BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER PN-AAH-688	2. SUBJECT CLASSIFICATION (695) NS00-0000-G146

3. TITLE AND SUBTITLE (240)

The Sahel epidemiological and environmental assessments project, vol. 3, part E, section II: excerpts from report of health sector assessment team, the Democratic Republic of the Sudan

4. PERSONAL AUTHORS (100)

Lennox, R. W.

5. CORPORATE AUTHORS (101)

Am. Public Health Assn.

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1977	41p.	AFR614.5.M571

9. REFERENCE ORGANIZATION (130)

APHA

10. SUPPLEMENTARY NOTES (500)

(Additional volumes: v.1, 321p.:PN-AAH-679; v. 2, 414p.:PN-AAH-680; Assessment Team rpts.: PN-AAH-681 - PN-AAH-691)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Sudan
Disease control
Diseases
Schistosomiasis
Trypanosomiasis
Environmental health
Rural water supply
Malaria
Onchocerciasis
Gastrointestinal diseases

13. PROJECT NUMBER (150)

698013500

14. CONTRACT NO.(140)

AID/afr-C-1253

15. CONTRACT TYPE (140)

16. TYPE OF DOCUMENT (160)

16

AID 590-7 (10-79)

PN-AAE-688

AFR
CONT
MSH
V. 3, PART E
SECTION II

The Sahel
Epidemiological and Environmental
Assessment Report

Section II Part E
VOLUME THREE

Excerpts from Report of
Health Sector Assessment Team
The Democratic Republic of The Sudan

Excerpts from Report of
Health Sector Assessment Team
The Democratic Republic of The Sudan

Studies & Report by: Robert W. Lennox, Sc.D.
Epidemiologist
International Health Programs Staff
American Public Health Association

During the Period: June 13 through July 14, 1977

At the Request of: Health/Nutrition Division
Office of Development Resources
Bureau for Africa
U.S. Agency for International Development

Authorized Under Contract No. AID/Afr-C-1253
Sahel Epidemiological and Environmental Assessment Project
Sept. 1977

CONTENTS

A. Major Endemic Disease/Environmental Health Problems 1

1. Malaria 2

2. Schistosomiasis 5

3. Visceral Leishmaniasis - Kala Azar 6

4. Gastroenteritis and Diarrheal Diseases 7

5. Onchocerciasis 8

6. Trypanosomiasis 9

7. Others

a. Leprosy 11

b. Bancroftian Filariasis 11

c. Guinea Worm 11

d. Hook Worm 11

e. Hydatid Disease 12

f. Cutaneous Leishmaniasis 12

B. Endemic Disease Control Program 13

1. Malaria - Nationwide 13

2. Malaria - Man-made Irrigational Areas 15

3. Control of Bilharzia - Schistosomiasis 19

4. Onchocerciasis 22

5. Sleeping Sickness - Trypanosomiasis 23

6. Kala Azar - Visceral Leishmaniasis 24

7. Gastro - Enteritis 24

C. Rural Water Supply and Environmental Health Program 26

1. Water Supply 26

D. Environmental Health Constraints 28

Major Constraints by Category 29

a. Planning & Coordination 29

b. Manpower 33

c. Commodities & Logistics 35

EXCERPTS FROM
"REPORT OF THE HEALTH
SECTOR ASSESSMENT TEAM - SUDAN"

A. MAJOR ENDEMIC DISEASES/ENVIRONMENT HEALTH PROBLEMS

As might be expected, the list of endemic and potentially epidemic diseases occurring in Sudan is extensive and imposing. Due to the extreme diversity of environmental, climatological and sociological differences in this vast country, however, few of these diseases are of more than regional significance. The exceptions include malaria, schistosomiasis and gastroenteritis (dysentery and diarrheal disease), which are sufficiently widespread to qualify as national health problems.

On the basis of severity of impact on large segments of the population, one should also include onchocerciasis and leishmaniasis. With the exception of leishmaniasis, these priority endemic diseases are associated with water either directly as the medium for the dissemination of the etiological agent, or indirectly as the breeding area for the disease vector or intermediate host.

In the case of these, as well as other, important endemic diseases, existing data are not sufficient to calculate their full impact upon the quality of life of the people or upon the nation's socio-economic development, but there is little doubt that it is significant.

Drawing upon available reports, the national health plan and discussions with MOH personnel, an attempt will be made to apprise the reader of the nature and extent of each endemic disease problem, particularly as regards quality of life and socio-economic development.

1. Malaria

With the exception of the Northernmost desert areas and parts of Red Sea Province, malaria in Sudan must be considered to be a country-wide endemic disease. Differences in intensity of transmission, seasonality and public health impact that occur from province to province are closely linked to the availability of water for Anopheles mosquito breeding and therefore tend to increase, as does the rainfall, from North to South.

a. Prevalence

Most recent country-wide statistics on malaria prevalence are extrapolated from health facility attendance records, rather than from surveys, and consequently few inferences can be drawn with regard to national trends in the incidence and prevalence of this disease. A limited number of regional surveys have been conducted, however, from which a few assumptions and speculations may be formulated. One such study of blood parasite rates in children 2-9 years old living in 16 villages located within the Gezira conducted in 1975 can be compared with a similar study initiated 14 years earlier in 1961-62. Of 1,124 children examined in 1961-62, 37 (2.9%) had blood films positive for malarial parasites. The 1975 survey of 1,293 children from the same villages showed 255 positive blood films (19.7%).

