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**GAMBIA RIVER BASIN  
DEVELOPMENT ORGANISATION  
(GMBDO)**

# **GAMBIA RIVER BASIN STUDIES WORK PLAN**

**THE UNIVERSITY OF MICHIGAN  
WITH HARZA ENGINEERING COMPANY**

**MARCH 1983**

**U.S. AGENCY  
FOR INTERNATIONAL  
DEVELOPMENT (USAID)**

**GAMBIA RIVER BASIN  
DEVELOPMENT ORGANISATION  
(OMVG)**

# **GAMBIA RIVER BASIN STUDIES WORK PLAN**

**WORKING DOCUMENT NUMBER 4**

**THE UNIVERSITY OF MICHIGAN  
ITH HARZA ENGINEERING COMPANY**

**Contract No. 625-0012-C-00-2158-00**

**Project No. 825-0012**

**MARCH 1983**

# GAMBIA RIVER BASIN STUDIES

## WORK PLAN

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## PREFACE

Under a contract with the U.S. Agency for International Development, the University of Michigan, in collaboration with Harza Engineering Company, has undertaken a set of environmental and socioeconomic studies of the Gambia River Basin. The purpose of the studies is to help the Gambia River Basin Development Organisation (OMVG) and its member states prepare for changes that will occur in the basin after a proposed series of dams has been built. The object of the dams is to create a salt-water barrier, generate hydroelectric power and provide water for irrigation. Construction of the dams is contemplated at Balingho (The Gambia), Kekreti (Senegal) and Kougoufoulbe, Kouya and Konkouré (Guinea).

The detailed work plans that follow explain how the University of Michigan/Harza team will carry out the field research phase of the project. This document is the culmination of work that began in December 1982 with a planning session in Ann Arbor, Michigan, and continued through a river basin reconnaissance mission in February 1983. Draft work plans for each of the four teams (socioeconomic, river resources, public health and wildlife/vegetation) were presented and discussed at meetings held in Banjul, The Gambia, on March 10 and 11, 1983. The comments and suggestions of colleagues from USAID and OMVG which were expressed at the time and later provided in written form have contributed greatly to the quality of the work plan.

We wish to express here our gratitude to all of our colleagues, both the members of the Michigan/Harza team and the staffs of USAID and OMVG, who have worked so diligently to prepare us for the ambitious research effort that is now beginning. We thank as well those who have labored to put this document in final form, particularly Ms. Patricia Johnson and Ms. Jane McCormick of the University of Michigan.

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March 28, 1983

## INTEGRATION WORK PLAN

The work plans of the four socioeconomic and environmental teams describe how each will gather and analyze data in Phase II of the University of Michigan Gambia River Basin Studies (UM/GRBS). The aim is to integrate research findings, analyses, and recommendations into a unified body of material. This will take the form of a preliminary integrated report scheduled for submission to USAID and OMVG by December 1, 1984.

Overall responsibility for ensuring the integration of UM/GRBS research activities lies with Dr. Karl Lagler in Banjul with appropriate assistance from Dr. Elon Gilbert in Michigan. The former is an environmental scientist with long experience in the study of river basins. The latter, an agricultural economist, will ensure that research results and analyses are placed in the economic context described below.

It will not suffice merely to integrate the various components of the UM/GRBS with one another. They must also be fitted into the context of other research being conducted in the basin under the auspices of OMVG. These other studies concern dam siting and feasibility, potential for irrigated agriculture, river hydrology after dam construction, river basin soils, and aerial mapping. Although it may be the task of OMVG to pull together the Michigan study and the others for basinwide planning purposes, it is the responsibility of UM/GRBS to make its own research program complementary to and compatible with the other studies. The technical staff of OMVG has expressed its readiness to assist UM/GRBS researchers in this process.

A framework for data gathering and analysis will be employed. It will on the one hand provide for compatibility with other studies and on the other hand serve to integrate the work of the four Michigan teams. One such framework has been suggested by Dr. Christopherson of the OMVG staff. Whereas it will require refinement, it represents an approach to the whole river basin that emphasizes potential tradeoffs between socioeconomic and environmental objectives, both long-term and short-term. It is the intention of UM/GRBS to work jointly with OMVG and other researchers in the basin to obtain the kind of data that will make the chosen model work. Michigan researchers will then use the tradeoffs identified by the model to complete their analyses and make their recommendations.

The work of the other contractors in the river basin will determine the limits to potential development in several respects. The site characteristics of the Balingho barrage and upstream dams, the potential of the soil, and the amount of land that can feasibly be irrigated will be specified more clearly in the coming months. Meanwhile, within the limits of research resources available, UM/GRBS will be gathering socioeconomic and environmental data that describe the present river basin. As information becomes available from each study it will help to flesh out the model. Thus there will be a framework into which bits and pieces of otherwise disparate data may be placed. In this process UM/GRBS researchers will meet frequently with OMVG technical staff and other contractors to address new information needs and to ask the right questions of the data.

Strictly within the limits of UM/GRBS, each research team will collaborate with the others in a variety of ways. In the data-gathering phase the environmental teams will make use of the socioeconomic team's staff of researchers and enumerators to obtain both individual village and basinwide data. As explained in the socioeconomic work plan, the intensive village studies will gather information over a full year on fisheries, public health, fuelwood use, wildlife, river use and other matters of interest to the environmental teams. It is recognized, however, that there are compromises that must be made in this effort. The villages selected for intensive, twelve-month study were chosen on the basis of socioeconomic criteria. These particular villages may be less than representative with regard to public health phenomena. Some may be too far from the river to provide much data on the use of river resources. Others may shed little light on current uses of wildlife and vegetation. In short, it is not feasible to run year-long surveys in enough villages to respond to every apparent need.

It is possible, nonetheless, to fill many gaps through the other components of the socioeconomic work plan. First, the thematic case studies provide an opportunity for socioeconomic and environmental team members to work together gathering data. In the Balingho downstream impact study, for example, the teams will seek data on fish production and consumption. This will permit later analysis of the income and nutritional effects of the impact of the barrage on downstream fisheries. By the same token, in the migration and resettlement case study the socioeconomic team will examine the effect of population movements, particularly those of sharecroppers (navétanes or strange farmers), on wildlife, vegetation, and public health indicators.

Second, the basinwide survey, which will be carried out over a period of five months, will gather information from scattered parts of the basin to assist all of the teams in filling gaps and verifying information obtained by other means. The key informant survey technique, which elicits answers to carefully constructed questions from individuals with specialized knowledge, will be employed for this purpose.

It is not just on the staff of the socioeconomic team that the burden for integration will rest. Each of the environmental teams expects to contribute to the others' work. The R/V Laurentian, operating under the control of the river resource team, will provide an opportunity for the wildlife/vegetation team to make observations and take samples from a river-borne base that will cover the river as far as Basse. The river resource team will also be in a position to take samples of snails and mosquitoes to aid the public health team in verifying the presence of disease vectors. The laboratory facilities afloat and ashore will be shared by all of the environmental teams.

Ideally, the wildlife team will be able to pass on to the public health team information regarding the possible role of wild animals in the transmission of human zoonoses such as rabies transmission by bats or the breeding of leishmaniasis-transmitting sandflies in warthog burrows or termitaries.

Once enough data have been collected for analysis to begin, use of the Christopherson model (or an adaptation thereof) will permit the research teams to look closely at the interrelationships between different parts of the ecosystem in a particular segment of the basin and then at the relationships between and among segments.

In simplified summary, the model facilitates conceptualization of the river basin as an entity. The basin will be divided into five to seven distinct ecological segments or, in modelling terms, subsystems. For each segment a limited number of variables will be used to represent possible ways in which agricultural development could proceed. Specifically, there would be two possible crop combinations, three packages of agricultural technology, three levels of realization of irrigation potential, and two time frames for irrigation development. This amounts to 36 different combinations or scenarios for each subsystem. There will be constraints on some of these possible combinations, however, as the choice of a particular development path in one or more segments has effects on those downstream.

A selected number of plausible scenarios can be subjected to a financial benefit/cost analysis to determine the net present value (NPV) of investment in dam construction and irrigation works. The chosen scenarios can then be ranked in descending order of NPV. The one ranked highest will represent, if only in relative terms, the greatest potential for financial gain from agricultural investment. There will be associated environmental costs, however, and they are apt to be higher the greater the changes introduced into the basin. The UM/GRBS environmental teams will be able to rank the scenarios in order from those that have the least environmental cost to those that have the largest. To some extent it may be possible to attach values to these costs, but decision makers will be cautioned that the rank ordering is more reliable than the numbers. In any case, they should be able to see, for example, how investment in large-scale rice production will have consequences for public health, wildlife, fisheries, rainfed agriculture, water quality, water availability, and other aspects of life downstream from the proposed investment.

After the probable impacts have been determined and discussed with OMVG and the member states, the UM/GRBS will focus on mitigative measures for those that are negative. Doubtless some types of mitigative measures can be suggested relatively early in the data-gathering phase. Indeed, the wildlife/vegetation team proposes in its work plan to field test mitigative techniques wherever feasible. However, it is unlikely that any intensive consideration of impacts and mitigative measures can begin before April or May 1984. By then a sufficient body of data should have been gathered and subjected to computer analysis, both on the river resource team's microcomputers in Banjul and on the mainframe installations that the socioeconomic team will use in Dakar. The UM/GRBS will call on Dr. Ariza-Nino, an agricultural economist from UM/CRED, to assist in the latter process. He will simultaneously be receiving help from, and training, OMVG and member state technical staffs in statistical analysis by computer.

UM/GRBS also plans to call on an economist who has specialized in the use of benefit/cost analysis to place values on environmental aspects of development projects and agricultural land use patterns. This and other forms of analysis will lead to determination of the economic attractiveness of various mitigative measures.

Each of the four UM/GRBS teams will submit a report responding to its particular terms of reference before its leader leaves the field in mid to late 1984.

The next step will be drafting the preliminary integrated report, followed by consultations with USAID, OMVG and member states. For this effort each of the team leaders will spend at least one month in the field from November 1984.

The strands of the multidisciplinary research efforts will thus have been woven together and placed in the context of the other research efforts underway in the basin. Phase II of UM/GRBS will be at an end. The following sections of the work plan describe in detail the objectives, methods, personnel plans, and time frame for each of the four research teams in this phase.

## **SOCIOECONOMIC TEAM WORK PLAN**

### **Senegal and The Gambia**

#### **INTRODUCTION**

In view of the scope and complexity of the socioeconomic study (SES), the proposed workplan is divided into two parts. The first is an overview of the entire socioeconomic research agenda: the objectives, purposes, means, location, staffing, scheduling, and analysis for all socioeconomic team operations in Senegal and The Gambia. The second part discusses the three types of investigation to be undertaken by the socioeconomic team in conjunction with other project teams: (i) intensive village studies; (ii) thematic case studies; and (iii) a basinwide farming system survey. The work plan details requirements for each component.

#### **Bibliographic Note**

In designing its research agenda, the socioeconomic team has drawn heavily on existing studies. The Gambia, and particularly the Lower River Division, has a fine record of socioeconomic and farming systems research dating back to the 1940's. David Gamble's work on Mandinka (Kerewan) and Wolof (Njau) communities and the long-term research of Margaret Haswell in Genieri (LRD) have both been fundamental for the formulation of research questions and the organisation of the village studies. The work of Peter Weil in Kwinella, and more recently in Wulli District URD, also provides a useful contribution to an understanding of the social context of farming systems research. In the priority zone, however, between Kaur and Georgetown, there is very little primary, intensive farm management data other than the important recent work of Jennie Dey near Sapu. The remainder consists of small-scale and incomplete rural surveys by PPMU, RDP and WARDA and of consultant group feasibility studies (e.g. Euroconsult and IFAD for the Jahally-Pachar project, the UNDP mission).

The LRDC study published in 1976 on agricultural development in The Gambia is one of the few nationwide farm management studies. This study, based on 15 villages studied between 1972 and 1974, provides an important reference point for the SES although some of the critical issues addressed by LRDC (for example the cotton programs and the groundnut packages) are only of secondary interest. Other work is for the most part quite uneven. Benini's study of an irrigation project at Koina (URD) is one exception. All of these studies provide important inputs into

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the SES design although in terms of village selection and issues of focus there is very little replication. This also applies to relations between the SES and other on-going research, for example the Colorado State Mixed Farming Project.

The literature situation in Senegal is less clear and quite uneven.\* The areas to the north of the Gambia border in the groundnut basin are well documented. The northeastern portion of the Basin is dominated by Fulani livestock systems which are being studied, at least partially, by the USAID Bakel livestock project. In the portion of the Upper Casamance that lies within the watershed of the Gambia River, Ange (1981) and Soumeh (1977, 1979) provide a useful contribution on the development of cotton-growing schemes in the Kolda region.

Aside from a few scattered ethnographic references, the socioeconomic literature on Senegal Oriental is quite thin. The regional literature is most complete on questions of land settlement and new lands programs (Benoit-Cattin, 1979; Dubois and Milleville, 1975; Dubois, 1975; Dubois, Milleville and Trincaz, 1976; Trincaz, 1979). Closer to the Gambia River in the areas south of Tambacounda there are a series of projects run by SODEFITEX and OFADEC which are of special interest since they involve mixed irrigation and rainfed systems, but the availability of information about these systems is uncertain. The remaining portions of Senegal Oriental to the east and south of Niokolo Koba National Park are relatively unstudied, notable exceptions being Nolan's research on the Bassari (1974), and a series of ethnographic reports and maps published by the Musée de l'Homme in Paris. Considering the dearth of information on Senegal Oriental, Pelissier's seminal text (1966) can be a useful guide to the ethnographic aspects of rural development in the region.

A working bibliography under the title of "Socioeconomic Conditions and Rural Development in The Gambia and Senegal Oriental" was prepared for the socioeconomic team by Ms. Mary Bivins of Michigan State in December 1982 and was distributed to OMVG representatives at that time. Copies will also be made available to USAID.

## I. OVERVIEW

- A. Objectives and Purposes: The objectives of the socioeconomic study (SES) are as follows:

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\* See Porges (1967), Bingen (1977), and Kostinko and Dione (1980) for bibliographic guides.

1. To delineate the fundamental character of farming systems throughout the Gambia River Basin, including a regional examination of indigenous marketing and migration patterns.
2. To assess the constraints on existing farming systems in their regional context and to evaluate prospects for improvement in light of the organisation of current production systems.
3. To assess the long- and short-term impacts of the proposed dam and irrigation interventions and, in particular, to assess the probable consequences and possible mitigative measures for marginal, at risk, and disadvantaged groups, and to develop relevant research priorities for national agencies of member states in relation to these interventions.
4. To develop, test in the field, and institutionalize in collaboration with OMVG and other national agencies, appropriate methodologies to monitor and evaluate developments in the Gambia River Basin on a continuing basis.
5. To analyse questions of special interest and pertinence for OMVG and member states.

In meeting these objectives, the purposes of the SES are: (i) to provide an integrated set of socioeconomic studies concerning "evolutionary" and "revolutionary" changes associated with the shift from rainfed to irrigated agriculture and the development of large-scale water impoundment systems and water management schemes; and (ii) simultaneously to strengthen OMVG and member state national agencies in their capacities to generate and synthesize socioeconomic data for planning purposes in the Gambia River Basin. Work at each stage will be conducted in such a way that member state nationals and agencies contribute directly to the SES agenda and simultaneously acquire new techniques.

- B. Means and Study Design: The development of the SES design has been informed by two preliminary activities: first, a literature search to prevent duplication of past or ongoing research work (for example, that of ISRA and ORANA in Senegal; and the LRDC study, the work of the Medical Research Council, the PPMU, and the Mixed Farming Project in The Gambia) and second, intensive reconnaissance work throughout the Basin conducted in the first two months of the study. To meet the SES objectives, the

socioeconomic team has designed a three-pronged agenda by which the requisite data can be generated. The questions posed and the type of information collected in each component are integrally related but nonetheless quite discrete. Each of the three components of the SES requires different staffing, research skills, and timing. Nonetheless, each element is internally linked to the others and generates complementary data that provide the basis for an integrated analysis appropriate to the complexities of a river basin development study. In outline, the three components are as follows:

1. Intensive Village Studies: These studies, to be conducted in 10 villages over a 14-month period, will provide detailed quantitative and qualitative information on the socioeconomic organization of rural production systems in the priority areas defined by OMVG.

In each of the villages selected, data will be collected on critical socioeconomic issues based on a twice-monthly interview schedule throughout an entire farm cycle (May '83 to May '84). In four of the 10 villages, moreover, detailed labor allocation data will be collected on a twice-weekly basis for the duration of the study. In each village selected for analysis, trained enumerators will reside continuously over the 14-month period. These enumerators will be directly supervised on a weekly basis by either a specially trained host country technician or a graduate student who, in addition to supervisory responsibilities, will also personally sample households and perform other assigned tasks. The village studies will also be given direct and continual supervision by a senior member of the socioeconomic team.

Two main types of data will be collected throughout the study year. One type, designated as "flow data," is of a detailed, recurrent nature and is best collected every four to fifteen days. The other, which may be referred to as "stock" or "single-point data," is susceptible to collection at less frequent intervals. These studies are costly and labor intensive, yet the data they generate will permit the use of various quantitative methods to assess the socioeconomic impact and constraints of government interventions on existing production systems. In addition, the village studies will provide a logistical base and a statistical frame from which the case studies (e.g. marketing, land tenure and water-use associations, extension) will benefit.

2. Thematic Case Studies: Each case study addresses one or more thematic issues that are critical components of the integrated socio-economic study. There will be a measure of planned overlap and for this reason the organization and staffing of some case studies are clustered (for example, land tenure and water-use associations, migration and resettlement). Some data pertinent to the case studies will naturally be derived from the intensive village studies and from the basinwide farming systems survey that will simultaneously accumulate data from peripheral areas. Each case study will differ in scope, timing, and staff requirements. At the most intensive level, some demand a quick start-up and require conduct over a 12-month period. They possibly also require sustained input by socioeconomic team members, short-term consultants, graduate students and enumerator-assistants. Conversely, other studies may be readily completed in several weeks with a few assistants and may not be initiated until the dry season of 1984.

Each socioeconomic team member will a critical intellectual, organizational, and supervisory input into several of the case studies in addition to the organization of intensive village studies. Furthermore, other UM/GRBS teams will be involved in the design, administration, and staffing of certain case studies (particularly the Kekreti study and downstream impact assessment). These case studies will thus constitute a type of mosaic fulfilling both short- and long-term data requirements of the OMVG. In addition, many historical issues are most appropriately pursued through such case studies, for example changing land tenure relations, new forms of gender relations, etc. Each study will develop appropriate qualitative and quantitative methodologies as required by it. The proposed case studies are: (i) Kekreti reservoir impact study; (ii) Balingho downstream impact assessment; (iii) migration and resettlement; (iv) water-use associations and land tenure; (v) marketing and the organisation of trade, and (vi) agricultural extension and input provision.

3. Extensive Basinwide Survey of Farming Systems: As the intensive village studies and the thematic case studies will not provide a complete picture of the basin's production systems, a separate farming system reconnaissance will be conducted over several months. The

principal goal of this effort is to provide baseline farming data in areas where our other studies are not represented and where high quality secondary data on farming systems do not exist. In addition, this rapid reconnaissance will feed into other components of the socioeconomic team effort corollary data (for example, on migration, commodity prices and tenure systems) from a wider geographical domain.

As a first step, a series of reconnaissance surveys are to be mounted in those areas where the data base is clearly deficient, for example in the southeastern part of Senegal Oriental. These surveys will adapt from the approach of Collinson in East Africa and/or McIntire in Upper Volta and will consist of a questionnaire covering a wide range of information. This would be complemented by open-ended interviews of extension personnel and farm family members by a two-person technical team composed of a social scientist and an agronomist, along with mobile enumerators.

A particular strength of this multicomponent approach is that it provides complementarity of methodologies, several differing scales and intensities of analysis, and the capability to examine critical issues through time, in both qualitative and quantitative ways, using data generated from each approach.

- C. Interfacing with Other Team Studies and with OMVG: In all components of its research, the SES will work directly with other teams to ensure both cost effectiveness in data collection and maximum integration of analyses. The specific types of collaboration are discussed in detail in Part II. Suffice it to indicate here that the SES three-component approach provides a matrix that can be directly utilized by other studies. The intensive village studies, for example, will administer biweekly questionnaires on hunting, fuelwood, and fishing as a part of the standard frame of data collection. Several of the case studies also involve a direct and systematic input by personnel from the health, wildlife, and fishing teams (for example, on the Balingho and Kekreti studies), as indeed will the basinwide survey.

Another important facet of the SES workplan is the interactive process between team personnel and OMVG. The latter have had a major input into the formulation of many of the case studies, which reflect the desire of OMVG to be provided with critical information early in the research process. In addition, OMVG is encouraged to participate in all levels of the design

work and most especially in the enumerator training programs. The basinwide reconnaissance work perhaps provides one of the most appropriate avenues for institution-building and training. This sort of exercise can provide evaluation and monitoring mechanisms, both of which involve skill acquisition by personnel of OMVG and national agencies. In addition, the socioeconomic team will convene twice yearly seminars to update OMVG and member state representatives on the progress of research activities and also to provide a forum both to assess preliminary project findings and to solicit input from national agencies (see Figure 1).

- D. Staffing and Sequencing of Operations: Since the first week of January 1983, Dr. Michael Watts, Mrs. Christine Scharffenberger and a short-term consultant, Dr. Peter Weil, have successfully initiated the first phase of the research agenda in anticipation of this detailed workplan. This has included the following: literature search, Kédougou reconnaissance, establishment of research bases, the development and printing of 23 questionnaires, pretesting of questionnaires, initial recruitment of enumerators and supervisors, preparations for enumerator and supervisor training, preliminary village selection and sensibilisation, completion of necessary contacts with, and discussions with appropriate ministries, local officials, parastatal organizations, and research institutions.

Some of the staffing arrangements for the period April 1983 to the termination of the project have yet to be completed. Mr. Franklin Casey will fill the position of economist in May. Mr. Walter West arrived in Senegal on March 25 to undertake the Kekreti study. However, not all of the personnel for the case studies have been recruited. Notwithstanding these limitations, the timetable for the next 22 months is indicated in Figure 1.

- E. Data Collection, Analysis and Write-Up: Data analysis and report writing insofar as practicable will be done in Senegal and The Gambia. The team has developed directly codable questionnaires that facilitate keypunching and subsequent computer analysis. A computer consultant, Mr. Djibril Ndiaye of Dakar, has been involved in questionnaire design and in the development of quality control mechanisms including verification of tabulations. Availability of computer hardware and statistical capabilities has been thoroughly researched in Dakar.



F. Deliverables:

1. Copies of questionnaires, coding sheets and research manuals will be delivered to OMVG as they are written.
2. Completed questionnaires with raw data will be given to OMVG after keypunching.
3. Case study and consultant reports will be published in the UM/GRBS Working Document series as work is completed.
4. The final socioeconomic team report covering all three components will also be published in the Working Document series. Target date: November 1984.
5. Copies of all socioeconomic team computer tapes and field notebooks, along with the socioeconomic document library, will be handed over to OMVG at the completion of the project.
6. A trained and experienced corps of survey supervisors and enumerators will be available to OMVG at the conclusion of the study.

G. Computer Operations and Workshops: A data processing consultant, Mr. Gerald Cole, is scheduled to be in Dakar during the period May 5-15 to assist the socioeconomic team in selecting institutions, firms, or individuals for keypunching and computer operations. During this period Mr. Cole will assist the OMVG in the identification of their data processing needs, particularly in reference to the hardware configuration appropriate to their future computer operations.

In conjunction with OMVG, the socioeconomic team will conduct a series of computer analysis workshops throughout the project. A short-term consultant, Dr. Edgar Ariza-Nino, will be provided for this purpose. The first such workshop is tentatively scheduled for the month of December 1983. As deemed advantageous by both the socioeconomic team and OMVG, other workshops can be conducted later in the data analysis phase of the project (ie. July to September 1984).

II: DETAILED WORK PLAN

A. Intensive Village Studies

Objectives and Purpose: To provide detailed quantitative and qualitative village-level data in the priority areas identified by OMVG. These data can be directly employed by OMVG and member state agencies: (i) to formulate research priorities and development policies, (ii) to plan for the short- and

long-term impacts of dam and irrigation development and (iii) to develop long-term socioeconomic monitoring capabilities. Of particular significance to the intensive village studies is the transition from rainfed to irrigated agriculture which demands a careful analysis of the economics of upland agriculture and of the labor constraints associated with double-cropped systems.

**Rationale and Significance:** The villages to be intensively studied are situated in OMVG priority areas. Ten communities, six in The Gambia and four in Senegal, have been selected (i) to represent in a systematic fashion the diversity of farming systems within each priority area (ii) to provide meaningful comparisons based on significant criteria (see the discussion on village selection below) and (iii) to provide information that does not duplicate existing work but yet can be used constructively in relation to extant studies.

**Village Selection:** The development of criteria and actual selection of a purposive sample consisting of ten intensive village survey (IVS) units occurred in the following manner:

- **Discussions with the OMVG.** The socioeconomic team has consulted representatives of OMVG over the last four and a half months. These discussions have led to a better understanding of OMVG's purposes and goals, its priority areas for investigation, and its information needs and their timing.
- **Literature search.** A second step in the generation of the criteria was a thorough search of the literature on socioeconomic aspects of rural life in the Basin, as well as on experience in other tropical river basins.
- **Consultations with officials of The Gambia and Senegal.** A third input to the generation of the criteria was a series of consultations with government officials of The Gambia and of Senegal in priority areas of the Basin. (A list of these individuals is in Appendix A). On several occasions the officials took time out from their schedules to accompany team members on study visits to villages under consideration.
- **Discussions with village-level officials, farmer groups, and individual farmers.** These occasions generated qualitative information that served as a basis for several of the criteria

- Professional analyses by members of the socioeconomic team. The socioeconomic team analyzed the information that had been obtained, drawing on the professional knowledge and experience of individual members. This constituted the fifth step in the elaboration of the criteria.
- Eight criteria for the selection of ten sample IVS villages in the basin emerged. The eight criteria are listed in Table I in order of decreasing importance, as are the subcriteria within each category. These criteria were then applied to choose the IVS units.

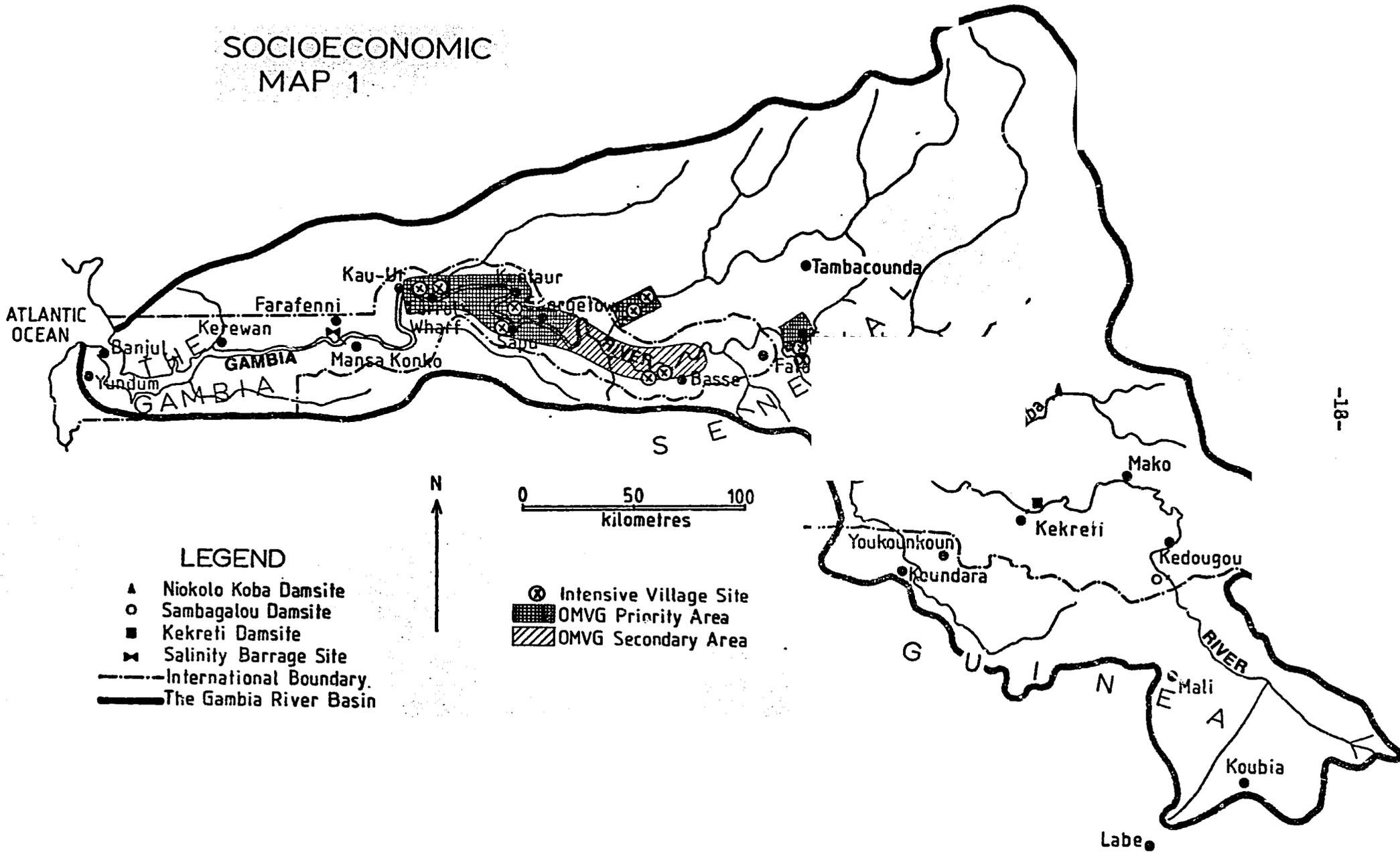
In Tables II and III, the socioeconomic team has applied the eight priority-ordered criteria to select the ten village units. These tables are a condensation of a very extensive matrix analysis used in determining site selection. Ultimately, six villages were selected in The Gambian portion of the Basin and four in the Senegalese portion.

