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Appendix 5A to HB 3, Part I
(TM 3:19)

PD-AAA6-181

AGENCY FOR INTERNATIONAL DEVELOPMENT PROJECT PAPER FACESHEET	1. TRANSACTION CODE A A = ADD C = CHANGE D = DELETE	PP 2. DOCUMENT CODE 3

3. COUNTRY/ENTITY	4. DOCUMENT REVISION NUMBER
Regional (Sudan)	Original

5. PROJECT NUMBER (7 digits)	6. BUREAU/OFFICE		7. PROJECT TITLE (Maximum 40 characters)
	A. SYMBOL	B. CODE	
698-0408	AFR	06	Health Constraints to Rural Production

8. ESTIMATED FY OF PROJECT COMPLETION	9. ESTIMATED DATE OF OBLIGATION
FY 85	A. INITIAL FY 81 B. QUARTER 1 C. FINAL FY 84 (Enter 1, 2, 3, or 4)

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY			LIFE OF PROJECT		
	B. FX	C. L/C	D. TOTAL	E. FX	F. L/C	G. TOTAL
AID APPROPRIATED TOTAL	396	108	504	1,436	686	2,122
(GRANT)	(396)	(108)	(504)	(1,436)	(686)	(2,122)
(LOAN)	( )	( )	( )	( )	( )	( )
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY	-	226	226	-	1,036	1,036
OTHER DONOR(S)						
TOTALS	396	334	730	1,436	1,722	3,158

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE		E. 1ST FY 81		H. 2ND FY 82		K. 3RD FY 83	
		C. GRANT	D. LOAN	F. GRANT	G. LOAN	I. GRANT	J. LOAN	L. GRANT	M. LOAN
(1) HE	S 512	544		504		518		532	
(2)									
(3)									
(4)									
TOTALS				504		518		532	

A. APPROPRIATION	N. 4TH FY 84		O. 5TH FY		LIFE OF PROJECT		12. IN-DEPTH EVALUATION SCHEDULED
	O. GRANT	P. LOAN	Q. GRANT	R. LOAN	T. GRANT	U. LOAN	
(1)	569				2,122		MM 09 YY 84
(2)							
(3)							
(4)							
TOTALS	569				2,122		

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OR IN PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET.

1 (1 = NO, 2 = YES)

14. ORIGINATING OFFICE CLEARANCE		15. DATE DOCUMENT RECEIVED IN AID W, OR FOR AID W DOCUMENTS, DATE OF DISTRIBUTION
SIGNATURE		
TITLE	DATE SIGNED	
2 Sept 1980 Director, USAID/Sudan	Director, REDSO/EA MM 08 DD 12 YY 80	MM 09 DD 10 YY 80

AID 1330-4 (3-75)

TABLE OF CONTENTS

I. SUMMARY AND RECOMMENDATIONS

A. Facesheet (attached)

B. Recommendations

The following actions are recommended herein:

1. Authorization, in an amount not to exceed $504,000 from FY 81 funds, of a project to develop a strategy for control of schistosomiasis in irrigated areas of Sudan.

2. Approval of life-of-project (four years) funding, subject to the availability of funds, in an amount not to exceed $2,122,000.

C. Description of the Project

The goal of the project is to improve the health and productivity of Africans through elimination of schistosomiasis. The project purpose is to produce an Africa regional strategy for control of schistosomiasis in large irrigation projects. This will be accomplished through an AID grant to Sudan's Ministry of Health to finance research on the disease, in conjunction with the government's WHO-supported Blue Nile Health Project, which is currently investigating control of schistosomiasis, malaria, and diarrheal diseases.

The research will take place in the Gezira, Sudan's major agricultural area. The Gezira produces most of the country's cotton exports, which are a key element of Sudan's balance of payments profile. In the Gezira, schistosomiasis is endemic, with virtually all school-aged children infected in some areas.

The project will develop a comprehensive approach to surveillance of schistosomiasis (utilizing a mini-computer to assist in collection analysis, and dissemination of information). This should lead to identification of selected interventions which are both efficacious and cost-effective.

The project will assist the government of Sudan's Comprehensive Approach to the Prevention and Control of Water Associated Diseases in Irrigated Schemes by providing technical assistance, training, materials and support for symposia in Sudan and attendance at international meetings. Specific components include the following:

Aid Inputs

1. Technical assistance: A biostatistician will assist the Director of the Research and Training Unit of the Blue Nile Health Project. The biostatistician (48 pm) will serve as the principal liaison with USAID/Sudan and assist the Mission with the management and logistic aspects of the U.S. financed components of the project. Short-term U.S. technical assistance (3 pm) will be provided to help in the selection of a suitable computer and develop appropriate software packages. Consultants will also be provided

on a short-term basis to conduct project evaluations (2 pm) as well as supply needed but as yet unidentified expertise during the implementation of the project (9 pm). AID will fund the salaries of several Sudanese professionals over the life of the project to carry out data collection, studies and experiments related to schistosomiasis control.

2. Training: AID will support up to 18 months of long-term training in the U.S. for a biostatistician. Up to 36 months of short-term U.S. training will be provided for personnel associated with the project.

3. Material support: AID will supply vehicles and POL to support field surveys and experiments and to allow for the frequent travel that will be required between Khartoum and the field Study Zone. The radio and mobile units will ensure effective communications between the Abu Ushar laboratory, field workers and Khartoum. The mini-computer will code, integrate, analyze and store the crude data collected in the field in order to prepare a comprehensive overview of schistosomiasis with respect to disease transmission, the nature of disease pathology, individuals at risk, and economic impact. The project will also provide a programmable calculator and hand-held calculators, as well as a generator, office equipment and supplies, and laboratory equipment.

4. Support for symposia and meetings: AID will provide funds to support two symposia on schistosomiasis in Sudan and allow selected Sudanese to attend international meetings on schistosomiasis.

GOS Inputs

The GOS will supply personnel, building facilities, vehicles and POL support to this project through the Research and Training Unit of the Blue Nile Health Project. Specific project inputs include:

1. Personnel: Eleven senior level persons will be assigned to work on the project. They include three biologists, two malecologists, two parasitologists, two epidemiologists, one clinician and one ecologist. At mid-level, the project will employ six technicians, four lab assistants, four public health officers and four interviewers. Support staff supplied by the GOS will consist of drivers, cleaners, lab attendants, messengers, guards and snail field workers.

2. Building facilities: Office and laboratory facilities at the Abu Ushar field site will be supplied by the GOS. The Khartoum laboratory and offices will also be provided.

3. Vehicles and POL: Four vehicles will be assigned to the project from GOS funds along with maintenance and POL.

D. Financial Summary

The total cost of the project over four years (FY 1981-84) is estimated at $3,158,000. AID's contribution is $2,122,000 or 67%; the GOS will contribute $1,036,000 or 33%.

AID*	FY 81	FY 82	FY 83	FY 84	TOTAL
Technical Assistance and Local Personnel Costs	266	303	321	356	1,246
Training	-	96	65	75	236
Commodities	192	42	87	46	367
Other	-	30	10	40	80
Contingency 10%	46	47	49	52	193
Total	504	518	532	569	2,122
GOS					
Personnel	173	173	173	173	692
Building Facilities	23	23	23	23	92
Vehicles/POL	9	9	9	9	36
Inflation	-	21	43	68	132
Contingency 10%	21	21	21	21	84
Total	226	226	269	294	1,036
Grand Total					3,158

* Inflation for AID's contribution factored into each category.

E. Project Implementation

On the AID side, USAID/Sudan will assign a direct-hire project manager to:

- Assume primary project implementation responsibilities for the mission;
- Coordinate project direction with the Director of the Research and Training Unit of the Blue Nile Health Project and the U.S. funded biostatistician working with the Unit;
- Prepare PIOs;
- Coordinate scheduled project evaluations.

The services of the long-term biostatistician will be obtained under a personal services contract; this individual will be the project's principal liaison with USAIDs. AFR/RA will be the primary Washington backstop office. AFR/RA will: assist in recruiting and contracting with appropriate project personnel; assist with project participants (through OIT); and provide general project support.

The Ministry of Health will sign the Grant Agreement and will have overall responsibility for the project for the GOS. More specifically, the Research and Training Unit of the Blue Nile Health Project will be the implementing agent for the GOS.

F. Findings

On the basis of the analysis contained herein, the Director of AFR/RA concludes that the project is technically, economically, and financially sound. The analysis reflected herein supports the conclusion that the project meets all applicable AID criteria and will not have an adverse impact on the environment.

G. Issues

During the course of the in-house AFR/RA project review, the only major issue raised concerned the recurrent cost implications of Sudanese technician salaries, currently slated to be paid for in part by AID. The Project Paper deals with recurrent costs on page 27. AFR/RA cabled the Mission for additional details; the Mission's response, via Khartoum 8322, was as follows: "Recurrent costs - - GOS has drawn a substantial portion of staffing for this project from other government supported activities, where at worst at the end of the project they could be reassigned. To extent that new employment is generated by hiring for this specific activity, the GOS assures us that it can readily absorb such increases in its overall budget."

II. BACKGROUND AND PROJECT DESCRIPTION

A. Background

In 1978 the Africa Bureau, AID/W, decided that the project: "Health Constraints to Rural Production" should be modified to focus entirely on the schistosomiasis problem in Africa rather than attempting to deal with all of the major endemic diseases as originally conceived in the PID approved one year before.

There are three forms of human schistosomiasis in Africa that cause public health problems. They include infections with the flatworm Schistosoma (S.) hematobium, which causes disease of the urinary system, S. mansoni which is responsible for a chronic disabling disease affecting the liver and intestines, and S. intercalatum a relatively unexplored variety of schistosomiasis confined to Central Africa causing clinical symptoms similar to those of S. mansoni. All three forms depend on certain species of snails in their life cycles. These snails inhabit fresh water sources. Following the creation of many man-made water impoundments in Africa for agricultural development, fisheries and for hydroelectric power the snails involved in the life cycles of schistosomiasis have spread rapidly.

In recent years there has been a marked movement towards an integrated approach to control. There is now less reliance on single control techniques such as molluscicide, much used in the past. Current integrated control methods employ all available forms of intervention: chemotherapy, focal molluscicide techniques, methods to meet basic health needs such as the supply of potable water at village level, the provision of sanitation, and of continuing health education as well as socioeconomic improvement.

Optimal application of integrated control strategies depend entirely on an accurate ecological assessment - of the human community and its parasitological characteristics, of the biology of the snail intermediate hosts, and of the physical and geographical characteristics of the environment. Man's behavioral attitudes and customs, including use of pesticides in agricultural schemes, are being given increasingly greater attention because of their crucial role in the success or failure of a control program.

The development of a rational, ecological sound and economically feasible control strategy in a given area depends on

an assessment of the local ecology of schistosomiasis. These studies are needed to determine the exact prevalence and distribution of infection and disease, the dynamics of transmission, identification of the person at risk of disease as well as of the many contributing factors of the human behavior, such as environment, parasite and snail biology all of which determine the levels of endemicity and the severity of disease in an area.

Focusing on ecological conditions in Africa which seem to characterize some of the essential variations in the epidemiology of schistosomiasis and of its impact on rural production, the Africa Bureau has selected two countries for implementing its regional project, i.e. the Republic of the Sudan and the United Republic of Cameroon. Both countries have recognized schistosomiasis as one of their most important public health problems in rural areas for which remedial action must be developed through field research.

In the Sudan there exists a serious problem of S. mansoni infection, causing severe disease and widespread infections in the Gezira, Managil Schemes and in other water development projects in the country. The problem is aggravated and becomes epidemiologically potentially dangerous because of the influx of about 500,000 migrant laborers from outside the irrigated areas. The systematic and costly control efforts to reduce the snail population and, thereby, the transmission of schistosomiasis in the Gezira by the GORS have been met with little success.

In Cameroon, there exists a variety of public health and economic problems caused by or closely associated with schistosomiasis. There are three species of Schistosoma which are endemic in different ecological areas of the GOURC including the Sahel, Sudan Savannah, mountaineous areas, forest and some of the major cities. It must be considered that the schistosomiasis situation may become more severe in the future as a result of AID and IBRD assisted development projects; including construction of water impoundments, fish ponds and rice fields under irrigation. The GOURC has recognized the potential danger of urban schistosomiasis and has accorded it high priority.

A comprehensive analysis of multidisciplinary studies in different settings using standardized techniques can be expected to yield results that form the basis for developing general and area-specific modifications of a strategy for effective,

economic and practical schistosomiasis control.

B. The Sub-Project in the Sudan

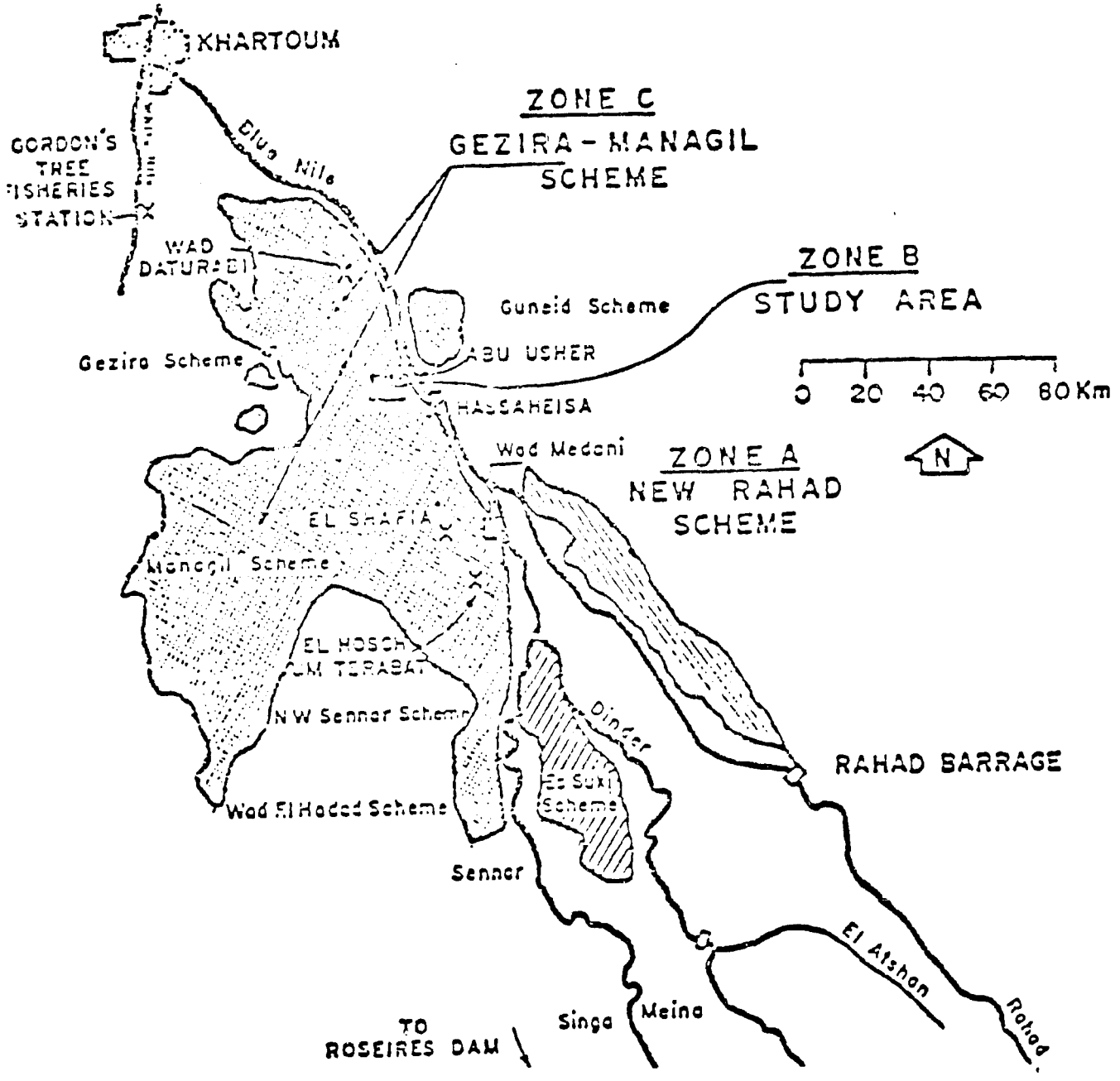
After preliminary discussions at technical and administrative levels between USAID/S, AID/W, the MOH and WHO, the GOS through its Ministry of Health submitted a proposal to USAID for assistance of its "Blue Nile Health Project". This project has been developed jointly by the MOH and the Regional Office of WHO (EMRO). Its overall objectives are the development of a strategy for the "integrated control" of three groups of important endemic diseases associated with water in the irrigation systems of the Blue Nile, namely malaria (P. falciparum, P. vivax and P. malariae), schistosomiasis (S. mansoni and S. hematobium), and diarrheal diseases of varied etiology. The estimated costs for this project are currently estimated as US$15 million per annum with a tentatively determined length of project of ten years.

The Blue Nile Health Project has four distinct operational phases. The first and second are concerned with the collection, analysis and evaluation of multidisciplinary data on the ecology of each of the three groups of diseases. This research is to be carried out in a sub-area of the Gezira, hereafter called the Study Zone, designated as irrigation blocks 26 and 27, with headquarters in the town of Abu Usher. (See map.) The resident population in this area is estimated at about 50,000 persons. During the cotton season there is a heavy influx of migrant laborers and of their families.

The Gezira-Managil agricultural scheme in Sudan is the largest irrigated area in the world. It was started in 1924 and enlarged in the 1950's when a seasonal irrigation schedule with a dry period was changed to perennial irrigation. After this change there has been a considerable increase of prevalence and intensity of schistosomiasis and, in 1976 a severe devastating epidemic of malaria. The latter had resulted from the gradual build-up of resistance of malaria mosquitoe vectors to the insecticides used for house spraying and larviciding. The development of resistance was greatly influenced and probably accelerated by the heavy use of insecticides in agriculture. The simultaneous application of different and even similar chemicals for different purposes in the same area has never been coordinated as far as disease control was concerned.

Malaria is now again under control but there is

MAP OF BLUE NILE IRRIGATION SYSTEMS AND PROPOSED PROJECT FACILITIES



increasing evidence that resistance to malathion (house spraying) and abate (larviciding) has developed in small foci. This has necessitated switching to yet another new pesticide, fenthion. The malaria service is well organized. Although only passive surveillance has been used for case detection, the present strategy can be considered far superior to that applied to monitor the schistosomiasis situation.

About 50% of the tenant farmers and their families in the Gezira are infected with Schistosoma mansoni. The age-specific peak infection rates in the adolescent population virtually reach 100%. The severity of schistosomiasis in the area is also reflected by the fact that up to 40% of the hospital beds in the Provincial Hospital of Wad Medani may be occupied by patients suffering from the advanced stages of schistosomiasis.

The total sedentary population of the Gezira-Managil is estimated at 1.7 million. At least 500,000 migrant laborers (plus their families) are needed annually to harvest cotton and to help plant, till and harvest the other crops, namely dura, wheat, ground nuts, rice and vegetables.

