemented in the target areas.

The regional laboratory has been in existence for 80 years. It provides analysis services for all the medical facilities in the region as well as analysis of water samples submitted by the water treatment plant. Because of costs, the water treatment plant has elected to do its own analysis and will soon discontinue sending samples to the laboratory. Despite its limited

Table A4 - 7

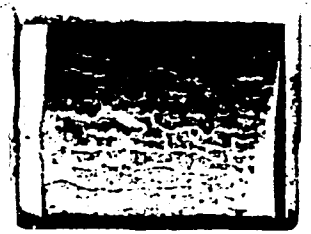
RIVER REGION MEDICAL SERVICE

Chief Medical Officer

St. Louis

Regional hospital	School health	Field services	Blood bank	Veneral diseases
Admin-Director (non-medical) Physicians - 2 medicine 1 pediatrician 3 surgeons 1 EENT (6 French TA - 1 Senegalese) 150 beds	1 Physician (Senegalese) (for 25,000 students)	2 dispensaries 2 MCH Clinics (no doctors)	Analysis performed by laboratory French nun; non-medical assists.	Analysis by laboratory. Nurse in charge (Senegalese who has provided technical adviser, French pharmaceatical firm support. Study has been completed on viruses V.D., brucellosis, etc. Awaiting results

Regional supply pharmacy	Environmental health	Regional laboratory	Technician training
Supplies medicine to all public medical facilities. Orders from national pharmacy in Dakar (except for laboratory). Headed by pharmacist - French TA. Also serves as hospital pharmacist.	Headed by technician - responsible for control of rats and mosquitoes. 2-4 persons on staff, spray some areas once or twice during rainy season	Headed by M.D. 1 Admin. Sec. 2 Technicians 2 Sanitary nurses 3 Aides (1 vacant) 2 Laborers 1 Driver 1 Biologist (vacant)	Health Education and Sanitarian training. Technician heads subject areas include use of equipment (vehicles, audio-visuals, loud speakers, etc.) conduct of extension work.



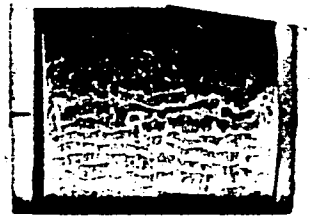


Table A4 - 8

Regional Laboratory

Chief - M.D.

Admin. Secretary	Housekeeping	Hygiene nurse	Driver-Chauffeur	Biologist
	1 Watchman 1 Laborer (vacant) (clean lab equipment, etc., take care of lab animals	Prepares cutler mediums and materials and takes care of serology supplies	1 messenger - Picks up blood samples from hospital and specimens for laboratory analysis.	1 biologist. Hard to recruit would be deputy to chief.

Bacteriology Section	Hematology Section	Immunology Section	Parasitology Section	Medical chemistry section
1 technician 2 year training 1 aide (no lab animals)	1/2 work covered by bacteriology, other 1/2 by immunology	1 lab aide Jr. high level practical training	1 lab aide (vacant) Expect trained technician soon	1 biology technician 2 sanitary nurses

facilities and budget, the laboratory has managed to increase the total number of examinations for all purposes completed from approximately 11,000 in 1970 to more than 36,000 in 1976. Much of this is accredited to the improved level of technician training. Following the completion of studies by outside expert teams to establish baseline data and recommended/control and continuing surveillance measures for schistosomiasis, malaria, and other vector borne diseases, and given the necessary resources and support, the Regional Health Service could continue a monitoring and surveillance program in the target area. Much of this responsibility would fall to the Regional Laboratory, which would need to be supplemented by field sanitarians.

Some efforts are already underway that will help to provide the background information for establishing a sound public health program in the target area. Under a contract with AID (6 month pilot study early 1977) a 5 man Yale University team has undertaken an exploratory study of the transmissible disease problems in the river region. The field team is composed of a virologist, a parasitologist, two medical entomologists, and a laboratory research assistant. In discussions with team members in Senegal special emphasis was being given to malaria, schistosomiasis, other intestinal parasites, and arboviruses.

Another effort about to get underway involves an "Assessment of Environmental Effects of Proposed Developments in the Senegal River Basin." This study includes a strong public health component and should produce considerable baseline health data and information on the river basin in general, much of which will be applicable to the target area. A multi-disciplinary public health team will conduct indepth studies on representative population groups throughout the Senegal River Basin. Data will be collected on demography, prevalence, and nature of diseases, nutrition, environmental

sanitation, potable water usage, and availability character and utilization of preventive and curative health services.