Map I shows the OMVG priority and secondary areas and the intensive village sites. The villages selected are representative of the most important types of farming system by ethnic group within the priority areas. Villages have not been chosen in the Balingho and Kekreti impact zones since these areas will be the subject of important case studies described below.

Four villages are to be the subject of intensive labor allocation studies, based on 3 to 4 day labor recall over a full calendar year. The choice of two "paired" villages for labor allocation studies in each portion of the basin is designed to highlight the labor profiles associated with irrigated and non-irrigated systems in villages that are in most other respects (e.g. ethnicity, ecology, demography, production systems) directly comparable. In other words, one labor allocation village can be used as a control to gain further insight into the socioeconomic impacts of the other's participation in irrigation programs.

Methodology of village surveys: The intensive village studies are organized around a frequent interview schedule and will continue throughout an entire annual farming cycle (May 1983 to May 1984), as previously stated. A frequent interview schedule is desirable because much of the data are sought through memory recall. The more frequent the interview the more easily remembered and reliable is the information. Given the importance of seasonality in all aspects of village life and economy, long-term recall methods cannot adequately capture temporal variability in social and

# SOCIOECONOMIC MAP 1



## LEGEND

- ▲ Niokolo Koba Damsite
- Sambagalou Damsite
- Kekreth Damsite
- ⋈ Salinity Barrage Site
- International Boundary.
- The Gambia River Basin
- ⊗ Intensive Village Site
- ▨ OMVG Priority Area
- ▧ OMVG Secondary Area

TABLE I.

Criteria for the Selection of Ten Sample IVS Units

- 1) LOCATION
  - i) Priority Areas
  - ii) Secondary Areas
  - iii) North and South Banks of the Gambia River
  - iv) Relative Distance from River and Bolongs
  - v) Pedology and Salinity Affecting Existing Rice Production
  - vi) Accessibility
- 2) PARTICIPATION, RECENT OR FORMER, IN IRRIGATION PROGRAMS
  - i) Participation in Double-Crop Irrigation in 1982 and intention to do so in 1983
  - ii) Participation in Single-Crop Dry Season Irrigation Programs
  - iii) Participation in Single-Crop, Wet Season Only Irrigation
  - iv) Former Participation (and When) in Irrigation Production Programs of any type.
- 3) PARTICIPATION IN TWO-SEASON, DOUBLE CROP NON-IRRIGATION RICE PRODUCTION
- 4) PARTICIPATION IN SINGLE-CROP, RAINY SEASON ONLY ("TRADITIONAL") RICE PRODUCTION
- 5) PARTICIPATION IN UPLAND FARMING ONLY
- 6) REPRESENTATIVENESS OF ETHNIC GROUPS WITHIN PRIORITY AREAS OF THE GAMBIA AND SENEGAL
  - i) Proportional Representativeness
  - ii) Village Unit/Research Site Size Representativeness
- 7) FORM OF PRODUCTION FOR MARKET
- 8) ACCESS TO PUBLIC SERVICES
  - i) Access/Distance from Major Agricultural Support Services
  - ii) Access to Other Public Services

TABLE II

## GAMBIA: Village Criteria and Selection

| Village  | Primary (P)<br>Secondary (S)<br>Area | North (N)<br>or<br>South (S) | Distance From<br>River/bolong                            | Salinity<br>H = High<br>M = Med.<br>L = Low | Access    | Ethnicity       | Size/Rank<br>Order   | Public<br>Services   | Commodity<br>Production                     | Aerial<br>Photo<br>Coverage |
|--|--------------------------------------|------------------------------|--|---|-----------|-----------------|--|--|---|-----------------------------|
| Nema (Fulladu West), M.I.D.  | P                                    | S                            | Adjacent to River Gambia                                 | L   | High      | Mandinka        | 168 + 59th of 150 villages in District<br>(1)                | Agricultural centre local market, close to primary/secondary schools                     | Groundnuts, some rice, some fishing         | Yes                         |
| Jakaba (Niani) M.I.D.  | P                                    | N                            | Near to bolong, medium distance between river and upland | L   | High/Med. | Mandinka        | 569 + 5th largest village in District<br>(2)                 | Proximity to all Kuntaur services  | Groundnuts, some fishing                    | Yes                         |
| Charman (Niani) M.I.D.   | P                                    | N                            | Near to bolong and river                                 | M/H early & late wet season                 | Med./Low  | Fula (Tukulor)  | 682 + largest village in District<br>(3)                     | Demonstrators, GPMB station, isolated from large market                                  | Groundnuts, some rice, cotton, some fishing | Yes                         |
| Bati Ndar (Upper Saloum) M.I.D.  | P                                    | N                            | Near bolong, peripheral floodplain                       | M/H   | Med./Low  | Wolof           | 470 + 2nd largest village in District<br>(4)                 | Demonstrators, within 3 kms. of large market, agricultural services, schools, dispensary | Groundnuts, some cotton                     | Yes                         |
| (i) Soutuma Sainy Kandeh<br>(ii) Sotuma Sambakoi (Fulladu East) U.R.D. | S                                    | S                            | Near bolong, medium distance between upland and river    | None  | Med./High | Fula (Jombonko) | 116 & 206: 48th and 78th largest villages in District<br>(5) | No village services<br>Access to Basse   | Some groundnuts, some cotton                | No                          |
| Alohungari (Fulladu East) U.R.D.                                       | S                                    | S                            | Near river   | None  | High      | Serahuli        | 2420 + 4th largest village in District<br>(6)                | Demonstrators, agricultural services, market, access to Basse                            | Groundnuts, rice some cotton                | No                          |

TABLE II (con't.)

## GAMBIA: Village Criteria and Selection

| Village  | FARMING SYSTEMS                  |  |   |                                  |                            |        |                | Logistical Considerations   |
|--|----------------------------------|--|---|----------------------------------|----------------------------|--------|----------------|---|
|  | Double Cropped*<br>Irrigation    | Dry Season*<br>Irrigation                  | Former<br>Irrigation*   | Non-irrigated<br>Double Cropping | Wet Season<br>Rice Systems | Upland | Upland<br>Only |   |
| Nema<br>(Fulladu West)<br>M.I.D.   | marginal<br>O,B,R,W (?)          | Irrigation<br>Service<br>O,B,R,W (?)       |   |                                  | ✓<br>(bafaro)              | ✓      |                | These two villages will have 2 enumerators each since they are the preliminary selections for the collection of labor allocation data. The villages will be under the direction of one supervisor, based in Nema. |
| Jakaba (Niani)<br>M.I.D.   |                                  |  | Pump in poor repair occasionally used as a wet season supplemental water source | ✓<br>(wami-faro)                 | ✓<br>(bafaro)              | ✓      |                |   |
| Charmen<br>(Niani)ja<br>M.I.D.   |                                  |  |   | ✓<br>(wami-faro)                 | ✓<br>(bafaro)              | ✓      |                | Both villages supervised by one supervisor stationed in Kaur. Must cross bolong by canoe until bridge completed. 2 enumerators.   |
| Bati Ndar<br>(Upper Saloum)<br>M.I.D.  |                                  | Irrigation<br>Service<br>O,B<br>(marginal) |   |                                  |                            | ✓      | ?              |   |
| (i) Soutuma<br>Sainy<br>Kandeh<br>(ii) Sotuma<br>Sambakoi<br>(Fulladu East)<br>U.R.D |                                  | Irrigation<br>Service<br>O,B<br>(marginal) |   |                                  | ✓<br>(bafaro<br>bantafaro) | ✓      |                | Supervised by one individual resident in Alohungari, and personnel in Basse. 2 enumerators.   |
| Alohungari<br>(Fulladu East)<br>U.R.D.   | Irrigation<br>Service<br>O,B,R,W | Irrigation<br>Service<br>O,B,R,W           |   |                                  | ✓<br>(bafaro)              | ✓      |                |   |

KEY: \* Participation in irrigation schemes may be as:  
 (1) Owners (O)  
 (2) Borrowers (B)  
 (3) Renters (R)  
 (4) Wage laborers (W)

1. 55% of District residents live in villages over 200.
2. 60% of District residents live in villages over 200.
3. 60% of District residents live in villages over 200.
4. 40% of District residents live in villages over 200.
5. 25% of District residents live in villages over 1000.

TABLE III

## SENEGAL: Village Criteria and Selection

| Village   | Primary (P)<br>Secondary (S)<br>Area | Distance From<br>River/Bolong      | Access   | Ethnicity  | Antiquity          | Size/Rank<br>Order  | Commodity<br>Production   | Public Services   | Aerial<br>Photography<br>1:12,500 |
|---|--------------------------------------|------------------------------------|----------|--|--------------------|---|---|---|-----------------------------------|
| Sao Soukouto (Maka)<br>Sao Soukouta<br>Department of<br>Tambacounda | P                                    | Adjacent to bolong,<br>(Sandougou) | Med.     | Mandinka   | Old                | 265 and 302:<br>22nd and 9th<br>largest in<br>Arrondissement<br>(1)             | Groundnuts  | Agricultural ser-<br>vices. Access to<br>dispensary, school<br>market at Maka                                 | Yes                               |
| Diende (Maka)<br>Department of<br>Tambacounda                       | P                                    | Adjacent to bolong<br>(Sandougou)  | Low/Med. | Mandinka   | Old                | 240 : 28th<br>largest in<br>Arrondissement<br>(1)                               | Groundnuts,<br>some rice  | Demonstrator.<br>Minimal services.<br>Isolation in wet<br>season  | Yes                               |
| Adjaff (Missira)<br>Department of<br>Tambacounda                    | (15 kms. south<br>of P.)<br>S        | 3-4 kms. from<br>river             | Med./Low | Fulbe  | Founded<br>in 1979 | 130 <sup>±</sup> fami-<br>lies (ca 4-<br>500) Not<br>included in<br>census. (2) | Groundnuts,<br>some rice,<br>maize, bana-<br>nas, vege-<br>tables | OFADEC provision-<br>ed small shop,<br>school, etc. Minimal<br>services, limited<br>access in wet sea-<br>son | No(?)                             |
| Sankane I and II<br>(Missira)<br>Department of<br>Tambacounda       | (15 kms. south<br>of P.)<br>S        | 3-4 kms. from<br>river             | Med./Low | <sup>1</sup> One com-<br>munity of autoch-<br>tones<br>(Fula)<br><sup>2</sup> One com-<br>munity of<br>settlers* | Founded<br>in 1981 | 67 conces-<br>sions (ca<br>500) Not in-<br>cluded in<br>census<br>(2)           | Groundnuts,<br>vegetables,<br>bananas                             | OFADEC facilities<br>Limited access   | No(?)                             |

\* Includes individuals from Cape Verde, Dakar, Sine-Saloum.

1. Mean village size in Arrondissement is 154.  
40% of all residents live in villages over 200.
2. Mean village size in Arrondissement is 153.  
65% of all residents live in villages over 200.

TABLE III (con't.)

## SENEGAL: Village Criteria and Selection

| FARMING SYSTEMS   |                |                       |                                  |                                 |                    |        |             | Logistical Considerations   |
|---|----------------|-----------------------|----------------------------------|---------------------------------|--------------------|--------|-------------|---|
| Village   | Double Cropped | Dry Season Irrigation | Former Irrigation                | State/Private                   | Lowland Wet Season | Upland | Upland Only |   |
| Sao Soukouto (Maka)<br>Sao Soukouta                     |                |                       |                                  |                                 | ✓                  | ✓      |             | Supervised from Sao. Difficult movement in wet season. 2 enumerators.   |
| Diende (Maka)<br>Department of Tambacounda              |                | ✓<br>(?)              | May not operate 1983-1984 season | SODEFITEX<br>13 ha rice         | ✓                  | ✓      |             |   |
| Adjaff (Missira)<br>Department of Tambacounda           |                | ✓                     |                                  | SODEFITEX/<br>OFADEC 52 ha rice | ✓                  | ✓      |             | Sites for collection of intensive labor allocation data. Four enumerators. One supervisor resident in Adjaff. |
| Sankane I and II (Missira)<br>Department of Tambacounda |                | ✓                     |                                  | OFADEC                          | ✓                  | ✓      |             |   |

economic activities. Some of the information to be collected can be considered of a sensitive nature. These more sensitive questions can be scheduled for later in the year after confidence has been established between the project staff and the rural community. Information that is "qualitative," e.g. on authority patterns and ethnic relations, will be gathered along with quantitative data.

Phase 1 of the intensive village studies principally concerns the preparation of (i) instruments necessary for the establishment of a compiling frame and, (ii) questionnaires to be administered biweekly and bimonthly for a year (flow-data). Phase 2 concerns the subsequent development and administration of inventory, stock and single-point-data questionnaires.

Table IV lists the subject matter of the questionnaires developed to date, samples of which are found in Appendix B, along with preliminary coding sheets. Additional questionnaires will be developed in consultation with OMVG technical staff and others, and the existing ones are subject to modification. New instruments will address the need for agricultural production cost data, livestock production labor data, and information on non-agricultural cooperative labor groups.

Enumerators, Supervision and Staffing: Enumerator recruitment was undertaken with the support of the appropriate national agencies. Testing procedures and examinations have been designed and administered to ensure the selection of high quality personnel capable of working independently on a variety of issues beyond questionnaire administration. Enumerator training was to begin in March and April in The Gambia and Senegal, respectively. Working in conjunction with concerned ministries, preliminary contracts have been drawn up pertaining to salary scales, benefits, job responsibilities, and performance standards. Supervisors have been carefully chosen after consultations with local institutions in order to select the highest quality personnel available. Senior socioeconomic team scientists anticipate that the April to June period will be devoted almost entirely to logistical, administrative, and supervisory tasks associated with the smooth running of the intensive village studies.

Duration of Operations; A consideration that has been missed in previous descriptions of the socioeconomic agenda is the necessity of extending the intensive village surveys in certain villages for a two to three month period longer than anticipated, perhaps until the end of July 1984. Such an extension

**TABLE IV.**

**Subject-matter List of Questionnaires**

| <b><u>Phase 1:</u></b>                                  | <b><u>Phase 2:</u></b>   |
|---|--|
| <b>Village Census</b>                                   | <b>Will include the following which are administered only once:</b>  |
| <b>Field Location</b>                                   |  |
| <b>A. Demographic Information I</b>                     | <b>1. Field Histories and Genealogy (including soil types, fallow history, cropping histories, land transactions, tenurial status)</b> |
| <b>B. Demographic Information II</b>                    | <b>2. Use of Agricultural Inputs</b>   |
| <b>C. Returned Migrant Questionnaire</b>                | <b>3. Attitudinal Survey on Extension and Government Services</b>  |
| <b>D. Field Identification</b>                          | <b>4. Yield and Harvest Measurement</b>  |
| <b>E. Field Master Sheet</b>                            | <b>5. Field Dimensions</b>   |
| <b>F. Price of Salaried Labor (weekly)</b>              | <b>6. Formal and Informal Credit</b>   |
| <b>G. Price Survey (monthly)</b>                        | <b>7. Livestock and Capital Goods Inventories</b>  |
| <b>1. Labor Allocation (twice weekly)</b>               | <b>8. Relations with Pastoralists (including grazing systems)</b>  |
| <b>2. Staple Foodstuffs IN (twice monthly)</b>          | <b>9. Merchant Survey</b>  |
| <b>3. Staple Foodstuffs OUT (twice monthly)</b>         | <b>10. Hunter Survey</b>   |
| <b>4. Livestock IN (twice monthly)</b>                  | <b>11. Fisherman Survey and Amount and Origin of food consumed</b>   |
| <b>5. Livestock OUT (twice monthly)</b>                 | <b>12. Local Resources Use (fuelwood, semi-cultivated plants, etc.)</b>  |
| <b>6. Salaried Labor IN (twice monthly)</b>             | <b>13. Mortality and Pregnancy Histories</b>   |
| <b>7. Salaried Labor OUT (twice monthly)</b>            | <b>14. Social and Ceremonial Expenses</b>  |
| <b>8. Nonfarm Income (twice monthly)</b>                | <b>15. Grain Reserves and Histories, including loss to pests</b>   |
| <b>9. NonSalaried Labor In (twice monthly)</b>          | <b>16. Perception of Risk and Cropping Strategies</b>  |
| <b>10. Nonsalaried Labor OUT (twice monthly)</b>        | <b>17. Social Stratification and Incipient Class Formation</b>   |
| <b>11. Strange Farmer Questionnaire (twice monthly)</b> | <b>18. Domestic Water Sources and Uses</b>   |
| <b>12. Strange Farmer Compounds (twice monthly)</b>     | <b>19. Agricultural and On-Farm Water Use</b>  |
| <b>13. Hunting (twice monthly)</b>                      |  |
| <b>14. Fishing (twice monthly)</b>                      |  |
| <b>15. Fuelwood Consumption (twice monthly)</b>         |  |

of the data collection period will be necessary in those villages where a crop (irrigated or nonirrigated) has been planted in the dry season of 1984. Crucial operations of the dry season rice crop, such as transplanting, not infrequently take place as late as mid-March, which means that harvesting operations are pushed into the following rainy season. Because dry season cropping operations are quite important for the study and the team would already have gathered data on other activities relating to the 1984 dry season crop, it is desirable to follow this productive activity to its conclusion.

**B. Special Case Studies**

The SES is intended to provide critical information to support an objective judgment of the short- and long-term impacts of the proposed dams, irrigation interventions, and water management schemes. This objective will be specifically addressed by a series of thematic case studies. They will utilize different methodologies than the labor-intensive village studies; the research designs adopted will be targeted on questions that concern the impact areas. The currently planned studies are as follows:

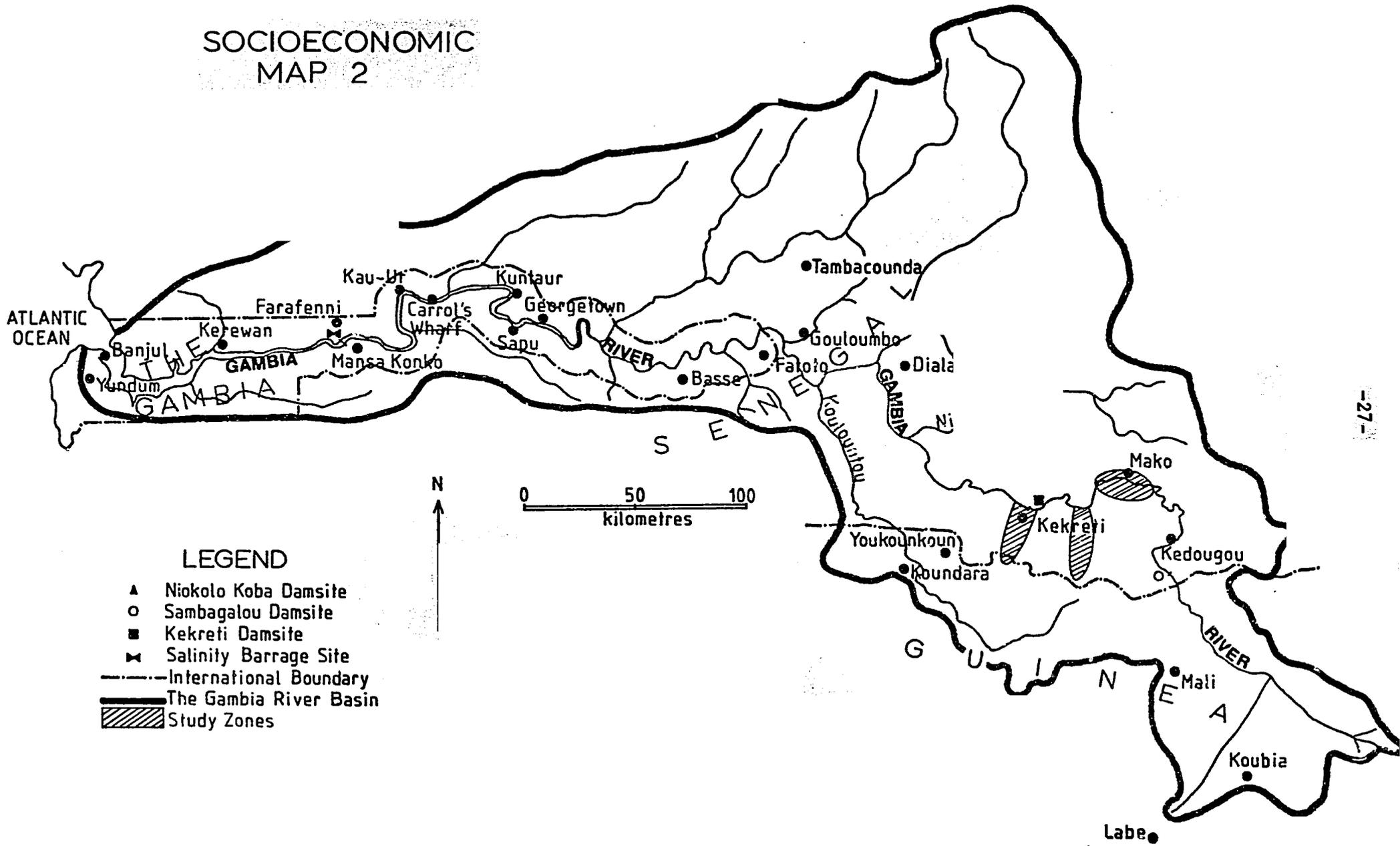
**1. THE KEKRETI RESERVOIR IMPACT STUDY:**

**Purpose and Objectives:** (i) To delineate the nature of agricultural, pastoral and other rural production systems in an area of considerable ethnic and agrarian diversity, and (ii) To evaluate projected long- and short-term socioeconomic impacts of the proposed Kekreti dam and reservoir construction.

**Issues:** Based on a two-week site visit by Dr. Derman, a subsequent visit by Dr. Watts and the multiteam reconnaissance mission, the following critical subject matters have been identified.

- a) What are the size, distribution, social organization and authority structures of populations most likely to be affected? How much variability is there among their production systems?
- b) In light of (a) what is the geographic extent and current utilisation of areas likely to be flooded (particularly bottomlands below 80m)? Is it possible to compute the aggregate loss of production, probable income effects, possible resettlement costs and potential problems; and to devise socially viable (and welfare optimal) development alternatives?

# SOCIOECONOMIC MAP 2



- c) What are the patterns of labor migration, particularly in relation to the development and growth of commercialized agricultural production and existing types of government activity?
- d) What are the general patterns of morbidity? What health problems will occur after the dam is built and how can they be mitigated?
- e) What are institutional and infrastructural capabilities?
- f) What are the problems of ethnic minorities and how might inter-ethnic relations be affected by dam construction?
- g) What are the wildlife and fishing resources and what is the importance of hunting and fishing in the regional and local economy? What will be the future fish potential of the new man-made lake and downstream?

Means and Research Design: It has become clear that the Kekreti area is not an apposite site for intensive village studies. The Agar-Und Hydrotechnik GMBH/Howard Humphreys Ltd. Report of March 1982 estimates on the basis of alluvial soil analysis that potentially irrigable land in Senegal Oriental lies "between the dam site and the Gambian border" (p. 72). The priority irrigation development areas in Senegal Oriental all lie north of the Kekreti site: south of Medina Diaka (12,700 ha), southwest of Gouloumbo (4,400 ha) and the lower stretch of the Sandougou Bolon (7,200 ha).

Intensive farm management studies which provide important production data are clearly relevant tools for an examination of those project areas in which irrigated agriculture will be extended. However, in the Kekreti region the principal concerns pertain less to changes in existing production systems than to other types of dam impact such as village displacement, resettlement, and health consequences of water impoundment, none of which require costly and time-consuming farm management studies.

A three-zone (see Map 2) approach will be adopted, reflecting the broad patterns of regional variation and the priority impact areas.

1. Diara River em Salémata (Bassari-Fula)
2. Tiokoye River em Koumafele (Fula-Sarakollé)
3. Gambia River em Make (Malinké-Fula)

An enumerator would be placed in each zone to administer questionnaires and obtain qualitative information. Each enumerator would be responsible for the collection of wet season data in one community on a variety of pertinent issues, particularly relating to bottomland production systems. After the rains, when mobility and hence supervision are made easier, the enumerator would obtain information from other villages within his zone.

The Kekreti site visits suggest the following approach:

- An extensive study is needed to obtain a full appreciation of the range of impacts of dam construction.
- The placement of enumerators and supervisors in the villages for the 1983 rainy season is desirable.
- Logistical difficulties in the wet season will be substantial, yet enumerators must be in places that permit regular supervision by supervisors and senior staff.
- Both qualitative and quantitative data should be collected.

Staffing: Design advice from senior socioeconomic team, graduate student leader (Walter West), a supervisor, 3 enumerators, and systematic input and support from health, wildlife and river resource teams.

Timing and Scheduling: Case study to begin in early May and to continue for 12 months for a total of 60 man-months.

## 2. DOWNSTREAM IMPACT ASSESSMENT OF THE BALINGHO BARRAGE:

Purpose and Objectives: (i) To provide an extensive overview of existing lowland farming systems and social structures using secondary and primary data and (ii) To determine the impacts of barrage construction -- particularly salinity and hydrological changes -- on existing agrarian systems and modes of livelihood.

### Issues:

- a) What are the characteristics of current lowland rice production systems in the downstream zone with emphasis on geographic extent, yield estimates, economic value, number of households involved, and the adaptive strategies of farming systems in relation to salinity and hydrological parameters?

- b) What are the potential long- and short-term impacts of barrage construction, especially the likely effects of salinity and river flow changes on extant systems of production?
- c) In pursuit of (b), what are the possible income and welfare effects of crop loss, both by gender and by socioeconomic status?
- d) What are the social structures and authority patterns of the areas to be affected?
- e) How can these findings be integrated with those of the fisheries subteam on the potential impact of barrage construction on fish production systems with their attendant income and nutritional effects?

**Means and Research Design:**

- An analysis of aerial photography (1947-82) to compute the extent of lowland rice systems and, in conjunction with field observations, to estimate gross production. This will result in a series of land-use maps detailing the changes in rice production since 1947.
- Extensive field research to derive data on the variation of local rice systems, yields, systems of labor mobilization, sexual division of labor and the technical attributes of lowland rice systems in relation to salinity, flushing, and water control.
- A literature review of relevant data and ongoing research in the downstream zone, including discussions with appropriate national agencies.

Systematic interaction with barrage technical teams and the other UM/GRBS teams to assure an integrated approach.

**Staffing:** Design input from senior socioeconomic team personnel, a short-term consultant, an agronomist/soil scientist (Ms. Moore), an enumerator/assistant, and systematic input from other teams.

**Timing and Scheduling:** To begin in the 1983 wet season, no later than June, and to continue for 12 months.

**3. MARKETING AND THE ORGANISATION OF TRADE:**

**Purpose and Objectives:** The objectives of this study are to assess the structure and performance of parastatal and private agricultural

marketing channels in the basin. Particular attention will be devoted to relationships between private and state institutions, especially for staple foodstuffs, at the local level. Market performance, integration, capacity and structure are important elements for planning further development of rice production.

Issues:

- a) What are the characteristics of local marketing, most especially patterns of household grain sales and purchases through time in relation to socioeconomic status?
- b) What are the relevant government marketing and price policies and how well do the marketing boards perform?
- c) How is private trade organized through the various levels of merchant activity from the rural wholesaler to the urban consumer? Some of the basic research on this subject has been done for Senegal (Ross, 1979) and for the Gambia by PPMU.
- d) How have prices behaved over a 20-year period? This will apply to several food staples and export commodities, using governmental, archival, and secondary sources supplemented by a limited basinwide market price study to assess seasonality and market integration for selected commodities.

Means and Research Design: The marketing case study will benefit directly from the intensive village component. It also involves other methodological approaches to quantitative and qualitative analyses of marketing phenomena. These are:

- The collection of bimonthly price and quantity data pertaining to staple foodstuffs (including fish) and export commodities over the course of 14 months, derived from 10 locations in Senegal and The Gambia.
- A review of existing institutional (e.g. GPMB in The Gambia) and other ongoing and completed research.
- Extensive surveys on market structure and conduct, concentrating on areas not covered by village studies.
- Qualitative and quantitative studies of private trade, based on structured interviews with, and observations of, rural traders.

Staffing: Under the direct supervision of Mr. Casey of the socioeconomic team, 3 enumerators, support from intensive village study and basinwide survey personnel.

Timing and Scheduling: A six-month study commencing in October 1983.

#### 4. MIGRATION AND RESETTLEMENT:

Purpose and Objectives: To delineate regional patterns of migration and resettlement as a basis for assessment of the impacts of dam construction and perimeter development. It is well established that the Gambia basin has been a crucible for labor migration even though the precise pattern of navétane and strange farmer movement is far from clear. The objectives of this study are to build upon existing studies of labor migration within the basin, refining the knowledge of regional mobility and labor use. This will serve as a basis for assessing the impact of the expansion of irrigated perimeters, of the construction of the barrage/dam system, and of village resettlement.

##### Issues:

- a) What are the dry and wet season patterns of migration, magnitudes of migrant in-flow and out-flow, extent of interregional movement, destinations, sources of employment, income effects, volume of remittances, occupational structures in various types of labor market, and public health implications of current migration?
- b) What are the origins, extent, organization, and income effects of navétane and strange farmer movements? Is there any relationship to wildlife/fishing activities?
- c) What is the history of regional settlement and what effect has it had on disease patterns?
- d) What lessons are to be learned from resettlement and colonization programs within the basin (e.g. Terres Neuves, OFADEC)?