The ethnic origin of the migrant workers varies but is predominantly from other parts of the Sudan. Some of the groups are strictly migrant workers who come only for the harvest season of cotton; others stay for longer periods of time and have built their own "non-registered" villages. Unlike the tenant farmers who have access to a potable water supply and have latrines, the "non-registered" villages and migrant labor camps have no such facilities. Therefore, defecation is indiscriminate and the household water is fetched from the irrigation canals. The first phase of the Blue Nile Health Project and, indeed, the most urgent requirement for the creation of a rational disease control program in the Blue Nile irrigation scheme is the collection of adequate baseline data on the distribution, prevalence, incidence and intensity of schistosomal infections in representative samples of the local population. This information has to be obtained by multidisciplinary epidemiological studies. While there is already considerable national strength in the biological and parasitological aspects of schistosomiasis there is virtually no specialized expertise to cope with the broad aspects of comprehensive epidemiology and data processing. This expertise combined with an adequate, yet modest computer facility would be the sine qua non for developing a surveillance system for schistosomiasis. Surveillance is the collection, retrieval, analysis and interpretation of relevant field data for action. Therefore, the design of simple field record forms

for each of the disciplines concerned, codes, identification, data linkage as well as the ability of instant data retrieval for distribution of the latest information to those concerned, forms the backbone of an effective disease control system.

At present, the Blue Nile Health Project has three separate subsectors. The first, the "Study Zone", is of immediate concern. It is based on ongoing investigations now being carried out by a team in which members of the MOH, the University of Khartoum and of the Medical Research Council of the Sudan cooperate in an area designated as blocks 26 and 27 of the Gezira scheme. A representative population sample of about 50,000 people living in this area has been studied intensively, including careful observation using sample survey techniques of water contacts, defecation habits, snail infection rates, and the prevalence of schistosomal infection by age and sex of the population. Unfortunately, this valuable information has been collected by different investigators with dissimilar techniques and without the aid of a common study protocol. Most data have been collected without using pre-coded data entries that would have facilitated the comprehensive analysis and interpretation of the findings by electronic data processing equipment. The thorough analysis of the wealth of the data collected in the studies by the Gezira Bilharzia Research Team would be an essential first step to design multidisciplinary protocols for disease control and surveillance as needed in the near future.

With the focus of the AID Project on schistosomiasis and in due consideration of the considerable efforts, time and funds that would be needed to overcome the legal barriers restricting the use of pharmaceuticals and pesticides not licensed or registered by the FDA and/or EPA, the best contribution AID can make to the overall Blue Nile Health project is in the field of applied multidisciplinary epidemiology and biostatistics, both areas of considerable strength in the U.S.A.

Instead of using the modest annual contribution of about $500,000 for the purchase of emergency supplies, equipment and cars, diluting it in a financial void, the concentration of the Project on one research objective supported by funds and US expertise would seem to be the most useful and timely contribution to the Blue Nile Health Project.

Here, it would fit entirely into the category of "Research and Training" which is directed by Dr. Mutamad A. Amin

who represents concurrently the scientific expertise on Schistosomiasis in the MOH, the Medical Research Council and as Director of the Research and Training Unit of the Blue Nile Health Project. The AID Project would be headquartered at the National Health Laboratory in Khartoum for its computer facility, administration and laboratories, and in Abu Usher, for the field studies. The development, testing, evaluation, adaptation and final integration of the schistosomiasis surveillance system into the overall Blue Nile Scheme would also meet one of the priorities listed in the General Recommendations made by the Expert Committee on Epidemiology and Control of Schistosomiasis of WHO[1/] that "emphasis must once more be given to the importance of conducting planned epidemiological, biological, and ecological studies before the implementation of water development schemes in tropical areas ..." Without the expertise, knowledge and facility for continuing surveillance, the WHO recommendation would remain academic and cannot be implemented for disease control and prevention on a large scale.

The overall direction of the project will come from Dr. Amin; however, as he has additional areas of responsibility, the role of assuring coordination of efforts to strengthen the multidisciplinary research will fall heavily on the full-time U.S. biostatistician who will remain on staff throughout the 4-year project period. The biostatistician will also serve as the liaison person with USAID/Sudan and assist with the management and logistic aspects of the US financed components of the projects. The long-term training for a Sudanese biostatistician/epidemiologist planned to commence in year two after selection and some project experience will assure continuity of a Sudanese with sufficient computer and systems experience to take over when the US advisor leaves.

Short-term US technical assistance will be concentrated in areas where Sudanese expertise is viewed as lacking, e.g., in the selection of a suitable computer and initial assistance with getting the software packages developed and operating. The Sudanese have many qualified researchers employed in such institutions as the Universities of Khartoum and the Gezira. Their services can also be sought when needed under the miscellaneous consulting services.

A few of the long-term Sudanese personnel who will be financed by AID under the project are already working

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1/ WHO, Technical Report Series, No. G43
WHO, Geneva, 1980.

part-time on Study Zone research but are supported from elsewhere. In other needed skill areas, the economist, the integrated pest management specialist, and the two social anthropologists (one of whom will be female), the Sudanese currently have no staff due to lack of funds. The public health inspectors will be utilized primarily for census taking, sampling frame construction and supervision of lower level interviewers. The lab technicians, most of whom have had prior jobs in related areas serve as the back-up personnel to the malacologists, fish expert, and other biologists.

Short-term training will be provided for members of the research team throughout the project. Many of the staff will benefit from exposure to US techniques being used, particularly in US Universities. This experience base could vary from a one-month stay in a US laboratory to learn a new snail examination mechanism to a 4 month course of formal study in quantitative methodology for anthropologists.

The vehicles will support the team efforts and will be supplemented by the four Sudanese vehicles. With the field laboratory situated in the Study Zone over 100 km from Khartoum, it is essential that commuting be made as easy as possible to assure adequate two-way communication. The radios are being supplied for effective supervision and close coordination.

The mini-computer will have a small room in the Public Health Laboratory. An airconditioner is provided and also a small generator and voltage regulator. Khartoum is known for power outages and variable current. The two additional airconditioners are for laboratories where aquaria have to be maintained at constant temperatures. The Hewlett Packard programmable calculator will serve as a back-up and a checking system for the mini-computer for use by biostatistician. The project will supply a photocopy machine since the entire MOH system has no operating photocopier. Other small equipment items are needed for support for the project. The laboratory equipment list was developed by the malacologist on the team in consultation with the Sudanese technical staff.

At the conclusion of this project it is expected that there will be a sound and cost effective strategy or strategies developed based on solid research results. The present joint GOS and WHO integrated approach to water-borne diseases has an overall plan of operation costing approximately

$15 million per annum. This has only received minimal WHO funding, with most being allocated for salaries, and a small sum from UNEP. If the research develops a tested and lower-cost approach, the core staff employed under this Project through US and GOS funding should then become members of the much larger staff necessary to implement the "umbrella project". The systems developed for evaluation and monitoring of the Project Zone will be equally applicable to carry on these needed functions over the entire Gezira area.

III. PROJECT ANALYSES

A. Economic Background and Analysis

Agriculture dominates Sudan's economy; it contributes 40% of GDP, 95% of exports and provides a livelihood to 80% of the population. The Gezira Scheme with its over 2 million acres (or over 12% of the total cultivated area) is the keystone of the agricultural economy. It produces 75% of the country's cotton, 85% of its wheat and 60% of the nation's foreign exchange in recent years.

However, the experts are not entirely optimistic about the future for irrigated agriculture in the country. The Nile water allocated to Sudan is now all either used or committed. Existing irrigation schemes are performing well below expectations partly due to poor maintenance. In the Gezira, yields of the key cotton crop have been falling in the last three years, as has the profitability per acre. At present, tenant farmers who may farm 20 to 40 feddans are often non-working managers, either relying on hired labor or share-cropping. The policy of the Sudan Gezira Board making most agricultural decisions, including cropping patterns, is not conducive to increased productivity. There has been a recent move by the Government to give farmers a greater share of any increases in output. However, there has been political resistance to this move and it has not been implemented. The problem of increasing pest populations on the cotton crop has not been satisfactorily tackled; the frequent and indiscriminate use of broad spectrum insecticides has led to larger and more complex spray programs. The white fly has become a major problem. The sticky honeydew on the open boll causes difficulty in the ginning process, and a drop in price and/or acceptability of the lint on the world market. Pesticides now form about 30% of the cost of production in cotton. The "package deal" method of contracting with insecticide firms to control pests in a specific area on a yield guarantee basis has exacerbated the problem. Again, partial action has been taken with the cutbacks in acreage under "package deals".

The numerous difficulties with the cotton crop are of major concern for the future of social services in the Gezira. Without adequate foreign exchange the purchase of items such as drugs from abroad will be curtailed. Without cotton as the "engine of growth" and chief export earner for the area, reduced yields and/or decreased profitability per acre will mean less money for the 2-3% allocated to Social Services by the S.G.B.

The current GOS and SGB strategies being utilized for cotton in the Gezira are not working. Recent and reliable statistics are difficult to find but there is little doubt that the yields of cotton per acre have fallen in the past three years. Since cotton prices have been high, the net profit per acre may not have fallen in spite of increasing production costs, especially those attributable to spray programs. The divergence of interests between the GOS which needs the foreign exchange generated by the crop, the individual farmer who at the moment has little incentive to increase yields per acre, the "package deal" spray contractor, and the human and animal population exposed to the pesticide residues can readily be seen.

While there is an obvious overlap between the agricultural side of the Gezira production economy and the public health aspects, they have not been examined in a comprehensive or systematic fashion. This proposed research Project deals mainly with the single problem of schistosomiasis, but the creation of a sound data base would make it much easier to add additional components if additional funding were available to tie in the agricultural (especially the toxicological) aspects.

The Government's conservative economic strategy has led to slow but solid gains in most of the country's fundamentals in the last two years. However, various factors including the increases in oil prices have resulted in an almost insurmountable balance of payments problem. Failing massive interventions by donor countries and international lending institutions, the shortfall in available foreign exchange will soon become critical with major repercussions on economic and political strategies.

Understanding the macro-economic picture in the Sudan enhances the appreciation of the difficult decisions facing the Gezira Board and other GOS institutions. Keeping cotton production and yields high clearly assists the balance of payments situation. Without adequate foreign exchange, purchase of molluscicides and expensive drugs for chemotherapy, the two strategies presently percieved as offering a degree of control for the schistosomiasis problem, are impossible. Foreign donors have shown reluctance to fund an expensive strategy control program for waterborne diseases based on unproven interventions. The need exists for fundamental research to look at all aspects of the schistosomiasis problem so that a comprehensive picture can give an overview of the strengths and weaknesses of any control strategy or strategies.

This comprehensive approach must include an economist to assess cost effectiveness of different strategies or combinations of interventions.

Within the Gezira Scheme there is currently a labor shortage. Even with about 1.7 million persons living in authorized villages and another half million "migrants", there is insufficient agricultural labor during the months with peak person power requirements, especially the cotton picking season. There is also a shortage of unskilled labor to perform dangerous, dirty or low prestige jobs such as canal-cleaning. While there have been only a handful of research projects which address the effects of S. mansoni infection on the quantitative and/or qualitative physical working capacity of agricultural labor, the results of these investigations have been equivocal. It is not unreasonable to assume that heavily infected person (with egg counts $\geq$1,000 eggs/gram) suffer decreases in their work capacity. One study conducted in the Gezira revealed an impairment amounting to 16-18% of maximum physical working capacity occurs in canal cleaners compared to lightly-infected and schistosomiasis-free Gezira workers. However, these differences were measured using physiological responses to exercise (especially oxygen intake), and other explanations are possible. It was interesting that in this study canal cleaners were reported to have slept about 2 hours longer per 24 hour period than villagers. There is little doubt that reduction in the water-borne diseases, especially schistosomiasis and malaria will result in an increase in available agricultural labor. The prevalence rates and the heaviest egg loads of people in the area reach their peak in the teenage and young adult age brackets, the very time when they are expected to be productive members of the labor force. Given the present lack of knowledge, however, it is not possible to put a value on crop production foregone because of the impact of the disease on labor.

If the schistosomiasis problem in the Gezira is to be alleviated, the costs of doing so must be realistic in terms of the national health budget. A 1978 study of the national health expenditures of the country estimated that the total per capita expenditure was $7.60. Of this amount $6.10 came from the Government; external aid and "self-help" amounted to about $0.50, and private health expenditures amounted to about $1.00. Even if these costs are realistic it should be recognized that perhaps more than half of the total health budget is spent in the Khartoum area, most of it on hospital care. In rural areas, a figure of $1 per capita for both preventive and curative care per annum is probably more realistic.

The Gezira area is considerably more properous than the rest of the country. The average annual per capita income nationally is around $100. In the Gezira scheme it is probably closer to $600. The new decentralization of government services means that the Gezira will be relatively better off than most provinces in terms of its health services. It already has a reasonably comprehensive system of fixed health facilities. The 2 to 3% social service charge remitted through the SGB has assured more schools, water services, and health related activities than are available elsewhere. Gezira residents have utilized self help to construct community health worker posts manned by community health workers. However, fixed facilities provide only a base and do not assure the availability of trained staff or drugs. Drugs come from Central Medical Stores which suffers from lack of foreign exchange, inadequate management capacity and a tendency to concentrate on hospital needs. Trained staff are often not available.

In the Study Zone prevalence rates of S. mansoni are known to be amongst the highest in the Gezira. They may range up to 95% of all children by the age of 10. The cost of outpatient visits for the afflicted is not known. A 1976 study reported about 7,000 outpatient visits for schistosomiasis from the study area. No information was available on what was done for these persons or whether they received medication. What is known, is that the percentage of patients admitted to the Wad Medani hospital suffering from bilharzia has increased markedly during the past three years. Figures were that half the patients admitted to the general wards were bilharzia cases, and 40% of all admissions. Obviously much more accurate figures are desirable. Of the cases seen on rounds, all were probably terminal in the near future and were young adults ranging from 17 to 45. Hospital costs per patient per day were probably low, drugs were almost no-existent and the patients seen were beyond the point where drug therapy would have been effective. The hospital was minimally equipped by any standards. Blood for the advanced cases was only available if relatives donated. In short, costing the per case cost in terms of outpatient treatment or per hospital stay in the Gezira at the moment with the lack of data is impossible. Little is being done for the clinical cases. The luckier individuals are receiving chemotherapy at an early enough stage to reduce egg counts and perhaps prevent permanent damage (if reinfection is then kept down). Estimating the cost of illness is a complex problem, but certainly some attempt could be made in the Study Zone. Good figures for morbidity and mortality to form a basis for rational decision-making simply do not exist and have to be collected.

As the recent WHO report on schistosomiasis clearly states the control strategies of the future are going to have to involve multiple interventions. A short summary of the costs and problems associated with single strategy interventions in the Gezira will illustrate this point.

1. If the molluscicide "Baylucide" were sprayed twice per year in the Study Zone alone, the cost would be about $100,000. It would not kill all the snails regardless of how frequently it was applied.

2. If the 50,000 people in the Study Zone all received chemotherapy with the drug of choice which is most frequently used at the moment, Oxaminaquine , at a cost of $14 per single dose, the Study Zone cost would be $700,000. In addition, the cost of pre and post clinical examination would add about $3.00 per capita, or $150,000 for a total cost of $850,000. Again this would have to be repeated; it achieves only a reduction in egg outputs but not a total cure, and finally it might prove harmful to those with advanced clinical disease symptoms. The new drug , Biltricide , offers some significant improvements including a currently estimated cost per dose of $4.

3. Improvements in water supply in the villages in the Study Zone would result in some reduction in water contact. About half the registered villages have deep bore wells. Twenty additional ones at $26,000 each would cost $520,000. That still leaves about 40 unregistered villages without easy access to potable water. Most registered villages are without sanitation and recreation facilities. The cost of providing 40 of these has been estimated at $2,000 per village or $80,000. While these interventions may provide additional health benefits, such as reduced diarrheal disease, they will probably have less effect on schistosomiasis transmission than the other two single interventions. First, water contacts such as children swimming in canals may be curtailed but never stopped. Secondly, unregistered villages must also be served with water supplies and sanitation. And finally, the inhabitants spend large parts of their days in the fields where facilities do not exist.

The Project should be able to establish better cost figures for all aspects of surveillance. At the macroeconomic level, if control of schistosomiasis induces a significant improvement in labor vitality, this can be quantified, though measuring labor productivity is never easy. Estimating the benefits of total social productivity, such as the woman's ability to better care for her children, is more difficult.

At the more micro level, the Project should keep detailed costs of trial interventions whether inside or outside the Study Zone. The systems analysis approach would enable a more rational decision on the slection of alternative strategies (or, more realistically, combinations of interventions), their costs and the objectives attained. It is obvious that total costs must not exceed realistic levels.

The Project will probably have the most success in collecting data on costs of ambulatory health care delivered in the Study Zone and hopefully for hospitalized patients coming from the Study Zone. It will be important to identify individual patients, number of visits per patient and whether the patients received any tests or treatment for schistosomiasis.

If the Blue Nile irrigated areas continue without efficacious and cost effective interventions to control schistosomiasis transmission, the country will suffer not only from the loss of agricultural production but from increasing costs of morbidity and mortality caused by the disease.

B. Social Analysis

The Gezira is the home of about 1.7 million farmers and laborers and .5 million seasonal migrants who help with the cotton harvest. Within the Gezira, the Project Study Zone consists of blocks 26 and 27 and encompasses some 30,000 - 50,000 residents in 41 villages and temporary camps. Most of the tenant farmers are African Arabs. A common Arab/Islamic heritage, fused with African (Hamitic, Nilotic, Nubians) elements, provides a considerable degree of cultural homogeneity, despite varied tribal backgrounds.

Ethnically close to the tenants, but lower in status, is the group known locally as Westerners. They come from various tribes in the western provinces of Darfur and Kordofan, and from as far west as Chad. Some Westerners are more or less permanent residents in the Gezira, other comprise the bulk of the .5 million seasonal laborers. In the Study Zone, Westerners tend to be Fur, who may specialize in the unenviable job of cleaning canals, or Tama who work as field laborers, often camping in the cotton fields in temporary shelters.

Additionally there are the Fellata, a generic term denoting Nigerians,especially Hausas, and other groups from West Africa.

Migrant communities of Fellata were established in the early years of the Scheme, but the composition of these communities remains relatively unstable. New migrants -- often pilgrims on their way to or from Mecca -- join the Gezira Fellata, and the latter may work as seasonal laborers in other parts of Sudan.

Westerners and Fellata are of relatively equivalent low status in the Gezira; they may be lumped together and called by either name by tenants or Gezira officials. Both tend to live in labor camps or in "unregistered" villages. The latter are not recognized by the Gezira Board and so receive no services, such as water supplies. Children of these groups often attend primary schools in neighbouring, recognized villages, but they tend to drop out early because they are needed to work in the fields and help with domestic chores.

