ENVIRONMENTAL ASSESSMENT:

THE POTENTIAL HEALTH IMPACT OF THE CONSTRUCTION

OF FIFTY-SEVEN DAMS IN THE MANDARA MOUNTAINS

(NORTH CAMEROON)

BY

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SUMMARY OF THE ENVIRONMENTAL HEALTH STUDY

In December 1977, a health team visited the Mandara Mountains to undertake a field study of the major parasitic diseases in the region and to determine the possible health impacts of the proposed project.

The field work was preceded by a bibliographical study of the available data relating to the prevalence and geographic distribution of protozoans and helminthiases in the area. An inventory of waterborne malarial vectors in the Logone River basin was made and a few notes were written about the distribution and ecology of intermediate hosts of the human trematodes. Except as far as malaria transmission is concerned, the entomological studies made by previous researchers are few.

During the study, the team visited a number of proposed dam sites at Djingliya and Mokolo. Numerous specimens were collected (see Appendix C). The team visited a representative sample of health facilities and had interviews with all levels of health personnel in the project area. (See Appendix A for the itinerary of the team's visits.)
SUMMARY OF FINDINGS AND RECOMMENDATIONS

The overall conclusion of the environmental impact study team is that the health problems that may be caused by the construction of the 57 dams in the Mandara Mountains region will be insignificant in comparison to the economic and social benefits gained. This conclusion will be valid, however, only if proper precautions are taken. What follows is a summary of the team's findings and recommendations following a ten-day visit to the project area. Further details are given in Chapters II and II...

The construction of dams in the region under study will increase the areas of suitable environment for the development of intermediate hosts of malaria, intestinal and and urinary schistomiasis (bilharzioses), onchocerciasis, guinea worm disease (dracontiasis), liver fluke-worm disease of cattle (Fasciola giganta). The increase of standing and, to a lesser extent, running water in the region can produce a significant increase in the transmission of the above diseases and fecally related diseases, such as bacillary and amebic dysenteries, and intestinal nematode worm infections. It is thought that there can be a significant improvement in nutritional status as a direct result of the project.

The epidemiological studies of water and fecal borne diseases show that the construction of dams should be consistent with the following standards if a significant increase in endemic diseases is to be avoided:

1. As far as possible, the reservoirs should have banks free from aquatic vegetation and from mud and should be constructed with steep slopes. This will provide an adverse environment for host snails. The fluctuation of the water level between seasons will also create an adverse environment to the establishment of snails in the reservoirs. Access to the reservoirs and the stream flowing into them should be forbidden to the inhabitants and their domestic animals in order to prevent disease transmission.

2. The overflow of each reservoir should be constructed in such a way as to prevent a permanent run-off, which might provide a suitable environment for black fly larvae. Any run-off, therefore, should be on an intermittent basis. The structure itself should not allow for the formation of standing water as this will be favorable to the development of mosquitoes.

3. The river bed downstream is probably the component which will be the most favourable to the transmission of disease. It
should, therefore, be considered as a part of the project and be kept free of standing water. A system should be provided to remove to a safe area any water that issues from the dam. The valleys downstream, which will likely be made into irrigated gardens or rice fields, must be strictly controlled so as to avoid the development of an environment for host snails and immature forms of the blackfly and Anopheles mosquito.

4. The well or water catchments to be used by the inhabitants should be fed by the underground water or directly from the reservoir and should not be allowed to overflow causing standing water in the area. They should be constructed with a simple filtration device of sand or gravel. Watering places for animals should be installed.

5. Permanent guardians should be installed at each dam site to enforce health safety regulations.

6. Latrines should be constructed at each site to assist in preventing fecal contamination.

7. Health education should aim at preventing the pollution of water found in the reservoirs and wells. It should stress the necessity of using latrines and the importance of preventing human and animal contact with the water. In relation to possible cultivation downstream from the dams, it will be important to explain to the population the means of transmission of water-borne parasites. The importance of boiling water to prevent guinea worm should be covered in any health education efforts.
I. INTRODUCTION

A. Physical and Human Geography of the Project Area

The Mandara Mountains are crystalline mountains of approximately 1,700 meters in altitude. They are located in the Marqui-Wandala and Diamaré departments, near the Nigerian border. They are bound by the large alluvial plain of the Logone River.

The dry season, from November to April, is followed by a rainy season from April to October. The rainfall is generally under 900 mm a year. The average temperatures vary from 20°C in January to 32°C in April; however, a maximum of 46°C and a minimum of 12°C have been recorded. The relative humidity varies between 10% in March to 95% during the rainy season.

Apart from the Logone River, there are no permanent rivers in North Cameroon. The hydrographic network is constituted by "mayos" (dry rivers) which presents flash floods during rain storms. They die away in the "yaéré" which are vast swamps. In the dry season, surface waters are limited to residual ponds and a few streams. There are a few small lakes created by dams previously constructed in the region.

The vegetation of the region is characteristic of the sudano-sahelian dry savannas. Millet is commonly grown in terraced fields. In the plains the crops are more diversified, with industrial crops (cotton) and food crops (sorghum, peanuts ...). Rice is beginning to be cultivated in the river beds.

The Fulbe people, who are Muslim, have lived in the Diamaré plain since the XIXth century. They are herders and farmers and are settled for the most part in towns of the region. The mountain inhabitants are animists and Christians, but some have become Muslims and "Fulbéisés" once settled in the plains. The "saré constitutes the family unit and the social cell. It is composed by a number of houses surrounded by a wall. Housing is scattered in the mountains, but grouped in the plains.