Means and Research Design: The migration and resettlement case study will benefit directly from and contribute to the intensive and extensive SES surveys.

- The 10 intensively studied villages will provide detailed and systematic data on patterns of in- and out-migration at the

household level (including occupational structure, duration, remittances, income effects etc.) over a 14-month period, patterns of strange fisherman/farmer mobility, strange farmer labor use, local settlement histories, and a detailed study of two OFADEC resettlement villages in Senegal (Missira).

The extensive basinwide survey will collect information on mobility in the regional economy in those areas not covered by village surveys and high-quality secondary data.

There will be a detailed assessment of the resettlement and colonization experience in the Terres Neuves (Phases I and II) in Senegal Oriental.

Demographic and settlement data will also be derived from the Kekreti case study. Information from these sources will be placed in the context of a comprehensive literature and census review (e.g. work of Swindell and FAO in The Gambia), similar national census studies and Colvin's research in Senegal.

**Staffing:** Supervision and design input from senior socioeconomic staff, Dr. Gilbert who will direct the extensive survey, a Senegalese researcher (to be recruited) who will conduct the Terres Neuves study, two enumerators, and one supervisor.

**Timing and Scheduling:** Intensive village studies (including OFADEC) begin June 1983, the extensive surveys in September 1983 for five months, and the Terres Neuves study in December 1983 for three months.

## 5. **WATER-USE ASSOCIATIONS AND LAND TENURE:**

**Purpose and Objectives:** To evaluate the various forms, extent and organization of water-use associations in the Basin (including customary, private and parastatal associations), as a basis for future perimeter development, and also to investigate the relationships between these associations and the changing tenurial arrangements associated with irrigation schemes.

Issues:

- a) What are the histories and organizational characteristics of the many types of water-use association in the basin (for example OFADEC and SODEFITEX in Senegal, and the plethora of customary, cooperative and project societies in The Gambia)?
- b) How do water-use associations perform in relation to local production systems, gender relations, the sexual division of labor, changing land status, and socioeconomic status?
- c) How do the present variety and complexity of land tenure arrangements for lowland and irrigated rice schemes look in historical perspective?
- d) What problems are associated with land tenure at four inter-related levels: (i) the application of government laws to customary land law and land-use conflicts, (ii) intervillage allocation and mobilization of land, (iii) intravillage customary land law and adjudication, and (iv) gender and household land questions, particularly conflicts and allocation-disposition problems between men and women?
- e) What land tenure problems can be expected as a result of resettlement from areas inundated by dams?

Means and Research Design:

- Household data on land tenure, notably farm histories, patterns of land circulation, and customary systems of appropriation and disposition, will be systematically collected from 10 village studies over the course of 14 months.
- Basinwide tenure issues will be studied in the context of the extensive farming system.
- There will be a literature review of existing and ongoing work (for example Dey's research in The Gambia).
- There will be an intensive study, using qualitative and quantitative approaches, of water-use associations and tenurial issues working through, but not limited to, the 10 village frame.

Staffing: With design and supervision input by senior socioeconomic team personnel and support from the extensive survey team (Dr.

Gilbert), the water-use/tenure study will be directed as a field operation by Mrs. Scharffenberger with the assistance of two enumerators.

Timing and Scheduling: Intensive village studies to commence in mid-April, extensive surveys in September and the case study in May to continue until December 1983.

6. AGRICULTURAL EXTENSION AND INPUT PROVISION:

Purpose and Objectives: To assess the organisation and evolution of extension systems in the river basin through a variety of means. Much of this effort will build upon extensive work already undertaken on input provision and the administration of extension services. Equally, the analysis will rely on the marketing studies, particularly of the marketing boards, that are discussed in case study #3.

Issues:

- a) What are the history and organization of extension services in the basin?
- b) How do extension services perform at the village level? How successful are they in transferring responsibility to farmer groups?
- c) What are the specific forms of input provision, particularly ox-ploughing schemes in The Gambia, and cooperative and credit schemes in Senegal?
- d) What interactions between private and public input systems are observed at the local level?
- e) What type of extension service and input provision would be most effective for new irrigated lands?

Means:

- A literature review, including extensive discussions with appropriate host-country agencies and personnel.

The use of household-level data derived from the 10 intensive village studies pertaining to on-farm expenditures, 6-month recall on input provision, and attitudinal surveys on extension and input provision.

Qualitative and quantitative work on specific extension activities and on parastatal organizations.

Staffing: Supervision and design input from senior socioeconomic team personnel, case study direction by Ms. Moore, two enumerators with logistical support from the intensive village study teams.

Timing and Scheduling: Intensive village studies commence in mid-April 1983; the literature review and case study will begin in January 1984 and continue for 6 months.

### C. BASINWIDE SURVEY OF FARMING SYSTEMS

The socioeconomic survey will collect detailed information via intensive village and case studies on the areas that would receive the direct impact from proposed barrage construction and associated irrigation developments. The Michigan team will also survey farming systems throughout the basin in a less intensive fashion in order to (a) describe the range of farming systems; (b) discuss constraints to, and areas of flexibility in, those systems; (c) suggest research priorities and possible improvement programs; and (d) advise on approaches to monitoring and evaluating developments in various parts of the basin on a continuing basis.

The extensive survey of farming systems will involve the following sequence of activities:

1. Discussions with researchers and representatives of institutions concerned with agricultural and rural development activities in the basin:

Institutions to be contacted include ISRA and the Ministry of Rural Development (Senegal), Ministry of Agriculture and PPMU (The Gambia), Colorado State Mixed Farming Project, SODEVA, SODEFITEX, and the World Bank. Information collected will be biological/technical in nature as well as socioeconomic. The purposes of the contacts with these agencies will be to determine the state of knowledge about farming systems in the region and to explore collaborative arrangements, particularly with appropriate national agencies, in carrying out surveys of selected portions of the basin.

2. Identification of areas to be surveyed: On the basis of the results of (1) above, the farming systems of the basin will be divided into three groups:

- (i) regions/systems for which available information is quite comprehensive or at least adequate for purposes of the basin study;
- (ii) regions/systems in which sufficient information is available to enable rough delineation of the farming systems, but in varying degrees is insufficient for purposes of the basinwide study. (Sufficiency for purposes of the basin study is a relative term. It is influenced by a variety of factors including the importance of prospective direct/indirect impacts of river basin development and the importance placed on the area by OMVG and member states.)
- (iii) regions/systems for which very little information is available.

Regions of the first group above will probably not be the focus of original data collection in the context of the basinwide survey; rather the survey of farming systems will rely upon available information. The latter two groups of regions will be visited at least once or twice, respectively, by survey teams.

3. Survey Procedure for Group iii Regions: This group of regions is made up of those in which information is insufficient even to make a preliminary delineation of the nature and geographic extent of their farming systems. In such instances it is proposed first to identify the major systems of the area using a procedure developed by CIMMYT's Eastern Africa Program and ICRISAT's West Africa Program, known as defining recommendation domains or as farm system zoning. This procedure involves administering to farmers a very brief questionnaire focusing on animal and crop enterprise mixtures, sources of cash, land-use preparation and timing, and hire and purchase of resources (labor, inputs). The information obtained will be used to make a preliminary classification of the farming systems and their geographical extent. The extension services that exist in the selected regions can assist in checking the results of the initial classification.

The farming system zoning research will be followed by a second survey with a more detailed questionnaire. The questionnaire and its associated procedures will approximate that developed by CIMMYT and ICRISAT for exploratory surveys.

In addition to questions covering the farming system (broadly defined), the exploratory survey questionnaire will include questions of special relevance to: (i) the case studies of marketing, migration and resettlement, land tenure, extension, and (ii) questions of special interest to the environmental study teams (health, wildlife/vegetation and river resources). A special effort will be made to involve representatives of interested organizations at the national and regional levels in these surveys to improve the quality of the surveys and to facilitate follow-up activities.

4. Survey Procedures for Type ii Regions: Type ii regions are those for which the state of information is adequate to make a preliminary delineation of farming systems. Accordingly, the farming system zoning approach will not be employed. Otherwise the procedures will be identical to those described for Type iii regions above.
5. Subsequent Surveys: Subsequent surveys will be conducted in selected areas on specific topics as needed. It is expected at a minimum that at the critical planting and initial weeding period of the 1984 farming season, visits will be made to areas initially surveyed in 1983 to administer questions based on an analysis of the results of the exploratory survey. In some instances, it may prove desirable actually to station enumerators in selected villages to carry out more formal surveys for one or more months as resources permit.
6. Analysis of Survey Results and Report Preparation: Survey results will be analyzed and a series of working documents prepared on farming systems in various parts of the basin. The reports will be jointly released with the participating national/regional institutions where collaboration in the survey work can be arranged. An integrated overview of farming systems in the basin will also form part of the final integrated report on the project.
7. Follow-up Activities: The socioeconomic team will seek to collaborate with other agencies in planning follow-up activities. Such activities might focus particularly upon the development of research agendas for on-farm and on-station trials, possibly beginning as early as the 1984 farming season. An important part of the exploratory surveys would be

to identify possible improvement measures that might be tested in the field by the regional and national agencies responsible for such activities.

8. Interfacing with Other Teams: The extensive surveys also provide the opportunity to collect basinwide data for other teams (see other relevant parts of this workplan). In particular, the wildlife and fish scientists have a need for certain baseline basinwide data that can best be systematically obtained in the course of the administration of farming system questionnaires.
9. Staffing: The extensive surveys will be under the direction of Dr. Gilbert, working closely with other socioeconomic team members and fish and wildlife subteams. Dr. Gilbert will be working with a team of 3 mobile enumerators who will be recruited in the process of enumerator selection for the intensive village studies.
10. Timing and Scheduling: The extensive surveys will commence in September 1983 with enumerator training and questionnaire design, and continue as a field operation for 5 months.

## SOCIOECONOMIC TEAM WORK PLAN

### Guinea

#### INTRODUCTION

The socioeconomic work plan for the People's Revolutionary Republic of Guinea (PRRG) is necessarily briefer and sketchier than that for the other two riparian countries. There are several reasons for this. First, the conduct of extensive socioeconomic surveys in Senegal and The Gambia in the 1983-84 crop year required activity to begin as soon as funds became available. As a result, the plan for the two downstream countries is at a more advanced stage. Second, socioeconomic work in Guinea was not required, even in Phase I, as it was for the other teams. Nonetheless, UM/GRBS assigned Dr. William Derman, senior anthropologist, to represent the socioeconomic team on the reconnaissance mission into Guinea in February 1983. Third, this brief mission provided the only significant opportunity for the team to obtain information on which a work plan could be prepared; it is therefore of a more preliminary and tentative nature than the work plan for the other countries. Fourth, secondary sources of information on the socioeconomic characteristics of the Guinea portion of the Gambia River Basin are extremely limited, as revealed in the bibliographic note below. Fifth, plans for the construction of dams and irrigation works are less advanced in Guinea than in the other countries, thereby increasing the uncertainties associated with any socioeconomic study related to them.

Despite these limitations, the UM/GRBS intends to conduct appropriate socioeconomic research in the Guinea portion of the basin, to match as far as possible the work to be done in Senegal and The Gambia. The tentative work plan presented below represents an estimate by UM/GRBS of what is required. The University's ability to carry out such a plan will depend on whether adequate funding becomes available. It will also depend on the active support of the authorities in the People's Revolutionary Republic and on the socioeconomic team's ability to overcome the formidable logistical obstacles found in the Fouta-Djallon highlands. The degree of difficulty of working in the highlands area is far, far greater than that in the lowland plains of the river basin, as the reconnaissance mission discovered in February. Costs of working in the highlands environment will be considerable.

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### Bibliographic Note

In recent years there have been no in-depth studies of Moyenne Guinée, and there are no special studies of the dam impact zones. There is a general literature on Guinea which includes Thomas O'Toole, Historical Dictionary of Guinea, Scarecrow Press, 1978; Lapido Adamolekun, Sekou Touré's Guinea, Methuen and Co., 1976; Claude Rivière, Classes et Stratifications Sociales en Afrique, University Press of France, 1978; Jean Suret-Canale, La République de Guinée, Editions Sociales, 1970; and William Derman, Serfs, Peasants and Socialists: A Study of a Former Serf Village in Republic of Guinea, University of California Press, 1973. The last named is the only field study done in the Fouta-Djallon.

More recently there has been the UNDP mission of November 1981, "Development of the Gambia River Basin: Annex of Expert Reports for the Pre-investment Action Plan for Guinea," United Nations Development Programme, 1982. This includes the sociology report by Dr. Gordon Appleby. There is also Dr. Van Tuu's report from the FAC (Fonds d'Aide et de Coopération) technical mission of November 1982. Finally, there is the multivolume Polytechna study entitled Plan Général d'Amenagement Hydraulique de la Moyenne Guinée, Bratislavia, 1981. For the Guinean Government's strategy for agricultural development see Ahmed Sekou Touré's La FAPA Révolution Verte, R.D.A. no. 164, Conakry (n.d.).

#### I. OBJECTIVES

- A. To obtain detailed social and economic data on the areas in the river basin where dams, irrigation, hydroelectric power and mining interventions are proposed and where impacts from these interventions may be expected.
- B. To analyze these data with the aim of providing to OMVG and its member states useful projections of the evolution of local production systems.
- C. To propose for the affected population measures to mitigate adverse impacts and to assist in adjustment to change as may be desirable and appropriate.
- D. To assist in the development of the socioeconomic analysis capabilities of OMVG and PRRG, including monitoring and the refinement of instruments of research for use in the future as more is learned and as proposed interventions are implemented.

#### II. MAJOR SOCIOECONOMIC ISSUES

Unlike many other parts of West Africa, the PRRG has a very thin data base. Substantial effort will be needed to collect fundamental data on village and family

organization, division of labor, labor migration, agricultural history, land use, and other matters. Not only are such data presently lacking for villages in the basin; the impact of governmental organizations on the activities of rural peoples is also poorly understood.

Given the paucity of data, there are clearly two major sets of concerns:

- (i) What are the current organization of agricultural production and its implications for irrigated agriculture? and
- (ii) What impacts can be anticipated in the zones above and below the proposed dams at Kogoufoulbe, Kouya, and Konkouré?

With regard to item (i), an area of particular concern is the potential for irrigation on the plains along the Koulountou River downstream from the proposed dam at Kogoufoube, where there is relatively low population density. Issues to be examined include:

- (a) Why are there so few people living there now?
- (b) How will the answer to (a) affect efforts to settle the zones?
- (c) In irrigable areas, what kind of irrigation should be utilized and what kinds of organization do different systems imply?
- (d) What kind of infrastructural changes are required to irrigate successfully?
- (e) What crop mixes are possible, and, of the possibles, which are in a "best" category?
- (f) What kind of technologies are best adapted or may be adaptable to the indigenous cultivators and to their farming systems?
- (g) What experience has Guinea had with irrigated agriculture and what implications does it hold for the plains along the Koulountou and its tributaries?

The second set of concerns (item ii) encompasses the aggregate impacts of the proposed dams, water impoundment, and water management schemes. Obviously there will be variations from one area to another. Basically, however, the key issues center on (a) what will happen to particular villages that will lose part or all of their resource base, and (b) what will be the regional consequences of dam building, reservoir creation, and associated activities.

Clarification of these key issues must await further enquiry. Nevertheless, one crucial determinant of the future evolution of the area will be transportation. Whether or not transportation is improved will affect prospects not only for such

matters as irrigation, the marketing of agricultural products in population centres, and the provision of services to dam-impacted populations, but also the conduct of the UM/GRBS itself.

Because of transport difficulties and related factors, it appears that there are today only limited possibilities for farmers to obtain agricultural inputs such as chemical fertilizers, plows, insecticides, etc. In the past, farmers in the Guinean portion of the basin have had to work their land under considerable constraints of this character. How peasant production has been carried out under such constraints needs investigation for it should reveal valuable insights into how many villages have kept their productive and social systems intact in the face of historic and environmental change. The subject matter to be studied should include but not be restricted to how production has been organized, productivity, utilization of labor, integration of herding and farming, patterns of intra- and inter-village cooperation, cropping patterns, field histories, labor migration, and development of household resources.

The emphasis here upon an inward-turning peasantry is only a hypothesis at this point and does not imply that there have not been strong regional and state influences. A most important recent agricultural development has been the formation of the FAPA (Ferme Agro-Pastorale d'Arrondissement). This is a government effort to increase agricultural productivity by providing support to young graduates of agronomic schools in the form of tractors, fertilizers, land and other resources so that they may serve as models for the peasantry. In the area below the proposed dam at Kogoufoulbe there are already two FAPA's which will probably be involved in any irrigation plans.

Unlike the socioeconomic studies in Senegal and Gambia, the work in Guinea will give greater priority to the impacts of dams operated to produce hydroelectricity and facilitate mining. The potentially irrigable zones in Guinea are much smaller than in the other two countries of the basin, and their extent is uncertain. In other respects as well the socioeconomic studies in Moyenne Guinée will have a distinctive orientation. It is clear from the Polytechna studies of Moyenne Guinée that the authors were trying to present alternatives for reorienting the productive systems of the Fouta-Djallon. These efforts are quite significant because there are serious, long-recognized problems in the Fouta which need special attention. They include erosion, deforestation, energy shortages, and labor migration. These problems, combined with the planned basin developments in Senegal and The Gambia, give an urgency to the socioeconomic studies in PRRG.

### III. METHODS

Given the range of problems to be considered it is clear that a mix of methods is required. First, there should be a general socioeconomic survey of (i) the proposed irrigation zones and (ii) the dam impact zones. This survey will be facilitated by the "recensement" (census) data currently being collected by the government in Guinea and by the aerial photographs and contour maps being prepared for USAID by Mark Hurd, Inc. The purpose of the survey work initially would be to choose:

- (1) villages for intensive study, and
- (2) case study topics which will deal with issues and information that cannot be obtained through village work.

The village socioeconomic survey work would continue in some form throughout the entire study in order to insure that the data obtained were representative of each of the different zones. Thus the socioeconomic survey would provide background information and would also strengthen the case studies.

Village socioeconomic survey work has become somewhat standardized over the past few years. One way of organizing such work is to:

- (1) Describe the village in terms of its social structure; political organization; religious organization(s); educational facilities and use; health facilities and use; marketing patterns; extension activities; water use; and cooperative labor associations. The next step is to delineate the character of productive activity.
- (2) Delineate productive activity by:
  - (a) the purpose (whether for sale, consumption, guarantee of after-life, etc.).
  - (b) the means used. For example, the agriculture survey would study the resources used, methods, tools and the rationale for each.
  - (c) the sequence or timing. It is important to know the reasons behind the timing. This applies not just to agriculture, but also to fishing, hunting, labor migration, etc.
  - (d) the spatial location. Where are the fields and gardens, what are the types of land, soil, and problems of access? Where is the wood cut, etc.?

- (e) the organization of labor within different productive activities. This includes the age and sexual division of labor, but also examines circumstance, caste, work groups, class specialization, etc.

In each of these general areas, the villagers' understanding of constraints, alternatives and the basis for their decision-making should be probed. One would attempt to detect changes from the productive activities of previous years and decisions that augur future change.

It should be added that in village socioeconomic survey work particular attention should be given to avoiding both a "tarmac" bias and a "male" bias. For example, regarding the latter, in studying agricultural production and income it is all too easy to lose sight of women's domestic lives. In addition, there may be difficulties in using only male informants and enumerators.

Starting at a later date will be intensive village studies and issue or case studies, as previously stated. These should be both qualitative and quantitative in nature. The development of specific questionnaires is premature at this time as the state of knowledge about Moyenne Guinée is much less than for Senegal and The Gambia. The development of specific questionnaires must await increased knowledge of the terrain and fuller elaboration of research activities thereon. By then a complete range of questionnaires will be available for the other parts of the basin, and a number of them may be adaptable for Guinea. Additional ones will have to be developed (for example on nutrition, mining, women). It is clear already that there should be case studies on forestry, deforestation, and soil erosion conducted in collaboration with the wildlife/vegetation team. It will be important to understand how the ecological system is perceived and evaluated by the occupants of the different villages to be considered. This information would then play a crucial role in designing appropriate strategies to conserve what is appropriate and to change that which is damaging to the basin or its human resource.

Even preliminary selection of villages for study as well as of topics for the case studies must await the results of a socioeconomic team mission to Conakry and to the two zones earlier identified in the Gambia River Basin of PRRG.

#### IV. TIMING AND STAFFING

There should be a distinct subteam for the socioeconomic studies in PRRG. The subteam would need a leader to be based in PRRG to coordinate efforts with the rest of the socioeconomic team in the basin. Either an anthropologist or a

sociologist is recommended as leader, rather than an agricultural economist, because much of the work will involve projected impacts and mitigation efforts rather than farming systems analysis.

Farming systems analysis will be needed as well, but it could be accomplished by a short-term consultant, perhaps in conjunction with the basinwide survey discussed elsewhere. Up to six months' time of a farming systems specialist would be essential to (i) help select the village and regional study sites, (ii) help develop the questionnaires and (iii) undertake preliminary analysis of the data.

In addition, an agronomist/pedologist would be needed for at least 2 months to analyse soil potential and quality in the different zones and to make specific suggestions as to agricultural possibilities. An agronomist/pedologist assigned to the team can also work collaboratively on the soil conservation and erosion questions with a short-term forestry expert from the wildlife/vegetation team.

In Guinea it would be desirable for the socioeconomic subteam to have the assistance of a medical anthropologist trained in both village studies and ethnomedicine as well as in epidemiology to assess current levels of disease, indigenous perceptions of health and illness, utilization of health resources, and probable impacts of planned interventions. Three to four person-months would be required.

Lastly, one graduate student is essential both to supervise Guinean student investigators and to engage in substantive research. The dispersal of research sites, difficulty of access and the number of student investigators will require more supervision time than the subteam leader can provide alone.

Another staffing dimension would be Guinean. Preliminary discussions by Dr. Derman indicate there is great interest on the part of the Polytechnical Institute of Conakry in working with the University of Michigan and OMVG. This would involve both faculty and students. To cover the proposed work plan requires a minimum team of 15 field enumerators and three supervisors. Depending upon their level of university education and experience, some of the enumerators would do "case study" work, as would the supervisors (in addition to supervising enumerators carrying out village research) under the general guidance of the subteam leader.

The timing of the socioeconomic study in PRRG is constrained by the need to synchronize with the related effort in The Gambia and Senegal while having a later starting date but the same terminal date. Certain of the research activities undertaken in the other two countries will simply not be possible in Guinea for lack of time.

Fuller development of the socioeconomic work plan for Guinea requires a second mission to PRRG, preferably in May 1983, if funding is available. May is critical for three reasons:

- (1) It would permit visits to and assessment of villages and areas in the impact zones that were not covered by the February 1983 reconnaissance mission or by Dr. Van Tuu of the FAC technical mission and the Polytechnical team. After May the rains would make access extremely difficult, if not impossible. This mission would permit not only preliminary selection of villages but also an evaluation of the appropriateness of the investigational instruments developed for Senegal and The Gambia. A determination could then be made of the kinds of new instruments that will be needed.
- (2) It would permit consultation in Conakry with professional colleagues and students at the University to work out criteria for selection of field enumerators and the system for their training and placement. Professor Ali Oularé of the University has stated to Dr. Derman that for field work to begin in the fall of 1983, selection of student investigators must be completed by July 30. Selection, training and placement of enumerators in villages will undoubtedly take longer in Guinea than in the other riparian countries. If the intensive village studies are to cover a twelve-month period, they can begin no later than the late fall of 1983.
- (3) It would allow time to work out an agreement with all interested parties (i.e. PRRG ministries, OMVG and USAID) to ensure adequate logistic support and proper coordination with other studies in the basin.

Dr. Derman is available for a four-week mission to PRRG in May. He should be accompanied by a representative of OMVG, whose assistance will be essential. Dr. Oularé has indicated that he may also be available to participate.

The best possible base of operations for the socioeconomic subteam in Guinea is Labé. Because of transportation difficulties and the distance between the Koundara and the Koubia/Mali zones, Labé seems to be the most reasonable location. Time will be needed to arrange for and establish a suitable base.

## APPENDIX A

### LIST OF PERSONS CONTACTED LISTE DES PERSONNES RENCONTREES

#### THE GAMBIA:

Mr. Tamsir Jagne, Agricultural Officer, Jenoi  
Mr. Reuben Thomas, Director, Department of Agriculture, Cape St. Mary  
Mr. M. Ceesay, Acting Permanent Secretary, Ministry of Agriculture, Banjul  
Mr. Ken George, PPMU, MANR, Banjul  
Mr. Goeting, Director, PPMU, MANR, Banjul  
Dr. M. Rowland, MRC, Fajara  
Dr. David Smith, MRC, Fajara  
Dr. H. Whittle, MRC, Fajara  
Dr. Mueller, German Forestry Project, Fajara  
Mr. Jagne, Commissioner, URD, Basse  
Mr. Bernard Baldeh, Commissioner, LRD, Mansa Konko  
Mr. Karamo Demba, Assistant Superintendent for Irrigation, Sapu  
Mr. A. Jammeh, Agricultural Officer, Kerewan  
Mr. Mustapha Kinteh, Assistant Superintendent for Irrigation, Kuntaur  
Mr. Ahmadu Sow, Assistant Superintendent for Irrigation, Basse  
Mr. Sonko, Agricultural Officer, Basse  
Mr. Bakari Jayiteh, Rice Demonstrator, Bati Ndar  
Mr. Usman Ceesay, Rice Demonstrator, Charmen  
Village Heads of Charmen, Bati Ndar, Nema, Tuba Koto, Bati Jaha, Alunghare  
and Sare Sambakoi  
Mr. Axel Thoma, Freedom from Hunger Campaign, Jenoi  
Commissioner, MacCarthy Island Division, Georgetown  
Mr. Roger Thomas, Action Aid, Banjul  
Mr. J. McCloughlin, Catholic Relief Services, Banjul  
Mr. G. Scharffenberger, Peace Corps Director, Banjul  
Mr. Sonko, Permanent Secretary, Ministry of Water Resources and Environment  
Mr. Falenkwoi Sanneh, Supervisor, Sapu  
Mr. Glen Folcher, Colorado State Mixed Farming Project, Banjul  
Mr. Byron Bahl, Mission Director, USAID, Banjul  
Ms. Emmy Simmons, Sahel Regional Development Program, Bamako

SENEGAL:

- Mr. Jaquin, Directeur Technique, SODEFITEX, Tambacounda  
Mr. Niang, Plant Breeder, SODEFITEX, Tambacounda  
Mr. Bataille, Directeur des Périmètres Irrigués, SODEFITEX, Tambacounda  
Mr. Bolly, Directeur Adjoint des Perimetres Irrigués, SODEFITEX, Tambacounda  
Mr. Moustafa Ndiaye, Démonstrateur de la SODEFITEX, Leba  
Mr. Bourema Sylla, Démonstrateur de la SODEFITEX, Diende  
Mr. L. Diallo, Directeur des Périmètres Irrigués, OFADEC, Tambacounda  
Démonstrateurs de l'OFADEC, villages de Adjaff, Sankane I, Sankane II, Courientine, Gouloumbo, Koar  
MM. les Chefs de village de Gouloumbo, Adjaff, Sankane, Courientine, Leba, Diende, Sao  
Mr. l'Inspecteur du Travail, Tambacounda  
El Hadji Baskhou Diaby, Khalife Général des Khadrias, Maka Coulibantan  
Mr. Boubaka Ba, Préfet de Kédougou  
Mr. M. Fodiyen, Chef de Section, Service de l'Agriculture, Kédougou  
Mr. Ousman Sadio, Adjoint, Service de l'Élevage, Kédougou  
Mr. Ndem Ndiaye, Responsable Régional de la SODEFITEX, Kédougou  
Mr. Louis Verger, Mission Catholique, Kédougou  
Frère Albert, Mission Catholique, Salémata  
Mr. Bakari Sylla, Centre d'Expansion Rurale, Salémata  
Mr. Diedhiou, Infirmier à Salémata  
Mr. El Hadj Diop, Adjoint, Service de l'Élevage, Salémata  
Mr. Oumar Mbeya, Sous-Préfet de Bandafassi  
MM. les Chefs de village de Salémata, Nanjar-Bassari, Hamdulla, Saleyanba, Afia I, Afia, Mako, Tambanoumia

GUINEA:

- S.E. le Gouverneur de Koundara  
Mr. Lansana Sylla, Direction Régionale de l'Agriculture  
Mr. Hamidou Barry, Coordination Régionale des FAPA  
Mr. Fodé Camara, Secrétaire Général de la Région de Koundara, chargé du développement rural et de la coordination des FAPA  
Mr. Kamfouré Diakité, Chef de Travaux Agricoles, FAPA No. 4, Sambailou  
Mr. Aliou Diallo, représentant de l'OMVG, Conakry  
Pr. Ali Oularé, Professeur de Sociologie, Université de Conakry  
MM. les Secréaires Généraux du Parti Démocratique de Guinée à Koubia, à Labé et à Mali

BASIC CODES

No. 2

Village:

- 01 Bati Ndar
- 02 Charmen
- 03 Jakaba
- 04 Nema
- 05 Allunhari
- 06 Sotuma Samba Koi
- 07 Sotuma Sairy Kandeh

No. 3

Household:

Refer to DEMOGRAPHIC INFORMATION I, Questionnaire No. A

No. 4

Interviewer:

- 01
- 02
- 03
- 04
- 05
- 06
- 07
- 08
- 09
- 10
- 11
- 12

No. 5

Questionnaire No.:

- 01 Labour Allocation
- 02 Staple Foodstuffs In
- 03 Staple Foodstuffs Out
- 04 Livestock In
- 05 Livestock Out
- 06 Salaried Labour In
- 07 Salaried Labour Out
- 08 Non Farm Income
- 09 Non Salaried Labour In
- 10 Non Salaried Labour Out
- 11 Strange Farmer Compounds
- 12 Questionnaire for Strange Farmers
- 13 Hunting
- 14 Fishing
- 15 Fuelwood Consumption
  
- 70 Demographic Information I
- 71 Demographic Information II
- 72 Migration Questionnaire for Returned Migrants
- 73 Field Identification
- 74 Field Master Sheet
- 75 Price of Salaried Labour
- 76 Market Price Survey

BASIC CODES CONT'D

No. (various) Date:  
See date code (beginning 001 on April 15th 1983) on calendar

No. (various) Name:  
See name code listed on Demographic Information I Questionnaire No. A

No. (various) Field No.:  
See field code on Field Master Sheet, Questionnaire No. E

No. (various) Activity:  
001 Travel to the field

Upland Land Preparation (by hand):

- 101 Clearing and preparation
- 102 Manure preparation
- 103 Ploughing (including ridging before planting)
- 104 Manure application
- 105 Chemical Fertilizer application
- 106 Planting
- 107 Broadcasting
- 108 Replanting, reseeding
- 109 Furrowing, ridge making
- 110 Fencing

Upland Cultivation and Field Care (by hand):

- 121 First weeding
- 122 Second weeding
- 123 Third weeding
- 124 Other weeding
- 125 Spraying (herbicide, insecticide)
- 126 Guarding fields, scaring birds, etc.
- 127 Mulching

Upland Harvesting (by hand):

- 131 Cutting, heaping, lifting
- 132 Stacking, tying, bundling
- 133 Threshing, winnowing, drying, bagging
- 134 Burning and/or collecting residues

BASIC CODES CONT'D

Upland Land Preparation (mechanical):

- 201 Clearing land (by oxen)
- 202 Clearing land (by tractor)
- 203 Ploughing (by oxen)
- 204 Ploughing (by tractor or other mechanical means)
- 205 Chemical Fertilizer application
- 206 Planting
- 207 Replanting
- 208 Furrowing, ridging (by oxen)
- 209 Furrowing, ridging (by tractor)

Upland Cultivation and Field Care (mechanical):

- 221 First weeding
- 222 Second weeding
- 223 Third weeding
- 224 Other weeding
- 225 Spraying (herbicide, insecticide)

Upland Harvesting (mechanical):

- 231 Cutting, lifting, heaping
- 232 Stacking, tying, bundling
- 233 Threshing, winnowing, drying, bagging

Lowland Land Preparation (by hand):

- 301 Install pump
- 302 Clearing
- 303 Levelling
- 304 Ploughing
- 305 Nursery preparation
- 306 Nursery sowing
- 307 Buy pump fuel, repairs to pump
- 308 Repair drainage channels and bunding
- 309 Digging and cleaning new channels and bunding
- 310 Fencing
- 311 Uprooting and bundling rice seedlings
- 312 Transplanting
- 313 First fertilizer application
- 314 Second fertilizer application

Lowland Cultivation and Field Care (by hand):

- 320 Weeding (nursery)
- 321 Weeding (field)
- 322 Spraying
- 323 Irrigation and watering
- 324 Guarding, rearing birds, etc.