More significant than positivity rate increase was the finding that all but 4 (98%) in the 1975 study were *Plasmodium falciparum* (malignant tertian) malaria. The earlier survey had shown only 5 (14%) to be *P. falciparum*. If this

trend is accepted as indicative of the whole area, there is good reason for concern as malignant tertian malaria is a significant contributor to morbidity in adults and ranks high among the major causes of infant mortality in Africa.

Within Gezira along an estimated 2.5 million persons are at risk to infection. This observation gains in significance when one considers that the Gezira irrigated perimeter accounts for 40% of the nation's gross domestic product, generates over 1/2 of its total employment (direct or indirect) and is responsible for 98% of the country's export earnings.

b. Socio-economic Impact

The special socio-economic importance of the Gezira coupled with the enhanced opportunity for mosquito breeding brought about by the area's vast irrigation canal system has led the Sudanese to describe malaria in their country as two separate problems. The first of these is referred to as "Nationwide Malaria". This term is meant to apply to all malaria that is not associated with large scale irrigated agricultural production. It is felt that this latter activity (i.e., irrigated farming) creates special conditions for malaria transmission that are distinctly different from those of the nation at large and use the term "Manmade Malaria" to describe the problem. The amount of irrigated acreage under cultivation has been expanded on an average of 5-6% per year and each new expansion has been accompanied by a rapid increase in the prevalence of malaria.

c. Vectors

The major mosquito vector in Sudan is *Anopheles*

gambiae, a particular vigorous species with few preferences for breeding sites. It is extremely aggressive and has a preference for biting humans. A. gambiae is extremely susceptible to malarial infection and as such is an efficient vector. In the South it is suspected that A. funestus may coexist with A. gambiae. A. funestus has a greater ability to survive in the drier months than A. gambiae and may be responsible for extending the malaria season and consequently maintaining transmission at a high rate.

d. Malaria Cases Rise

In 1974 there were 1,000,000 cases of malaria reported in Sudan but due to underreporting and the inadequacy of diagnostic facilities, it is felt by the MOH and supported by WHO that the true nationwide figure is actually triple or more, bringing the estimated incidence rate to 20% of the population per year. While no increase in rate above the present 20% level has been anticipated during the next 6-year plan, it is expected that the absolute numbers will increase by 25% due to natural population increase.

In summary, despite the paucity of hard data there is little doubt that malaria is a serious problem in Sudan. Its apparent increase since the 1960s, its suspected shift from benign to malignant disease, its established serious effect upon infant survival and its expected potential for depressing socioeconomic development and production have led the Ministry of Health to give malaria control first priority in the upcoming National Health Program.

2. Schistosomiasis

Schistosomiasis (Bilharzia) transmission has been reported to occur in all provinces of Sudan except the Red Sea Province.

a. Species - Distribution

Both species of schistosomes known to occur in Africa can be found in Sudan. The first of these is Schistosoma haematobium, the etiological agent of urinary schistosomiasis. Considered in Sudan to be primarily a disease of children it, and its snail intermediate host Bulinus truncatus, tend to be distributed along the river courses and locally within the surface water impoundments and streams of the west and north. In spite of its sporadically high prevalence and potential for causing significant urinary system damage and hematuria, it is not considered to be one of Sudan's major endemic disease problems.

The second species, Schistosoma mansoni is the causative agent of intestinal schistosomiasis which is a significant contributor to extensive liver and intestinal damage in adult and child alike. The distribution of S. mansoni as well as its snail host, Biomphalaria pfeiferi, is most intense along the heavily populated areas of the Nile and the Bahr el Ghazal. The presence of the parasite in large numbers within the irrigated areas of the Gezira and other agricultural projects is considered to be a major threat to human health as well as to economic development.

b. Prevalence

The exact prevalence of schistosomiasis in Sudan is not known, but the records of health facilities show that in 1974, 6% of all visits were for bilharziasis. Similarly, the records from health facilities indicate that there has been a net increase of reported cases per 100,000 population amounting to 33% from 1965 to 1974.

c. Economic Impact

In its country profile for Sudan, WHO has estimated the total economic loss to the country from Bilharzia to be LS 52,000,000 (US $130,000,000) per year.

3. Visceral Leishmaniasis - Kala Azar

Visceral leishmaniasis has been reported in Sudan since 1904 in both endemic and epidemic forms.

a. Species/Reservoir

It is believed that the etiological agent, *Leishmania donovani* is present in a non-human reservoir as well as in man, but several recent attempts to identify that reservoir by field examination of likely species (rodent, canine and feline) have not been successful.

b. Vector

The usual vector, the sandfly (genus: *Phlebotomus* or *Sergentomyia*) is present as thirty-eight species or sub-species, but to this date the numbers of infected flies of any species have not been high enough to explain the prevalence of the disease or, indeed, to incriminate the usual vector species responsible for transmission.

c. Endemic Areas

Endemic in the area bounded by the Ethiopian border and the White Nile (East and West) and by Kassala and Halakal (North and South), Kala Azar appears to occur at all times of the year in men, women and children with about equal frequency. One isolated focus north of Khartoum seems to be confined to children, and other widespread foci are known in the west and as far south as Jongeli and Eastern Equatoria.

