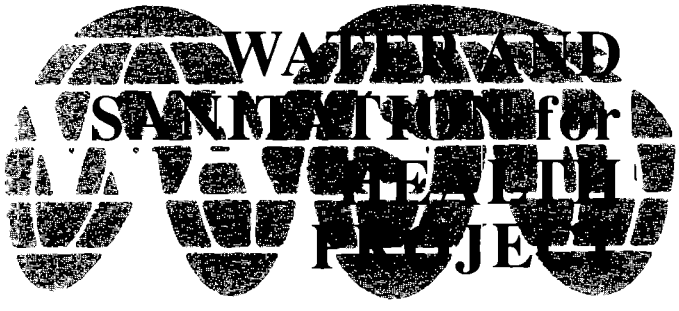
FIELD REPORT

HEALTH IMPACT ASSESSMENTS OF SMALL DAMS IN THE DOGON COUNTRY, MALI

Field Report No. 357
July 1992



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WASH Field Report No. 357

HEALTH IMPACT ASSESSMENTS OF SMALL DAMS IN THE DOGON COUNTRY, MALI

Prepared for the USAID Mission to Mali
under WASH Task No. 262

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CONTENTS

ACRONYMS v
ABOUT THE AUTHORS vii
EXECUTIVE SUMMARY ix

1. INTRODUCTION 1

1.1 Objectives and Problem Statement 1
1.2 Background 2
1.2.1 Location 2
1.2.2 Climate 2
1.2.3 Hydrogeology 2
1.2.4 Small Dam Construction 3
1.2.5 Agricultural Practices 4
1.2.6 Dogon People and History 5
1.3 Methods and Materials 6
1.4 Clients and Audience for this Report 8

2. SOCIAL FACTORS AND HEALTH ISSUES RELATED TO THE SMALL DAMS 11

2.1 Social Issues 11
2.1.1 Social Organization 11
2.1.2 Water 13
2.1.2.1 Water Uses 14
2.1.2.2 Significance of Water Use for Health and Hygiene 21
2.1.3 Hygiene Practices and Beliefs 22
2.1.4 Local Perceptions of Illness and Health 24
2.1.4.1 Guinea Worm 24
2.1.4.2 Schistosomiasis and Skin Infections 27
2.1.4.3 Diarrhea 29
2.1.4.4 Malaria 30
2.1.4.5 Eye Infections and Onchocerciasis 30
2.1.4.6 Infant Mortality, Morbidity, and Other Illnesses 31
2.1.5 The Dogon and Development 33

2.2 Health Problems 34
2.2.1 Waterborne Diseases 34
2.2.2 Water-washed Diseases 36
2.2.3 Water-contact Diseases 42
2.2.4 Water-related Diseases 44

3. ENVIRONMENTAL AND ENGINEERING ISSUES RELATED TO THE SMALL DAMS AND HEALTH CONDITIONS 45

3.1 Environmental Engineering 45
3.1.1 Small Dams for Irrigation 45
3.1.1.1 Dam Construction 45
3.1.1.2 Dam Repair 49
3.1.1.3 Operation and Maintenance 49
3.1.2 Water Supply and Sanitation 50
3.1.2.1 Water Contact 50
3.1.2.2 Water Supply 52
3.1.2.3 Water Quality 54
3.1.2.4 Sanitation 56
3.2 Environmental Assessment 57
3.2.1 Key Physical, Biological, and Cultural Factors 58
3.2.2 Assessment of Different Interventions 60
3.2.3 Environmental Assessment Criteria 62

4. CONCLUSIONS 65

5. RECOMMENDATIONS 67

6. LESSONS LEARNED 73

7. BIBLIOGRAPHY 75

PHOTOS 79

APPENDICES

A. Scope of Work/Requesting Cables 85
B. Schedule 95
C. Persons Contacted 97
D. Assessment Questionnaire 105
E. Catholic Mission Small Dam Inventory 111
F. DED Small Dam Inventory 113
G. Map Indicating Villages Visited 119
H. Description of Villages Visited 123
I. Tables on Water Sources and Water Consumption 129
J. Tables on Hygiene Practices and Latrine Use 137
K. Tables on Dogon Perceptions of Disease 141
L. Tables on Dogon Development Priorities, Communication and Migration . . 159

TABLES

1. 1991 Price of Dried Onions—Bandiagara Yields 6
2. Dogon Disease Terms 25
3. Disease Statistics 26
4. Estimated Mortality of Children in the Dogon Country 32
5. Reported Guinea Worm Cases in the Dogon Region, by Year 38

FIGURES

1. Bandiagara Annual Rainfall, 1965-1990 3
2. Life Cycle of the Guinea Worm 37
3. Life Cycle of Schistosomiasis 43
4. Cumulative Construction of Dams Since 1950 46
5. Key Environmental Factors 59

ACRONYMS

A.I.D.	U.S. Agency for International Development (Washington)
CFA	Local currency: 280 CFA = US $1
DED	Deutscher Entwicklungs Dienst, a German NGO
DNHE	Direction Nationale de l'Hydraulique et de l'Energie
GIS	Geo-base Information System
GRM	Government of the Republic of Mali
GTZ	Gesellschaft for Technische Zusammenarfeit
HDS	Harmonie du Sahel
IEE	Initial Environmental Evaluation
MOH	Ministry of Health
NGO	Nongovernmental organization
O&M	Operations and maintenance
OCP	Onchocerciasis Control Program (sponsored by WHO)
ORT	Oral rehydration therapy
PCV	Peace Corps Volunteer
PVO	Private Voluntary Organization
R&D/H	Bureau for Research and Development, Office of Health
SAC	Service Agricole
SHBC	Systeme d'Hygiene de Bandiagara Cercle
UNDP	United Nations Development Program
USAID	U.S. Agency for International Development (Overseas Mission)
VBC	Vector Biology and Control Project
WASH	Water and Sanitation for Health Project
WHO	World Health Organization
WID	Women in Development (Office in A.I.D.)

ABOUT THE AUTHORS

The consultant team for this report consisted of the following individuals.

Team leaders:

- Arthur Dennis Long, Sc.D., P.E., Office of Health, A.I.D., Tropical Disease Specialist and Environmental Engineer who had worked in the Dogon Country in 1975.

- Issa Degoga, M.D., National Guinea Worm Coordinator, GRM, Public Health Specialist who studied Guinea worm in the Dogon Country in 1977.

Team members:

- Eve Crowley, Ph.D., Anthropologist, WASH consultant. Research affiliation with the University of Leiden in the Netherlands. Extensive research experience in the Upper Guinea Coast and the Sahel.

- Hamancire Daou, Civil Engineer, USAID/Bamako.

- Rita Klees, Ph.D., AAAS Fellow (American Association for the Advancement of Science Award), Office of Health, A.I.D. Previous field experience in water supply and sanitation activities in Africa and Central America.

- Mohamed Konare, Water Resources Engineer, Africare, who designed and supervised construction of the Yamé dam.

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EXECUTIVE SUMMARY

The objective of this activity was to assess the health impacts of small dams in the Dogon Country of Mali. During the last 40 years, approximately 108 small dams have been built in the region to support the production of onions (the primary cash crop in the region), which are sold throughout Mali and are exported to neighboring countries. Approximately 80 percent of the dams contain sufficient water to support one to two growing seasons (from September to January for one season and from January to May for the second season). However, 50 percent of the dams support only one season. Due to poor siting and/or poor construction, approximately 20 percent have failed; that is, they do not hold water beyond the rainy season.

The provision of a year-round supply of surface water for agricultural purposes presents potential health risks in West Africa, notably malaria, schistosomiasis, and Guinea worm. Of course, surface water also offers potential health benefits, such as improved nutrition and improved hygiene, with a reduction in skin and eye diseases. In the absence of baseline health data, the consultant team's approach was to look at villages with dams, without dams, and with failed dams to determine if there were significant health risks associated with the presence of dams. The team developed and investigated health, socio-economic, engineering, and environmental criteria for an impact analysis. In all, the team visited 12 villages, 8 with and 4 without dams, during a 12-day period. The relationship of village water supply and sanitation conditions to water-associated disease was also studied.

Health conditions were found to be universally poor in all villages and included high levels of diarrheal diseases; Guinea worm; skin diseases; eye diseases, including trachoma; schistosomiasis; and malaria. Knowledge of basic hygiene and of simple proven solutions such as Oral Rehydration Therapy (ORT) were minimal. Latrines were virtually nonexistent. While all villages with dams also had a source of safe drinking water, most used the impounded dam water to drink at least occasionally, and/or other unsafe drinking water sources because of convenience or taste factors. Practices of collection and storage of water were unsafe in many villages. Not surprisingly, diarrheal disease was reported as the most serious health condition. The eradication of Guinea worm was noted in all cases in which a safe drinking water supply was located and used exclusively for drinking.

Only one disease was found to be specifically related to the presence of dams—schistosomiasis. The Government of the Republic of Mali (GRM), with assistance from the Gesellschaft for Technische Zusammenarfeit (GTZ), has been operating a schistosomiasis research and control program in the Bandiagara region for several years. This program was started in response to the GTZ's own concerns about the health effects of small dams they had built in the region. The research to date has shown that although schistosomiasis (*Schistosoma haematobium*) is endemic to the region, both the prevalence and intensity of infection increase

following dam construction. Therefore, GRM's current strategy is to provide treatment in villages that possess dams.

The consultant team also concludes that dams may slightly reduce water-washed diseases. The need to incorporate plans for a safe drinking water supply, sanitation facilities, and a hygiene education program into small dam projects is manifest. Findings indicate that the most cost-effective and potentially sustainable intervention to address health issues identified during the team's study would be child survival activities. Improved nutrition, an anticipated indirect benefit of the dams, was not investigated but would be assumed to occur due to improved economic circumstances.

Determination of economic benefits realized because of the dams was beyond the scope of this project. Clearly, however, the Dogon people perceive economic benefits associated with small dams.

Given the relationship of dams to schistosomiasis and the existing control program, the team's recommendations focused on schistosomiasis control and addressed 1) dam construction, design, and operation; 2) alternatives to small dams; and 3) possible approaches to reducing water contact. The team also identified the need for the Dogon to address marketing issues related to increased onion production.

Chapter 1

INTRODUCTION

1.1 Objectives and Problem Statement

The objectives of this study are to

- Assess the health impacts of construction of small dams in the Dogon Country, Mali
- Make recommendations to mitigate potential impacts
- Recommend future research, if appropriate
- Assess other health risks related to water use and sanitation practices and recommend possible mitigation measures

Approximately 108 small dams have been built in the Dogon Country during the last 40 years. Their purpose is to provide water for irrigating onions and other vegetables, which the Dogon produce as cash crops. As more dams were built, however, donors became aware of possible negative health effects involved. Africare, which recently completed two dams in the region, raised this issue. As a result, this study is being conducted at the request of Africare and USAID/Bamako to determine if there are significant health effects from the construction of small dams (see the scope of work and requesting cables, Appendix A). The study was conducted 4-26 September 1991, during the rainy season and just prior to the harvest, and therefore a time of food scarcity. Although 1990 was a drought year, good rains occurred in 1991, from which the harvest promised to be plentiful. In all, the consultant team visited 12 villages, 8 with and 4 without dams, during a 12-day period. (See Appendix B for the schedule.)

Mali's population is approximately 8.2 million, with a life expectancy of 48 years and an illiteracy rate of 83 percent (World Bank, World Development Report 1991). By most measures, Mali is one of the poorest countries in the world and has performed very poorly with respect to basic human needs. Approximately 85 percent of its total labor is employed in the agricultural sector, which accounts for nearly 50 percent of gross domestic product (GDP). Given this economic picture, onion production is an important aspect of both the Dogon and national economies.

Despite being adversely affected by OPEC I and II, Mali has experienced real per capita income growth since the military took over in 1968. After periods of real decline in 1972-74 and 1982-85, Mali enjoyed periods of rapid growth in 1974-77 and 1985-86. Gross national

product per capita in 1989 was $270 (World Bank, World Development Report 1991). In March 1991, a coup overthrew the one-party regime of Moussa Traore. With multiparty elections currently scheduled for January 1992, this is a time of political change within the country.

1.2 Background

1.2.1 Location

The Dogon Country covers 7,250 square kilometers and is located on a sandstone plateau (Bandiagara Plateau) between 14 and 15 degrees northern latitude. The Bandiagara Plateau is in central Mali and runs northeast-southwest for some 200 km and ranges from 75 to 100 km in width. Emerging with a gentle slope from the banks of the Niger and Bani rivers, the plateau reaches its greatest height in the northeast, where it terminates in a series of 300 to 350 m (and in some places higher) escarpments abutted by the Seno Plain. The terrain is rugged and can be described as rocky hilly country with scattered tree cover, deep gorges, valleys, and large eroded sandstone outcrops. The infrequently flat rocky spaces on the plateau are occasionally covered with very thin soils that possess very little water retention capacity. These poor soils make up the largest part of the plateau's arable land. The seat of the Dogon Country is Bandiagara City. The region is divided into eight arrondissements with a total population of about 300,000 living in approximately 400 villages.

1.2.2 Climate

The Dogon Country is located within the semi-arid Soudan-Sahelian climate zone, which is dominated by two seasons: a dry season from October to May, and a rainy season from June to September. Rainfall varies from one ecological zone to another. Figure 1 presents annual rainfall data for 26 years from the Bandiagara rain gauge station. The mean annual rainfall from 1965-90 was 467.0 mm (standard deviation of 96.3), with a range of 329.2 mm in 1967 to 638.2 mm in 1977. Analysis of the rainfall data shows that there is a trend of less rainfall in recent years, with the 1970s' 10-year average at 565.8 mm (standard deviation of 55.5) dropping in the 1980s to a mean annual rainfall of 407.9 mm (standard deviation of 56.3).

1.2.3 Hydrogeology

The hydrogeology varies throughout the Dogon region. The Bandiagara Plateau is riddled with faults of varying width and depth that serve as natural water reservoirs in the impermeable sandstone. On the plateau in the Yamé River system are small water courses, ponds, and springs. These are all fed by rainwater and, with the exception of the springs, do not flow during the dry season. On the adjacent Seno Plain, water resources are more scarce. Only depressions that carry rainwater and then dry up with the end of the rainy season have been identified there.

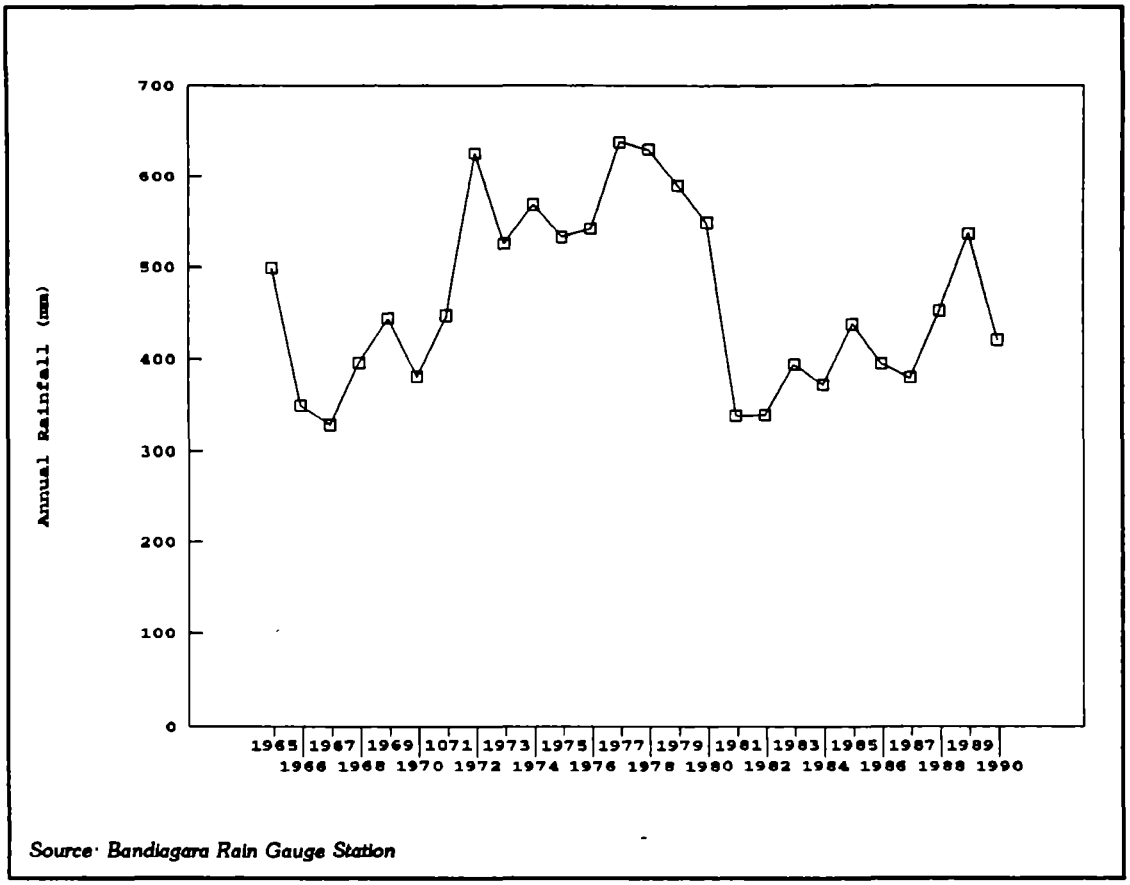

Figure 1

Bandiagara Annual Rainfall 1965-1990

1.2.4 Small Dam Construction

The primary water resource management activity of the Dogon Country has been construction of small dams to provide irrigation water during the dry season. The construction of the first concrete dam on the plateau in Sangha during the late 1940s was an important landmark in the diffusion of gardening, the primary target of the dam projects. The gardens that grew up in Sangha demonstrated the possibilities of cash cropping and, in concert with the expansion of the road system in the 1950s, stimulated a growth of gardening in the Dogon Country that was augmented by increased small dam construction. As noted previously, to date, 108 small dams have been built. With the passage of time it became evident that in addition to the economic advantages associated with small dams, there were health and environmental ramifications to consider as well. In 1977, the chief doctor of Bandiagara indicated evidence of an increased incidence of schistosomiasis and Guinea worm among villagers with access to dam water for gardens. It was also suspected that aquatic plants in the dam reservoirs were

serving as support for snails, the intermediate hosts of schistosomiasis. While these concerns were voiced by many, no definitive study was conducted nor any remedial action taken.

Since the dams in the Dogon were built with one purpose—to increase the income of the Dogon farmers by increasing crop yields—it is necessary to keep in mind the agricultural and economic benefits accrued while weighing the health costs. Based on this kind of analysis, some donors have begun to question the value of continued dam construction. Falls in onion prices suggest to some that onion production has reached a level of saturation on the national market during the harvest. Some of the onion transformation techniques developed by the Service Agricole (SAC) may help overcome this bottleneck, as would diversification of garden crops.

1.2.5 Agricultural Practices

Traditional Dogon gardens are situated around faults covered by sand and sediment. The quantity of water held in the faults and available for gardening is difficult to determine. To extract the water, the Dogon dig shallow wells.

The Dogon have several hundred years of experience with the production of onions and have proven themselves competent with the resources at their disposal. For example, they have developed composting methods for maintaining soil fertility; they have used the rocks in the environment for fencing and terracing and erosion control; they have moved soil to rocks adjacent to water sources to develop gardens; and they have molded local materials into suitable vessels for irrigating dry-season gardens. Thus the dams can be viewed as an augmentation to traditional agricultural practices and as one method of increasing agricultural productivity in the area.

The most important vegetable the Dogon grow is the small white onion *Allium cepa*. Onion gardening can only take place near water sources. Onions are hand watered with large calabashes that hold from 7 to 25 liters (most hold about 15 liters). Water is dipped from the water source, usually by people wading into the water with the open calabash held in both hands.

Dogon onions have a 60 to 70 day growing season, in contrast with American varieties of open-pollinated short day onions, which require 160 to 180 days to mature and must be propagated by seeds. In determining agricultural benefits of the onion crops, consideration of length of growing season and availability of water is necessary. The lack of water is the largest factor limiting increased onion acreage (Remington, n.d.).

The actual economic benefit to the villagers from increased onion production has been the subject of some controversy. A 1977 study examined the issue of overproduction of onions and identified marketing difficulties as impediments that keep villagers from realizing the full benefits of the increased water supply available for irrigation (Remington, n.d.). More recently,

to address these marketing difficulties, the SAC has developed a project that seeks to enhance the benefits of increased onion growth. SAC has a project involving 13 villages throughout the Dogon that helps villagers with the technical and marketing aspects of producing dried onions. After a pilot-scale investigation, a simple machine was developed for farmers to use on-site to shred onions. A solar screen drying device has also been designed to dry the shredded onions. Additionally, farmers can opt to transport the onions to Bandiagara themselves at a savings or have SAC pick up the onions in the village. The onions are then brought to a small enterprise in Bandiagara that packages them.

The project buys the onions directly from farmers and guarantees them a price for their participation in the project. The onions ultimately are sold primarily in Bamako, although there is also a market for them in Dakar and Abidjan. Table 1 gives the most recent prices paid to the farmers for dried onions.

The project produced 15 metric tons of dried onions in 1990, its first year of operation, and 8.7 metric tons in 1991. The drop was due to the price of onions falling last year. SAC's goals for the project include enhancing the farmers' independence from traders and encouraging a private enterprise in Bandiagara to take over the packaging and marketing component. This project illustrates the potential for innovative solutions to overproduction of onions.

1.2.6 Dogon People and History

The Dogon are a fairly homogeneous people living in an extremely hostile natural environment. The population numbers about 300,000, with densities in the Dogon Country districts varying from 5 to 50 inhabitants per km^2. With the exception of Bandiagara Town, the areas of greatest density also happen to be the most inaccessible. The geographical variation and isolation of settlements on the Bandiagara Plateau have contributed to a striking plurality and variation in Dogon social and linguistic groupings. Several of the 40 to 50 dialects in the region are mutually incomprehensible. Despite this diversity, Dogon people are bound together by a common work ethic that has enabled them to survive in difficult conditions and to endure the major problem of water scarcity through enterprise and hard work.

The Dogon are organized into patrilineages, groups of people tracing descent through their fathers. Members of the same lineage cannot intermarry. At marriage, the new conjugal household establishes residence with the husband's lineage. In most respects, Dogon society is patriarchal and women occupy few positions of authority. Lineage affiliation, residence, and age grades form the principal bases for the organization of labor and space. Time is structured in a five-day week, in keeping with markets that occur once every five days in larger villages.

Throughout the region, roads are poor and many villages can only be reached on foot. Poor roads contribute to the social and linguistic diversity of the region, hinder access by government and international services, and hamper the transportation of market vegetables,

Table 1

1991 Price of Dried Onions--Bandiagara Yields

Wholesale price (minimum 40 kg) in CFA/kg

	Cash Payment	Credit (6 mos.)
40 kg sacks	615	650
500 g packets	680	715
100 g packets	865	900

Note: The yielded price in Bamako = the yielded price in Bandiagara + 20 CFA/kg.
The yielded price in Sévaré/Mopti = the yielded price in Bandiagara + 5 CFA/kg.

thus reducing farm-gate prices. The improvement of basic infrastructure, such as road networks, would have a marked positive impact on health conditions and the commercialization of market products. Difficult access and the plurality of Dogon dialects block the flow of information and explain the absence of many communication networks in the region.

1.3 Methods and Materials

The team spent 12 days in the Bandiagara region, working out of Bandiagara (see Appendix B for a copy of the team's schedule). So as to observe disease burden firsthand, the team's work took place during the rainy season, which corresponds with the transmission season for most of the diseases of concern, and allowed for inspection of dams at times of peak water levels. Due to the absence of baseline health data, for comparative purposes the team chose to study villages with dams, without dams, and with dams that were no longer working properly. For villages without a dam, the team chose to study villages with and without a safe drinking water supply in order to isolate the health impacts of this variable. A description of the villages studied is given in Appendix H. Villages were selected based on the following criteria.

They were villages:

- In which the client, Africare, had worked;
- In which team members had previously worked, or in which prior studies had been conducted;
- From different watersheds on the plateau;
- With no safe drinking water supply; and
- That were accessible.

The villages chosen covered three administrative zones, four to five dialect groups, and three watersheds (see Appendix H). The team's methodological approach was to conduct focus group discussions using a standard questionnaire (see Appendix D) and additional questions as appropriate within each subdiscipline. In addition to information about dams, the questionnaire included information on other water sources and sanitation conditions and practices. Field observations were made of all village water sources, including the dam and reservoir, and sanitation facilities. When possible, water contact and use behaviors were also observed. Men, women, and children were questioned separately.

Market days occur every fifth day on the plateau and involve most of the villagers. Therefore, the team also spent three market days in Bandiagara interviewing small enterprises and government, local, and international services based in Bandiagara that are working throughout the region. Interviews were also held with key officials in Bamako. (Appendix C comprises a list of persons interviewed.)

The team was divided into two subgroups: health and social; and engineering and environmental. Initially the two groups worked together to develop and finalize the questionnaire. After the initial village study the two groups worked separately in several villages, coming together in the second week for the final three villages. In these last three villages, the female members of the team interviewed focus groups of women and children, while male members focused on male village representatives. Therefore, among all villages visited, some were visited by only one group. The health and social team also spent one night in the village of Koundo-Da, which allowed for more detailed observation on water use.

The team did not attempt detailed diagnostic, epidemiological, or environmental measurements (e.g., measurements of water quality), as such measurements were beyond the scope of this study, and would have required laboratory and other facilities. For the purposes of this study, gross indicators such as the presence of Guinea worm were thought sufficient.

At the village level, all interviews were conducted in Dogon with the use of two male professional interpreters.

The consultant team for this report consisted of the following individuals.

Team leaders

- Arthur Dennis Long, Sc.D., P.E., Office of Health, A.I.D., Tropical Disease Specialist and Environmental Engineer who had worked in the Dogon Country in 1975

- Issa Degoga, M.D., National Guinea Worm Coordinator, Government of the Republic of Mali (GRM), Public Health Specialist who studied Guinea worm in the Dogon Country in 1977

Team members

- Eve Crowley, Ph.D., Anthropologist, WASH consultant

- Hamancire Daou, Civil Engineer, USAID/Bamako

- Rita Klees, Ph.D., Environmental Engineer, Office of Health, A.I.D.

- Mohamed Konare, Water Resources Engineer, Africare, who designed and supervised construction of the Yamé dam

Translators

- Antiamba Tembely, Secretary of Social and Cultural Affairs, Harmonie du Sahel (HDS)

- Aguibou Degoga, USAID/Land Tenure Center Translator

1.4 Clients and Audience for this Report

This activity was conducted at the request of Africare/Mali and USAID/Bamako. The audience for this report includes the following:

- Government of the Republic of Mali

- Local services and nongovernmental organizations (NGOs) working in the Dogon Country, including Africare and the Peace Corps

- USAID
- Other bilaterals and multinationals

Chapter 2

SOCIAL FACTORS AND HEALTH ISSUES RELATED TO THE SMALL DAMS

2.1 Social Issues

2.1.1 Social Organization

Dogon villages range in size from a few hundred to several thousand individuals. Settlements are often located on rock outcrops and cliffs, offering security from attack by outsiders and animals, and allowing the community to take full advantage of the cultivable areas found at the base of the rocks. Dogon houses are rectangular, built of stone, and covered with mud. Most are windowless, with low doors and a ceiling hole supported by beams. Households and multiple thatched granaries are usually clustered closely together into stone walled compounds. Within these walls is an enclosure for bathing and urinating. Nearby and also within the compound, farmers create a compost heap with organic material where they tie their animals and wash utensils. The compost accumulates throughout the year, and is transported to garden sites to enrich the meager soil.

The basic unit of social organization is the patrilineage, which is the organizational principle that guides inheritance and residential, production, and consumption activities. A typical compound consists of several households of different brothers, each composed of a man, his wife, and his children. In the dry season, family members work together in a common field, but as brothers and sons reach maturity and marry they may acquire separate plots of land, where they may work in their spare time to supplement individual income. During the rainy season, family members consume the compound's harvest, but in the dry season, each adult male and his nuclear family are expected to fend for themselves. A series of cross-cutting age grades and communal work groups (*tons*) are an important basis for organizing villagewide labor activities.

Dogon villages are usually organized around a palaver shed (*toguna*), where village elders and other authority figures meet to discuss village affairs. Villages are typically subdivided into wards, often located at a considerable distance from each other and separated by crevices and faults. The number of wards varies, usually between two and five wards, depending on village size. Ward members are linked by kinship relations and, with the exception of spouses and other affines, most inhabitants bear the same family name.

Dogon society is highly diversified and stratified, with various decision-making centers. Seniority plays an important role in determining political power and status. Senior members of founding lineages (*ginna*) generally hold the most important positions of authority, such as that of village chief. Many Dogon practice traditional animist religions; less than half have

become Islamicized, and even fewer have converted to Christianity. In many cases all three belief systems coexist within the same communities or households. In animist villages, the *Hogon* is the supreme ritual and political authority, and his decisions are made with the assistance of a council of village elders. In addition to free Dogon (*dibón*), a number of villages contain members of different occupational castes (*nyânyo*): praise singers (*saké*), leather workers (*djon* or *kossodjo*), cobblers (*gogoné*), and blacksmiths (*dembé*). Many villages also accommodate Fulbe populations, most of whom are pastoralists who take part in seasonal transhumance through the Dogon area. For the most part, Fulbe are excluded from decision-making processes.