B. The Project

A total of fifty-seven small dams with 47 to be financed by AID and the remaining 10 by the World Bank, will be constructed in the Mandara Mountains of North Cameroon. These dams are designed to provide potable water for human and animal consumption and water to be used for increasing the production of small gardens during the 7-month season.

The proposed dams will be constructed in narrow mountain valleys of reinforced concrete, varying from 4.5 to 10 meters in height, and they would have a water retention volume ranging from 10,000 to 60,000 cu. meters.
Although the project area is traversed by secondary and tertiary roads, many of the dam sites are not accessible by vehicles.

The project is intended to benefit approximately 128,000 Kirdi villagers (76% of the Mandara Mountain region's population) by significantly increasing the amount of water available during the dry season and reducing the time each family spends hauling water to the household. The average water-hauling time is four hours per day at present. This task is routinely accomplished by women and school-age children. The reduction of hauling time would free women for productive activities such as gardening and handicraft manufacture and possible allow for an increase of school attendance.

Project objectives include increased protein intake (from healthier livestock) and increased mineral and vitamin intake (from the increased production of vegetables) for the target population. It is expected that the year around water supply may also provide a surplus of vegetables and livestock, the sale of which will have a beneficial economic impact on the region.

C. Objectives of the Environmental Health Study

The Project Identification Document (PID), following AID Environmental Procedures (AID TO CIRCULAR A-493, dated 9/8/76), calls for an environmental assessment prior to the final design of the project. This study surveys the health implications confronted by the project.

The creation of standing bodies of water behind the proposed dams could have a negative impact upon the population of the Mandara Mountains through an increase in incidence of water and vector borne diseases. In order to determine the exact nature of the possible health impacts of the project, a team was sent to the project area. It visited proposed dam sites and existing water bodies and talked with health personnel in the region, between December 13 and 23, 1977. The team was composed of Dr. C. Ripert and Dr. Same Ekobo, both parasitologists at the University Center for Health Sciences (CUSS), and Douglas Palmer, a Public Health Specialist of the AID Regional Development Office in Yaounde. The team's specific tasks were to:

1. Assess the current health status of the people as it relates to the project activities;
2. Determine the health impact of the construction of the dams;
3. Make recommendations to eliminate or minimize possible negative health impacts of the proposed dams.

II. HEALTH FACTORS WHICH MAY AFFECT PROJECT PURPOSE AND OUTPUTS

A. Water/Vector Borne Disease:
1. Epidemiology of Malaria in North Cameroon

In 1959, prior to a re-organization of the anti-malaria campaign, P. Cavalie and J. Mouchet undertook a epidemiological study of malaria in the Diamaré, Margui-Wandala and Mayo-Danai departments. The results of this study show that Plasmodium falciparum is responsible for more than 95% of the infections whereas P. malariae, alone or associated to the previous species, can be found in less than 5% of cases.

The parasitic indices in children of less than 10 years old are above 50%, whereas they are under 20% in children more than 10 years old. This type of distribution is characteristic of Tropical Africa. The parasitic indices vary with the season, with an increase at the end of the rainy season, from November to January. The gametocitary index is very low in the dry season and is above 10% after the rainy season.

Malaria, alone or associated with pulmonary or digestive infections, is responsible for more than half the cases of child mortality in North Cameroon.

Anophelian Fauna

Fourteen species of the Anopheles type mosquito have been identified in the region, but, in fact, only A. gambiae and A. funestus are real vectors of malaria.

A. gambiae can be found in every village; however, in the dry season, it is absent from the places where no larval shelters are found. This fact is particularly noticeable in villages located far from temporary rivers and in the mountainous areas of the Diamaré and Margui-Wandala. The typical larval shelters of the species are sunlit water bodies without vegetation. The water must be frequently changed as larva do not tolerate an excess of dissolved organic matters. The shelters during the rainy season are found in the slopes where an impermeable ground allows rain water to accumulate. Residual shelters are formed when the "mayos" dry up, leaving ponds which are very favorable to the development of A. gambiae. The sporozoitic index is 2% for this species.

A. funestus is not as frequently found in the mountainous areas as A. gambiae. The immature forms can be found mainly in clear standing water with a profuse vertical vegetation. The typical shelter is the "yaéré", a vast swamp, having standing water from August to January. During the rainy season, the flooded rangeland provide good shelters both in the mountains and in the plains. After the rains, however, host shelters dry up. The sporozoitic index is 1.6% for A. funestus.

2. Epidemiology of Intestinal and Urinary Schistosomiasis

The geographic distribution of human schistosomiasis in Cameroon was studied by R. Deschiens, A. Delas, S. Ngalle-Edimo and A. Poirier in
1968. In the North, urinary schistosomiasis, transmitted by *S. haematobium* and intestinal schistosomiasis, transmitted by *S. mansoni*, are extremely prevalent. A few cases of schistosomiasis transmitted by *S. intercalatum* can be found in the Tokombéré area.

In Maroua, according to A. Kegoum (1977), only 1.4% of the people living in the Doualaré quarter emit *S. mansoni* eggs in their stools. In Koza, the figures are higher and have been up to 11.2% of the examinations performed in the Adventist Hospital (Dr. J. Steveny, 1975); 22% of school children emit *S. haematobium* eggs in their urine.