Lacking the more sophisticated methods of diagnosis, field hospitals diagnose the disease on clinical grounds. This practice probably results in an inflated prevalence report. Primarily considered to be of relatively low incidence, the disease has approached epidemic proportions about 8 times within the last 70 years. Recent information indicates that a significant number of patients formerly diagnosed as having cutaneous leishmaniasis (*Leishmania tropica*) may have been exhibiting diffuse cutaneous symptoms due to *L. donovani* or perhaps to some unique species. If so, the dynamics of transmission of visceral leishmaniasis will become even more obscure.

4. Gastroenteritis and Diarrheal Diseases

a. Prevalence Nationwide

Virtually no part of Sudan is free from enteric disease - including infant diarrhea, acute diarrhea, dysenteries and cholera. This broad category of infection accounted for 8,255 cases per 100,000 population in 1974 based upon hospital

reported figures alone. Considering that the majority of cases are not reported, one can only assume that the true prevalence rate must be staggering. Second only to malnutrition as a cause of significant morbidity, diarrheal disease resulting from poor sanitation and the lack of safe water supply is the third highest cause of hospital death.

b. Rate Increasing

Ministry of Health officials have estimated that the increase in infection amounts to about 10% per year and that by 1984 the rate per 100,000 population may exceed 14,000. Of particular concern is the effect of gastroenteritis on children. Ranking as one of the five most important causes of infant mortality, diarrheal disease of children accounted for 526,898 reported cases from all health facilities in 1974.

5. Onchocerciasis

Onchocerciasis is a filarial infection with vast potential for economic impact as well as for producing human misery.

a. Causative Agent

The causative agent, *Onchocerca volvulus*, is a nematode worm transmitted to man by the bite of the black fly *Simulium damnosum*. The resulting infection produces cutaneous nodules in the victim and, in a significant proportion of cases, blindness.

b. Prevalence

In Sudan, estimates of infected individuals, based upon WHO surveys and reports of the Ministry of Health,

number 160,000, with nearly 40,000 categorized as "Economically Blind." The disease distribution closely parallels the location of the fast moving streams which are the breeding places of the insect vector. The severity of pathology (i.e., blindness) is most intense in Bahr el Ghazal Province. But other foci occur around Abu Hamed, below the 5th cataract, along the Atbara River in Kassala Province, and in stretches of the Blue Nile in the vicinity of Rosseries Dam along the Ethiopian border. Another suspected focus is located in the Southeast corner of Eastern Equatoria Province.

In the continued absence of an integrated control program, it has been estimated that the numbers of infected and blind persons will approach 200,000 and 50,000 respectively by the end of the 6-year plan. It should be emphasized, however, that these projections take into account only the natural increases in population and do not anticipate any increase in the rate of transmission.

6. Trypanosomiasis

a. Problem in South

Exclusively a problem of the Southern Region, Trypanosomiasis or sleeping sickness tends to inhibit economic development in at least two ways: firstly, as a chronic progressively fatal disease of man (*Trypanosoma gambiense*) that is greatly feared; secondly, as a highly fatal disease of cattle (*Trypanosoma brucei*), called nagana, that makes the grazing of cattle impossible in the highly endemic areas of Equatoria.

14

b. Tsetse fly - Vector

Both diseases are transmitted by tsetse flies (Genus Glossina) and have greatly influenced the distribution of man and animals in Southern Sudan.

c. Control Efforts

Sleeping sickness has been a problem in this area since early in the century, but periodic efforts to control its spread through prophylactic administration of pentamidine and elimination of tsetse flies and their breeding places has been historically effective. Since the recent civil strife, however, dispersion of the population and interruption of the control program have resulted in a sharp increase in the numbers of reported cases. In the absence of a comprehensive program of active case finding, it is difficult to estimate the severity of the situation, but it is believed to be deteriorating and is described as "epidemic" in the National Health Program.

Recent reports of new foci of Gambian sleeping sickness by WHO at Yei and Torit suggest that the range of the disease has spread in a ring around Juba and a focus of the highly fulminating form caused by Trypanosoma rhodesiense (Rhodesian sleeping sickness) has been reported from Pochala Area in Upper Nile Province along the Ethiopian border.