BASIC CODES CONT'D

Lowland Harvesting (by hand):

- 330 Cutting (with sickle)
- 331 Cutting (with small hand knife)
- 332 Stacking, tying, bundling, heaping
- 333 Threshing, winnowing, drying
- 334 Bagging

Lowland Land Preparation (mechanical):

- 401 Clearing
- 402 Levelling (by oxen)
- 403 Levelling (by tractor or other mechanical means)
- 404 Ploughing (by oxen)
- 405 Ploughing (by tractor or other mechanical means)
- 406 Fertilizer application

Lowland Cultivation and Field Care (mechanical):

- 411 Weeding (by oxen)
- 412 Weeding (by tractor or other mechanical means)
- 413 Spraying
- 414 Irrigation and watering

Lowland Harvesting (mechanical):

- 421 Cutting
- 422 Stacking, tying, bundling
- 423 Threshing, winnowing
- 424 Bagging

Vegetable Gardens/Orchards

- 450 Clearing, fencing
- 451 Bed preparation
- 452 Nursery preparation, seedling protection
- 453 Transplanting
- 454 Manure or chemical fertilizer application
- 455 Irrigation and watering
- 456 Weeding
- 457 Spraying (insecticides, herbicides)
- 458 Mulching

BASIC CODES CONT'D

Transport and Marketing

- 501 Transportation of product to and from field
- 502 Transport of product to market
- 503 Market transactions (all types)

Other Farm Activities

- 601 Supervision
- 602 Repair and maintenance of tools

Livestock Production

- 701 Watering animals
- 702 Guarding animals
- 703 Herding, care and
- 704 Milking
- 705 Corral constructi
- 706 Other (specify)

Non Farm Activities

- 801 Hunting
- 802 Gathering
- 803 Fishing
- 804 Craft production
- 805 Services
- 806 Transport
- 807 Trade in livesto
- 808 Trade in agricu
- 809 Other trade

Domestic and Household Activities

- 901 Food preparation (incl. grain processing and cooking)
- 902 Fetching fuel
- 903 Fetching and carrying water
- 904 House cleaning
- 905 Tending children
- 906 Washing clothes
- 907 Bathing
- 908 Compound repairs
- 909 Other household activity

BASIC CODES CONT'D

Other Activities

- 990 Salaried agricultural labour
- 991 Salaried non agricultural labour
- 992 Other labour. (communal, exchange, etc.)
- 993 Leisure
- 994 Social and ceremonial activities
- 995 Illness (specify)
- 996 Travel
- 997 Religious activities
- 998 School
- 999 Absence from village (due to migration, school, social-personal reasons, or lack of knowledge)

No. (various)

Cash or Value:

Round off to the nearest whole as in the following:

|                   |   |       |
|-------------------|---|-------|
| 1-49 Bututs       | = | 0     |
| 50-Bututs - D1.49 | = | 1     |
| D1.50 - D2.49     | = | 2     |
| D49.63            | = | 50    |
| D863.24           | = | 863   |
| D6,419.95         | = | 6,420 |

No. (various)

Man Day (s):

The early morning to the early afternoon work period = 1 man day

The early afternoon to evening; and early morning to late morning = ½ man day

No. (various)

Measures:

- 01 Handful
- 02 Ladle
- 03 Liter
- 04 Small calabash
- 05 Large calabash
- 06 Washing bowl
- 07 Eating bowl
- 08 Kilo
- 09 Pound
- 10 Basket (large)
- 11 Basket (small)
- 12 Bundle (large)
- 13 Bundle (small)
- 14 Sack (large)
- 15 Sack (small)



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Socio-economic unit

2. Village \_\_\_\_\_

3. Household \_\_\_\_\_

4. Interviewer \_\_\_\_\_

5. Questionnaire No. \_\_\_\_\_

**D. FIELD IDENTIFICATION**

6. Name of household head \_\_\_\_\_  
List all fields cultivated by people in this compound last year.

| 7. Field No. | 8. Name | 9. 1982<br>1982<br>1982<br>Crop | 10. 1982<br>1982<br>1982<br>Crop | 11. Type of Rice field (incl. dry or wet seas) | 12. Crop to be cultivated in 1983 | 13. Collective or individual field | 14. Give name of owner | 15. Persons cultivating the field with owner | 16. Distance | 17. Direction | 18. Comments |
|--------------|---------|---------------------------------|----------------------------------|--|-----------------------------------|------------------------------------|------------------------|--|--------------|---------------|--------------|
|              |         |                                 |                                  |  |                                   |                                    |                        |  |              |               |              |
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|              |         |                                 |                                  |  |                                   |                                    |                        |  |              |               |              |

KEY: Question No. 9  
 Borrowed: Did you borrow any of these fields last year? Will these borrowed fields be cultivated this year? Will you borrow other fields to cultivate this year?  
 Loan: Did you loan any fields last year which you or someone in your compound will cultivate this year?  
 Strage Farmer: Did you use any strange farmers last year? Will you cultivate any of these fields this year?  
 Fallow: Were there any fields left fallow last year which you will cultivate this year? Did you cultivate any fields last year which you will leave fallow this year?  
 Rental: Did you rent (in or out) any fields last year? Will you rent this year? Will you rent (in or out) any other fields this year?

\_\_\_\_\_

\_\_\_\_\_

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\_\_\_\_\_

2. Village \_\_\_\_\_

3. Household \_\_\_\_\_

4. Interviewer \_\_\_\_\_

5. Questionnaire No. \_\_\_\_\_

**C. MIGRATION QUESTIONNAIRE FOR RETURNED MIGRANTS**

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Socio-economic unit

| 6. Date of interview | 7. Name | 8. Age/Sex | 9. Date of departure | 10. Date of return | 11. Duration in days | 12. Days unemployed | 13. Days employed | 14. Location | 15. Reason for location | 16. Who employed you | 17. Pay what job | 18. Payment per week | 19. Reason at departure | 20. Cost of residence per week | 21. Cost of return transport | 22. Cost of food per week | 23. Other major expenses (value) | 24. Amittances in cash during migration | 25. Amittances in kind during migration | 26. Cash brought back into village | 27. In kind items brought back (value) | 28. Did you migrate last year | 29. Location | 30. When did you first migrate | 31. Location | Comments |  |
|----------------------|---------|------------|----------------------|--------------------|----------------------|---------------------|-------------------|--------------|-------------------------|----------------------|------------------|----------------------|-------------------------|--------------------------------|------------------------------|---------------------------|----------------------------------|---|---|------------------------------------|--|-------------------------------|--------------|--------------------------------|--------------|----------|--|
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2. STAPLE FOODSTUFFS : IN

(Food Purchases, Loans and Gifts Received, including gathered and collected wild foods)

No. 2, 3, 4, 5, 6, 7 See Basic Codes

No. 8 Foodstuff:

- 01 Early Millet
- 02 Late Millet
- 03 Millet (Felah)
- 04 Millet (Findo/Fonio)
- 05 Sorghum
- 06 Local Rice (early)
- 07 Local Rice (late)
- 08 Imported Rice
- 09 Salt
- 10 Cowpeas
- 11 Garbonzo (beans)
- 12 Cassava, yams
- 13 Vegetables
- 14 Maize
- 15 Groundnuts (including groundnut paste)
- 16 Bread
- 17 Meat
- 18 Fresh fish
- 19 Dried fish
- 20 Sugar
- 21 Oil
- 22 Milk
- 23 Major gathered foods, eg baobab leaves, locust bean (specify)
- 24 Other

No. 9 Type of Transaction : how was this foodstuff acquired?

- 1 Market transaction
- 2 Exchange
- 3 Gift (specify type)
- 4 Loan (specify type)
- 5 Gathered/collected

No. 10 Location of Transaction:

- 1 Within village, not in marketplace
- 2 In village market
- 3 In a village or market within 5 miles
- 4 In a village or market more than 5 miles distant
- 5 Other (specify)

No. 11 From Whom:

- 1 Household within village, related by blood ties or marriage
- 2 Other household within village
- 3 Village based retailer
- 4 Village based wholesaler (grain merchant, moneylender)
- 5 Outside village retailer
- 6 Outside village wholesaler
- 7 Government agency (specify)
- 8 Other (specify, e.g. food relief, food for work)

Nos. 12, 13 & 14 See Basic Codes



6. SALARIED LABOUR : IN

Nos. 2, 3, 4, 5, 6, 7, 8 See Basic Codes

No. 9 Type of Contract:

- 1 Payment by the day or half-day
- 2 Payment by the task
- 3 Other (specify)

No. 10 Sex of Workers:

- 1 Adult male
- 2 Adult female
- 3 Adult males and females (equal)
- 4 More adult males than adult women
- 5 More adult women than adult males
- 6 Boys
- 7 Girls
- 8 Boys and girls

Nos. 11, 12, 13, 14, 16, 18 See Basic Codes

7. SALARIED LABOUR : OUT

Nos. 2, 3, 4, 5, 6, 7, 8, 9 See Basic Codes

No. 10 #1 = Payment by the day  
#2 = Payment by the task  
#3 = Other (specify)

Nos. 12, 14 See Basic Codes



8. NON-FARM INCOME

(excluding crop/livestock sales, salaried labour)

No. 2, 3, 4, 5, 6, 7 See Basic Codes

No. 8 Revenue Earning Activity

Crafts

- 01 Spinning, Weaving, Dyeing
- 02 Woodwork
- 03 Metal working, blacksmiths
- 04 Pottery and basket making
- 05 House construction and repair
- 06 Well construction and repair
- 07 Granary construction and repair
- 08 Tailoring
- 09 Butchering
- 10 Milling
- 11
- 12
- 13
- 14
- 15
- 16 Miscellaneous craft production and repair

Trade

- 30 Trade in agricultural products
- 31 Trade in livestock
- 32 Other trade (specify)

Woman's Activities

- 40 Millet pounding
- 41 Prepared food sales
- 42 Water carrying
- 43
- 44
- 45
- 46
- 47 Other woman's revenue earning activities (specify)

Migration

- 50 Migration remittances

Gifts

- 60 Alms, gifts

8. NON-FARM INCOME CONT'D

2

Miscellaneous

- 70 Selling firewood
- 71 Services (barbering, praisingsing)
- 72 Transport and driving
- 73 Plow renting
- 74 Cart renting
- 75 Sale of personal effects
- 76 Non-agricultural wage labour
- 77 Local government employee
- 78 Animal renting
- 79
- 80
- 81
- 32

No. 9 See Basic Codes

No. 10 Location

- 1 Within the village or village territory
- 2 In a village or area within 5 miles of the village
- 3 Beyond five miles from the village
- 4 In an administrative centre or large market town in the region
- 5 Other (specify)

Nos. 11, 13, 15 See Basic Codes

Note: Important

No. 14 Gross Income: The aim of this question is to estimate the total income (both in cash and in kind) derived from a particular activity (e.g., carpentry) in the previous two week period.

No. 15 Net Income: (value): This question attempts to estimate the net income of the same activity (e.g., carpentry). That is to say, gross income earned from carpentry over a two week period less costs (e.g., wood, nails, etc.)

## RIVER RESOURCE TEAM WORK PLAN

### I. OBJECTIVES

The objectives of the river resource study of the Gambia River and estuary have been compiled from three different sources. The most important source is the terms of reference developed jointly by OMVG, USAID, and the University of Michigan. These terms of reference provide broad, important objectives as a major focus for the overall study. The objectives required additional refinement to move to the specifics of a sampling program. The information used to sharpen them was drawn from two sources: previous research on the Gambia River and previous research experience in aquatic ecology by members of the river resource team. These expanded objectives are as follows:

- A. Catalogue, assemble, and review existing relevant literature and data from the Gambia River. The duration of the study (one year of field sampling) and the urgent need for the results provide a mandate to avoid repeating research from previous studies. Preventing this repetition requires a complete understanding of the accomplishments of prior studies of the Gambia River. In addition, information from parallel studies conducted in other tropical river and estuarine systems will also be reviewed.
- B. Develop a preliminary understanding of the Gambia River system through the February 1983 reconnaissance mission. The effort required to study the Gambia River will face the logistical problems of research in a tropical environment along with the scientific problems associated with conducting a large, ecological study. Designing such a study requires an almost unlimited amount of advance planning. The reconnaissance mission has provided valuable input to the planning stage of the full study. Included in the objectives of the reconnaissance mission were: preliminary analysis of river samples, collection of representative fish and plankton taxa, identification of feasible sample sites, and classification of the river drainage system into distinctive ecological zones. The fish samples collected during the reconnaissance mission also helped in the preparation of the illustrated taxonomic fish key for use during the full study.

- C. Develop as complete an understanding of the ecology of the Gambia River and estuary as possible. This objective is the major thrust of the river resource team. The intent is to conduct the best possible study of the ecology of the river. This objective is of fundamental importance, for without its successful completion the remaining objectives cannot be achieved. Completion will require a variety of sampling techniques and strategies tailored to the specific sampling environments in the river. A description of these techniques and strategies is given below. Two points are considered essential in planning a sampling strategy: 1) the study, especially in its predictive aspects, cannot rely solely on simple species lists and biomass estimates, and 2) fisheries are an integral part of the entire study and not a separate entity.
- D. Develop a detailed understanding of the fishery (finfish and shellfish) dynamics of the Gambia River and its estuary. Much of the information needed to achieve this objective will result from effort on objective C. However, because of the problems associated with collecting representative samples and the economic importance of the river and estuarine fisheries, additional research objectives beyond the ecological study are included. In particular, many fishes and crustaceans are highly mobile and develop elaborate migration patterns. A major objective of the study will be to identify feeding grounds and preferred spawning habitats of economically important species. In addition, this objective includes the identification of migratory routes of these species and the seasonal patterns of migration. These objectives are primarily intended to determine if the salinity barrage and/or upstream dams will disrupt the normal migratory habits and routes, as well as to determine other impacts of proposed water management schemes.
- E. Determine the importance of fish to the local economy. This objective will be addressed in cooperation with government fishery departments and the socioeconomic team. The Gambia River and its estuary are known to support a rich diversity of fish, crustaceans, and mollusks. Studying all of these species in detail is beyond the resources of this project. The chosen method of focusing the study on a few key species is to consider only those that are most important economically. During the aquatic field sampling, the river resource and socioeconomic teams, drawing on information already available for The Gambia, will jointly estimate the value of fisheries to the local

economy, appraise the kinds, sources, amounts, and importance of major species consumed in the local diet, catalogue fishing methods used on the Gambia River, and perform economic analyses to estimate the effect of changes.

- F. Projections of the impact of the salinity barrage and dams on the river and estuary. This is an ultimate objective of the river resource study. Through successful completion of the previous objectives, a sufficient database will be available to accurately predict what effects the structures and their impoundments will have on the physical and chemical environment of the river. These effects will then be used to estimate changes in the overall ecosystem structure and function. The estimates will be generated through two mechanisms: subjective interpretations combined with statistical inferences from multivariate analyses of the database, and simple deterministic ecological models. In order to achieve this objective, the sampling program will be planned to yield the correct types and amounts of data for adequate prediction.
- G. Recommendations of mitigating measures in response to ecological damage created by the dams and salinity barrage. This objective will be addressed in conjunction with objective F. Once the anticipated effects of the barrage and dams are available, the river resource team in collaboration with OMVG and government agencies will develop several alternatives to minimize these effects.
- H. Continuation of aquatic studies. An important objective of the river resource team will be to involve riparian country personnel in all phases of the river study. Selected individuals will be trained in sample collection and analysis beginning with the second research cruise. (The river resource team will not begin extensive training during the first cruise, which will be reserved for team members to develop and/or refine their own sampling techniques and analytical procedures.) The river resource team has a strong belief that extension of the study will vastly increase its meaning and usefulness to the riparian countries. This objective will be achieved by extensive training as well as by leaving a functional aquatic research laboratory in the basin (provided that adequate facilities are provided by OMVG in a timely fashion.) This laboratory will initially be equipped with instruments and sampling

equipment left behind by the river resource team and may be strengthened subsequently by material, data files, etc. from project headquarters in Banjul.

## II. PRELIMINARY RESULTS

- A. Literature Review. The terms of reference for the river resource study, as well as the scientific objectives of the study, call for the preparation of a detailed bibliography of Gambia River studies. Major strides have been made in developing this bibliography since mid-December 1982. Currently a 74-page working bibliography has been prepared which includes previous studies of the Gambia River as well as related studies. Much of this literature is available in Ann Arbor, Dakar, or Banjul. River resource team personnel at all levels continue to review the literature. Additional West African materials will be gathered and analyzed by river resource team personnel in the riparian countries. The bibliography will expand during the study and be left as a computerized database upon completion of the project. Preliminary versions will appear as Working Documents of UM/GRBS.

While a large variety of relevant literature is available for use in planning the river resource study, a small pool of information is particularly useful. This information includes parallel studies of dams and salinity barrages, and of basin development on the Niger, Senegal, and Casamance Rivers. The effect of development has been well documented (e.g., Lagler 1969; Freeman 1974; Rounsefell 1975; Chowdhury and Lagler 1978; Triplett 1982)\* and includes impacts on freshwater and marine flora and fauna. Additionally, many studies have been conducted that will provide useful background or relevant information within a variety of specific disciplines. Examples of such studies include hydrology and sedimentation (Cooper 1927; Lawson 1969; Lowe-McConnell 1973; Lesack 1981), plankton and invertebrates (Gunber 1961; Biswas 1966; Kutkuhn 1966; Taylor-Thomas 1972; Monteillet and Plaziat 1979), fisheries (Boulenger 1900; Budgett 1901; Assheton 1907; Svensson 1933; Johnels 1952, 1954; Daget 1962; Balon 1972; Bazigos 1972; FAO 1970; FAO/UN 1972; Taylor-Thomas 1971, 1972, 1973 1976; Welcome 1974, 1975, 1977, 1978, 1979), and general ecology (IFAN 1930-1980; Lauff 1967; Green 1968; Frazer 1972; Snedaker 1978; Austin et al. 1982).

\* For full citations see UM/GRBS Working Document 1.

B. Reconnaissance Mission. The reconnaissance mission in the Gambia River Basin was conducted on the part of the river resource team by: Drs. Dorr and Rainboth in Guinea, Senegal and The Gambia, and Dr. Moll in The Gambia. This effort included studying the river for accessibility of sampling sites by land, as well as determining available accommodation for team members while conducting upstream sampling. Some limited sampling of the river and estuary was conducted during the field trip. This elucidated an appraisal of the aquatic flora and fauna and chemistry of the ecosystem.

C. Staffing. The entire river resource team has been staffed from University of Michigan personnel. The staff is as follows:

Dr. Russell Moll - team leader

Mr. Thomas Berry - electronics repair

Mr. Robert Cordover - marine biologist

Dr. John Dorr - fishery biologist

Mr. Loren Flath - aquatic biologist

Mr. Gerald Krausse - aquatic chemist

Ms. Donna Page - plankton biologist

Mr. Philip Schneeberger - aquatic biologist

Mr. Heang Tin - aquatic biologist

Mr. Cordover is currently engaged in literature review in London. The remaining staff is now working on experimental design, equipment procurement, and a continuing literature review in Ann Arbor. This staff will arrive in Africa about June 1 to begin field operations. In addition, Mr. Michael Jasinski, a hydrologist from Harza Engineering Company, will spend at least five months with the river resource team.

D. Illustrated Fish Key. Previous research has indicated that the species diversity of the Gambia River fish community is high. Furthermore, many of those species are poorly described taxonomically. In order to avoid delay in the study, an illustrated fish key is in an advanced state of preparation and will be completed prior to start of full-scale fieldwork by the river resource team. This key will enable team members and host country biologists to use a uniform taxonomic guide throughout the duration of the study. This key will also serve as a valuable tool for future studies in West Africa. The key will continue to expand and evolve throughout the study of the river. It will appear in the Working Document series of UM/GRBS.

### III. SAMPLING STRATEGY AND TECHNIQUES

- A. Seasonal Variation. The Gambia River Basin is characterized by two major seasons, dry (October-May), and wet (June-September). The onset of the rains in June is somewhat variable. Between 80 and 90% of the total annual rainfall in the basin occurs in July, August, and September. This dichotomous pattern of annual precipitation has a major impact on the entire hydrologic cycle. The Gambia River responds to this seasonal pattern of rainfall with a late summer flood and a spring period of low flow. These different hydrologic periods have a major effect on the chemistry of the river and estuary and on the aquatic flora and fauna.

In an effort to accommodate the seasonal aspect of the ecology of the river, four periods of concentrated sampling will occur in conjunction with four different hydrologic periods: rising water (June-July), flood (September), declining water (November), and low water (February-March). Each of the four periods is expected to present a different environment for the inhabitants of the river and estuary. By sampling in each of them the river resource team will be able to characterize the aquatic environment throughout the year.

Sampling during four periods will have a second benefit to the study. Once the barrage and dams are constructed on the Gambia River, the dichotomous pattern of annual flow will be altered to a more even flow. Hydrologists can estimate the nature and extent of this regulated annual discharge. The river resource team will be able to match the river flow estimated to occur after construction of the barrage and dams to one or more periods of flow under the current unregulated regime, and thus predict the biological community in the river and estuary as well as recommend water management measures to mitigate adverse effects of the barrage and dams.

An additional motivation behind the seasonal sampling regime is the effect the hydrological cycle has on the estuary. Figure 1 shows the temporal and spatial distribution of salinity in the estuary. The extent to which salt water penetrates the river is highly dependent upon river discharge. Only through sampling in different seasons will the effect of the shifting saltwater-freshwater interface on the biota be understood.

The sampling regime in Guinea must adapt to the impassable conditions of many roads and trails during the wet season. Rainy season field data collection will thus necessarily be curtailed because of problems of

ANNUAL VARIATION OF SALINITY WITH  
DISTANCE FROM BANJUL  
VARIATION ANNUELLE DE LA SALINITE  
AVEC LA DISTANCE DE BANJUL

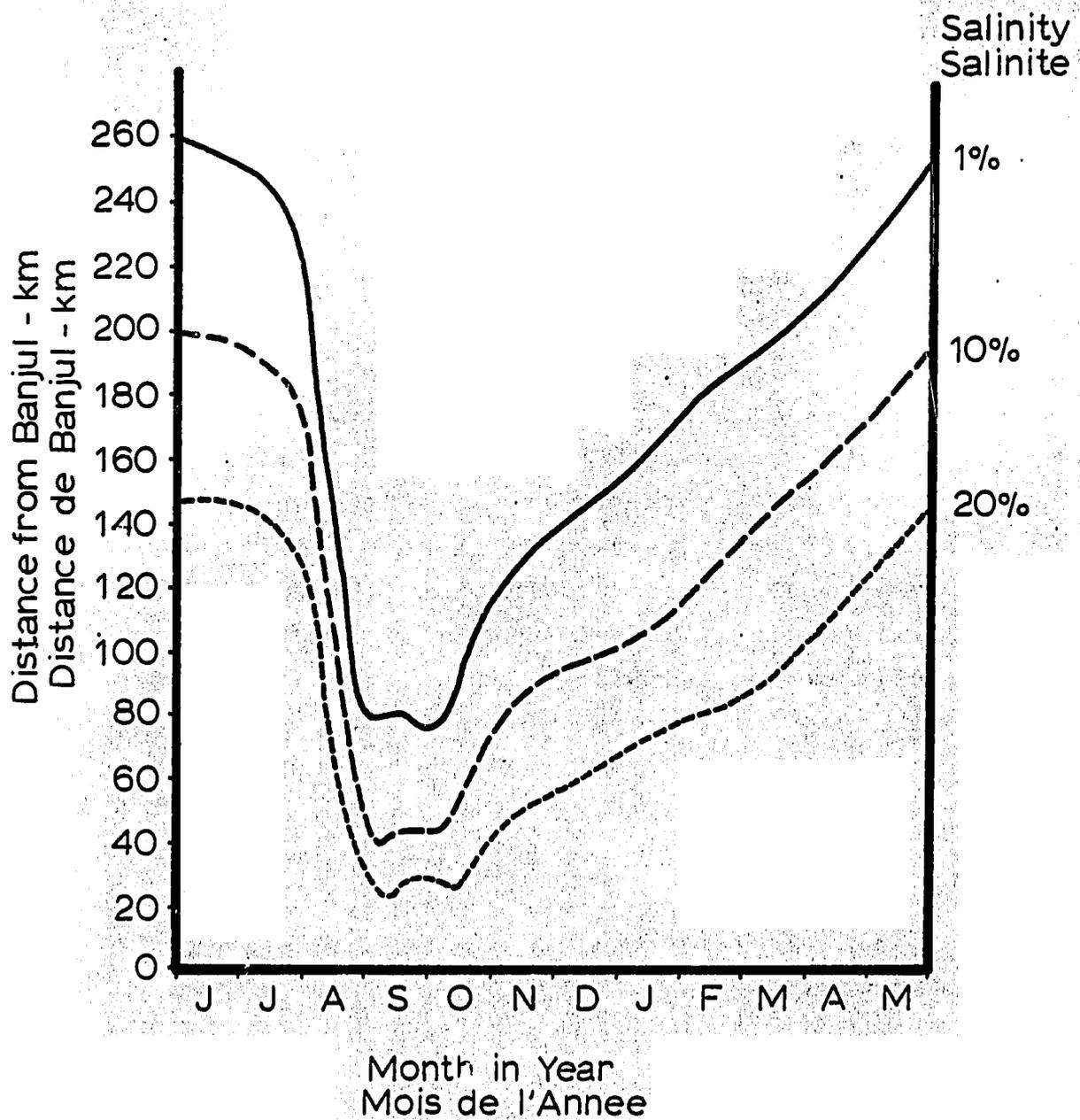


FIGURE 1

accessibility to study sites. Three major field expeditions are presently planned with one near the end of the rainy season (late September), another during the early dry season (December), and the third late in the dry season (March). These three expeditions will permit an understanding of the dynamics of the aquatic environment throughout most of the year.

- B. Spatial Variation. The large size of the Gambia River and estuary prevents intense sampling throughout the entire ecosystem. Thus, a compromise must be made between either intense sampling in only a few locations or superficial sampling in many locations. Only the former of these two strategies can be used to achieve the objectives of the study. This strategy is not without precedent in that several previous studies of the Gambia River have divided the ecosystem into distinct zones based on the flora and fauna and the physical environment. The strategy of this study has divided the river and estuary into five longitudinal zones and three cross-sectional zones. Equal sampling effort will be placed in four of the five longitudinal zones, and all of the cross-sectional zones.