There have been no basic demographic studies in the Study Zone. We have no population pyramids or evidence for possible population shifts over time. There is poor monitoring of the many seasonal laborers who live for months at a time in the Study Zone. Their movements of course have great health significance. In 1978 a modest study was undertaken by sociologist Ann Cheesmond to learn something about both the excretory and water-contact behavior of the people in the village of Angudu (pop. c. 1,100) and its environs. The study yielded some interesting results, but additional data from a wider area of the Gezira are needed, and basic demographic/sociological data are needed to make sense of what we have. This conclusion was voiced at the March 1980 conference on schistosomiasis at Abu Ushar, the headquarters of the Study Zone.

As a research rather than an operational Project, the social effects will be minimal. There will be neglible disruption of everyday activities. Some cooperation will be required in order to carry out research. The Project might anticipate a few problems in collecting stool and urine samples, but experience has shown that such problems are not insuperable. Moreover, health programs have proven to be among the most acceptable and desired of programs in the Gezira.

The research Project will yield identifiable benefits. Sudanese scientists from a variety of disciplines including sociologists, will be employed and trained further in schistosomiasis research, which will better enable the GOS to research and intervene in schistosomiasis after outside funding ceases. Moreover, health care of the people on the Study Zone will improve since

the Project will supply much needed medicines to the dispensaries and health posts of the area.

Looking beyond the research phase, the discovery of an effective intervention strategy would benefit the people of the wider Gezira, (pop. 2,000.000) both in terms of economics and quality of life. The presently proposed intervention strategies dicussed in the larger "Blue Nile Water-Borne Disease Strategy" paper are either too expensive to be broadly applied to all the people living in irrigated areas, or of doubtful efficiency. Therefore, this research Project is most important in identifying strategies which can be targetted towards specific goals meeting cost-effective standards. The quality of life would be improved by the enhanced feeling of health for persons with wormloads that have not yet caused the clinical manifestations of disease. Micro research has so far failed to establish conclusively the assumption that schistosomiasis seriously impairs labor productivity. However, this is probably because the sampling bias of prior efforts have excluded workers with severe disease. Severe disease is present in many persons in their young adult years in the Gezira. If their condition can be alleviated it is not unreasonable to assume that their economic productivity will increase. Since the state of the Sudanese economy is largely dependant on the foreign exchange derived from cotton, and since 75% of Sudan's cotton is grown in the Gezira, increased productivity in the Gezira would benefit the entire nation.

Moreover, seasonal workers from all over Sudan become infected with schistosomiasis while working in the Gezira. Effective interventions derived from the research Project would prevent the spread of schistosomiasis to other areas of Sudan. This spread has already occured and will accelerate with increased infection in the Gezira. This lends a sense of urgency to the Project: after nearly 50 years of losing the battle with schistosomiasis in this region, a careful baseline study needs to be undertaken to determine the best strategies for controlling the disease.

Women in developing societies usually lack the social and economic power resources that men enjoy. Certain cultural features found in LDC's help ensure the subordinate of women. The Gezira features most of these: polygamy, patrilineal descent, patrilocal residence, and deeply-embedded, patriarchal Arab/Muslim values that demand female purity, seclusion, modesty, and submission.

The sexes are quite segregated, even after marriage. Both men and women seem to prefer the company of their own sex. Arab

women remain in the home and perform domestic chores. Some activities, such as fetching canal water require them to move about, but they are seldom far from home.

Islamic law allows women half the inheritance to which their brothers are entitled, thus some Arab women hold tenancies. However, someone else must manage and work the land for them since Arab women are not supposed to work in the fields. Off-farm income-producing occupations that are open to men are closed to women. The only exceptions are midwifery or if the woman is educated, teaching (secondary schools are segregated by sex).

The situation is different for Fellata or Western women. They, along with their children provide over half the labor in the fields. They also perform a wider range of domestic chores for Arab women, as well as for their own husbands. They may additionally sell ground-nuts or marisa, the local beer. Thus they are somewhat less restricted, but certainly more hard-working than Arab women.

Better health would not miraculously emancipate women from their subordinate and disadvantaged position; it would however greatly improve the quality of their life. There is evidence that women with schistosomiasis are going without treatment and are suffering, and sometimes dying, at home. This may happen because the extreme value place on female modesty and purity tends to inhibit women from going to health care workers (who are predominantly male), whose job it is to perform physical examinations and take stool samples.

The Project takes into account the special position of women by involving a Sudanese female sociologist to interview the women. The data ought to yield useful results that can be employed in a strategy for reaching women to reduce their prevalence rates of schistosomiasis.

C. Environmental Concerns

Economic development in Sudan has been intimately linked to the productivity of the Gezira Scheme. The irrigation project has increased agricultural production in Sudan and has contributed significantly to the country's annual GNP. The production of extra long staple cotton -- made possible largely because of the Gezira Scheme -- has greatly increased the nation's export earnings and has strengthened its place in the competitive international market.

The development of the Gezira Scheme, however, has resulted in certain undesirable consequences. It in fact serves as a classical example of the adverse environmental impacts that can rise inadvertently from agricultural development.

In creating the enormous Gezira Scheme and the large network of irrigation canals, the engineers also provided a mammoth habitat for snails that are the critical link in the life cycle of the parasite (Schistosoma mansoni) which causes schistosomiasis. The larvae of the parasite enter the human body by penetrating the skin and eggs are passed out of their human host with bodily wastes. In the absence of good sanitation facilities, the larvae in the eggs return to the aquatic environment to perpetuate the cycle.

Schistosomiasis is not a new disease in Sudan -- there are reports of its occurrence in ancient Sudan -- but its increase has been favored in recent decades by agricultural development along fertile river plains. Before irrigation, the area of the Gezira was an arid, fertile plain with scanty seasonal rainfall, and schistosomiasis was not a major problem. The establishment of irrigation canals in the area changed this situation. Schistosomiasis is now endemic and very serious, affecting 50 percent or more of the human inhabitants. Its debilitating effects make it a major health concern in the Gezira. The Gezira Scheme has given rise to other environmental problems.

The Gezira Scheme was the first large irrigated scheme in the Sudan. High yielding varieties of crops were introduced. Irrigation schedules and fertilizer programs were developed to maximize the yield potential of the new varieties. In order to bolster the effects of irrigation and fertilizers, various chemical pesticides were introduced as preventive measures against pest ravages. The pesticides were relatively cheap, and some chemical agents, such as DDT, were broadly toxic and persistent and could protect against a whole complex of pests. Therefore, they were applied preventively on a calendar schedule even when the pests were present at less than damaging levels. This strategy worked well initially.

However, the inherent drawbacks of depending on the chemical pesticides as the primary line of defense against pests are increasingly apparent in the Gezira. Heavy use of insecticides in cotton has created a particularly worrisome problem. There is evidence that whiteflies -- insect pests which produce "honeydew" that causes stickiness of cotton lint, drastically reducing the

sale price of the fiber -- apparently have developed genetic resistance to monocrotophos and dimethoate, insecticides which previously were highly effective. In 1979, whiteflies were out of control and caused severe damage to the cotton crop in fields treated as many as eleven times. The problem has placed an extremely heavy financial burden on farmers. Pesticides now constitute 30% or more of the total cotton production expenses and, yet, they do not guarantee protection against the pests. Many cotton protection experts believe that cotton production in the Gezira is rapidly approaching disaster -- namely, the production of "sticky" cotton which will not sell at a profit on the world market. This disaster looms in the near future unless cost effective pest control alternatives are developed. This was the conclusion recently reached by the FAO/UNEP Panel of Experts on Integrated Pest Control, a panel represented by some of the world's most renowned and respected authorities in pest control. Their conclusion is accepted by some of the highly qualified Sudanese experts working on the same problem in the Sudan.

The heavy use of pesticides -- namely insecticides -- on cotton in the Gezira has produced other unsavory results. Unacceptable residues of DDT and other so-called persistent pesticides are known to occur widely in aquatic systems, livestock, fish, and certain wildlife species and may accumulate in human tissues. The use of some of the less persistent insecticides -- organophosphorus compounds, for example, which have been introduced as alternatives to DDT and other persistent insecticides -- may present even more potential threat to humans because of their effects on crucial enzyme systems and acute toxic effects. Adding to the problem, the use of insecticides on cotton has accentuated the problem of malaria. DDT and malathion applied to cotton have drifted into mosquite habitats and given rise to genetically resistant strains of malaria mosquitoes in some areas. Malaria was a minor problem in the Gezira area prior to the irrigation scheme. Now, it is now endemic in the Gezira and the evoluation of insecticide resistance has created a new serious dimension in public health.

It is clear that policies and programs of public health in the Gezira cannot evolve independently from those of agriculture, or vice versa, without dire consequences resulting. Nor can public health or agricultural development programs achieve their goals without considering the complex and delicate relationship between the natural and man-altered environment. Many years of experience with international development aid indicates that well-intended measures sometimes fail because their recipients fail to perceive this relationship.

The interdisciplinary team approach being proposed in this Project promises to lead to a more rational system of environmental management in the public health sector. It should lead to a clearer understanding of the ecological relationship of the intermediate snail hosts of schistosome, their environment, and the onset and manifestation of schistosomiasis. This understanding undoubtedly will strengthen Sudan's capacity for designing and carrying out cost effective snail control programs employing ecologically sound and safe control techniques that should cause minimum harm to the Gezira environment and the human inhabitants. A spin off -- the ultimate goal -- will be an environment freer of the terrible schistosome disease.

The long-term management of schistosomiasis, malaria, and perhaps other diseases in the Gezira, however, must be tackled by a joint effort of medical, biological, and agricultural scientists who percieve and approach the problem holistically, considering public health, agriculture, and the natural environment as interlocking components of the Gezira "agroecosystem". Anything less than this approach cannot be expected to yield optimal results in public health in the longer term.

D. Technical Feasibility

The Project, is by its nature, an attempt to conduct research to develop new methodologies and to improve existing techniques for obtaining a data base upon which an integrated control program may be mounted against schistosomiasis. It is anticipated that the development of such a system will be transferable from the Study Zone (block No. 26 and No. 27) to the entire Blue Nile Project. The technical feasibility of the Project may be evaluated, therefore, with respect to the following parameters: 1) personnel, both with respect to present competence, projected training, and input provided by selected consultants; 2) facilities, those presently available and those projected and funded, in part, by AID; and 3) the research goals and objectives envisioned in the Project.

Personnel: The individual most directly involved in the supervision and direction of the research activities in the Study Zone will be Dr. Mutamad A. Amin, a well trained parasitologist who is presently Director of the Medical Research Council, and presently designated Director of Research and Training for the Blue Nile Project. His extensive experience

in schistosomiasis research and control in the Sudan and in the Gezira, in particular, eminently qualifies him for his role in the project. In addition, he has recruited a staff of experienced Sudanese personnel in the fields of epidemiology, malacology and anthropology to implement the requirements of the project. Several of these individuals are presently working part-time on the Project, but will become full-time staff members when the Project is funded. This nuclear staff will be complemented by additional professionals, technicians, and consultants as provided for and funded by A.I.D. and is deemed adequate to insure attainment of the goals and objectives set forth in the Project. An integral member of the team will be the U.S. biostatistician who will serve in a research capacity and as a computer specialist to develop and systematize an integrated data collection and retrival system; this person will serve also as a direct liaison officer between the project and USAID/Sudan.

It is difficult, at this time, to envision the exact nature of supplementary training that will be required. However, it is evident that intramural training in statistical coding, data retrieval,and an updating of quantitative epidemiologic evaluation will be needed. Likewise, extra-mural experience (short-term courses or fellowships) for selected disciplines (e.g., biological control and alternatives to molluscicidal systems and intergrated pest-management) appear likely and warranted.

Facilities: At present, modestly equiped laboratory space for snail maintenance, biological control studies, parasitological and clinical studies, and life-cycle maintenance are presently available at the ITM and have, in fact, been utilized in preliminary surveys and investigations conducted in the Gezira region. Space will also be provided at the ITM for the housing of the computer facilities and a mini-computer will be purchased by A.I.D. This facility will be under the supervision of the U.S. biostatistician and will serve as the principal repository for the storage, evaluation, intergration and retrieval of all data collected in the Project's various studies.

Two buildings, to be used as a field laboratory and staff quarters for personnel working and living in the Study Zone, are in the process of being remolded by the Sudanese Government at Abu Usher. The laboratory building will be equiped, in part, by A.I.D. funds and will serve as a base for parasitological, malacological and epidemiological studies in blocks No. 26 and No. 27. Likewise, it is anticipated that this facility will serve as an operational base for anthropological investigations and as the primary repository

for preliminary data to later be integrated at the computer facility in Khartoum. The Abu Usher facility is ideally situated near the main highway with ready access to both Khartoum and to the Gezira Board Headquarters in Wad Medani.

Goals and Objectives: It is axiomatic that the control of schistosomiasis requires an intimate knowledge of the factors which may influence the epidemiology and transmission of the disease in a particular environment, including the biological attributes of the snail intermediate hosts and the cultural attitudes which contribute to water-contact. To this end, the Project proposes to initiate a research and training program oriented towards obtaining such information and to the establishment of an integrated data collection system necessary for disease surveillance and for evaluating economic impact and cost-efficiency of anticipated interventions.

Schistosomiasis has been recognized in the Gezira for more than 50 years and in spite of repeated intervention programs, the prevalence of infection has not been materially reduced and may, in fact, be increasing. Epidemiologic methods, as proposed and used in preliminary surveys by the project staff, are well recognized and acceptable techniques (quantitative Kato stool examination for S. mansoni and urine filtration of aliquots for S. haematobium) providing an adequate and representative sample of the population is surveyed. Observational and interview techniques for assessing water-contact have not, as yet, been adequately developed by the existing project staff and cannot be assessed. Likewise, it is evident that the impact of potable water as provided by deep-bore wells requires critical evaluation. Until a firm and integrated data base is established, it will not be possible to devise a means for assessing the economic implications of this disease; however, this is one of the goals of the project and will require a significant input from qualified consultants.

Control of the intermediate snail hosts continues to be an important component of integrated strategies to control schistosomiasis. The objectives of snail control programs may be broadly characterized as follows: 1) the complete eradication of the snail hosts in a given area, or 2) the reduction of the snail population to a level at which disease transmission is significantly reduced. The first objective is seldom practicable or possible, nor is it particularly adviseable with respect to the balance of the biotic community. Attainment of the second objective has been hampered by insufficient data relevant to the biology, ecology, and sampling of the snail hosts. The relevant question, therefore, is at what level must a snail

population be reduced in order to significantly affect disease transmission? Methods presently used to control snail populations include a) the application of molluscicides--applied either focally or area wide; b) environmental alterations to eliminate or render aquatic habitats unsuitable for snails; and c) biological control by means of introduced or natural predators and parasites. Molluscicides have and, in many areas, continue to be the method of choice; however, in view of the increasing awareness of the dangers of such agents to the environment, alternatives must be sought and are being demanded. It is an objective of the Project to seek and investigate potential alternatives. Environment control requires considerable cooperation of the local population and is often quite expensive but has the advantage of being permanent. Biological control, which is an area of study selected by some members of the Project staff, has scarcely been explored. It should be noted, that although various predators and parasites of freshwater snails have been recognized and some have received study in the laboratory, few appear to be of practical value in controlling the host snails under field conditions. An exception may be Marisa cornuarietis, a South American prosobranch snail which attacks the egg-masses and young of the host snails and has been used with some success in Puerto Rico. Its applicability to the Sudan would require serious evaluation. Recent studies on competitive interaction between species of Helisoma and host snails are likewise encouraging and require further study. The use of fish predators, e.g., the African lungfish has been proposed as an area of study by the Project staff. A supply of these fish have already been collected from the Western Sudan and preliminary experiments suggest that they will prey upon snails. In this regard, it should be noted that a variety of predatory fish have been studied, in the past, including at least 40 species in Africa. Fish predation, however, has never been shown to be highly specific and snails are eaten only when the prey population is of sufficient size to warrant the energy expenditure required by the predator. Observations that snail infection rates at levels of 1% or less are capable of maintaining human prevalence at levels between 20 and 60% mandates a careful evaluation of this method of control.

Experimental studies on natural plant products control agents, in particular "Habat-El-Mollok" (=Croton sp.), will be conducted. Preliminary studies by Dr. Asim A. Daffalla have demonstrated that the product was effective against Biomphalaria pfeifferi and Bulinus truncatus, the respective hosts of S. mansoni and S. haematobium. The material, however, is not effective against snail eggs nor the larval schistosomes. There is,

also, no evidence that it is effective against mosquito larvae as is the plant product Endod. Chemical characerizations remain to be done and toxicity studies do not appear to be adequate.

Molluscicidal intervention (e.g., Niclosamide) will not be part of the Project per se; however, it is likely that the Study Zone as a component of the overall Blue Nile Scheme will be subjected to such measures. This raises some concern with respect to the integrity of suitable controls for alternative measures and it is recommended that at least a portion of Blocks 26 and 27 be kept free of molluscicidal treatment for experimental purposes.

E. Administrative Arrangements

The Project will make a direct contribution to the Blue Nile Health Project by developing a surveillance system for schistosomiasis. The administrative unit within the GOS which has been charged with the research and training activities of the Project is the Research and Training (R&T) Unit of the Blue Nile Health Project. In addition to the staff provided by the MOH, the Unit has a number of professionals from the Medical Research Council of Sudan and from the University of Khartoum. The Director of the R&T Unit, Dr. Mutamad A. Amin, is also Director of the Medical Research Council and a Professor of Parasitology at the Medical School. He is assisted by two administrative assistants. This AID Project will strengthen the research organization of the R&T Unit by adding expertise in biostatistics and epidemiologic data processing and analysis to the already existing multidisciplinary competence in parasitology, malacology and field epidemiology. It will also provide funds for additional field staff of the research team and for equipment and supplies to expand the field research in the Study Zone.

It is proposed that the American biostatistician act as the liaison officer between the Research and Training Unit of the Blue Nile Health Project and USAID/Sudan and that an officer of USAID be designated as local Project Manager. It is further recommended that a special bank account be established for the Project.

The office and laboratories of the Research and Training Unit are located at the fifth floor of the National Health Laboratory in Khartoum. The AID Project will also be housed at the R&T Unit's headquarters, while the field research component of the Project will be attached to the Abu Usher facilities

in the Gezira.

As biostatisticians with training and field experience in epidemiology are rare, some delays can be expected in the recruitment of a suitable candidate. Interested direct-hire professionals in AID concerned with the project should be given ample time to interview prespective candidates and to brief the incumbent before assuming his duty station in Khartoum. AID/W would also be expected to recruit the consultants for the project and to assist in the logistics for providing the highly specific needed for the project on time. Moreover, direct technical assistance from AID/W may be needed in certain phases of the project.

