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Sahel Water Data Network and Management III Program
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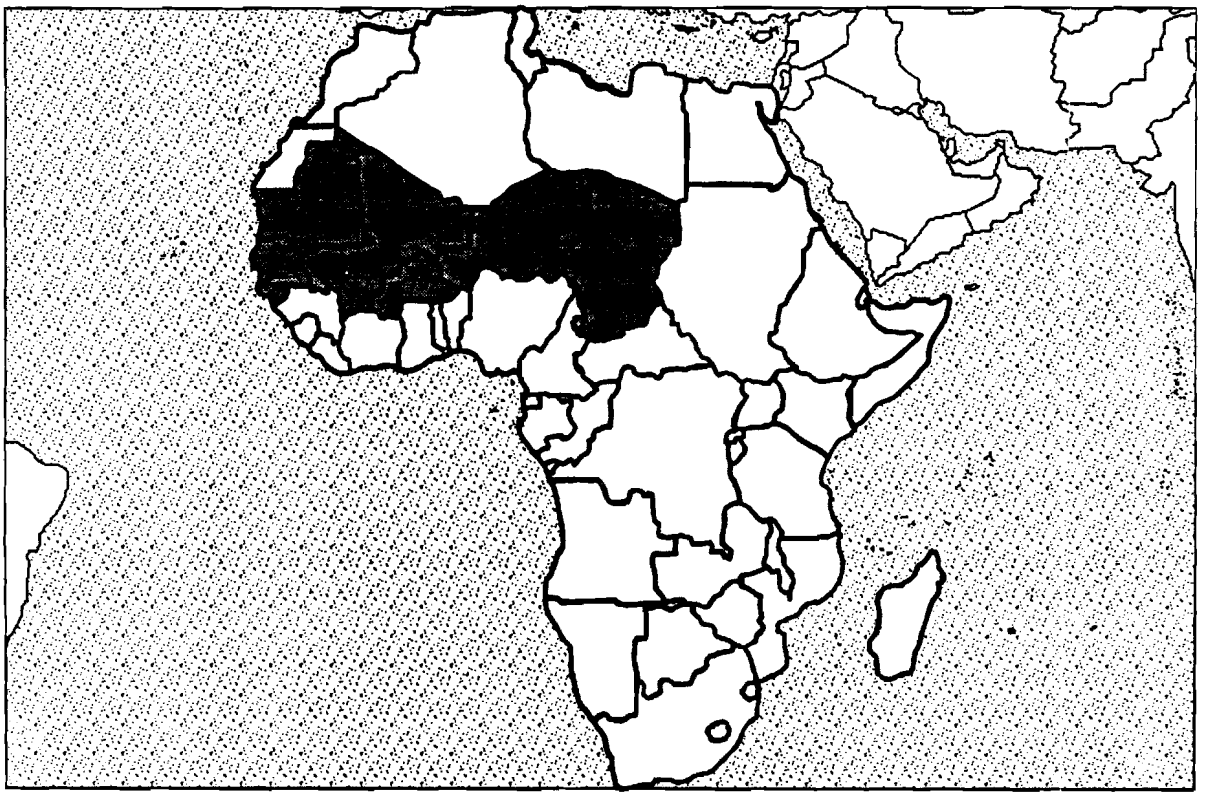

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SAHEL WATER DATA NETWORK AND MANAGEMENT III PROGRAM

(AGRHYMET PROJECT)

EVALUATION

April 23 - May 31, 1991

Team: - Derrick J. Thom, Team Leader
- Andrew Stancioff, Remote Sensing/GIS
- Douglas Brown, Computer Hardware Analyst
- Andres Ravelo, Agrometeorologist

Niamey, May 31, 1991

TABLE OF CONTENTS

ACRONYMS viii

EXECUTIVE SUMMARY 1

RECOMMENDATIONS 4

1.0 BACKGROUND 19
- 1.1 **AGRHYMET Program** 19
- 1.2 **AGRHYMET Project** 20
- 1.3 **Evaluation - Phase III** 20
  - 1.3.1 **Scope of work** 20
    - 1.3.1.1 Objectives 20
    - 1.3.1.2 Evaluation criteria 20
      - 1.3.1.2.1 Mandate - First Order 21
      - 1.3.1.2.2 Potential Contribution - Second Order . . . 21
      - 1.3.1.2.3 Feasibility and Sustainability - Third Order 21
    - 1.3.1.3 Evaluation Team 22
    - 1.3.1.4 Work plan 22

2.0 AGRHYMET REGIONAL CENTER ACTIVITIES 24
- 2.1 **Management Issues** 24
  - 2.1.1 **AGRHYMET Program Management** 24
  - 2.1.3 **USGS Management** 26
  - 2.1.4 **USAID/Niger Management** 26
  - 2.1.5 **Management Recommendations** 27
- 2.2 **Remote Sensing** 28
  - 2.2.1 **Background** 28
    - 2.2.1.1 Greenness Maps 28
    - 2.2.1.2 Additional Products 29
    - 2.2.1.3 Role of Remote Sensing 29
  - 2.2.2 **Remote Sensing Data Acquisition Generation Methods** . . 30
  - 2.2.3 **Remote Sensing Products** 30
  - 2.2.4 **Applicability, Distribution and Use of Products** 31
  - 2.2.5 **Use of the Products and Their Potential** 32
    - 2.2.5.1 Potential Uses of These Products 32
    - 2.2.5.2 The Limiting Factors of NDVI and Associated Products 33
    - 2.2.5.3 Increasing Food Production 33