Many villages also have committees and commissions created to address the needs of specific interest groups. Dam commissions, women's groups, and youth age grade organizations all serve as bases for mobilizing community support and for acquiring the funds (usually through dues) needed to address members' concerns. The management capacity of these groups varies considerably, and only a few have literate treasurers to keep accounts and the capacity to sanction rule violations. Nevertheless, these groups have the potential of providing the basic structure needed for organizing programs involving community participation.

The Dogon are essentially patriarchal and women occupy few positions of authority. Notable exceptions include traditional and introduced midwives, the wife of the village chief, and the president of village women's committees, where these exist. Nevertheless, the involvement of women in villagewide decision making is normally limited.

Throughout the plateau, Dogon have been greatly affected by seasonal and permanent migration. Appendix L, Table 2 provides some insights into the reasons for and destination of Dogon migrators. Permanent migration occurs year-round, while seasonal movements occur most frequently during the dry season. Dry-season migrants return to their home village in the rainy season to assist with agricultural tasks. In both cases, most emigrants are male youths between the ages of 18 and 35 who go to towns and cities, such as Bandiagara, Mopti, Sikasso, Ouagadougou, and Abidjan, because of insufficient employment opportunities and low levels of labor remuneration at home, and the desire for economic independence.

For the most part, Dogon view seasonal emigration as positive. Through remittances, emigration provides rural families with an alternative source of cash income, which helps to pay taxes and provides an important buffer in years of drought and crop failure. Seasonal emigrants have also been instrumental in introducing innovations in their home villages: they are often the first to recommend the construction of latrines to improve health conditions. Permanent emigration, on the other hand, is considered to be negative. In some cases families may continue to pay taxes and hold land for family members who have been absent for as long as 40 years. In some cases, entire villages have resettled to Sikasso or the Seno Plain in search of better land and more regular water supplies.

Low literacy levels, poor roads, and the plurality of Dogon dialects impede information flow and limit the number of available communication networks. Dogon relay important information both within and between villages orally by messenger.

2.1.2 Water

"Di yal wo, kini wolo."
"Without water, there is no life."
—Dogon Proverb

As this proverb implies, water (*di*) is an essential factor in the formation and survival of Dogon villages. Dogon establish settlements only where water has been discovered; thus, the origins of most villages are intimately connected with water sources. Similarly, the disappearance of water requires resettlement. Years of drought have caused numerous springs and streams to dry up, forcing whole villages to relocate, usually to lower lands, in search of more permanent water supplies (e.g., Songo, Arou, and one-fifth of Koundou-da). As the main constraint in village survival, water is the single most valuable resource in the Bandiagara Plateau.

Because the rock plateau has a very low water table, each Dogon village is generally forced to rely on water from a number of different sources. Every village requires a potentially permanent water supply. Some of the most common supplies are pools of rainwater that have collected in a series of open faults or fracture lines in the rock surface of the plateau. These pools may be as large as 20 m by 4 m, are often algae covered, and because of their substantial surface area are exposed to evaporation. Natural pools such as these may be used by anyone within the village territory.

A second source of water is subsurface water that collects in hand-dug holes, sumps, or traditional wells. Many are essentially natural sources of water that collect run-off during the rainy season, and have been deepened by farmers in an attempt to pursue the receding water level. Others are entirely man-made and dug over several years during the dry season. Whatever a sump's origins, precipitation determines sump water availability in any given year. Water holes dug in the beds of watercourses are generally open to anyone for use, whereas those dug by an individual or group are considered private property and may be exploited by nongroup members only upon request.

Small springs that trickle out from between rock layers and flow down to lower elevations are a third common supply of water. Some provide yearlong supplies, but many that were once thought to be permanent now flow only during the rainy season, due to successive droughts.

Among the temporary sources of water in the Dogon Country are seasonal streams that flow through valleys between May and October but dry up shortly afterward. During this season, shallow puddles of rainwater also collect in hollows on rock surfaces.

For the most part, newly introduced water sources, such as wells and dams, coexist with rather than supplant these traditional water sources. Appendix I, Table 1 provides a list of some of the principal water sources and what they are used for in the villages studied.

2.1.2.1 Water Uses

The quantity and distribution of water influence crop yields, animal growth, and living conditions. Naturally, water quality directly affects the general state of health.

The Dogon conceive of water as a resource used in two general domains, depending on its use. Water for agricultural pursuits is mostly a male domain, and includes rainwater used in rain-fed millet cultivation and river, spring, or rainwater used for irrigating crops. Water for domestic use, such as drinking, bathing, and laundry, is considered mostly a female domain. These different spheres have important implications for the definition of target populations to which development projects in agriculture, potable water supply, or hygiene might be oriented.

- Water for Agriculture (*di gidi*)

The Dogon main subsistence activity is rain-fed cultivation of staple grains, principally bulrush millet, and to a lesser extent, sorghum, fonio (*digitaria exilis*), and rice. This activity occurs during the rainy season, between May and October, and throughout this period is given priority in labor allocation. Family members who have migrated during the dry season return to their villages to assist in millet cultivation. Dogon accord priority to rain-fed agriculture because it provides for the subsistence needs of the compound from one rainy season to the next.

Once the harvest is completed (October), each household looks after itself and must attend to its own consumption needs. Younger family members who do not have their own fields must purchase grain to eat until the next rainy season begins. These seasonal differences in labor and grain supply make vegetable gardening and marketing a crucial means of survival for all Dogon, and land-poor villagers in particular.

Although secondary to millet cultivation, dry-season market gardening is virtually the only source of income in the plateau region; most vegetables are sold to purchase grains needed to supplement the millet harvest. For this report, however, gardening is most significant because it, more than any other activity, has been profoundly affected by dam construction.

The most important vegetable that Dogon grow is the small white onion (*Allium cepa*). This appears to be an ancient practice, and some evidence exists that onion cultivation in the area predates colonial discovery ("Bulletin Agricole" in Eskelinen, 1977; Bouju, 1984). Other common vegetables include sorrel or "dah" (*Hibiscus sabadariffa*), eggplants (*Solanum melongena*), hot peppers (*Capsicum frutescens*), squash (*Cucurbita pepo*), melons, calabash, tomatoes, and tobacco.

Proximity to existing water sources rather than to village settlements determines the location of garden sites on the Dogon Plateau, in order to facilitate hand-watering of vegetables. Gardens are located adjacent to water sources and are of two basic types: full soil or artificial soil gardens. Full soil gardens are often created in fields after the millet has been harvested and consist of small beds of soil bordered by earthen dikes on relatively flat terrain. Protected from animals by stone walls or thatched fences, full soil gardens are generally irrigated with water obtained from water holes and natural springs.

Artificial soil gardens, built upon bare rock, are perhaps the most striking example of Dogon ingenuity and industriousness. These plots, surrounded by stones, are made of soil that has been brought from some distance, mixed with organic compost and debris, and surrounded by small stone walls to prevent runoff. These plots require special care in watering, since excess pressure can easily wash the soil away. Artificial garden plots present a rare case of how tenure rights to soil and land do not necessarily coincide.

Onion gardening begins in October (although some seeding may begin in September) and watering of the crops begins the same day or the day afterwards and continues on a daily basis. Some vegetables are cultivated in small garden plots during the rainy season. Watering is the most arduous task in onion cultivation because of its duration. Able-bodied men, women, and children leave for the gardens by about 6:00 a.m. Using a calabash (*sadia-kodjon*), gourds (*djogou*, *saballe*), or a ceramic water jar (*deyn*), the gardener descends to the level of or into his water supply, fills the container, and then climbs back out to water each bed by spraying. The amount of water required in onion cultivation depends upon the particular stage of onion growth but, by some estimates, averages about 9.4 liters per m^2 or 94 m^3 per hectare per watering, twice a day (Eskelinen, 1977). This figure does not take into account the spillage that occurs when water is carried from the water source to the plots, which may be located anywhere from 2.5 m to half a kilometer away. As the water level drops, farmers must descend even lower into the sumps in order to fill the container. Where permanent water sources exist, such as springs, hand-dug canals are sometimes used to transport water to the gardens and to adjoining holes, from which water is drawn for spray-watering.

Several factors are crucial to market-garden irrigation. One is labor availability. The regularity and duration of watering which vegetable plots require present a labor constraint because vegetable cultivation begins at the same time as the millet harvest. The fact that early onion crops receive higher prices constitutes an additional economic pressure to begin onion cultivation as early as possible. Larger families generally divide up to allow the simultaneous performance of millet harvest and vegetable irrigation tasks. Small families, however, generally do not have this luxury.

A second factor in market garden irrigation is proximity to a water source. This is critical because gardens are hand watered. Universally, land located closest to the water source is of highest value and is generally controlled by senior members of the village, be they lineage chiefs or elders. In contrast, the plots of junior lineage members and of residents from

neighboring villages who have borrowed land are usually located at some distance from the water source. Proximity also seems to determine plot size, since larger plots located closest to the water source can be irrigated more easily with the same labor required for smaller plots further away.

Thirdly, in contrast to millet cultivation, market gardening is essentially an individual and male pursuit. In several areas, 79 percent of all males age 15 and above are active in gardening (Eskelinen, 1977). Although women may also participate in this activity, in most areas, women are excluded from owning their own plots due to inadequate water supply and to the patriarchal system in which males are the focus of income-earning activities. Women do, however, work on their husbands' plots and sometimes receive small profits by selling the produce. In some areas, men have rights to the bulb and women to the green shoots of the onions, providing an additional source of income to women.

Indeed, farmers claim that the main constraint to the expansion of gardening is inadequate water supply. Of all the resources within a village territory, water for irrigation is the most valuable and is associated with clearly defined usage rules. Each village territory consists of a collection of water, land, soil, and other resources that determine the location of fields and residences. The boundaries of the territories are clearly demarcated by tradition. All natural resources found within their frontiers and all improvements made to these resources are intended for the use and benefit of village members. The resources within the territories are, in turn, divided up into many plots, which are exploited in common by members of distinct lineages. Access to irrigation water determines the value of the other resources within a territory and, in fact, governs the organization of space.

- Effect of Small Dams on Dogon Life

By providing a more regular supply of irrigation water, small dams have revolutionized Dogon life. Dams make cultivation possible in lands that had once been marginal and of little value. They allow individuals with prime fields to cultivate larger surface areas with less labor. Dams also permit cultivation during the dry season, a period in which agricultural activities would otherwise be limited. Through their contributions to agriculture and especially market gardening, these water control structures have transformed Dogon definitions of space and time.

As in the case of traditional water sources, farmers usually descend to about knee level into the dam and carry water out with calabashes or ceramic jars. For dams that only retain water through part of the season, farmers are forced to descend further and further into the riverbed as the water level recedes. When water level is extremely low, farmers dig holes in the riverbed and drop into these to collect extra water.

Aside from providing irrigation water, dams are perceived as bringing many other advantages, although they were unintended in the dams' design. Dams permit fish cultivation, the

propagation of lilies for consumption, the creation of recreational swimming areas, a source of drinking water, and a place to water animals. In areas where dams have produced increased siltation, the new soil is also considered to be a benefit to villages owning the land, as it is transported and used for vegetable cultivation. All villagers of the territory in which the dam is constructed are permitted to use dam water for these secondary purposes.

Dam water for irrigation, however, is governed by strict usage rules and, as a consequence, dam construction often contributes to disparities between water-rich and water-poor wards and villages. Only wards and villages with territories that adjoin a dam site have the right to use its water for irrigation. Where water supply and available arable land exceed village demand, outsiders may acquire a loan of land near the dam site from the village chief. However, dam construction often benefits surrounding villages unequally. Although it is close by, the village of Korou, for instance, is excluded from using irrigation water from the Korou Dam because the stream is located just outside its territory and belongs exclusively to the more distant village of Dourou, whose residents also have access to two other dams. Korou residents may only irrigate using water from a small stream, which appears to have little potential for the construction of water control structures.

In addition to intercommunity disparities, villagers attribute other problems to the existence of dams. The residents of numerous villages studied asserted that dams produced changes in watercourses that resulted in the obstruction of roads. As a consequence they are forced to walk much longer distances to reach their fields or health and government services. A second problem, which Songo women identified, was that the dam caused all of the largest, ancient trees (e.g., Baobab, Silk Cotton, Tamarind) to die. These trees had been an important source of fruit, condiments, firewood, and medicines for which the Dogon have been unable to find appropriate substitutes.

Despite these problems, Dogon claim that dams have had an important positive influence on their lives. Villages without dams request them, villages with poorly or nonfunctioning dams seek assistance in repairs, and villages with dams associate them with prosperity and well-being. For the most part, villages with functioning dams claim that health has improved since they were constructed. It is unclear, however, if this perception is due to the general association of dams with well-being, an actual improvement of nutrition, or better hygiene because of greater availability of water. Whatever the reasons, the idea of stopping dam construction because of potential health risks is anathema to the Dogon conception of development and improved quality of life.

As with the construction of dams, other new water sources also occasion changes in land values and give rise to tenure disputes. In Vaou, for instance, the discovery of an artesian well produced a dispute between the landowner and other villagers. In the end, the land was redistributed among villagers and the landowner received a larger parcel or some other form of compensation.

- Water for Pastoral Use

Water scarcity makes watering of animals the most arduous task of livestock herders. On the plateau, sheep, goats, cattle, and donkeys are watered at dams and natural sumps, usually at some distance from the village. These animals frequently descend into ponds and faults to drink. In some areas, different water sources may be classified for animal consumption or for human consumption, but as the dry season progresses, the distinction between these two types often becomes blurred.

Although most Dogon herd their own animals, some entrust them to Fulbe herders, who acquire all the milk produced in return for their services. Where water scarcity is a real problem, Fulbe herders take Dogon herds on a northeasterly transhumance to the Niger Delta. In addition to Dogon-owned animals, many Fulbe herds visit the plateau on seasonal transhumance; these animals are permitted to graze on millet remains because of the rich manure they deposit on farmers' fields. The presence of Fulbe herders in many communities introduces a potential vector for disease transmission.

- Water for Domestic Use

Water for domestic use is principally a female domain, as women are responsible for fetching water for drinking, bathing, laundry, and most other household uses. As a rule, women tend to use the closest water supply which in many areas requires walking and climbing long distances over extremely steep rocky terrain. Appendix I, Table 2 represents household water consumption and fetching and storage practices in the villages studied. These figures are based on rainy season estimates; the quantity consumed is said to be somewhat less during the dry season. Women use a variety of containers to hold water, including rubber well bags, narrow-mouthed gourds, and metal buckets. Able-bodied girls and women usually fetch water for the consumption of their own households, although in some villages, women of numerous households of a common lineage fetch water together, store the main supply with the senior household, and transfer smaller quantities into separate containers for their own household's consumption. Both processes usually involve transferring water to two or more consecutive containers. Women claim to fetch water only when the existing supply is depleted and to rinse the containers before each filling, but observation showed that this was not always the case.

Whereas rights to irrigation water are carefully guarded, most water to be used for domestic needs is considered to be common property and may be exploited by both villagers and nonvillagers, even when it comes from a dam. Some villages use all water sources indiscriminately; others distinguish between water sources destined for drinking and those for other purposes. For example, one pond may be used for drinking water (*di nod f*), while an adjacent pond may be used for bathing and washing utensils and clothes.

Water sources used for all types of domestic consumption vary greatly from season to season, as numerous temporary ponds and puddles formed by rainwater become sources of drinking

and bathing water. As water supplies become limited during the dry season, ponds that were dedicated exclusively for drinking water may also be used for irrigation, watering animals, or bathing. It is significant to note that this proliferation of water sources during the rainy season coincides with a marked increase in diarrhea, malaria, Guinea worm, and rashes associated with schistosomiasis.

Based on the volume of the water containers and self-reported data of the number of times the containers are replenished daily, the team determined that the average amount of water used by Dogon for domestic purposes ranges from 15 to 30 liters per person per day. The average is about 23 liters per person, with roughly one-third being used for drinking and two-thirds for other domestic uses. These figures do not include water used at nearby streams and puddles for bathing and laundry.

When drinking water and water for other domestic uses come from different sources, quantities are usually stored in different containers. Otherwise, the household water supply is usually held in narrow-lipped ceramic bowls. Most of these bowls are kept in a kitchen in the house, although in the rainy season they may be left open outside to catch extra rainwater. Despite the abundance of flies, there seem to be few rules about covering stored water; both covered and uncovered containers were observed. Covers are usually metal dishes or are made of wicker. Some women complained that they had nothing with which to cover their storage jars.

The presence of pumps and improved wells greatly facilitates women's work, though in many cases these may also be located at a considerable distance from the settlement. Among the other disadvantages of improved wells that women cited were bad taste (due to metallic pipes), short or fragile cords, cost (750 to 1000 CFA), and scarcity of rubber well bags, forcing some families to wait their turn to borrow well bags from other families.

Women consider accessibility and taste as the principal criteria for selecting drinking water sources. Sweet tasting ponds or springs that have been used for generations are often the preferred drinking water sources, even when these are a known source of Guinea worm. In Dourou-tanga, a ward renowned for the prevalence of Guinea worm, villagers continue to take sweet tasting drinking water from a traditional seasonal spring, Kametutúru, even though an improved well is located even closer to the village and a Peace Corps Guinea worm volunteer lives in a nearby village. For the most part, farmers working in their fields and gardens also select accessible and tasty water sources, though in at least one case, farmers brought well water with them to the field to drink during the day.

Even though Dogon generally prefer traditional sources of drinking water, when a sweet tasting, easily accessible improved well is installed, the results are dramatic. In Korou-na, for example, women claim to take drinking water only from the improved well and use two other

traditional wells for bathing, laundry, and dish washing. The two types of water are stored in separate containers. In 1989, the year after the Catholic Mission installed the improved well, Guinea worm disappeared.

Although rarely employed today, filters (*di teguru*) to improve potable water quality and prepare certain foods and beverages were traditionally used by Dogon people. This practice is demonstrated by this popular riddle:

Q: *"Neme di le mogozi. Din injele mogozi?"*
One cleans dirty things with water. With what is water cleaned?

A: *"Din yagire le mogozi."*
Water is cleaned by filtering.

Traditional filters usually consisted of a basket or an old perforated metal container placed above a ceramic jar and filled with millet husks. Some also contained layers of ash or sand. The purpose of these filters was less to purify water than to strain out the worst of the debris. Many villagers claimed that they no longer use filters because they now have clean water sources or because they have fewer diseases than before. Nevertheless, some filters (*tommo*) continue to be used to make ash *potasse* for a popular dish (called *to*) or for millet beer.

A number of years ago the Hygiene Service attempted to introduce sand, charcoal, and gravel filters, but villagers found the process too labor intensive, particularly because the sand and charcoal required for the filters needed to be changed regularly and could be obtained only at great effort and expense. More recently, the Peace Corps has attempted to introduce nylon filters in their Guinea worm eradication program. Some of these have been attached to traditional sieves (*tami*) used for straining millet flour. The success of these efforts has also varied, principally because most women do not draw the connection between ingesting water and Guinea worm. Some women also claimed that the *tami* were not always easily available or, at a cost of 125 to 200 CFA apiece, were too expensive.

As a result of the Peace Corps and Hygiene Service Guinea worm campaign, many women have begun to use improvised filters. Sieves covered with loose-mesh net cloth are common but ineffective. Women's head ties are also used to filter drinking water. Women do not always discriminate between the types of fabric used, although both Peace Corps and Hygiene Service personnel encourage them to use the tighter woven materials. Women dip the cloth in water, making it easier to stick to the recipient, and then pour water through. Afterward the cloth is left in the sun to dry, to be reused later. The Hygiene Service maintains that this is the most appropriate form of filtering for the Dogon and claim to have instructed women to draw a point on one side of the head cloth before it is dipped in the water to ensure that the underside does not become contaminated. The Peace Corps does not encourage the practice of dipping the cloth in the water prior to filtering. With some experimentation and a carefully

run extension program, improved water filters would probably be adopted given that Dogon use an equivalent technology in traditional beverage and food preparation.

To motivate residents to take drinking water only from improved and tested wells, some villages have instituted a system of fines for water usage violations. These fines can amount to 2,000 CFA per person per violation. Hygiene officials assert that these regulations are internally generated by village councils and that the proceeds are kept in a village *caisse* for the benefit of all residents. Nevertheless, many villagers appear to be clearly dissatisfied with these regulations, suggesting that they provide an opportunity for officials to extort money from villagers.

2.1.2.2 Significance of Water Use for Health and Hygiene

Water use and scarcity have a major impact on the state of health and hygiene on the Bandiagara Plateau. Three factors in particular are crucial to community health. One is water contact. Farmers everywhere come into regular direct contact with dam and pond water in the performance of their daily subsistence activities. Farmers remain for hours, knee-deep in water while deepening ponds and fetching irrigation water. In many areas, villagers have to walk through streams and ponds to reach their fields or visit family.

This water contact seems to be unavoidable. Failing the introduction of hundreds of small bridges and very cheap, labor-saving, sustainable, and universally available alternatives, farmers are forced to come into contact with water to irrigate their gardens and to travel. As long as clean, safe, sweet tasting (this is a translation of the local word, which implies pleasant or good tasting), and easily accessible water supplies remain scarce, children will continue to be exposed to schistosomiasis as they bathe in dam reservoirs and streams, and women will continue to fetch water from sources that spread Guinea worm. Part of the solution to the water contact problem, then, clearly is the introduction of clean, abundant, accessible water supplies. Only then could appropriate technology and training be introduced to reduce some of the behavioral constraints.

A second factor relating to the water use and scarcity is poor hygiene practices, particularly among certain segments of the population, occurring when water is scarce. Women and children appear to suffer most from poor hygiene. Men often bathe at home with water that their wives have obtained for them. In the rainy season, able-bodied women and children frequently bathe in shallow puddles on rock surfaces, ponds, streams, and dams. However, this type of washing is impossible in the dry season. Because carrying water is such an arduous task, men tend to receive priority in using household bathing water and women and children attempt to bathe when it is convenient. Not surprisingly, women are those who most suffer from lice. Women wash small infants daily with some of the household bathing water, but children between the ages of 5 and 15 do not receive this attention and seldom wash themselves more than once or twice a week. Many of these children can be seen with nasal and eye discharges that attract flies and remain uncleaned for hours or days. In villages that

have them, dams offer an opportunity for better hygiene as an important source of bathing water, particularly for children of this age group.

Dogon often wash their hands only before meals or after defecation; soap is a luxury and is rarely used. There is a considerable risk of oral-anal contamination, particularly among children above the age of five who are responsible for their own hygiene. The lack of latrines and infrequent handwashing contributes to the spread of oral-fecal diseases.

Seasonal changes in water supply are a third factor in water use and scarcity, making water contact behavior difficult to control. In villages without dams, children become exposed to schistosomiasis especially in the rainy season, when they bathe at seasonal streams and puddles producing rashes related to *cercariae* penetration. During this period, villagers also obtain drinking water from many other sources that are difficult to protect from contamination, hence the prevalence of Guinea worm and diarrheal infections during this period.

These points demonstrate that women are key to the success of any development project aimed at improving water, sanitation, or hygiene. They obtain water for domestic uses, are responsible for nutrition, and teach their children hygiene. In some villages, discrepancies between male and female responses to the questionnaire suggested that, with the exception of irrigation, men did not really know which water sources were used for which purposes or from where household drinking water came.

2.1.3 Hygiene Practices and Beliefs

Dogon compounds contain thatched or walled enclosures used for urination and bathing. When far from the village, Dogon urinate wherever it is convenient or private (in the case of women).

Many Dogon believe that body products (e.g., fingernails) and excretions have contagious properties and can be used in magic aimed at the person from which the product emanates. For fear that their feces will be used against them in harmful "medicines," many Dogon attempt to be as inconspicuous as possible when they need to relieve themselves. Others consider defecation to be a shameful activity and something that should be hidden and as unobtrusive as possible, even among family members. Residents of a few villages said that defecation is a natural bodily function that need not be hidden. These beliefs have important implications for defecation practices and the potential acceptance of latrines in Dogon areas.

Most villages have no latrines, so residents defecate in the bush or in the area surrounding the village, sometimes within 10 m of the house. Usually, however, defecation takes place at a distance of some 50 m or more from the village, with the exception of children, the elderly, and the infirm (Eskelinen, 1977). Most people tend to defecate in the early morning or evening hours; therefore, the tendency is not to go too far from the village. While working in the fields, defecation is often permitted only in uncultivated areas. Residents of a few of the

larger and more accessible villages claimed to take water with them to clean themselves following defecation, but none used soap. Most others, however, use sticks and stones, or wait to bathe when they return home. Little children defecate in the house and are cleaned with the mother's bangle. The fecal matter is then covered with dirt and swept away. When children reach the age of six or seven, they begin to accompany their parents to the bush and learn about appropriate defecation sites. Children of this age and older are said to be less careful about washing after defecation; anal scratching suggests that this is an important source of oral-fecal contamination. Privacy and convenience are the two main considerations in the selection of a defecation site. Appendix J, Table 1 provides data on these hygiene practices.

The location of bush defecation sites varies considerably from village to village. The team observed sites both at higher elevations and lower elevations from settlements. Some of these were located near rainwater pools and other seasonal supplies of drinking and bathing water. Defecation sites located above the village present a risk of contaminating settlements and water sources located downhill from rainwater flow.

Very few wards have latrines; those that do exist are usually associated with public services, such as schools or rest houses. As Appendix J, Table 2 shows, the rare cases of privately owned latrines belong to village chiefs, merchants, midwives, government functionaries, or families with members who had migrated to urban areas for some time. Children begin to use the latrines when they are about 14 or 15 years of age, since before then they are said to disregard the hole, taking advantage of the privacy to relieve themselves.

Dogon beliefs about the magical properties of feces suggest that they would be hesitant to adopt latrines. The team speculated that communal latrines would be easier to introduce since the waste of many villagers would be mixed together, making it difficult to identify the target for a victim of magic. Family latrines, on the other hand, would provide an easy means for enemies to attempt to eliminate an entire lineage.

Contrary to the team's theory, however, most Dogon villagers seemed interested in the idea of establishing latrines, particularly if this could be done on a family-by-family basis. The main advantages cited were privacy, convenience, easy access (particularly for the ill and elderly), and social status. Villagers without latrines stated that the main obstacles to their construction were expense and lack of materials, labor shortages, difficult maintenance, insufficient space, and inadequate know-how for construction. The main problems cited in villages that already had latrines were unsanitary conditions as a result of improper use, especially from children missing the hole, and hesitancy in sharing the latrine with children and nonfamily members. With the exception of school latrines, children are generally permitted to use household latrines only when they reach about 12 to 14 years of age.

2.1.4 Local Perceptions of Illness and Health

"Indé konou selé loulo la ya."
"Illness is the enemy of humankind."
—Dogon proverb

Dogon perceptions of disease causation and treatment are intimately connected with beliefs in supernatural forces. The High God (*Amma*), Allah, and bad luck (*dougo*) are frequently reported as the cause of maladies. This association with uncertain and unforeseeable forces reflects a somewhat passive attitude toward disease and other dilemmas generally considered to be beyond human control. Nevertheless, Dogon populations have developed a number of traditional remedies for some of these afflictions, and villages exposed to regular health services usually have a slightly more developed sense of disease causation. The presence of numerous traditional healers and the coexistence of animism, Islam, and Christianity also offer sufferers some psychological consolation and alternatives to homemade remedies. Appendix K provides tables on local perceptions of causation, treatment, and change for the major diseases studied.

The Dogon language contains words for a wide number of illnesses and afflictions that are endemic to the area. Table 2 provides Dogon equivalents for some of the afflictions deemed relevant to this study.

This table shows that Dogon categories of disease do not correspond directly to English terms. For the most part they focus on single symptoms rather than on a collection of symptoms associated with specific causes. The first five diseases listed are significant for this study, although they do not always coincide with what Dogon consider to be the worst illnesses. Depending on the village, diarrhea, Guinea worm, chicken pox, rheumatism, sickle-cell anemia, schistosomiasis, and malaria were considered the most serious health problems. In aggregate terms for nine villages, local perceptions of the worst diseases in descending order were diarrhea, schistosomiasis, malaria, eye infections, Guinea worm, measles, skin infections, coughs, and sickle-cell anemia (see Appendix K, Table 1). Given that onchocerciasis has been eradicated, interviews with 48 women about diseases among their 174 children yielded data on Guinea worm, schistosomiasis, diarrhea, and malaria. A summary of these data is provided below in Table 3 and form the basis of the statistics provided in the following subsections.