The longitudinal zones were identified from previous research on the Gambia River and the reconnaissance mission. These zones are: lower estuary, upper estuary, lower river, upper river, and upland river. The biota in each zone is different from that in the other zones. As a result, the impact of the barrage and dams will differ from zone to zone. Geographically, the estuarine zones are located in The Gambia, the lower river in The Gambia and Senegal, and the upper river in Senegal. A fifth, more or less distinctive headwater area is in Guinea. The lower estuary zone may receive less effort than the other zones; it is anticipated that the effects of the barrage and dams will be minimal at the river mouth. Tentatively the zones have been located as follows: lower estuary - river mouth to Mootah Point, upper estuary - Mootah Point to Pappa Island, lower river - Pappa Island to the confluence of the Koulountou and Gambia Rivers, upper river - upstream from the confluence point to the Guinea border, and upland river - Guinea headwaters.

The cross-sectional zones were identified by the same method as the longitudinal zones. The three zones which have been identified are: mid-channel (always underwater), low bank (usually, but not always, submerged or intertidal), and upper bank (only occasionally submerged). The low bank zone includes some of the mangrove swamps. Each cross-sectional zone is present

in all of the longitudinal zones except upland river. However, the width and characteristics of these cross-sectional zones vary considerably among the four lower zones. In many locations the Gambia River is not a single channel but a variety of aquatic environments which include "bolons," lateral channels, lagoons, mangrove swamps, flood plains, etc. Within each cross-sectional zone care will be taken to sample all of the different habitats represented. Sampling effort will be apportioned equally among the three cross-sectional zones with the caveat that cross-sectional zones which are seasonally dry do not have an aquatic environment to be sampled.

The reconnaissance mission has shown the upland river zone in Guinea to be a complex zone with a variety of microenvironments which include: small rivers, streams of 1st to 5th order, blackwater streams, pools, falls, and rapids. The cross-sectional zonation adapted to sampling in the lower river is reduced to a single more or less mid-channel sampling site at most locations. As a consequence increased emphasis will be placed on sampling the various microenvironments rather than different cross sections of the streams. The choice of sampling locations in Guinea will be based upon site visits on the Gambia and Koulountou Rivers.

Within the other longitudinal zones sampling sites have been selected based on results from the reconnaissance mission. In the lower estuary the primary sample site is near the mouth of the Bintang bolon. Some samples will be collected in the bolon, while others will be collected in the adjacent portion of the Gambia River. Two primary sample sites have been selected in each of the other three zones. These sites are: in the upper estuary near Tendaba Camp and near Bai Tenda; in the lower river near Kuntaur and near Basse or Gouloumbo, and in the upper river at Kédougou. Each of these sites has been selected as a result of accessibility and anticipated impact from the barrage and/or dams. This sample selection was based on the land-based reconnaissance mission. A final refinement of station selection will be made when the river resource team makes a water-based reconnaissance mission in early June. In addition, sampling locations will be adjusted to produce as much joint sampling between the river resource team and the other teams as possible.

- C. Diurnal Variation. A complete understanding of the ecology of the Gambia River and estuary cannot be made until both day and night samples have been taken and analyzed. Diurnal variation in the Gambia River and estuary will

be measured at one of the primary sampling sites within each longitudinal zone. The effort required to conduct 24-hour sampling is large; therefore the number of days spent on 24-hour sampling runs will be limited to one or two per longitudinal zone, until results lead to some adjustment of this schedule.

In the estuarine zones, 24-hour sampling will serve a second purpose. High tides which occur during the night often carry a very different flora and fauna into the estuary than do high tides which occur during the day. Careful planning will allow the river resource team to sample high tides which occur at different times of the day or night.

Sampling Techniques. The methods used to collect and analyze samples from the Gambia River will be adapted as needed from standard hydrobiological procedures in response to the conditions encountered on the river. The research experience of the team in aquatic sampling provides a strong resource of skills to develop the best possible sampling program. Furthermore, the preliminary samples collected during the reconnaissance mission have helped in the initial selection of the most appropriate analytical techniques.

The sampling techniques used in the upland river zone will be similar to those used in Senegal Oriental. However, modifications of certain techniques will be necessary because of the shallow and/or fast-flowing nature of the rivers and streams. These modifications will include smaller fish nets and more robust water and bottom samplers.

The most difficult sampling problems faced by the river resource team is the logistical effort required to mount a field program in mountainous terrain. Travel is strictly by 4-wheel drive vehicle over rough roads. The slow and often perilous travel lengthens the effort per sample and requires lengthened field expeditions or a reduction in their number. Furthermore, as indicated previously, many areas of the river basin are inaccessible during the rainy season. The determination of sample sites will be a compromise between river access and habitat type.

Methods of sample collection will integrate use of the R/V Laurentian, small boats, and vehicles. The Laurentian will serve as a floating primary laboratory and housing unit for the river resource team. A selected, small cadre of riparian country personnel will also be accommodated from time to time, on board the Laurentian, as required for their training. In the estuarine zones and part of the lower river zone, the Laurentian will serve as a central

laboratory. Small boats will conduct much of the field sampling, especially near shore, in the vicinity of the Laurentian. The Laurentian will move upriver from zone to zone and remain within the sampling area of each zone for approximately one week. Four or five days in each zone will be devoted to measuring physical and chemical variables, and to collecting biological samples, while two days will be devoted to process studies.

Upstream from Georgetown, the team will typically conduct its sampling without the support of the Laurentian. Vehicles and/or small portable boats will be used to achieve access to the river. During this phase of the sampling program, the team may split, leaving two or three team members with the Laurentian, while the other members collect samples upriver. Upriver samples will either be analyzed on site or returned to the Laurentian for immediate processing. Upriver team members will be in communication with the Laurentian by radiotelephone.

Measurement of environmental variables will be conducted either by submersible probes or analysis of discrete water samples. Portable meters will be used to measure temperature, salinity, conductivity, dissolved oxygen, and underwater light intensity. Water samples will be collected for additional physical variables as well as for chemical and biological variables. The water samples will be split immediately after collection. One subsample will be used for a pH measurement as soon as possible. A second subsample will be filtered through a  $0.45 \mu$  filter; the filtrate will be saved for chemical analyses while the filter will be used for chlorophyll determinations. The chemical analyses will be conducted on an Autoanalyzer. A third subsample will be stored for analysis of suspended solids and total nitrogen and phosphorus. Additional subsamples will be preserved for zooplankton and phytoplankton enumeration. One more subsample will be preserved for bacterial enumeration.

All analytical methods for chemical, biological, and physical variables will follow standard oceanographic and limnological techniques. Chemistry samples analyzed by the Autoanalyzer will use US EPA-approved techniques. An elaborate system of duplicates, standards, and blanks will serve as the basis of a quality control system. Plankton, fish, and macrophyte identification will be conducted with a variety of taxonomic sources for West African flora and fauna. Research microscopes will be available for bacterial enumeration and plankton identification.

The fish, macrophyte, and benthic surveys will employ standard collection methods from aquatic biology. Transects will be sampled and the results used to estimate local species diversity and standing stocks. In most cases, biological samples will be subsampled in the field with the subsamples preserved for later analysis. Fish collection will utilize a variety of gear so as to adequately sample a range of species, sizes (adults, juveniles, larvae), and habitats. Depending upon habitat and sampling logistics, these gear may include: poison, electrofishing, echo sounding, seine, gill net, long line, trawl, cast net, impounding nets (block net, hoop or fyke net, minnow trap), and plankton net or fine-mesh seine.

In the upper river zone, sampling will proceed without the immediate support of the R/V Laurentian. Most samples can be adequately preserved for later analysis. However, some chemical measurements must be made within hours of sample collection. These perishable samples will be analyzed by a portable chemistry laboratory. Constant checks will be made to determine if the portable chemistry laboratory has accuracy and precision equal to that of the Laurentian laboratory.

In each of the river zones, up to the following number of samples will be analyzed from each cruise:

|     |                       |
|-----|-----------------------|
| 100 | chemistry samples     |
| 100 | chlorophyll samples   |
| 40  | adult fish samples    |
| 6   | larval fish samples   |
| 45  | bacteria samples      |
| 10  | zooplankton samples   |
| 8   | benthos samples       |
| 5   | phytoplankton samples |
| 5   | macrophyte samples    |

**E. Sampling Variables - Physical, Chemical, and Biological.** A complete list of suggested measurements of the Gambia River and estuary was included in the original proposal. Whereas that list remains fairly accurate, it has been modified as shown in Table I. Further modifications will be required as the study proceeds.

The number of variables sampled in Guinea will be slightly smaller than downstream for two reasons. First, there is no estuary (and associated estuarine species) in the upland river zone. Second, highly perishable samples

TABLE I.

MEASUREMENTS OF THE GAMBIA RIVER BASIN RIVER  
RESOURCES STUDY

|  |
|--|
| <p><b>Physical Variables</b></p> <ul style="list-style-type: none"><li>Salinity</li><li>Conductivity</li><li>Temperature</li><li>Suspended Solids</li><li>Sediment Load</li><li>Underwater Light Intensity</li></ul>   |
| <p><b>Chemical Variables</b></p> <ul style="list-style-type: none"><li>pH</li><li>Alkalinity</li><li>Dissolved Nutrients (Nitrogen, Phosphorus, Silicon)</li><li>Particulate Nutrients (Nitrogen, Phosphorus, Silicon)</li><li>Organic Matter</li><li>Dissolved Oxygen</li><li>Biochemical Oxygen Demand</li></ul>   |
| <p><b>Planktonic Biological Variables</b></p> <ul style="list-style-type: none"><li>Chlorophyll</li><li>Phytoplankton Species Enumeration</li><li>Zooplankton Species Enumeration</li><li>Bacterial Enumeration</li></ul>  |
| <p><b>Fishery Survey</b></p> <ul style="list-style-type: none"><li>Species Identification and Enumeration</li><li>Assessment of Major Species Distribution, Abundance, and Migratory Pattern</li><li>Biomass (Stock) Estimates</li><li>Catch Composition and Statistics</li><li>Impact Assessment of Barrage on Estuarine, Coastal, and Marine Fisheries</li></ul> |
| <p><b>Macrophyte Survey</b></p>  |
| <p><b>Benthic Invertebrate and Shellfish Survey</b></p>  |

cannot be taken as they will be downstream when working from the R/V Laurentian. Furthermore, the emphasis in Guinea will be on hydrology, fisheries, and chemistry. The variables in Table I which will not be measured in the upland river zone are: salinity, underwater light, BOD, and bacterial enumeration. Nor is there need for a shellfish survey.

- F. Process Studies. The chemical, physical, and biological variables listed in Table I will provide detailed information on the species composition and standing stock of organisms within the river. However, a thorough understanding of the ecology of the river cannot be developed from these data alone. For example, the data will not provide information about the exchange of materials among components of the ecosystem. The information regarding material exchanges will be gained from a series of process studies conducted in each longitudinal river zone. Process studies are typically complex experiments requiring sophisticated equipment and technical support. Given the constraints of working in a tropical environment, only simple studies will be attempted. Nonetheless, with four different experiments, much of the necessary information can be obtained. The four experiments are: (i) dark heterotrophic uptake of organics by bacteria and algae, (ii) primary productivity by phytoplankton and macroalgae, (iii) zooplankton grazing, and (iv) fish predation. A variety of techniques are available to measure each of these processes. The techniques used will be a compromise between logistic simplicity and technical accuracy.

#### IV. FISHERY ECONOMIC ANALYSIS

An important aspect of the riverine resource study is the determination of the contribution of fish to the local diet and economy. This will be achieved through three mechanisms. First, the river resource and socioeconomic teams will jointly evaluate the importance of fish and fish products to the local economy. A marketing survey will estimate the quantity and value of fish (locally produced and "imported") in the local market place. Another survey will catalogue fishing methods, particularly in Senegal.

A second source of information will be the Village Catch Survey being conducted by the Gambia Fisheries Department. This three-year-old survey covers most of the fishing villages in the country. The river resource team proposes to strengthen it by providing logistical and advisory support.

The third source of information will be fishery studies conducted by the river resource team itself. Fish samples will indicate if entire fish populations are either underutilized or absent in local markets. For example, some fish may not be present if local fisherman lack gear or other means to catch these species.

The river resource team plans to coordinate the fishery economic analysis as follows: first, all relevant survey questionnaires have been reviewed by the river resource and socioeconomic teams. This review has achieved compatibility of purpose and expected results. Next, a special short-term consultant (e.g., a fishery economist) will review the survey forms and suggest possible modifications to improve the results. The surveys will then be conducted for 12 months from June 1983 to June 1984. Near the conclusion of the surveys, the fishery economist will join the project to analyze the results and prepare the final report. This final analysis will be conducted in collaboration with the socioeconomic team and in relation to other aquatic resource findings.

#### V. SPECIAL STUDIES

A complete understanding of the Gambia River system will require more than the sampling program discussed above. Four areas in particular require specific attention beyond the normal sampling program. Two of these will be incorporated into the river resource sampling program, while the other two can be considered for future effort.

One special study will be of a river floodplain. These areas are important seasonal fish breeding sites and regions of high primary production. Floodplains will be highly affected in the vicinity of the salinity barrage. An intense short-term sampling program will be put into place after the floodplains are inundated in midsummer. A small floodplain similar to that near Kalagi will be sampled extensively for fish (including juveniles), aquatic chemistry, and aquatic plants. The analytical methods will be the same as those used in the monitoring program. The objective of this study is to determine the contribution of floodplain systems to the river ecosystem. Net primary production and fish production on floodplains will be considered as available export to the river. The fish production study at this location will be conducted with the assistance of riparian country personnel.

A second special study will be of the mangrove ecosystem. These marshes are known sites of high productivity of plants and shellfish. Furthermore, mangroves are an active part of the river ecosystem throughout the entire year. A study will be conducted to evaluate the importance of mangroves in exchanges of

materials between the river and the marshes. A mangrove near Banjul will be sampled for one tidal cycle twice monthly. The mangrove chosen will be small enough (30-100 ha) so that it is filled and drained by a single channel. Samples for biological and chemical analysis will be taken hourly in that channel. The result will be estimates of changes in water quality between flooding and ebbing tides. These net flux data combined with biomass estimates (calculated from measurements of instantaneous standing crop) of the flora and fauna will indicate if the mangrove ecosystem is a net producer or consumer of organic matter. Furthermore, this study will help in impact assessment of alternate water management schemes on the mangrove ecosystem.

A third topic of special concern is the anticipated problem of toxic substances. Precedent has shown that with the onset of irrigation comes a major increase in herbicide and pesticide use as a farm management tool. Working with the agricultural economist, estimates of the potential of this problem in the Gambia River Basin can be made. This problem can have a severe economic impact on resources in the river. Pesticide accumulation can render fishes unfit for consumption as well as destroy wildlife. This interdisciplinary problem has not been covered in the river resource, wildlife, or socioeconomic work plans. Additional effort in the area of toxic substances will require a coordinated sampling program as well as additional funding.

A final topic of concern to the people of The Gambia is the safety of waters in the vicinity of Banjul. The river resource study may be able to identify areas of possible sewage and/or animal waste contamination in the vicinity of Banjul. Using this information, public health laboratories in The Gambia may wish to initiate bacteriological monitoring programs near shellfish beds and swimming beaches.

## VI. HYDROLOGICAL STUDIES

The river resource team has recognized the importance of hydrological studies and modelling to the objectives of the project. A hydrologist from Harza Engineering Company, Mr. Jasinski, has been included under the Harza budget. He has spent four years in the region and is very familiar with Gambia and Casamance River Basins. In particular, he will address the concern of saltwater mixing near Balingho and sediment bed load near the dams. Much of the baseline data in these two areas is currently available from the Howard Humphreys Ltd. and AHT studies. The main role of the hydrologist will be to take these available data and utilize them for the purposes of the UM/GRBS. He will estimate hydrological regimes after barrage and dam construction so that ecological responses to these regimes can be predicted.

Hydrological studies in Guinea will require a considerable amount of field work. The main concern in Guinea is sediment bed load in relation to the life span of the proposed dams. Working in collaboration with riparian country counterparts, sediment measurements may be made on the Gambia and Koulountou Rivers, if necessary to complement the work already planned by AHT/HHL.

#### VII. ASSESSMENT AND PREDICTION OF IMPACTS OF SALINITY BARRAGE AND DAMS

Prediction of impacts on the basin can begin to evolve only as the four UM/GRBS studies begin to draw to a close in May 1984. Nonetheless, the river resource team has a preliminary strategy for assessment and prediction already developed. The following information will be obtained for these purposes: estimation of loss or change of species habitat, disruption of species migration patterns, displacement of one species by another, and exchange of energy among different components of the food web.

As previously indicated, two techniques (among others) will be used for prediction of environmental impacts, multivariate statistical analysis and ecological models, procedures which are not new to team members. Successful implementation of these predictive techniques requires timely input of results into the project microcomputers. Each team member will be required to follow a schedule which allows sufficient time for data input and analysis between sampling trips upriver, and key results will appear in working documents. By following this schedule, riparian country personnel will be able to work with river resource team members in analyzing and interpreting results throughout the entire project, not just at the termination of the field effort.

Successful management of aquatic resources will be greatly enhanced if OMVG and the member states continue a monitoring and surveillance program after the departure of the University of Michigan team. Only by this means will the member states be able to determine if the environmental predictions made by the river resource study were correct. The river resource team is fully committed to developing this continuing program through effective institution building.

#### VIII. INSTITUTION BUILDING

Institution-building is a major objective of UM/GRBS. Training of riparian country personnel in sampling techniques will begin with the second (September) upriver trip. (The river resource team leader would welcome one observer on the first upriver sampling trip.) Training will include detailed instruction of several

individuals in a variety of sampling techniques. If the ability of riparian country personnel can be brought up to a level close to that of the University of Michigan staff, a portion of the sampling program may be assigned completely to these newly-trained scientists at the discretion of the team leader. The river resource team expects this training will enhance the project in two ways. First, some technology transfer will take place. Second, by participating in sample collection and data analysis, riparian country scientists will be much more adept at interpreting the results of the river resource study.

A total of no more than six riparian country scientists are desired to work with the river resource team beginning in August or September 1983. These scientists will then be trained over a 10-month period in several aspects of the program. The river resource team leader will reserve the right to determine the technical suitability of each nominee. The team will provide logistical support for counterparts during field trips, but they may be asked to arrange for their own support in getting to and from rendezvous points. The R/V Laurentian has accommodations for two counterparts at a time.

The six counterparts trained by the river resource team should cover a variety of disciplines in aquatic sciences. The nominees should have at least a college degree and two or more years of relevant work experience. Five of the six counterparts will be trained at the technical level. These technicians would learn methods in fishery biology, aquatic chemistry, plankton taxonomy, and data analysis. The sixth counterpart should be at a more senior level and work directly with the team leader. This senior counterpart should have a Ph.D. or equivalent experience in aquatic biology or ecology.

Two tools will be left behind by the river resource team to aid in future studies. One tool will be a laboratory equipped with the remaining working equipment from the river resource study. When purchasing equipment, the team has taken care to make sure all items will be functional and repairable in West Africa. The laboratory will also be stocked with collections of fish and plankton for future taxonomic reference. The other tool is a video system for recording lessons on various techniques. The tapes can be used for future training and for review purposes in the environmental monitoring effort. The tapes will be a constant, visual reference library to aid riparian country personnel in keeping their scientific skills at a high level.

The location of a laboratory to continue the river study will be a compromise between convenience and functionality. The most convenient location is one where all three OMVG member countries can readily base their sampling operations. This location should be on the Gambia River to facilitate launching of sampling boats. An example of such a central location would be Basse. However, a working laboratory must have several types of support to remain functional. Reliable electrical power and running water are necessary. In addition, the laboratory must be near a good source of scientific supplies such as chemicals and glassware. Furthermore, the laboratory should not be inaccessible to instrument servicemen. These latter concerns typically require laboratories to be located in larger cities such as Banjul. The riparian countries and OMVG should begin site selection and development of the new laboratory well in advance of the departure of the University of Michigan team.

In addition to the laboratory and its equipment, a constant investment is required to maintain the facility in good working condition. This investment takes two forms. First, a well-trained staff must be present for routine maintenance. Second, electronic gear must receive constant preventive maintenance. This type of service is especially important in the dusty environment commonly found throughout the Gambia River Basin. In the United States, these maintenance procedures typically cost from \$5,000 to 10,000 per year.

#### IX. DELIVERABLES

The work plan for river resources has carefully set out sampling strategies associated with various objectives. These strategies will result in many products which OMVG can use to best manage the valuable resources of the Gambia River. While those products are implicitly defined in the work plan, they are listed below.

1. A detailed bibliography of the literature on the Gambia River.
2. An illustrated fish key of the Gambia River. This includes both estuarine and freshwater fishes.
3. Sample collections of fish and plankton from the river basin. Species will be identified and catalogued for future taxonomic reference.
4. A functional, well-equipped laboratory designed to continue the river studies after the departure of the University of Michigan team. This laboratory will be equipped with scientific gear and samples left in the basin by the University of Michigan team.

5. An extensive computerized database of the chemical, biological, and physical environment of the Gambia River.
6. A thorough description of the ecology of the Gambia River both on a zone-by-zone basis and from an integrated perspective.
7. An ecological model of each segment of the Gambia River. This model can be used as a powerful cause-and-effect management tool.
8. Trained host country personnel to continue the river studies beyond the departure of the University of Michigan team. These personnel will be trained in both sample collection and data interpretation.
9. An evaluation of the ecological role and importance of floodplain ecosystems to the entire river system.
10. An evaluation of the ecological role and importance of the mangrove ecosystems to the entire river system.
11. An appraisal of the importance of fish to the local economy and diet. This appraisal will cover underutilized species as well as currently exploited stocks.
12. A catalogue of various water management strategies for the Gambia River Basin.
13. An identification of those factors which are the most important in the ecology of the Gambia River.
14. Recommendations on how accurately to monitor these factors.
15. Recommendations on how best to manage these key factors to the benefit of all concerned.
16. Recommendations on overall management systems for fish and aquatic species. These management systems will strike a compromise between economic costs and environmental consequences.
17. Identification of future problems in the Gambia River associated with basin development.

At least once every six months key personnel from the river resource team will meet with OMVG, USAID, and national institutions to review project programs and present preliminary copies of certain deliverables. These meetings will also be used to discuss suggested changes in the overall sampling program. Furthermore, one or more preliminary reports will be prepared after each of the sampling trips.

**RIVER RESOURCE TEAM**  
**APPENDIX**  
**LIST OF PERSONS CONTACTED**

**Guinea**

**Mr. Mamadou Kana Diallo, hydrologist, Labé**

**Senegal**

**Mr. Thiam, hydrologist, Tambacounda**

**The Gambia**

**Mr. Omar Fye, Chief, Environment Department, Banjul**

**Mr. Mousa Sowe, Fisheries Department, Jenoi**

**Mr. Momadu Chiam, aquaculturalist, Fisheries Department, Bansang**

## **PUBLIC HEALTH TEAM WORK PLAN**

### **GENERAL OBJECTIVES**

The development of water resources in a major river basin entails environmental changes that may eventuate in altered patterns of transmission of certain waterborne diseases. This has been true of all the major development projects in Africa, including the Kariba dam in Zimbabwe, the Kainji dam in Nigeria, the Volta dam in Ghana and the Aswan dam in Egypt (Deom, 1982). Each of these developments has brought with it its own set of health problems and, in general, there is no specific model of health alterations for any given river that can be transferred intact to another system. However, painted in broad strokes, certain disease entities are to be anticipated, including malaria, schistosomiasis, trypanosomiasis and onchocerciasis.

In the Gambia River Basin, all of these entities occur with varying degrees of intensity. The Gambia River is, however, not homogeneous and the significance of waterborne disease transmission at the present time varies according to the level and character of the river. If malaria seems to be holoendemic throughout the populated areas associated with the entire basin, river blindness (onchocerciasis), which is so severe in the upper reaches of the basin, has not been recorded from The Gambia. Schistosomiasis, which is transmitted by different species of freshwater snails in different countries, has a distinctly nonriverine pattern of transmission in The Gambia, unlike what has been reported from Senegal.

It seems clear that any discussion of waterborne diseases in the Gambia River Basin will be useful for planning purposes only to the extent that differences between parts of the basin are recognized. To this end, descriptive profiles which focus on the areas of interest to OMVG must be developed for The Gambia, Senegal, and Guinea. Each profile must present in detail the available information on each disease entity together with its public health significance at present and, by extrapolation, under conditions of future water impoundment.

In addition to the outstanding waterborne diseases mentioned above, certain other infectious diseases whose transmission is associated with the availability and quality of water (amebiasis, enteric bacterial infections, hepatitis, and poliomyelitis) and/or personal hygiene (trachoma, ringworm, scabies, hookworm, and yaws) may be directly or indirectly affected by water resource development programs that change life-styles because of the freer availability of clean, safe water supplies.

The public health section of the Gambia River Basin Studies (UM/GRBS) will have four components: (1) review of the literature, (2) field data collection where indicated by gaps in the available data, (3) projection of public health impacts in the context of development activities, and (4) recommendations for mitigative measures. These components are treated as the first four of the tasks that have been identified under the public health rubric.

## **I. TASK 1. LITERATURE SEARCH**

### **A. Objectives**

- (i) To assemble and evaluate available information, both published and unpublished, relating to the public health significance of those water-borne diseases which will be influenced by proposed water resource development schemes in The Gambia (Balingho barrage, irrigated perimeters for rice), Senegal (Kekreti dam), and Guinea (dams at Kougoufoulbe, Kouya, and Konkouré), and
- (ii) To determine what new information is required to project and mitigate health impacts of proposed developments.

The very large amount of information concerning Guinea, Senegal and The Gambia that has accumulated over many decades and the comparatively easy retrieval of such data from a limited number of documentation centers in The Gambia and Senegal justify a strong emphasis, at least in the early months of the project, on documentation research. Supplemental data may be forthcoming from field research projects now being actively conducted in the OMVG member states.

### **B. Methodology**

1. Primary information sources in the region:
  - a. Library and data bank of the Medical Research Council, Fajara, The Gambia.
  - b. Libraries and data repositories of the Pasteur Institute, Office de la Recherche Scientifique et Technique Outre Mer (ORSTOM), Organisme de Recherches sur l'Alimentation et la Nutrition Africaines (ORANA), Institut Fondamental d'Afrique Noire (IFAN), all in Dakar.
2. Secondary information sources in the region:
  - a. Major agencies and institutions engaged in field research.

3. Sources outside of the region:
  - a. OCCGE in Bobo-Dioulasso
  - b. OCP headquarters in Ouagadougou
  - c. School of Public Health, Yale University

C. Time Frame

1. Work has already begun on basic data sources, and source references appear in UM/GRBS Working Document No. 1.
2. Library sources at the University of Michigan will be consulted during April 1983.
3. Contact will be made with Yale University, School of Public Health in April 1983.
4. In The Gambia and Senegal, literature searches and personal contacts will continue for the duration of the project. However it is anticipated that sufficient data will be available within the first three months (June-August 1983) to permit an easy transition to activities under Task 2.

D. Personnel

1. Dr. Curt R. Schneider, Team Leader
2. Dr. Abdoulie Jack (The Gambia)
3. Mr. Alioune Badji (Senegal)
4. Guinean counterpart (to be nominated)

E. Deliverables

1. Report: evaluation in terms of public health significance of the following important waterborne diseases in the Gambia River Basin: malaria, schistosomiasis, onchocerciasis, trypanosomiasis, leishmaniasis, filariasis bancrofti, yellow fever, and dengue. Reporting parameters will include prevalence (number of cases at any one time), incidence (number of new cases each year), and morbidity (intensity of infection), measured against the population at risk according to age, sex, occupation, and location. Appropriate graphics will be included.
2. Report: shorter accounts of other waterborne diseases in the Gambia River Basin which may be affected by changes in the availability, supply and usage of domestic water sources (amebiasis, enteric bacterial infections, hepatitis and poliomyelitis).

3. Report: shorter accounts of certain diseases of the region whose transmission is usually associated with personal hygiene and which may be indirectly affected by a program of water resource development that eventuates in changed life-styles (trachoma, ringworm, scabies, hookworm, leprosy, and yaws).
4. Report: detailed reference accounts of the behavior, habitats, geographic distribution, and essential aspects of population dynamics of important invertebrate transmitters of the important regional water-borne diseases (malarial mosquitoes, freshwater snails, tsetse flies, blackflies).
5. Report: to pinpoint where gaps occur in the database, and to characterize new information required by development planners.

#### Selected References

World Health Organization. 1981. Projet Sénégal Gambie. Lutte contre l'onchocercose en Guinée, Guinée-Bissau, Mali, Sénégal et Sierra Leone. VBC/81.2, AFR/ICP/MPD/007.

Brown, D.S. 1980. Freshwater Snails of Africa and their Medical Importance. Taylor & Francis Ltd., London. 487 p.

Deom, J. 1982. Water resources development and health. A selected bibliography. World Health Organization, PDP/82.2.

U.S. National Academy of Sciences-National Research Council. 1962. Tropical Health. A Report on a Study of Needs and Resources. Publication No. 996. Washington, D.C. xxx + 540 p.

## II. TASK 2. SUPPLEMENTAL FIELD RESEARCH

### A. Objective

Data from Task 1 may identify the need by planners for specific field studies to supplement available information. In anticipation, provision will be made to develop collaborative protocols for data collection with teams already working in the field.

Preliminary searches through available documents indicate that field studies may be required on snail bionomics and taxonomy, in The Gambia, Senegal and Guinea, as well as on mosquito identifications and bionomics in downstream areas of the Gambia River which will change from predominantly salt to predominantly fresh water after installation of the Balingho barrage.