7. Other Endemic Disease Problems

Although not identified as priority health problems, other endemic and parasitic diseases exist in Sudan that have potential for causing widespread misery if not significant

negative socio-economic impact. No attempt has been made in this report to address these problems in detail, but it would seem appropriate to mention them in passing.

a. Leprosy

Leprosy is endemic in the western and southern regions of Sudan, with infection rates approaching 3% in some areas. A 1966 survey sponsored by WHO gave an estimate of 100,000 cases in Sudan. With the help of several international donors, the MOH has established more than 10 leprosaria that monitor treatment with dapsone and are planning to establish rehabilitation and training centers near Wau.

b. Bancroftian Filariasis

Known to exist in Sudan since 1944, Bancroftian filariasis (Wuchereria bancrofti), with associated hydrocele and elephantiasis, is presently restricted to a relatively small number of people in three areas of Sudan: Zalingi, close to the Chad border in southern Darfur; Kadougli area in Southern Kordofan, and in Southern Blue Nile Province near the Ethiopian border.

c. Guinea Worm

About 3,000 cases of Drancontiasis are reported annually in Sudan. Most are located in areas of the Nuba Mountains, Blue Nile Province, Bahr el Ghazal and Equatoria, where step wells are in common use.

d. Hookworm

Primarily due to Ancylostoma duodenale, hookworm infection is highly prevalent in Sudan in the regions south of

the Bahr el Ghazal. This rule of thumb also applies to the other common intestinal helminths such as Ascaris, Trichuris and Strongyloides.

e. Hydatid Disease

While very little information could be found on echinococcosis, most authorities questioned agreed that it does occur with some regularity in parts of Equatoria.

f. Cutaneous Leishmaniasis

Although the primary concern for leishmaniasis lies with the various forms of Leishmania donovani infection, some of the drier northern areas such as El Fasher, En Nahud and in the Gezira (Wad Medani) are known to be endemic areas for Leishmania tropica transmission.

In summary, it may be said that while Sudan has a wide variety of potentially serious problems with endemic diseases, the MOH has selected six as priority health problems:

1. Malignant Tertian Malaria - (due to Plasmodium falciparum) in the irrigated areas as well as nationwide.

2. Intestinal Schistosomiasis (due to Schistosoma mansoni), primarily in irrigated areas.

3. Sleeping Sickness (due to Trypanosoma gambiense) in Western Equatoria.

4. Onchocerciasis (due to Onchocerca volvulus) in the Bahr el Ghazal, the Nile Valley and its tributaries.

5. Kala Azar (due to Leishmania donovani) in the middle section of the country east of the White Nile.

6. Gastroenteritis (due to a wide variety of etiological agents) throughout the country.

B. ENDEMIC DISEASE CONTROL PROGRAMS

The entire 6-year National Health Plan for Sudan has been set forth in the form of eight programs. Four of these are specifically aimed at the control of major endemic diseases.

- Program No. 1: Malaria-Nationwide
- Program No. 2: Malaria- Man Made
- Program No. 4: Control of Bilharzia in Irrigated Areas
- Program No. 8: Onchocerciasis
- Program No. 3: Primary Health Care, has three sub-elements that deal with control of endemic diseases, namely:
  - Gastroenteritis
  - Sleeping Sickness (Trypanosomiasis)
  - Kala Azar (Visceral Leishmaniasis)

This section will cover the salient features of the seven programs or subprograms set forth by the Ministry of Health to control or contain these priority endemic diseases.

1. Malaria Nationwide: (Program No. 1)

a. Aims and Objectives of Program

The aim of this program is to reduce the transmission of malaria in Sudan to an insignificant level by 1984 and perhaps to set the stage for eventual eradication. The specific objective is to reduce morbidity from its present estimated level of 20% to 5% per year, thus offsetting the expected increase in total cases due to natural population increase during the 6 year plan. The major indicator of program

Success will be morbidity as reflected in the expected decrease in the number of patients diagnosed as having malaria in each year at the nation's health facilities.

b. Strategy of Program

In fact, the program plan calls for the application of three strategies, one for each of the following problem areas:

1. The Southern Region - The control of malaria in the South will be the responsibility of the Primary Health Care Program. The health workers will emphasize treatment of all cases of malaria with chloroquine. Special emphasis will be given to the treatment of infants, young children and pregnant women. The plan does not call for the use of insecticides in the South except for within urban areas and within agricultural schemes.

2. The Remaining Provinces - This problem area excludes agricultural schemes, the Gezira and urban centers. As in the South, the treatment of malaria will be under the control of the Primary Health Care Plan. No attempt will be made to dispense prophylactic antimalarials. The major difference in the strategy from that in the South will be the application of one round of DDT spraying inside houses just prior to the rainy season at the concentration of 2 grams per square meter of surface.

3. Urban Areas - Treatment of malaria cases with chloroquine will again be controlled by the Primary Health units and other medical facilities. No DDT or insecticide spraying of houses will be done. Larvacides (i.e., oil or Abate^{R}) will be applied to all known mosquito breeding places.

2. Malaria: Man-made-Irrigated Areas: (Program No. 2)

a. Aims and Objectives of Program

Although the aims and objectives are the same as for nationwide malaria control, the problem is considered to be more complex, the socio-economic implications more grave and the opportunities for devising a coordinated, cost effective long-term malaria control strategy more promising. Toward that end, a set of indicators of success have been selected that are more comprehensive.

1) The number of cases/year of "clinical malaria" in all age groups reported by hospitals in irrigated areas.

2) The proportion of positive blood slides obtained by passive and active case detection combined.

3) The parasite rate (point prevalence surveys) among 2-9 year old children.

4) Days off work due to sickness with fever/year.

5) The total amount of chloroquine and other anti-malarial drugs dispensed in an irrigated area by government and private sources combined.

b. Strategy of Program

The program sets forth two strategies to be employed during the 6 year plan. The first is a short-term, emergency "plan of action."