2.1.4.1 Guinea Worm

Because of its clear symptoms, Guinea worm is one of the diseases that Dogon diagnose most easily. Perceptions of causes vary greatly depending on exposure to health services. Appendix K, Table 2 provides data on perceived causes, treatment, affected population, and changes in Guinea worm prevalence in the study area. Many villagers, either in afflicted or eradicated zones, see no direct association between water ingestion and Guinea worm, particularly

Table 2

Dogon Disease Terms

Illness	**Dogon Term**
Guinea worm	*téguele, yoró, yolo*
diarrhea	*kolosále* ("runny belly")
bilharzia	*ndiari tentén* ("tinted urine")
malaria/fever headache	*godunomó* ("hot body"), usually accompanied by body and headaches *Koudjin*
eye infections/onchocerciasis simple eye problems conjunctivitis	*gridjɾn* *girdjɾn sála* *apollo* (believed to have been brought down by the space shuttle)
intestinal parasites big worms in feces small worms in feces	*soudi* ("worms") *susún, kikébu* *odjɾ*
skin infections/rashes	*godumenou*
lice	*cou semé*
red hair (due to illness or malnutrition)	*kinguele bane*
night blindness	*nyanganyama* (*pinki*, Fulbe)

Table 3

Disease Statistics

Village	Sample size	GW	%	Schisto	%	Diarrhea	%	Malaria	%
Dourou-tanga	12	4	33	11	92	1	8	—	—
Korou	18	0	0	8	44	2	11	—	—
Yamé	31	0	0	31	100	7	23	7	23
Koundou-da	29	0	0	29	100	2	7	—	—
Nandoli	12	*0	0	12	100	4	33	12	100
Songo	14	*0	0	2	14	3	21	4	29
Vaou	19	0	0	4	21	1	5	5	26
Kori-kori	39	*0	0	12	31	8	21	13	33
Total	174	4	2	109	63	28	16	41 (sample 115)	36

* Denotes villages with Guinea worm, but with no cases in sample studied.
Key: GW = Guinea worm; schisto = schistosomiasis.

because of the long gestation period. Rather, walking in infected water, witchcraft or spells cast by jealous family members, or God are common explanations for the malady. In some Peace Corps villages, women had been told that Guinea worm was caused by ingesting contaminated water and had begun to use water filters on a limited scale, even though they still doubted the connection. In some places where improved water supplies have been provided (e.g., Korou), the results have been dramatic and the population is well aware of the causes of the disease. More often than not, however, even with improved water sources, villagers continue to drink from contaminated seasonal water supplies during the rainy season, and progress is slow (e.g., Songo).

Guinea worm is said to be common in three of the eight villages studied, but a sample of 174 children revealed only four cases, all of which were found in a single ward, Dourou-tanga. Four of the villages had not had a case of Guinea worm for a number of years. Women interviewed in one village (Kori-kori) mentioned three Guinea worm cases, but these were believed to have resulted from water sources used during travel outside of the village.

Guinea worms erupt during the rainy season, the agricultural season in which labor demand for subsistence is at its highest. Farmers claim that the debilitating illness has a significant

economic cost, since it seriously reduces productivity by hindering most physical activity. Depending on the number of worms and their location, sufferers are often unable to work or walk at all. Because of this drain on labor, large households with an available substitute work force appear not to suffer quite as severely as smaller households.

The population that is said to be most affected by Guinea worm varies greatly from village to village. In many villages, Guinea worm affects all social categories equally, with the universal exception of nursing infants. In Dourou, one ward (Dourou-tanga) had an exceptionally large number of sufferers, undoubtedly because of a contaminated water source. Similarly, in some areas, certain compounds or families were said to be more affected than others. In still other villages, men or children were said to be the major victims, suggesting that choice of drinking water sources varied by age, gender, and household. Efforts at eradication would have to take these demographic factors into account, especially household consumption patterns.

Dogon usually treat Guinea worm by puncturing the blister where the worm is to emerge, rubbing the area with shea butter, often mixed with medicinal leaves, and covering the area with a cloth. Over a period of weeks, the dead worm and pus slowly ooze out of the sore. Dogon say that Guinea worm sufferers try to avoid water contact at this time because placing the affected area in water, especially cool water, is extremely painful and can produce infection.

If local perceptions can be considered accurate, residents of all affected villages have noticed a marked decline in the prevalence of Guinea worm (see Appendix K, Table 2). In several cases, eradication occurred spontaneously, without any campaigns or behavioral changes. In others, the decline was associated with improved well construction, well treatment, filters, and sanctions against drawing water from contaminated sources. In addition to these measures, a logical first step to eradication would be prohibiting Guinea worm sufferers from coming into direct contact with unimproved drinking water sources. Another solution which would help to mitigate this problem would be the introduction of appropriate nylon-mesh water filters, circulated initially by local NGOs or Peace Corps volunteers.

2.1.4.2 Schistosomiasis and Skin Infections

Skin infections are included in this section on schistosomiasis because the most common skin problem mentioned by villagers was described as "a rash-like eruption over the entire body affecting children immediately after swimming in freshwater sources" (see Appendix K, Table 3). This description, given by Dogon from many villages, suggests that the rash is associated with the penetration of *cercariae* following exposure. These rashes are said to be particularly frequent during the rainy season. Infectious boils associated with poor hygiene and eczema were other skin infections mentioned, but were of a secondary nature. The team documented no traditional remedy for any of these skin problems.

Schistosomiasis is a particularly insidious disease in Dogon Country because its apparent symptoms (blood in the urine) are associated principally with one particular age group (children ages 5 to 15). This fact suggests that children become exposed to the disease when they are first able to swim and play independently in nearby water holes. The overall rate of schistosomiasis in eight villages studied was 63 percent. In a sample of 174 children, this rate ranged from 14 percent in Songo to 100 percent in Koundou-da, Nandoli, and Yamé. Although the conclusions from this random sample are tenuous and the results are highly variable, the highest schistosomiasis rates were generally found in villages with working dams and nonfunctioning dams (Yamé, Koundou-da, Nandoli, and Dourou-tanga). The lowest rates were in villages without dams (Songo and Vaou). Two villages exhibited medium rates of the disease: Kori-kori (31 percent), with a partially functioning dam, and Korou (44 percent), without rights to a dam for irrigation but with one in the vicinity used by children for swimming. Only one village, Arou, had no reported cases of schistosomiasis among its 18 inhabitants, but this is an exceptional case for many reasons (see Appendix H). These results suggest that the prevalence, but not the presence, of schistosomiasis is related to dam construction.

Because the disease is so widespread (in most areas it has existed as far back as the elders can remember) and because the evident symptoms eventually disappear, many Dogon do not consider schistosomiasis to be a disease and rarely seek treatment for it. In these places, blood in the urine is thought to be sent by God or is almost considered to be a necessary rite of passage for children. Other villages recognize schistosomiasis as a disease because children experience so much pain when they urinate or because people who have urinated blood in their youth never become very strong. Only two of the nine villages (Dourou, Kori-kori), both with school and health services, correctly associate schistosomiasis with water contact. Most Dogon interviewed said they knew of no treatment but that the disease eventually "cured itself," although three villages mentioned herbal folk remedies and dispensary pills said to have variable results. Appendix K, Table 3 provides data on Dogon views of schistosomiasis causation, treatment, and epidemiology.

Reducing water contact and preventing people from urinating in standing-water sources, the behavioral solutions to schistosomiasis, would be very difficult to implement. Such a program would require intervention on a regional scale in the many, isolated villages where small dams have been built. Heat and water scarcity make swimming in infected areas an important means for children to bathe, cool off, and enjoy themselves. Children urinate where they swim. Unless alternative, uninfected water supplies are provided, dam sites will continue to be used for these purposes. Boots or piers into the dam reservoir aimed at reducing water contact, even if affordable and made universally available, would probably be of limited effect since it is unlikely that children would have access to them.

2.1.4.3 Diarrhea

Of all the diseases that the Dogon described, diarrhea was most often considered the most deadly (see Appendix K, Table 1). Villagers were unable to identify the causes of "runny belly," as diarrhea is called, but residents of a number of villages postulated that it could be due to poor drinking water, bad food, or teething. Appendix K, Table 4 presents Dogon perceptions about this disease. Although diarrhea affects people of all ages, it is said to be particularly common among children under five years of age and is a typical cause of infant death. It is important to note here that Dogon mothers have the habit of supplementing the breast milk for nursing infants with drinking water and even mashed foods beginning as early as three months.

In a sample of 174 children, about one out of every six children (16 percent) had diarrhea during the two weeks preceding the study. During this time period, diarrhea rates ranged from 5 to 8 percent in Vaou, Koundou-da, and Dourou-tanga to 33 percent in Nandoli. These figures are probably at the high range of the scale, given that the sample focused on children and that most villagers visited said diarrhea occurs most frequently during the rainy season, the period of the team's research. Vaou and Dourou-tanga are examples of water-rich communities, but generalization about the connection between water availability and diarrheal disease should be made with caution (as the water-poor community of Koundou-da suggests). Nandoli, Kori-kori, and Dourou, all with fairly high rates of this disease (21 to 33 percent), cited diarrhea as the worst of all maladies for their communities.

Dogon employ a variety of home remedies to treat diarrhea. The most common remedy is drinking cool fresh water. Other treatments include a variety of herbal infusions (such as guava leaves, baobab fruit juice, or sorrel) and foods (millet and jackfruit). When traditional remedies fail, villagers located near health services request medication or injections from nurses. Two villages mentioned as remedies diarrhea medicine from dispensaries or the Catholic Mission. Only one village (Kori-kori) was aware of ORT, but there it was described accurately and was common knowledge to all women interviewed, probably because of the hard work of a single, diligent midwife.

Women were clearly unaware of the connection between diarrhea and fecal contamination. Some women openly admitted to giving one infant breast milk with the same hand that had just been used for cleaning another child's defecation. Diarrheal infections could be reduced through the introduction of locally made covers for water storage containers where these do not exist, consciousness-raising about the importance of covering of improved wells and keeping well bags and cords free from contamination, and training in the importance of uncontaminated drinking water sources. A long-term program of women-run and women-oriented training in basic hygiene and first aid would also greatly alleviate this problem. Traditional and government-trained midwives present in many of the larger villages would be a logical catalyst for this type of project.

2.1.4.4 Malaria

Many Dogon of all ages complained of fever and headaches, the main symptoms they associate with malaria, suggesting that the disease is endemic throughout the region. A surprisingly small number of villages (three) related the disease to mosquito bites, as Appendix K, Table 5 shows. Most had no idea what caused the disease or attributed fever to bad nutrition, insufficient water, and strenuous agricultural labor under the hot sun. One village (Korou) described the symptoms of a strange illness they said was equivalent to malaria but that they called *danâ*. The main symptom of *danâ* in infants, which is said to be most common during the late rainy season in September and October, is the rising and falling of the connective tissue at the soft spot on an infant's cranium. This symptom is said to signify an advanced stage of malaria and almost certain death.

In a sample of 115 children, 36 percent (41) had malaria-related fevers at some point during the rainy season. The highest rate was in Nandoli, which reported that 100 percent (a sample of 12) of the children had severe fevers and headaches due to malaria in the last few months. Residents of Yamé and Songo considered malaria to be the worst disease affecting their populations. In most communities, all ages and sexes were equally affected by the disease and, as would be expected, it is said to be most prevalent during the rainy season.

Once again, a variety of herbal infusions and warm water baths are traditional remedies most commonly used for malaria. Few villagers appeared to use mosquito nets, probably because of their cost. At present, Dogon with easy access to health facilities claim that "quinamax" injections and chloroquine pills are the best remedies to malaria they have encountered so far, although preventive measures may also be in order.

2.1.4.5 Eye Infections and Onchocerciasis

Dogon do not distinguish between onchocerciasis, conjunctivitis, trachoma, and other infections of the eyes. Onchocerciasis is now said to be eradicated, although the black fly continues to exist in many areas. The team observed only a handful of cases of elderly people who may have become blind as a result of this disease.

Most of the other cases of eye infections may be considered water-washed diseases, related to lack of water. Eye infections were of unknown cause and said to be spontaneous, coming and going in a few days. As Appendix K, Table 6 shows, these infections affected all social categories. A number of cases of persistent eye infections leading to blindness (perhaps trachoma) were also observed.

Two villages (Nandoli and Songo) listed eye infections among the worst diseases affecting residents. Songo was one of the two villages that had no dam or other abundant supply of water, such as an artesian well. The Nandoli dam holds water only part of the year. Although more reliable data can only be acquired during the dry season, when water-washed diseases

would probably be at their highest, these two examples suggest that water scarcity and subsequent poor hygiene are instrumental in the proliferation of eye infections. Enigmatically, it is the rainy season that is most often mentioned as the period in which eye infections abound.

The Dogon believe most eye problems to be caused by supernatural forces. A few villages treated them with herbal eye drops that had been boiled and cooled. Others used antibiotic creams obtained from health dispensaries. Better hygiene practices, particularly greater care by mothers in cleaning eye discharges in their children, would help alleviate some of these infections, such as trachoma.

2.1.4.6 Infant Mortality, Morbidity, and Other Illnesses

The most striking of all illnesses observed were those affecting emaciated infants with no single symptom or easily identifiable disease. These scrawny nursing infants no longer had diarrhea or fevers; they were just the products of repeated illness and long periods of poor nutrition and hygiene. It would seem that it is this general condition, rather than any single disease, that most takes its toll on children's lives. The following table shows that the average mortality of children as reported by mothers was 45 percent (144/319), but this figure is probably too high, due to the relatively advanced age of many of the women interviewed (i.e., it could include deaths of grown children).

A list of other illnesses and Dogon views about them is provided in Appendix K, Table 7.

Two signs indicated problems of malnutrition in many of the villages studied. One is the large number of children with kwashiorkor, apparent by unnaturally reddish hair. A large number was observed in three villages (Kori-kori, Yamé, Songo), and the problem appeared to be most prevalent among young girls of 5 to 15 years of age and nursing infants with diarrhea. Girls interviewed said they were not born that way, but that the red could not be washed out of their hair. Many of them also showed signs of stunted growth. Mothers associated the red hair in infants with illness but could provide no explanation for its prevalence among girls. In many cases, it was considered to be natural and a condition that would be outgrown with adulthood.

A second sign of insufficient vitamin intake is night blindness, an affliction that in some villages is clearly recognized as being related to poor nutrition. Depending on the village, adults, the elderly, and, above all, women are the populations most regularly affected. For the most part, night blindness was seen as rare among children, possibly because they gather and eat a variety of fruits that adults consider to be unsuitable for consumption. No clear correlation was observed between season and frequency of the illness; Dogon frequently describe it as a malady that comes and goes. The most common remedy known to Dogon is to cook beef or mutton liver, and have the patient rinse his or her face and eyes in the juice and eat the liver.

Table 4

Estimated Mortality of Children in the Dogon Country

Village	Sample Size of Mothers	Total Number of Births	Number of Deaths	% Dead
Korou	4	29	11	38
Dourou-tanga	5	24	12	50
Yamé	13	99	45	45
Koundou-da	6	58	26	45
Nandoli	3	13	1	8
Songo	4	54	26	48
Vaou	5	10	1	10
Kori-kori	12	58	22	38
Total	**48**	**319**	**144**	**45**

A number of other illnesses mentioned are indicative of poor hygiene. The most notable are intestinal parasites and lice. Worms were found to be particularly common and of two types: flat white worms and small thin round worms. These affected all segments of the population and were very common in several villages. Lice also seemed to be a problem in some areas, especially among women who left their hair plaited for long periods. Two villages said that measles was a major cause of child mortality. All villages knew of the vaccination campaigns as the only treatment for the disease. Measles were said to be most common in the dry season. Epidemics plague different villages in different years, but 1988 is remembered as a particularly bad year. Skin infections, bladder and urinary tract infections, and coughs are difficult to analyze since some of these may be secondary symptoms of schistosomiasis or other parasitic diseases. Some cases of skin and bladder infections may also be attributed to poor hygiene. Rheumatism was a common adult complaint, especially afflicting older people. Sickle-cell anemia, hemorrhoids, and constipation were some of the other widespread maladies noted.

The sample of 174 children analyzed here can only be considered a cursory representation of illness in the Bandiagara Plateau. This sample establishes no clear connection between four of the five principal illnesses (Guinea worm, diarrhea, malaria, and onchocerciasis) and the presence or absence of dams. The data suggest, however, that dams may be linked to increases in the prevalence of schistosomiasis. Clearly, more extensive research is needed to verify these findings. A dry-season study would illuminate seasonal changes in disease

frequency and provide useful insights into water-washed diseases and changes in hygiene practices in times of water scarcity.

2.1.5 The Dogon and Development

For almost 40 years, the Dogon have been receiving assistance from various outside actors, first the colonial administration and, more recently, a host of foreign donors and government agencies. This has led to mixed receptions on the part of villagers, as swarms of outsiders coming in for unknown reasons can be a bewildering experience. Numerous villages, for example, criticized state-run vaccination campaigns for not informing them properly about the reasons for the campaign or explaining why certain segments of the population were selected as opposed to others. Most villagers did not know the purpose of the vaccines they received. With experience, villagers have become extremely adept at telling development agents what they want to hear. Furthermore, the vast majority of the local representatives of these organizations are men, which necessarily contributes little to female participation. For example, in the Hygiene Service, aside from midwives, there is only one woman among the 33 extension agents, or *animateurs*. As a rule, development programs that are village based, such as the Peace Corps, or that involve long-term and repeated visits to the same village, such as the Catholic Mission, tend to be more easily comprehended, better received, and more effective.

In many parts of the world, donor considerations in formulating development programs do not necessarily coincide with village level priorities. With families, age grades, and interest groups as the basis for organizing labor, villagewide systems capable of ensuring the participation of the entire community are often only rudimentary. In the Dogon Country, however, donor priorities complement those of the villagers.

Appendix L, Table 1 shows some of the gender-based differences in development priorities from the Dogon perspective. The major development priorities of Dogon men in the villages interviewed were improved food security, either through more or improved dams or food aid in drought years, and increased water supply (in villages with nonfunctioning dams or where the only water sources were located at a great distance). Other priorities included education (in French), fertilizer, roads, dispensaries, and grain credit banks. Women mentioned more accessible water sources, such as improved wells, and management assistance in marketing local produce as their main development priorities. Grain mills, pharmaceutical dispensaries, and child care were other objectives that women mentioned.

These local development priorities show a surprising consistency between donor focus and village interests. Labor-saving devices for women (such as grain mills) may give women more free time to concentrate on child nutrition and hygiene. Improved roads also promise to have an important health and economic effect by promoting access to health facilities and markets. Over all, from their present perspective, the Dogon consider the economic benefits of dams to outweigh significantly any environmental and health disadvantages they might cause.

Too often development interventions make target villages dependent on nonlocal and nonrenewable products or leave them even more vulnerable to the circumstances of their social and physical environment than they had been before. Suggestions of new technologies and training to reduce water contact and improve drinking water sources should take these shortcomings into account.

2.2 Health Problems

The objective of this study is to determine if the construction of small dams in the Dogon region is harming the population's health. Several potential negative health effects have indeed resulted (most notably schistosomiasis), as well as possible benefits (nutrition and increased water for washing). The framework for this analysis is that first presented by White, Bradley, and White (1972) and expanded upon by McJunkin (1982). Their classification of water-associated diseases breaks the various health problems involved into four categories:

- Waterborne diseases
- Water-washed diseases
- Water-contact diseases
- Water-related diseases

This classification also recognizes the different routes of infection (consumption, hygiene practices, physical contact with infected water, and vector-borne diseases). The consultant team selected representative diseases within each category and inquired about their presence, absence, and importance in each community visited, using the village-type categories described in Section 1.1:

- Villages with working dams
- Villages with broken dams
- Villages without dams

The following is a brief description of each disease, along with the team's findings.

2.2.1 Waterborne Diseases

Although there are many waterborne diseases prevalent in the Dogon Country, the team focused on two: diarrhea (undefined) and Guinea worm.

Diarrhea

Description and treatment: There are many etiological causes of diarrhea. Diarrhea, defined as frequent watery, loose stools, is the result of the lack of adequate, safe water; lack of protection from human excreta; and contaminated food, filth, and flies, resulting in acute morbidity. In infants and children there is also the serious risk of death. Diarrhea is treated with the use of ORT—a simple, inexpensive, and standard remedy that can be purchased or made at home.

Findings: Diarrhea was a major complaint in all villages visited. Diarrhea seems to be most severe in the rainy season and at the end of the dry season, causing loss of life in infants and small children. One village estimated that one out of every two children die of diarrhea, a figure that is clearly overestimated but that indicates the perceived importance of diarrhea as a health problem. The team was particularly distressed to find, with the exception of one village, a general lack of knowledge of ORT. Diarrhea is endemic throughout the plateau but no association was found with dams. It would appear that dams would increase water supply and therefore reduce the incidence of diarrhea; however, dams are not the primary source for drinking. Rather, dam water is primarily, but not exclusively, used for washing and irrigation, thus the lack of an association.

Guinea Worm

Description and treatment: Guinea worm disease (*Dracunculus medinensis*) is common throughout the Dogon Country. The disease is obtained by drinking water containing infected cyclops, a small crustacean. The worm then takes up to one year to develop before the mature female worm pierces the skin to discharge her eggs when the wound is placed in water. The larvae infect cyclops, which when consumed by man continue the cycle (see Figure 2).

Findings: Among the villages visited, the team found several with and without Guinea worm (See Appendix K, Table 2). While the presence of a protected well may be a factor in the disease's absence, the team visited a village (Dourou-tanga) that had a protected well but where villagers preferred another, contaminated source, and a village (Koundou-da) that did not have a protected source but where Guinea worm was not present. Dams appeared to be a secondary source of drinking water and therefore are not clearly associated with Guinea worm (the Dourou Dam is adjacent to several villages, only some of which harbor Guinea worm).

Guinea worm is a seriously debilitating disease that occurs from late June to October/November. This is the critical planting and gardening season; therefore, the impact of Guinea worm is directly felt in village economies. Mali is participating in the global Guinea worm eradication program. The use of filters has already been discussed (Section 2.1.2.1), and all sorts of cloths are currently being used for the filter material, although several observed

were too porous to work effectively. Proper use of filters, health education in all villages in which the disease is endemic, and provision of safe drinking water sources are required if Guinea worm is to be eradicated.

Table 5 provides information on reported cases since 1986. It is difficult to interpret these data, as the team believes gaps in the data and underreporting to be a problem; however, there appears to be a downward trend. Twenty-five percent of all villages have dams, and 25 percent of villages with dams report Guinea worm. Anecdotal information from interviews showed some connection between improved drinking water supplies and Guinea worm eradication. This information also illustrates the benefits which can accrue with the combined introduction of small dams and a safe drinking water supply. Current practices of Africare and other donors call for provision of safe drinking water in each village provided with a dam.

2.2.2 Water-washed Diseases

This group of diseases covers those in which water availability and quantity rather than quality are the criteria for poor health; the lack of sufficient water for basic hygiene can result in serious health problems. In most villages women carry water for domestic use, although men were sometimes observed carrying water, usually for irrigation. Under no conditions is this easy work, but it is particularly hard in the hilly, rocky, hot terrain in which the Dogon live.

The team looked at three water-washed diseases: skin problems, eye diseases, and yaws. Yaws, which is prevented by good personal hygiene, appears to be endemic and is indicative of the basic lack of sound hygiene practices plaguing the Dogon people. Skin infections were found to be common in all villages, particularly among children. Again, good hygiene can be effective in reducing skin diseases. Additionally, in several villages, cases of trachoma and conjunctivitis were a common complaint.

The study took place during the rainy season, when water is relatively available. During the dry season, water is scarce, and sometimes people need to travel far to obtain water. Under these conditions, water use is restricted. Thus, throughout the year, the Dogon use very little water—on the average approximately 25 liters per person per day. In this respect, dams have a potentially positive effect. As noted in previous sections of this report, in the Dogon Country, the use of water for bathing and hygiene competes with other uses, such as swimming, playing and washing clothing. Therefore, an increased availability of water for hygiene could result in fewer water-washed diseases, but the team was unable to measure this, and, nevertheless, this potential benefit may be countered by increased schistosomiasis. Understandably, health education could have a significant impact on hygiene practices and associated diseases in the Dogon Country.

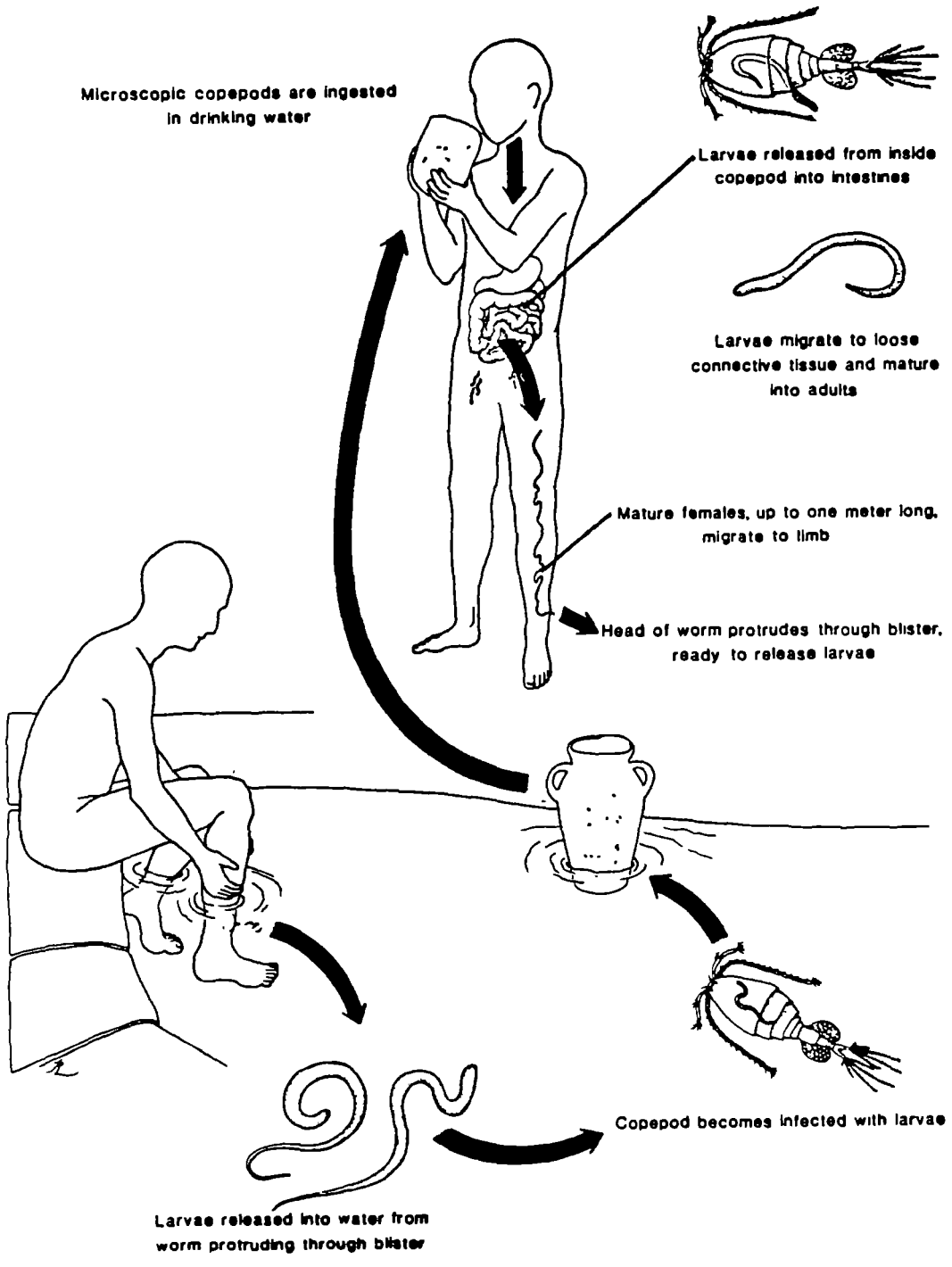

Figure 2

Life Cycle of the Guinea Worm

Source: *Tropical Diseases in the Developing World.* The VBC Project Tropical Disease series.

Table 5

Reported Guinea Worm Cases
in the Dogon Region, by Year

Region/Village	86	87	88	89	90	91*
Central						
Benediely	40	16	1		47	
Boro	11	3	0			
Koundougou	7					
Djiguibombo	144	35	0	52	38	
Anakanda				15	18	
Lougourou Goumbo				15	7	
Goro					11	
Tabagola		0	0			
Songo		0	0			
Kori-kori		0	0			
Kani Gogouna						
Kani	0			3		
Goundoly	5			52		
Irely-Bolo	35		37		9	
Sobo	66	22	4			
Amalaguene	7	53	0		17	
Dologou		26				
Kediely		7	5	26	23	
Elme		39				
Sougoudounou			2			
Dono Nandoli			3		35	

*Data are provided by Peace Corps for Dourou only.

Region	86	87	88	89	90	91*
Tabatongo				36		
Sal Oguol				2		
Ningart						
Doumogou	5					
Kidou	33	11		6		
Komodia		3	39		32	
Sobodt		1				
Kouguiri		10				
Guinekanda		34		1	3	
De			22			
Banakane			2			
Donou				11		
Indou				7		
Soughily				14		
Dimbti				29	0	
Indeli					3	
Djaganda					1	
Banna					9	
Kendie						
Koundiala	191	45			36	
Dieye		3				
Doni		33	41			
Honguye		29				
Sogodougou			7		0	
Madina			60		50	
Gosse			48		17	
Indeguin			21			

Region	86	87	88	89	90	91*
Kendie			55		0	
Kende					45	
Tuol					35	
Inguire					3	
Kantabale					2	
Dourou						
Dourou	0					
Dourouc tanga	87			38	41	39
Dourou na	58				0	3
Pelou	33					4
Guuumini Kum	5					1
Yawa	7		34			4
Guindodjou	8					
Nombort		88	75	2	6	6
Kombo Kani		24			16	8
Gognogourou		44		14	16	5
Wedie				5	31	50
Konsogou do				6		12
Kayes						1
Yamé						1
Ouo						
Komo	56	9				
Toumouni	54	10				
Bolimba	24	13			19	
Ghaniley	10					
Mendoli	3		4			
Dialloin	1	4				

Region	86	87	88	89	90	91*
Eguela Do		0				
Ama		5	16			
Niogono		0	11		22	
Pah		1	4			
Koubewel		16	13		0	
Gamba			25		0	
Koko			48		3	
Guoni				18	30	
Tegueri				48		
Ouo					0	
Soh					0	
Toti				0		
Goundaka						
Fiko	12	30				
Kanssila						
Tanga Douba		0				
Bounou			2			
Bombori Sare			1			
Niana			44			
Kargve			1			
Makou		11				
Kounsila		0				
Sangha						
K. Komodiguili	11	0				
K. Gondakilemo		6				
Kamba Bendie		0				
TOTAL	**913**	**631**	**625**	**398**	**627**	**134**

2.2.3 Water-contact Diseases

The team focused on one water-contact disease--schistosomiasis.