With regard to onchocerciasis, the extensive clinical and entomological field work of the past ten years on onchocerciasis in West Africa, carried out in connection with the Onchocerciasis Control Program of WHO, provides ample background information for development planning in the Kekreti area of Senegal as well as the Kougoufoulbe and Kouya-Konkuré areas of northern Guinea.

Detailed maps have been prepared of all blackfly breeding sites in the area of the Kekreti dam and its inundation area. All villages in the vicinity seem to have been surveyed and characterized as to intensity of involvement. Thus there would seem to be no need to divert limited project funds into additional field studies of onchocerciasis.

## **B. Methodology**

### **1. The Gambia**

- a. Contact authorities of the Ministry of Health, Epidemiology Unit, to ascertain departmental programs and goals.
- b. Establish liaison with the Ministry of Water Resources and Environment.
- c. Establish liaison with the Department of Animal Health and Production, Abuko.
- d. Ongoing field research on epidemiology of schistosomiasis is being conducted by MRC at its field station at Basse and on transmission of malaria at the MRC field station at Farafenni. Field studies on these diseases supported by project funds in The Gambia would be organized in such a way as to benefit from the extensive experience of MRC scientists, many of whom have spent long years on their subject in this area.

### **2. Senegal**

- a. Establish cooperative effort with the Department of Parasitology, University of Dakar. Interest has been shown in supporting field studies on schistosomiasis and malaria in the Kekreti-Kédougou area. Support will take the form of assigning one or two students to work with project personnel in this area.
- b. Coordination of efforts with the Secteur des Grandes Endemies of Senegal Oriental in Tambacounda. Staff of the organization's Parasitology Laboratory will cooperate with public health team

staff and students from the University of Dakar in identifying field problems that can be tackled during the life of the project, results of which will meet the requirements of OMVG.

### 3. Guinea

In view of the need to coordinate project efforts with requirements and programs of the PRRG, specific plans must await the results of consultations with authorities in the Ministry of Health in Conakry (sector of transmissible diseases and sector of prevention). It is possible that coordination will take the form of sending Guinean technicians to Senegal to participate in field work that will be conducted jointly through the University of Dakar (Professor Samba Diallo) and the Secteur des Grandes Endemies in Tambacounda. Such candidates will be proposed by the PRRG Ministry of Health, will have had experience with the vaccination programs in Guinea and will be familiar with logistic problems in their country. They will receive six months of training in standard parasitological techniques and elements of field entomology and malacology (urine, blood and stool examinations, mosquito, blackfly, tsetse fly identification, snail identification). The center for the work will be the Parasitology Laboratory at Tambacounda. Field areas used for training purposes will be selected with the interests of OMVG in mind and will be coordinated with activities of the socioeconomic team.

The ensuing activities of these trainees are necessarily vague at this point, given the necessity of prior consultations and coordination with authorities in the Ministry of Health of the PRRG. However, in parallel with the training described above, meetings will be arranged between OMVG personnel, the medical directors of the Koundara and Labé hospitals, the interested authorities in the Ministry of Health in Conakry, and the UM/GRBS public health team to develop strategies, identify objectives, establish lines of logistical support, target time frames for fieldwork, and agree on reporting channels for work in Guinea. An initial meeting will be held the first week in May in Conakry. Subsequent meetings will be held in Dakar.

- b. In Guinea, the socioeconomic team has recommended obtaining the assistance of a medical anthropologist trained in village studies and in ethnomedicine and epidemiology to assess levels of significant diseases, perceptions of health and illness, traditional health practices, utilization of modern health facilities and projected impacts of planned interventions. The resulting report would be of use to the public health team as well as the socioeconomic team in preparing the final report.

C. Time Frame

The need to take into account seasonal variations in vector density, human activities, population shifts, and disease morbidity dictates at least four periods of field activity: September (end of rains), December (young dry season, surface water still abundant), February (middle dry season, some surface water still present), and May/June (beginning of new rainy season).

D. Location

Planning sessions in Conakry, Dakar and Tambacounda, for Senegal and Guinea, in Banjul for The Gambia.

Field stations at Farafenni and Basse in The Gambia. Field stations to be established in the Kédougou-Kekreti area in Senegal.

E. Personnel

Professional counterparts and field assistants will be assigned, based on availability, from governmental and university departments, based on technical requirements to be determined.

F. Cooperation with River Resource Team

Reports and samples of snails and phytoplankton will be made available to the public health team.

G. Cooperation with the Wildlife/Vegetation Team

Reports of aquatic vegetation and shoreline plants will be made available and will be useful in predicting the suitability of new habitats.

H. Cooperation with the Socioeconomic Team

Reports from village surveys of water contacts, animal contacts and knowledge-attitudes-practices studies for major waterborne diseases.

## **I. Deliverables**

Field studies will complement baseline data taken from the available literature. Field data will be utilized to assist in evaluating the potential for spread of each major disease under impoundment conditions (Kekreti and Guinea dams) or westward in The Gambia as a result of salt exclusion upstream from Balingho.

## **III. TASK 3. PROJECTION OF PUBLIC HEALTH IMPACTS**

### **A. Objective**

To project public health impacts of proposed water resource developments in terms of predicted changes in prevalence, incidence or morbidity. Particular attention will be paid to the experience of other development projects in Africa where large migrant work forces have been present during construction activities.

### **B. Methodology**

With data from epidemiological surveys, maps for ready visual appraisal and future monitoring will be made of geographical areas which will undergo significant public health changes. In addition, graphics will depict anticipated migrant labor movements, source areas of migrants, areas of present high population density and areas of developmental interest to OMVG and the Member States

### **C. Time Frame**

Art work to start as data are received.

### **D. Location**

Graphics section of CRED, Ann Arbor.

### **E. Deliverables**

Maps, charts, graphs.

## **IV. TASK 4. MITIGATIVE MEASURES**

### **A. Objective**

Preparation of recommendations for mitigative measures to deal with adverse health effects of river development. These will be based on established technology which has given measurable results in other African water development schemes. Where possible, innovative technology will be described (for example, slow release elastomers in treating ponds with molluscicides).

**B. Methodology**

Mitigative measures will be tailored to the health problem in question, based on data from all the UM/GRBS teams.

Special emphasis will be placed on environmental management techniques, including marginal plant control, cementing of water channels, and/or draw down fluctuation.

The surveillance and monitoring of beneficial as well as negative impacts will be established. Coordination will be through health agencies of the OMVG member states. Public health authorities of the member states will be contacted to assure that recommended surveillance/control procedures are adjusted to national objectives.

**C. Time Frame**

Entire 16-month period of study. Results will emerge from consultative and planning sessions with health authorities of OMVG member states held throughout the year, as well as from data obtained in Tasks 1 and 2.

**D. Deliverables**

The results will form a major part of the final report.

**V. TASK 5. INSTITUTIONALIZATION**

**A. Objective**

To institutionalize research and analytic methodologies within concerned agencies of OMVG member states.

**B. Methodology**

Working forward from Task 2, the ideal way to develop institutional strength for implementation of recommended programs will be within the context of specific disease studies.

Concerned ministries in the member states will be interested in the planning and staffing of activities associated with disease control which may imply long-term national commitments and budgetary requirements.

**C. Time Frame**

Working through OMVG, member state counterparts will be nominated fairly early in the life of the project and should be ready to participate in planning sessions by June 1983.

D. Personnel

1. Dr. Curt R. Schneider, team leader
2. Dr. Abdoulie Jack, Ministry of Health, Banjul, The Gambia
3. Dr. Sanyang, Department of Animal Health and Production, Abuko, The Gambia
4. Mr. Alioune Badji, Secteur des Grandes Endemies, Tambacounda, Senegal
5. Dr. Saidou Barry, Labé Hospital, Labé, Guinea (provisional)

E. Deliverables

Establishment of a liaison nexus involving OMVG with health authorities of member states.

VI. TASK 6. MEDICAL ESTABLISHMENT IN MEMBER STATES

A. Objective

To construct flowcharts of the existing medical establishment in the member states for the use of OMVG in future health planning and in the development and maintenance of reliable surveillance and monitoring systems.

B. Methodology

Elements for such charts are obtainable from:

1. Annual reports of the ministries;
2. Verbal reports of medical authorities.

Included will be: number and type of hospitals, dispensaries, primary health care units, listed medical services, number of physicians, technicians, medical assistants, primary health care personnel and their designations, midwives, nurses, etc.

Data will also be reported on training centers, drug distribution centers, and medical supply systems, including cold-chain systems for vaccine delivery. Budgetary data will be reported where available.

C. Time Frame

Ad libitum as information is received, but within the first three months of the project: June-August 1983. It is anticipated that this list will be included in the third quarterly report of UM/GRBS to USAID/OMVG.

D. Deliverables

Report on the existing medical establishments of the member states.

## VII. TASK 7. RURAL WATER SUPPLY AND SANITATION

### A. Objective

To develop an overview of rural sanitary conditions in regions of interest to OMVG and the member states which might require attention and/or amelioration in the context of waterborne disease control.

The installation of safe, piped water supplies, the availability of safe alternatives to surface waters for domestic purposes, and the protection of the immediate environment from human wastes are actions that promote improved life style and result in decreased incidence of most waterborne diseases.

### B. Methodology

Considerable data exist in information centers in Banjul and Dakar and will be researched.

Syntheses of available data, supplemented by village site visits, where warranted, will be used to construct a proposal for the sanitation segment of the mitigative actions under Task 4. The precise nature of such interventions, whether to correct the impact of irrigation and drainage on sanitation, alter water contact patterns in rural communities, or install piped water supplies, hydrants, hand-pumps, or community laundries, will depend on local conditions. In this connection the questionnaire results from the socioeconomic team with regard to water contacts will be extremely useful.

### C. Time Frame

To be determined based on availability of a consultant. Report will be issued during first three months of the dry season, 1984.

### D. Location

Working out of Banjul, site visits by the consultant to be made to villages of OMVG interest downstream and upstream of the Balingho site in The Gambia, and in three areas south of the Kekreti site. Visits will be made to Gambian sites working from Farafenni and to Senegalese sites working from Kédougou.

### E. Personnel

One water supply and sanitation expert (Dr. Morton S. Hilbert, Department of Environmental and Industrial Health, School of Public Health, Ann Arbor) assigned to the project through the auspices of the USAID Water and Sanitation for Health Project (WASH).

**F. Deliverables**

Consultant's report on rural water supply and sanitation situation in the Gambia River Basin, with recommendations for actions to mitigate adverse health effects of water resource development.

**VIII. TASK 8. NUTRITIONAL STATUS**

**A. Objectives**

To develop an overview of the relationship of nutritional status in rural Gambians, Senegalese and Guineans to infectious disease in relation to water resource development.

**B. Methodology**

Infectious determinants of poor nutritional status will be identified. Regional considerations of potential decreases or increases in fish production will be addressed. Nutritional implications of the possible replacement or alteration of subsistence crops by the introduction of high technology cash crops will be addressed.

**C. Time Frame**

To be determined based on availability of a consultant.

**D. Location**

Information centers, Banjul and Dakar.

**E. Personnel**

Consultant in nutrition, assigned to project for 2 months.

**F. Deliverables**

Consultant's report.

APPENDIX  
LIST OF PERSONS CONTACTED

A. Senegal

1. Dakar:

Dr. J.P. Digoutte, Director, Pasteur Institute

Dr. Michael Cornet, ORSTOM entomologist

Dr. Samba Diallo, Professor and Chair of parasitology, University of Dakar

Dr. Michael White, USAID

Mr. J. Michael Rieffel, Director, Kekreti Reservoir Project, AHT/HHL

2. Tambacounda:

Dr. Madike Ndao, Médecin Chef des Grandes Endémies du Sénégal Oriental

Mr. Alioune Badji, Technician, Entomology-Parasitology, Secteur des G.E.

Mr. Arokouty Bassene, Technician, Entomology-Parasitology, Secteur des G.E.

3. Simenti:

Mr. Andre Du Puy, Head Curator, National Parks of Senegal

B. Guinea

1. Koundara:

Dr. Mamadou Rafi Diallo, Koundara Regional Medical Director

Mr. Amadou Baldé, chief of personnel, Koundara hospital

2. Labé:

Dr. G. Maka, Chief of Services, Labé Hospital

Dr. Saïdou Pathé Barry, Chief of Preventive Medical Services, Labé Hospital

3. Donguel-Sigon:

Dr. Fava Kamano, Chief, Medical Center

APPENDIX (con't.)

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C. The Gambia

1. Banjul:

Dr. Hatib Njay, Deputy Director of Medical Services, Ministry of Health

Dr. Abdoulie Jack, Director, Epidemiology Unit, Ministry of Health

Mr. Omar M. Fye, Director, Environmental Unit, Ministry of Water Resources and Environment

Dr. Ben Akim, WHO representative in Banjul

Dr. Peter Spain, Evaluator, Mass Media for Infant Health

2. Abuko:

Dr. Famara Sanyang, Department of Animal Health and Production

Dr. Momodou Lamin Ceesay, Department of Animal Health and Production

3. Fajar:

Dr. Brian Greenwood, Director, Medical Research Council Laboratories

4. Keneba:

Dr. William Lamb, pediatrician, MRC field station

5. Bansang:

Dr. Jagne, Director, Bansang Hospital

Sean O'Leary, nurse, Save-the-Children foundation

6. Basse:

Dr. Andrew Wilkins, parasitologist, MRC field station

Dr. Jens Erik Jelnes (visitor), Danish Bilharziasis Laboratory,

## WILDLIFE/VEGETATION TEAM

### WORK PLAN

#### INTRODUCTION

Forestry and wildlife inventories have been successfully implemented for decades. Unfortunately, these activities have tended to be segregated and treated as separate entities at all levels: academic training, governmental agencies and even project design. This has resulted not only in duplicated effort, but often in data sets which cannot readily be incorporated into a functional model of the actual ecosystem being evaluated. Our methodology proposes to integrate these two activities.

Because of the economic importance of timber resources, inventory and assessment techniques are well established and the art of "timber cruising" has progressed to a well-honed science. Remote sensing, especially the use of moderately large-scale aerial photos, is common practice. Although these techniques have emphasized the more commercially valuable timber products (i.e., lumber), they are equally adaptable to provide information on fuelwood productivity and other secondary forest products of importance to West African cultures. Wildlife populations, on the other hand, are inherently dynamic and often quite elusive. These dynamics are poorly understood for many species and man has the ability to drastically influence them through hunting pressures, livestock grazing, wildfire control, agricultural programs and other actions. Consequently, direct investigations of wildlife numbers (the traditional wildlife assessment method), may not accurately reflect the land's suitability for wildlife, especially when only a single annual cycle has been studied. Knowledge of suitability is essential for evaluating and mitigating development impacts. Rather than use an animal censusing approach, which can yield erroneous and highly variable results, we propose to assess the status of most wildlife species by

analyzing the condition and utilization of habitat. Wildlife habitat is the arrangement of food, cover and water required to meet the biological needs of one or more individuals of species. For many wildlife species, a primary diagnostic attribute of habitat is the associated plant communities, unique combinations of plants that occur in particular locations. Since plant communities tend to reflect the physical parameters of the environment, such as climate, soil, elevation, slope, aspect and solar radiation, the plant community functions as an indicator of the many complex physical and biological relationships between an organism and its environment. Since forest types and wildlife habitat can be strongly correlated with their common denominator, plant communities, vegetation becomes the means for integrating our survey. The appropriateness of this approach is well documented in a landmark publication on "Wildlife Habitats in Managed Forests,"<sup>1/</sup> which demonstrates that by associating wildlife species and groups of species with plant communities and their successional stages the forest manager can readily translate standard forest inventories into information on wildlife habitat.

Our inventory will commence with delineating areas that appear homogeneous on aerial photography and satellite imagery. These preliminary mapping units will be correlated with existing plant communities (including forest types) by a combination of photointerpretation, knowledge derived from previous investigations, and field surveys. In addition to type-mapping, data will be acquired on significant characteristics of the vegetation, particular plant species of economic and/or cultural importance, condition and trend, and other attributes recognized to be pertinent to this study. Concurrently, during the initial phase

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<sup>1/</sup> Thomas, J.W. 1979. Wildlife habitats in managed forests of the Blue Mountains of Oregon and Washington. USDA, For. Ser. Handbook No. 553, Washington GPO, 510 pp.

of this project, the biological requirements of wildlife species will be identified from existing literature, knowledgeable individuals, and, if necessary, field observations. The plant community map will then be reviewed in terms of the now defined wildlife habitat types. Generally, several plant communities and ground cover types will be combined to form the habitat for one species. For instance, the hippopotamus habitat will include river and wetland types, riparian vegetation communities and, in certain areas, adjacent agricultural fields.

Within each habitat type, data will be collected on abundance of forage species, and indicators of trends (erosive actions, reproduction of key forage species, degree of hedging, etc.). This information will define the condition of the habitat. Finally, the status of the wildlife populations will be determined by the degree of utilization and other signs of faunal activity. For example, if a habitat type is found to amply provide for all of the basic needs of a given species, yet appears underutilized, one can infer that the species is not currently abundant and probably has the capability to increase its population. Conversely, if a habitat is in poor condition and still heavily utilized, one must infer that the wildlife species is exceeding the carrying capacity of that habitat type. There are, of course numerous intermediate possibilities for habitat condition and wildlife population status. Throughout this analytical procedure, our emphasis will be on identifying both critical habitat elements (e.g. key food species, specific breeding requisites), and the current limiting factor for each wildlife species of importance.

Although the primary methodology for our assessment of the wildlife will be based on the habitat analysis approach described above, we will employ aerial surveys and the more traditional "animal counts" in appropriate situations, or when some statistical reliability can be achieved.

The forest and wildlife inventory is merely a preliminary activity under this scope of this project. The ultimate objective is clearly to predict the impacts of the proposed developments, and to identify suitable mitigating measures. The importance of this final goal becomes more obvious when one considers the nature of the anticipated impacts, and the usual results of conflicts between the environment and development activities. This is particularly true in developing countries where such interventions are so crucial for increased food and energy self-reliance, and there are no powerful lobbies and legal precedents for expensive environmental compensations. This should not be construed as a defeatist attitude. Instead, we state these realities only to emphasize the great importance that we place on the identification of innovative mitigation recommendations within the realm of economic possibilities, as necessary for the successful completion of our work.

TASK 1. DETERMINE THE STATUS OF EXISTING INFORMATION

A. Purpose

In any study of a regional nature it is obviously imperative to locate and review as many sources of existing information as possible. This minimizes duplication of effort. Moreover, it would be impossible to originate within the scope of this project much of the detailed information acquired from certain specific investigations (for example, Carter's ongoing dissertation research on chimpanzees,<sup>2/</sup> or Clark's 1953 report on the hippopotamus in the Gambia<sup>3/</sup>).

The literature on West African wildlife and vegetation is so vast and scattered that we would be naive to suppose that more than a small fraction of it could be assembled, much less read, in a year's time. We will extend our existing bibliographic file continuously throughout the study period but will not attempt to procure or read the material until we are sure that it is applicable.

B. Specific Actions

1. Search for and Acquisition of Existing Information

a. Prior studies/projects (including both published literature, and unpublished or limited distribution reports).

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<sup>2/</sup> Carter, J. Chimpanzee Research Project (on-going), Wildlife Conservation Dept, The Gambia.

<sup>3/</sup> Clark, J.R. 1953. The Hippopotamus in The Gambia. J. Mam. 34: 299-315.

b. Maps (topographic, specific topical, etc.); aerial photography; satellite imagery.

c. Museum collections (United States; Great Britain; France, etc.).

2. Establish contacts with ongoing projects/studies.

3. Identify knowledgeable individuals.

a. expatriate specialists (scientists, engineers, etc.)

b. in-country experts and agency personnel

c. local people (especially hunters and guides)

4. Catalogue and label acquisitions

C. Proposed Methodology

1. Techniques

a. Initial literature search at the U.S. Library of Congress (Africa Bureau; general card catalogue and Map Room); University of Michigan/CRED library and Harza Library. From this start, additional references can be backtraced from appended bibliographies and/or key author names. Certain bibliographic and indexing services/publications will also be used (especially The Wildlife Review). Computer searches are not expected to be as productive as manual card sorting for this effort, but inquiries will be made regarding specific topics.

b. Major agencies and institutions involved in wildlife related work will be contacted for both references and knowledgeable persons. These include, but are not limited to: The Wildlife Society; major ornithological societies; World Wildlife Fund; International Union for the Conservation of Nature (IUCN); African Wildlife Leadership Foundation (AWLF); U.S. National Wildlife Federation (International Depart-

ment); U.S. National Park Service (International Affairs); National Academy of Sciences; l'Institut Fondamental d'Afrique Noire (IFAN); Office de la Recherche Scientifique et Technique Outre Mer (ORSTOM); OMVS Documentation Center (Saint Louis, Senegal).

c. Maps will be sought from the following sources:

- (1) U.S. Library of Congress Map Room
- (2) U.S. Defence Map Agency (DMA)
- (3) U.S. National Oceanic Survey (NOS)
- (4) Institut Geographique National (IGN-Dakar)
- (5) Survey Dept., Ministry of Public Works, The Gambia

d. Aerial Photography and Satellite Imagery

- (1) I.G.N. - Dakar, Conakry, Paris
- (2) Survey Dept., Ministry of Public Works, The Gambia
- (3) EROS Data Center (EDC), U.S. Geological Survey, Sioux Falls, South Dakota, U.S.A. A computer print-out of all available imagery over the Gambia River Basin is available. It includes information such as date, exact area covered, quality, percent cloud cover, etc. Imagery selection will be based initially on these data, and subsequently finalized by reviewing microfiche copies at EDC.
- (4) USAID/Mark Hurd aerial photographs and maps (when available).

e. Existing museum specimens collected within the GRBS project area will be located by a computer search of holdings in major U.S. museums. It is also anticipated that visits will be made to certain major collections in Europe (in particular in Great Britain and France).

f. All floral, faunal and ecological documentation will be catalogued initially on index cards, including complete bibliographic information and source of reference (the latter being particularly important for reports), or name and address of individual for personal contacts. Duplicate cards will be made for author, subject and systematic indexes as needed. This information will eventually be entered into the University of Michigan computer/word processing system to prepare additions to the bibliography already completed as Working Document No. 1 of the UM/GRBS.

g. The effort on literature search will be concentrated in the first half of 1983, but will be continued throughout the entire project as new references or contacts are made.

2. Equipment. Nonexpendable items under this task will consist of the reference library, file containers, satellite images and office copies of maps. Expendable items will include field maps, xerox paper for copying references of limited distribution; binders for xeroxed reports; heavy-duty binder stapler; and similar office supplies.

D. Location of Proposed Activities

1. Library of Congress, Washington, D.C.
2. University of Michigan, Ann Arbor, Michigan.
3. Harza Engineering Co., Chicago, Illinois.

4. London, England
5. Paris, France
6. Rome, Italy (FAO)
7. Dakar, Senegal
8. Banjul, The Gambia
9. Other towns and regional centers within Senegambia

E. Key Personnel

1. Peter L. Ames, Team Leader
2. B. Dean Treadwell, Wildlife and Range Ecologist
3. Andre de George, OMVG

F. Schedule of Activities (and Work Accomplished To Date)

1. Work on several aspects of the specific actions has already begun, and is summarized below:

a. Four days were spent in the Library of Congress by Treadwell in December 1982. Excluding secondary references or those listed in such abstracting services as the Wildlife Review, over 150 initial citations were collected. Two very useful bibliographies located were: Gamble and Sperling, 1979, A General Bibliography of the Gambia; and Rogers, 1979, A Bibliography of African Ecology.

b. Contacts with most relevant U.S. - based agencies (U.S. National Park Service; U.S. Fish and Wildlife Service; World Wildlife Fund - U.S.; African Wildlife Leadership Foundation) have been made.

c. U.S. map depositories (DMA; NOS; Lib. of Congress) have been contacted and available maps ordered. IGN-Dakar, IGN-Conakry, and Survey Dept., The Gambia, have also been visited. Single copies of 1:200,000 scale maps were purchased for the reconnaissance trip and

work plan preparation. Additional copies of Guinea maps will require an official request.

We have decided that the basinwide vegetation map will be prepared at a scale of 1:100,000. This will require photographic enlargement of existing 1:200,000 and 1:250,000 scale maps, which can be accomplished at the Survey Dept., Ministry of Public Works, The Gambia. In this event, film and developing materials will be provided by GRBS.

d. Aerial photography of the entire basin has been flown under contract with USAID by Mark Hurd Aerial Surveys, Inc. These photos have the nominal scale of 1:50,000 and are available in color infrared and black-and-white. The majority were flown in 1982. Most requirements for aerial photography can be met by this coverage, which is available at the OMVG office, Dakar.

Other photography available for The Gambia and archived at the Surveys Dept. includes:

- 1980 entire country (Teledyne) CIR
- 1972 " " 1:25,000, some 1:10,000; b/w
- 1968 " " 1:25,000; b/w
- 1956 " " 1:25,000; b/w
- 1946 " " 1:25,000, some 1:10,000;

These photos should be of use to document changes in plant cover and land use for critical areas.

IGN has not yet been contacted regarding aerial photography for Senegal and Guinea, but aerial photos are available for most francophone countries.

Computer printouts have ordered and reviewed for Landsat imagery; images have been ordered and one complete set arrived in Banjul on 22 Feb 1983.

e. We do not anticipate visiting European museums (e.g., London, Paris) until sometime well into the project. It is necessary to complete the initial literature search and species lists prior to this activity. It is likely that some specimens collected during the course of this project may have to be identified by comparison with museum materials in Europe during these visits. If possible, brief stops will be made when team members are enroute to Africa in May, but these one- or two-day stops will be primarily to acquire key literature, and FAO Rome will be a primary stop for this purpose.

f. Literature search, personal contacts and cataloguing of references will continue throughout the duration of the project. We anticipate that a minimum of two person-months will be devoted to this important task and additional "spare" time will be spent reviewing the literature collected.

#### G. Deliverables

1. List of names and addresses of individuals and institutions contacted.
2. Minimum of one complete set of topographic maps.
3. Two complete sets of Landsat images covering the basin.
4. Alphabetized bibliography of wildlife and vegetation references.
5. Library copies of these references (within budget limitations).

TASK 2. BASINWIDE GROUND RECONNAISSANCE AND AERIAL OVERFLIGHTS

A. Purpose

On-ground reconnaissance missions prior to finalizing work plans are important for several reasons. Vegetation types can be evaluated in terms of their complexity and degree of degradation. Initial data can be collected for evaluating the imagery and/or aerial photography used for mapping. Similarly, preliminary decisions can be made concerning the regional nature of wildlife habitat, the degree of human habitation and exploitation, and determine the suitability of various survey techniques (for example, the visit to Niokolo-Koba indicates that strip census techniques are a viable option, rather than using only indirect methods). Lastly, but of critical importance, is the opportunity to determine logistic requirements. These include, among others, road conditions and map accuracy, travel times between various locations, distribution and reliability of gasoline supplies and necessary vehicular services, types of field equipment required.

An early aerial reconnaissance is useful in other ways. When mapping projects are contemplated, particularly those based on remotely sensed data (e.g., Landsat images), the aerial perspective allows evaluation of the imagery, rapid identification of those complex areas requiring more intensive ground data collection, and even a modest amount of actual vegetation type-mapping. Of particular importance for this project will be the opportunity to fly with the Director of Senegal National Parks (A.R. Dupuy) and the Director of the Wildlife Conservation Department of The Gambia (E. Brewer) and to record firsthand their knowledge of particular areas. A corollary benefit of the flight will be determining the location of hippopotamus concentrations.

Additional overflights will be scheduled later in the project with the precise objectives to be determined according to need. These later

flights will be especially important in some of the more remote parts of the basin. Their objectives will include verification of vegetation map boundaries and type identification, animal censusing, acquisition of low-level (large-scale) and local color aerial photographs to supplement other photograph and Landsat imagery, and/or transport to areas inaccessible during the rainy season.

B. Specific Actions

1. Three-week on-ground reconnaissance mission to Senegal oriental, the Gambia (and northern Guinea) areas within the Gambia River Basin partly completed in February 1983.

2. Two-day reconnaissance overflight of specific basin localities jointly selected by Dupuy, Brewer, Ames and Treadwell.

3. Subsequently overflights (duration, location and purpose to be determined).

C. Proposed Methodology

1. Techniques. The ground reconnaissance mission was designed to visit those areas identified by national counterparts as important, with appropriate considerations for both official introductory meetings and routes which could be driven within the allotted time period (approximately one week in each country). Records consist of road travel logs (routes, distances and travel times) and highlights of pertinent observations of a general nature (i.e., areas with abundant wildlife versus heavily exploited areas); lists of any species observed or mentioned by local inhabitants; general types of plant communities and species.

Aerial reconnaissance missions are to be conducted at low elevations (100-200 meters) and at slow speeds (less than 200 kph), primarily

for visual records and on-site observations with the National Park directors of The Gambia and Senegal. Photographic records will be made with hand-held and/or strut-mounted 35 mm cameras. The photographic records will serve two purposes: (a) to document observations of specific features, animals or plant communities, and (b) to acquire accurately located, large-scale aerial photo-transects indicated on base maps and tape recorded.

## 2. Equipment

a) Aircraft. Must be of high-wing design to allow for maximum visibility by all observers; single or twin engine; five to seven seats, including pilot.

b) Cameras. Hand-held cameras will consist of 35 mm single-lens reflexes with 28-, 50-, and 80-200 mm zoom lenses (personal equipment of team members will be used). Exposures will be taken at oblique angles.

A wing strut-mount for 35 mm camera or a sliding-window camera mount ("Meyers" type) can be used to take vertical photo-transects. A window mount is available from the University of Michigan School of Natural Resources but will require a suitable aircraft.

c) Maps. Available topographic base maps (1:200,000) will be used for navigation and the recording of localities. We anticipate that at least a portion of one overflight will be used to assist in vegetation mapping.

d) Voice tape recorder will be used to record data and observations.