Twenty-one water points surveyed between December 14 and 21, 1977, in North Cameroon showed the presence of snails. (See Appendix C). Snail "mayfly" drainage canals, ponds, irrigation canals, springs and dam overfalls were visited. *Bulinus globus*, intermediate host of *S. Haematobium* was found nine times; *Bulinus forskali*, intermediate host of *S. intercalatum* was found 10 times and *Biomphalaria pfeifferi*, intermediate host of *S. mansoni* was found 7 times.

Two dams existing in the region were studied in details. The dam providing Nokolo with water, which is located near the city of the road to Rumsiki, has the shape of a basin closed by a concrete wall with granite banks. There is no water vegetation in the reservoir and the water level varies noticeably around the year. No snails were found in the lake. *Biomphalaria pfeifferi* and *Bulinus globus*, on the contrary, can be found in the overfall as well as in the river bed downstream. This area has water year-round emanating from the run-off of the dam.

The Djingliya dam is similar to the Nokolo dam in its nature, size and importance. The valley is closed by a wall made of granite blocks sealed with concrete. There is no vegetation in the lake and the water level varies significantly according to the season. No snails were found in the lake, but *Biomphalaria pfeifferi* was found in the river downstream, where rice paddies were being cultivated.

3. Epidemiology of Onchocerciasis

The centers of onchocerciasis in North Cameroon, known to date and described by J. Anderson, H. Fugelsang and C. Marshall (1974), are located in the valleys of the Vina and the Mbere, which are affluents to the Logone River, and are found in the valley of the Benoue and its affluents. However, onchocerciasis was also recently discovered in the Koza area (Dr. J. Steveny). Undertaken by Doctor Steveny in 1977, a survey of twelve villages of the region and involving 675 people showed that 51.2% are infested by microfilaria of *O. volvulus*. These were found in skin snips taken at the iliac crest.

Onchocerciasis lesions presented by villagers are typical of the savanna region. Nodules (on the hips), skin atrophy, "lizard skin"
and pre-tibial discoloration are symptoms found in the population studied by Stevency. There was also some blindness noted among the older people. The prevalence rates observed in the Koza study are as follows:

Nguetchwewe (45, 69%), Gokoro (132, 79%), Mozogo (50, 22%), Gabasse (50, 86%), Marazawa (50, 74%), Nkosota (62, 48%), Mawa (50, 68%), Gabona (84, 73%), Koofta (22, 90%), Koza (50, 44%), Djinguya (50, 26%), Gousda (30, 7%).

During the dry season, immature forms of the black fly are found in the permanent streams of the project area. Those found belong to the following species:

At the Djingliya dam, downstream in the mayo, and on the dam overfall: *Simulium (euschistum) ruficorne*.

At the mayo near Gousda, having a rough granite sand bed, on plants: *S. (Metomphalus) medusaeforme hargreavesii*.

At the mayo near Kilda, granite flags, waterfalls and sand bed, on immersed plants: *S. (Euschistum) ruficorne, S. (Metomphalus) adersi, S. (Metomphalus) medusaeforme hargreavesii*.

At the Mayo Tsaraga, under the bridge on Mokolo-Goza road, granite and sand: *S. (E.) ruficorne, S. (Met.) medusaeforme hargreavesii*, and *S. (Met.) adersi*.

*Simulium damnosum*, the only vector of human onchocercosis known in North Cameroon, was not found during this recent survey. In the dry season, the hydrographic network of the region, tributaries of the Logone River, is almost completely dry. During the rainy season, it appears that the vector blackflies are carried upstream from tributaries of the Vina River, such as the Touboro in Cameroon and Baibokoum River in Chad.

4. Epidemiology of Guinea Worm Disease (Dracontiasis)

The epidemiological study of Dracontiasis among the Podokwo population of the Mandara Mountains was made by H. Issonfi (1970). The most important center of Guinea worm disease in the project area is located in Oudjilla and the adjacent area. The disease, however, can also be found in other villages such as Doukoula and Cavara near Koza.

In Oudjilla, 26.6% of the 944 patients examined were carrying Guinea worms and 75.7% had been infested at least once in their life. Both male and female were infested, especially between 6 and 33 years of age.

The number of worms varies from 1 to 5 per carrier. In 93% of cases the legs are infested, in 47% of cases the feet are attacked. Less frequently infested are the head (0.3%), the breasts (0.3%), the external
genitals (0.8%). The patients are disabled and the sores get over-infected. Definitive anchylosis of the ankle is frequent and the knees are often attacked.

The prevalence of the disease varies according to whether water is hauled from a modern well with lips or from an unprotected traditional well. To collect water, the people must enter the traditional wells up past their ankles (where the nematode infection usually occurs) and, thus, they contaminate the well with nematode larvae. The larvae will infect humans when the contaminated water is drunk.

5. Epidemiology of Cattle Liver Fluke-Worm Disease

Lymnaea natalensis, intermediate host of the cattle liver fluke-worm, Fasciola giganta, is very frequent in the North. This snail was found in 3 out of the 21 stations surveyed. Human fasciolisis caused by this parasite is scarce, but it does cause important losses among livestock according to the annual reports of the Maroua Veterinary Sub-Sector. The statistics of the slaughterhouse in Maroua verify this.

B. Fecally Related Diseases

1. Bacillary dysentary, amebic dysentary and other diarrheal diseases are very prevalent and the second leading cause of morbidity in the project area. (See selected morbidity statistics for the region on the following page.)