F. Evaluation Plans

Since this Project consists of a research entity created to gather and analyze data related to the surveillance of a specific disease, the evaluation differs from the more usual type of project activity surveillance. Provision has been made for two evaluations, one at the end of 18 months after the Project's inception, and the second one at the termination of the Project.

The personnel required for each evaluation will be very similar with respect to their technical skills. The co-ordinator of the team should be provided by either AID/W or REDSO/EA and have had prior experience conducting evaluations and producing well-written reports. The team will require two persons who will probably have to be procured under contracts by AID/W: a malacologist with prior African experience with schistosomiasis problems and a social anthropologist with a background in either medical enthropology, schistosomiasis or both. AID/W should assist with a person with a good systems background, knowledge of software for social science analysis, and capable of giving practical guidance useful to scientists without extensive analytical training. Either AID/W or REDSO/EA should assist in providing two additional skills, a medically trained person familiar with the clinical aspects of the disease and an integrated pest management specialist capable of assessing the interactions of the whole ecosystem being studied.

The relatively large (6) American team will be assisted by Sudanese senior staff selected by the Director of Research and Training. He will attempt to identify qualified individuals working within the country on similar

disciplines and their relationships to the disease, but not currently working on this project.

The initial evaluation will focus particularly on the following areas:

1. Should the project continue without change?
2. Is re-scheduling indicated?
3. Are the inputs provided sufficient and of the right types to do the job?
4. Is the project meeting the objectives specified?
5. Are the interdisciplinary team members working well together and utilizing the services provided to the fullest capacity?
6. Is the intra-organizational management effective?
7. Are the linkages between the Abu Ushar and Khartoum Units effective and harmonious?
8. What inter-organizational linkages have developed with other bodies interested in similar problems?
9. How do the representatives of the various disciplines evaluate the data produced to date?
10. Is the budgeting appropriate if any changes have taken place?

The initial evaluation will be followed by a symposium to be held in Khartoum for the entire Sudanese staff to present any papers related to the topic. The budget is sufficient to allow overseas participants to attend. The selection of these persons will be at the discretion of the Director, Research and Training Division of the Schistosomiasis Division. It should be useful to share the jointly prepared US/Sudanese evaluation report in order to seek constructive recommendations from experienced international personnel. A representative from WHO Geneva from the Division of Schistosomiasis and other Helminthic Diseases would be a valued consultant for such a symposium.

The timing of this first evaluation should coincide with the annual meetings of two newly created groups which advise the Blue Nile Health Project: the International Donors Review Committee and the Scientific Advisory Committee.

The final evaluation which will occur at the end of the fourth year will focus on the overall objectives of the project and how well they have been attained. Major concerns will include:

1. What has been the productivity of the scientist working with the project with respect to quality and quantity?
2. What skills have been added to the Sudanese staff through the project?
3. Can the project be expected to continue at the same efficiency level without outside assistance?

4. What prospects are there for an effective and appropriate control strategy to evolve from the work? Are further data needed?

5. Should the project be continued or a sequel to it considered? By whom? What level of funding would be required?

A symposium will be held at the end of the Project. Again, the level of funding is sufficient to invite outside consultants. All papers produced during the project should be presented in at least summary form. It would be appropriate if the outside consultants wished to comment on the desirability of future funding.

G. Financial Plan

The following summary financial table shows a breakdown of total Project costs to AID and the GOS by category and foreign exchange/local currency costs. All cost estimates are based on current prices for technical assistance, Sudanese salaries, training, equipment, supplies, and operating expenses. Inflation has been calculated at between 10-15% for US supplied goods and services beginning in FY 1982. The GOS contribution has been inflated at 10% per year starting in 1982. A 10% contingency factor has been added to both the AID and GOS contributions. For details on these budget estimates, refer to Annex B, Financial Notes.

The GOS contribution is 33% of total project costs, thereby satisfying Section 110(a) of the Foreign Assistance Act.

This Project will not burden the GOS with significant recurrent costs during its implementation or after its termination. Most of the costs attributed to the GOS are associated with personnel already employed, existing buildings and facilities, and vehicles previously purchased. It must be noted, however, that AID is funding the salary costs of several long-term Sudanese professionals to work on this Project (biostatisticians (2), socio-anthropologists (2), public health inspectors (2), lab technicians (4), an economist, and a pest management specialist). Once the Project is completed, a source of funding will have to be found to support this trained and experienced staff. Hopefully, the Project will develop cost effective programs for control of schistosomiasis which will be funded by the GOS and external donors in the future. The core staff employed during the life of this Project would certainly be ideally suited for employment on any follow-on activities.

SUMMARY COST ESTIMATE AND FINANCIAL PLAN
(OBLIGATIONS US $000)

SOURCE AND CATEGORIES	FY 81			FY 82			FY 83			FY 84			TOTAL		
	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL
AID															
Technical Assistance and local personnel costs (1)	180	86	266	176	127	303	181	140	321	201	155	356	738	508	1,246
Training	-	-	-	96	-	96	65	-	65	75	-	75	236	-	236
Commodities and POL	180	12	192	28	14	42	60	27	87	18	28	46	286	81	367
Other	-	-	-	15	15	30	10	-	10	20	20	40	45	35	80
Inflation (factored into each category)															
Contingency @ 10%	36	10	46	31	16	47	32	17	49	31	20	52	111	62	193
Total AID contribution	396	108	504	346	172	518	348	184	532	345	223	569	1,436	686	2,122 -67%
GOS															
Personnel	-	173	173	-	173	173	-	173	173	-	173	173	-	692	692
Buildings/facilities	-	23	23	-	23	23	-	23	23	-	23	23	-	92	92
Other	-	9	9	-	9	9	-	9	9	-	9	9	-	36	36
Inflation @ 10%	-	-	-	-	21	21	-	43	43	-	68	68	-	132	132
Contingency @ 10%	-	21	21	-	21	21	-	21	21	-	21	21	-	84	84
Total GOS contribution	-	226	226	-	247	247	-	269	269	-	294	294	-	1,036	1,036 -33%
Total Project Funding	396	334	730	346	419	765	348	453	801	345	517	863	1,436	1,722	3,158 -100%

(1) Includes evaluation costs totaling $49,000 (FY 82, $22,000; FY 84, $27,000)

H. Implementation Arrangements

USAID/Sudan plans to carry out this project as follows:

1. A project manager will be designated within USAID/S to:

   a. Assume primary project implementation responsibilities for the mission;
   b. Coordinate project direction with the Director of the Research and Training Unit of the Blue Nile Health Project and the US funded biostatistician working with the Unit;
   c. Prepare PIO/ts for the long-term advisor and short-term consultants;
   d. Prepare PIO/Ps with the assistance of USAID/Sudan's foreign national training officer for project funded participants;
   e. Prepare (with REDSO/EA assistance, if necessary) Project PIO/Cs naming a procurement service agent in the US as the authorized agent of the GOS;
   f. Coordinate scheduled project evaluations.

2. The services of the long-term biostatistician will be obtained under a personal services contract (See Annex E for job description.) This individual will be the Project's principal liaison with USAID/S.

3. AFR/RA will be the primary Washington backstop office for this project. AFR/RA will assist in the recruitment and contracting appropriate project personnel; assist with project participants (through OIT); and provide general project support.

4. The Ministry of Health will have overall responsibility for the project for the GOS. More specifically, the Research and Training Unit of the Blue Nile Health Project will be the implementing agent for the GOS.

The Project Agreement will contain one covenant to read as follows:

> The grantee covenants and agrees that prior to the procurement or use of any pesticide by the Project, the grantee will inform USAID/Sudan in writing of the proposed procurement or

use of the pesticide, including a detailed description of how the pesticide will be used and the safeguards to be followed, and shall obtain the written approval of USAID/Sudan prior to procurement or use of the pesticide.

Preliminary Implementation Schedule and Procurement Plan

The following implementation plan identifies the major actions which must be carried out to get this project underway. No attempt is made here to specify the various research activities and experiments that will be carried out under the project. This will be the responsibility of the individual scientists working under the gneral guidance of the Director of the Research and Training Unit, Blue Nile Project. One of the first tasks of the biostatistician upon arrival in Khartoum will be to submit a research and experiment plan for the first year of the project to USAID/Sudan.

Action	Date	Action Agent
1. PP submitted.	August 1980	REDSO/EA, USAID/S
2. PP approved.	November 1980	AID/W
3. Project Agreement signed.	December 1980	USAID/S with REDSO/EA
4. PIO/T for biostatistician submitted.	January 1981	USAID/S
5. PIO/Ts for first year short-term consultants submitted.	January-March 1981	USAID/S
6. PIO/Cs for first year vehicles, commodities and supplies submitted.	January-Apr. 1981	USAID/S with REDSO/EA assistance; PSA
7. Biostatistician arrives at post.	June 1981	AID/W contract Office, USAID/S
8. Vehicles, commodities and supplies arrive.	June-Oct. 1981	AID/W Procurement/PSA
9. Arrival of short-term consultants.	As scheduled in PIO/Ts-throughout 1981	AID/W Contract Office, USAID/S

ANNEX A

PROJECT DESIGN SUMMARY

LOGICAL FRAMEWORK

Project Title & Number: Health Constraints to Rural Production PP (698-0408)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: 1. Sector Goal: To improve the quality of life for the people of the Sudan. 2. Program Goal: To remove health constraints to rural production caused by water borne diseases in the Blue Nile irrigated areas. 3. Sub-goal: To ameliorate the impact of schistosomiasis	Measures of Goal Achievements: Reduction of prevalence and/or severity of schistosomiasis	Data Output sheets Evaluation reports	Assumptions for achieving goal targets: 1. Schistosomiasis causes a decrease in either the quantity or intensity of people's work capacity. 2. Successful completion of the project will assist in the development of viable and replicable interventions for the Blue Nile irrigated areas.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose: To develop a multi-displinary system for epidemiological surveillance (collection, analysis, interpretation or relevant data and their prompt dissemination to those concerned) of schistosomiasis in study zone of the Gezira.	Conditions that will indicate purpose has been achieved: End-of-Project status. The existance of a functioning surveillance system for the designated study zone (Irrigation Blocks 26 & 27) which can provide on demand the available data in space and time on acceptable parameters necessary to evaluate the transmission and control of schistosomiasis.	Output of analyzed data sheets Evaluation reports.	Assumptions for achieving purpose: Scientists are willing and able to work together to achieve common goals.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Outputs:	Magnitude of Outputs: By 1984:		Assumptions for achieving Outputs:
1. Trained personnel working in or associated with the study zone. 2. A completed census of the total population of the zone and sampling designs & techniques developed. 3. Precoded forms and data collection and analysis techniques developed for multidisciplinary studies. 4. A functioning computer facility with appropriate hardware. 5. A surveillance system operating for the study zone suitable for expansion.	1. Sudanese technicians and staff will be trained in various disciplines related to schistosomiasis surveillance. 2. Maps, census data, and sampling frames will have been developed. 3. Data will have been analyzed and interpretend on all aspects of the surveillance system. 4. The computer facility will meet staff needs in a routinized manner. 5. The system is ready to assist in the development of an effective and economical control strategy.	Annual reports of Project Advisor. Periodic publications of staff members evaluation reports.	1. Personnel are available for training and willing to work in the study zone. 2. The participating Sudanese investigations and supporting facilities are available at the appropriate time. 3. The population in the study zone whether in designated or undesignated villages cooperate in the study. 4. Interventions exist which could emeliorate the schistosomiasis problem in both an effective manner and at reasonable cost.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Inputs: Technical assistance - long term - US short term- US Participant Training - long term - US short term - US Local Personnel Support - GOS & US Commodities - US	Implementation Target(Type & Quantity) See detailed Budget Table.	1. USAID Controller records 2. AID/W Controller records 3. MOH records	Assumptions for providing Inputs: 1. AID funding available on timely basis 2. GOS and related budget support continues.

ANNEX B

AID FINANCED COSTS
($000)

NOTE: ALL FIGURES ROUNDED TO THE NEAREST THOUSAND DOLLARS

CATEGORY	FY 81			FY 82			FY 83			FY 84			TOTAL		
	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL	FX	LC	TOTAL
TECHNICAL ASSISTANCE															
Long-Term															
- Biostatistician - 48 PM @ $120,000/yr + 10% inflation/yr	120		120	132		132	145		145	160		160	557		557
Short-Term-U.S./Sudanese															
- Computer advisor - 1 PM	10		10										10		10
- Computer Programmer/Analyst 2 PM	20		20										20		20
- Evaluation team - 2 PM				22		22				27		27	49		49
- Miscellaneous consulting-9 PM @ $10000/mo.+ 10% inflation/yr	30		30	22		22	36		36	14		14	102		102
Long-Term-Sudanese															
- Biostatisticians @ $10,000		10 (1)	10		22 (2)	22		24 (2)	24		27 (2)	27		83	83
- Socio Anthropologists @ $ 10,000		10 (1)	10		22 (2)	22		24 (2)	24		27 (2)	27		83	83
- Economist @ $10,000		10 (1)	10		11 (1)	11		12 (1)	12		13 (1)	13		46	46
- Pest management @ $10,000		10 (1)	10		11 (1)	11		12 (1)	12		13 (1)	13		46	46
- Biologists @ $10,000		10 (1)	10		22 (2)	22		24 (2)	24		27 (2)	27		83	83
- Public Health Inspectors @ $6,000		12 (2)	12		13 (2)	13		15 (2)	15		16 (2)	16		56	56
- Lab technicians @ $6,000 Salaries @ 10% inflation/yr		24 (4)	24		26 (4)	26		29 (4)	29		32 (4)	32		111	111
TRAINING															
- Biostatistician - 18 mos. @ $1,850/mo. + 2,400 int'l travel + 15% inflation/yr				40		40							40		40
- Short-term U.S.- 12 participants 3 mos. each @ 3,500/mo. + int'l travel @ $2,400 + 15% inflation/yr				56 (4)		56	65 (4)		65	75 (4)		75	196		196
VEHICLES/POL/COMMODITIES & SUPPLIES															
VEHICLES															
- 1 carryall @ $8,500	15		15										15		15
- 4 4WD utility @ 9,000	32(2)		32				42 (2)		42				74		74
- 1 Pickup @ $8,000 Base inflated @ 15%/yr spares @ 30% of base. Shipping @ 35% of base + spares.	14		14										14		14
POL @ 30% of base price + 15% inflation/yr		10	10		12	12		23	23		26	26	71		71
Commodities & Supplies															
- 10 kw generator + voltage regulator	11		11										11		11
- Mini computer @ $15,000 + service contract	15		15	5		5	5		5	5		5	30		30
- 3 air conditioners @ $700	2		2										2		2
- 1 HP 41C calculator @ $1,400 + 3 hand calculators @ $150	2		2										2		2
- Photocopy machine @ $10,000				10		10							10		10
- Radio (master + 3 mobile) $12,000	12		12										12		12
- 2 Typewriters @ $500	1		1										1		1
- 4 office files @ $250	1		1										1		1
- Printing, mapping, publications								2	2				2		2
- Office supplies	2	2	4	2	2	4	2	2	4	2	2	4	8	8	16
- Disposable supplies	10		10	10		10	10		10	10		10	40		40
- Lab. + Ref.material	3		3	1		1	1		1	1		1	6		6
- Tech.Equip.-List attached	60		60										60		60
OTHER															
- Symposia in Sudan				15	15	30				20	20	40	35	35	70
- Attendance at int'l meetings							10		10				10		10
SUB-TOTALS															
- Technical Assistance	180	86	266	176	127	303	181	140	321	201	155	356	738	508	1,246
- Training	-	-	-	96	-	96	65	-	65	75	-	75	236	-	236
- Vehicles/POL,etc.	180	12	192	28	14	42	60	27	87	18	28	46	286	81	367
- Other	-	-	-	15	15	30	10	-	10	20	20	40	45	35	80
Sub Total	360	98	458	315	156	471	316	167	483	314	203	517	1,305	624	1,929
- Contingency at 10%	36	10	46	31	16	47	32	17	49	31	20	52	131	62	193
Grand Total	396	108	504	346	172	518	348	184	532	345	223	569	1,436	686	2,122

GOS CONTRIBUTION
(ALL COSTS LOCAL CURRENCY EXPRESSED IN $000

CATEGORY	FY 81	FY 82	FY 83	FY 84	TOTAL
Personnel					
- Senior staff salaries 3 Biologists 2 Malacologists 2 Parasatologists 2 Spidemologists 1 Clinician 1 Ecologist	67	67	67	67	268
- Mid-level staff salaries 6 Technicians 4 Lab assistants 4 Public Health Officers 4 Interviewers	36	36	36	36	144
- Support Staff 8 Drivers 6 Cleaners 4 Lab attendants 3 Messengers 3 Guards 30 Snail field workers	70	70	70	70	280
Salaries calculated as a percentage of time spent on project activities using current pay scales in Sudan. Percentages range from 25-100%.					
Buildings					
- ABU USHAR laboratory/ offices based on 15 yr. depreciation and yearly maintenance	19	19	19	19	76
- Khartoum laboratory-- imputed rental value per sq.ft.	2	2	2	2	8
- Director's house-- rental value	2	2	2	2	8
Other					
- Depreciation of 4 cars @ 1,000 ea./yr.	4	4	4	4	16
- Maintenance/POL @ $5,000/yr.	5	5	5	5	20
Sub Total	205	205	205	205	820
Inflation @ 10% yr	-	21	43	68	132
Contingency @ 10% of sub total	21	21	21	21	84
Grand Total	226	247	269	294	1,036

Equipment & Supplies

	Major Equipment (Over $500)	Cost $U.S.
5	binocular, compound microscopes with lights & mirror	12,500
2	dissecting microscope	2,000
2	table-model centrifuges with standard heads (18-12 tube capacity, 12-15 ml tubes)	2,400
1	Micro-hematocrit head for above	125
1	Portable Generator; 1200 W capacity (Hands Type)	800
1	All glass, electric still for dist. H_2O	450
1	16 cu ft capacity refrigerator with freezer compartment	600
1	Hatch Field Kit with Spectraphotometer for water analysis	450

	Minor Equipment (Under $500)	
2	digital scales - $100 each	200
1	baby scale	90
2	Large, insulated cold chests + 1 dz freezer packs	200
1	Magnetic mixer + stirring bars	125
1	laboratory balance, 0.01-100 gm capacity	550
2	Stethoscopes	200
2	Percussion hammers	35
2	blood pressure cuffs and manometers	250
1	opthalmoscope	175
1	otoscope	175
2	physician bags	170
2	battery operated hemoglobometers + extra chambers (6)	700
	Leur-lock milli-pore filter-holders, plastic	500
	Fine forceps and scissors, stainless steel	100

Lab. Supplies (for year 1)		Cost $US.
Assorted glass ware(beakers, slides, graduates, pipets etc)		3,000
Assorted chemicals & stains		2,500
Disposables (sample cups, applicators sticks, gloves tape, filter pads, syringes, etc.)		3,000
Pharmaceuticals and pallatives (Chloroquin, Aspirins, Opthalmic ointment, etc.)		5,000
Aquarium supplies		1,000

Soc. Anthropologists Equipment		
Binoculars (2 pr)		400
2 S/70 Polaroid camera with film		600
Present cost estimate		38,295
+ 20% inflation		7,659
	Sub Total	45,954
+ shipping cost 30%		13,786
	Total	59,740

Disposable Supplies (after year 1)	
Lab items	4,000
Pharmaceuticals	5,000
Aquarium supplies	1,000
	10,000

SOCIAL ANALYSIS

Introduction

The Gezira Scheme is the world's largest irrigated farm under single management. The main cash crop is cotton. Other crops include dura(sorghum), wheat, groundnuts, lubia, (bean) rice, vegetables, and fruits. The Scheme began in 1925 with the completion of the Sennar Dam, which transformed 1.8 million feddans into arable land. Now, more than 2 million feddans are under cultivation, not including the new and adjacent Rahad scheme.