During the past year a phase one plan of action was undertaken in which 1) two rounds (June and September) of malathion were applied to a significant number of dwellings in the Gezira, 2) mass chemotherapy using presumptive doses of chloroquine and pyrimethamine were given to residents and 3) Abate[R] larvacide was applied to known malaria mosquito breeding places. This exercise was undertaken as an emergency measure in order to avert a mass epidemic that was expected to occur and to create the basis for a continuous malaria control program (long-term strategy).

On 11 October, a resolution was passed to establish: 1) A central board for malaria control, and 2) A technical malaria control committee. These two bodies made up of representatives of the Ministries of Health, Finance, Local Government, Agriculture, Irrigation, Education Planning as well as from the Faculty of Medicine, the Gezira Board Sudan Tenant Union, Labor Union and the Peoples Council as well as a large number of technical experts. This move has provided a mechanism to coordinate activities of the various projects in the irrigated areas and to make policy that should eventually lead to a more expeditious use of malaria control resources in the Gezira as well as throughout Sudan.

c. Long-Range Strategy

The strategy for long-term control is comprehensive and has eleven separate elements.

1) Organization and management in Gezira - The Gezira Board is to employ all of the malaria control staff and to fund the malaria control operations. Formulation of the actual control plan, however, will be done with the technical assistance of the MOH. All curative activities will be the administrative and financial responsibility of the Ministry of Local Government and the Provincial Executive Council.

2) Irrigation Water Management - Primarily concerned with drainage of waste water, canal maintenance and weed clearing of canals, this element will provide for environmental control of mosquito breeding places.

3) Geographical Reconnaissance - This activity conducted by "Mosquito Men" under the supervision of sanitary overseers and public health officers will conduct an annual census of all structures and dwellings in order to provide complete coverage in the spraying program.

4) Residual House Spraying - To conduct an annual spraying campaign in which all dwellings are treated with an appropriate residual insecticide.

5) Insecticide Policy - With representation on the insecticide committee, the malaria entomologist will help to coordinate the use of insecticides to be used for agricultural purposes so as not to increase the risk of developing resistance of malaria mosquitos to residual sprays. His responsibility also includes continuous monitoring of malaria mosquitos for evidence of resistance. So far, no resistance has been observed to the organophosphorous compound malathion, but significant resistance to DDT has made this chemical useless in many parts of the irrigated areas.

6) Mass Chemotherapy - A single dose of chloroquine-Pyrimethamine will be given to the entire resident and migratory work force population of the Gezira each September timed to capitalize on the persistant effect of the malathion.

7) Legal Requirements - Local ordinances with appropriate penalties prohibit replastering of inside walls on dwellings between 1 June and 1 November each year. This is to prevent covering up of residual sprays.

8) Anti-Larval Measures - The larvacide Abate[R] will be applied weekly throughout the dry season (November - June) to all potential breeding places.

9) Curative Activities - Two programs are proposed. At health facilities where diagnosis by laboratory methods is possible, radical cures with some combination of chloroquine, pyrimethamine and primiquine will be administered according to the species of parasite detected. In areas where these facilities are not available, chloroquine and pyrimethamine will be provided through the village councils for a program of self-treatment supervised by specially trained "voluntary collaborators."

10) Public Information - Through the offices of the Gezira Board and the Tenants Association, all avenues of mass media will be employed to inform the public of personal methods of malaria protection and facilitation of the strategy.

11) Evaluation - Parasitological surveys on random samples of 2-9 year old children will be carried out in January and June of each year in 16 indicator villages. Entomological sample surveys to assess vector densities by indoor catches will be conducted continuously in 10 houses per month in each of 32 indicator villages. Susceptibility to insecticides will be monitored.

3. Control of Bilharzia-Schistosomiasis: (Program 4)

a. Aims and Objectives of Program

Designed for the control of intestinal schistosomiasis (*Schistosoma mansoni*) in the 2 million acres of irrigated perimeters of the Gezira and Managil areas, the aim is to reverse the present trend of increasing incidence. The specific program objectives are threefold.

1) To reduce the prevalence rates of infection in the following age groups:

3 yrs from 11% to 0%

4 yrs from 25% to 0%

5 yrs from 35% to 0%

6 yrs from 45% to 5%

7 yrs from 60% to 10%

2) To reduce the prevalence of diarrhea with blood in 9-12 year old school children from the present level of 40% to 10%

3) To bring vector snail populations down to 1% of the current level.

Indicators of program success will be threefold:

1) The incidence of new infections appearing in children of both sexes aged 3-7 to be measured by the annual examination of stools by the Kato method (S. hemotobium ova in urine collected from children who were examined the previous year and found to be negative (i.e. conversion) will be recorded as well. It is felt that S. hematobium is not a major health problem but the data may be useful in future programs.)

2) The prevalence of diarrhea with blood (annual history survey) of children of both sexes age 9-12. (This is taken as presumptive evidence of S. mansoni infection).

3) Monthly sampling of vector snail population densities.

b. Strategy of Program

The strategy is divided into two parts as follows:

1) Snail control - using a combinatoon of drip feed, back pack sprayers and aerial spraying, it is proposed to deliver into the canals of the irrigation system 5 applications of molluscacide (Frescon[R] or Bayluscide[R]) per year. The decision as to the delivery system and most cost effective chemical is under study.