2. Intestinal nematode worm infections (ascariasis, etc.) exist in the project area but are not serious.

3. Other parasitic diseases exist in the project area, but are not considered to be of serious consequences to the project.

A study made by E. Kegoum (1977) of a population sample of the Doualare area showed the following results:

Trichomonas intestinalis (11.9%), Taenia saginata (9.3%), Necator americanus (2.5%), Ascaris lumbricoides (1.4%), Strongyloides stercoralis (0.1%).

The presence of skin Leishmaniosis in North Cameroon has been detected for 40 years, but the center near Mokolo was described in 1976 by K. B. Djibrilla. The disease appears during the rainy season with the multiplication of the vector phlebotomi. 58 patients were identified in 1976 and 19 among them were native of Mandaka. The uncovered parts of the body, face and members are particularly attacked. Leishmaniosis will not affect this project.

Overall morbidity for the project area are sketchy and somewhat outdated. What follows are figures obtained at the Ministry of Health,
Bureau of Statistics in Yaounde, for the Department of Margui-Wandala which encompasses most of the project area, excepting the region around Meri. The latest statistics available are for 1974. For morbidity statistics for selected dispensaries and hospitals of the project area, see Appendix D.

Selected Morbidity Statistics for the Department of Margui Wandala, 1974
(Population 496,000: 1976 Census)

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In summary, malaria intestinal and urinary schistomiasis, onchocerciasis draconcosis, and bacillary and amebic dysenteries and diarrheal diseases are the major human diseases found in the region where the project will take place. These diseases are water borne, transmitted by an organism developing on a vector living in water all or part of its life, or a disease whose transmission is greatly affected by water.

The prevalence of these diseases, and liver-fluke worm disease in cattle, is likely to be most influence by modifications occuring in the hydrographic network through the dam construction. Diseases such as amoebiasis and intestinal worms (ascaridiosis, necatorosis) though transmitted by water wet ground, will probably be less influence by the project. The prevalence of skin leishmaniosis and taeniasis will not be affected by the project.

III. OBSERVATIONS ON THE HEALTH FACILITIES IN THE PROJECT AREA

The team visited nine hospitals and dispensaries and one veterinary post during the study. These include the hospital in Maroua and in Pette. All of these facilities were directed by non-Cameroonians and most were mission supported. Health facilities visited, with a few exceptions, did not keep morbidity or mortality data on record for more than one calendar year but sent them in directly to the Health Sector headquarters at the hospital in Mokolo. Dr. Pabot, Director of the Mokolo Grandes Endémies, related that these statistics were not kept at Mokolo but forwarded directly to Yaounde. It appears that this practice leaves no statistical basis for determining personnel and medical allocation to the regions' health facilities.

Not surprisingly the efforts of the great majority of health personnel in the region is curative. The two exceptions met with was one,
a Cameroonian, trained by the Adventist-run hospital in Koza. He does part-time health education work. Another government trained health educator was working out of Takombéré. Both worked in surrounding villages. The team did not investigate the status of the health extension worker training program run by Catholic Relief Services (CRS) at Sir, Mokolo, Koza, Djingliya, Mayo-Ouldame and Tokombéré (all are found in the project area). According to objectives of the CRS project, up to 37 health extension workers are being trained and could be used part time in health education activities in the area.

IV. RECOMMENDATIONS FOR MITIGATING ADVERSE HEALTH FACTORS

A. Specific Diseases

There are four components of the dam sites to be considered when making recommendations to lessen or prevent an increase of diseases due to the construction of the dams. These components include: (1) the reservoir and the stream that enters the reservoir; (2) the overflow or leakage of the dam structure itself; (3) the stream that issues from the dam and the water bodies created below the dam; and (4) the wells that will be used by the population to procure water.

Each component is considered separately in the recommendations given under this section.

1. Water/Vector Borne Diseases

a. Malaria:

The team believes that there is likely to be some increase in incidence of malaria due to the increased and permanence of water bodies created by the project dams. Malaria is, as previously noted, the leading cause of reported morbidity.

It is not thought, however, that there will be a significant increase in the incidence of malaria. The morbidity statistics for malaria at the Djingliya dispensary, which serves an area where a small dam has been in existence for three years, shows no obvious higher incidence of malaria per population than other areas without existing dams. A very few mosquitoes were collected near the existing dam in Djingliya, and it did not seem that the reservoir or the water flowing below the dam provided an optimum breeding habitat for mosquitoes; however, this is no certain as our visit was made three months into the eight month dry season. It is recommended that a separate entomological study be made of the project area during the rainy season.

There is little that can be done to insure that there will not
an increase in malaria due to the construction of the dams. It is not recommended that the Government of Cameroon be charged with application of insecticide, since this is not considered to be feasible and may be dangerous. Emphasis on health education efforts throughout the entire area should be made to encourage sanitary improvements, such as filling and draining any non-utilized small bodies of water to eliminate breeding habitats of mosquitoes. The Ministry of Health should be encouraged to assure that the regional hospitals and dispensaries have an adequate supply of suppressive drugs on hand.

b. Schistomiasis (Bilharziosis):

As much as it is possible, the banks of the reservoirs created by the dams should not provide an environment for snails. This will entail constructing neat, steep slopes at least to the maximum level of reservoir during the rainy season. The banks should be free from rocks, mud and aquatic vegetation.