Schistosomiasis

Description and treatment: While both *Schistosoma mansoni* and *Schistosoma haematobium* are found in Mali, within the Bandiagara Plateau, the organism's presence is limited almost exclusively to the latter species. In field work, *S. haematobium* is easier to identify because it is characterized by blood in the urine. The team found that schistosomiasis occurred in all but one village, the exception being the chantry of the Hogon of Hogons, Arou. This one family community is not involved in irrigated agricultural production and therefore has limited water contact. Further, its very small dam and reservoir are covered by rock and do not support aquatic life.

Adult schistosomes excrete eggs (*S. haematobium*) that are discharged through the urine. Upon entering fresh water, the eggs hatch into miracidia, which are free swimming and infect a host snail (for *S. haematobium* these are of the species *Bulinus*, which were found in all standing-water bodies studied). Sporocysts form in the snails and rupture out as free-swimming cercariae, which then infect humans through direct skin penetration when a person enters the water. The disease can be controlled through changes in water contact behavior (difficult), chemical or biological snail control (expensive and not long lasting), and chemotherapy (see Figure 3).

Findings: There was some indication that schistosomiasis was worse in villages with dams, but host snails were also found in natural water bodies. The transmission season is associated with the rainy season, when water contact is frequent.

Schistosomiasis has been a recognized problem for some time, and dam construction is a possible source for spreading the disease. The GRM, with support from GTZ, has for the last several years carried out a control program. The government reports that while schistosomiasis was endemic before the significant increase in dam construction, following construction, increases in both the prevalence and intensity of infections has been observed. Brinkmann et al. (1988) report that schistosomiasis is a man-made health problem in rural Mali that is associated with irrigation projects. Infections are associated with water contact patterns for play, washing, and agriculture. Currently GRM and GTZ are providing mass chemotherapy for all villages with dams, but this leaves untreated cases in neighboring villages, which are a source for reinfection. The two groups are also looking at possible natural biological control agents (aquatic plants) and the relationship between intensity of infection and morbidity.

The work of GRM and GTZ clearly indicates that dams are a source of increased prevalence and intensity of schistosomiasis and, therefore, disease. There is no indication that dams have

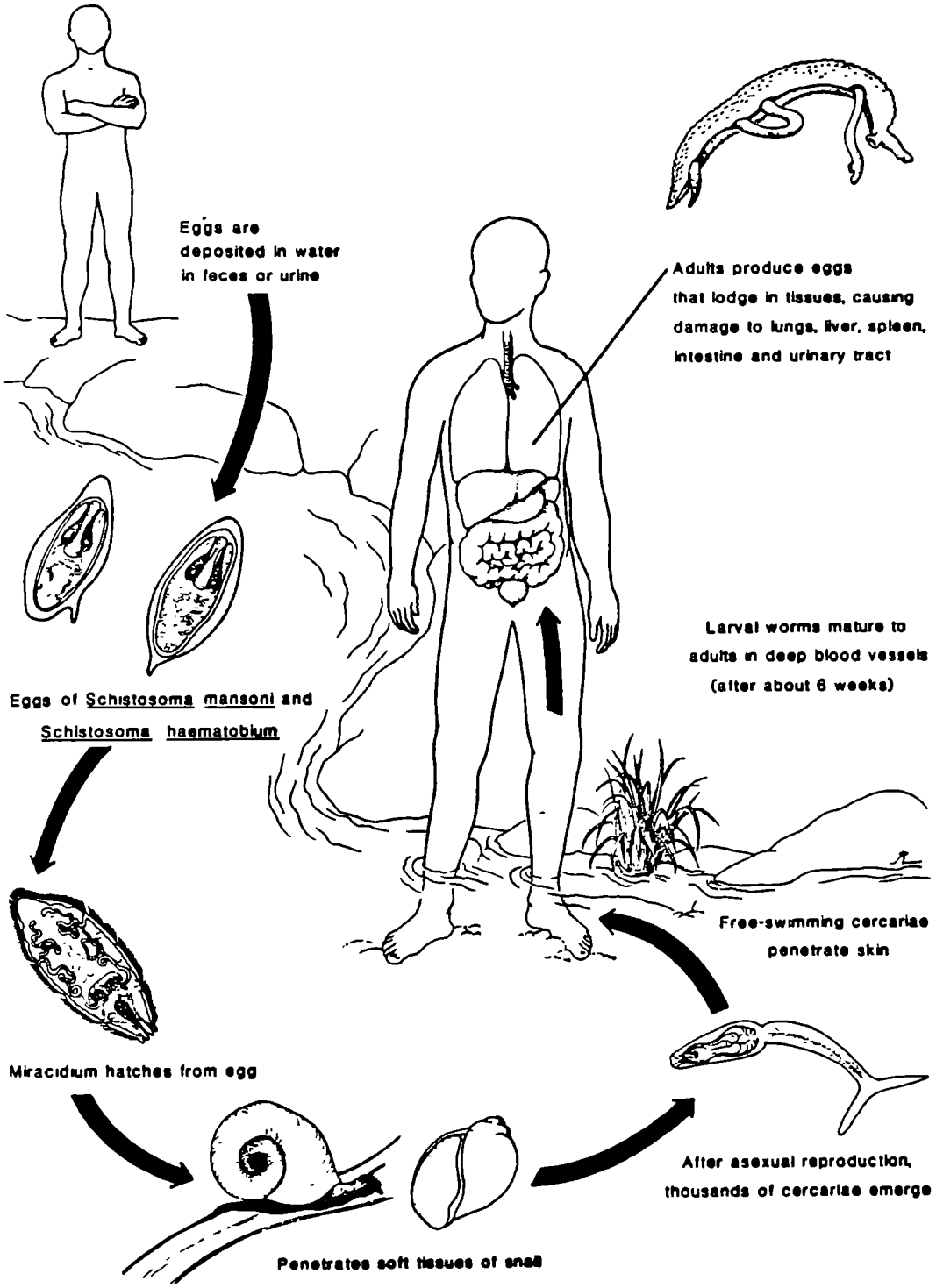

Figure 3

Life Cycle of Schistosomiasis

Source: *Tropical Diseases in the Developing World.* The VBC Project Tropical Disease series.

resulted in the introduction of this disease, but this is of little help to newly infected individuals. Werler (1989) has tested focal molluscicide treatment using nilosamide but found it too expensive. Because each dam is an isolated storage system, the Dogon Country may be a good test site for biological control using predator snails.

2.2.4 Water-related Diseases

Water-related diseases include those vector-borne diseases for which the vector requires water to breed. The team asked questions about two diseases: malaria and onchocerciasis.

Malaria

Description and findings: Malaria is endemic in the region, with the vector (*Anopheles* mosquitoes) breeding in puddles and other standing sources of water. While impoundment and water use creates additional potential breeding sites, malaria is endemic in villages with and without dams. The major transmission season is the rainy season, when mosquitoes are most abundant. No active control program exists. Some individuals seek treatment at a government clinic, but most do not. Malaria is probably a significant cause of infant and early childhood death. Most of those who have been exposed to and have survived malaria develop some resistance to the disease. Sickle cell anemia, common in Mali, also provides some protection against malaria. House construction, sleeping behavior, and mosquito biting patterns suggest that this might be a suitable region for the use of bed nets.

Onchocerciasis

Description and findings: The major river in the country, Yamé River, and, potentially, dam spillways offer breeding sites for the vector (*Simulium* flies). Mali was included in the original zone covered by the WHO Onchocerciasis Control Program (OCP). After 15 years this program has proven very effective; as a result a generation has grown up without this disease and its associated blindness. Mali is scheduled to be included in devolution (transfer of the international program to the various host governments). Given the lack of other investments in the Dogon Country, it is unlikely that the GRM will be able to maintain spraying as conducted by OCP, and the lack of knowledge at the village level of ORT or other basic child survival tools makes one question the potential for effective distribution of the drug, Ivermectin, even though it is free. Therefore, onchocerciasis may return, and dams may have increased the number of breeding sites. However, given the current effectiveness of the OCP program, onchocerciasis is not a public health problem at the present.

Chapter 3

ENVIRONMENTAL AND ENGINEERING ISSUES RELATED TO THE SMALL DAMS AND HEALTH CONDITIONS

3.1 Environmental Engineering

The environmental focus of this study and of the following discussion is on the impact of small dams on the physical environment as it pertains to water-related disease and the interrelationship between environmental conditions, water supply and sanitation, and water-related health conditions.

While small dam projects may enhance the project environment and increase the economic well-being and quality of life of the target population, dams also produce negative effects on the natural and human environment. Regarding the natural environment, these adverse effects may include soil erosion, excessive water percolation resulting in groundwater contamination, and disruption of native flora and fauna. (The team did learn that a valuable resource, tamarind trees, had been eliminated from one village due to reservoir construction.) An environmental assessment to include these parameters was beyond the scope of this study, but a checklist of key environmental factors to consider in such an assessment is included in Section 3.2.

3.1.1 Small Dams for Irrigation

The purpose of the small dams constructed in the Dogon Country is to increase the water supply in order to improve small-scale irrigation, primarily of onion gardens. The first small dam in the Dogon Country was built in 1947. Since then, 107 additional concrete dams, typically of about 100 to 150 m in length and 2 to 4 m high, have been built.

3.1.1.1 Dam Construction

Figure 4 shows the cumulative growth in dam construction since 1950. As can be seen, the total number of dams has increased sharply since 1977, with the largest number (12) being built in 1987. Figure 4 also indicates the number of growing cycles for which the dam can hold water. This is an important criterion for judging the success of a small dam and will be discussed in depth later.

A number of donor organizations have been active in small dam construction, most notably the Project d'Hydraulique Rurale of the Catholic Mission, Genie Rural, and GTZ. Africare has recently entered into small dam construction, building two small dams (Ouolo and Yamé)

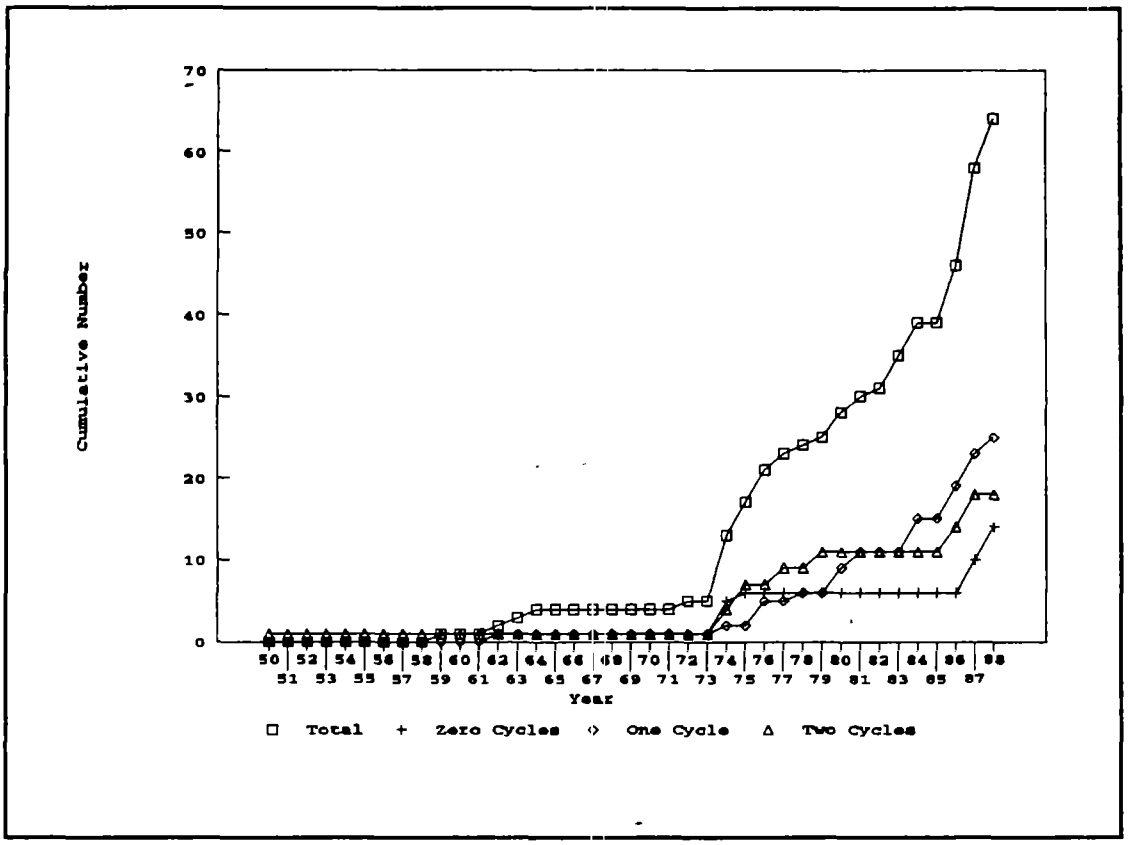

Figure 4

Cumulative Construction of Dams Since 1950

since 1987. Appendix E presents information from 1987 on donors, dams constructed, and conditions of the dam. According to these data, approximately 65 percent of the 78 dams listed were found to be in some kind of working order. Another, more comprehensive inventory of Dogon dams was conducted by GTZ in 1988 and includes 96 of the 108 dams (Appendix F). The inventory includes the following information:

- The number of dams in each of the eight arrondissements
- The year of dam completion
- Who financed the dam
- The height and length of the dam

- The volume of masonry used
- The reason the dam does not hold water as planned
- The Deutscher Entwicklungs Dienst (DED) classification of the state of the dam and necessary repairs
- The availability of water in the reservoir. This includes three components: 1) the month(s) in which water will be found impounded in the reservoir; 2) after the reservoir is depleted, the month(s) in which water will be found in upstream *puisards* (little wells in the riverbed); and 3) the month(s) in which water will be found in puisards in the riverbed downstream of the dam.
- The number of growing cycles for which water is made available by presence of the dam

The length of time a dam holds water is used in the GTZ inventory as a criterion to evaluate the success of a dam. In the Dogon Country, where the purpose of the dams is to increase water supply for irrigation, dam failure or success is measured by the amount of time water is retained in the reservoir following the end of the rainy season in September. Dams are categorized as those that will hold water for one growing season (roughly two and a half months—until December) or for two seasons (until May), after which time the rainy season commences. Totally failed dams are those that hold no water. With this criterion in mind, the inventory, which gives water availability data for only 74 dams, indicates that 30 percent of the dams hold water until May and, therefore, are fully successful; 50 percent hold water until December and thus would be considered partially successful, and 20 percent are useless. It can be said that 80 percent of the small dams are functional to some degree.

The reasons for dam failure are important to indicate, since small dam construction is very expensive. Africare estimates that it has spent 19 to 20 million CFA on each of the two dams it has built. The following reasons for dam problems have been identified by the GTZ inventory. The number in parentheses indicates the number of dams experiencing this problem. Note that a dam can have more than one structural problem.

- The dam wall is not watertight. (10)
- The dam foundation is poor. (17)
- Vertical fissures under the dam allow for the leakage of water. (26)
- Horizontal passage of water occurs around the side of the dam. (13)

Of the 96 dams on the GTZ survey, 40 percent were found to be in good condition, requiring no repair; 15 dams are considered to be poorly sited and virtually useless; and 44 dams need repair of the following:

- A new plastering or new asphalt on wall. (19)
- A new watertight wall upstream. (20)
- Injection of mortar under the soil. (14)
- Repair or replacement of metal parts, e.g., sluice gates. (12)

The consultant team's observations found that the conditions of the dams visited were as reported in the GTZ inventory.

The reasons and frequency of dam failures were discussed in Bamako with the director of the Service Hydraulique. He explained that it is difficult to supervise and coordinate the dam construction activities in the Dogon not only because of the remote locations involved but also because of the variety of organizations active in the area. No standard design criteria or permit requirements exist for dam construction. The consultant team's concern was that lack of design standards might account for the large number of dam failures under the aforementioned conditions. However, the director and others active in dam construction indicated that there are so many different reasons a dam would fail that standards would not guarantee remediation of this large failure rate.

The various donor groups building small dams in the Dogon Country each take their own approach to the task. The team met with the major dam builder donor group, the Catholic Mission, in Bandiagara to determine the guidelines it used. The Project d'Hydraulique of the Catholic Mission has constructed 35 dams in the last 19 years in the Dogon. The villages requesting a dam need to demonstrate their willingness to participate in constructing and maintaining it. In its village meetings, the Catholic Mission staff met with the Village Dam Committee to determine village contribution. A village must be willing to provide board for the dam laborers, who are often provided via food-for-work programs. The project next conducts hydrogeologic tests to determine a proper dam site. Given that the largest number of dam failures are due to leakage under the dam through fissures, this testing is obviously crucial. Yet, as the Catholic Mission reports, given field conditions and financial limitations, sophisticated testing adequate for proper siting is impossible. Following construction of the dam, the village is responsible for alerting proper organizations of needed repairs.

The lack of community participation in dam construction was mentioned repeatedly as a hindrance to sustainability. Applying lessons learned in this area, Africare, a relatively new player in dam construction, has incorporated the following activities into dam projects. A Village Dam Committee must be formed with a treasurer, and a bank account with 500 CFA

per family per year should be established. While this money is intended for dam repairs, the Africare dams are too new to have incurred any repair costs, and, therefore, the money is used as a kind of bank, from which loans are made to villagers. The Village Dam Committee also is charged with maintaining the dam reservoir as much as possible. Two young people are chosen to be dam guardians, work for which they receive no pay. Their task is to go to the city to report dam problems should they occur. The hope is that this level of participation will foster a sense of dam ownership among the villagers, something that is conspicuously lacking at older dam sites.

3.1.1.2 Dam Repair

Dam repairs in the Dogon are conducted under a project operated and financed by the DED, a German NGO. The project's goal is to repair 70 dams in the period of 1990-93 with a budget of 3 million Deutsche marks. Roughly 10 to 15 dams are repaired each year from October to March. In order for repairs to occur, villages must request them from DED. DED pays for the materials and mason costs but requires the village to have a fund such as that described above; 500 CFA per family per year is the recommended contribution. The village pays approximately one-fourth to one-third of the dam repair costs to DED, which sets this money aside. Cracks in the joints and masonry are noted to be the most common repair necessary. The largest impediment to dam repair is transportation; a bag of cement weighs 50 kilograms, and necessary vehicles for hauling materials are lacking.

DED has noted the lack of a sense of ownership on the village level. Other donor groups have reported that in villages where the community was active in requesting, funding, providing labor for, and siting of the dam, there was a noticeable increase in attention to the dam. This experience illustrates the importance of community participation in development activities.

3.1.1.3 Operation and Maintenance

On the village level there are virtually no dam operation and maintenance activities. Villages with dams recently built may have an appointed guardian whose task it is to report dam problems to town. In theory, the Village Dam Committee is responsible for overseeing the general functioning of the dam, including reservoir maintenance. Most of the dams in the Dogon Country are overflow dams with no spillways or sluice gates. When the gates are operated, it is usually at the beginning of the rainy season, when they are used to "clean out" the dam. A villager is assigned this task.

One maintenance area in which the village could be active is in reservoir management. As previously described, most dams are not constructed in a manner to allow for control of the water level in the reservoir. However, the village could be involved in maintaining the reservoir. For example, in one field visit, the team observed several dead trees caught at the dam wall, a problem that could require dam repair in the future. In addition, reservoirs should

be kept free of aquatic vegetation. This is another area in which village participation would be needed.

3.1.2 Water Supply and Sanitation

A common environmental concern associated with small dam projects is water-related health problems. The quality of the water impounded may be detrimental to humans, whether by virtue of dermal contact or ingestion; widespread water availability may offer potential for contamination of the drinking water supply as humans gather to bathe, wash clothes, and obtain water for domestic purposes. Accumulation of aquatic plants in the reservoirs make control of vectors and intermediate hosts more difficult, and lack of adequate sanitation may also result in contamination of the impounded water as well as other water supplies in the community. The following discussion will describe problems in the areas of water contact and water supply and sanitation and present suggestions for remediation.

3.1.2.1 Water Contact

Transmission of schistosomiasis, a focal point of this study, occurs when a community comes into contact with contaminated surface water. As previously discussed (Figure 3), schistosome eggs in human excreta or urine hatch upon reaching water. The resulting larvae must invade suitable snail hosts or perish. Following a multiplication process within the snail, the free-swimming schistosome larvae (cercariae) escape from the snail to infect humans by penetrating immersed or wet skin. The cercariae usually remain just below the surface of the water. Therefore, the effect of dams on the human environment, as they relate to water contact, is an important consideration.

Snails were observed attached to aquatic vegetation and/or the dam wall. Aquatic vegetation provides snails with a firm footing, a place for fixing egg clusters, and algae feeding grounds. The team observed snails and egg clusters on the bottom of many of the lilypads. Aquatic vegetation also facilitates the breeding of some species of mosquitoes. Consequently, control or removal of this vegetation is a recommended approach to schistosomiasis control. Aquatic vegetation was usually abundant in the dam reservoirs and in the downstream riverbed.

Snails were only found in those reservoirs that contained aquatic vegetation (Ouolo Ouolo, Yamé, Kori-kori, and Dourou). No snails were observed in reservoirs without aquatic vegetation (Tegourou and upstream Nandoli Dam). In Nandoli, however, the villagers reported that if they wash in the reservoir they "get itchy skin." The snails found were thought to be *Bulinus*, which transmit *Schistosoma haematobium*. Only in Kori-kori did the team find both *Bulinus* and *Biomphalaria* snails, and, indeed only in Kori-kori was there any suggestion of the possible presence of *Schistosomiasis mansoni* per villager health reports.

Team members were interested to know if the villagers perceived any benefits to the vegetation. Some thought it reduced evaporation (which it probably does); others mentioned

that it was good for fish. Additionally, the vegetation is used for animal feed, and some people eat the fruit of the lily pad. Since there seemed to be no high value placed on the vegetation, a program to involve the villagers in its removal from the reservoir as a schistosomiasis control measure seems viable.

Assuming the reservoir waters are transmission points for schistosomiasis, water-contact activities are important to understand. Table 1 of Appendix I presents water-contact activities observed or reported at the dam sites visited. As they were designed, the dams provide water for irrigation. The most common method of using the water is to gather it in a calabash, which is carried to the garden and its contents sprinkled on the garden. This usually involves wading into the water up to the knees many times a day throughout the year. The hands are also submersed as the calabash is filled. These irrigation practices obviously present health risks to the farmers.

Several alternatives to these water-contact irrigation measures have been considered in the Dogon Country. In the construction of the Tegourou Dam, several technical measures were used to reduce farmers' contact with reservoir water (Brinkman, 1986). One is a system of gravity-fed canals that reduce contact with the water. Another is water intakes situated in the deep regions of the reservoir. These measures are reported not to be used by Tegourou which continues to report a high level of schistosomiasis. Unfortunately, a gravity-fed canal system is unrealistic in most of the Dogon Country.

In another attempt to protect workers from cercariae-infected waters, the Catholic Mission in 1976 tried to introduce a pump that would deliver the water to the garden from the dam. The project was considered a failure and abandoned in 1977, because the pump was found to be too clumsy and heavy. In addition, the nature of the garden soil is such that water pressure would wash it away. The sprinkling method with the calabash is well suited for these gardens and not a method to be easily discarded.

Other measures that would reduce farmers' contact with cercariae-infected waters while irrigating need to be implemented in the Dogon Country. One possibility would be to place stairs at the dam site that would allow farmers to walk to the water level and not into the reservoir. The use of sprinkler cans to replace the calabash and eliminate hand contact while drawing or sprinkling the water is another alternative. Sprinkler cans are common in Bamako for gardening and cost about 700 CFA. Protective gear for farmers, such as rubber boots, may seem unrealistic but as the Malians pointed out, other workers, e.g., beekeepers, are used to the notion of protective gear. In summary, methods need to be explored to reduce farmer contact with reservoir water for irrigation.

Besides irrigation, other water-contact activities of concern are recreational and domestic activities. Schistosomiasis is so common among Dogon children in villages with and without dams that it often seems to be a natural part of childhood. Although most villages associated swimming in the reservoir with some health problems (itchy skin), only in Nandoli and Dourou

was the team told that children are strictly forbidden to swim in the dam area. Elsewhere it was recommended not to swim or bathe in the reservoir, but the team observed these activities nevertheless. Washing bodies and clothes is also more the rule than the exception, as is cattle drinking. Fishing was observed at several dams but always from the wall so that the individual was not in contact with the water. As described previously, in villages with dams where children were routinely swimming, skin and eye infections seemed less prevalent than in villages with no dams, such as Songo. Finally, in one case, Tegourou, the major road crossed the riverbed just downstream of the dam. When the dam is overflowing, as it was during the team's visit, people walk through the water as they pass along the road—another contact point for schistosomiasis transmission.

Clearly, the increase in surface water associated with dams infected with cercariae has implications for schistosomiasis transmission via recreational, domestic, and agricultural use. Since the villagers do not have a clear understanding of transmission, their motivation to change water-contact behaviors may be limited. As described earlier, it does not appear that they connect water-related diseases with the dams. A program directed toward health education and hygiene behavior is clearly needed in the Dogon Country to address this problem.

3.1.2.2 Water Supply

The immediate consequence of the building of a dam is the establishment of a reservoir of water directly available to the local population. As described previously, in the absence of a dam, traditional water sources are numerous. Since water is at a premium, people will use water found anywhere, and water sources often change seasonally. The most common source is a series of open faults or fracture lines in the rock surface of the plateau. Secondarily, in some low-lying valley areas, dug holes tap a subsurface water source or water collects in small caves or trickles out from between rock layers, where people collect it. During the rainy season, seasonal streams flow through valleys and are exploited for bathing, drinking, clothes washing, and agriculture. It is important to note the evaporation losses in Mali are considerable and that much of the surface water is lost to evaporation between rainy seasons, even in high rainfall years.

The use of reservoir water for drinking is of great importance in determining the health effects of small dams. It is interesting to note in documents from the 1970s that the dam is referred to as a drinking water supply in addition to an irrigation supply. Given the scarcity of water, this is not surprising. However, as the relationship between drinking dam water and disease became evident, dam builders and health officials cautioned the populace not to drink the dam water. It was clear from the team's fieldwork that all villages with dams have been educated not to drink dam water. Compliance is another matter. In all villages with and without dams the teams gathered information about water sources for all purposes (see Tables 1 and 2 in Appendix I). In villages with dams that hold water for any length of time, all but one, Korikori, report that at some point in the year the inhabitants drink the dam water despite warnings

to the contrary. Convenience is most often cited as the reason for this, as well as taste. In Nandoli, for example, where the upstream dam holds water until December, the villagers choose to drink the water because the borehole-cistern well is 20 minutes away; the dam is only 5 minutes away. An unprotected well is located in town but, "the water tastes bad" there. When the dam is dry, villagers dig holes in the bed that fill with water; this becomes the domestic and drinking water supply. Yamé villagers also commented that the pump was too far away (25 minutes), although people passing by on the road use the well. Two villages at first claimed not to drink the water (Dourou and Tegourou), but when it was explained that the team was there to help with health and needed honest answers, the people again said the dam water tasted better and was convenient.

An iron taste to well water from India Mark II handpumps is the common taste complaint. This has been a problem throughout Mali and activities are currently underway to seek a solution. The UNDP/World Bank Water and Sanitation Program has proposed field tests of PVC rising mains to provide suitable alternatives to stainless steel pipes. The U.N. is also working with Direction Nationale de l'Hydraulique et de l'Energie (DNHE) in field tests of simple iron-removal devices.

Some villages report that when a dam is full and the water is flowing over the top, inhabitants feel it is safe to drink the water; when it is stagnant they use another source (Ouolo-Ouolo, for instance).

Realizing the importance of providing a safe drinking water supply to villages with dams, the Catholic Mission, as part of its Project Hydraulique Rurale (which has installed 35 dams), has installed more than 500 wells and more than 100 pumps in the Dogon Country since 1972. The mission's goal is to have at least one pump or well in every Dogon village with or without a dam. In a switch from earlier methods, the Catholic Mission now only constructs dams in villages where a well is also put in. The dam is virtually free to the villages, but they must contribute up front for pump installation. The cost of the pump (India Mark II, manufactured in Mali) is 300,000 CFA. Whether villagers use the pumped water as a drinking water source, of course, is more a matter of education. In general, the villagers prefer a system of a borehole with a cistern well attached from which they draw their water because they want to avoid broken pumps. Repairs are reported by villagers to be prohibitive (Korou). No system is in place on the village level for operation and maintenance of the pumps.

Traditional hand-dug wells have been rehabilitated by the Catholic Mission and other donors. The protection of these wells may include a wall around the well, a lining in the well, an apron around the well, drainage devices, and a cover. The need for some kind of protection was evident in the consultant team's field observations. The team observed several unprotected wells that were virtually algae covered ponds that required one to enter the water to get water, were open to livestock, and were eroding along the sides. These holes should be filled in where there is an alternative source of water. The level of protection and its use varies from community to community. Tegourou had the best-protected borehole-cistern well observed.