The Gezira area is the home of about 1.7 million farmers and laborers, and .5 million seasonal migrants who help with the cotton harvest. The tenant farmers, who are ethnically Arabs, operate in partnership with the government of Sudan and the government-controlled Sudan Gezira Board (SGB), a public corporation which handles the administration of the scheme and marketing of the cotton crop.

The Gezira accounts for 12% of the total cultivated area of Sudan and its cotton earns 60% of the nation's foreign exchange.

The People

Within the Gezira, the Project Study Zone consists of blocks 26 and 27 and encompasses some 30,000-50,000 residents in 41 villages and temporary camps. Most of the tenant farmers are African Arabs. A common Arab/Islamic heritage, fused with African (Hamitic, Nilotic, Nubian) elements, provides a considerable degree of cultural homogeneity, despite varied tribal backgrounds.

Ethnically close to the tenants, but lower in status, is the group known locally as Westerners. They come from various tribes (usually sendentary, agricultural) in the Western Provinces of Darfur and Kordofan. Some come from Chad. Westerners may be more or less permanent residents in the Gezira; others comprise the bulk of the .5 million seasonal laborers. In the Study Zone, Westerners tend to be Fur, who may specialize in the unenyiable job of cleaning (weeding) canals, or Tama, who work as field laborers, often camping in the cotton fields in temporary shelters.

Another group is the Fellata, a term derived from Fulani and which refers to Nigerians, especially Hausas, as well as to other Sudanic peoples from West Africa. Migrant communities of Fellata were established in the early years of the Scheme, but the composition of these communities remains relatively unstable. New migrants -- often pilgrims on their way to or from Mecca -- join the Gezira Fellata, and the latter may work as seasonal laborers in other parts of Sudan.

Westerners and Fellata are of relatively equivalent status in the Gezira; they may be lumped together and called by either name by tenants or Gezira officials. Both tend to live in labor camps or in "unregistered" villages. The latter are not recognized by the Gezira Board and so receive no services such as wells or water supplies. Children of these groups often attend primary schools in neighbouring recognized villages, but they tend to drop out early because they are needed to work in the fields and help in domestic chores.

Two low-status groups remain. One consists of descendants of slaves that once belonged to indigenous Arab tribes. The other consists of transhumant cattle-herders from east of the Blue Nile who graze their cattle in the Gezira for 1-3 months, and who additionally earn laborers' wages during the cotton picking season. The former are well-integrated into village life; the latter are not but their presence, as is true for all seasonal workers, has significance in terms of health and the spread of schistosomiasis. It is also significant that the government has no effective means for monitoring the movements, or the health status, of the various migrant workers who comprise perhaps one-quarter of the Gezira's total population.

Inter-Group Relations

The society is a highly-stratified, caste-like one with tenants in a relatively high position and with several ethnic/occupational groups at the bottom. The social organization in the Gezira area has been this way since antiquity. Records from pre-modern times describe the Fung Farmers of the 10th century as a leisure class which depend largely on tenants, hired labor, and slaves to carry out cultivation tasks for them.

Leisure is highly valued by the Arab tenants of today. Conversely, manual labor is associated with slaves. Accordingly, tenants hire as much field and domestic labor as they can afford or need. Need for labor varies with size of landholdings, the sex and age composition of the tenant family, and the distance between the fields and the tenants household.

Going beyond tradition and Arab values, it should be noted that the Gezira Scheme was never planned with self-sufficiency of lacal labor in mind. There has always been a need for importing seasonal labor. In fact labor has been, and remains, in short supply.

Tenants and laborers, while socially segregated, are mutually bound in a web of economic relationships. For a tenant to find laborers, he must have good "credit" locally, i.e. he must make good his promise to pay after his crop is in. In the meantime, the tenant paterfamilias must help feed and provide for the hired family -- and perhaps their animals. The tenant himself is in a perpetual state of debt to the shopkeeper-moneylender, since cash is always short yet always needed to provide for laborers. Most tenants sell their cash-crops at the same time of year, thereby getting the lowest possible price. Values are

are again relevant: generosity , display, and what even might be called conspicuous consumption on the part of the relatively wealthy are called for. One of the worst things a person can be called is a miser. This has a leveling effect on wealth disparity in Gezira; it means that people will spend or lend rather than save or invest.

It should be noted that tenants work in a system that is tightly controlled by field inspectors and other members of the Gezira Board. Board decisions are based on considerations of cotton ouput and variable world market conditions, and not necessarily on the interests or welfare of the tenants, to say nothing of the laborers. For example, tenants often wish to grow more dura than they may be given permission to. Dura is locally referred to as "our daily bread", as opposed to "the government's" Dura is not only the basic subsistence crop, it is also the basis for credit or loans from local shopkeepers-moneylenders. Yet the larger system demands that cotton be given highest priority and that it be produced at the lowest price possible in order to maximize profits. The justifying rationale is that income from cotton benefits the entire nation.

Who are the Poor?

From the above, it can be seen that all of the people of the Gezira are relatively poor, even if some have more money and property than others. Both malaria and schistosomiasis are highly endemic to the area and that there are no significant prevalence rate differences between ethnic groups. Schistosomiasis is a desease of rural poverty; it is related to inadequate housing and sanitation, to poor diet and lowered resistence, and to poor access to health care services.

Of course, the Westerners, Fellata, and other labor groups are the poorest in the area. They lack access to potable water for the most part, and they are denied basic services that the SGB provides. (Arab villages of less than 1,000 population may also lack services.) It is men from these groups that perform jobs like canal weeding, which requires long hours of immersion in contaminated canal water. A 1980 study that determined age and six-specific prevalence rates of S. Mansoni eggs in the stools of two labor groups found that male "Westerners" (who clean the canals) were the only group for whom prevalence rates do not drop after teen-age, the years of maximum bodily exposure to canal water resulting in increased intesity of infection the longer they are employed in this occupation.

The high prevalence of schistosomiasis among males is not to be taken as evidence that women's life is easier, as will be shown in the text section.

It should be remembered that the Gezira Scheme is labor-intense and that the system of using migrant labor helps redistribute the Scheme's income more equitably and further, that it helps spread income, food, and goods originating in Gezira to many other parts of the nation.

The Role and Statutus of Women

Women in developing societies usually lack the social and economic power resources that men enjoy. Certain cultural features can carry this to an extreme; the Gezira seems to have most of these; polygamy patrilineal descent, patriarchal Arab/Muslim values that demand female purity, seclusion, modesty, and submission. The value of female purity to single out one-- leads to the practice of infibulation, or complete female circumcision, in an attempt to ensure that female sexual activity is confined to husbands or husbands-to-be.

The sexes are quite segregated, even after marriage. Both men and women seem to prefer their own company. Arab women remain in the home and perform domestic chores. Some activities, such as fetching water from a canal, require them to move about, but they are seldom far from home.

Islamic law allows women half the inheritance to which their brothers are entitled, thus some Arab women hold tenancies. However, someone alse must manage and work the land for them, since Arab women are not supposed to work in the fields. Off-farm income-producing occupational roles that are open to men -- merchant, shopkeeper, butcher, religious funcionary, tractor leaser, industrial laborer at textile factory or tannery, tailer, carpenter, house repairer, canal guard, samad (agricultural supervisor)-- are all closed to women. The only occupations open to Arab women, and these are part-time, are those of midwife (traditional or "trained") or healer. If she is educated, a women can teach in secondary school. These schools are segregated by sex.

The situation is different for Fellata or Western women. They, along with their children, provide over half the labor in the fields. They also perform a wide range of domestic chores for arab women, as well as for their own husbands. They may additionally sell ground-nuts or marisa, the local beer. Thus they are somewhat less restricted, but certainly more hard-working, than Arab women.

Village authority and decision - making

Nowdays the two key authority figures in villages in the Study Zone are the Sheikh, whose position is hereditary, and the head of the village council. It is probably necessary to have a development project sanctioned by both of them before villagers are likely to cooperate. The Shikh is the traditional kin-group (asaba: patrilineage) head or patriarch. He arbitrates disputes, collects taxes, and may have a number of ritual functions. His support should be solicited for the research and date gathering efforts.

The village council head presides over a council made up of a number of committees that have somewhat separate functions. An average-size village would have an agricultural, development, youth, women's, and "people's committee. All of these come under the influence of the Sudan Socialist Union. As a result of the SSU's socialist ideology,women

have been encouraged since 1970 to form unions and to participate in their village councils. However, they are not as yet very active or ifluential. For one thing, they tend to be uneducated and for another, they would not dare oppose or challenge the views of their husbands.

There are 15 elected members on each committee. In smaller villages, there is a great deal of overlap of personnel on these committees. In practice, some villages simply have a single council that handles whatever problem arises without dividing into committees.

The development committee, if it exists as such, coordinates with the SGB to develop, construct, or maintain things like wells or water filter systems, health posts, or schools. Much is done on a self-help basis. In spite of fair degree of factionalism based on endogomous kin/Ethnic /religious-sect (tariga) groupings, self-help projects seem to work quite well as long as people believe that projects actually benefit them. Of course,skeptiscism and non-compliance set in if government promises remain unfullfilled or if too many ideas are discussed without follow-up or implementation. Community development officers are employed by the SGB to suggest community self-help projects to village development committees, and also to pass along committee ideas or request to the SGB. Apparently, there are so few of these officers that they are seldom seen in the villages.

Health Beliefs and Practices at the Community Level

Traditional medicine in the Gezira represents a syncretic fusion of Arab and African influences, with the former predominating. Bantu and Sudanic influences -- notably witchcraft and sourcery -- and of course more evident among the Fellata.

The Arab/Muslim system of medicine took root in the Gezira over the centuries since the Bedouin conquest. Today, fakihs (fakirs) are found in virtually every village. These traditional healers share a well-developed herbal pharmacopoeia and system of healing, a system which includes surgical proceedures, bone-setting, cauterization blood letting, and magical manipulation or divination based on powers believed to be inherent in the written word of the Koran. Some of the materia medica has objective efficacy, such as the earth rich in iodides of mercury which is used to treat syphillis.

Traditional midwives are available to assist in childbirth and perinatal health problems of the mother. These midwives are said to be secretive, and not much is known about them by males or outsiders. The village of Angudu, within the Study Zone, has a female healer whose role is similar to that of a fakih. She prescribes magical medicines and is believed to have the power to counteract the harmfull spell of a Fellata healer.

Fellata healers are somewhat distinguished from Arab fakihs by their abilities in sorcery and divination. Arab villagers are said to go to Fellata healers to learn the identity of a thief through divination, or to harm another Arab through sorcery.

Faith in traditional healing is strong in the Study Zone, especially among older people. There seems to be no mutual trust or patient referals between the fakih and the local representatives of modern medicine, the medical assistant and the (male) nurse. People view modern and traditional medicines as separate, competitative systems. Each has its strengths and weaknesses. People move from one to the other system depending on the nature of their illness and whether or not, and how quickly, they find satisfaction. Satisfaction in this sense, it should be noted, means not only the objective removal of symptoms, but also gaining understanding of the maning of why a person becomes ill. The fakih, as part of the community and belief system of the patient, usually does a far better job than the medical assistant in explaining why a particular person becomes sick.

Another disadvantage of modern medicine in the Gezira-- in fact through much of rural Sudan is that local clinics are usually short, or completely out, of medicines. The supplies from the central government stores are irregular and unreliable. This has led many medical assistants to buy medicines commercially and sell them to patients -- at great personal profit many villagers believe. One of the strategies by which the research team hopes to create good project-community relations is by keeping local dispensaries and health posts well-supplied in medicines.

The medical assistant in Angudu reports that he spends most of his time treating colds, sore throats, malaria, fever, and headaches. He refers the following problems to the "hospital" in Abu Ushar: schistosomiasis, broken bones, appendicities, serious wounds, and other conditions he does not feel competent to handle.

If results from modern medical care are not quickly evident, a patient often turns to the fakih; perhaps at the urging of an older relative.

It should be noted that women visit medical assistants or (male) nurses far less frequently than do men. This is because men do not want their wives to be alone with other men, especially in situations such as physical examinations. Thus, a good but unknown proportion of female morbidity goes untreated, at least by modern medicine. This may be especially true for schistosomiasis where the presenting symptoms are vague and require an examination of the body to rule out other types of disease.

It seems clear that for the foreseeable future, female health educators and clinicians will be needed to work with the women of the Gezira. At present, there are few female primary health care workers. One low-cost strategy by which to partially remedy this would be to up-grade the skills of the village mid-wife, whether she be trained or traditional. The trained mid-wife in Angudu (a native of that village) reports that she is never consulted about any medical problem beyond those connected with pregnancy and childbirth. Nor has she ever been asked to speak to the village council or to any other group in the community. It would seem that the current mid-wife training period of 15 months could be extended by perhaps another 6 months -- not necessarily all in one time block-- and that the mid-wife could become more of a general nurse and health educator.

In order to plan an intervention strategy, or mix of strategies, for schistosomiasis it is necessary to know something about the water/sanitation - related knowledge, attitudes, and practices of the people for whom the interventions are intended. A study was conducted by sociologist Ann Cheesmond (now at the University of Hull, U.K.) in 1978 in order to answer some of these questions. She focused on one village, Angudu, and on surrounding canals and abueshreens (irrigation ditches). The study yielded some useful results, but there need to be additional data from a wider area of the Study Zone before resources are invested in water and sanitation systems. Such was the conclusion of the conference on schistosomiasis held in Abu Ushar, the headquarters for the Study Zone, in March, 1980.

The longer the contact with infested water, and the greater surface area of the body that is exposed, the greater the risk of schistosomiasis infection. Therefore children, who spend more time swimming in the canals and abueshreens than adults, are more exposed to infection than adults. Other variables are relevant as well: the season and the time of day determine the relative density of both infected snails and cercariae. And due to agricultural practices, the flow of water, and various behavioral factors, abueshreens and minor canals are liklier to be infested than the larger canals.

In addition to swimming, children also spend hours on end walking through the canals with fishing nets, another high-risk activity. Due to strong cultural sanctions requiring female modesty and seclusion, girls beyond the age of ten seldom if ever swim, and bathing (washing) is done only in a partial way while clothed, or with canal water carried to a secluded spot. Thus, teen-age and adult women are less at risk than their male counterparts.

A particularly high-risk activity is cleaning the canals, that is, removing the weeds that impede the flow of water and provide an ideal habitat for snails. This is considered a very low-status and dangerous (from the point of view of health) job throughout the Gezira. In Angudu, only Fur men clean canals, and in 1978 "many"(unquantified) were engaged in this activity. In 1980, there were fewer men from any ethnic group willing to perform this task. The paltry wages could be earned more easily and less dangerously in Khartoum or in agricultural jobs.

Other categories of potentially infective bahavior include doing laundry, washing utensils, and collecting water. Arab women favor wading to the middle of a canal to collect flowing water, as they regard it as cleaner than the more stagnant water by the banks. Non-Arab women usually collect water by standing on the banks, thereby reducing exposure to infection.

Thus the risk of exposure to schistosomiasis infection varies with age, sex and ethnic group (as well as with distance of a village from infested water), although further investigations are called for before

conclusions can be drawn. However, at this point the evidence suggests that a separate intervention strategy needs to be designed for different groups.

The Cheesmond study also looked at excretory behavior. Men were found to be more contaminative in this respect than women. Female modesty and seclusion keep women from venturing far from home; they usually urinate or defecate near their homes just before sunrise or after darkness has fallen. Young children likewise excrete near their homes, and older children cover the faeces with sand.

According to the data gathered by Cheesmond, few people excrete directly in the abueshreens or canals, nor does excretion usually occur sufficiently close to these bodies of water to contaminate them. If people excrete near a canal, e.g., on the outside bank, it is because the irregular terrain and possible foliage offer privacy. Cheesmond claims that it is the search for privacy, not proximity to water, that causes people to excrete near canals. The surrounding fields are usually flat tnad without any protective foliage.

Cheesmond believes that a good deal of contaimination occurs when people wash clothes and their hands are soiled with excrement in the canal. This finding seems to be somewhat at odds with the view held by many urban-based Sudanese that people contaminate canal water in a more direct fashion. Clearly, nore research into this behavior pattern needs to be carried out.

It was mentioned that Arab women generally judge the cleanliness of water by whether or not and how quickly it flows. This seems to hold true for Fellatas and Westerners as well. Those that may occassionally excrete directly into canal water are said to feel that they see no problem if it immediately flow downstream. They apparently do not worry about what might be floating down from upstream.

The people of the Gezira know that schistosomiasis comes from contaminated water, but they don't adequately understand all the links to the vector snail. They moreover seem resigned to have to live with this danger in their environment. The delay and complex cause and effect relationship between water contact and the appearance of symptoms may also lead people to believe that one swim in an abueshreen will make no difference. Appropriate helth education could make a difference here. For example, if people avoided water contact during the peak densities of cercariae, i.e., during the hottest hours of the day, the risk of infection could be reduced.

A number of Arab villages in the Study Zone have deep bore-wells, many built thru a combination of village initiative and money from the SGB Social Service Board (which operates on a tax called from the sale of Gezira Cotton). Unfortunately, the well pumps break down frequently and spare parts are seldom forthcoming. When the pumps are inoperative, people drink canal water which is the only source of water for poeple outside registered villages.

ANNEX D

INITIAL ENVIRONMENTAL EXAMINATION

Project Location:	Gezira Scheme of Sudan
Project Title:	Health Constraints to Rural Production - Sudan
Funding:	
Life of Project:	Four Years (1980-83)
IEE Prepared by:	Dale G. Bottrell University of California, Berkeley Consortium for International Crop Protection 2288 Fulton Street, Suite 310 Berkeley, California 94704 (U.S.A.)
Date of Preparation:	July 1980
Environmental Action Recommended:	Negative Determination
Concurrence:	Date: Sept. 2, 1980
Assistant Administrator's Decision:	

1. Description of the Project

a. Purpose and Proposed Activities

The purpose of the Project "Integrated Data Base Development for Schistosomiasis in the Gezira" is to create a multidiscriplinary system for epidemiological surveillance of schistosomiasis, a serious snail-borne disease of humans in the Gezira Scheme of Sudan. Project activities will be restricted to research. The research will be concerned primarily with the collection, analysis, interpretation, and dissemination of data relevant to the development of a surveillance system required to properly analyze, prevent, and control schistosomiasis.