Recognizing the potential for the introduction of schistosomiasis into the delta (target area), the Regional Laboratory and the SAED have developed a study program for a systematic, qualitative, and quantitive study of fresh water mollusks in the delta. The study would embrace (a) an evaluation of the level of infection of migrants (new arrivals) from endemic areas, (b) locate, identify and evaluate the population and and rate of infection of the intermediate host (Bulinus) for schistosomiasis, and (c) make a study of urine samples and determine the rate of infection in the population. The proposal suggests that the study be coordinated by the Regional Medical Center. The Regional Laboratory would provide technical direction and implementation, and the SAED would be responsible for administrative and logistic matters. Funds are needed to implement this study.

E. Water Pollution Surveillance

Through interviews with GOS representatives and other observations, make an assessment of the GOS and target area capabilities for monitoring and controlling down streams and in-project water pollution from fertilizer and pesticides which might result from the project.

Little attention has been given to the possible pollution of streams, marigots, or groundwater as a result of the application of many tons of fertilizer and pesticides in the delta. It is unlikely that the implementation of the Lampsar/Diagambla project will be an exception. Except for salinity, no chemical analysis of water in the canals, marigot, or of ground water were available. Since the equipment for determining the concentrations of pesticides and other synthetic organic substances in water is both costly and sophisticated, it is not likely that such determinations will be undertaken by the GOS in

the immediate future.

The previously mentioned environmental assessment study of the S.R.B. includes an in-depth analysis of groundwater and the impact of irrigation practices on their quality. It also proposes to measure and evaluate the quality and quantity of existing ground water sources; determine the effect of new water sources on the ground water system; identify potential groundwater pollution impacts from surface sources; and prepare a proposed groundwater quality/quantity monitoring system. While the discussion on groudwater in the environmental assessment study specifically plans to measure potential pollution from pesticides, the discussion on surface water does not. The water quality parameters identified for measurement of estuary and fresh water do not include a measurement of pesticide levels.

It is readily seen that the OMBS environmental assessment study is significantly important in terms of (1) establishing baseline quality data for both ground and surface waters, as well as (2) predicting the effects of future activities in the S.R.B. on these resources, and (3) the making of recommendations of methods to control or abate pollution of surface and ground water. Neither the information nor the capability now exists for monitoring or effectively controlling downstream and in-project water pollution from fertilizers and pesticides attributable to irrigation practices.

Appendix V

Scope of Work for Demonstration Vector Control Project Lampsar/Diagambal Perimeters

Objective - To design, develop, and implement a vector control program for malaria control for the villages in and adjacent to the Lampsar/Diagambal perimeters.

1. Identify and locate on a contour map all villages and communities within a half mile flight distance of the perimeter areas or canals serving the perimeters. Determine population, age, and sex distribution, and living habits for each village. Determine malaria incidence in wet and dry seasons in demonstration area.
2. Determine species, breeding locations, and adult nesting habits of mosquitoes in the demonstration area. Establish background mosquito and larvae counts for dry and wet seasons. Isolate non-controlled area for evaluation during course of the demonstration.
3. Determine most effective and economical pesticide for control purposes. Organize, train, and supervise teams for larviciding and residual spraying.
4. Organize, train, and supervise crews for canal maintenance, including inspection, weeding, and dike repair.
5. Operate a vector control program for malaria control for one year.

6. Determine the optimum size of teams and areas per unit of irrigated lands, together with training, equipment, and supply requirements for an annual operating program. Assess the cost of implementing a full scale program in the river region.

It is estimated that a minimum of one year and probably 18 months to two years would be required to satisfactorily undertake the vector control demonstration program prescribed above. The full time services of an entomologist working with a professional sanitarian trainer would be required.

Appendix VI

Scope of Work for A Demonstration Village Water Supply System

Objective - To determine if a low pressure, rural distribution system, supplied with treated ground water, Senegal River water, or water from the Lampsar marigot can be used to economically provide safe drinking water to the villages within and adjacent to the Lampsar and Diagambal perimeters.

1. Undertake a feasibility study to determine which water source to use and what type of distribution system is best suited for the conditions and needs of the area. The feasibility project should include a discussion of the viable alternatives, treatment requirements, and comparative estimates of construction and operational costs. One of the alternates should be recommended for use in designing a pilot water treatment plant and distribution system.
2. When instructed design a pilot water treatment and distribution system that when constructed and operated will demonstrate the feasibility of providing the villages with safe drinking water. Such a design should reflect the use of economical and reliable materials, ease of construction, minimal maintenance, and simple treatment and operation processes. System design should anticipate a minimum of 25 gallons per capita per day.

3. Prepare bid specifications, assist in bid evaluation, and oversee construction of the pilot water system.
4. Select, train, and supervise local operators over a one-year period.
5. Prepare a report that evaluates all facets of the demonstration project, and if indicated discuss the use of such systems throughout the river region.

It is estimated that this demonstration project will take a minimum of 18 months and most probably two years to complete. It should be be under the direction of a consulting environmental engineering firm that has in-house experience in the design of rural water systems. The full time services of an engineer located in the project area will be required during the construction and a portion of the operational phases of the project.

Appendix VII

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