Built by the Catholic Mission, it included an apron, a surrounding wall, structures around the circumference of the apron to hold the water containers (canneries) upright, and a drainage canal where excess water went to a basin for livestock. It had no cover though. People usually bring their own vessel to the well. It is important to note that there is no method of retrieving water from the well to avoid contamination. There is a need to incorporate a winch and pulley system into well design and a place to rest water vessels safely (such as that described in Tegourou). However, as mentioned before, protected sources are insufficient to ensure usage. In Kori-kori the team saw the only well fitted with a cover, but it was raised permanently—the villagers thought it was too much trouble to lift the metal cover each time they wanted water. In other locations, the well cover was permanently removed.

Drinking water supplies in villages with no dams were also examined for comparative purposes. The Catholic Mission is involved in providing safe drinking water in these villages as well. As Table 1 in Appendix I shows, only Yawa and Koundou have no improved water supply. An ideal groundwater source is an artesian spring, of which there are few known in the Dogon Country. Of all sites visited, Vaou probably had the best quality and quantity of year-round water supply. An improved artesian spring built in 1984 provides Vaou residents with all their drinking water needs. There is no Guinea worm in Vaou.

Another village with no safe drinking water source, Yawa, uses an unprotected spring in the river. One wades in the river, if it is flowing, to capture the spring water as it flows from the ground. Yawa supplements this with puisards in the Yamé riverbed. Songo has an unprotected well that it uses for drinking water because its borehole is too far away. (As previously mentioned, it is this type of hole that should be filled in, since it presents a public health risk and another, safer water supply source exists.) The borehole is only used when everything else dries up. Guinea worm is prevalent in Yawa and Songo.

Villages with dams that report no Guinea worm indicate that since they began drinking well water, Guinea worm has gone away. This information demonstrates that the presence of the dams does not affect Guinea worm disease. Guinea worm can be eradicated by the provision of a protected safe drinking water supply. Schistosomiasis was reported in all the villages with and without dams, with the exception of Arou. Only Yawa reported "very little" schistosomiasis, which could be related to the scarcity of surface water anywhere in the area.

3.1.2.3 Water Quality

The consequences of impoundment by dams on water quality include: 1) drastic reduction in the rate at which water flows, resulting in an increase in the number of microorganisms present; 2) likelihood of human or animal excreta deposition near the reservoir, which can rapidly pollute the stagnant water; and 3) concentration of materials carried by the water in the reservoir. Although the water quality of the Dogon reservoirs has not been measured or monitored, it can be assumed that some of the consequences of impoundment are operative and that the water is unfit for human consumption. Purification of unsafe drinking water under

rural conditions is expensive and requires technical training. Therefore, it is critical to protect the viable drinking water sources from pollution. Particularly in the hydrogeologic conditions in the Dogon Country, groundwater contamination and subsequent pollution of drinking water supplies is a concern. Groundwater is filtered as it flows through the ground. Where it flows through rocks and fissures, as it does in many places in the Dogon Country, natural filtration may be minimal. Unprotected wells, which are the drinking water source for many of the Dogon, are subject to pollution by spilt water as people stand on the edge; by the vessel and rope used for drawing water; by rubbish or dead animals that get in the well; by infected persons walking into the edge of the well; by surface water runoff; and by polluted groundwater. Given the multiple sources of contamination present in any Dogon village and the condition of much of the water supply, the quality of the groundwater resources used in the Dogon villages is of concern.

An official with Systeme d'Hygiene de Bandiagara Cercle (SHBC) described the water quality testing and monitoring program used. He is the sole staff member assigned to this task in the region. His office is also in charge of general environmental health conditions in the urban area, a responsibility that consumes most of the office time and resources. In theory, the following is the water quality monitoring program. Each well should be tested bacteriologically on an annual basis. If the well is contaminated it is treated with chlorine, retested in three months, and then tested three times yearly if there have been problems in the past. No wells are ever closed. In practice, however, little testing occurs. Villages reported to the team that someone came out infrequently (every one to three years) and put chlorine in the wells. The SHBC official notes that lack of staff, transportation, and materials makes the job impossible. Currently, there is no battery for the field coliform test kit. Of particular concern to this study, the SHBC official, along with a representative of the Catholic Mission, notes that the well test results frequently show fecal contamination. This is thought to be due to pollution of unprotected wells by livestock and by the ropes and buckets used to extract water. Given the potential for contamination of the drinking water source, the use of filtration techniques was of interest to the team. As previously described in Section 2.1.2.1, procedures for filtration of water for domestic use varies among villages.

The team visited the Bandiagara market with a local entrepreneur who makes buckets out of inner tubes with which to draw water. These are lightweight and small (about 4 liters). The water is then transferred at the well to a larger container. The entrepreneur's company also makes sieves for food straining and adapts these, using a finer woven material, to make water filters. This shows the potential to market effective filters for Guinea worm if the material can be provided.

The importance of water quality to the maintenance of health and the difficulty in providing a water quality monitoring system in remote rural settings serve to highlight the need for adequate sanitation within the village.

3.1.2.4 Sanitation

The hygienic disposal of human excreta is vital to community health. The sanitary disposal of wastes will help to control all those infectious diseases that are caused by pathogens in the urine or feces of humans, including diarrheal diseases and schistosomiasis. While most diseases are rarely transmitted in urine, *Schistosoma haematobium*, the predominant form of schistosomiasis in the Dogon region, is the exception, which highlights the need for sanitary disposal of urine as well as excreta.

Prior to the team's field visits, the team was told that sanitary facilities were nonexistent in the Dogon Country. On a national level, rural sanitation coverage is 5 percent (UNDP/World Bank Water and Sanitation Program, 1991). However, as can be seen in Table 2 of Appendix J, latrines were indeed observed in the field. In addition, the team was informed that the Latrinization Project of the Systeme d'Hygiene has installed 35 latrines in 20 Dogon villages (some of those observed in the team's study). Team members expected some cultural resistance to the ideas of latrines, since excreta disposal is often considered to be more complex socially than technically. What was found was a general acceptance of the idea but a lack of knowledge, on the village level, of how to construct appropriate latrines given the region's soil conditions. On the district level, the team found the classic lack of staff, funds, and transportation as impediments to the latrinization program.

As described in Section 2.1.3, traditionally, in most areas, people defecate in the bush, sometimes within 10 m of the home. Usually, defecation takes place at a distance of some 50 m from the village, with the exception of children, the elderly, and the infirm (Eskelinen, 1977). In areas with dams, the villagers said they defecated in areas far away from the dam but agreed that the possibility existed for rain to wash fecal material into the dam. Human fecal material within 20 m of the dam reservoir was observed during the field visits at two sites. Privacy and convenience are the two main considerations in the selection of a defecation site. For urination, the traditional practice is to urinate in a spot in the home compound that is outdoors and often in a corner area. This is also where people wash.

When asked if they would use a latrine if they had one, villagers always responded affirmatively. The advantages they perceive include 1) convenience - when one has diarrhea it is easier to go close to the house and not to the bush; 2) when one has diarrhea sometimes one cannot make it to the bush and so you defecate in the house, which is embarrassing; 3) privacy; 4) the elderly find walking down the rocks difficult; therefore, a close latrine would be easier; and 5) snakes live in the bush. The villagers who have latrines in their compound are usually important community members: the chief, the chief's assistant, the midwife, and the teacher (if these people are part of the community). Thus, there is a sort of cachet attached to having a latrine.

Most latrines observed in the field were single unimproved pit latrines. Most were equipped with a concrete squat plate. In some instances the superstructure was simply a wall without

a roof. The most sophisticated latrine was the communal latrine in Tegourou located adjacent to the mosque. People clean the latrine as they come and go to the mosque. This latrine, constructed by the Systeme d'Hygiene, was a modified version of the ventilated improved double-pit latrine. One pit was sealed, but the other now fills. Each pit had the requisite ventilation pipe, although the pipe was sealed within the adobe superstructure. The pipes had screens on top. Other types of latrines observed included elevated pit latrines with a superstructure but no roof at the school in Kori-kori. Although there are three latrines at the site, the children could not keep them clean; consequently, two are now closed and the third sports a hand-drawn picture of how to use the latrine properly. Nevertheless, the floor of the school latrine was littered with fecal material, substantiating adults' claim that "children miss the hole."

The request for latrines often occurs after villagers on migration return to the Dogon Country having seen latrines in more developed areas. A village puts in a request at the Systeme d'Hygiene latrinization program. The latrine costs 30,000 CFA, and the population is required to participate in digging the hole. The salary of the mason and the cost of the slab and cement are paid for by the project. When the Systeme d'Hygiene constructs latrines in villages, it first has several animateur sessions with the villagers to acquaint people with their use.

The agency has many more requests for latrines than it can meet. Clearly, there is a need for improved sanitation throughout the Dogon Country and a latrine program would contribute to the overall health of the population while serving to mitigate against some of the negative health impacts associated with the dams. Also needed is an appropriate, low-cost latrine. Due to the rocky soil, there are places in the Dogon Country where digging down is difficult. The latrine observed in Nandoli hit rock at a depth of 1 m. Furthermore, the cost is considered exorbitant by some. For comparison, the latrine costs 30,000 CFA; a metric ton of millet, which would feed an average family for a year, costs 50,000 CFA. Much of the latrine cost is in the concrete slab and the pipe. Therefore, modifications are needed. Finally, location of the latrines is important to consider. Most home compounds are not large enough to house a latrine safely; therefore, the use of communal property may need to be considered.

3.2 Environmental Assessment

Observations in the field, comments from interested parties in Mali, and the above assessment led the consultant team to conclude that small dam projects should incorporate a preliminary environmental assessment as part of the design phase. For projects funded by A.I.D., this would be covered by an Initial Environmental Evaluation (IEE). However, dams have been built by a host of relief and development agencies, each of which has its own project design process. Therefore, the following simple checklist is provided to ensure that environmental issues are considered during any design phase and that mitigation measures are taken where appropriate. This checklist should not be considered exhaustive, but rather helpful in providing a basic direction for environmental investigations.

In the design and development of small dams, developers are encouraged to incorporate proactive steps in the identification and mitigation of potential environmental impacts. To do so, project planners should demonstrate the following:

1. Knowledge of the existing ecologic conditions of the project area

2. Identification of the potential effects, positive or negative, of project activities upon the environment

3. Development of strategies for the mitigation and/or prevention of potential, negative impacts

To facilitate this process, these environmental guidelines have been developed. Section 3.2.1 provides a list of physical, biological, and cultural factors which will assist project planners, PVOs, NGOs, etc., to assess environmental characteristics of the project area. Section 3.2.2 assists in the identification of the potential impacts of different interventions. Examples of mitigative measures are provided, and questions to ask about projects are included. Section 3.2.3 includes planning and design recommendations which will help PVOs and NGOs to plan environmentally sound projects.

3.2.1 Key Physical, Biological, and Cultural Factors

These guidelines are designed to assist in understanding the ecologic characteristics of the area where the project will take place. An inventory of basic physical, biological and cultural factors will provide planners with an understanding of components that they will need to monitor in the future.

A listing of key factors to be considered is provided in Figure 5.

PHYSICAL FACTORS

Climatic factors

- Precipitation—average monthly rainfall amounts
- Temperature—mean annual temperature

Watershed characteristics

- Location of the project area within the watershed including a topographic map of the project area. A larger scale vicinity map may be necessary to identify adjacent/nearby streams and rivers and project infrastructure
- Size of the watershed—hectares above the project area, including the project area
- Overall slope of the watershed

Groundwater hydrology and quality

- Well inventory and prevailing depth of the aquifer

Surface water hydrology and quality

- Elevation difference between intake and the water users
- Stream discharge rates—liters/second
- Waterborne pathogens (*E. coli bacteria, Salmonella, Schistosome*, etc.) if intended as a potable water source

Morphology of the area

- Prevailing slopes in the project area
- Slope concavity or convexity as an indicator of erodability
- Aspect of the project area; an indication of the quality of the site
- Floodplain characteristics, the frequency of floods, depth of floods, etc., delineation of the floodplain on the larger scale vicinity map
- Stability of land forms—mass movement of soil in the vicinity of the project area
- Water erosion of soil—the degree to which it is occurring presently, location of silt deposition as a result of the erosion

Soils

- Soil classification—from a soil scientist or government soil classification maps, including physical structure and depth to bedrock
- Percolation capacity
- Compaction of soil from past activities

Figure 5

Key Environmental Factors

BIOLOGICAL FACTORS

Fauna

- Threatened species—state of the population
- Endangered species—state of the population
- Critical habitats for threatened, endangered, and commercially exploited species

Flora

- Existing vegetative cover—secondary forest, pasture, agricultural lands
- Traditionally utilized species—food, medicinal, etc.
- Threatened species—state of the population
- Endangered species—state of the population
- Critical habitats of threatened and endangered species

CULTURAL & LAND USE FACTORS

- Traditional/culturally sensitive sites
- Land/soil ownership
- Access routes to villages
- Water use practices
- Level of community participation in the project

OTHER PHYSICAL OR BIOLOGICAL FACTORS

Please list any other environmental factors your field staff has identified that could be affected (positively or negatively) by the project, and which your staff will need to monitor in the future.

Figure 5 continued

Key Environmental Factors

3.2.2 Assessment of Different Interventions

This section will assist project planners to determine the type of impact that can be expected for different types of projects. The projects are mostly designed for water storage for irrigation and potable water supply. Other actions will likely include training and education, and

operation and maintenance. Taking no action is an alternative which should be considered, if any of the proposed activities are judged to be undesirable in the long or short term.

In general, projects should not be located in areas where they will produce significant negative environmental impacts on:

- Historical and archaeological resources,
- Endangered animal and plant species, or
- Groundwater quality.

Archaeological resources are the remaining traces left over by earlier cultures. As the science of archaeology matures, every fragment of material in an archaeological site is of potential value to reconstruct the way of life of peoples of the past. Consequently, archaeological resources should be preserved.

Endangered and threatened species are those that are in danger of extinction as a result of human activities or other conditions. These species need to be protected to maintain the bio-diversity of the ecosystem.

Groundwater should be protected because it is the source of water for many communities, and once polluted, it is very expensive to purify.

Environmental Impacts and Impact Mitigation

Development of water projects will produce short-term construction impacts and other long-term impacts.

Short-Term Construction Impacts:

Construction impacts are generally short term and may include dust, noise, siltation and erosion. Appropriate construction techniques should be used to control siltation, e.g., the use of hay bales to catch the silt but allow passage of water. To prevent erosion and dust, construction should be carried out in the dry season, using dust control measures such as wetting. Construction noise should be minimized and controlled so that it does not became a nuisance to the dwellings in the vicinity of the construction project. Project planners should also be sensitive to the social impacts of the construction crew on villagers who may be required to provide housing and food.

Long-Term Impacts:

Long-term impacts are those that affect the physical characteristics of the environment in a permanent way.

Archaeological resources can be impacted by construction activities of the projects. During project planning a preliminary investigation to determine if an archaeological site is likely to be found in the project area should be conducted. If that possibility exists, an anthropologist or archaeologist should be engaged to determine the importance of the site, and to discuss the importance of the site with village leaders.

Endangered plant and animal species could be adversely affected by the project. The projects should therefore disturb surrounding vegetation as little as possible.

- Downstream soil erosion needs to be minimal and may include soil catchment basins or other mitigating activities.

- Flooding due to dam failure is a risk. Sites should be selected to ensure that downstream communities are protected.

3.2.3 Environmental Assessment Criteria

Project developers should use environmentally sound planning and design practices to propose projects which will:

- Maintain or enhance water quality
- Use water efficiently
- Protect native and animal populations
- Protect water rights of existing users
- Use existing social organizations and cultural values for environmental rehabilitation and conservation
- Maintain or improve soil productivity
- Include plans for protection of native species and undisturbed wild areas
- Decrease existing levels of water-associated disease
- Insure long-term sustainability of the water source
- Make optimal use of locally available material and human resources
- Have community support and involvement
- Be based on community-identified and/or community realized needs
- Increase potential for community self-reliance in both short and long term
- Be compatible with available funding
- Make use of and adapt traditional technologies

- Have a reasonable time frame for the community to take responsibility for the subproject
- Have potential for being maintained and monitored by the community

When planning a project the designers should ask themselves these general questions:

- Have other possibilities been considered for accomplishing project objectives?
- Have all alternatives been examined in detail?
- Have all environmental aspects been considered?
- Are the planned project actions environmentally sustainable?
- Have all the negative environmental aspects of the project proposal been identified? Can some or all of those negative environmental effects be mitigated?
- Are the development plans in agreement with Malian laws regarding the environmental sector?
- Are there national, regional, or subregional water resource plans? Is the project proposal in general agreement with those plans?
- If the project is not in agreement with national, regional, or subregional water resource plans, can the project proceed and succeed regardless?
- Is the project area near an established protected area?
- Have critical sites been identified?
- Have critical habitats been identified (for example, threatened and endangered species, subsistence or hunted species, medicinal plants, etc.)?
- Finally, and perhaps most important, have the planned beneficiaries of the project been consulted in project development?

Chapter 4

CONCLUSIONS

The objective of this study was to determine whether the construction of small dams in the Dogon Country had potential health effects. The consultant team's conclusions are as follows:

- Dams are a source of increased prevalence and intensity of schistosomiasis, but because dams are not a primary source of drinking water they do not present other significant health risks.

- Dams may slightly reduce water-washed diseases.

- Dams are perceived by the villagers to have a significant positive economic impact on the village, providing a cash income that is used to buy grain during the dry season.

Given that schistosomiasis is the only serious negative health effect, what should be done? GRM and GTZ are already managing a schistosomiasis treatment and control program, but this program could use additional assistance. Further, the program should be expanded to cover villages without dams, and there should be increased health education to improve hygiene practices and reduce water contact. However, there may be an alternative to dam construction that would not result in the same health effects. The team felt that the region's groundwater potential has not been fully investigated, and that groundwater may provide a permanent source of safe water for both agriculture and domestic uses.

Other pressing health issues should also be addressed—namely child survival (particularly through diarrheal disease control) and Guinea worm disease control. Recommendations addressing these needs have been included and focus on the need for safe drinking water supplies, sanitation facilities, health education, and hygiene education.

In the agriculture sector, water is in the domain of men, but for domestic uses, water is involved in women's work; therefore, the team suggests targeting health education programs to women. Aside from the indirect advantages of increased household income and improved hygiene because of increased water availability, dams have benefitted women very little.

Chapter 5

RECOMMENDATIONS

The team's recommendations address the initial objective of this study, namely the potential health effects of small dams in the Dogon Country, as well as other health, socioeconomic, and environmental issues identified during the study. Further, the recommendations are specifically addressed to 1) GRM, 2) the NGO community, particularly Africare, 3) USAID, the Peace Corps and other bilaterals, and 4) the World Bank and other multinationals. While there is no specific project associated with this study that can implement these recommendations, the team has attempted to keep them simple and implementable in hopes that the various players involved will act on them.

In response to the objective of this study, the consultant team offers the following recommendations.

For GRM/Ministry of Health (MOH):

- The schistosomiasis treatment program must continue but should be expanded to all villages in the region. While ownership of a dam is associated with individual villages, schistosomiasis is endemic in the region, and villages without dams use the dammed areas for swimming and washing. Leaving neighboring villages untreated invites continual reinfection.

- Greater emphasis should be put on hygiene education at the village level. Most people do not perceive schistosomiasis as a disease, but rather consider blood in the urine a normal event for children between the ages of 5 and 15. The potential impact of schistosomiasis on productivity and long-term negative health consequences have not been analyzed in the Bandiagara context. Health education on these topics may be effective in changing perceptions about schistosomiasis and therefore water-contact behavior. The St. Lucia, Richfond Valley project, a major research project funded by the Rockefeller Foundation (Jordan et al. 1975, 1978), demonstrated the effectiveness of water supply and sanitation in reducing *Schistosoma mansoni*. *Schistosoma haematobium* is more difficult to eliminate because people are more likely to urinate in or near water. Providing alternative safe sources of water for drinking and washing will reduce contact with contaminated water and therefore reduce the burden of this disease.

For Africare and other NGOs working on water projects on the Bandiagara Plateau:

- All proposed dam projects should include a basic environmental assessment prior to implementation (see Section 3.2).

- To ensure that villagers do not use dams for drinking water, before providing a dam donors should adopt the Catholic Mission policy of providing a safe source of drinking water (protected well or handpump). This should be an explicit policy of all future water projects. In addition, unsafe water sources should be eliminated by filling in holes, puddles, and so on once a safe water source is provided. Unprotected wells should be protected. This includes incorporating a safe method of water retrieval, such as a winch and pulley system. Success of any water supply and sanitation program requires active community participation. The development of the community participation program needs to begin prior to construction and will involve several meetings with the village committee. The purpose of these meetings is not only to ensure active participation in the construction phase, but also to ensure community ownership of the project once construction is complete. Many villages reported that it was the responsibility of the donors to repair broken pumps, and so on, indicating that the perception of ownership was lacking. A community operation and maintenance (O&M) program should be established and be responsible for the O&M of the dam, reservoir, wells, and pumps. These responsibilities would include removing debris and aquatic vegetation from the dam reservoir. Provision of safe water sources for drinking water should be accompanied by an educational program demonstrating hygiene practices and the advantages of safe water use.

- In Dogon culture, child rearing, nutrition, domestic water use, and hygiene are considered to fall within the women's domain. Even though women have little authority at the village level, these functions make them crucial actors in the struggle against undernutrition, ill health, and infant and child mortality. Future health, nutrition, and hygiene projects should be targeted specifically to women. To have a lasting impact, these interventions would have to involve long-term education and fundamental social change and specific training of village women or female village committees as health agents. Such projects should include basic instruction in hygiene and first aid, including ORT, advice on locally available nutritional supplements, training in culturally appropriate water purification techniques, and studies on feasible behavioral modifications to limit water contact.

- Coordination of all development activities must take place on the plateau. The team's work made its members aware of the interconnections between health, water supplies, agriculture, and cultural practices. A local NGO (the team recommends Harmonie du Sahel—HDS), with assistance from an international NGO (the team recommends Africare), should take on the function of providing overall coordination of all development activities and should become an information resource to each development partner. As part of the global Guinea worm eradication program, UNICEF is developing a simple Geo-base Information System (GIS) to characterize regional Guinea worm. This system could easily be adapted for the needs of regional coordination. Therefore, Africare and HDS may want to work closely with UNICEF and the national Guinea worm eradication program. The other two key players in the region are GTZ and the Catholic Mission.

- All developers of water resources and promoters of onion production should consider alternative irrigation approaches (e.g., gravity or siphon systems for downstream fields) or other measures to reduce water contact. The Catholic Mission looked at pumping as a possibility, and GTZ has developed an extensive irrigation system at Tegourou, which the team observed. The disadvantages to these systems are cost, maintenance, accessibility, and getting the farmers to use these new technologies as intended. Other possibilities might include the use of boots or small bridges over the water to allow collection without entry. The possibility of replacing calabashes with sprinkling cans (available in Bamako) should be explored. Reducing water contact is difficult but effective in disease prevention.

- All new dams should be constructed with release mechanisms such as sluice gates. This would allow for control over the water level in the reservoir and provide a habitat control mechanism for schistosomiasis. It would also allow for dam repairs throughout the year.

For USAID:

- Technical assistance should be provided to the schistosomiasis control program through R&D/H's Vector Biology and Control Project II (VBC). Staff in the program have already worked with a subcontractor on the VBC Project. Of particular interest are further characterization of the distribution of schistosomiasis, particularly with respect to the presence or absence of dams, measurement of morbidity resulting from schistosomiasis, and the potential economic impacts of schistosomiasis on

Dogon onion production. This offers an opportunity of close collaboration between GRM, GTZ, and USAID.

For bilaterals and multilaterals:

- The emphasis to date has been on the provision of surface water storage for agricultural production. However, the structural geology, particularly along the cliffs, and the presence of artesian sources (Vaou), plus the high dam failure rate (loss of water through seepage), suggest that there are significant untapped groundwater resources. New techniques in groundwater exploration using LANDSAT imagery and horizontal drilling could result in identification of significant new water resources. Vertical wells on the top of the plateau, unless they are artesian, have the disadvantage of requiring pumping. Horizontal wells in the cliffs, while technically more difficult to drill, could result in gravity-fed systems. A German consulting firm (Agrar-Und Hydrotechnik GMBH) is already conducting initial studies on the existing artesian sources. This should be coupled with state-of-the-art exploration studies. Why groundwater? Because groundwater is more sustainable than surface water, could support three onion production seasons, has no negative health effects, and would also be a safe source of drinking water. In addition, along the cliffs, there is the potential for springs and gravity-fed systems, which have not been exploited.

In addition to the above recommendations addressing dam impacts on the prevalence and intensity of schistosomiasis, the following recommendations are made.

For GRM:

- Guinea worm is a serious and debilitating disease for the Dogon. As part of implementation of its eradication program, the following are recommended:

  - GRM should work closely with UNICEF in the development and implementation of an information system (GIS).

  - GRM should obtain and distribute filter material. Local craftsmen (Daphene) already make filters but with inappropriate material. If filters can be produced and sold at the local level, perhaps with Peace Corps volunteers (PCVs) or other local NGOs providing health education, eradication of Guinea worm is attainable.

- It is important to characterize the economic impacts of Guinea worm on onion production to justify expenditures to control this disease. Reduction in health impacts, particularly Guinea worm, may be more effective in increasing yields than further investments in water schemes, insecticides, and so on. Therefore, the team strongly encourages such a research study.

- Where possible and in heavily infested villages, provision of protected water sources is the most effective way to eradicate Guinea worm at the village level. Filters only deter Guinea worm, while safe water sources deter several health problems.

- It is important that the program not only focus on the Dogon but also the Fulbe, as they are also infected and move from village to village when they sell milk. While the Dogon are village based, the nomadic Fulbe are a possible source of transporting Guinea worm from an infected village to an uninfected village, although the Dogon themselves are an alternative source.

- Health and hygiene education should be particularly directed toward women because in the Dogon Country, the collection of water, the training of children in hygiene practices, and basic health, nutrition, and first aid are the responsibility of women. Water and water supply is a Women-In-Development (WID) activity.

- Malaria is a major problem throughout the region and a cause of infant and childhood death. Dogon house structures are very permanent and the Dogon tend to sleep inside. Therefore, this is a community in which bed nets should be an effective control strategy if the cost is not prohibitive. As a national health intervention, the GRM should consider subsidizing the importing of bed net material, or at least ensuring that there are no taxes on the importation of this material.

For NGOs:

- The consultants identified a strong interest in latrines; indeed, the primary stated objection to latrines was cost, not social taboos or unfamiliarity. It has been found that providing safe water alone does not result in significant health improvements, but when it is coupled with sanitation, health improvements occur. Therefore the team encourages a pilot latrine project that builds upon experience gained to date.

- The team was surprised by the lack of knowledge of ORT and the reported high infant death rate (up to 50 percent fetal deaths reported, although the team questions this figure). Therefore, with the advances of the child survival program, promoted by A.I.D. and UNICEF, the team recommends that a child survival program be targeted to the Dogon.

- With dams, significant water is lost through evaporation (approximately 1 cm a day). One approach to reduce evaporative losses is to construct a compartmentalized reservoir. Using either smaller dams and gravity-fed systems or pumps in a compartmentalized reservoir, depth to surface area can be maintained, thus reducing evaporative losses and extending the usefulness of the reservoir.

For the Peace Corps:

- The Peace Corps Guinea worm program should be closely tied to the national eradication program. The national program could provide the filter material, while volunteers could assist in the production of filters for sale at local markets and provide health education in their use.

- PCVs need also to focus on child survival interventions, e.g., ORT.

For USAID and other bilaterals and multinationals:

- Child survival is a critical issue in the Dogon Country and should be given emphasis.

- Many development initiatives begin with education, but levels of education services in the plateau are very low. Therefore, the USAID-funded education program should be expanded to the Mopti-Bandiagara region.

- The presence of artesian sources suggests the potential for an economically viable water bottling operation in the Dogon Country. Currently, hard currency is used to import bottled water. If a local source could be developed, foreign exchange could be reduced, and depending upon the quality and quantity of the supply, the product could be exported.

- The Dogon region is an isolated but extremely beautiful region of Mali and an important tourist attraction. However, the national voice of the Dogon is limited as they are a minority group. Initiation of effective programs will require an outreach effort by GRM, NGOs, and bi- and multilaterals.

Chapter 6

LESSONS LEARNED

Based on the team's experience in carrying out this activity, the following recommendations are made for conducting future field studies:

- The composition of the team, involving both Malian and outside experts, clients, and funders (Africare, GRM, WASH, and A.I.D.) proved extremely helpful in understanding the problem and completing the activity with the necessary logistical support. Therefore, similar diversity is recommended in the future.

- By conducting a two-day team planning meeting in-country following WASH's guidelines, all team members were in agreement as to the scope of work, roles and responsibilities, and expectations of team members. As a result, this team worked very effectively together once it went to the field. Again, as a result, the team recommends continuing such a process in future studies.

- Rapid village assessment for water supply and sanitation projects is an activity all team members have undertaken in the past, yet there is no standard protocol or checklist for conducting such rapid assessments. The team therefore recommends that WASH develop a rapid assessment tool.

- The use of local NGOs (in this study, HDS) was particularly helpful in arranging logistics and facilitating entry into the villages and the culture and is a practice that should be continued.

- Field methods that include interviews with female focus groups are crucial for acquiring reliable information on issues relating to women and development. Interviews with focus groups of women revealed gender-based differences in development priorities and knowledge of health and water use practices. Women are generally hesitant to speak in male-dominated meetings and committees, perhaps because female interaction tends to be less assertive and more participative. These differences made team members aware of both the importance of talking to women and the need to focus interventions and educational programs toward women.