A major support activity will be the collection of data on the distribution, prevalence, incidence, and intensity of schistosomal infections in representative samples of the human inhabitants in a selected area of the Gezira Scheme, known as blocks 26 and 27, and referred to here as the Study Zone (see accompanying map). Parallel with this activity, a variety of field investigations on the biology, ecology, behavior, and control of the schistosome - bearing snails and the interrelationships of the snails, schistosomes, and human hosts will be conducted in the study zone. Complementary laboratory studies will be conducted at facilities in the study zone and at Khartoum University in Khartoum. In addition, various sociological, anthropological, and economic studies will be carried out simultaneously with the other activities described. Finally, appropriate biostatistical analyses will be performed as required for the systemization and interpretation of relevant data.

The Project activities will be coordinated by Dr. Mutamid A. Amin, Head of the Institute of Tropical Medicine at Khartoum University, member of the National Research Council of Sudan, and Director of Research and Training for the "Blue Nile Health Project in Sudan". Dr. Amin, his research staff, and additional technicians and professional staff and short-term consultants funded by AID will carry out the Project activities. The Project will support intramural training and extramural training (short-term courses, fellowships of the project participants) as required to increase the Project expertise in specific areas (integrated pest management, statistical coding, and data retrienal, for example).

b. The Location

Primary Project activities will be carried out in the Study

Zone, an area of about 20,235 hectares [1/] in the Gezira Scheme, shown on the accompanying map. The well-known Gezira Scheme, South of Khartoum between the White and Blue Niles, is the largest irrigated area in the world, totaling about 0.88 million hectares.

c. Major Land and Water Forms

The climate of the Gezira is semi-arid, with an average annual rainfall of 300 millimeters. The land is very flat, so that it is easily reached by the Gezira irrigation system of small canals and minor distributory channels. Further, it consists of cracking clays well suited for irrigation. The tableland of the Gezira "triangle", between the Blue Nile and the South Nile south of their confluence at Khartoum, slopes gently toward the north and west, permitting natural gravity irrigation from the irrigation dam at Sennar.

The Gezira is extensively cultivated. The noncultivated land is inhabited by desert scrubs and grasses. Agricultural production is adequate only on the cultivated, irrigated land.

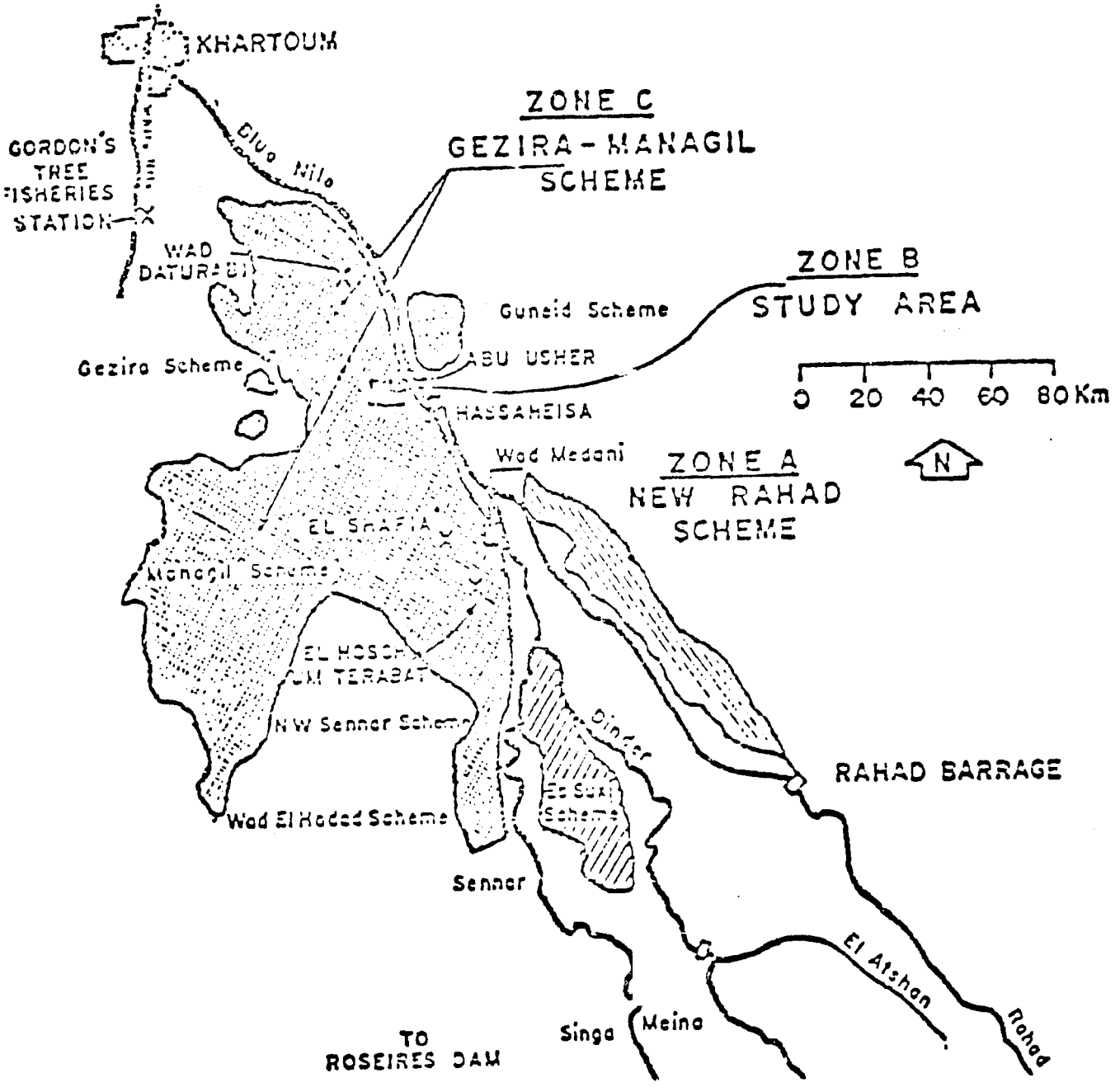
The climate, land and water forms, and land use of the Study Zone are similar to many other areas of the Gezira of comparable size.

d. Present Land Use Patterns

The Gezira Scheme is divided into 14 Groups which are sub-divided into 107 blocks (54 in the Gezira proper and 53 in the Managil, south western extension, fed by an extension canal). (As stated, Blocks 26 and 27 comprise the Study Zone.) From the Sennar Dam, water flows through a network of channels and ducts to irrigate the cultivated blocks. The land and water are owned and managed by the GOS under the administration of the Sudan Gezira Board. The operation is a weld of State ownership and private enterprising. The GOS provides the land and manages the irrigation scheme. Private entreprenuers -- tenants -- manage and harvest the crops.

1/ In Sudan, a feddan, is commonly used in preference to hectare One feddan equals 0.42 hectare.

MAP OF BLUE NILE IRRIGATION SYSTEMS AND PROPOSED PROJECT FACILITIES



The Gezira Scheme was developed primarily to produce extra long-staple cotton, gossypium barbadense. Cotton was grown on small scale prior to completion of the Sennar Dam in 1925. The area planted in cotton increased significantly in 1951-52 with the addition of a north western extension and nationalization of the Scheme in 1950 and again in 1960-61 with the development of the Managil extension.

The Sudan Gezira Board reports that agriculture of the Gezira Scheme forms the largest farm under one management in the world. The Scheme constitutes 12 percent of the total area cultivated in the Sudan. Cotton is the economic backbone of the Gezira. The Scheme produces 75 percent of the Country's extra long staple cotton. In recent years, Sudan (Gezira plus other agricultural areas) has produced 30-40 percent of the world harvest of extra long staple cotton. Cotton and cottonseed account for over 50 percent of Sudan's export earnings. Other major crops of the Gezira are dura (sorghum) -- the principal food crop of the Sudanese -- wheat, groundnuts (peanuts), rice, and vegetables, with the following number of hectares being planted to each in the Scheme in 1979-80:

Cotton	227,244
Dura	137,463
Wheat	151,815
Groundnuts	95,989
Rice	3,808
Vegetables	13,956

The addition, the legume, lubia (Dolichos lablab) is grown as animal fodder. Though dura, milled and processed into a bread called kisra is the principal food crop, the beans of lubia are eaten by people during times of hardship. Phillipesara (Phaseolustrilobas sp., a legume) is also grown as animal fodder. Miscellaneous crops include citrus and other fruit trees, and oil seed crops (castor, for example), and trees produced for firewood and lumber. Large number of grazing animals -- primarily goats and cattle -- and poultry are kept in the Gezira. Fishing, though not a major industry, provides an important source of food for some villages nearest the Nile rivers.

On a given plot of land, cotton, lubia, and dura are rotated with fallow land in a rotational scheme that recycles every 6th (Managil extension) or 8th (Gezira proper) year, as prescribed by the Sudan Gezira Board. The Board supplies the fertilizers and plant protection chemicals and administers the use

of these materials. The land-use situation in the study Zone is generally similar to that described above for the Gezira.

e. Present Population and Population Trends

The Gezira Scheme is the home of about 1.7 million farmers and laborers, a half million seasonal migrants who work in the area during the cotton growing season, and an unknown of nomadic herdsmen who graze cattle in the area from 1 to 3 months per year.

Some 30,000 people reside in about, 40 villages and temporary camps in the Study Zone. Most of the tenant farmers are African Arabs. A common Arab/Islamic heritage, fused with African (Hamitic, Nilotic, Nubian) elements, provides a considerable degree of cultural homogeneity, despite varied tribal backgrounds.

The GOS has no effective means for monitoring the population growth in the Gezira or, specifically, in the Study Zone, or the impact of seasonal migration on population trends. The annual population net increase in Sudan is estimated at about 2.5 percent.

f. Present Economic Conditions and Activities

The Gezira Scheme is the keystone of Sudan's agricultural economy. It produces 75% of the country's cotton, 85% of its wheat, and 60% of its groundnuts. Export of Gezira cotton fiber and cotton-seed is the country's chief source of foreign currency.

However, agricultural experts are not entirely optimistic about the future for irrigated agriculture in the Gezira. Nile water allotted to irrigation schemes is now being used or is already committed. Existing irrigation schemes are performing well below expectation, partly because of poor maintenance. Cotton profits have fallen off in the past three years, primarily for two reasons: lack of price incentives and growing problems with insect pests called whiteflies that secrete a sticky substance on the cotton lint, deteriorating its quality and sales value. Pesticides now form about 30% of the cost of production in cotton and, yet, there is evidence that they are not effectively reducing the whitefly problem. If the cotton pest problem worsens --- which it likely will unless cost effective alternatives to pesticides are developed --- disaster may loom, forcing a radical reappraisal of the future of the crop.

The cotton problem, coupled with various factors including the increases in oil prices, have resulted in an almost insurmountable problem in balance of payments. Failing massive interventions by donor countries and international lending institutions, the shortfall in available foreign exchange may soon become critical with major repercussions on economic and political strategies.

g. Social and Cultural Characteristics

The population of the Gezira is that of a highly-stratified, caste society with tenants in a relatively high position and several ethnic/occupational groups at the bottom. This general social organization has existed since ancient times. Though the Gezira Scheme is the most agriculturally advanced region in Sudan, the inhabitants still are relatively poor.

The tenant farmers, who are ethnically Arabs, operate in partnership with the Gezira Board. Ethnically close to the tenants, but lower in status, is the group known locally as Westerners. Some are permanent residents in the Gezira. The Westerners also comprise the bulk of the half million seasonal laborers.

Westerners and Fellata (migrant communities of Fellata, from West Africa, were established in the Gezira in its early years) are of relatively equal status. Both tend to live in labor camps or in "unregistered" villages. The latter are not recognized by the Gezira Board and receive not services such as water wells or water supplies. Children of these groups often attend primary schools but tend to drop out early because they are needed to work in the fields and perform domestic chores.

Two additional low-status groups inhabit the Gezira: the descendants of slaves that once belonged to indigenious Arab tribes and the transhumant cattle-herders from east of the Blue Nile who graze their cattle in the Gezira for 1-3 months each year and sometimes work as laborers during the cotton picking season.

2. Description of Possible Environmental Impacts

This section identifies the reasonably foreseeable effects of proposed Project actions on the human environment. First the overall Project actions will be described. The proposed Project will support the following activities:

Epidemiological Studies

A major activity will be the collection of data on the distribution, prevalence, incidence, and intensity of schistosomal infections in representative samples of the human inhabitants in the Study Zone. It is envisioned that approximately 2000 inhabitants of the Study Zone will be included in the studies. Each year, during the 4-year Study, they will be examined (via blood, stool and urine samples and visual and other appropriate examinations) for the presence of schistosome parasites and other diseases, such as malaria, that may contribute to the morbidity associated with schistosomiasis. In addition, they will be interviewed, and their personal habits and surroundings will be observed as required to determine the effects (singly and in various combinations) of economic status, social status, ethnic background, personal hygiene, diet, water source, and numerous other factors that may be involved in the onset and severity of schistosomiasis. Sampling of blood, urine and stool specimens will be administered by technicians trained properly for this work. Interviews and observations will be carried out by sociological and anthropological specialists, economists, and medical specialists assigned to the Project.

Field and Laboratory Research

A variety of field studies of snail biology, ecology, behaviour, and control will be conducted. The population dynamics and behavior of snails as related to the onset and severity of schistosomiasis will be studied under various environmental conditions as affected by water pH, aquatic plants, soil type, presence of naturally occuring biological controls, and human interventions (chemical control, use of snail-eating fish, Environmental manipulations, etc.), for example. The snails will be studied in their natural aquatic habitats, in field cages, and in laboratory acquaria in the Study Zone and in aquaria at Khartoum University laboratories at Khartoum.

One aspect of snail research will involve the monitoring and testing of various proven or promising snail control methods -- chemical molluscides, engineering and manual methods (e.g., mechanical control of aquatic plants serving as important snail habitat, hand removal of the plants, and flushing the irrigation canals), biological control (via predatory fish such as the Chinese grass carp or competitive snail species), and promising alternative methods that cannot presently be identified -- used

either singly or in combination in "integrated pest management systems." Trained biologists and malacologists will carry out the research. An integrated pest management specialist, trained in ecological principles of pest population management, will collaborate in testing the control methods singly and in combination in integrated pest management systems. Any pesticides that may be tested will be done so only for research purposes on a very small-scale basis and under the direct supervision of project personnel trained on the proper use of pesticides.

(NOTE: Environmental Procedures of AID's Regulation 16 establishes guidelines on the use of pesticides in AID financed projects. Paragraph 216.3 (b) (2) (iii) specifies requirements of projects including the assistance for procurement or use, or both, of pesticides for research or limited field evaluation purposes by or under the supervision of project personnel and, therefore, applies to the present Project. Specific pesticides that may be tested in the Project presently cannot be identified. The approval of use of any such pesticide purchased with Project funds or tested experimentally in the Project -- irrespective of its source -- is subject to requirements of the Project Covenant as specified in section (blank) of this document.)

Other laboratory studies, in addition to those described, will entail microscopic examination, preparation of slide smears, bio-chemical analysis and other techniques, appropriate to the analysis and quantification of blood, urine, and stool specimen samples, samples of water etc.

Biostatistical Analyses, Data Collation, and Data Interpretation

The coding, analysis, collation, and interpretation of data, required of research projects, will be carried out by Project personnel. Electronic calculators, mini-and macro-computers, and other appropriate data analysis and processing equipment will be used for this purpose.

Training

Refer to section 1 a. above for discussion.

From the above discussion, the following foreseeable effects of the proposed actions on the human inhabitants and their environment in the Gezira have been identified:

a. Effect on the Resident Human Population.

Immediate

(1) Positive:

*The Project will generate increased local income and enhance the purchase power of the Project employees.

*The Project will increase the level of medical expertise and related skills in the Study Zone. Therefore, the Zone and surrounding area should theoretically benefit from the resulting improved disease diagnostic and presentation capability.

(2) Negative:

*The Project will result in an increase locally in number of persons in higher education and income levels. The physchological effect on the resident population or the socio-politio-economic impact cannot be predicted, but it may be negative.

*Unless safeguards are established, some of the sampling procedures employed on the resident human population may result in personal health hazards. For example, use of non-sterile blood sampling devices could cause harmful effects.

Appropriate procedures will be adopted in order to mitigate the potentially harmful effects. Only sampling procedures that are widely acceptable by the medical profession will be adopted. The Project Coordinator will ensure the use of acceptable procedures and also that sampling, interviews, and other activities involving the interaction of Project personnel with resident population are conducted professionally by competent employees.

Long-term

(1) Positive:

*The Project aims to develop an improved surveillance system required to properly analyse, prevent, and control Schistosomiasis. In the long-term, this should lead to a reduction in the problem of disease and improvement in the

quality of life of the people of the Gezira.

(2) Negative:

*The possible negative consequences resulting from improved quality of life in the Gezira cannot be predicted.

b. Effect on Project Employees and Indigenous Institutions.

Immediate

(1) Positive:

*The Project should increase employment and learning opportunities for Sudanese scientists and technicians engaged in the biological and medical sciences.

(2) Negative:

*The Project employees working in the Study Zone may be exposed to higher risks (than they were previously associated with) of contracting schistosomiasis, malaria, and intestinal diseases, which may be very serious in the Gezira. Also, pesticide use in the agricultural environment of the Study Zone is quite high; therefore, the Project employees may be exposed to high levels of pesticide contaminants.

Several safeguards will be established to protect the health of the Project employees: At time of employment, and again at yearly intervals (or closer intervals, if determined appropriate), they will take a thorough health examination. Field workers will be regularly monitored for pesticide effects. Changes in acetylcholinesterase activity (an indicator of the effects of organophosphorus insecticides which are commonly used in the Gezira) will be watched carefully. Field personnel will be required to discontinue work in the field and will be treated for pesticide poisoning, if treatment is determined necessary. Antimalaria drugs (chloroquin) will be made available to all project personnel. Field workers will be regularly examined for the presence of schistosomes and treated for schistosomiasis, if necessary. All Project personnel, upon employment, will receive training on the health hazards of schistosomiasis, malaria, other prevalent disease in the Gezira, and pesticide poisoning. Further, they will be instructed on procedures for monitoring and treating the problems. All appropriate safety apparel and devices and materials required for monitoring and treatment will be made available by the Project

Coordinator.

Long-Term

(1) Positive:

*The Project should strengthen Sudan's Institutional capacity for ameliorating the impact of schistosomiasis.

(2) Negative:

*No long-term negative impacts can be predicted.

c. Effect on the Gezira Environment (Other than the Human Inhabitants)

Immediate

(1) Positive:

*No immediate beneficial impact can be predicted.