2) Mass treatment of 5-19 year olds. This age group constitutes 37% of the population, have the heaviest egg loads and are least likely to suffer adverse reactions to anti-schistosomal drugs. It is proposed to treat with an appropriate anti-schistosomal drug at the same time molluscaciding commences in the area of residence. Several areas of research both proposed and in progress, are considered to be vital to the success of the program.

a) Finding of more cost-effective focal control methods of molluscacides.

b) The economic impact of bilharzia in irrigated areas.

c) The natural course of infections, their clinical significance and more sensitive indicators for evaluation.

d) The investigation of snail ecology and bionomics including the course and extent of infection.

4. Onchocerciasis: (Program No. 8)

a. Aim and Objectives of Program

The primary aim of the program is to reduce the incidence of economic blindness due to onchocerciasis chiefly in the area of the Bahr el Ghazal. The objectives during the six year plan are:

1) To reduce the percentage of skin snip positive and nodule positive cases (male - age 5-14) by 25%.

2) To reduce the number of new cases of economic blindness in males age 15-24 by 35%. The indicators of project success will be (a) a reduction in the skin snip and nodule positivity rates in the designated groups as determined by random sampling in a specific geographical area and (b) a reduction in the number of new cases of economic blindness in the designated group within the same sample area.

b. Strategy of Program

The plan calls for identification of persons in imminent danger of becoming economically blind by one or more accepted criteria and instituting treatment with Suramin^{R}, Diethylcarbamazin or some combination of

both. It is expected that passive case detection (i.e. affected individuals seeking out the team for evaluation) will be employed. A second strategy to be employed is to seek out breeding sites of the black fly host in areas close to human habitation and treat these sites with larvacides (Abate[R]).

5. Sleeping Sickness-Trypanosomiasis: (Program No. 3)

a. Aims and Objectives of Sub-Program

Covered under the Primary Health Care Program, the objective is to reestablish control of sleeping sickness in the Southern region by 1980. That is, to bring the present epidemic to an end and reduce the possibility of transmission to a negligible limit.

b. Program Strategy

The plan calls for a two phase strategy: Phase 1 (from the present to 1979) to concentrate on a program of active case finding among the 30,000 inhabitants of Yambio District in Western Equatoria using six teams of trained personnel. All positive cases will be treated with Antrypol[R] or Melarsonyl[R] until they are cured, thus reducing the parasite reservoir and obviating the need for extensive tsetse fly control. Phase 2 (from 1980 onwards): In this phase the Primary Health Care Units will be in place and will have personnel especially trained to identify infected cases and will refer them to local hospitals for diagnosis and treatment.

6. Kala Azar-Visceral Leishmaniasis: (Program No. 3)

a. Aims and Objectives of Sub-Program

It is difficult, due to the lack of information about the vector, the reservoir and basic epidemiology of this disease, to propose a comprehensive program for its control. The major thrust of the control effort will be in the diagnosis by personnel of the Primary Health Care Unit and referral to local hospitals for treatment. A second objective will be to conduct surveys to assess the magnitude of Kala Azar present in the affected areas.

b. Strategy of Program

To conduct surveys in the affected area in order to find active cases and put them under treatment. To establish a research and training center at Malakal with support from WHO in which personnel may learn the basic techniques of epidemological and entomological surveys as well as methods for diagnosis. At the center it is hoped that field and laboratory research may provide much of the basic information needed to launch a more comprehensive program in the future.

7. Gastro-Enteritis: (Program No. 3)

a. Aims and Objectives of Sub-Program

To reduce the incidence of gastro-enteritis (infant diarrhea, acute diarrhea, dysentery and cholera) by 1984 by 70% of the expected level. That is to

reduce the incidence from 2.8 million to just over 800,000 cases per year. The indicator of program success is to be the number of new cases of gastroenteritis reported in a specified population/unit time by the supporting health facilities.

b. Strategy of Program

The program which is to be incorporated into the Primary Health Care Delivery Service has a curative strategy whi is divided into three parts depending on the seriousness of the patient's condition.

1) Mild Cases - This category represents about 20% of the cases seen and would be treated by oral rehydration. The oral rehydration fluid would be prepared on the spot by dissolving the contents of a pre-packaged powder in water.

2) Intermediate Cases - Constituting 30% of the total problem, these cases would be treated either in primary health care facilities by oral rehydration or in hospitals by parenteral rehydration depending on severity or duration.

3) Severe cases - All to be treated by parenteral rehydration at the hospital level.

The facilities to produce rehydration fluids for use in this program do not presently exist in Sudan. A program for construction of such a facility has been developed and will be addressed elsewhere in this document.

C. RURAL WATER SUPPLY AND ENVIRONMENTAL HEALTH PROGRAMS

In the National Health Plan, 1977/1984, two of the eight priority programs come under the general heading of rural water supply and environmental health: Program No. 5 - Safe Water Supply; and Program No. 6 - Environmental Health.