Chapter 7

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PHOTOS

Photo 1 Well in Nandoli, built in 1991 by the French This well is a 20-minute walk from the village When the well in town dries up during the dry season, villagers use water from this well to drink. People working in the fields also use it

Photo 2 Dourou dam built in 1984, 3 5 meters high and 131 meters long Villagers bring the soil to garden plots adjacent to the dam and build up gardens on top of the rock

Photo 3 Kori-kori dam, built in 1973, is 2 meters high and 234 meters long Besides irrigation and livestock watering, the reservoirs are used for bathing, swimming, domestic uses, fishing, and sometimes drinking The reservoirs typically contain large quantities of aquatic vegetation which provide a habitat for the snails which transmit schistosomiasis Also apparent in this picture is leakage at the dam's downstream base

Photo 4 Kori-kori dam Water contact with reservoir water is extensive in most villages Here one woman is bathing herself and another is preparing to wash her clothes

Photo 5 This farmer has built his garden adjacent to an impounded water site Traditional irrigation practices require walking into the water and immersing the hands and arms to fill calabashes

Photo 6. In Yawa, a village with no dam or protected water supply, villagers have been taught to filter their drinking water to protect against guinea worm disease This woman is using her head scarf as a filter

Photo 7 Focus group discussion held in Yamé

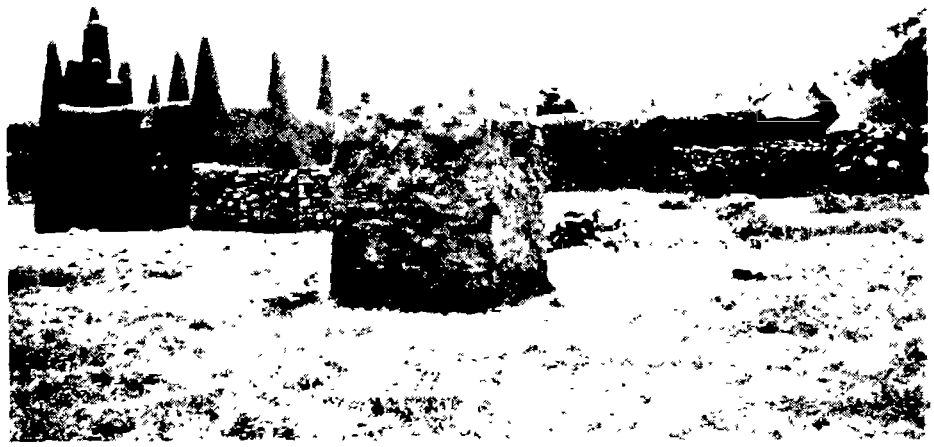

Photo 8 One of the very few latrines in the Dogon This ventilated improved double pit latrine in Tegourou is adjacent to the village mosque

Photo 9. Antiamba Tembely, Secretary of Social and Cultural Affairs of the Harmonie du Sahel, at an India Mark II pump built by the Catholic Mission in 1985. The hollowed-out log serves as a watering trough for animals The pump is about 15 minutes walk from the village. Passersby drink from it but the villagers prefer to drink from surface water sources. The water from the pump "tastes bad "

Appendix A

SCOPE OF WORK/REQUESTING CABLES

SCOPE OF WORK

MALI: TA TO EXAMINE THE HEALTH EFFECTS OF DAMS IN THE DOGON COUNTRY

BACKGROUND

Nearly 100 dams have been constructed in the Dogon region over several years. Though waters in the dams were meant to be used for irrigation to increase traditional garden production, they are also used for drinking water. The dams are suspected of being responsible for some increase in water related diseases. This may be because the water stagnates for up to 11 months after the rainy season, and because the villagers use this water for personal and domestic needs, including animal use. Africare, GTZ and other international donors involved in the financing and construction of the dams, are becoming increasingly concerned about their environmental health effects and in identifying what can be done to mitigate these effects. As a result, USAID has requested WASH Technical Assistance.

SCOPE OF WORK

Activities for USAID

The WASH consultant will be part of a three person team including an environmental public health expert and a water resources engineer from AID's Office of Health of the Bureau of Science and Technology that will go to the Dogon region in Mali for a period of three weeks to do a rapid qualitative assessment of the extent of the problem, to identify obvious immediate and long term remedial actions if possible and to make recommendations for further study if needed.

GENERAL TASKS OF THE TEAM WILL INCLUDE:

(1) gather information on the prevalence of water related disease and existing local programs to combat them;

(2) assess the environmental health effects of dams;

(3) identify mitigating measures for use in design and after construction;

for villages which have dams;

(5) consider and recommend other alternatives for providing drinking water such as water wells, catchments, etc. with due consideration for groundwater availability and cost of such alternatives;

(6) submit draft report to AID/Bamako's Health Officer and discuss results with AID and other concerned parties and;

(7) finalize WASH field report.

The specific tasks of the social scientist will include:

(1) Conduct interviews with selected people (by age,sex, ethnic composition) onchanges of disease patterns as they relate to the construction of the dams. This task can be done in focus groups and then followed up by more in depth interviews. The information here should note differences between categories, e.g. are migrants more prone to disease than settlers?, men to women?, etc.;

(2) determine whether or not people view the environmental health effects as resulting from the dams;

(3) identify key indicators that will need changing if and when programatic action is taken to reverse effects of dams and;

(4) outline additional reseach, if necessary, to develop the most appropriate interventions for health improvements and;

(5) assist with the writing of the WASH field report

PERSONNEL

The WASH consultant will be a social scientist with a public health background, fluent in French, with experience in French speaking Africa - prefarably in Mali.

END PRODUCTS

ANN - PLEASE FILL IN.....

SCHEDULE

Start:	August 11, 1991
Team Planning Meeting:	August 12, 1991
Field Work:	August 13 - September 5, 1991
End:	December 30, 1991

(4) identify possible health training interventions and their costs for villages which have dams;

(5) consider and recommend other alternatives for providing drinking water such as water wells, catchments, etc. with due consideration for groundwater availability and cost of such alternatives;

(6) submit draft report to AID/Bamako's Health Officer and discuss results with AID and other concerned parties and;

(7) finalize WASH field report.

THE SPECIFIC TASKS OF THE SOCIAL SCIENTIST WILL INCLUDE:

(1) Conduct interviews with selected people (by age,sex, ethnic composition) on changes of disease patterns as they relate to the construction of the dams. This task can be done in focus groups and then followed up by more in depth interviews. The information here should note differences between categories, e.g. are migrants more prone to disease than settlers?, men to women?, etc.;

(2) determine whether or not people view the environmental health effects as resulting from the dams;

(3) identify key indicators that will need changing if and when programmatic action is taken to reverse effects of dams and;

(4) outline additional research, if necessary, to develop the most appropriate interventions for health improvements and;

(5) assist with the writing of the WASH field report.

PERSONNEL

The WASH consultant will be a social scientist with a water and public health background, fluent in French, with experience in French speaking Africa - preferably in Mali. The consultant should also be able and willing to travel under difficult conditions.

END PRODUCTS

WASH field report

SCHEDULE

Start:	July 18, 1991
Team Planning Meeting:	August 30, 1991
Field Work:	September 2 - September 25, 1991
End:	December 30, 1991

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INCOMING TELEGRAM

AGENCY FOR INT'L DEV.
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AIDAC

AID/W FOR ST/HEALTH JOHN AUSTIN AND AFR/TR/HPN JOHN COURY; ABIDJAN FOR REDSO/WCA JOHN PAUL JAMES

E.O. 12356: N/A
SUBJECT: PROPOSED ST/HEALTH AND WASH CONSULTANCY TO MALI IN AUGUST, 1991

REFS: (A) ST/HEALTH TO USAID FAX 4/12/91;
(B) 90 BAMAKO 07048; (C) 90 STATE 24117,
(D) BAMAKO 03237

1. WE APPRECIATE PROPOSAL FOR FIELD ASSESSMENT MISSION. OUR ABILITY TO PROVIDE LOGISTIC SUPPORT (COMPUTERS, SECRETARY, ETC.) IS LIMITED BUT WE WILL DO OUR BEST. PEACE CORPS WILLING TO PROVIDE ASSISTANCE WITH LOCAL TRANSLATORS AND VILLAGE INTRODUCTIONS THROUGH THEIR VOLUNTEERS IN THE AREA. WE WILL UNDERTAKE

TRANSPORT ARRANGEMENTS BUT WILL HAVE TO CONSULT ON TEAM SCHEDULE TO ENSURE COORDINATION WITH OUR OTHER REQUIREMENTS. TIMING OF ARRIVAL IS FINE.

2. LOCAL PRITECH REPRESENTATIVE WILL BE AVAILABLE FOR MEETINGS WITH TEAM IF DESIRED BUT WOULD NOT BE INVOLVED WITH FIELD VISITS. WE RECOMMEND INCLUSION OF LOCAL NIH MALARIA ADVISOR, DR. RICHARD SAKAI, IN THIS ASSESSMENT AS WELL AS HIS MALIAN COUNTERPART WHO IS FROM DOGON ETHNIC GROUP.

3 EARLIER COMMUNICATIONS (REF B) REQUESTED ST/HEALTH TO CONTACT AND BRIEF AFRICA BUREAU ENVIRONMENTAL OFFICER JOHN GAUDET. PLEASE ADVISE IF THIS BRIEFING HAS TAKEN PLACE.

4. PLEASE BE ADVISED THAT MISSION POLICY REQUIRES THAT ALL NON-USDH TRAVELERS TO USAID/MALI MUST BE COVERED BY A VALID MEDICAL EVACUATION INSURANCE POLICY AND NOT JUST A MEDICAL HEALTH BENEFITS INSURANCE PLAN. UPON ARRIVAL IN MALI, TRAVELERS WILL BE REQUIRED TO PROVIDE THE NAME, ADDRESS AND TELEPHONE/TELEX NUMBER OF THE INSURANCE COMPANY, AS WELL AS THE POLICY NUMBER TO THE USAID/MALI MANAGEMENT OFFICE. VISITORS WITHOUT PROOF OF A VALID POLICY MAY BE DENIED ACCESS TO EMBASSY HEALTH UNIT FACILITIES.

5. PLEASE PROVIDE ADDITIONAL INFORMATION ON CONSULTANCY WHEN AVAILABLE. BEST REGARDS. GELBER

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AMEMBASSY ABIDJAN

UNCLAS BAMAKO 05473

AIDAC DIRECT RELAY

AID/W FOR ST/HEALTH DENNIS LONG AND AFR/TR/HPN JOHN COURY; ABIDJAN FOR REDSO/WCA JOHN PAUL JAMES

E.O. 12356:N/A

SUBJECT: WASH CONSULTANCY TO MALI TO STUDY HEALTH EFFECTS RESULTING FROM SMALL DAM CONSTRUCTION

TO: EDDY PEREZ
-- CAMP DRESSER & MCKEE INTERNATIONAL, INC.
-- WASH
-- ROOM 1001
-- 1611 NORTH KENT STREET
-- ARLINGTON, VIRGINIA 22209
-- TEL (703) 243-8200

SUBJECT: WASH CONSULTANCY TO MALI TO STUDY HEALTH

EFFECTS RESULTING FROM SMALL DAM CONSTRUCTION

REFS: (A) PEREZ/WOODRUFF FAX RECEIVED 7/30/91;
-- (B) STATE 238717

1. USAID AND AFRICARE CONCUR PROPOSED THREE WEEK VISIT OF DENNIS LONG, RITA KLEES, AND EVE CROWLEY TO MALI BEGINNING O/A 9/5/91. USAID DRIVER WILL MEET AND ASSIST IF ETA RECEIVED. WE ALSO CONCUR WITH PROPOSED CHANGES IN SCOPE OF WORK IN REFTEL B.

2. ALL FINAL ARRANGEMENTS FOR LOGISTICS, TRANSPORTATION, TRANSLATORS ETC. WILL BE MADE WHEN THE TEAM ARRIVES IN COUNTRY. USAID AND AFRICARE WILL ASSIST TO THE EXTENT THAT OUR RESOURCES PERMIT. USAID CAN PROVIDE ONE VEHICLE FOR TEAM AND THEIR STAFF AND AFRICARE IS WILLING TO PROVIDE ONE VEHICLE WITH THEIR PARTICIPANT BUT EXPENSES OF FUEL MUST BE MET BY WASH. LOCAL PEACE CORPS VOLUNTEERS IN BANDIAGARA RECOMMENDED AN EXCELLENT DOGON TRANSLATOR ON A PREVIOUS TRIP TO THE REGION AND CAN ADVISE TEAM IN MANY OTHER WAYS ON LOCAL CONDITIONS.

3. AFRICARE STATES THEY PLAN TO SEND ONE INDIVIDUAL WITH THE TEAM. USAID SUGGESTS TEAM CONSIDER INVITING DIRECTOR OF NATIONAL GUINEA WORM CONTROL PROGRAM, DR. ISSA DEGOBA, TO ACCOMPANY TEAM WHO IS NATIVE TO THE DOGON REGION. USAID MAY SEND ONE OR TWO REPRESENTATIVES FOR PART OF TRIP, POSSIBLY HEALTH OFFICER OR HIS MALARIA ADVISOR AND MISSION ENGINEER, BUT CANNOT CONFIRM AT THIS TIME.

4. MISSION POLICY REQUIRES THAT ALL NON USDH TRAVELERS TO USAID/MALI SHOULD BE COVERED BY A VALID MEDICAL

BAMAKO 05473 050949Z 7623 080244 AID1982

EVACUATION POLICY, NOT JUST A MEDICAL HEALTH BENEFITS INSURANCE PLAN UPON ARRIVAL IN MALI, THE NAME, ADDRESS, AND TELEPHONE/TELEX NUMBER OF THE INSURANCE COMPANY AND THE POLICY NUMBER MUST BE PROVIDED TO THE USAID/MALI MANAGEMENT OFFICE. VISITORS WITHOUT PROOF OF A VALID POLICY MAY BE DENIED ACCESS TO EMBASSY HEALTH UNIT FACILITIES.

5. PLEASE BE ADVISED THAT MANY LOCAL HOTELS ACCEPT ONLY CASH PAYMENT, AND THAT VISITORS TO USAID/MALI MAY HAVE ONLY LIMITED ACCESS TO USG CHECK-CASHING FACILITIES. A LOCAL BANK OFFERS TWICE WEEKLY SERVICE ON THE USAID COMPOUND TO CASH US DOLLAR CHECKS FOR AID-FUNDED PERSONNEL CHARGING 1 PERCENT COMMISSION. TEAM SHOULD BRING SUFFICIENT PERSONAL CHECKS OR TRAVELERS CHECKS TO COVER ALL ANTICIPATED AND UNANTICIPATED EXPENSES.

6. APPRECIATE WASH ASSISTANCE AND LOOK FORWARD TO VISIT.

BEST REGARDS: WJWOODRUFF, HPO
USAID/MALI, C/O AMERICAN EMBASSY BAMAKO, TELEX NO.2448
AMEM MJ, BAMAKO/MALI. GELBER

NOTE: PASSED TO ABOVE ADDRESSEE

Africare

L'Amélioration de la vie en afrique rurale en développant les ressources hydrauliques, la production agricole et les services de santé
B.P 1792 Tél. 22.37.03 · Bamako
République du Mali

Effects of Bandiagara Circle Water Retention Structures on Health - Need for Assessment

January 1990

Background

During 1989 Africare and the villagers of Oulou-Oulou, Bandiagara Circle, completed construction of a 90 meter long rock and masonry dam. The project has allowed the 40 Dogon families associated with the project to expand their production of onions by increasing the area under cultivation from 2.0 to 3.0 hectares and by permitting the planting of two, rather than one, crops during the October to March growing season. The result is that the villagers now grow nearly three times as many onions as before the dam and they have been able to grow additional crops such as floating rice on the perimeter of the dam. This project, which is now in its last stage, is partially funded by a $30,000 grant from the United Methodists Committee on Relief (UMCOR) and in part from Africare's matching agribusiness project (Grant No. PDC 0266-G-SS-5068-00) from AID. The project not only entailed the construction of a dam but also training in accounting and management for the gardeners to maximize their benefits and contribute to the sustainability of the project.

The success of the Oulou-Oulou dam inspired the neighboring village of Yame, three kilometers northeast of Oulou-Oulou, to request that Africare help them construct a similar dam. With nearly 12,000,000 FCFA from the FED and $25,300 from the Jesse Besser Foundation, Africare and the villagers began this project in 1989. This nearly identical replica of the Oulou-Oulou project is now fully underway with the excavation of the foundation completed and the first masonry work begun in January 1990.

The Oulou-Oulou and Yame dam projects are among nearly 100 dams constructed or being constructed in the Bandiagara Circle with most having been constructed by the Catholic Mission, GTZ and the GRM's Genie Rural. Of the nearly 100 dams about one-third have failed to hold water effectively enough to have much agricultural impact. The other two-thirds of the dam have significantly helped the population increase their incomes and production. The GTZ attributes 40% of the onion production in Bandiagara to these dams.

Possible Problem

As in other water retention programs it is possible that the dams constructed in the Circle have had negative health impacts by increasing the incidence of water borne diseases. Malaria, schistosomiasis and guinea-worm have all been identified as diseases found in Bandiagara and it is possible that the dams have helped aggravate the problems. In the design of the Africare projects it had been anticipated that the Affairs Sociales of the GRM would provide health education and sanitation instruction to the village population. While some extension training has taken place, Africare has noted that many gardeners in Oulou-Oulou continue to drink water from the dam rather than from the forage well installed by the Catholic Mission in conjunction with the

project. The gardeners presumably believe the convenience of drinking water from the dam reservoir outweights the potential health benefits of drinking the well water. GTZ and Catholic Mission workers have noted the same problem at other dam sites.

Unfortunately no baseline health data was obtained in Oulou-Oulou or Yame indicating the health situation prior to construction of the dams nor any survey taken after the construction of the Oulou-Oulou dam. Since we do not know the incidence of disease either before or after construction of the dams, we do not know the degree of health problem (if any) caused by the Africare dams. Unfortunately no money is available at this time to conduct surveys in either Yame nor Oulou-Oulou. To our knowledge, no other organization has collected data on the incidence of water borne dieases in the Bandiagara region before or after the construction of a dam.

Services Needed

There is and has been health training about water borne diseases in the area but these have not been conducted in conjunction with any reliable data collection. To properly understand and potentially address any negative health problems caused by dam construction in the Bandiagara Circle, it would be useful to:

1) gather information regarding the prevalence of disease in the zone and the programs to combat them;

2) assess the environmental health effects of dams in the Bandiagara Circle (a baseline study could be conducted in Yame, which does not yet have a dam, and it could be compared to a similar study in the neighboring village of Oulou-Oulou which has a dam);

3) potentially identify and help plan a health training intervention for villages which have dams.

DRAFT SCOPE OF WORK FOR NEW TASK
MALI: THE HEALTH IMPACT OF SMALL DAMS

version number : 2
date: July 2, 1991
draftee: Eddy Perez

Background

Nearly 100 dams have been constructed in the Dogon region over several years. Though water in the dams were meant to be used for irrigation to increase traditional garden production, they are also used for drinking water. The dams are suspected of being responsible for some increase in water borne diseases (guinea worm, schistosomiasis, and posily malaria). Africare , GTZ and other international donors involved in the financing and construction of the dams, are becoming increasingly concerned about their environmental health effects and in identifying what can be done to mitigate these effects. As a result, AID has requested WASH Technical Assistance.

SCOPE OF WORK

Activities for USAID

The WASH consultant will be part of a three person team including an environmental public health expert and a water resources engineer from AID's Office of Health of the Bureau of Science and Technology that will go to the Dogon region in Mali for a period of three weeks to do a rapid qualitative assesment of the extent of the problem, to identify obvious immediate and long term remedial actions if possible and to make recomendations for further study if needed.

General tasks of the team will include:

(1) gather information on the prevalence of water related disease and existing local programs to combat them;

(2) assess the environmental health effects of dams ;

(3) identify mitigating measures for use in design and after construction;

(4) identify possible health training interventions and their costs

Appendix B

SCHEDULE

September	Activity
4-5	Team Planning Meeting in Bamako
6	Briefing with USAID
6	Interviews in Bamako
7	Travel to Mopti
8	Travel to Bandiagara
9	Interviews in Bandiagara

Team Schedule

11	Visit Yamé, Ouolo-Ouolo (Environmental/Engineering Subgroup)
	Visit Dourou-tanga (Health/Social Subgroup)
12	Visit Yawa (Environmental/Engineering Subgroup)
	Visit Korou (Health/Social Subgroup)
13	Interviews in Bandiagara
14	Visit Tegourou (Environmental/Engineering Subgroup)
	Visit Koundou (Health/Social Subgroup)
15	Visit Nandoli (Environmental/Engineering Subgroup)
	Visit Arou (Health/Social Subgroup)
16	Interviews in Bandiagara and market
17	Visit Songa
18	Visit Vaou
19	Visit Kori-kori
20-21	Return to Bamako
22-24	Write report
25	Deliver report to A.I.D. and Africare
26	Briefing with A.I.D. and Africare, depart

Appendix C

PERSONS CONTACTED

Dan Gerber	Representative, Africare
Friedeger Stierle	First Aid Care, Bandiagara Circle, Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ)
Mamadou Traoré	Chief of Community Health Division, Coordinator of the Schistosomiasis Program, Institut National de Recherche en Santé Publique (INRSP)
Karen Woodbury	Director, Peace Corps
Fritz Etienne	Program Manager, Peace Corps
Douglas Steinberger	CARE
M. Diarrah M. Sekou Toure	CCA-ONG
Souleimane Awande	Adjunct Chief Doctor, Bandiagara
Mamadou Issa Tapo	Commander of Bandiagara Circle
Seyni Sidibe	Chief Doctor
Mamadou Keita	Sanitary technician
Amadou Cisse	Technician in community development and social work
Siaka Diakite	Project Chief, CRMT (Regional Center for Traditional Medicine)
Pierre Mounkoro	Doctor
Wobig	Coordinator, DED (Deutscher Entwicklungs Dienst)
Assana Diawara	Commander of Dourou Circle
Alou Simala	Medical Post Chief Segou

Antimbele Nango	Medical Post Chief Pelou
Amadou Tepili	Health Care Assistant Pelou
Awa Sagara	Midwife-Dourou
Amadou Andié Sagara	Village Chief-Dourou
Amadou Ogueré Sagara	Extension Agent-Dourou
Djibril Sagara	Village Advisor-Dourou
Amadou Sagara	President, Dourou Dam Management Committee
Salif Sagara	Member, Dourou Dam Management Committee
Awa Sagara	Extension Agent
Allaya Sagara	Member, Dourou Dam Management Committee
Oumar Sagara	Member, Dourou Dam Management Committee
Soumeyla Sagara	Observer, Migrant, returned to Dourou on holiday (works on health and family planning in AMPPF, Mopti)
Mamadou Sagara	Extension Agent-Dourou
Mamadou Kediu	Member, Dourou Dam Management Committee
Ogopemó Banou	Chief of Korouna
Ahmadou Banou	Counsellor of Korouna chief
Zachary Banou	Counsellor of Korouna chief
Seguei Banou	Extension Agent, first aid hygienist, Korouna
Ambako Banou	Eldest person of Korouna
Fanta Sagara Kimbe Banou Asa Kassoge	Women of Korouna

Diko Yebedje Yama Sagara	
Fatumatu Sagara Aisata Sagara Aissata Sagara Derapin Sagara and Others	Women of Douroutanga
Nyime Tembely Nyandou Djiguiba Merepe Karambe Isayi Yebeize Djendje Tembely Yande Yebedje Fanta Djiguiba	Women of Yamé
Valerie Flax Tom Zimmer Julie Donahue John Stultz	Peace Corps Volunteers, Bandiagara
Aguibou Degoga	Translator USAID/Land Tenure Center
Antiamba Tembele	Secretary of Social and Cultural Affairs, Harmonie du Sahel (HDS), NGO
Amadou Basil Sumburu	Permanent Secretary, HDS
Justin Sagara	Accounts Secretary, HDS
Dominique Sagara	Administrative Secretary, Adjunct to the Permanent Secretary, HDS
Dicko Kassoghe	Conflict Secretary, Secretary to the Organization, HDS
Mamadou Coulibaly	Treasurer, HDS
Li Sumburu	Local Committee Representative of HDS, Pankass
Atana Sumburu	Local Committee Representative of HDS, Korou
Sedou Samake	Local Committee Representative of HDS, Mopti

Iaia Samaka	Nurse, Sangha Health Post
Samba Coulibali	Assistant Nurse of Sané
Anna Guerin	Nurse, Sangha Health Post, member of Community Aid Association
Oumarou Coulibaly	Commander of Circle of Sangha
Batam Darrah	State Committee Member, Koundou-da
Batagadja Darrah	Secretary General of Youth, Koundou-da
Oumarou Darrah	Ward chief, Koundou-da
Ahmadou Darrah	Koundou-da youth
Amperou Darrah	Koundou-da youth
Anewe Darrah	Elder, Koundou-da
Atanu Darrah	Former State Committee Member, Koundou-da
Balele Kodjo Anai Darrah Sama Darrah Yabale Darrah Munyi Kalan Darrah Miriama Darrah	Koundou-da women
Hogon	Arou
Ooyonidiou Din	Son of former Hogon, brother of current Hogon
Aisata Tapili Djeneba Karambe Kadidia Tapili	Nandoli women
Moktar Tapili	Man of Nandoli
Karin Darame	Head of small enterprise, Dafine filter and well bag makers, Bandiagara Market

Moussa Sidibe	Apprentices, Dafine filter/well bag maker
Dakarija Senu	
Oumou Karembe	President Songo women
Eseta Yanoga	Songo women
Gado Karembe	
Misana Guindo	
Aisata Tapili	Vaou women
Yamba Kansé	
Hawa Tapili	
Hawa Djiguba	
Yatimbe Kassonke	
unnamed	Group of 9 Vaou children
Suruna Djigiba	President of Kori-kori women's association
Timbe Napó	Kori-kori women
Misiru Tembely	
Bintou Kasogue	
Assata Guindo	
Maimouna Tembely	
Arama Guindo	
Assata Anogue	
Assata Tapili	
Absatou Tembely	
Kadidja Tembely	
Fatumata Karambe	Midwife, Kori-kori
unnamed	Group of 33 Kori-kori children
Tom Ponsioen	Director, Catholic Mission, Bandiagara
Antoine Spijkerman	Engineer, Catholic Mission, Bandiagara
Armand Kassogne	Catholic Mission, Bandiagara
Mamodou Keita	Chief, Service d'Hygiene de Cercle Bandiagara
Oumer Siedibe	Engineer, Chief, System Hydraulique - Bureau Barrages et Des Energies

Hamadou Tapily	Nandoli Village Chief
Amadou Tapily	Men of Nandoli
Hamadou Tapily	
Moctor Tapily	
Hamadou Tapily	
Immolou Tapily	
Mamadou Tapily	
Kadikia Tapily	Women of Nandoli
Geneba Karamba	
Kadia Tapily	
Keneba Tapily	
Fatamta Tapily	
Amacome Dolo	School teacher - Kori-kori
Saifourou Tembely	Women of Kori-kori
Bibe Karambe	
Korilla Djijeibe	Men of Kori-kori
Ali Dierra	
Aobame Karambe	
Aboloulaye Kanambe	
Alpha Djiguiba	Yamé Village Chief
Soulehmane Djiguiba	Yamé President of Committee Management
Bourweima Djiguiba	Men of Yamé
Aboudou Djibuiba	
Ibrahama Djibuiba	
Fontomata Djibuiba	
Oumar Djibuiba	
Samba Djiguiba	
Mouneron Djibuiba	
Fontonmata Kjibuiba	Yamé Woman
Mousa Sagara	Yawa Village Chief
Ali Sagara	Men of Yawa
Aguib Degoga	
Amadou Sagara	
Amadou Sagara	
Adama Sagara	

Ousseyni Sagara

Amadou Djiginba	Village men of Tegourou
Hassana Djiginba	
Ali Djiginba	
Brehima Traoure	
HamidouDjiginba	
Bondary Djiginba	
Mamadou Dfiginba	
Baujeune Djiginba	
Koumdjon Banou	
Belco Kassogue	
Jalif Djibinba	
Kogenma Djiginba	Village women of Tegourou
Aissanda Djiginba	
Kormo Karambe	
Yanibeme Karambe	
Yamidyn Karamba	
Yissa Djiginba	Tegourou Dam Commitee Members
Aissn Karamba	
Yaba Kjiginba	
Adjarotu Sagara	
Ogotimbelou Djiginba	
Djondo Kjiginba	Men of Ouolo-Ouolo
Houssn Djiginba	
Amadou Sekou Djinginba	
Assana Ante Djiginba	
Seydou Djiginba	
Dommo Djiginba	
Bouruma Djiginba	
Keme Djiginba	Woman of Ouolo-Ouolo
Morissa Sagara	Men of Yawa
Ali Sagara	
Agmib Degoga	
Amadou Sagara	
Adama Sagara	
Ousseymi Sagara	
Ousseymi	

Hamashan Sagara	
Amadou Sagara Fatima Sagara Awa Sagara	Women of Yawa
Hilke Eberting	Civil Engineer, DED
Noel Yebeize	Animateur, DED
Brendt Wobig	Civil Engineer, DED
Sdou Djibi Maiga	Staff, DED
Christoph Kessler	Service Agricole de Cercle Bandiagara
Antoine Spijkerman	Engineer, Catholic Mission
Tom Ponsioen	Director, Catholic Mission
Keita Mamadou	Director, Service d'Hygiene de Bandaigara
Oumar Disdibe	Director and Engineer, Bureau Barrages et des Energies Systeme Hydraulique

Appendix D

ASSESSMENT QUESTIONNAIRE

Date:

Village: Ward:

Population:

Persons Interviewed In Village

	Name:	Position:
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Description of Water Source

No.	Source Type and Condition	For what purpose?	Distance/ Duration	When was it constructed?	By whom?
1					
2					
3					
4					
5					
6					
7					

Access to Water Source

No.	Who owns the source?	Who takes care of it?	Any person or village that can't use the water?