The team believes that in cases where significant evaporation will take place during the dry season the reservoirs will not provide a suitable environment for snails. Host snails tend to establish themselves in shallow water along the shoreline, and the water level of the reservoirs are expected to fluctuate between the wet and dry seasons to an extent that a favorable environment for snails can not exist. Host snails, especially Biomphalaria, which make little attempt to retreat as the water level drops, will be exposed and desiccated.

If it is found or suspected that there will not be significant water-level fluctuation of the reservoirs during the year because of the severe gradient of the lake shore, excessive shade in the area, etc., it will be necessary to assure that the above measures are taken.

It is strongly recommended that there be no human and animal contact with the reservoir and the stream that enters the reservoir, which will provide a significant area of shallow water environment. To avoid contact with the reservoirs, it is recommended that a thorn fence be constructed around the reservoir. Thorn fences are common to the project area and will be of little expense. (See Part IV, Conclusions and Recommendations of Dr. Fibry and Mr. Tchala-Alova, Social Soundness Analysis of the project).

The dam itself should be constructed so that there will be no over-flow and as little run-off as possible. The team believes, however, that the project dams because of their design will allow the issuance of a small but continuous
stream at the base of each dam. This has occurred at both the existing Djingliya and Mokolo dams. It is doubtful that these leaks can be avoided and it will be necessary to assure that the water issuing forth from the dams is not allowed to provide a favorable environment for aquatic plants and, consequently, for snails that may provide the intermediate host for schistosomiasis. The possibility of having a small stream and/or water bodies below the dam will be the most serious component of the dam sites. This area will present the most favorable environment for the transmission of schistosomiasis as well as other water borne diseases.

Depending on the individual dam site, provisions will have to be made to prevent water bodies forming below the dams, or human and animal contact with these water bodies. Team suggestions include:

1. Constructing an open cement chute below the dam, directing the run-off to an area where it will not provide an environment for snails. A cement chute will not allow the growth of aquatic plants and water velocity will tend to sweep away any snails that attempt to establish themselves there;

2. Fencing off any water collecting an areas below the dam;

3. Diverting the water flow to any subterranean cavern -- if such exists in the area.

There will be a tendency for local people to utilize any water bodies below the dams for irrigation. It was noted, both at Mokolo and Djingliya, that rice paddies were under cultivation below the existing dams. Both these areas harbored host snails for schistosomiasis. The cultivation of irrigated crops in this area is to be discouraged. This may be the responsibility of a local guardian.

The wells or watering places for people and animals will likely be located below the dam area. It is important that water can not overflow out of these structures causing water bodies to form. Access to these structures must be at all times free of standing water.

c. Onchocerciasis:

Onchocerciasis is, as stated, a serious problem in the area of Koza. There will be three dams constructed in the most seriously affected area (No. 64 and two proposed Bank dams, see Appendix C). However, because of the long flight range of the black fly, it is important to assure that the dams in all the project areas
do not create any rapidly running streams, which will create the breeding environment for the female black fly (genus *Simulium*).

As in the recommendations for schistomiasis, measures will have to be taken to control water flowing from the base of the dams. The use of insecticides to control vector larvae, as for the control of other disease agents of concern in this project, is not recommended. The team believes that the use of insecticide will not be feasible because of cost, bureaucracy and isolation of the area.

d. Guinea Worm Disease (Dracontiasis):

Guinea Worm Disease is a serious health problem in the Ouidjilla village area. It is also found in the villages of Doukoula and Gabora near Koza. For the construction of the dams in these areas, it is recommended that a special effort be made to prevent humans entering the water. It is also recommended that emphasis be put on health education efforts in the infected areas (see Part B). Any health efforts should include the presentation of the mode of Guinea worm infection and stress why it is wise to boil water. It is to be understood, however, that the team believes that environmental change, i.e. barring entrance to water, is the more important and feasible method than an attempt to change the practices of the people in the project area.

e. *Fasciola giganta*:

*Fasciola giganta*, a liver fluke disease, is found in cattle throughout the region. As previously recommended, it is important to prevent cattle from coming into contact with the reservoir or any water bodies below the dam that may harbor the vector snail.

2. Fecally Related Diseases

Fecally related diseases are prevalent in the project area. This problem requires that all water bodies created by the dams be protected from fecal contamination by the population using the water source.

It did not appear to the team members that the local population used latrines to any extent. It will, therefore, be important to assure that all bodies of water (the reservoir, the area above and the banks of the reservoir, and the water bodies below the dam) are not contaminated with human or animal feces. Needless to say, contamination can take place not only by direct contact but indirectly, especially during the raining season when fecal material may be washed into the reservoir.
It is recommended that:

a. Access to all reservoirs be restricted. A thorn fence, mentioned previously, appears to be the most reasonable means to do this;
b. That pit latrines be constructed on the path leading to the water source -- close enough and convenient to be used by those coming for water but far enough away so as to prevent any contamination;
c. That a permanent guardian be installed at each dam site; and
d. That health education efforts be directed towards fecally related diseases.

F. Nutritional Issues

The team believes that there will be no harmful effects on the nutrition of the population (i.e., the amount and type of food consumed). Furthermore, it is thought that there can be a significant improvement in nutritional intake as a direct result of the project.

An AID-supported Cameroon National Nutrition Survey was conducted in late 1977/early 1978 and covers the project area. The results of this survey will be available in mid-1978. It is recommended that data from this survey be reviewed to determine nutritional problem areas related to the project and to suggest ways to incorporate nutritionally related activities into components of the project.