3. Expendables. The primary expendable item used on the aerial reconnaissance flights will be film (35 mm, 36 exp.; ASA 25, 64 or 400 color). Films will be selected as appropriate for season, camera lens and general flight and haze conditions.

D. Locations of Proposed Activities

The ground reconnaissance mission followed a route from Dakar-Tambacounda-Koundara (Guinea)-Labe-Koubia-Mali-Kedougou (Senegal)-Salemata-Simenti (and areas within Niokolo-Koba National Park) - Velingara-Basse (The Gambia)-Banjul.

The initial aerial reconnaissance flight will be planned to include appropriate areas within both Gambia and Senegal. Should it to become contractually feasible, portions of Guinea also will be included. In the Gambia, the primary flight line will be along and immediately adjacent to the river. A possible overflight of the Senegal portion of the basin could be:

- a. Tambacounda to about Sintiou Tapsirou (65 km southwest of Bakel) = 150 km,
- b. south to Kedougou = 200 km,
- c. refuel, if necessary, at Kedougou (prior arrangements may be necessary if fuel is to be available),
- d. Kedougou to Kekreti reservoir area to Niokolo-Koba to Simenti to Tambacounda = 250 km. The total distance is approximately 600 km with a flying time of about 4 hours. The Gambia would be flown as a separate mission or an additional leg added to this flight.

Subsequent flight routings will be determined according to the particular objective of each mission.

F. Personnel

1. Harza/UM. Each member of the Wildlife/Vegetation Team (Ames, Treadwell, Rodriguez) should be involved in at least one flight. Members of other teams will participate as space permits.

2. OMVG. Idrissa Samba, Andre de George.

3. Counterparts. The following have shown interest in participating in the flight:

- M. A. R. Dupuy, Director, National Parks, Senegal.
- Mr. Eddie Brewer, Director, Wildlife Conservation Dept., The Gambia.
- M. Sylla, Conservateur, Niokolo-Koba National Park.
- M. Rigulot, Conservateur, Delta of Saloum National Park.

4. Service Personnel. A pilot will be required since none of the above individuals is licensed to fly in Senegal or The Gambia.

F. Scheduling Considerations, Problems Encountered, Work Completed

The on-ground reconnaissance mission has been completed (5 February to 22 February 1983). A summary of the trip travel log and major observations is appended to this work plan.

It was intended to complete the first aerial reconnaissance prior to submission of this detailed work plan. Locating a suitable high-wing aircraft in Senegambia has been difficult, however, and by the end of March, 1983, only two suitable aircraft had been found. We now plan to make the first study overflight soon after the Wildlife/Vegetation Team arrives in Africa (i.e., late May, early June), subject to the availability of the aircraft. There is also some uncertainty as to the requirements for special permits although the general consensus is that all that is required is that the pilot file a flight plan.

### Deliverables

1. For each overflight the mission leader will provide a concise trip report in the form of a Working Document that indicates flight plan, area covered, work accomplished, key observations made, and any problems encountered or recommendations for future missions. If data are tape-recorded, a transcript will be made and placed in the project files. Observations and locations of will be shown recorded on accompanying maps.

2. Low level, large-scale 35 mm photographs will also be referenced and filed appropriately (see Objective 5 for details on photographic records and file system) and used selectively in the associated Working Document.

TASK 3. INTERACTION WITH SOCIOECONOMIC TEAM FOR INFORMATION ACQUISITION

A. Purpose

The purposes of this important activity are sixfold:

- Use knowledgeable local inhabitants (hunters, guides, forest product specialists, etc.) to help locate areas of human interactions with animals and other important wildlife features. It is important to accomplish this activity as early as possible in the field studies in order to take fullest advantage of local knowledge to identifying primary study areas.
- Identify hunter-guides throughout the basin to assist in such aspects of fieldwork as tracking, collecting, and observing animals.
- Through interviews, determine the importance and values of wildlife and forest products to peoples within the basin along with levels of exploitation, wild foods gathered, species utilized, and capture methods employed.
- Specifically identify problems, concerns, and perceptions of local peoples as the wildlife resource, which animals are agricultural pests, which are dangerous.
- Attempt to collect information on historical and rare and endangered species, numbers (at least their relative abundance) and distributions.
- Collect detailed time-allocation information from selected villages to document amounts of animal products and fuelwood used, seasonal

variations thereover, amount of time spent acquiring these materials, etc.

B. Specific Actions

1. Provide input into time-allocation (bimonthly) questionnaires which are intended to generate detailed information throughout the annual cycle of 12 villages relative to land-use, and wild animal product and fuelwood exploitation.

2. Develop, in association with the Socioeconomic Team, a "hunting questionnaire" specifically designed to extract maximum information from those individuals specializing in wild animal exploitation. These questionnaires/interviews will be administered at the 12 villages selected for intensive study, incorporated into the extensive survey, and used in conjunction with a systematic basinwide survey conducted under the direction of the Wildlife Team.

3. Conduct a basinwide survey at systematic intervals (perhaps 30-50 km) designed to locate general regions containing significant wildlife populations. This effort will be made early in the fieldwork activities in order to locate major areas for more intensive investigation, as well as knowledgeable informants to assist with these surveys.

4. Provide input into the extensive villages surveys regarding information needs and localities.

5. In coordination with the Socioeconomic Team, design a "plant products" questionnaire/interview to be administered during both intensive and extensive village surveys.

6. Analyze data.

C. Proposed Methodology

Sociological and human ecological information will be acquired in two basic ways. Detailed data from certain localities, including time-allocation information will be collected by the Socioeconomic Team from their intensive and extensive village surveys. The Wildlife Team will have a direct input in designing questionnaires.

Unfortunately, site selection for both the intensive and extensive surveys by the sociology teams were of necessity based on priorities other than wildlife (such as planned agricultural developments) and consequently considerable portions of the entire project area will not be covered by these efforts. This necessitates that the Wildlife Team itself undertake a separate, systematic survey specifically planned to locate important wildlife areas, or areas of significant human-wildlife interactions. For this effort, the Wildlife Team will design the questionnaire with the assistance of the Socioeconomic Team. The Socioeconomic Team also will assist in training the interviewer(s) and in pre-testing the questionnaire. It is possible that portions of this survey can be coordinated with the ongoing survey by the Gambia Dept. of Fisheries and with parallel fisheries studies by the River Resource Team.

Analysis of the data from all surveys will be coordinated with the Socioeconomic Team and its computerized capabilities.

Proper determination of animal species will be facilitated by carefully documenting local names, asking for descriptions of diagnostic characteristics or markings, and preparing a picture book display. This picture series will include certain closely related species not found in the region, to evaluate the accuracy of the informants knowledge.

D. Locations of Proposed Activities (see attached map).

E. Personnel

1. GRBS/HARZA

- Peter Ames (Team Leader; special pest problems)
- Dean Treadwell (Wildlife and Range Ecologist: mammalian fauna exploitation)
- John Chitty (Forester; fuelwood and secondary forest products).
- Dario Rodriguez (Forester, forest products)

2. Socioeconomic Team -- all team members and enumerators.

3. OMVG

- Gordon Appleby (Sociologist)
- Kjell Christopherson (Forest Economist)

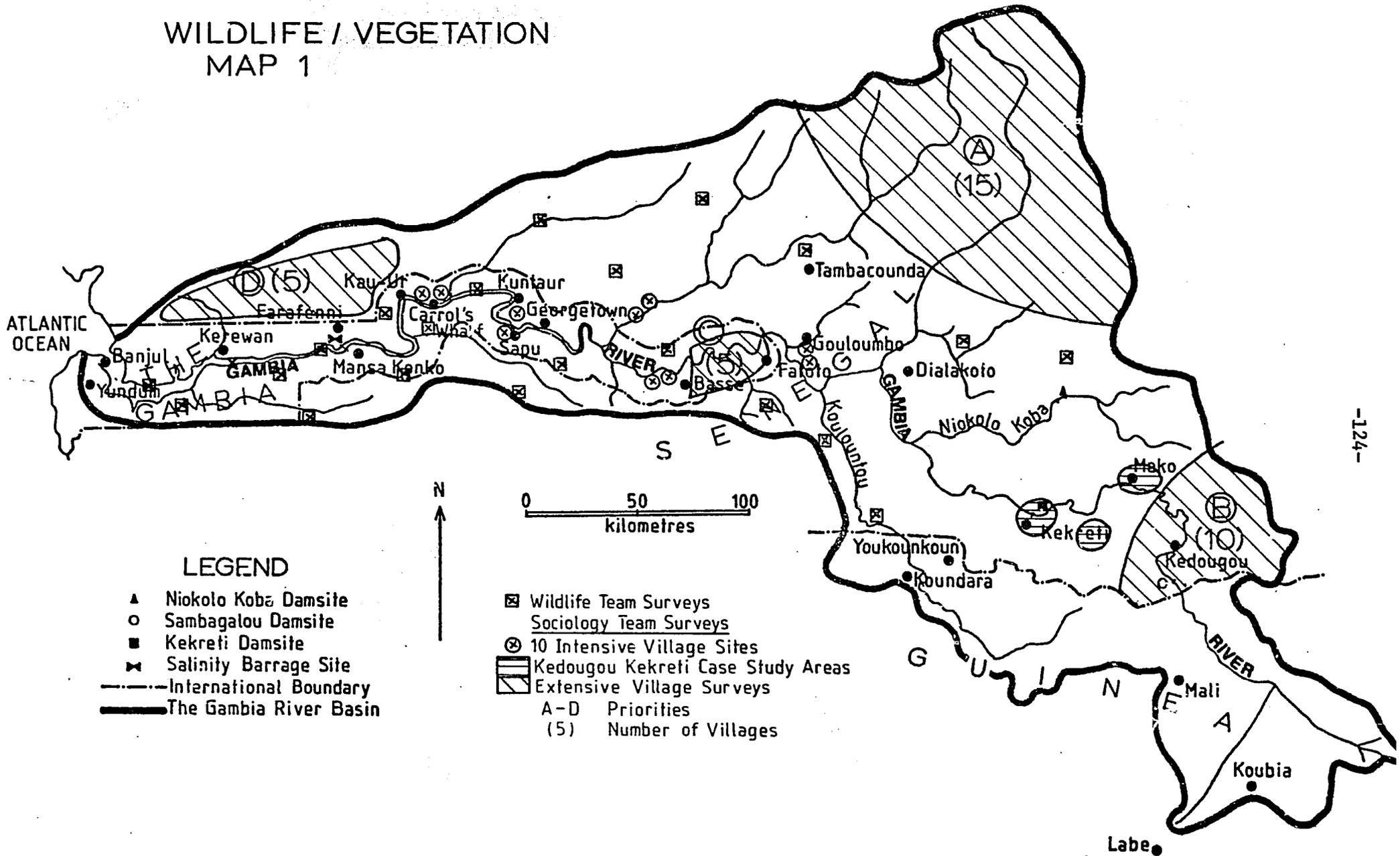
4. Counterparts

- Rural Sociologist, part-time on Wildlife team (to be selected)
- All counterparts will be asked to identify any known wildlife/forest resource utilization familiar to them.

5. Service Personnel

None required specially for this task, although drivers and field assistants can be excellent sources of information and also can serve as interpreters.

# WILDLIFE / VEGETATION MAP 1



## LEGEND

- ▲ Niokolo Koba Dam site
- Sambagalou Dam site
- Kekre Dam site
- ✕ Salinity Barrage Site
- International Boundary
- The Gambia River Basin
- ☒ Wildlife Team Surveys
- ☒ Sociology Team Surveys
- ⊗ 10 Intensive Village Sites
- ▨ Kedougou Kekre Case Study Areas
- ▨ Extensive Village Surveys
- A-D Priorities
- (5) Number of Villages

F. Scheduling Considerations

1. The "Hunting Questionnaire" and "Fuelwood Questionnaire" for the time-allocation studies of intensive village surveys already have been prepared.

2. The general "Hunting-Wildlife Information" questionnaire will be designed during April-May 1983 based on a preliminary list of questions (Appendix 6).

3. It is hoped that the Systematic Hunting-Wildlife Survey can be accomplished in Senegambia in June and July 1983, by the Wildlife Team.

4. Input into the Extensive Village Survey will be finalized during the months of May and June 1983.

5. The Plant Products questionnaire will be developed between May and August 1983, and administered during the Intensive and Extensive surveys of the Socioeconomic Team.

6. Information returns from the Socioeconomic Team:

Data from the detailed, one-time "Hunting-Wildlife" questionnaire from the 10 Intensive Village Sites will be available by the end of June 1983.

• Comparable data, as well as identification of major hunters within the Kekreti Case Study area, will be available by the end of August 1983.

• Data from the extensive village site survey should be available early in 1984 (the survey to be conducted between September and December 1983).

- Time-allocation data from Intensive Village Survey should be available early summer, 1984.

G. Deliverables

It is anticipated that a Working Document will report the data from this Task and that the data will be used subsequently to evaluate and determine the importance of wildlife and forest products to indigenous populations and vice versa. All interview questionnaires and data sheets will be labeled and filed according to locality, ethnic group, date and authority.

TASK 4: VEGETATION/LAND USE AND WILDLIFE HABITAT MAPPING

A. Purpose

Spatial dimensions such as total area, distribution and interspersion of natural plant communities and animal resources are essential for evaluating basinwide impacts. This is especially true for wildlife resources because many species obtain life requisites (food, cover, etc.) from a variety of vegetation types and the juxtaposition of the different plant communities is an important factor. Similarly, certain plant communities provide numerous secondary forest products for human use, and their distribution and areal extent must also be considered, if large areas might be inundated or otherwise lost.

Vegetation and land-use maps are a mechanism for determining present basinwide allocations of land for various purposes. These include agriculture (dry land and irrigated), pasture, fuelwood production, building materials and other forest product sources, and distribution and extent of wildlife habitat.

The only currently available vegetation map of the project area is the 1:1,000,000 ORSTOM map. Our 1:100,000 Vegetation/Land Use/Wildlife Habitat Map therefore will constitute a major original contribution to renewable natural resource management in the Gambia and Senegal Oriental.

Wildlife forms are closely associated with particular vegetation types for cover and/or food. Vegetation maps serve as a first approximation of wildlife habitat, and thus are an important aspect of wildlife surveys. Animal species do not prosper in areas where the habitat is unsuitable. Recognition of the various limiting factors (i.e., inadequate forage, seasonal unavailability of water, etc.) is a useful tool for both wildlife management and impact mitigation.

B. Specific Actions

1. Determine Status of Current Knowledge. The following list includes the major studies, maps and reports located thus far:

Senegal

- USAID/South Dakota State University Remote Sensing Center; Soil/Land Suitability Vegetation Map @ 1:500,000
- USAID Bakel Livestock Project
- FAO and EEC Soil Surveys
- Le Plan Directeur de Développement Forestier
- Projet Inventaire Forestier (Senegal Oriental) FAO, M. Catinot, M. Andeke.
- Projet P.A.R.C.E. à Kaffrine (Forestier); Director Mr. Bathily, M. Lillelund, M. Blanchez.
- SODEFITEX (Senegal Oriental); M. Martin.

The Gambia

- Land Resource Study #22, The Gambia; Directorate of Overseas Surveys. 1:125,000 Map of Soil Associations with some information on related vegetation types.
- German-Gambian Forestry Project. 535 1:10,000 scale maps indicating land-use and timber volume; inventories of 66 Forest Parks.
- USAID Mixed Farming Project. Includes livestock and range management component.
- BADEA-FAO. Development of 4 divisional nurseries.
- CILSS/Club du Sahel Case Study of Forests and Forestry in the Sahel: The Gambia. Comprehensive statement, 2 volumes, February 1981. (Includes a list of research completed, currently underway and proposed, page 33).

The Gambia: Land and Vegetation Degradation Study, by R.D Mann. Dept. of Agriculture, Yundum. Ref C/GAM/LRP/75.

2. Interactions with Other UM/GRBS Teams. A primary source of information will be the socioeconomic surveys pertaining to use of fuelwood and other forest products; hunting and wildlife distribution; and livestock numbers and distribution in selected areas.

3. Original Work to be Performed. Development of an ecologically-based Vegetation Classification System. Primary sources of starting information are the ORSTOM Vegetation Map of West Africa, and the LRS Soil Map of the Gambia.

- 1:100,000 Vegetation/Land Use/Wildlife Habitat Map covering the Senegambia portions of the Gambia River Basin.

### C. Proposed Methodology

Techniques. The Vegetation/Land Use/Wildlife Habitat Map will be produced using standard remote sensing techniques which have been routine for resource mapping for more than a decade. Landsat satellite imagery (false color composite photographic prints; 1:250,000) will provide the primary visual interpretive base. We will delineate similarly appearing areas on the image on the basis of characteristics such as color, tone, texture, shape, and pattern. Once these images have been pretyped we will make on-ground control observations in the field to ascertain exactly which vegetation types or other land use characteristics correspond to the particular image characteristics delineated. The corresponding delineations/identifications then will become the mapping units. As the image-subject relationships become better defined, image interpretation can be used to extrapolate the information to more remote areas. Questionable areas will be verified in the field whenever possible. Those areas for which on-site verification is pre-

cluded by lack of time or accessibility and in which the relationship between image and ground conditions is not clearly understood, will be appropriately indicated to show of comparative reliability.

Detailed field forms will be completed at each ground verification site. Locations will be precisely determined and pinpricked on both the image and the topographic base map. A unique site number will be assigned to the map location and the corresponding field form in order to provide a permanent readily verifiable record. Information recorded will include a detailed list of plant species, ranked according to the relative prominence in each vegetation stratum (i.e., tree canopy, shrub understory, herbaceous ground layer). Other data recorded will include topographic setting (slope, exposure, landform), general soil characteristics, evidence of disturbance (cutting, grazing, burning, etc.), and other pertinent observations. Ground level color photographs will be taken and labeled according to field form number to provide a visual record of key situations.

Habitat information from all the sites visited will be combined into composite maps to be compared with the maps generated from the remote imagery and with the data from the socioeconomic questionnaires to evaluate the distribution and importance of various habitat types. Natural areas rich in forest products such as fuelwood, honey, thatch and medicinal plants can be rated on economic, as well as ecological grounds.

Wildlife habitat information such as species observed, or determined by signs (tracks, scats, nests, etc.) will be recorded. The abundance and variety of animal sign serves as one indication of the importance of the particular mapping unit as wildlife habitat at that particular time. Observations will also be made on which plant species are being utilized as forage, and the relative amount of plant cover availa-

ble. Special habitat features, such as water sources, mineral licks, and rocks for denning, will also be noted.

Aerial photography (1:50,000 color infrared flown for the Gambia River Basin by Mark Hurd, Inc. and very large scale, i.e., 1:10,000 and 1:2000, color exposed during our aerial reconnaissance flights) will provide a secondary interpretive base for selected representative areas, or areas where the Landsat coverage or quality is inadequate. Time and budget constraints preclude the use of aerial photos for vegetation mapping of the entire basin. Certain aerial photographs of record may be used to document changes in vegetation/land-use in certain critical areas.

An ecological vegetation classification will be developed in the course of this project and will reflect both plant communities and wildlife habitat. This is an important activity because a 1:100,000 scale vegetation map will not depict all the necessary details of habitat types for all wildlife species of interest. Accordingly, a detailed ecological classification will be developed to address different associations of plant communities, complexes of several communities within a single mapping unit, and the majority of plant species important to wildlife. As time permits, we will also collect data to reconstruct some of the successional sequences apparent as a result of fires and agricultural fallow cycles. Inquiries as to the length of time since a field has been planted, data from the Forest Parks, and comparisons with "sacred groves" maintained by some villages will be used to achieve this goal.

Soil surveys and personnel were not included in AID's terms of reference, but they are important in vegetation studies and in evaluating erosion potential. To fill this gap, we will record basic soil information (texture, color, depth) at field sites. Some of the more severely eroded areas will be identified from the remote imagery and

others during the aerial surveys. The Guinea Highlands pose potentially severe erosion problems, with implications for the working lives of reservoirs in Guinea and Senegal. We will employ a watershed management specialist to examine this problem in Guinea.

Equipment. Visual interpretation of Landsat imagery is ideally suited for this project because it does not require elaborate equipment. However, stereoscopes for interpretation of aerial photography are available in country.

It is anticipated that the 1:100,000 base map will be produced by enlarging the available 1:200,000 and 1:250,000 topographic maps using a simple photographic process. A suitable copy camera and easel are available from the Survey Department, Ministry of Public Works, The Gambia. It is also anticipated that this process can be used to project map overlays interpreted from the Landsat imagery onto the final, planimetric base map.

A binocular microscope for plant identification is available through the courtesy of USAID mixed farming project, and another through the river resource team of GRBS.

The primary expendable items used for this objective will be:

- clear mylar drafting film for overlays;
- copies of maps for field use;
- photographic film; developing chemicals and papers;

D. Locations of Proposed Activities

The vegetation/land-use/wildlife habitat map will cover the entire Gambia River Basin. Ground data collection activities will be distributed throughout the project area as necessary to achieve adequate accu-

racy at the proposed map scale. The intensity of fieldwork at a given locality will be determined by the significance of the locality, the quality of the imagery, and the complexity of the resources being mapped.

E. Personnel

1. HARZA/GRBS

- B. Dean Treadwell (Wildlife Habitat, rangeland and remote sensing specialist).
- Dario Rodriguez (Tropical Forester, remote sensing specialist)
- Dr. Charles Olson (Forester, Remote Sensing Specialist)
- Dr. Samuel Snedaker (Mangrove Specialist)

2. OMVG

- Kjell Christopherson (Economist)
- Andre De Georges (Environmentalist)
- Idrissa Samba (Environmentalist)

3. Other Expatriate Remote Sensing Experts

- Frederick Hilwig (AID/RSI, Dakar) Soil Scientist
- Gray Tappan (AID/RSI, Dakar) Plant Geographer

4. National Counterparts

Senegal

- M. Bodian (Eaux et Foret, Botanist)
- M. Abdou Karim Cissé (Specialiste en télédétection)
- M. Bocar Sall (Eaux et Forets, Kaolack)
- M. Moumar Gueye (Eaux et Forets, Tambacounda)

- M. Diata, (Dakar)  
The Gambia
- Bye Mass Tall (Director, Forestry Dept., Banjul)
- Amadou Sey (Forestry Dept., Banjul)
- M.L.K. Janneh (Graphic Reproduction, Survey Dept., Banjul)
- Ebrahima Cham (Senior Cartographer, Survey Dept.)
- Local Forestry Agents will be assigned for temporary duty throughout the Gambia by Bye Mass Tall.

F. Scheduling Considerations

Location, Acquisition and Review of Pertinent Reports. Most of the key reports for Senegambia have been located (e.g., Plan Directeur Forestier for Senegal; CILSS Gambia Case Study - Forestry; British Overseas Directorate Land Resources Survey #22 (Soil Associations; German-Gambian Forestry Project). Unfortunately, these reports are in short supply and will have to be expensively photocopied for use throughout the vegetation mapping program of GRBS.

Acquisition of Landsat Imagery. This has been accomplished and one set of images is already in Banjul.

Reconnaissance Overflight. This is currently scheduled for early June (see Task 1), subject to the availability of appropriate aircraft (and other considerations).

Image Interpretation and Ground Data Collection. The majority of this activity will be conducted between 1 June - 1 September, by Rodriguez.

Subsequent Refinements. This activity will continue, with special short field trips, for the duration of the project period and will be accomplished predominantly by Treadwell.

Mangrove Studies. Dr. Samuel Snedaker will undertake these studies, although exact dates have not been established.

G. Deliverables

1. 1:100,000 Vegetation/Land Use/Wildlife Habitat Map, complete with descriptive legends for each mapping unit.
2. Vegetation Classification System
3. Field Record Form files, and Photographic Records
4. Appropriate sections in the Final Report.

TASK 5: FIELD STUDIES OF MAMMALS, BIRDS AND OTHER TERRESTRIAL VERTEBRATES.

A. Purpose

This task constitutes the major activity of the Wildlife/Vegetation Team. Previous tasks have reviewed the available literature relative to terrestrial and avian vertebrates, conducted reconnaissance missions for general familiarization and provided a map of habitat types to serve as a biophysical framework for correlating plant and animal observations. This activity will verify the presence of the various species listed in the literature, ascertain their distribution and relative abundance along with pertinent habits, life requirements, and environmental limiting factors, and evaluate the condition of habitat in terms of species requirements.

B. Specific Actions

All activities except data analysis will be field-oriented. Specific actions will depend upon which technique or combination of techniques is being used (see Proposed Methodology, for details).

More time will be devoted to the study of habitat and the wild fauna. Information pertaining to domestic livestock interactions with wildlife will be obtained from three sources: (a) questionnaires and interviews administered by the Socioeconomic Team; (b) general field observations on distribution and condition of rangelands; and (c) discussions with ongoing livestock programs, notably the USAID Bakel Livestock Project in Senegal, and the Mixed Farming Project in the Gambia.

C. Proposed Methodology

1. Species Priorities. Determine primary, secondary and tertiary interest species. This determination will be based on literature review (including "rare and endangered" lists), and consultation with recognized authorities (e.g., Dupuy, Brewer).

2. Area Priorities. Develop a list of priority study areas on the basis of literature, known critical habitat, known faunal distribution, project impact areas identified by USAID, OMVG and other agencies and consultation with in-country authorities.

3. Activity Phases. The field studies will comprise three levels of intensity, differing in objectives but overlapping in time.

Reconnaissance. Initial familiarization with Project area from both on-ground and aerial missions. Primary goals are to ascertain complexity of land resource types; locate certain areas which merit more intensive study; evaluate possible study techniques (see below) relative to actual terrain, vegetation density and general accessibility; and evaluate overall logistical problems, such as road condition and travel times, specific vehicle, camping and study equipment, gas supplies and other support services.

General Field Survey. This activity will also be basinwide and the primary goal will be to develop an understanding of the animal - environmental relationships so as to recognize specific needs for more detailed information. This survey will consist of repeated field trips of several weeks duration, accomplished during the second half of 1983 and early 1984, and generally in conjunction with vegetation mapping and hunter interview activities.

Intensive Studies. The specific nature and location of these activities will be determined by the results of the field surveys. It is certain that these activities will concentrate on endangered, threatened, unique or otherwise important animal species (e.g., hippopotamus, crocodile, manatee, eland, chimpanzee, sitatunga, pangolin, cape otter), and areas of primary impact of the proposed developments. Other areas of critical habitat or particular animal species will be included as need and time permits. Certain intensive studies might be conducted under the general category of Impact Mitigation or Resource Enhancement Actions (see Task 7). One example of such a study would be a systematic evaluation of various proposed strategies of deter or prevent hippopotamus depredations on agricultural fields.

4. List of Standard Wildlife Study Techniques. There are various standards techniques for the study of wild animals. It is likely, with the exceptions noted, that each of those listed below might be used under certain conditions. We recognize the restrictions on certain activities within The Gambia and Nickolo Koba National Park. All techniques will be cleared with the appropriate Wildlife Conservation Director prior to use. Many of the techniques use simple direct observation or photography. Others use capture and release (with or without marking) largely for the purpose of confirming species identity or determining biological condition. In every case we will employ the most benign method that will yield the required information.

Visual Surveys and General Observation Techniques. These activities will constitute the main body of wildlife data gathering. Visual and listening techniques will be used to verify species presence, to classify animals according to age, sex and physical condition, and to collect pertinent information on behavioral characteristics habitat preferences, and relative abundance. Techniques used will include day and night observations (with spotlights and infrared), stationary observations (from tree platforms or blinds) and walking transects. Local

hunters and game scouts will be employed as guides, as needed. Where roads are impassable to vehicles, horses may be used. In this event there will be substantial logistic and veterinary problems (e.g., trypanosomiasis) but these are not insurmountable.

Specialized Observation Techniques. These will include observations or animal counts from aircraft (e.g., hippo surveys along the river, or open savanna area surveys), squeaking and other prey calls (vocal and taped) to attract predators, and remote automatic cameras.

Indirect Techniques. These include the recognition and identification of various animal signs such as tracks, scats, nests and dens. Niokolo Koba would be an excellent area to begin studies of this type because the animals are easily observed. The signs of most of the more prominent species are well-known to game scouts and hunters.

Capture-Release Techniques. These methods are suitable for virtually all classes of land animals (large and small mammals, birds, reptiles), and have the advantage that the animals (particularly those uncommon or nocturnal) can be verified, various data collected, and the animal released. In order to make maximum use of any animals captured, we will mark them before release, so that data on home range, longevity, and condition might be obtained when the animal is encountered again. Marking techniques include ear tags, colored collars, tattoos, freeze brands, and metal rings, depending on the type of animal. For capture, methods will include nets, live traps, snares, pitfalls, one-way corral traps, and tranquilizing equipment. Blood and ectoparasite samples will be routinely collected, labeled, and preserved for animals handled. Zoonoses (transmittable to either humans or domestic stock) are not well understood, so data collected could be of particular value to the Public Health Team.

Collection of Specimens. When necessary and permissible to take specimens of small mammals, reptiles or amphibians, birds, this will be accomplished using either Museum Special or similar snap traps, firearms or pellet guns. Specimens will be recorded and preserved according to internationally established techniques. The preparation of specimens will be coordinated with the Public Health Team to ensure that samples of blood and/or organs are preserved in cases requiring parasitological study (e.g., trypanosomiasis).

We will comply strictly with regulations governing the taking of scientific specimens and the performance of studies within national parks. Permit applications require the collector to indicate the areas under study, methods of collecting, animal groups to be taken, and disposition of specimens. We will initiate discussions with responsible individuals at the regulatory agencies in order to expedite the issuance of permits, a process normally taking several months.