Types of Water Contact

No.	Contact/Use	Season of Use	Time of Day/Frequency

Describe the impacts the village perceives from dams (health, social, time saved by women, agriculture, nutrition, economic, environment):

Drinking Water

No.	Other Uses	Protected Quality	Who collects?	How stored?

How much water is used daily for domestic purposes?

Human Wastes

Where do you do your needs?	Is it near water sources or fields?	How many latrines and who built them?	Who uses these latrines?

Health

Diseases	Present Morb. Mort.	Cause	Treatment	Who/ Age/ Sex/ Group	Period
Water Borne					
Diarrhea					
Guinea Worm					
Water Washed					
Skin Diseases					
Trachoma					
Water Contact					
Schistosomiasis					
Water Related					
Malaria					

For critical diseases, please describe village perceptions of the cause of the disease.

Possible health impacts from increased water from dams:

Nutrition, water-washed diseases (eg. skin, lice):

Appendix E

CATHOLIC MISSION SMALL DAM INVENTORY

Tableau récapitulatif des constructeurs de barrages et de leurs résultats connus (*)

Exécuteurs	Nb. de barrages	ETAT		
		passables	défect	bons
'Projet Hydraulique Rurale de la Mission catholique	27	1	9	17
Génie Rural	25	9	12	4
G. T. Z. / D. M. H. E.	12	-	-	12
"SIX S."	7	?	?	?
G. T. Z. / O. T. E. R.	3	1	1	1
G. T. Z. / G. R.	2	1	-	1
Peace Corps	1	-	-	1
Grisule (par G. R.)	1	-	-	1
TOTAUX	78	12 +?	22 +?	38 +?

Appendix F

DED SMALL DAM INVENTORY

Explication pour le tableau :

N°	numero du barrage dans l'inventaire
Année	année de construction
Financement	bailleur de fonds (voir abréviations)

Causes pertes d'eau :

a	mur d'étancheité non étanche
b	fondation mal construite
c	failles verticaux au dessous du barrage
d	passages d'eau horizontale autour des ailes du barrage

Classification DED/GR :

A	demande un nouveau crépissage ou couche de goudron
B	demande un nouveau mur d'étancheité en amont
C	demande des injections de mortiers dans le sous-sol
F	demande une réparation ou remplacement des parties métalliques
ó	bon état
Ø	inutil, mauvaise site ou conception
Phase	réparation prevue pour la phase 1, 2 ou 3 du programme des réparations DED/GR (voire le programme)

Disponibilité d'eau

Retenu :	disponibilité d'eau dans la retenue jusqu'au mois indiqué
Puisards :	disponibilité d'eau dans la retenue dans des puisards jusqu'au mois indiqué
Aval :	disponibilité d'eau en puisards et cuvettes naturelles en aval du barrage jusqu'au mois indiqué

Inventaire des barrages au Plateau Dogon / Arrondissement de : KENDIE

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur arête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification B.E.D / G.E A	B	C	F	G	β	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risiculture +	-
I1	Segedougou	75	GTZ	2.80	210										X			Janv.	Mars		2		+	
I2	Semeli	74	GTZ	6.50	155										X			Juin		Juin	2	2	+	
I3	Bombo	75	GTZ	5.60	53 + 75		X		X		X		X				2	Déc.	Mars	Juin	2	2 +		
I4	Kentaba	76	MC	1.21	133	408									X			Oct.			- 1			
I5	Tuol	84	PAC	2.00	267	985						X		X			2	Janv.	Juin		1 +		+	
I6	Andomben	87	SIX S	3.60	163										X			Déc.	Avril		1			
I7	Orei 1	87	SIX S	7.15	37	263				X	X						2	Janv.		Juin	1	2		
I8	Orei 2	87	SIX S	2.75	116	159			X		X						2	Janv.	Mars		2			
I9	Lanti	87	SIX S	3.50	44	62										X					0			
I 10	Goumbain / Siri	88	SIX S	4.70	140	296			X	X	X						2	Oct.			0			
I 11	Finiam 1	86	SIX S													X					L'eau à boire			
I 12	Finiam 2	86	SIX S													X					L'eau à boire			
I 13	Querba		MC	En chantier																				

Inventaire des barrages au Plateau Dogon / Arrondissement de : BANDIAGARA

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur arête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification B.E.D / G.E A	B	C	F	G	β	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risiculture +	-
II 1	Tegadou	80		2.90	140	679		X	X			X	X	X			2 + 3	Nov.	Déc.	Déc.	1	1	+	
II 2	Indell	80		2.85	179	1068		X	X		X		X				2 + 3	Déc.			1		+	
II 3	Ondougou	83	MC	1.87	89	140			X		X	X	X				(MC)	Oct.			0			
II 4	Seddigué	86	MC	4.70	33							X			X		(MC)	Nov.	Juin	Juin	2	1		
II 5	Dangu	88	FENU	2.75	103	313		X	X						X		(GEER)	Nov.			0			

Inventaire des barrages au Plateau Dogon / Arrondissement de : CENTRAL 1

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.R.D / G.R A	B	C	F	O	ß	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Liaison + -
VI 71	Doukombo	46		3.60	27							X		X			1						
VI 72	Tenniéirne	48		3.20	86				X						X			Nov.	Juin	Juin	2	2	
VI 73	Bandiagara 1 (amont)														X								
VI 74	Bandiagara 2														X								
VI 75	Bandiagara 3 (aval)														X								
VI 1	Andiembolo	38		0.90	91		Construction d'un nouveau barrage										IV.12	Nov.	Juin	Juin	1		
VI 2	Ouinayalena	avant 60													X								
VI 3	Longourougoungou	avant 60		1.05	72	358			X						X			Nov.			1		
VI 4	Kori-Kori	73/80		2.00	134	822	X					X		X			2	Déc.	Janv.		1		•
VI 5	Ndiombo / Folkanda	73/81		2.60	159	528	X					X		X			2	Nov.	Déc.		1		•
VI 6	Sibi-Sibi 1	74	[illegible]	1.40	69	139					X						1	Janv.	Juin	Juin	- 2	VI 8	•
VI 7	Boundioulou	73/83	[illegible]	5.50	355				X		X			X			1	Janv.	Juin	Juin	2	2	•
VI 8	Sibi-Sibi 2 (aval)	77	[illegible]	8.05	98	173									X			Janv.	Juin	Juin	- 2		•
VI 9	Diombairou	79	[illegible]	4.00	207				X	X	à refaire ?						2 + 3	Oct.		Juin	0	2	
VI 10	Anakanda / Danasougo	80	[illegible]	2.65	191	363				X		X		X			2	Nov.	Mai		1		•
VI 11	Tégourou	81	[illegible]								X						1	Mai		Mai	2	2	•

Inventaire des barrages au Plateau Dogon / Arrondissement de : CENTRAL 2 (suite)

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.R.D / G.R A	B	C	F	O	ß	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Liaison + -
VI 12	Kokadjagou	81	[illegible]	3.40	386						X						1	Mai		Mai	2	2	•
VI 13	Baga 1 (aval)	85	[illegible]	10.00	550										X			Avril		Mai		2	
VI 14	Bassari	83	[illegible]	2.64	78	180									X			Nov.			- 1		
VI 15	Diembeleléye	85	[illegible]	2.52	237	583									X			Nov.	Juin		1		•
VI 16	Baga 2 (amont)	86	[illegible]	2.00	77	144					X		X				1 + 3	Déc.	Juin		2		•
VI 17	Kolonzbanga	86	[illegible]	1.67	81	137									X			Déc.	Av.	Av.	2		
VI 18	Djigibombo	87	[illegible]	2.19	83	381										X		Oct.			0		
VI 19	Sibi-Sibi 3 (amont)	87	[illegible]	2.40	60	126			X				X				3	Oct.					
VI 20	Sebele 1	86	[illegible]	3.00	83	321				X		X					1	Déc.	Juin	Juin	1	- 1	
VI 21	Sebele 2	87	[illegible]	4.75	82	824			X				X				3	0					
VI 22	Koundougou 1	87/88	[illegible]	1.35	101	92									X			Nov.	Juin	Juin	- 1		•
VI 23	Koundougou 2	87	[illegible]	0.60	50	42									X			Oct.					
VI 24	Solo-Solo		Afrisure	Deuxième étappe en chantier																			
VI 25	Boré		[illegible]	En chantier																			

Inventaire des barrages au Plateau Dogon / Arrondissement de : Bandiagara

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.N.D / G.R A	B	C	F	O	S	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risque fuite +	-
III 1	Tené amont	62		2.35	53	500		X							X			Oct.	Juin	Juin	1	1		
III 2	Mandoli aval	63		2.55	174	385										X		Oct.			0			
III 3	Mandoli amont	64		2.30	176	345										X		Oct.			0			
III 4	Yabitenga	74	LC	4.40	117	518				X					X			Déc.			1			
III 5	Tené aval	76	USAID	7.60	105			X	X	X		X	X				2 + 3	Oct.	Juin					
III 6	Delegou	76	USAID	3.00	91	390		X	X	X		X	X				2 + 3	Oct.	Déc.	Juin	1	2		
III 7	Tountounema	78	LC	2.15	193	396		X	X			X					2	Oct.	Juin		1 +			
III 8	Boundou	80	LC	2.40	150	405			X				X				3	Nov.	Déc.		1			
III 9	Bolomo	82	LC	3.80	107	450																		
III 10	Amala Ouiné	84	FAC	2.20	129	286		X	X			X					2	Déc.	Mai	Déc.	1 +		+	
III 11	Gonge	86	LC	1.60	45										X		(LC)	Nov.		Déc.	1	1		
III 12	Gondo - Ori	87	LC ?	3.60	93	554								X	X		(OTHR)	Mars						
III 13	Komogou	87	LC	4.90	36	234			X						X		(LC)	Nov.						

Inventaire des barrages au Plateau Dogon / Arrondissement de : Bankass

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.N.D / G.R A	B	C	F	O	S	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risque fuite +	-
IV 1	Gouan / Oriaolo	50		13.00	18	1226									X			Juin		Juin	2			
IV 2	Pegué	74		2.40	21	45	X	X				X					2	Nov.			0		+	
IV 3	Koundouda	74	USAID	1.77	24			X				X					2	Oct.		Déc.	0	1		
IV 4	Yougouna	74	USAID	2.30	18											X		Oct.			0			
IV 5	Doga / Hassassa	74	CILADE	8.00	62	1994									X			Avril		Avril	2			
IV 6	Amani	74	CILADE	8.50	34 + 67	456		X	X	X						X		Oct.			0			
IV 7	Bongo	76	BIRD	3.50	219	1018	X	X	X		X		X				1 + 3	Mars			1+			
IV 8	Gandakilama 1	77	LC	2.80	78	250	X				X						1	Janv.	Juin		2		+	
IV 9	Gandakilama 2	77	LC	2.70	50		détruit 82									X								
IV 10	Kamba Siandé	81	LC	2.80	52	435				X			X	X			3	Nov.	Juin	Mars	- 1			
IV 11	Ogolda	66	LC	4.70	69	526									X			Déc.	Juin		1			
IV 12	Dibougou / Ogolleye	86	LC	3.60	35	255	X		X		X							Mars			1			
IV 13	Yayé	86	USAID	1.00	12	digue									X			Fév.			1		+	
IV 14	Dini	87	USAID	1.90	29	49			X						X			Oct.			- 1		+	
IV 15	Tireli	67	VILLAGE	0.50	34	45									X			Déc.			1			
IV 16	Ireli	68	ISF	5.00	27	209									X									
IV 17	Barouma	84	DNH	3.10	56	175									X									

Inventaire des barrages au Plateau Dogon / Arrondissement de : DOUROU

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.E.D / C.E A	B	C	F	O	S	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risiculture +	-
V1	Poleu 1	72	PAC	2.10	186	378			X	X						X		Oct.	Mai	Déc.	0			
V2	Dobolo / Somadié	74	OTZ	5.20	97	1286	X	X	X	X		X	X				1 + 3	Avril		(V3)	2	(V3)	+	
V3	Dobolo / Goleou	75	OTZ	4.35	163	780			X		X						1	Avril		Avril	2	2	+	
V4	Douroo - Tanga	79	LC	6.25	48	545									X			Mai			2			
V5	Soninghe	81	PAC	2.70	159	498	X		X		X						1	Déc.	Juin	Juin	1	1	+	
V6	Vodié	83	MC	1.52	80	96						X			X		2	Déc.	Déc.	Juin	1	2	+	
V7	Kaeou	83	PAC	3.00	236	785	X		X		X						1	Déc.		(V8)	1	(V8)		
V8	Douroo	84		3.45	131	818					X						1	Déc.			1			
V9	Kansogoudo / Garapouroo	84	PAC	3.40	156	509									X			Nov.			1	1	+	
V10	Idé / Kradia	86	OTZ	2.30	128	319			X				X				3	Nov.	Juin	(V2)	2	(V2)	+	
V11	Idieli - Douou	87	LC	4.25	113	418	X		X		X			X			1	Av.			2		+	
V12	Douroua / Dougou Domberé	86 x	LC	4.30		110						X					(étude)	Juin		Juin	1		+	
V13	Kassambouroo	87	MC	3.00	120	324									X			Pév.	Avril		2	1		
V14	Poleu 2	87	LC	7.50	51										X			Mai		Mai	2	2		
V15	Kakoua	87 x	LC	4.75	38										X		(LC)							

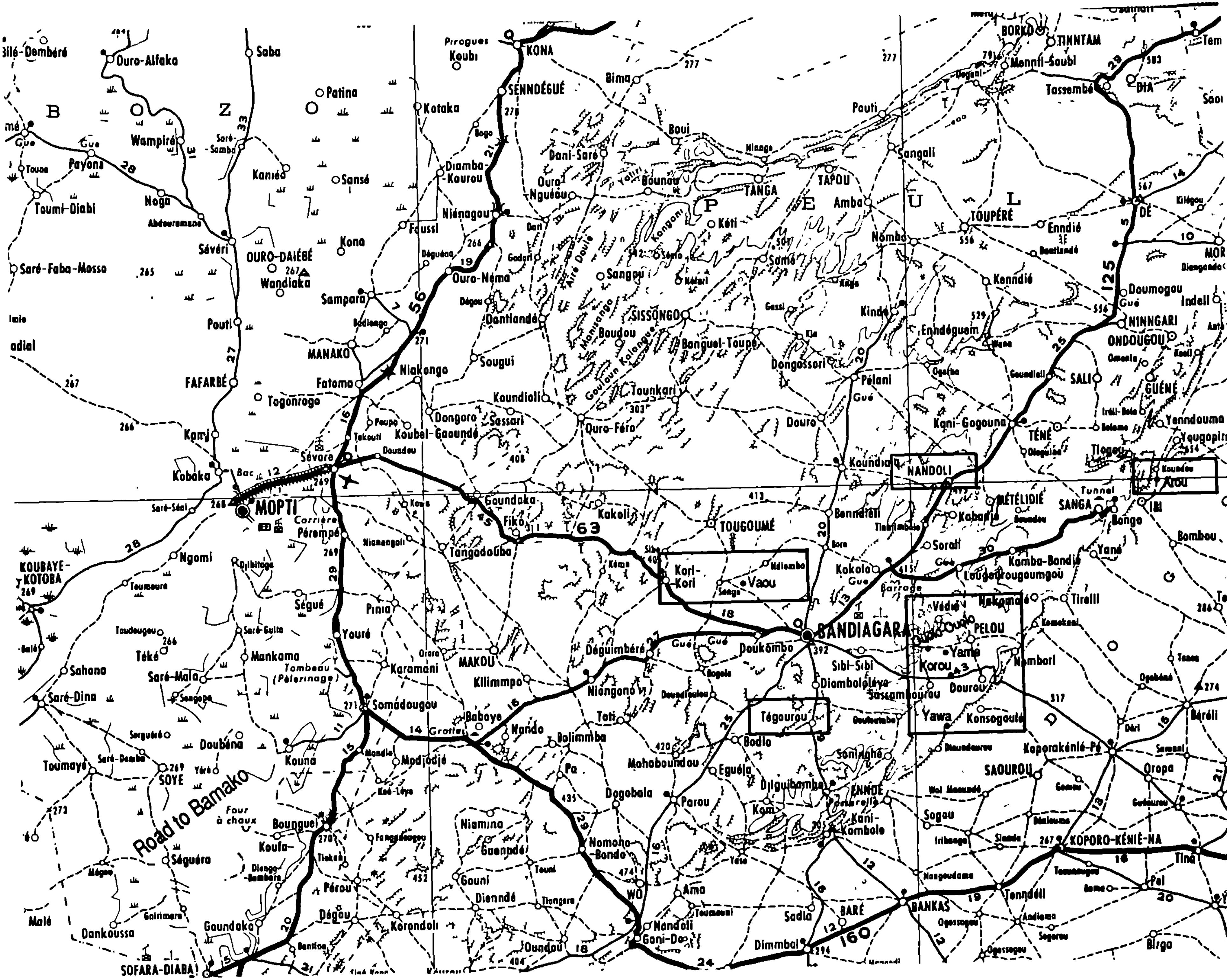
V2 : x hauteur prevue pas encore achevée.

Inventaire des barrages au Plateau Dogon / Arrondissement de : BO

N°	Nom de l'Ouvrage	Année fin de construc.	Financem.	Hauteur max. m	Longueur crête m	Volume maçonnerie m³	Causes pertes d'eau a	b	c	d	Classification D.E.D / C.E A	B	C	F	O	S	phase	Disponibilité d'eau retenue mois	puisards mois	aval mois	Nombre cycles retenue	Nombre cycles aval	Risiculture +	-
VII1	Simbana	59		1.05	74	116		X	X			X		X			2	Oct.			0			
VII2	Diankassagou	75	CIMADE	2.40	120	462	X	X	X							X		Oct.			0		+	
VII3	Sango	83	MC	1.75	134	195				X		X		X			2	Oct.	Juin		0		+	

Appendix G

MAP INDICATING VILLAGES VISITED


B O Z O
P E U L
Road to Bamako
MOPTI
Sévaré
BANDIAGARA
BANKAS
KONA
SENNDÉGUÉ
Koubi
Pirogues
Bima
Saba
Ouro-Alfaka
Bilé-Dembéré
Patina
Kotaka
Wampiré
Payona
Toumi-Diabi
Noga
Sévéri
OURO-DAIÉBÉ
Wandiaka
Kona
Saré-Faba-Mosso
Kanieo
Sansé
Diamba-Kourou
Niénagou
Foussi
Ouro-Néma
Sampara
Pouti
MANAKO
Niakongo
Fatoma
FAFARBÉ
Togonrogo
Sougui
Dantiandé
Dongoro
Sassari
Koubel-Gaoundé
Koundioli
Kamj
Kobaka
Doundou
Goundaka
Fiko
Kakoli
TOUGOUMÉ
Bennétéli
Péremptó
Tangadouba
Ngomi
KOUBAYE-KOTOBA
Ségué
Pinia
Youré
Mankama
Tombeau (Pèlerinage)
Karamani
MAKOU
Klimmpo
Sahona
Téké
Saré-Mala
Saré-Dina
Somadougou
Baboye
Nando
Grottes
Doubéna
Kouna
Modjodjé
Toumayé
SOYE
Bounguel
Koufa
Séguéra
Péroú
Dégou
Korondoli
Goundaka
Dankoussa
SOFARA-DIABA
Malé
Four à chaux
Niamina
Guenndé
Gouni
Dienndé
Oundou
Nomono-Bondo
WO
Pa
Bolimmba
Dogobala
Toti
Niongono
Déguimbéré
Doukombo
Kori-Kori
Vaou
Ndiembo
Mohaboundou
Eguéla
Parou
Dilguibambe
Bodio
Tégourou
Diombolo
Sibi-Sibi
Sassambourou
Konsogoulé
Yawa
Dourou
Korou
Yame
Nombori
PELOU
Ama
Nandoli
Gani-Do
BARÉ
Sadia
Dimmbal
ENNDE
Kani-Kombole
Sogou
Soninghé
SAOUROU
Koporokénié-Pé
KOPORO-KÉNIÉ-NA
Tennéli
Oropa
Pel
Birga
Tina
Bimbou
Bongo
SANGA
IBI
Arou
NANDOLI
MÉTÉLIDIÉ
Kabanla
Sorali
Kakolo
Barrage
Lougourougoumgou
Kamba-Bandié
Yané
Tirelli
Bérélí
Kani-Gogouna
TÉNÉ
Tiogou
Yenndouma
Yougopiri
GUÉNÉ
SALI
ONDOUGOU
NINNGARI
Doumogou
Indeli
Kenndié
Enndéguem
Kindé
Pélani
Douro
Koundiou
Ouro-Féro
Tounkari
Dongossori
Banguel-Toupé
SISSONGO
Boudou
Sangou
Saména
Kéti
Nombo
Amba
TAPOU
TANGA
Bounou
Ouro-Nguéou
Dani-Saré
Boui
Pouti
Sangoli
TOUPÉRÉ
Enndié
DÉ
Tassembé
DIA
BORKO
TINNTAM
Menngi-Soubi
Tem
MOR
Gué
Bac
Carrière
Tunnel
28
33
27
56
16
29
15
20
63
18
27
16
29
14
12
160
125
25
30
20
13
43
12
16
24

Appendix H

DESCRIPTION OF VILLAGES VISITED

The following is a brief description of the villages visited and justification for why they were selected. They cover three watersheds, roughly five major dialect clusters, three administrative zones, and all regional religions.

Dourou and Dourou-tanga

The village of Dourou, located at the center of an administrative "circle" of the same name, has benefitted from the presence of three dams and of numerous government and development services stationed in the vicinity. Among the most significant for this study were a Peace Corps volunteer working on Guinea worm, a school, a dispensary, latrines, and a resident health and hygiene official. In spite of this infrastructure, Dourou also has a high rate of Guinea worm. This is particularly true of one ward or neighborhood, Dourou-tanga, where residents continue to drink from a sweet-tasting walk-in spring rather than from the improved well located several meters away. Dourou center was the subject of the pilot questionnaire conducted jointly by both sub-teams, and Dourou-tanga was the focus of a more in-depth, follow-up study (with male and female focus groups) carried out by the social-health sub-team.

Korou (Korou-na)

The team selected Korou as a case to be analyzed in conjunction with Dourou. Korou constitutes a striking example of a village that has no dam, and thus has received none of its economic and agricultural benefits, but is located near the Dourou dam and uses the water for domestic and non-agricultural purposes, such as bathing and watering animals. Although the Dourou dam that abuts Korou is called "Korou," the dam is located just outside Korou territory and residents of that village have no rights to using the water for irrigation. Our hypothesis was that Korou might be an example of a village that received the health costs, but not the benefits provided by dams. Korou demonstrated that the health risk of dams could not be examined in an isolated fashion. An inspection of the undammed Korou stream revealed the presence of snails with the potential of transmitting schistosomiasis. In marked contrast to Dourou, Korou has relatively few services and yet has eradicated Guinea worm since 1987, due to the construction of an improved well by the Catholic Mission. Both sub-teams surveyed the major water points of the village and the social-health team conducted interviews with focus groups of men and women from one ward, Korou-na. The fact that men and women provided different answers about which water sources were employed for which ends demonstrated the strict separation between male and female domains and the fact that women are responsible for and generally more knowledgeable about domestic water supplies and hygiene.

Yamé

Constituting a separate dialect cluster with Ouolo-Ouolo, Yamé is a small village selected because of the presence of a dam which Africare constructed. Although the dam was built only recently (1989-90), the rate of schistosomiasis in the sample of 31 children was 100 percent, suggesting that the disease may have been endemic to the area even prior to dams. A borehole-pump is located about 25 minutes walk from the settlement, so villagers tend to draw drinking water from an unprotected well and nearby streams and ponds. While the designers of the water supply system realized the inconvenience of the location, technically this location was optimal. These are all walk-in sources, but apparently uncontaminated by Guinea worm since there have been no cases there since 1988. Nevertheless, the potential for recontamination remains. The two sub-teams conducted interviews and visited water points in Yamé separately.

Koundou (Koundou-da, Koundou-Andó) and Arou

Koundou represents a third dialect cluster and administrative zone, and was selected because one team member had lived and worked there some 15 years before, thus providing some longitudinal data. This isolated village, which receives no regular government services, was the site that Hans Guggenheim selected to construct a dam in 1975. The dam holds no water, even in the rainy season, but even so the schistosomiasis rate appears to be very high (100 percent of a sample of 32 children). This is probably because of the snail-filled, lily-covered fresh water ponds that form during the rainy season and furnish water for domestic uses, drinking, and dry season gardening. The population appears to be typical of many of the more isolated villages of the plateau in that they suffer from severe water scarcity. Even in the rainy season, when water sources are relatively abundant, women must climb sheer rock faces over one kilometer away to get drinking water for their household. Under these circumstances, isolation appears to be the major factor influencing the absence of Guinea worm.

The social-health sub-team hiked for 15 kilometers from Sangha to Koundou, along the escarpment of the plateau, and spent two days and one night on site. Although Koundou is made up of four wards, the team concentrated its interviews in the chief's ward, Koundou-da, and conducted briefer, informal interviews and visits in the ward of Koundou-Andó and in the neighboring village of Arou which shares the same dam. Arou is a sacred place, the home of the highest spiritual chief of the Dogon, the *hogon* of *hogons*, and the paths to and from this sanctuary are surrounded by numerous prohibitions. Although containing only a population of 18, all of a single family, Arou was significant in our sample of villages as the only site in which schistosomiasis was entirely lacking. This population relies exclusively on rain-fed agriculture (as opposed to gardening which demands direct water contact), is small and isolated, and has restricted contact with the outside due to its ritual significance. These factors undoubtedly contribute to the absence of schistosomiasis in Arou.

Nandoli

Nandoli was selected because of its dam and the existence of a prior study on schistosomiasis (Pleah, 1976). There are two dams in Nandoli. The first, built in 1973, was immediately found to be a failure due to leakage beneath the dam, through a fault. A second dam was built 200 meters upstream of the first in 1974. This dam, too, is not completely successful in that it only holds water from the end of the rainy season (September) until December. As with the first dam, the second experiences leakage underneath the dam, through faults. The area between the dams is dry and used for gardening. The second dam was not full, as would be expected, during the team visit. Once again, 100 percent of our sample of 12 children had schistosomiasis. Nandoli appears to have many cases of Guinea worm despite the presence of clean sources of drinking water. A borehole-cistern well located 20 minutes past the dam, which is adjacent to the village, is a source of safe drinking water. However, for convenience, the villagers prefer to use an unimproved well located within the village or the dam for drinking water. Both teams interviewed residents of Ganda, which is divided into two wards.

Songo

As a village without a dam, Songo was studied as a controlled comparison. It was also the subject of a study on Guinea worm, conducted by one of the team members (Degoga, 1977) and providing long-term data on this disease. Furthermore, Songo belongs to a fourth group of Dogon dialects and appears to have a rather sizeable Fulbe minority population. The sacred grotto above the village contains spectacular cave drawings. Moving in accordance to water availability, this village was once located high above on rock outcrops, but eventually moved to lower ground as available water sources dried up. The high rates of Guinea worm documented in 1977 continued through 1984, when it was reported to have afflicted as much as 80 percent of the population (Interview: Cisse). Since the construction of an improved borehole, the health and hygiene service cites Songo as a success story, where Guinea worm is said to be eradicated. However, our field study suggested otherwise, revealing numerous cases of the disease. One probable explanation is that the population has been reluctant to use the well because it is believed to be haunted: a child fell inside and died when the cord snapped, shortly after it had been completed. The Fulbe herders resident in and visiting the village may also serve as a potential vector for Guinea worm transmission.

Vaou

As a village without a dam but with a source of safe drinking water, Vaou was studied as a controlled comparison. Of all of the villages visited, Vaou was the most discouraging. The presence of an artesian well provides abundant seemingly clean drinking water and makes it possible to cultivate vast areas of land all year round. Yet the water is very poorly managed and wasted: it is allowed to flow uncontrollably creating new streams and providing numerous breeding sites for mosquitos. Water pipes donated to improve water management have been used as beams in house construction. Most disconcerting of all is the population's passive

attitude toward their good fortune. Women interviewed claimed that God had brought the water, and that God caused and treated all disease. It was thus unnecessary to intervene to try to cure diseases. Similarly, women said that to cover the household water storage bowl required too much effort, unless outsiders gave them the covers. Although the artesian well shows some potential for a water bottling plant, the attitude of the population would be a major obstacle in any future development intervention. The entire team visited Vaou together. Female team members conducted focus group discussions with women and children, males with men.