(2) Negative:

*Most of the proposed Project activities would not be expected to significantly alter the terrestrial or aquatic environments of the Study Zone or of other areas of the Gezira. No major environmental interventions are proposed. As stated above, the Project activities will be restricted to research, involving primarily the collection, analysis, interpretation, and dissemination of data relevant to the development of an improved schistosomiasis surveillance system.

However, two research activities possibly will involve small-scale environmental intervention that, without appropriate safeguards, could result in harm to the environment. One involves the testing of biological control agents against schistosome-bearing snails. The other involves the experimental evaluation of chemical molluscicides.

Biological control of snails, viz use of predatory snails, especially Marisa sp., has shown some promise. Integrated with other methods -- molluscicides and environmental management, for example -- biological control has untested but perhaps considerable promise. Though biological control is generally considered to be a highly desirable method of pest control, misuse of the method can result in harm to the environment (e.g., by disrupting important

food chains in the ecosystem). Therefore, the biological agent must be carefully studied before being introduced into a new environment.

Specific biological control agents presently cannot be identified, but Project personnel may want to evaluate some agents in the laboratory or in limited field tests. Only those approved by GOS official in charge of enforcing animal and plant quarantine regulations may be evaluated in the Project. The Project Coordinator will ensure that their use in the Project is consistent with appropriate GOS policies and regulations on biological control introductions and evaluations.

*Project personnel may want to evaluate (in the laboratory or on limited scale in the field) various chemical molluscicides, though none presently can be identified. As stated above, use of pesticides in AID projects is subject to the requirements of Regulation 16. In accordance with Regulation 16 and current AID policy, prior to the procurement or use of any pesticides for Project purposes, the Project Coordinator will submit for approval by AID/Khartoum the name of each proposed pesticide. Such request for approval will describe in detail the manner in which the pesticide is to be used and safeguards which will be employed. AID/Khartoum will review each pesticide request to determine (1) whether sufficient toxicological and environmental data are available to ensure the safety of project personnel and the quality of the environment and (2) whether appropriate tolerances have been established for the pesticide and whether Project personnel can ensure the enforcement of residue requirements. Upon written notification that AID/Khartoum has approved the use of a pesticide, Project personnel may procure the pesticide, subject to such conditions as may be imposed in the notification approval.

In addition, the Project will provide a minimum of one full-time Sudanese integrated pest management specialist and a minimum of four professional months (during the four-year Project) of consultantship by a U.S. environmental toxicologist. The former will collaborate in developing methods of integrating chemical and non-chemical pest control techniques into Project activities. The latter will assist in evaluating environmental effects of pesticides and in interpreting AID's regulations and policies on pesticide use in AID financed projects.

Long-Term

(1) Positive:

*The Project promises to develop an improved system of schistosomiasis management that causes minimal harm to the human environment.

(2) Negative:

*No long-term harmful effect can be predicted.

3. Summary

Most of the impacts have been identified as being beneficial. If the appropriate safeguards are established, as discussed, the Project should result in minimal harm to the human environment.

4. Recommended Threshold Decision

"Negative Determination"

5. Check List of Impact Areas and Sub-Areas

Refer to following pages.

IMPACT IDENTIFICATION AND EVALUATION CHECK LIST

Impact Areas and Sub-Areas	N	L	M	H	U
A. Land Use					
1. Changing the character of the land through:					
a. Increasing the population					x
b. Extracting Natural resources		x			
c. Land clearing	x				
d. Changing soil character		x			
2. Altering natural defenses					x
3. Foreclosing important uses					x
B. Water Quality					
1. Physical state of water					x
2. Chemical and biological states					x
3. Ecological balance					x
C. Atmosphere					
1. Air additives		x			
2. Air pollution		x			
3. Noise pollution	x				
D. Natural Resources					
1. Diversion, altered use of water					x
2. Irreversible, inefficient commitments					x
3. Wildlife					x
E. Cultural					
1. Altering physical symbols					x
2. Dilution of cultural traditions					x
3. Damage to primitive cultures					x
F. Socioeconomic					
1. Changes in economic/employment patterns					x
2. Changes in population					x
3. Changes in cultural patterns					x
4. Dislocation of population					x
G. Health					
1. Changing a natural environment		x			
2. Eliminating an ecosystem element		x			
3. New pathways for disease vectors		x			
4. Safety provisions		x			
H. General					
1. International Impacts					x
2. Controversial impacts					x
3. Larger program impacts					x
I. Other Possible Impacts (not listed above)					x

JOB DESCRIPTION OF SUDANESE INTEGRATED PEST MANAGEMENT SPECIALIST

The Project will employ the full-time services of one integrated pest management specialist to coordinate the evaluation and integration of snail control techniques------biological, physical, chemical, etc.---used in comprehensive management strategies. The individual will possess an MS degree or equivalent in ecological principles of pest management. If required to develop the needed expertise, the individual will be awarded a fellowship for training, not to exceed 3 months, at a U.S. university recognized in the field of integrated pest management.

The integrated pest management specialist's work will be coordinated with that of the Project biologists, sociologists, economists, and others working on various aspects of snail biology, ecology, and socio-economic interrelations. One important role will be to assist in the identification of pesticides environmentally acceptable in pest management programs. Another will be to begin initial steps to identify possible interactions in the agricultural and public health sectors which may now hamper the development of an effective schistosomiasis management program.

JOB DESCRIPTION OF U.S. BIOSTATISTICIAN

Professional Qualifications for the U.S. Biostatistician are as follows:

Training: The candidate should have at least a master's degree in biostatistics or biomathematics and a strong orientation and formal training in epidemiology and in electronic data processing, retrieval and analysis.

Experience: The candidate must have a record of a minimum of two years successful work as a team member of a large epidemiologic, demographic or disease control program in an LDC. He/she should have teaching experience at the university or equivalent level and must be familiar with coding and code systems of medical data, population demography and supervision of statistical clerks and key punch operators.

Skills: The candidate is expected to adapt the scientific method to the actual field situation, be resourceful and make technical improvements and improvizations as needed.

In addition, the candidate must have demonstrated an ability to work harmoniously as a member of a multidisciplinary research team. Fluency in English is essential. Working knowledge of Arabic would be an asset.

PROJECT CHECKLIST

CROSS REFERENCES: Country checklist for FY 1980 is up to date. See Experimental Swamp Transport (650-0044) Project Paper approved in July, 1980. Standard Item Checklist has been reviewed for this Project.

A. GENERAL CRITERIA FOR PROJECT

1. FY 80 App. Act Unnumbered; FAA Sec. 634A;Sec. 653(b);.

(a) Describe how authorizing and appropriations Committees of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?

a. See Congressional Presentation FY 1981, Annex 1, Africa, page 559.
b. Yes.

2. FAA Sec. 611(a) (1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and (b) a reasonably firm estimate of the cost to the U.S.of the assistance?

a. Yes
b. Yes

3. FAA Sec. 611(a)(2). If further, legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?

N/A

4. FAA Sec. 611(b); FY 80 App. Act Sec. (501). If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?

N/A

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed

$1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?

N/A

6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.

This Project is part of comprehensive approach to the prevention and control of water-associated diseases for which the Sudan is seeking support from several donors.

7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.

N/A

8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

All commodities and most of the technical assistance provided by this Project will come from the U.S.

9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.

The GOS local currency contribution to this Project is 33% of total costs.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?

N/A

11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?

Yes.

12. FY 80 App. Act Sec. (521). If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity?

N/A

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions, (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

a. This Project will conduct research into the control of schistosomiasis in the Gezira region of the Sudan. Ultimately, the results of this research will (a) benefit the poor of this rural area.
b. N/A
c. N/A
d. Women suffering from schistosomiasis will benefit in the long run from the research done under the Project.

e. Results of the research conducted under the project will be shared with other countries in the region.

b. (2) (104) for population planning under sec. 104(b) or health under sec. 104(c); if so, a. extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

This project will gather information and conduct research into the most cost effective methods of controlling schistosomiasis throughout the Gezira area.

c. (107) is appropriate effort placed on use of appropriate technology? (relatively smaller, cost-saving, labor using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor.)

Yes

d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least developed" country)?

The GOS will contribute approximately 33% of the Project cost.

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?

N/A

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports

civil education and training in skills required for effective participation in governmental processes essential to self-government.

The Project will address of the most important health priorities of the GOS, namely, the control of schistosomiasis in the Gezira region. Most of the research conducted under the Project will be done by local Sudanese scientists, thereby strengthening the capacity of indigenous health institutions.

g. FAA Sec. 122 (b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth?

Yes. See economic analysis section of PP.

2. Development Assistance Project Criteria (Loans Only)

a. FAA Sec. 122 (b). Information and conclusion on capacity of the country to repay the loan, at a reasonable rate of interest.

b. FAA Sec. 620 (d). If assistance is for any productive enterprise which will compete with U.S. enterprises, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

N/A

3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531 (a). Will this assistance promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102?

b. FAA Sec. 531 (c). Will assistance under this chapter be used for military, or paramilitary activities?

N/A

(b) To assess and reorganize immediately the on-going disease control programme in the Gezira/Managil scheme and develop and implement an interim comprehensive strategy based on improving currently used methods and materials and strengthening the existing infra-structures.

(c) To develop and assess a long-term comprehensive strategy in a Study Zone which will reduce disease transmission, maintain the results achieved at low costs with minimal environmental hazards, and to apply this strategy in the project area.

(d) To seek innovative control measures which are considerably more cost-effective than present techniques, emphasizing environmental management, biological control, community participation, health education and reduced foreign exchange requirements.

(e) To maximize socio-economic benefit of disease control by improving basic health services, water supply, sanitation, and integration of project activities into local basic health services.

(f) To establish the costs and benefits of water-associated disease control in tropical agricultural systems, including measurement of community productivity, for planning of new water resource developments.

(g) To train decision-makers, planners, designers and operators of water resources projects and health staff in the Sudan and elsewhere on the approach and methods for the prevention and control of water-associated diseases in water resources projects.

(h) To promote and establish close coordination amongst the national departments and institutions involved and with international agencies.

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PROPOSED BUDGET FOR STUDY ZONE, 1980-1983

YEARLY BUDGET FOR U.S. FISCAL YEAR,
BEGINNING OCTOBER 1979, IN 1000 U.S. DOLLARS

	$ FY1980	$ FY1981	$ FY1982	$ FY1983
PERSONNEL				
Project Manager	(Sudan Government + WHO)			
Senior Staff	(Sudan Government + WHO)			
10 Jr. Scientists(M.S.)at$10 000	100	100	100	100
10 P.H. Officers at $6 000	60$	60	60	60
100 Field Assistants	(Sudan Government)			
Sub-total	160	160	160	160
TRANSPORT				
7 Station Wagons,4x4 W/spare parts	70	-	-	-
10 Pick-Up Trucks,4X4 "	70	-	-	-
10 Motor Cycles, W/spare parts	20	-	-	-
Gasoline,Oil & Maintenance	40	45	50	55
Sub-total	200	45	50	55
MATERIALS AND SUPPLIES				
18 Compound microscopes, Oil Immersion at $500	9	-	-	-
Laboratory supplies	4	4	4	4
Oxamniquine Tablets	50	50	50	50
Surveying & Drafting equipment	10	-	-	-
Sub-total	73	54	54	54
FACILITIES				
Mobile Clinic, air conditioned	20		-	-
20 Village Water supplies at $26 000	-	200	200	160
40 Village Sanitation + Recr. at $ 2 000	-	30	30	20
Laboratory and office addition	24	-	-	-
Earth Moving Operations	-	15	15	15
Sub-total	44	245	245	195

Some relevant economic parameters

The Gezira/Managil scheme represents 12% of the total area cultivated in the Sudan and yet produces 75% of the country's main product - cotton, 60% of Durra and 84% of wheat. The scheme's cotton sales provide some 40% of the nation's total national revenue and up to 60% of its foreign exchange.

Malaria and schistosomiasis are considered two major impediments to production in the Gezira/Managil and Rahad Schemes. The socio-economic implications of malaria and schistosomiasis are reflected in the general poor health of the population, low productivity and the burden of expenditure on health care of every family and the health services.

It has been estimated that in 1974 in Gezira/Managil, an average of 33 working days were lost per tenant due to malaria. In this same year, the average production yield of cotton was 4 kantars per feddan while the estimated minimum yield should have been 5 kantar/feddan. In the absence of effective malaria control, the average shortfall due to malaria was estimated at about 20 kantars per tenancy or 0.5 million kantars for Gezira as a whole. If 50% of this loss was attributed to malaria, then the total loss of the whole cotton cultivated area of 0.5 million feddan will be 0.25 million kantars. The estimated loss in terms of money was about 10 million dollars for cotton only. Similar estimates can be put forward for other major crops - wheat, durra and groundnuts, and in respect of schistosomiasis.

The benefits to be derived when malaria and schistosomiasis are controlled will be considerable and can be estimated on the basis of the above and the cost avoided of diagnosis and treatment.

A number of economic parameters are relevant to thinking about the design and assessment of the health programmes. National documents emphasize the necessarily provisional nature of much of the data which must be used to indicate such parameters.

Average family income and the distribution of family income is an important parameter, both for the design of health programme systems and for the assessment of benefits.

GDP per capita is sometimes used as a very rough indicator of family income. According to government data, GDP for 1974/75, for Sudan as a whole, was £s. 1 511 million (the Six year plan of economic and social development, 1977/78 - 1982/83, vol.1, Ministry of National Planning, Khartoum, April 1977, p.2). If we assume a population of about 15 million, this implies a per capita GDP of about £s.100 in 1974/75.

Another source of family income data for Sudan is the Household sample survey in the Sudan, 1967/68 (Dept. of Statistics, Ministry of Planning, August 1976). According to the Survey, for these years, average annual net income per family was £s.411 for urban households, £s.370 for semi-urban households and £s. 148 for rural households (see page 48). According to government data, the cost of living index increased at an average annual rate of about 15 per cent between 1969/70 and 1974/75(the Six year plan of economic and social development, 1977/78-1982/83, vol.1, page 20). This substantial rate of inflation suggests that the household income findings of the Survey would be considerably higher expressed in 1978.

Economic data for the Sudan as a whole do not represent the economic status of Gezira Province which itself originates a major proportion of Sudan's total GDP and which is economically much better off than other areas of the Sudan. Precise estimates of current average family income in the Gezira irrigated scheme could not be obtained. However, knowledgeable estimates are that the average income of the tenants is at least £s.600 per year.

Bilharzia and Malaria

The Ministry of Health had established a successful malaria control programme in 1975 as a response to a crippling epidemic caused by resistance to DDT in Anopheles arabiensis, (An. gambiae species B). Thus a basic organization with 800 people is in operation, but it is now faced with recent resistance to the second insecticide, malathion. Obviously a change is needed to decrease the reliance on insecticides. Simultaneously, the old bilharzia control organization, established in 1955, had been overwhelmed by increasing parasite transmission since the irrigation flows were doubled in 1966 after construction of a large storage dam upstream of Sennar, at Roseires. The logical solution is (1) to combine the malaria and bilharzia programmes to improve operating efficiency (2) switch the emphasis to environmental and permanent control measures and (3) use all available control measures in an integrated programme.

Bilharzia and malaria have been very severe in this area (1, 2, 3, 4). The Blue Nile irrigation systems contain the single largest foci of intense Schistosoma mansoni transmission in the world, as well as being a major source of falciparum malaria and other water-associated diseases (5, 6, 7.). In addition to heavy S. mansoni infections transmitted by Biomphalaria pfeifferi, there are also foci of S. haematobium, transmitted by Bulinus truncatus. Thus the area will be a crucial testing ground to develop the ability of public health agencies to cope with these diseases in most of Africa and the Middle East.

Lower Costs

Trials of single factor control strategies have shown them to be expensive and sometimes inadequate (8, 9, 10). Overemphasis on residual spraying in malaria control has led to unsatisfactory results in many countries. Although single factor control strategies can control bilharzia, the annual costs are usually $3-$5 per capita, almost 10 times the normal expenditure for all public health programmes in the Sudan and similar countries (11, 12, 13, 14). Considerable reduction can be accomplished by combining methods and combining organizations, but will be difficult to lower these costs much below $1 per capita annually, 1978 prices (15).

A major difficulty in lowering the costs of control further has been the reliance on synthetic pesticides and drugs which are extremely costly, require scarce foreign currencies and involve continually recurring expenditures, since disease eradication is not possible. Thus any long-range control effort must be accompanied by a research component aimed at developing alternatives to these expensive chemicals.

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Environmental and biological control of mosquitoes and snails, changes in human behaviour, and permanent modification in agricultural and domestic water use are the most promising alternatives for large-scale use of pesticides and drugs. While their success has been documented in only a few cases, their extremely low costs offers adequate incentive (17, 18, 19, 20). In Puerto Rico biological control of snails in irrigation systems cost about 1% of control with current molluscicides, and the snails in the Nile Valley are equally susceptible to competition, predation and decoy effects by snails such as Pellsoma and Marisa (21, 22). While introduction of foreign snails to the Nile Valley will have to be preceeded by extensive research, immediate evaluation can be made of indigenous african snails which may have similar effects, although not so dramatic (23, 24). In addition, local and imported fish have been found to control weeds, snails and anopheline larvae, offering another biological control possibility.

The extremely high cost of new effective drugs for bilharzia, (oxamniquine and praziquantel) requires that traditional mass chemotherapy strategies be modified in favour of cost-effective use of the drugs for transmission control on a community basis, instead of treatment of people as individuals. This requires evaluation of chemotherapy for high risk segments of the population at dosages which may not cure all persons but will cause very significant decreases in transmission. Such evaluation can only be performed in endemic communities, and requires a full understanding of the disease epidemiology, far beyond the simple egg-excretion rate of the treated persons.

Water Supply

Water and its agricultural, domestic, and recreational uses is the major single environmental factor involved in malaria, bilharzia, gastrointestinal diseases, and other vector-borne infections such as onchocerciasis. Thus another emphasis in reducing the cost of this disease control programme is to emphasize safe, convenient and adequate domestic water supplies, and provision for reducing human contact with water by supplying alternate, safe facilities for laundry, bathing, and water oriented recreation. Combined with proper health education, the multiple benefits of water supply become a major asset, and the cost per capita can be apportioned to the several diseases to the increased convenience, and to the labour savings realised with a piped system. Fortunately the Blue Nile geography makes community water supplies relatively cheap and simple to operate. The land is flat and the subsurface water table is close to ground level in most areas near the river.

Initially the Blue Nile Health Project will be divided into 3 zones. In Zone A (The new Rahad Scheme) presently available control measures will be used to prevent malaria and bilharzia transmission from becoming serious (Map 2). Zone B, the Study Zone in the Gezira will be given an intensive epidemiological base-line survey in 1980 before introduction of an integrated comprehensive control strategy to decrease transmission of all water-associated diseases which presently are major problems. Zone B includes 55 villages in Blocks 26 and 27 where control will be started in 1981, and 20 villages in other parts of the Gezira System which will be the untreated Comparison Areas. The overall 2 million acres of the Gezira-Managil System is collectively known as Zone C wherein improved methods and strategies will be gradually applied on an operational basis, as they become [illegible] present knowledge and from the Study Zone (Table 1).