C. Health Education

The team recommends that all existing government and non-governmental support health educators in the project area be contacted and provided with a summary of the project plan and a summary of the potential health impacts of the project. It is recommended that the existing health educators are encouraged to make special effort in the villages most likely to be affected by the dams. It is not recommended that the Government of Cameroon or the missions provide additional health educators as this would put a burden on work-load and funds.

The team also recommends that every village chief of the recipient villages be apprised of the potential health problems of the dam being constructed near their village and be asked to relay this information to his villagers. This type of presentation (although at a separate time) should be given to the guardians of the dams.

From the team's observation of the guardian of Djingliya, it appears that it would be a positive benefit to have a permanent guardian living near each dam. The method of payment would have to be worked out. The guardian at the Djingliya dam is paid by GEMI Rural. A Government of Cameroon supported guardian at each project dam is not feasible (see the Social Soundness Analysis for the project on the recommendations
regarding guardians).

Health education provided to existing educators, village chiefs and guardians should be given during the construction but before the completion of the dams.

D. Health Structure and Statistics

1. Each health facility in the project area should be provided with a copy of the Project Paper Summary and a map of the proposed dam sites in their service area. (See Appendix E for a list of health facilities.)

2. Just prior to the commencement of dam construction, base-line data (morbidity and mortality statistics) for at least 1 calendar year should be collected for all health facilities in the area (Appendix E). These statistics can be obtained at the Statistics office in Yaounde. The same statistics collection should be made each year following the construction of the dams for the life of the project.

3. The Government of Cameroon, through the Ministry of Health, must assure that the Health Sector headquarters keep on file disease statistics of the region. This office must be instructed to be aware of and respond to any increase of disease incidence that may be related to the dams.
BIBLIOGRAPHY

Studies on onchocerciasis in the United Republic of Cameroon. 


ANNEX A

NARRATIVE REPORT OF VISITS TO PROPOSED PROJECT DAM SITES

EXISTING DAMS AND OTHER WATER SOURCES AND TO AREA HEALTH FACILITIES

Soon after arrival in Maroua on December 13, 1977, the team visited the Maroua General Hospital and talked with the French Director, Dr. Aubies, a surgeon, and Dr. Amadou Abdul, a recent CUSS graduate. The provided us with general information as to what diseases existed in the Project area and suggested contacts to make to obtain further information. One recommended contact was a Dr. Anne Marie Schönberger in Pette (which is North of Maroua and out of project area); this person had had experience with Guinea Worm disease (Dracunculiasis) in the project area.

The following morning Dr. Abdul accompanied the team to water sites within Maroua. The team visited two sites on the Tsanaga River, in the city, where no snails were found. A visit to a small irrigation canal which crosses the road approximately 10 kms from Maroua towards the airport found both the Biomphalaria snail (Shistomiasis mansoni) and Bulinus snails (Shistomiasis haematobium and S. intercalatum) as well as other non-vector types. (See No. 44, Appendix C). Later in the morning the team visited with the Director of Veterinarian School in Maroua, where specimens of Fasciola gigantica (a trematode that infects cattle) was collected. We were advised that this cattle disease exists at a moderate level in the area.

A short visit was made to the Service des Grands Endemies (SGE).

The team had an afternoon meeting with Dr. Schönberger in Pette who, with other members, runs a Swiss supported mission hospital. She suggested visiting mission dispensary south of Mora as there was a high incidence of Guinea worm in the area.

In the afternoon the team collected Bulinus in a small stream at Mora (Nos. 45 and 46 Appendix C). A visit was made to Doula, a village 7 kms north of Mora, where a resident had said "all the villagers urinated red", meaning a high incidence of S. Haematobium. No snails were found at this site although not all water sources were visited.

On December 15, the team visited Mora Hospital (German doctor in charge). He verified that there was a focus of Guinea worm disease a short distance to the south of Mora. We subsequently visited the Luthern mission dispensary in Godigong (on the road to Oudjila) and found numerous cases of Guinea worm being treated, all coming from Oudjila area. (See Appendix D, page 1 and 2 for morbidity statistics from area).
The team went on to Oudjila and visited wells (both French built and traditional) and a small pond close to a proposed Bank dam site in the area. We didn't test it thoroughly but saw no snails. We were told by villagers that S. Hematobium (i.e. "red urine") was not a problem. We also were told that further down in the valley there were year-round water sources, which we did not visit.

In the afternoon, the team travelled back through Mora, then south on the road towards Meri to the Catholic Mission at Mayo-Ouldémé. This village is located 4 kms from an AID dam site (No. 36) to the south west and approximately the same distance from a Bank dam site to the north west.

The team briefly talked with the French MD at the Mission-run dispensary who related that the incidence of malaria and schistosomiasis (S. Mansoni) was high but there was no Onchocerciasis and very few cases of Guinea worm found in the area. We were directed to a small irrigation dam on the Milé om Mada River (Mayo Ouldémé) which was the main reason for the visit. This river is said to have running water year around. We found numerous specimens of Biomphalaria, which tended to confirm the high incidence of S. Mansoni. (See the dispensary health statistics, Appendix D, page 3.)