Kori-kori

Kori-kori is a village which demonstrates the benefits of education for health. With a dam that holds water roughly until February, schistosomiasis is virtually universal. However, there was a marked absence of the disease among children of educated people (e.g. government functionaries, school teachers, etc.), since these required their children to bathe and drink from well water and forbade them from swimming in the dam. Education, provided by a particularly active mid-wife, is also instrumental in that fact this was the only village that knew of Oral Rehydration Therapy and all 12 women interviewed could correctly describe how to prepare oral rehydration solutions. Although Guinea worm is technically eradicated from Kori-kori, children sited three current cases of the disease in the village, possibly contracted during travel. This would suggest that contamination of unprotected water sources is a continuous possibility, and would caution against leaving wells untreated over long periods (the hygiene service has not treated the well in Kori-kori in three years). Despite the numerous latrines and other aforementioned benefits of the school in the village, several infants have severe malnutrition and girls appear to be suffering from kwashiorkor and stunted growth. The female members of the team interviewed focus groups of 13 women and 33 children of the ward Tabatondo. Male members met with village officials and male focus groups.

Ouolo-Ouolo

Ouolo-Ouolo is a village with a dam built by Africare and a safe drinking water source. It has a borehole-pump and one unimproved well. Villagers also drink water from the dam. When the dam is full and overflowing they drink the dam water; when it is stagnant they do not. The villagers indicated when they began to drink water from the pump and well rather than the dam or other sources Guinea worm disappeared, and there are no cases now. In addition to schistosomiasis which afflicts most children and also adults, other urinary problems of unspecified diagnosis were described which the villagers said occurred after the dam was constructed (1987). The engineering sub-team examined the dam and water sources and met with 13 villagers including men and women in a focus group.

Tegourou

Tegourou was chosen for study because it has a dam with a canal irrigation system; dam modifications were designed to mitigate negative health impacts (Brinkman, 1990). It is located in a watershed not covered in this study by any other village. Tegourou also has a safe drinking water supply, a borehole-cistern well. The engineering team met in the field with 15 men during a break from their work building compost piles. In the village the engineering team met in a focus group with men and women. For the most part, the technical modifications on the dam were not being used. The irrigation canals were operational and in use and would reduce water contact for the workers. In Tegourou the road crosses just downstream of the dam around which water was passing. This required wading through water released from the impoundment to cross the streambed. Guinea worm was once considered a critical disease, but since the installation of the borehole-well (1984) and the use of this well for drinking water, Guinea worm has been eradicated. All children were reported to have schistosomiasis. The engineering team examined the dam, irrigation structures, and water sources. They met in the field with 15 men during a break from their work. In the village the engineering sub-team met in a focus group which included the village dam committee and was composed of 10 men and women.

Yawa

Yawa is a village without a dam or a safe drinking water supply and was studied as a controlled comparison. Yawa is located high above the Yamé river on a rocky outcrop. To reach the village by road and to collect water, one must traverse a steep passage. The villagers identified water scarcity as the most critical village problem. The cultivated fields are 25 kilometers away from the village. They have requested a dam and a well, but no action has been taken on their requests. Springs in the riverbed below the village are the primary water source for all purposes. A Peace Corps Guinea worm volunteer lives in Yawa.

There were several cases of Guinea worm but villagers report decreased incidence since they began to filter their water—using head ties—under direction of the Peace Corps volunteer. Schistosomiasis afflicts most children as does diarrhea. The engineering sub-team examined the water source and met in a focus group with 13 men and 2 women.

Appendix I

TABLES ON WATER SOURCES AND WATER CONSUMPTION

TABLE 1: WATER SOURCES

Village	Dams irrigation	Dams (other uses)	Streams	Wells/ boreholes (Improved)	Wells (Traditional)	Ponds/ springs/ puddles
Dourou	3	bathe, fish, drink	bathe	yes	yes	bathe
Korou	0	1 of Dourou bathe, water animals	1 bathe in rainy season, water animals	2—drink (1 per ward)	2—wash utensil clothes bathe cooking in dry season	bathe wash clothes utensils in rainy season
Douroutanga	3	bathe, fish, cultivate lilies	bathe, wash clothes	1—bathe wash clothes, drink	2—bathe wash clothes, drink	drink (best, sweetest); take water out to wash in dry season
Yamé	1—new, no effect yet	drink, water animals	1—drink, bathe, wash clothes utensils in rainy season, nearby	1—drink, too distant	—	drink, bathe, wash clothes lasts all year

TABLE 1: WATER SOURCES						
Village	**Dams irrigation**	**Dams (other uses)**	**Streams**	**Wells/ boreholes (Improved)**	**Wells (Traditional)**	**Ponds/ springs/ puddles**
Koundouda	1—does not hold water; rice cultivated downstream (3 km)	watering animals	1—water animals in rainy season	—	—	1—drinking & dry season irrigation (1.5 km) 2—bathing, dry season irrigation, animals (2 km)
Nandoli	1—not hold water for long, 1—holds no water	in rainy season, drinking, washing clothes utensils		1—too far (20") to drink, passers-by drink here	1 for drinking & domestic use dry season	

TABLE 1: WATER SOURCES						
Village	**Dams irrigation**	**Dams (other uses)**	**Streams**	**Wells/ boreholes (Improved)**	**Wells (Traditional)**	**Ponds/ springs/ puddles**
Songo	0	0	children swim & bathe	1—drink (far, built Catholic Mission 1980)	2—drink, wash utensils, clothes water animals (far)	2—for drinking & other domestic uses in rainy season (near), have filled with silt over the last 10 years; many others: (far) stagnant where children swim
Vaou	0	0	due to artesian well: irrigation, watering animals bathing laundry	1—artesian well: drink, irrigate, all domestic uses, bathing	—	before well used permanent lowland puddle all year, all purpose

TABLE 1: WATER SOURCES						
Village	**Dams irrigation**	**Dams (other uses)**	**Streams**	**Wells/ boreholes (Improved)**	**Wells (Traditional)**	**Ponds/ springs/ puddles**
Kori-kori	1—built 1974, holds water until Jan. or Feb.	children swim, rainy season: women wash clothes & bathe, water animals	near Yamé in dry season: women wash clothes, water animals	1—uncovered improved well, preferred drink, domestic uses in dry season; 1—pump drink (bad taste), domestic use	—	1—puddle drains into dam where children bathe; 2—hand dug holes near dam in drought for drinking water when pump dries & well water too low
Oulou-Oulou	1—built by Africare in 1987. Holds water throughout the dry season	livestock, irrigation of onions, drinking water if dam is overflowing, children drink water all the time, swimming bathing	—	1—used for drinking, 5 minutes from village, built in 1987. Water said to "taste bad," prefer the well to drink	1—used for drinking	—

TABLE 1: WATER SOURCES						
Village	**Dams irrigation**	**Dams (other uses)**	**Streams**	**Wells/ boreholes (Improved)**	**Wells (Traditional)**	**Ponds/ springs/ puddles**
Tegourou	1—built in 1981 by GTZ	drinking, irrigating gardens, fishing, washing, bathing, livestock, cooking. Sometimes filter dam water to drink	—	1—built in 1984. Close to village	—	Sometimes dig hole near dam site & let it fill up with water which they drink
Yawa	0	0	Only in the rainy season	0	0	In the rainy season, the springs run "like a river." In dry season dig holes in the dry stream bed & use this water to drink, water gardens & all other domestic purposes

TABLE 2: WATER CONSUMPTION					
Village	**Liters/-day/household** **liters/person**	**Filter**	**# times per day**	**Source-destination**	**Storage**
Korou	140-175 17-23	no	7 times	improved well-drinking; traditional well-toilet, utensil	ceramic bowls in house; drinking water stored separately
*Douroutanga	270 (1/3 drink; 2/3 other domestic uses) 27	women say they always filter household drinking water	3 times	unprotected spring-drinking; improved well-utensils, bathing	transfer from buckets to ceramic bowls; drinking water stored separate.
Yamé	90-160 15-27	no	3-4 times (pref. all in morning)	streams & unprotected spring—all domestic uses; improved well when other sources dry	in clay bowls, water for all domestic uses stored together
Koundouda	180 18-26	no	12 times	pond 1—all domestic uses, supplemented with rain water in rainy season; pond 2-bathing	in clay bowls, drinking water stored separately
*Nandoli	90-105 15-17.5	sometimes use headtie	6-7 times	dams—rainy season, all domestic uses; wells—dry season (shared with another village)	in clay bowls, water for all domestic uses stored together

TABLE 2: WATER CONSUMPTION					
Village	**Liters/-day/household**	**Filter**	**# times per day**	**Source-destination**	**Storage**
*Songo	120-160 (1/2 drink; 1/2 other domestic uses) 13-18	women sometimes, with metal sieve or headtie (to remove large impurities)	4 times (2 people 2X per morning & evening	traditional wells near borehole, & improved well—-drinking	in covered clay bowls
Vaou	150-200 15-20	no	10 times (2 people 5X per day)	artesian well—all domestic & agricultural uses	in clay bowls; no covers & can think of nothing to use
*Kori-kori	120 (1/3 drink; 2/3 other domestic uses) 24	no	6 times (4X toilet, utensils; 2X drink	improved well & pump—all domestic uses (well pref. drinking)	in clay bowl, sometimes covered
Oulou-Oulou	120 for washing & drinking	no	3 times	borehole & traditional well; dam when it's overflowing, not when it's stagnant	drinking water stored in clay bowl, which should be covered but isn't always
Tegourou	80	yes—health workers gave them special material for filter	fill a clay bowl in a.m. or p.m. Takes 5-6 trips to fill it.	improved well for cooking & drinking; dam for washing	clay bowl

TABLE 2: WATER CONSUMPTION					
Village	**Liters/-day/household**	**Filter**	**# times per day**	**Source-destination**	**Storage**
Yawa**		yes-use head scarf	4 women to each day. 5x for the village	stream bed or springs. Use a spoon to fill a bucket	filter water put in a clay bowl**

* Villages with Guinea worm

** A Peace Corps Guinea worm volunteer living in Yawa says the villagers do not filter the water but are told to do so.

Appendix J

TABLES ON HYGIENE PRACTICES AND LATRINE USE

TABLE 1: HYGIENE PRACTICES				
Village	**Urinate**	**Defecate**	**Age Begun**	**Clean with**
Dourou	anywhere, enclosure in compound, fields	bush, infants in house or compound	7-8 yrs	sticks, stones, sometimes water
Korou	anywhere, enclosure in compound, fields	bush behind village	6-7 yrs	sticks, stones, sometimes water
Douroutanga	anywhere, enclosure in compound, fields	closest place in bush	7 yrs	sticks, wash in nearby puddle water or with water from spring in dry season
Yamé	anywhere, enclosure in compound, fields	several hundred meters to 2 kms. downhill from village away from water source; in uncultivated areas near fields	7-8 yrs	sticks, rocks, some adults use water
Koundouda	anywhere, enclosure in compound, fields	in rocks nearby above & below the village, wherever one can hide	6-7 yrs	sticks, stones
Nandoli	anywhere, enclosure in compound, behind trees near dam	in bush that is closest to house	7-8 yrs	wash with water when return home
Songo	anywhere, enclosure, women wash with water	in bush uphill & away from village or in latrines	bush: 7-8 yrs latrine: 10-12 yrs	adults with water, children wash with water when return home

TABLE 1: HYGIENE PRACTICES				
Village	**Urinate**	**Defecate**	**Age Begun**	**Clean with**
Vaou	anywhere, enclosure	anywhere where one can hide, especially in fields	6-7 yrs	all people, even children always wash with water afterwards
Kori-kori	anywhere, enclosure	in bush, each to different direction, or in latrines	bush: 6-7 yrs latrine: 14 yrs	adults with water taken in container or when return home
Oulou-Oulou	enclosure in compound, usually anywhere but women cannot urinate in the fields. They must urinate in a cultivated area or they won't get a husband.	in bush away from the dam	—	—
Tegourou	anywhere, enclosure in compound	bush or latrines	—	—
Yawa	enclosure in compound	an open area away from the stream is designated for defecation; men & women go on separate sides	—	—

TABLE 2: LATRINE USE					
Village	**# latrines**	**Used by**	**Owner**	**Advantages**	**Disadvantages**
Dourou	5	family, children over 7	village chief, midwife, 3 merchants	easy access	expensive, shameful for whole family to share one latrine
Korou	0	—	—	privacy convenience, easy access	they fall down, messy, badly maintained
Douroutanga	0	—	—	privacy, convenience, status	costly, too labor intensive, no materials
Yamé	0	—	—	status	unknown
Koundouda	0	—	—	status, convenient for elderly & infirm	lack materials; don't have habit of use; bad for many people to defecate in same place
Nandoli	0	—	—	convenient, easy access	smells bad, disinfectant costly
Songo	10+	young families, migrants with cash earnings, visitors	some families with migrants have 2; guest house	convenient for old people; safer, quicker faster than walking & falling on bad paths to bush	insufficient space in compound, costly in cash & labor

TABLE 2: LATRINE USE					
Village	**# latrines**	**Used by**	**Owner**	**Advantages**	**Disadvantages**
Vaou	0	—	—	none	costly, unlikely that they would ever use them decide
Kori-kori	10+	teachers & their families, school children, children over 14 (otherwise miss the hole), many others	all teachers; school; families with money	easier access & more convenient for sick people; good for health	too many people using same latrine can promote contagious illness
Oulou-Oulou	0	—	—	—	—
Tegourou	5	Some are privately owned (4); one located adjacent to mosque is used by anyone who wants	1—community 1—chief 1—chief's assistant 1—government worker 1—educated villager	Easier & more convenient if you are sick with diarrhea; it's better to have a latrine in proximity; the bush is too far; form lines to use latrines	expensive
Yawa	0	—	—	none	too expensive, easier to use bush

Appendix K

TABLES ON DOGON PERCEPTIONS OF DISEASE

TABLE 1: WORST DISEASES
(1 = worst)

Village	G. worm	Schisto.	Diarrhea	Malaria	Other	Comment
Dourou			1	2		
Korou		1	2		3—coughs	
Douroutanga	1				2—skin infections	none kills most
Yamé		2		1		schisto. kills most
Koundouda		1		3	2—measles	2—kills most (1988 epid.)
Nandoli			1		2—eye infections 3—sickle cell	
Songo				1	2—eye infections; 3—measles	3—major cause of death; 1—also causes death
Vaou						god kills, not illness
Kori-kori		2	1			1—kills most children

TABLE 1: WORST DISEASES
(1 = worst)

Village	G. worm	Schisto.	Diarrhea	Malaria	Other	Comment
Oulou-Oulou		3	1	2	rheumatism	all children get 1-2-3, in rainy season 1+2
Tegourou		1	3	2		Guinea worm was worst disease until they installed the well.
Yawa		3		2	1—pain in the sides of the stomach	Everyone old & young has this. If come to the point where you cough, you get better. Otherwise, you die.

TABLE 2: GUINEA WORM					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
*Dourou	drinking infected water, especially during first rains	—drinking from treated wells —puncture blister with hot needle, rub with shea butter & medicinal leaves —soak in warm water	many people, especially 1 ward (Dou-rou-tanga)	decreased in recent years	sometimes rash appears 48 hours before worm erupts
Korou	drinking water	drink from improved well	no one	eradication since 1987	eradicated after con-struction of improved Catholic Mission well
*Dourou-tanga	told drinking water, but not con-vinced	filter	everyone, certain fam-ilies more than others, worse for children	decreased in recent years	sanctions for drinking from bad source
Yamé	unknown	unknown	no one	absent since 1988	unexplained eradication
Koundou-da	unknown	unknown	no one	absent since 1983	unexplained eradication
*Nandoli	drinking dirty water, e.g. from the dam	unknown, puncture blister, worm comes out slowly on own	many people in both wards	—	—

TABLE 2: GUINEA WORM					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
*Songo	god	no prevention, puncture blister, rub with shea butter, worm comes out slowly	more men, residents of village chief's compound	—	women say men do not filter water
Vaou	unknown	unknown	no one	—	—
*Kori-kori	drinking dirty water	hygiene service treats well	very few cases, arbitrary or due to travel	marked decrease since 1988	decrease due to hygiene service water treatment
Oulou-Oulou	drinking dirty water	none	none	as soon as drank well and borehole water (1985 & 1987), G.W. was eradicated	villagers not sure why G.W. is gone now but note connection with drinking water from an improved source
Tegourou	from water; eggs in water you drink	none	1	since drinking well water, 1984, G.W. has been eradicated	one man got G.W. elsewhere & is now living here
Yawa	drinking stagnant water	none	2	since filtering water, no G.W.	they think those afflicted got G.W. elsewhere

* Villages with Guinea worm

TABLE 3: SCHISTOSOMIASIS					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived Change**	**Comment**
Dourou	bathe in water where should not	none	children	—	children get rash after swimming in stagnant water
Korou	unknown	none	children	—	—
Dourou-tanga	god	none	children	increase in recent years	not considered illness, but people who bleed when young never get fat or big
Yamé	unknown	none	children	occurs when settle in village from other area	recognized illness since children suffer
Koundou-da	god	none	children	—	visiting nurses confirm there is no cure
Nandoli	god	plants & herbs	children	—	recognized illness
Songo	unknown	plants with little effect; pills from doctor	children	—	recognized illness since children suffer
Vaou	god	none	some children	more common in past	not considered illness

TABLE 3: SCHISTOSOMIASIS					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived Change**	**Comment**
Kori-kori	bathing in infected water	herbal infusion to drink	children who swim in dam	decrease in some parts of population due to pump & well use	children of functionaries & school personnel do not have schisto.
Oulou-Oulou	children washing & swimming in dam. If stagnant, water makes you sick	none	adults & children	none	lots of children urinate blood; 3 kinds of urinary problems: 1) urinate blood 2) can't urinate 3) urination contains pus
Tegourou	unknown	none traditional. Go to clinic in Bandiagara	children & young	less now that it can be treated in Bandiagara clinic	all children have schisto.
Yawa	unknown—swimming in river is suspected	none traditional. Very painful. Go to Bandiagara for treatment	children, but not many are affected		after age 15 no one has it

TABLE 4: DIARRHEA					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
Dourou	—drinking dirty water, —bad nutrition	—medicine or injection from nurse —drink clean cool water —eat cotton mixed with cooked millet & jackfruit	children 0-5 yrs.	increase in rainy season	—
Korou	—unknown —teething in infants	—drink water —drink infusion of guava leaves —medicine for children from Catholic Mission (ORT?)	children	increase at end of rainy season	usually accompanied by fever & vomiting
Dourou-tanga	unknown	drink water	varies by family	increase in recent years	common cause of death especially in afternoon
Yamé	unknown, possibly lack of nourishment or eating certain foods	drink water boiled with medicinal herbs	everyone	increases in late rainy season	—
Koundou-da	god	drink water, eat mashed medicinal herbs	everyone, but especially women & children	increases in rainy season	

TABLE 4: DIARRHEA					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
Nandoli	unknown	drink water, medicinal herbs	children especially	increases in rainy season	accompanied by fever & gas
Songo	unknown	eat heavy meals; drink fruit juice (sorrel)	everyone	all year	rarely kills
Vaou	god	nothing; sometimes drink water or eat mashed herbs	everyone, but not common	—	—
Kori-kori	unknown	ORT or drink water cooked with guava leaves	everyone, especially children	all year	major cause of infant death
Oulou-Oulou	don't know	drink water cooked with leaves	many small children have it continually	increase in rainy season	in rainy season everyone has it
Tegourou	don't know	—boil leaves in water & drink it —drink a lot of water	mostly children	—fewer children died (4) this year of diarrhea —increase in rainy season	most people die from malaria or diarrhea

TABLE 4: DIARRHEA					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
Yawa	don't know	boil leaves in water & drink it	children beginning at age 2-3	—increase in rainy season —4 years ago children died of diarrhea. With treatment of boiling leaves & drinking this, the deaths have decreased.	—

TABLE 5: MALARIA					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
Dourou	mosquito, bad nutrition insufficient water, excessive exposure to sun, fatigue	medicine, mosquito nets	everyone	rainy season	—
Korou	unknown, maybe mosquito	sometimes medicine from dispensary	children	rainy season, time of mosquitos	causes infant's head to rise & fall & death
Dourou-tanga	unknown	sometimes medicine from dispensary	everyone	rainy season	—
Yamé	unknown	sometimes medicine	everyone	rainy season	—
Koundou-da	unknown	wash with warm water	everyone	rainy season	—
Nandoli	unknown	infusion of water & herbs	everyone	rainy season	—
Songo	god	none	everyone	rainy season	chronic form kills
Vaou	god	god	everyone	rainy season	—
Kori-kori	mosquito bites	boil medicinal herbs to drink & bathe	everyone	rainy season	—

TABLE 5: MALARIA					
Village	**Cause**	**Treatment**	**Popul. Affected**	**Perceived change**	**Comment**
Oulou-Oulou	unknown	none	all children	none	when grass grows & it's raining, it's season to get schisto. & malaria
Tegourou	unknown	none	everyone	occurs in rainy season	kills people
Yawa	unknown	none	everyone	occurs in rainy season	everyone gets it

TABLE 6: EYE INFECTIONS					
Village	**Cause**	**Treatment**	**Popul. affected**	**Perceived Change**	**Comment**
Dourou	spontaneous	eyedrops of warm water heated with medicinal herbs & ashes	everyone	increase in rainy season	—
Korou	unknown	unknown	everyone	—	—
Yamé	unknown	sometimes cream from dispensary	everyone	often worsens over 6 month period	present in 3 of 13 women interviewed; severe cases affect 2 eyes
Koundou-da	unknown	unknown	everyone, can lead to blindness	rainy season	—
Nandoli	unknown	unknown	everyone	rainy season	2 eyes get red
Songo	unknown	cream from dispensary	everyone	—	2nd worse disease
Vaou	god	eyedrops with medicinal leaves	everyone in village in some years	worse in certain years	—
Kori-kori	unknown, contagious?	unknown	everyone	—	3 of 39 children interv.
Oulou-Oulou	unknown	none	children & adults	—	trachoma present

TABLE 6: EYE INFECTIONS					
Village	**Cause**	**Treatment**	**Popul. affected**	**Perceived Change**	**Comment**
Tegourou	unknown	none	—children & adults —6 people are blind	5 years ago blindness got worse, unexplained	lots of trachoma, much blindness
Yawa	lack of vitamins or old age	none	children & adults	—	night vision problems

TABLE 7: OTHER ILLNESSES					
Village	**Illness**	**Cause**	**Treatment**	**Popul. affected**	**Period/ Comment**
Dourou	skin infection	swimming in stagnant water	wash in salt water, wear scratchy woolen clothes	children	rainy season
	intestinal worms	unknown	medicinal plant, including spores of a mushroom	mostly adults, but also children	—
	night blindness	lack of meat	rub blood from liver on eyes & eat liver	people with bad diet	—
	lice	—	wash hair & crush lice	most women who braid hair	—
Korou	coughs	unknown	unknown	everyone	—
	constipation, hemorrhoids	unknown	unknown	everyone	—
	night blindness	unknown	unknown	women & children	—
	red hair	prolonged illness	unknown	children, rare	2 cases
	bladder/ urinary tract infections	unknown	unknown	adults	10+ cases (due to schisto.?)
Dourou-tanga	skin infection	unknown	unknown	worst illness among children	—

TABLE 7: OTHER ILLNESSES					
Village	**Illness**	**Cause**	**Treatment**	**Popul. affected**	**Period/ Comment**
Yamé	skin infection/rashes	unknown	unknown	children	rainy season
	red hair	natural among children	unnecessary	very widespread among children	disappears at adulthood
	night blindness	unknown	none	old people	great decrease in recent years
	measles	epidemic	vaccine	many children, unexposed adults	dry season, early rainy season, epidem. 1988, 1984, 1981
	rheumatism	unknown	none	adults & old	increase with age
Koundou-da	measles	unknown	vaccine	major cause of death in children	dry season, hottest time, epid. 1988
	skin infections	unknown	unknown	everyone	all year
	night blindness	unknown	none	everyone	rainy season
	red hair	illness	unknown	infants, rare	all year
	worms	unknown	unknown	everyone	white, small flat
	"rheumatism"	unknown	unknown	adults	bones aches, accomp by violent headaches, curvature of spine

TABLE 7: OTHER ILLNESSES					
Village	**Illness**	**Cause**	**Treatment**	**Popul. affected**	**Period/ Comment**
Nandoli	sickle cell	unknown	unknown	a few people of all ages	periodic severe internal pain, swelling joints
	skin infections	unknown	unknown	everyone, common	often with boils
	red hair	—	—	no one	-
	night blindness	unknown	none	women, rare among men & children	all year
Songo	measles	unknown	vaccines	children	major cause of death
	night blindness	unknown	wash with & eat mutton liver	many adults, some children	—
	red hair	natural for children	unnecessary	children	not assoc. with illness
	worms	unknown	unknown	everyone	2 kinds
Vaou	red hair	illness, diarrhea	god	infants	—
	worms	—	—	no one	—
	night blindness	—	—	no one	—
Kori-kori	measles	epidemic	vaccine	children	epid. 1991
	fungus on skin & in mouth	unknown	unknown	a few people	1 of 39
	eczema	unknown	cream from dispensary	a few people	2 of 39 children interv.
	stomach aches	unknown, bad food?	unknown	all ages	sometimes accomp. by swollen stomach, blood in feces

TABLE 7: OTHER ILLNESSES					
Village	**Illness**	**Cause**	**Treatment**	**Popul. affected**	**Period/ Comment**
Oulou-Oulou	skin disease	stay too long in water		everyone	
	rheumatism	water	traditional remedy		
	urinary tract problems	washing in dam	none	everyone	
Tegourou	rheumatism				generally think mosquitos transmit diseases
	measles	unknown	none	one child died this year	
	blindness	see Table 6			
Yawa	pain in the side of the stomach	unknown	none	everyone	may kill you

Appendix L

TABLES ON DOGON DEVELOPMENT PRIORITIES, COMMUNICATION AND MIGRATION

TABLE 1: DEVELOPMENT PRIORITIES FROM VILLAGE PERSPECTIVE		
Village	**Male**	**Female**
Korou	dams; more cultivable land, regular food supply; education; compost, fertilizer	grill to roast groundnuts; transport of women & produce to market; regular & varied food supply
Yamé		nearby improved well without pump; grain mill; more cash to buy seed; better terms of trade (onion prices have declined)
Koundou-da	repaired dam & irrigation water; roads; school in French; dispensary; cereal bank	health care; higher agricultural production; wells
Nandoli		child survival; nearby improved water supply (well); grain mill
Songo		regular food supply (secure harvest); fuel wood; easier way to get household water; cash earning activities, management training to buy condiments & medicine
Kori-kori		grain mill; repair dam; labor-saving seeding techniques; transport of fuel wood

TABLE 2: COMMUNICATION AND MIGRATION						
Village	**Radios**	**Inter-village Commu-nication**	**Intra-village Comrnuni-cation**	**Migration**	**Reason**	**Destina-tion**
Korou	10	oral by messenger	select messenger to notify population	youth since 1989	no food	Office du Niger, Bamako, Katiola Abidjan
Koundou-da	12	oral by messenger	select messenger to inform each neighbor-hood	temporary: youth with primary school education;	better opportun-ities;	Bamako Ivory Coast;
				perma-nent: 7/45 families	land	Seno Plain
Songo		oral by messenger	select messenger to notify population	women migrate	to feed children	
Vaou		oral by messenger	select messenger to notify population	dry season: most all youth	to earn money	Bandia-gara, Bamako
Kori-kori	many	oral by messenger	select messenger to notify population			

TABLE 2: COMMUNICATION AND MIGRATION						
Village	**Radios**	**Inter-village Communication**	**Intra-village Communication**	**Migration**	**Reason**	**Destination**
Yawa	—	—	—	100 young people last year	leave during dry season because there's not enough to eat	Bamako; Bandiagara

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THE WASH PROJECT

With the launching of the United Nations International Drinking Water Supply and Sanitation Decade in 1979, the United States Agency for International Development (A.I.D.) decided to augment and streamline its technical assistance capability in water and sanitation and, in 1980, funded the Water and Sanitation for Health Project (WASH). The funding mechanism was a multi-year, multi-million dollar contract, secured through competitive bidding. The first WASH contract was awarded to a consortium of organizations headed by Camp Dresser & McKee International Inc. (CDM), an international consulting firm specializing in environmental engineering services. Through two other bid proceedings since then, CDM has continued as the prime contractor

Working under the close direction of A.I.D.'s Bureau for Science and Technology, Office of Health, the WASH Project provides technical assistance to A.I.D. missions or bureaus, other U.S. agencies (such as the Peace Corps), host governments, and non-governmental organizations to provide a wide range of technical assistance that includes the design, implementation, and evaluation of water and sanitation projects, to troubleshoot on-going projects, and to assist in disaster relief operations. WASH technical assistance is multi-disciplinary, drawing on experts in public health, training, financing, epidemiology, anthropology, management, engineering, community organization, environmental protection, and other subspecialties

The WASH Information Center serves as a clearinghouse in water and sanitation, providing networking on guinea worm disease, rainwater harvesting, and peri-urban issues as well as technical information backstopping for most WASH assignments.

The WASH Project issues about thirty or forty reports a year. WASH *Field Reports* relate to specific assignments in specific countries; they articulate the findings of the consultancy. The more widely applicable *Technical Reports* consist of guidelines or "how-to" manuals on topics such as pump selection, detailed training workshop designs, and state-of-the-art information on finance, community organization, and many other topics of vital interest to the water and sanitation sector In addition, WASH occasionally publishes special reports to synthesize the lessons it has learned from its wide field experience.

For more information about the WASH Project or to request a WASH report, contact the WASH Operations Center at the above address