ANNEX G

Khartoum, ...17 September 1979.....

No./MIN. / 44 / ...2-95.....

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النمرة : — وص / ——————— / /

Gentlemen:

We are pleased to enclose the proposal on "THE BLUE NILE HEALTH PROJECT IN SUDAN" for consideration by U.S.A.I.D., under the Africa Bureau's Regional Affairs Project on "HEALTH RESTRAINTS TO RURAL DEVELOPMENT". Our proposal is a request for about $500 000 per year to finance part of the operation research portion of The Blue Nile Health Project. The project was started as a joint Sudan-World Health Organization effort in 1979, under an agreement and Plan of Operations signed on 17 September 1979, a copy of which is enclosed. The project is envisioned as a 10 year programme costing $15 million per year.

The Blue Nile Health Project is aimed at control of Bilharzia and other diseases in the major water resource developments in Sudan and should provide useful information for many countries in Africa, thus we hope you will consider it as part of your Regional Affairs Programme.

Through previous discussion we have learned from your Washington D.C. staff that the study zone, where we will evaluate the comprehensive strategy for costs and effects, is the component of the project which best fills your criteria. We hope it meets your approval.

Yours faithfully

DR A.A. EL GADAL
Director General for
International Health Affairs

DR ABBAS MUKHTAR
Under Secretary

Sudan Office
U.A. Agency for International Development
Khartoum
Sudan

cc. Regional Director, WHO, Alexandria
WPC, Khartoum
Mr H. Rafatjah, Chief EPO/VBC, WHO/HQ., Geneva ✓

(The Blue Nile Health Project)

The Blue Nile Health Project was recently initiated to improve the health and agricultural productivity of one of the most important rural areas in the Sudan, the irrigation systems along the Blue Nile. These include the Gezira-Managil System and the new Rahad System.

The Blue Nile Health Project was conceived as a response to two major and growing realities in tropical public health: increased water-associated diseases in agricultural communities related to new irrigation systems, and prohibitively high costs for control of these diseases on a large scale, by current fragmented strategies. As the first step, WHO assisted the Sudanese Ministry of Health (MOH) in establishing a 10 year multi-disciplinary programme for the irrigation systems south of Khartoum, utilising existing MOH organizations and basic health services to protect the agricultural population of 2 million people. This will be a single programme for control of malaria, bilharzia and other water-associated diseases, with a budget averaging about $15 million per year. Presently available methods will be combined in the most cost-effective manner, in a comprehensive strategy emphasizing permanent modifications which impact on all of the diseases and their vectors.

The second step is to concurrently develop new and less expensive control techniques for integration into the comprehensive control effort, and to make a careful epidemiological and economic evaluation of the impact of the control effort on the total agricultural community, in an area of 50 000 acres in the northern Gezira called the Study Zone. Thus the value of the control programme could be scientifically assessed, and interpreted for application to other irrigation systems in similar tropical regions.

This proposal to the U.S. Agency for International Development is a request for about $500 thousand per year for 4 years to partially support the activities in the Study Zone. It is particularly appropriate, as the methodologies and information on costs, effects and benefits from the Study Zone will be applicable to similar endemic areas in rural Africa where irrigated agriculture is linked with bilharzia and other diseases. Thus the results from the Study Zone should be useful to many other countries of the African region, fulfilling the purpose of the Africa Bureau's Project on Health Restraints to Rural Development.

Objectives:

The overall objective of this project is to control and prevent the major water-associated diseases, primarily bilharzia, malaria, through a comprehensive programme of disease prevention and control and to assess its health and socio-economic impacts.

The project will have the following specific objectives:-

(a) To prevent schistosomiasis transmission from developing in the Rahad irrigation system, emphasizing permanent and long-term vector control measures.

Table 1

Zone	Name	Population	Villages	Area in Acres	Remarks
A	New Rahad Scheme	50 000	30	300 000	Rapidly expanding since 1976.
B	Study area, Blocks 26-27	50 000	55	46 000	Proposed area for Trial on Integrated Control.
	Comparison Area	20 000	20	20 000	Proposed Untreated area
C	Gezira-Managil Scheme	1 600 000	1 936	2.1 million	Existing malaria and bilharzia control organization to be upgraded gradually.

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The Blue Nile Health Project includes several components including a bilharzia prevention programme in the Rahad System, a revision of current operations in the Gezira-Managil System, and testing of a comprehensive strategy in the STUDY AREA.

This STUDY AREA is a critical component in the overall project, in which an integrated programme for control of the major diseases will be evaluated epidemiologically, for its cost-effectiveness, and for its impact in improving community productivity in this rural population.

Study Area

This zone includes Blocks 26 and 27 of the Mehelriba Council and similar comparison area (s) in the Gezira/Managil scheme. Blocks 26 and 27 have a resident population of 50 000 people in 55 villages and 70 000 feddans of cultivated land.

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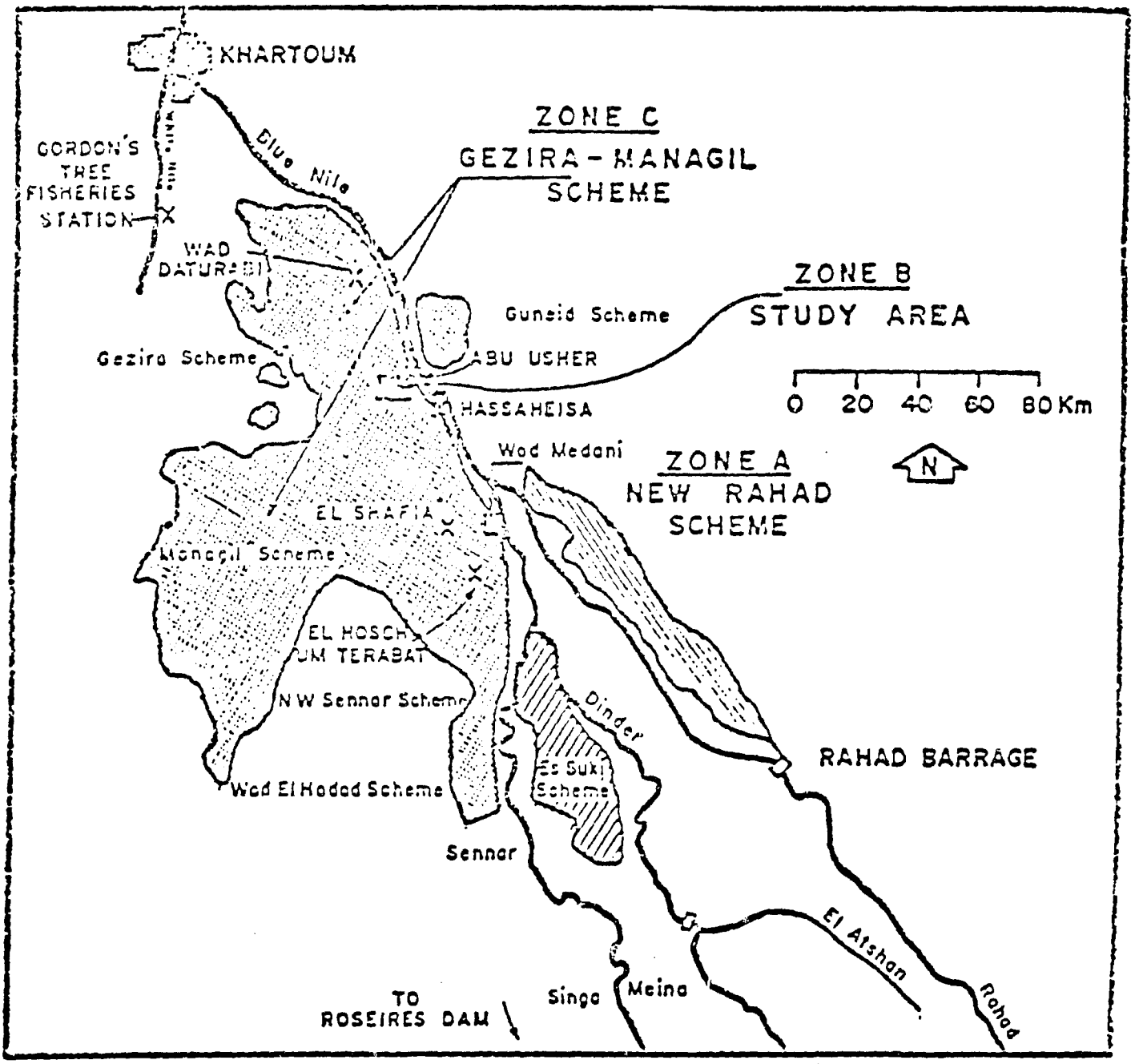
Figure 2

LOCATION OF BLUE NILE IRRIGATION SYSTEMS AND PROPOSED PROJECT FACILITIES



Activities will occur in 4 time sub-phases.

A general survey and reconnaissance will be made leading to selection of the comparison area (s). This area will be similar to the Study Zone, including 20 village areas designated for comparative monitoring from 1981 through 1985 and afterwards, until they are covered by the second phase control activities.

Sub-Phase I - January through September 1979

Staff will be recruited and trained, office facilities, transport and supplies ordered. The ongoing antimalaria and anti-schistosomiasis operations will continue. Concurrently with strengthening of health services and of their malaria passive case detection and treatment component (see under Zone B), stratification of malarious areas will be initiated. Collection of parasitological data through passive case detection will be intensified and entomological investigations will be done as required. Survey techniques for schistosomiasis will be developed as well as a system for monitoring population movements.

Improvement of water supply and sanitation will be planned and initiated.

Sub-Phase II - through 1980

In the Study Area antimalaria activities will continue. However, existing schistosomiasis control activities will be suspended. Epidemiological data for both diseases will be collected on a monthly basis with the addition of 2 prevalence surveys and the intensity of infection for schistosomiasis. Other base-line data will be collected monthly to determine seasonal pattern of transmission including monitoring of mosquito vectors and snail density, snail infection, human habits including water contact and water contamination behaviours. Feasibility analysis and pilot trials will be made with a carefully selected combination of known methods for environmental management, biological control, chemical control, community education and participation and chemotherapy. Operations for improvement of water supply and sanitation and strengthening of health services will continue. A comprehensive strategy will then be defined and planned for testing in Phase III and preparations made for its implementation.

Several operational research projects will be developed. The total impact of disease control on treated communities in the Study Zone including socio-economic development will be compared with the untreated communities in the comparison area. Innovative control methods will be investigated for integration into the comprehensive strategy, including biological control, pesticides application including materials from local plants, better drug delivery system, techniques for better management of water, crops and land, improved water supply and sanitation and recreation activities for decreasing human contact with vector and infected water.

Application of various methods of control within the comprehensive strategy will be carefully studied to insure mutual compatability. Serological techniques will be appraised to decrease the amount of parasitological work. Simple transmission models will be developed for comparative evaluation of control strategies. A special biological control substation will be developed for testing of the biological agents before introduction into the Study Zone. Supplies, equipment and transport will be obtained for Phase III and staff will be recruited and trained.

Sub-Phase III - 1981, 1982 and 1983.

The comprehensive strategy selected and organized in Phase II will be initiated when collection of base-line data is completed.

Residual spraying for malaria control will continue except in areas where endemicity was found to be low with little or no transmission detected during preceding phases and where adequate case detection with treatment and vector control operations other than residual spraying have been instotuted. In these areas residual spraying will be discontinued, epidemiological monitoring will be strengthened and emergency supplies of drugs and insecticides will be maintained. The residual spraying withdrawal is expected to be completed in the entire Study Zone before the end of 1983.

For schistosomiasis control, Bayluscide (70% wp) will be applied selectively concentrating on confirmed and suspected transmission sites. Oxamniquine, metrifonate and other promising drugs will be administered to high risk population. Competitor snails and predator fish (mud fish) will be introduced when available for operational use and environmental management against snails and mosquitos will be introduced and/or intensified. Rehabilitation of water supply and construction of new systems will continue.

For evaluation prevalence, incidence and intensity of infection in people will be measured in the monitor population, and monitoring of mosquito vectors and snails, their infection rates, human habits including contact with water and other related activities will continue from Phase II.

Sub-Phase IV - 1984 through 1989

At the beginning of Phase IV the results from Phase III, from the operational research and from operation programmes in Zone A and B will be carefully evaluated, preparing a final comprehensive strategy for the entire Gezira/Managil Scheme. When the strategy is defined it may then be instituted in the Study Zone for one more full year before expanding to the rest of the Gezira/Managil and Rahad Schemes in 1985. Annual evaluation will continue to the end of Phase IV and will include socio-economic impacts.

As of 1984 the comprehensive strategy will be subject to continuous studies to investigate the deletion or reduction of the least cost-effective component and the incorporation of newer more permanent and long-term economical methods of control that produce a wide range of benefits.

A seminar will be organized for international planners and water-resource engineers. Training of new staff for expansion of the comprehensive strategy will be initiated and compilation and analysis of results will be completed for publication and dissemination.

Methods

1. Disease prevention and control

The comprehensive approach to be adopted in the programme will utilise primarily proven methods (those methods which have already been found effective and proved feasible to apply) of environmental management, biological control of vectors[1]; community water supply and sanitation, chemotherapy and chemoprophylaxis as well as selective use of pesticides.

The existing and proven methods that are currently being applied will be assessed and improved for greater efficiency and effectiveness. On the other hand, methods which have been successfully applied elsewhere will be assessed locally for determining their effectiveness and feasibility of application under local conditions.

Innovative methods for the control of malaria vectors, snails intermediate hosts and weeds as well as those of environmental management engineering will be subjected to field testing to determine their cost/effectiveness and safety to man and the environment for subsequent large scale application.

For the implementation of the proven methods and for testing the innovative methods relevent techniques and procedures are described under Activities and will be elaborated in detail in protocols. A general outline of the main methods is as follows:-

1.1 Environmental management

Environmental management will be a principal long-term measure in the comprehensive strategy, utilising proven engineering methods which will decrease or eliminate permanently habitats of mosquitos and snails and which will reduce human contamination and contact with infective water. These activities will be planned and carried out with full consideration of the design, operation and maintenance of the present irrigation and drainage systems and of current agricultural practices.

1/ The term "vector" is used in its broadest sense to represent vectors, animal reservoirs and intermediate hosts of human and animal diseases.

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1.2 Biological

Proven and safe biological control agents will be evaluated under local conditions and introduced into the project area. Snail competitors and predators and mosquitos biological control agents will also be evaluated to determine their efficacy, safety and suitability under local conditions, in coordination with local environmental authorities.

1.3 Community water supply and general sanitation

Obligatory water contact and contamination at snail habitats and transmission sites will be reduced or prevented by improving the present water supply, excreta disposal and sanitation systems and extending them to cover the whole of the programme area.

1.4 Chemotherapy

The existing health services will gradually be strengthened and extended to cover progressively the whole population in the project area with improved detection, treatment and follow-up of cases. Chemotherapy efforts will be aimed at achieving rapid reductions in load of infection and transmission potential, while the slower but more permanent environmental control measures are being introduced.

Available drugs will be used according to the recommended dosage and treatment regimens with improved coverage and treatment schedules and practices. Chloroquine currently used will be administered for suppression and radical cure (combined with primaquine) of the predominant malaria infection *P. falciparum*. Metrifonate will be administered for treatment of urinary schistosomiasis (*S. haematobium*) and Oxamniquine for *S. mansoni*, while consideration will be given to the introduction of newer compounds for treatment of both *S. haematobium* and *S. mansoni*.

1.5 Pesticides

Pesticides presently used will be applied selectively as an integrated part of the comprehensive programme. It is foreseen that in the initial stages of the programme the use of pesticides may need to be retained at the present scale or increased but their use will gradually be decreased as the comprehensive control programme develops.

The pesticides to be used for control of vectors of malaria are malathion wdp for indoor residual spraying and Abate *"EC" for larviciding. Fenthion will be used for larviciding in polluted waters. Other pesticides will be tested as replacement compounds or for use by other application methods as required. **"Bayluscide" will be used for snail control while plant products and other molluscicides will be subjected to field testing for evaluation under local conditions.

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* temephos
** Niclosamide

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2. Community participation and health education

In the implementation of all the above methods, the population will be stimulated to participate in the programme by adopting responsible and cooperative attitudes in the irrigation and agricultural practices, by exercising self-protection and utilization of protective facilities to be provided to them by the programme, and by assisting programme staff in the accomplishment of their duties. Health education will be intensified, utilizing appropriate media.

3. Evaluation

The methods to be adopted for collecting base-line data and for evaluating the control measures and socio-economic impacts are described under Activities (Part 1). Methods of diagnosis, identification of vectors and intermediate hosts, the standardisation of sampling and the determination of the parameters of infection will be detailed in protocols which will include methods for recording and data processing. Annual assessment of the Programme will be undertaken by independent review teams and boards.

REQUIREMENTS FOR STUDY AREA

Personnel Requirements

Activities in the Study Area will be directed by the Project Manager and the Co-Manager, each using 50% of their time. The remainder of their time will be dedicated to the other Zones in the Blue Nile Health Project. They will supervise 5 Units in the Study Zone, each one directed by a Scientist who will also spend 50% of his time on the Study Area. The Units will be on Epidemiology, Biology, Community Participation, Engineering, and Evaluation. These units will have full responsibility for all base-line studies, control activities and monitoring and evaluation.

Each Unit will include in addition to the Scientist, 2 Junior Scientists, 2 Public Health Officers and 20 field assistants. An Administrator with 5 clerks will assist the Project Manager.

Transport

The units will also have appropriate transportation: 1 Landrover Station Wagon with driver, petrol, spare parts and maintenance, 2 pick-up trucks with petrol, etc., 2 motocycles with petrol, etc., and transportation allowances for use of animals. The Project Manager and Co-Manager will each have a Station Wagon vehicle.

Materials and Supplies

Additional expenses involved in control operations will be primarily water-supply construction (by contract), environmental modifications and drugs. There is also a requirement for microscopes, slides, containers and basic equipment for the Epidemiology Unit. The Engineering Unit will need basic surveying equipment and drafting supplies. Insecticides and molluscicides will be provided by the Government, WHO and sources other than USAID.

Facilities

The basic headquarters for the Study Area will utilize the existing laboratory offices and housing at Abu Usher, with additions and improvements. The most important addition will be construction of an Epidemiology Laboratory for the fecal, blood and urine analyses, and an Evaluation Office for data collection, analysis and reporting.

Mobile Clinic

A mobile clinic (or an air conditioned trailer 25' = 8' x 8' with self-contained electric and gas supply, microscopic laboratory and examining room) will be needed for epidemiological work, specifically, the total health evaluation of a 3 village sub-sample in the Study Zone and a 7 village sub-sample in the Comparison Areas. The trailer will be pulled by a 4 wheel drive vehicle.