The team continued south to the large mission hospital at Takonbére where Dr. Aurenche related that malaria and schistosomiasis, and malnutrition were problems, but cases of Onchocerciasis and Guinea worm did not exist. (A few cases of Onchocerciasis have been reported to Yaounde by the Koza Hospital. See Appendix D, page 6.)

The next morning, December 16, visits were made to several stream/water-holes and wells a few kilometers west of Takonbére. Sampled sites had Bulinus or Biomphalaria snails. (See Appendix C, numbers 48 to 50). Just north of the hospital in Tabonbére, a water-hole which was suspected by Dr. Aurenche to be the primary source of Schistosomiasis was explored and the team found no species of host snails. (See Appendix D, page 4).

The team tested several water sites on the road to Meri. These produced genus Biomphalaria and Bulinus snails. (See Appendix C, numbers 50 and 51.)

Late on the 16th, the team visited the existing dam constructed by Genie Rural in 1974 at Djingliya and collected a few mosquitoes in the guardians' shack adjacent to the dam, but at 9:00pm found no mosquitoes in an occupied Mafa villager's house in front of the dam and up the slope of the mountain. (Appendix D, page 5 for the morbidity statistics).

The morning of the 17th, the team collected Biomphalaria snails in quantity and some Bulinus snails in the permanent waterbodies created by leakage from the dam. No snails were collected in the lake itself. It
appeared that the level of the lake greatly fluctuated between dry and wet seasons and hampered aquatic vegetation growth, as almost none was observed along the shores of the lake. Without this vegetation, the snails will not exist. Below the dam the amount of aquatic vegetation was profuse, a result of a constant amount and level of water leaking from the dam.

On the same day the team visited the large dam at Mokolo which provides the town with drinking water. A similar situation was found at that Mokolo dam, as was found at the smaller Djingliya dam: it leaked at the base and there was a small, but apparent constant stream that trailed away from the dam. This stream was found to harbor both Bulinus and Biomphalaria (Number 54, Appendix C). A little further down the stream, after it crosses the road, the team observed women washing clothes while their children played in the water. There was a French-constructed well next to the stream at this site. Further down, a few paddies of rice were under cultivation.

The lake created by the dam of Mokolo harbored no snails. This was apparently for the same reason as the Djingliya dam: yearly fluctuations in the water level prohibited aquatic plant growth, thus eliminating the necessary environment for a population of snails.

Later in the day the team visited Dr. Stevny at the Adventist Hospital at Koza. He related that malaria, dysentaries, and Shistosiasis were problems. He also said that there was a focus of Onchocerciasis to the northeast of Koza with the village of Gaboua at about its center. Dr. Stevny had done a study of the incidence of Oncho in this area (skin biopsy) and the results showed an incidence of a low of 36% in Djingliya to a high of 90% in Koofa. (See Chapter II, A.3: for Oncho-cerciasis statistics in the Koza area).

Following our visit to Roumsiki on the 18th, the team revisited Koza and travelled to Gaboua to obtain blood specimens from villagers affected with Oncho. It appears that the highest incidence of this disease is found in the plain; the number of cases drop as you go up into the mountains. The hospital statistics show only 14 cases of Oncho since January 1976. This may be due to patients with double cases, and they were reported for the other disease, or, more likely, they did not come in for treatment. (With an incidence of up to 90%, people affected are the norm). The village chief of Gaboua was blind; however, trechoma is the likely cause.

The team also collected a quantity of mosquitoes at the hospital at Koza. (See Appendix D, page 6 for hospital reported statistics).

Early on the 18th, the team visited three proposed dam sites in the Roumsiki area. South of Roumsiki, no water was found at site No. 151, but there was a traditional well and a small pond close-by where no snails were found. Snails were collected (Pulimus) in a small water
body within a kilometer of this site (No. 55, Appendix C).

The team did not reach site 140 north of Roumsiki and found no standing water in the vicinity. Site No. 141 was found to be dry, but water bodies of this area harbored Bulinus (No. 56). There was evidence that a local farmer was cultivating rice on a small scale in this area. (See Appendix D, page 7 for morbidity statistics of the area.)

On December 19th, the team visited site No. 99, two kilometers south of Mokolo. There was no water at the actual site, but the team collected snails (Bulinus, No. 57, Appendix C) in a stream close to the site.

Dr. Ripert talked with Dr. Pabot, the Director in charge of SGE in Mokolo, and was told that the health sector office did not keep area health facility records but forwarded them on to Yaounde. Dr. Pabot also related that his health impact report done for the World Bank was very general and was written when he did not have much experience in the region. (See Appendix D, page 8 for the statistics of the Mokolo dispensary.)

In the afternoon of the 19th, the team visited the area of site No. 129 at Mogoumaz, to the north-west of Mokolo. On the way, the team stopped at a small tributary of the Tsonaga River, which flows directly into the second Mokolo dam (at Douvar), now under construction. The team collected and observed many genus Biomphalaria snails (No. 58, Appendix C). The construction foreman of this dam related that they have built a small lake in the area that will be used by the local populace. If the environment is adequate in this lake, there is no doubt that Biomphalaria will spread and the lake will harbor a large population of this genus of snail.

The team did not reach the actual dam site (No. 129) at Mogoumaz but did collect a species of snail (not a host to Schistosomiasis) in a traditional well near the site. (See No. 59, Appendix C.)

On December 20th, the team visited dam site No. 59, which was dry, and a water body near dam site No. 55 approximately 15 kilometers east of Mokolo, on the road to Maroua. Bulinus and Biomphalaria snails were taken from this site (No. 60, Appendix C).