It would be difficult to think of a health problem in Sudan that does not impact either directly or indirectly on one or both of these areas. Conversely, it would be equally difficult to find a health problem that would not be reduced by a nationwide comprehensive program to improve potable water supplies and sanitation.

1. Water Supply: (Program No. 5)

With the exception of some of the larger urban areas that have reservoirs and pipe-borne water supplies, the vast majority of the inhabitants of Sudan obtain water for drinking from:

a. Sources

1. Deep-bore wells that are occasionally provided with pumps but more often with rope and bucket.

2. Haffirs which are man-made or natural depressions in which surface water is stored.

3. The Nile or other rivers of Sudan.

4. Hand dug wells of varying depths.

5. Rain water collection systems from roof-tops or cysterns.

6. Shallow step wells dug in dry river beds during the dry season.

There are few mechanisms for the protection of stored water

from contamination with human and animal waste. It is in regard to this point that Program No. 5 has been designed.

b. Present Level of the Problem

It has been estimated that there are 900 government-owned and 30,000 privately owned wells, 850 haffirs and 30 dams in the country that lack adequate means of protection from human and/or animal waste. It has also been estimated that the number of new shallow wells increases by about 100 per year. Due to administrative, traditional and technical difficulties, it is not feasible to devise a public system for the protection of haffirs and privately owned wells. By 1984, however, it is estimated that the number of public wells requiring protection from contamination will be about 1900. The aim of the program is to provide that protection. Two objectives have been proposed for the program:

c. Long-term Objective - To provide the needed protection for all 1900 wells.

d. Short-term Objective - To design a pilot project to protect 45 (5%) of the existing shallow wells from contamination.

D. Environmental Health Constraints

1. Introduction

In this broad category of health problems, the National Health Program has six of its eight priority program.

Program 1, Malaria-Nationwide

Program 2, Malaria-Man Made

Program 4, Bilharzia in irrigated areas

Program 5, Safe water supplies

Program 6, Environmental health

Program 8, Onchocerciasis

Because many of the programs have common constraints, an outline for identification of several categories is proposed in which examples have been recognized.

a. Those constraints inherent in the plan of the program.

1. Lack of correlation between plan and objective (i.e., plan if successfully implemented will not have good chance of achieving the objective).

2. Indicators that are not sufficiently sensitive to measure success.

3. Plan that is not comprehensive enough to reach a large segment of the population.

4. Plan that lacks coordination with other programs.

b. Those constraints associated with quantitative or qualitative deficiencies of personnel.

1. Lack of manpower

2. Lack of training

3. Lack of financial support for salaries and incentives.

c. Those constraints associated with deficiencies in commodities and logistics.

1. Shortage of raw materials, i.e., insecticides, larvacide , drugs, molluscacides.

2. Shortage of logistical support, i.e., transport, storage, fuel, spraying equipment.

The input necessary to overcome these constraints is in essence the aim of the AID program.

The corresponding inputs to remedy the constraints in category a are technological assistance/planning; for category b, training and subsidy; for category c, commodity supply.

What follows is an attempt to identify in a horizontal fashion the major constraints to the implementation of six Environmental Health related programs by the categories outlined above.

2. Major Constraints by Category

a. Constraints inherent in the plan.

1) Lack of correlation between plan and objective

Each of the six national plans related to Environmental Health/Endemic Disease Control has some degree of deficiency in this regard.

The Malaria Nation-Wide Program, for example, hopes to reduce morbidity from 20% to 5% by the end of the 6-year plan in the South using only treatment of identified cases. Mosquito control will be attempted only in municipalities. In the North and West

DDT spraying is to be used to accomplish the objective without drug distribution (DDT resistance on the part of Malaria vector mosquitos is already wide-spread in parts of the Sudan). It has long been considered by most malaria control experts that a control program based upon a single control method has a limited chance of success.

Considering that fulfilling the stated program objective would require eliminating morbidity due to malaria by more than 2 million cases per year, it would appear that a much more comprehensive, multifaceted approach is required.

Similar deficiencies can be found in the bilharzia program, where the objective is to reduce age specific prevalence rates among children, but as of now no effective, safe drug has been identified for treatment and the delivery system for molluscacides is capable of treating less than 10 of the total irrigated area of the Gezira and Managil areas.

The safe water supply program has a reasonable chance of achieving its objective only because it is so limited (to provide buckets, ropes and cement covers for 1900 wells).

The environmental health (sanitation) program is admittedly an important area, but at present, lacks both objective and plan.

The plan for onchocerciasis control hopes to reduce the percentages of skin-snip positive males in certain age groups by 25% using, primarily, treatment of infected individuals with diethylcaribamizin. A very limited vector control program is planned. Only the malaria control program for the Gezira (man-made malaria) has any reasonable chance of accomplishing a worthwhile objective - this mainly because a comprehensive, multifaceted approach is planned.

In summary, at present it is doubtful if the plans set forth in the National Health Program can fulfill more than a token number of the stated objectives.

2) Insufficiently sensitive indicators.

The majority of indicators on which program success is to be determined are related to passive case identification in Primary Health Care Units. For instance, success in reduction of malaria morbidity will be achieved when there is a reduction in the number of cases reported by the Primary Health Care Units. It is more likely that an effective drug distribution program will record an increase rather than a decrease in cases initially. A true indicator of reduced morbidity should be based upon sample survey, rather than on clinic visits.