Census Techniques. Censusing will not be a primary activity during this project, except under certain circumstances. Census techniques are time-consuming and expensive and often of questionable accuracy. Furthermore, one-time censuses are not always reflective of actual conditions, due to animal movements. Applicable techniques include aerial counts, strip census (well suited for Niokolo Koba), bait stations on established transects, roadside counts of tracks, and riverbank surveys from a small boat.

Food Habits. Observations on the use of plant species by animals will aid in determining habitat requirements. During transect studies the percent of plants browsed and grazed will be noted. Fecal analysis, useful for determining prey species of carnivores, may yield some field data on ungulates.

5. Record Keeping. Accurate permanent records are the essence of scientific technique and are vital to the eventual preparation of a report.

Field Journals/and Logs. Each team specialist will keep a daily field record in permanent form, handwritten but clearly legible, that will include at least the following information, except where this information is recorded on the standard data forms:

- Localities visited; means of travel; itinerary
- Personnel present (associates, counterparts, visitors, assistants, drivers, guides)
- Weather conditions; time of day
- Types of field data taken (most data will be taken on specialized forms or in catalogues and need not be repeated (see below))
- Unusual observations, items of interest to other teams, special problems encountered

We recognize that legible final notes are not always possible after a long day of field work. We anticipate that most team members will take rough notes progressively during the field day and do final notes as time permits during or after the field trip. Some voice tape recording will be used.

Each team member's field log will be photocopied after each field trip, the photocopies to be stored centrally and controlled carefully.

Specimen Catalogues. Every specimen collected will be field labeled in the manner conventional in the appropriate branch of zoology or botany. The collector will give each specimen a field number and will record the data in a personal specimen catalogue maintained by him. This is the standard field procedure followed worldwide. Individual

catalogues will be photocopied after each field trip and the copies filed centrally.

Data Forms. Certain tasks that are standardized and require comparable data for analysis lend themselves to standardized data forms. These ensure that the data are complete and are properly recorded. An example would be an "Endangered Species Report Form."

Species Accounts/Files. All data collected will be cross-referenced to files for each species.

Photographs. Photographs in color or black-and-white, as appropriate, will serve the following purposes: recording habitat type or condition from the air or on the ground; recording specific study locations, trap sets, net sets, etc.; supplementing notes and drawings to aid in describing perishable specimens, whether collected or not (tracks, scats, nests, fruits, etc.); recording animals for subsequent identification or verification when collecting specimen is undesirable or impossible; night records by flash or infrared photos to determine the presence of animals not detectable by day.

Labeling and Storage. Each roll of film purchased for the team will be given a unique number and logged out to the user. The roll number will be retained through developing and will constitute part of the designation of each photo.

In the field, the photographer will record in his field notes the roll number as the camera is loaded and unloaded and (at intervals) the frame numbers as photographs are taken. After the film has been developed the photographer will label each slide with roll and frame number, subject, locality, date and his name.

Slides will be stored in numerical order in transparent plastic sheets. Photocopies of these sheets will be kept in a central file open to all project participants. All photos made with project film and with project equipment will be property of the project, with sole rights reserved but the acknowledgement guaranteed.

6. Interactions with Other Team. A "Wildlife Observation Data Form" will be designed and printed on a 6x8 in notecard and copies will be provided to members of all teams. It is expected that all project personnel will have the opportunity to make wildlife observations periodically in the course of their field activities (e.g., River Resource Team personnel sightings of hippos and crocodiles). Such records are valuable if organized and recorded in a systematic and complete manner. The data card will include spaces for all necessary observations, including date, observer, location, time of day, setting, animal observed or detailed description, activity, etc.

Socioeconomic Team. Information inputs to the wildlife study will consist of the formal questionnaires/interview results, identification of suitable guides and completed Wildlife Observation forms.

River Resource Team. Observations of riverine wildlife species should be routinely recorded on the Observation form. The Wildlife Team will share small boats of the River Resource Team for wildlife river bank surveys and other transport needs as feasible.

Public Health. Communication lines are established to incorporate samples and/or studies of wildlife animals suspected or determined to be reservoirs or intermediate hosts of important diseases.

7. Equipment. For convenience in compiling as complete a preliminary list of equipment as possible, we have indicated both permanent and expendable items together, for each technique considered:

### Visual Surveys

- Binoculars, 8 x 30 or 40, 3 pairs
- Spotting scopes (telescopes), fixed power 60 x and 20 - 60 zoom, 2 each (one already on hand)
- Tripod and other telescope mounting devices.
- Auto spotlights, 100,000 cp to plug into cigarette lighter, 1 per vehicle (2).
- spotlights, 1.2 v., rechargeable, portable, 2, with extra parts.
- tree stands and climbing harness, 1 set
- portable blind and/or camouflage material, net type.

### Specialized Techniques

- various animal and bird call tapes
- remote automatic cameras. Two different types are currently being considered: (1) motorized film back for 35 mm camera with movement detecting photocell and/or thermal infrared heat sensor triggering devices; night photography will also require separate spotlight capability. (2) similar to above, except using a super-8 movie camera set to expose brief, 5 second bursts.

Indirect Techniques. No special equipment required except cameras and film for records, and small plastic (whirlpack) bags for scat specimens.

Capture-Release Techniques. Not all of this equipment will be purchased immediately. For certain items, sources only will be located, and arrangements made for immediate shipment upon telex request.

- mist nets (birds and bats)
- drop and rocket nets (larger mammals)
- live box traps (various sizes for small and medium mammals)
- tranquilizing equipment (rifle, blowtube, darts, syringes, appropriate tranquilizing drugs).
- marking equipment (ear tags, collars, tattoo, freeze-brand)
- dip nets, snake hooks

#### Scientific Collecting

- shotgun (16 or 12 gauge, with adapters for .410 and 22 cal.)
- pellet gun, Crossman, with 4x telescopic sight
- snap traps, museum specials
- weighing scales, measuring rules, dial calipers
- dissecting kit (scalpels, scissors, forceps, etc.)
- other preparation equipment (wetable tags, cotton string, dacron or cotton, specimen drying box, paradichlorobenzene, etc.), corn meal, plastic surgical gloves (disposable)
- reagents (buffered or neutral pH formalin; 30,50 and 70 per cent alcohol)
- whirlpack plastic specimen bags, glass and plastic vials, microscope slides and covers, etc., cloth bags

#### Other Specialized Equipment

- radio-telemetry equipment (if necessary)
- canoe, aluminum with outboard motor
- horse equipment (saddle, bridles) Note - still  
under consideration and subject to approval by Director of  
National Parks.

Slide projector. Kodak Carousel & screen (for office use, conferences, discussions). This item will be acquired for the W/V team only if one is not acquired for the whole project.

- Film, color, Kodachrome or Ektachrome; about 200 rolls of 36 exposure, various ASA (to be developed at Kodak Labs, U.S.A.).
- Film, black-and-white, Plus-X, Tri-X or infrared; about 30 rolls, 36 exposure. (develop b/w film locally if possible).
- Slide storage sheets, 9 x 11 1/2" plastic, 20 slide capacity; about 400 sheets. Note: all film can be obtained through the Univ. of Mich.
- Color prints and print envelopes.

#### Field Equipment

- Vehicles - 2 long-bed, 4 wheel-drive trucks. These vehicles should have extra gas tanks with manual switches, locking tool boxes; camper shells and/or covered luggage racks, 2 extra spare tires, handyman jacks, power-take-off winch and two chains, overload springs, cigarette lighters for accessories, dual battery system, jumper cables, cab storage pouches, foam-type air cleaners. These vehicles will be needed by the Wildlife/Vegetation Team almost continuously during the first year. We anticipate that much of the time between field trips will be used for maintenance and modification of the trucks.

Camping equipment, to include those items acquired for the reconnaissance mission, plus: 9x12 canvas wall tent with screen, fly and floor; 10x10 screened porch with floor; shower bags; jungle hammocks; work tables and chairs; 12 v. lights; gas lights; additional cooking equipment; storage chests.

D. Locations of Proposed Activities

1. Reconnaissance Mission. Included representative areas within the entire basin, including Guinea, Niokolo Koba, and the Gambia in general.

2. General Field Surveys. This work will also be throughout the basin, attempting to include as many different habitat types as possible.

3. Intensive Studies. These will be centered where particular problems or species of interest are found to exist, e.g., if manatees are reported to inhabit one particular bolon, an intensive study would focus on that area.

4. Museum Studies. The following institutions are known to have significant collections from the basin:

- IFAN, Dakar
- Musée Nationale des Sciences Naturelles, Paris
- British Museum (Natural History), London
- U.S. National History Museum, Washington, D.C.

E. Personnel

1. University of Michigan/Harza

Peter L. Ames (Team Leader, Ornithologist, Herpetologist)

B. Dean Treadwell (Mammalian Wildlife Ecology).

Short-Term Consultants (as needed basis)

Jeffrey Lang (crocodiles)

Dietrich Schaaf (elephants)  
George Petrides (large mammals)  
Janis Carter (chimpanzees)

2. OMVG

Andre De Georges  
Idrissa Samba

3. National Counterparts

M. Sylla, Conservateur, Niokolo Koba, Senegal  
Dr. Camara, Gambia Wildlife Conservation Dept., Abuko

4. Service Personnel

Camp assistant, cook  
Maurice Cabot, research assistant, specimen preparator, sociology enumerator.  
Game scouts, guides, hunters

F. Scheduling Considerations

1. Reconnaissance Mission. completed 5-22 February 1983.

2. General Field Surveys. Scheduled to begin about 1 June 1983 and continue for approximately six months on a schedule of about two weeks afield, and two weeks in Banjul for office work, rest and refurbishment. It is anticipated that some wildlife team members will be in Banjul while others are afield, and at some times, all team members might be afield although in different areas. This work will be coordinated with other initial wildlife/vegetation team activities, notably vegetation mapping, and the systematic hunter/wildlife questionnaire/in-

interviews conducted by the Wildlife Team. It is possible that the rainy season will delay some trips in August.

3. Intensive Studies. Scheduling will depend on the nature of the problem being studied, relationship to wet and dry seasons and other requirements of field surveys. It is expected that some studies will commence during the general surveys, and continue intermittently through late 1984.

4. Potential Problems and Contingency Solutions. Specialists from the United States and elsewhere may not be available when needed, but there should be adequate flexibility in the overall schedule to accommodate this possibility.

#### G. Deliverables

Field studies and other special investigations of baseline ecological conditions will result in a general report by the end of the study. Preliminary findings will be provided to USAID and OMVG in the Monthly Progress Report.

At the end of each field trip, the trip leader will file with the Field Director a brief report summarizing: Trip Objectives; Itinerary and Localities; Personnel; Major Findings; Problems and Solutions. This report will be placed in the general files.

The total result of the field survey will be a description of ecological conditions in the Gambia River Basin. This will form a major part of the Wildlife/Vegetation Report and will be incorporated into the full report at the conclusion of the study.

Other deliverables to be generated will include: distribution maps; photo records; museum specimens (only if acceptable storage is available).

TASK 6: IDENTIFY AND EVALUATE POTENTIAL IMPACTS OF THE PROPOSED DEVELOPMENTS PROJECTS

A. Purpose

To identify and analyse the potential environmental (wildlife/vegetation) effects, both beneficial and adverse, of the six major development activities (i.e., the dams) and their associated scenarios. This activity can be considered as one of the most important aspects of the entire project program, second only to that of Task 7 (identifying Mitigation and/or Resource Enhancement Actions). Although the field surveys and maps are major program activities, they are basically only the tools and database used to address the real goals of this project, which are to identify the impacts, and propose viable mitigations for those which are adverse.

B. Specific Actions

1. Develop Impact Assessment Process. In consultation with other teams (especially Socioeconomic), the OMVG staff economist (Christopherson), and other projects (i.e., dam site surveys), develop a conceptual framework for systematically analyzing the impacts and associated values according to the various possible development scenarios at each dam site and its environs (i.e., dam site proper, reservoir area, access routes, other support areas, etc.)

2. Incorporate the Lessons Learned from Similar Projects.

a) Past Studies. This Task will rest on a broad foundation of literature dealing with the observed effects of large dams and irrigation projects. The literature on antisalinity barrages is less volumes, although there is a pertinent study in India.

Much of the open literature is devoted to the effects of the large African dams of the 1950's and 1960's: Akosombo (Volta), Kossou, Kainji, Kariba, and Aswan. Latin American projects also are relevant and there is considerable literature on Afobako (Brokopondo) in Surinam, Guri (Venezuela) and Brazilian dams.

b) Ongoing Studies. We know of an ongoing work at several African dam/reservoir projects and will be in contact with others.

We are aware of ongoing studies on mangrove affected by the anti-salinity barrage on Marigot de Guidel, near Djibelor, in the Casamance (Souleye Badiane, pers. com.)

3. Identify Potential Project Effects.

C. Proposed Methodology

1. Techniques. The prediction of environmental impacts is a process of identifying potential cause-effect relationships between and within two hypothetical systems: the future environment of a proposed project and the project itself. One must know a great deal about each system in order to predict future interactions. The basic process is as follows:

We plan to adopt the model proposed by Christopherson (OMVG) to derive economic values of wildlife and vegetation impacts, expressed as "opportunity costs". We will work with the economists to develop other ways of expressing ecological costs in economic terms, such as food, tourism or cultural values.

a. Analyze and describe baseline (present) conditions in all areas that might be affected by the project.

World experience has shown that the areas usually affected by a large dam or barrage, or an irrigation development project area are the following.

- 1) The area of inundation.
- 2) The construction area, i.e., dam site or agricultural development area, including borrow and spoil areas.
- 3) The corridors of access roads and adjacent lands.
- 4) Areas of support facilities, such as the workers' town, shops, offices.
- 5) The river downstream of the project, including the floodplain.
- 6) Transmission corridors (hydroelectric dams) and canal corridors (irrigation systems).

b. Project baseline conditions to the period of project construction and operation. Many impacts (e.g., access roads) are left during the period of project exploration and design, but the most severe usually occur on project construction and during the period of operation. Some trends in natural resource use and condition to be looked at are:

- 1) Human population change, through growth or migration.

- 2) Agricultural and livestock development.
- 3) Vegetation changes, natural succession, deforestation reforestation.
- 4) Soil erosion and watershed management.
- 5) Animal population changes through poaching or conservation.

c. Analyze project features of construction and operation to quantify the extent of impacts. Some features will be at the prefeasibility stage, at which several alternatives are being considered. Environment impact studies always should commence at the prefeasibility level of planning, in order for mitigating actions to be introduced before large commitments of funds have made further design changes difficult. Major aspects of the project to be looked at are:

- 1) Reservoir characteristics, especially surface elevation.
- 2) Project operation, especially the timing and extent of drawdown and the amount and timing of downstream releases.
- 3) The design and position of intakes which strongly influence the quality of water released downstream.
- 4) Construction work force: number and source.
- 5) Operating work force (including security force): number and source.

- 6) Sources of materials and means of transportation to project site; for dam and satellite structures.

d. Identify and quantify (insofar as quantification is possible) the primary (or direct) impacts, i.e., interactions between each project features and each aspect of the environment. This may be done through the use of a matrix, which will serve to ensure that no likely interaction will be overlooked. Because the units used to quantify various project offers are different and not convertible to a common unit (e.g., economic value), the matrix, if used, will be nonquantitative and will serve only as a checklist.

e. Identify, through extrapolation from other projects, potential secondary, tertiary, etc. effects of each project. Include also the potential interaction among projects. For example, dams in Guinea, if built, will substantially affect the operating characteristics of downstream projects, such as Kekreti Dam.

1. Equipment and Supplies. No special equipment or supplies are required for this Task.

#### D. Location of Proposed Activities

Most of this task will be accomplished in the Banjul office. However, meetings will be held in Dakar. Use will be made of library facilities in the U.S.

#### E. Personnel

Impact analysis is an interactive process requiring inputs from all specialists available. These will include members of all teams of the University of Michigan staff and members of the OMVG staff (largely in a

review capacity, via discussions). Counterparts and other in-country specialists are expected to contribute as available.

F. Scheduling Considerations. The identification of impact has already begun and will continue throughout the period of this study. Formal analytical work on this task, such as the construction of a matrix, is expected to begin early in 1984.

G. Deliverables

This Task will result in a major section of the Wildlife/Vegetation Report, which in turn will be part of the complete Project Report.

TASK 7: PROPOSE MITIGATION AND/OR RESOURCE ENHANCEMENT ACTIONS AND ANY FEASIBLE ALTERNATIVES

A. Purpose

To identify and describe project modifications that could be made by project planners and actions that could be taken by interested agencies to avoid or minimize adverse impacts and to enhance the projects overall benefits.

One of the most significant conclusions drawn from a 1979 Symposium on Mitigating Losses of Fish and Wildlife Habitat was that mitigation is primarily a reactive process, and is incapable of maintaining the status quo. At best, there will be no net gain in wildlife management options, and in general, the trend is definitely towards net losses. Further, mitigation efforts often fail because fish and wildlife considerations are not incorporated at an early enough stage in the development planning process. It is noteworthy that potential international donors for the Gambia River development projects have recognized the potential for long-term and irretrievable impacts, and strongly suggested the importance of an environmental impact assessment which ultimately resulted in this contracted project. It indicates that the donors are quite cognizant of the probable impacts, and perhaps with realistic and economically feasible mitigation options, many of the more serious wildlife/development conflicts might be resolved during the design process.

B. Specific Actions

1. Other Projects. Incorporate experience from similar studies.

a. Past Studies. As for Task 6, the literature on development projects contains many instances of mitigating actions. Unfortunately, it is rare for project planners to discuss in detail the degree

of success achieved. There are, however, example of both successful and unsuccessful mitigating actions.

b. Ongoing Studies. We know of a few major dam projects where laboratories have been established to gather data on reservoir conditions.

2. Propose Detailed Recommendations.

3. If and where possible, plan and conduct pilot studies to determine the viability and potential results of the recommendations. For example:

a) Hippopotamus Deterrents. Conduct experiments to determine the effectiveness of various proposed techniques to keep hippos from agricultural fields (scarecrows devices; trenches; white picket fences; guards, etc.)

b) Fire Breaks. In cooperation with the Forestry Department, study the effectiveness of fire breaks to mitigate plant cover and soil loss resultant from wildfires (this is a significant problem in terms of rapid siltation of the dam reservoirs).

C. Proposed Methodology

1. Techniques. The process of developing mitigating/enhancing measures follows naturally the identification of impacts. Some project impacts cannot be mitigated within the framework of project development and require compensatory actions elsewhere. Not infrequently, mitigation actions have been undertaken with worthy motives but without adequate analysis of their effectiveness. Two examples will suffice:

a. Animal Rescue Operations are undertaken to "save" animals (usually large mammals) that would otherwise drown as a result of rising reservoir waters. Despite sound humanitarian motives, such operations usually lack the ecological planning that would enable the survival of the rescued animals. One frequent result is disruption of receiving ecosystems and eventual loss of those animals. Such operations, if undertaken, require thorough and complex advanced planning and lengthy follow-up studies and management programs.

b. Reservoir Clearing Operations are performed to protect reservoir water quality, permit the use of nets for fishing, and salvage valuable lumber. Rarely are the adequate ecological or economic studies performed. Recent studies by Harza in Tanzania showed that in many areas (depending on the type of vegetation inundated) reservoir water quality is better when vegetation is left in place, and that fishing takes place only among the dead trees standing in the reservoir.

It is for this reason that we place great emphasis on the available literature and discourse with ongoing projects, and will attempt to demonstrate the viability of certain mitigations with pilot projects, when possible.

In proposing mitigation/enhancement measures, we will perform network analyses on series of alternatives, including the "no action" and "no project" extremes.

2. Equipment. No special equipment is required for this task, except as necessary for any pilot experiments.

#### D. Location of Proposed Activities

1. The primary effort of this Task will be performed in Banjul, with meetings in Dakar for inputs from appropriate specialists.

2. Selected field sites for pilot experiments.

E. Personnel

This task will require the inputs from members of all study teams, OMVG, counterparts, and occasional specialists who may be consulted on special problems.

F. Scheduling Considerations

This task will be performed concurrently with Task -6, beginning about 1 January 1984.

G. Deliverables

The discussion of mitigation/enhancing measures will be a major section of the Wildlife/Vegetation Report and the overall Study Report.

TASK 8:            INSTITUTIONALIZATION

A.    Purpose

The OMVG is a permanent group whose purpose is to continue the management of the Gambia River Basin, including aspects begun or recommended by the University of Michigan Team during this project. Accordingly, institutionalizing the experience of this project is an important objective. Through this process, an improved library, certain facilities, as well as a cadre of professionals with augmented experience and newly trained technicians will remain in the member countries to carry out the role of OMVG.

B.    Specific Actions

1.    Compilation of a Reference Library
2.    Personnel training/instruction in the office and particularly in the field on all aspects of the work methodology.
3.    Occasional informal short courses, workshops on specific methodologies (e.g., image interpretation, use of tranquilizing equipment).

C.    Proposed Methodology

It is expected that the professional expatriate staff (Ames, Treadwell, Rodriguez and other short-term specialists) will be interacting with OMVG and national counterparts on a virtually daily basis. Furthermore, most of the specific techniques will be used routinely and repeatedly in the field, thus providing multiple opportunities for individual instruction and experience. In this regard, a considerable amount of training and technology transfer will be an automatic byproduct of this project.

In those instances where the technology is too specialized, such as fundamentals of image interpretation or may be employed too seldom (e.g., operation of airborne camera systems; use of tranquilizing equipment) we are prepared to conduct informal training sessions as the need develops.

D. Locations of Proposed Activities

It is anticipated that the majority of technology transfer training will be accomplished on-location, i.e., in the field at a personal level. Any aspects of this activity more suited for laboratory or office presentation, such as workshops, will be handled accordingly.

Compilation of the reference library will stem from work accomplished at the appropriate institutions in the United States and Europe by the professional expatriate staff, and in Dakar and Banjul as necessary (see Task 1).

E. Personnel

The expatriate professional staff (both long-term and short-term specialists) will all make suitable contributions to this activity.

F. Scheduling Considerations

The reference library will be compiled according to the plan and schedule set forth under Task 1 of this Work Plan. Instruction in the field will be accomplished throughout the duration of this project during all field activities.

Workshops will be scheduled on an as-needed and mutually convenient schedule.

G. Deliverables

1. The Reference Library will be compiled as per Task 1.
2. Most field training will not provide tangible deliverables.
3. When possible or available, and particularly for workshops, xerox copies of pertinent summary material such as lecture outlines, written instructions on the use of Mist Nets, will be provided as hand-outs.
4. Team generated Working Documents will be a part of this library.

APPENDIX A

PRELIMINARY LIST OF QUESTIONS FOR POSSIBLE INCLUSION IN QUESTIONNAIRE/  
INTERVIEWS ON WILDLIFE-HUNTING AND UTILIZATION OF SECONDARY FOREST PRODUCTS.

Wildlife/Game

What fraction (percent, weight) of the family diet is composed of wild animal meat, including all types of animals (mammals, birds, reptiles, fish), divided by category. Alternatively, how often is wild animal meat eaten, what kind(s) and how much per meal? What is the size of the family?

What other animal products are used? (hides, horns, bones, etc.)

What are these used for?

How are animal products obtained (i.e., hunted, purchased, traded)? If purchased or traded, determine prices or values.

How much time is devoted to hunting? How many people hunt in this village? What is the size of the village (persons?; families?) Has the importance of hunting and time spent on this activity increased or decreased in recent years?

What animals are taken? (Using pictures and local names, try to be as specific as possible, i.e., species; however, if necessary groups can be generalized to water birds, small songbirds, rodents, antelope, etc.)

Does importance of hunting change seasonally? Do composition and abundance local fauna change seasonally?

How are animals taken (guns - what type, caliber, etc.; traps, snares, nets, etc.)? Photos should be taken if possible; get descriptions of baits or lures.

What parts of the animal are consumed by the family, which are sold or traded? (If sold or traded, where or to whom?)

Where are animals captured (as specific as possible)?

How often are animals taken (by species or group)? Or how many have been taken during a specified period of time?

How are animals parts prepared for use?

What is the informant's opinion of population trends of the animals that are used?

How long has the informant been a hunter? Has he hunted in other areas?

Will hunter/informant assist us in the field with tracking and observations? Will hunter help us collect live specimens? (We will pay for these services.) Will he keep skulls for our inspection/identification?

Are there specific taboos associated with certain animals? (Describe)

Which animals are considered by the informant to be pests (on crops, as personal hazards, as predators on livestock)?

How much damage is done? What times of the year does this occur?

What measures are currently being taken by the village, individual, or government to mitigate the hazard or loss?

What would the best solution be to these problems?

Can the informant think of anything else related to wild animals that he considers might be useful for us to know?

Secondary Forest Products

What form of fuel is used for cooking?

How and where is it obtained? If purchased or traded, price? How far must the user travel to source of supply? How much daily time is required to meet their family needs? How large is the family?

Does the informant or his family gather fuelwood or make charcoal to sell? How much and what income is derived from this activity? Is this activity year long or seasonal?

How has the availability of fuelwood changed, if at all, in recent years? Does the informant have any concerns about its future availability?

What are the preferred fuelwood species? Are they still as available as in former years?

What other products are obtained from the forest (by self or purchased from others)? (thatch; timber for house supports; twigs for mud wattle and/or fences; bark for rope; reeds and grasses for mat weaving; food stuffs, including honey; drinks such as palm sap for beer/wine; medicinal plants; etc.)

For each of the above, which species are used, when are they collected, what quantities are collected, how are they prepared, is any income derived from sale or barter?

Are there any taboos, mystical, religious or other cultural significances to certain plants including trees?

Which wild plant species are now cultivated, transplanted, etc.

Are there any areas that represent what the "former" forest might have looked like? Does the village have a sacred grove, where; composition; area; and may we see it?

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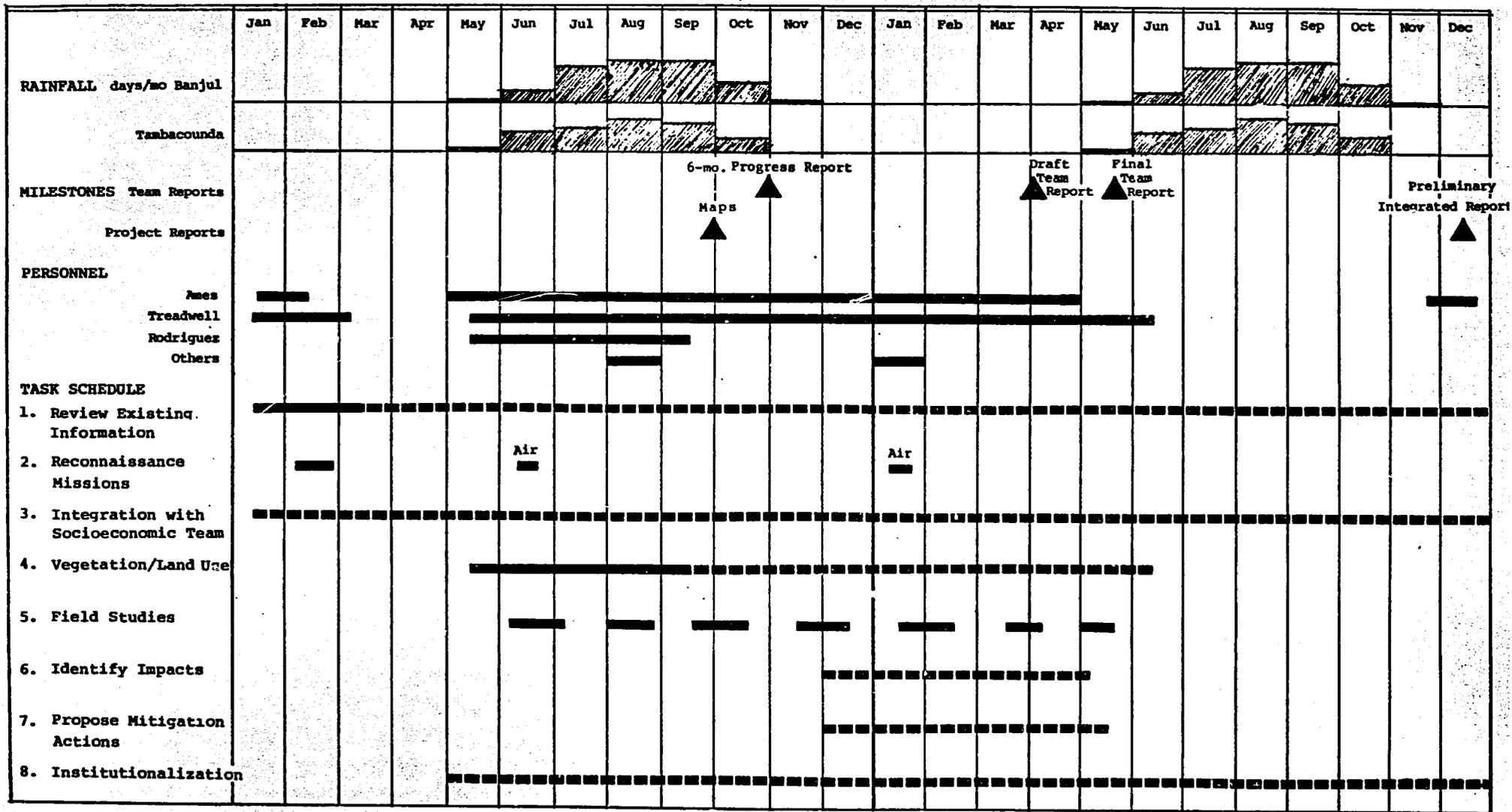
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GAMBIA RIVER BASIN STUDY WILDLIFE/VEGETATION TEAM

SCHEDULE OF ACTIVITIES



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