In the afternoon, the team travelled to Yagoua where we talked with Dr. Hamidou Issoufa, Director of the hospital and a former CUSS graduate. On the 21st, a visit was made to Kousseri. The team returned to Maroua on the 22nd, and Yaounde on the 23rd of December.
THE SITES OF THE 57 DAMS IN THE MANDARA MOUNTAINS
LES SITES DES 57 BARRAGES DANS LES MONTS MANDARAS

The numbers refer to dams in Aid Project No. 681-8012.
'B' refers to those proposed by the World Bank.
APPENDIX C

SNAILS LIVING IN FRESH WATERS IN NORTH CAMEROON

COLLECTION DATA OF PRESENT STUDY: December 14 - 21, 1978

(Dr. RIPERT's collection numbers; location; environment; snail species)

Nos.

44. Drainage canal on the road between Maroua and the airport. Deep water, mud bed, aquatic vegetation:

- Pila werneri
- Bulinus Forskalli
- Bulinus Truncatus rohfei
- Bulinus Globosus
- Biomphalaria pfeifferi
- Lymnaea natalensis

45. Hole on the roadside used to water cattle, before arriving in Mora from Maroua along the hard road. Some water plants on the bank:

- Bulinus forskalli

46. Small Mavo, with aquatic vegetation, before going to Mora from the hard road. Standing water. Rock bed with rough sand:

- Bulinus forskalli
- Bulinus globosus

47. Mayo Ouldeme, near Ouldeme mission. Clear river with a swift current on a rough sand bed. Found in the irrigation canals, obtained by blocking of the river, water plants and vegetable gardens:

- Bulinus forskalli
- Biomphalaria pfeifferi

48. Mayo in Mofokot village, near the Takombe mission. Spring coming form the mountain of granite stones. Rough sand bed. Aquatic vegetation, clear water, slow current:

- Lymnaea natalensis
- Biomphalaria pfeifferi

49. Ponds in the dried up bed of a stream in the "milieu de la plaine", near Kodjin village. No current. Abundant aquatic vegetation:

- Bulinus forskalli
- Bulinus globosus

50. Residual pond with water lilies in the Mayo Takombeere bed, aquatic vegetation:

- Bulinus forskalli
- Afronyxus coretur
- Gyrolus costulatus
- Segmentorbis kanisaensis
51. Mavo in Guirzina. Clear water in residual ponds after the sewer on the road to Heri. Aquatic plants.

52. Dipholyia dam. Concrete wall. Reservoir of clear water with fluctuating level. No snails in the reservoir. Downstream, in the river bed having water vegetation and rice fields:
   - Biomphalaria pfeifferi
   - Bulinus globus

53. Ford on the Mavo Gousda. Clear standing water, green, filamentous weeds:
   - Curculio costulatus

54. Reservoir providing Yokolo with water. Banks of granite stones and rocks. Concrete wall. Fluctuating water level. The river downstream is partially dried up but has some aquatic vegetation:
   - Biomphalaria pfeifferi
   - Bulinus globus

55. Mavo Mogodi, in the Kansidi plateau, large residual ponds maintained with water, water vegetation, watering of cattle:
   - Lymnaea natalensis
   - Bulinus globus

56. Karachi Mavo, near a sewer, on the Boumsiki-Yokolo road, in a river maintained with water:
   - Bulinus globus

57. Mavo Dalan, near the dam site number 99, rough sand bed. Little water vegetation:
   - Bulinus forsalii

58. Mavo Tsanaqa. Slow current. Sand bed and water vegetation. Upstream from the new large dam being constructed:
   - Biomphalaria pfeifferi
   - Curculio costulatus

59. Doubdian village. Spring providing water to a traditional well and on the granite banks:
   - Curculio costulatus

60. Mavo Sabonnari. Sewer on the Yokolo-Yagoua road. Downstream from the road, a few plants on a sand bed and green, filamentous weeds:
   - Bulinus forsalii
   - Biomphalaria pfeifferi

61. Rice fields in a canal, near Yagoua SEMRI I, with scarce water plants:
   - Bulinus forsalii
62. Residual pond with water lilies, in Yagoua:
   - Pila wernei

63. Danay river; (no communication with the Lonone river in the dry season).
   - Lanistes ovum

64. Drainage canal out of Yagoua on the road to Pouss. Mud bed.
    Graminaceous plants on the banks. Filamentous green weeds:
    - Bulinus truncatus rohlfsi
    - Gabriella senharemensis
    - Cleonatra bulimoides
# appendix D, Page 1

## Morbidity Statistics

For Mora Hospital 1976

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APPENDIX E

HEALTH FACILITIES IN THE PROJECT AREA

1. Mora Hospital
2. Godigong Dispensary
3. Tala Mokolo Dispensary
4. Guldémé Hospital
5. Tokonbéré Hospital
6. Meri Dispensary
7. Kilouo Dispensary
8. Mokong Dispensary
9. Tourou Dispensary
10. Koza Hospital
11. Djingliya Dispensary
12. Soulede Dispensary
13. Mofguele Dispensary
14. Mokolo Hospital
15. Zamay Dispensary
16. Zidim Dispensary
17. Hina Marbak Dispensary
18. Gavar Dispensary
19. Mogode Dispensary
20. Sir Dispensary
21. Guili Dispensary
22. Bourrai Dispensary
23. Gamboura Dispensary