3) Plan not comprehensive enough to reach a large segment of population

In this respect, all of the endemic disease/environmental health programs are deficient. To cite a few examples:

- Bilharzia program does not deal with populations outside of Gerzira.

- Malaria program does not serve the nomad populations.

- Onchocerciasis program only serves those in iminent danger of blindness .

- Safe water supply program is designed to protect only 1900 wells. No protection of water from hafirs, the rivers or privately owned wells.

These are only illustrative examples. Many additional unserved populations could be listed.

4) Lack of coordination with other programs.

Due to the vertical organization of the elements of the National Health Care Program, there is very little evidence of intra-program coordination. To cite a few examples:

- DDT spraying for insect control is stated as a program function for the malaria program, the sanitation program and various agricultural programs.

- Abate[R] larvacide will be distributed by persons involved in both malaria and onchocerciasis control.

- Each of the endemic disease control programs maintains its own training program for field

workers, in spite of the similarity of their functions (specimen collection, spraying, water testing).

- Those involved in insect vector control hold the agricultural planners responsible for having induced insecticide resistance in vector population by indiscriminate use of DDT and other chemicals

- Each of the programs has its own infrastructure, supervisory personnel and vehicles.

In spite of many possibilities for coordination between programs there is little evidence that it exists or has been planned for in the future.

b. Constraints Associated with Quantitative or Qualitative Deficiencies of Personnel.

1) Lack of manpower

Each of the program representatives interviewed expressed little concern about finding a sufficient number of individuals to carry out the activities in the programs. The only reservations they had were in finding the funds to support their salaries. It should be considered, however, that most of their projections on available manpower, like the programs themselves, are vertical. It is questionable whether sufficient manpower exists to fill all of the needs of all programs unless intra-program coordination is forthcoming. This is particularly true in the South, where secondary school graduates are in limited supply and will be competed for not only by the Primary Health Care Program, but by various agri-

cultural programs as well. It is clearly a potential problem worthy of more study.

2) Lack of training

All of the endemic disease control/ environmental health programs maintain their own training program which is administratively and physically separated from the others. In some cases, the programs observed were reasonably sophisticated and functional. One case in point was the malaria field training center at Sennar that has been giving field and classroom training in all aspects of malaria work to a variety of health workers for more than 10 years. These is a similar program for bilharzia (schistosomiasis) at the University of Khartoum, with a field station at Abu Ushar in the Gezira. Onchocerciasis training is centered at Wau in Bahr el Ghazal province.

In short, it appears that each of the programs has a corresponding training element which is functioning at present. Some are apparently more functional than others, and it is unknown whether the existing facilities can produce all of the individuals in all categories to carry out the proposed programs. It would be anticipated that problems will arise in this area.

3) Lack of financial support for salaries and incentives.

It is in this area that the program

personnel were most vocal. They expressed concern that recent budget allocations were not sufficient to meet the needs for salaries of workers involved in current programs. In fact, they stated that some workers in the field have been working without compensation for several months. This was said to be particularly true of the lower level field staff.

The program personnel have had problems in the past in keeping workers in more rural control areas. Traditionally, incentives (money, bicycles, donkeys) had been given to keep them in the place where they were needed. However, this incentive program was terminated due to lack of funds. The anticipated resistance to maintaining personnel in the more remote areas in the absence of incentives is regarded as a serious constraint to program success.

c. Constraints Associated with Deficiencies in Commodities and Logistics.

Expectedly, lack of commodities and transport vehicles was viewed as the most important obstacle to achieving program goals by all of the program personnel.

1) Shortage of raw materials

Most of the endemic disease control programs have some requirement for consumable raw materials such as:

- insecticides: DDT for nation-wide malaria
- larvacides: Abate[R] for malaria and onchocerciasis
- molluscacides: bayluscide and frescon for bilharzia
- drugs
- chloroquine and pyramethamine for malaria
- diethylcarmanazin for onchocerciasis
- ambilhar or hycanthone for bilharzia

The total requirement for commodities in this category for all programs could be estimated to be in excess of 4 million dollars per year. It is expected that more than 60% of the funding will have to be from external donors. Current pledges from CPEC countries and from WHO (the two most important outside sources to date) are expected to amount to less than 1 million next year. Sudanese program personnel stated categorically that if the AID program did not provide funds for their chemicals that it was doubtful if their assistance would have much relevance.

2) Shortage of Logistical support

This category was identified as a second major area of need for foreign donor support by program officials. Some of the major requirements were:

- vehicles (Landrover station wagons and pick ups for personnel, 5 ton trucks for equipment)

- spraying equipment for delivery of insecticides, molluscacides and larvacides

- storage facilities for insecticides and chemicals

- water testing equipment

- teaching materials (films, projectors and classroom materials for use in training programs

- field and laborabory equipment for research programs on control

In summary, the major expressed constraints on the part of Sudanese program officials were in the areas of commodities. Following discussions, however, it was conceded that constraints existed in the areas of planning, coordination and manpower development as well. In the section on recommendations, an attempt will be made to realistically address the major constraints and provide alternatives for AID assistance to overcome them.