2.2.6 **Production of New Products** 33
2.2.6.1 Hydrologic Index 34
2.2.6.2 Locust Location Map 34
2.2.6.3 NDVI Isoline Map 35
2.2.6.4 Cumulative Third Decadel Map 35
2.2.6.5 Other Products 35
2.2.7 **Observations on Remote Sensing** 36
2.2.8 **Recommendations for the Remote Sensing Component** . 37
2.2.9 **Feasibility and Sustainability of the Remote Sensing Component** 37
2.2.9.1 Satellite Data Interpretation 38
2.2.9.2 Sahelianization 38
2.2.9.3 Training 38
2.2.9.4 Famine Early Warning 38
2.2.9.5 Computer Obsolescence 40
2.2.9.6 The Telecommunications Problems 40
2.2.9.7 Appropriate Systems and Tools 41
2.3 **G.I.S. Component** 42
2.3.1 **Background and Introduction, Project Goals and the G.I.S. Component** 42
2.3.2 **Scope of Work** 43
2.3.2.1 System Definition 43
2.3.2.2 Additional Training 44
2.3.2.3 Technical Assistance 44
2.3.3 **Observations** 45
2.3.3.1 G.I.S. Accomplishment within the Project 45
2.3.3.2 Problems in Reaching Project Goals of Creating a GIS 46
2.3.3.3 Feasibility and Sustainability of AGRYHMET GIS 48
2.3.3.3.1 Feasibility 48
2.3.3.3.2 Sustainability 49
2.3.3.4 GIS Component Recommendations 50
2.4 **Computer Systems** 51
2.4.1 **Hardware Issues** 51
2.4.1.1 VAX 11/780 Capacity 51
2.4.1.2 DECNET Communications 51
2.4.1.3 VAX 11/780 to Personal Computer (PC) Communications 52
2.4.1.4 LAN for the Training Room 52
2.4.1.5 Obsolete Hardware 52
2.4.1.6 ARC to NAC Communications Equipment 52

2.4.2.2 Reception Station Operating System 54
2.4.2.3 Microcomputer Software 54
2.4.3 **Personnel and System Management** 54
2.4.3.1 ARC Maintenance Staff 54
2.4.3.2 Software Manager 54
2.4.3.3 Training Room Maintenance 54
2.4.3.4 Microcomputer Equipment Management 54
2.4.3.5 Microcomputer Hard Disk Management 55
2.4.3.6 Minicomputer Management 56
2.4.4 **Conclusions** 56
2.4.5 **Recommendations** 57
2.5 **Agrometeorological Applications** 58
2.5.1 **Climatological Monitoring** 58
2.5.1.1 Climatological Data Base Development 58
2.5.1.2 Climatological Analysis 58
2.5.2 **Agrometeorological Analysis** 59
2.5.3 **Observations** 59
2.5.4 **Agrometeorological Applications Recommendations** 60
2.6 **Data Acquisition and Distribution** 61
2.6.1 **Meteorological Data** 61
2.6.2 **Bulletin** 62
2.6.3 **NDVI "Greenness" Maps** 62
2.6.4 **Recommendations** 63
2.7 **Training** 63
2.7.1 **Agrometeorological Applications** 63
2.7.2 **Computer Training** 64
2.7.3 **Remote Sensing/GIS Training** 64

3.0 NATIONAL AGRHYMET CENTERS 66
3.1 **Burkina Faso** 66
3.1.1 **Observations** 66
3.1.2 **Conclusions** 68
3.1.2.1 Accomplishments 68
3.1.2.2 Problems 68
3.1.3 **Recommendations** 69
3.2 **Mali** 69
3.2.1 **Observations** 69
3.2.2 **Conclusions** 72
3.2.2.1 Accomplishments 72
3.2.2.2 Problems 72
3.2.3 **Recommendations** 73

3.3 Mauritania 74
3.3.1 Observations 74
3.3.2 Conclusions 75
3.3.2.1 Accomplishments 75
3.3.2.2 Problems 76
3.3.3 Recommendations 76
3.4 Chad 76
3.4.1 Observations 77
3.4.2 Conclusions 78
3.4.2.1 Accomplishments 78
3.4.2.2 Problems 79
3.4.3 Recommendations 79
3.5 Niger 80
3.5.1 Observations 80
3.5.2 Conclusions 81
3.5.3 Recommendations 81
3.6 Senegal 82
3.6.1 Observations 82
3.6.1.1 AVHRR and Teledetection 82
3.6.1.2 GIS 83
3.6.1.3 Computer Knowledge 85
3.6.1.4 Natural Resource Data and Socio Economic Data . . . 87
3.6.1.5 Bulletin 87
3.6.1.6 Logistics 88
3.6.1.7 Training 89
3.6.1.8 Other topics 89
3.6.2 Conclusions 89
3.6.3 Recommendations 90
3.7 Cape Verde 91
3.7.1 Observations 91
3.7.1.1 AVHRR and Remote Sensing 91
3.7.1.2 GIS 91
3.7.1.3 Computer Knowledge 91
3.7.1.4 Natural Resource and Socio Economic Data 92
3.7.1.5 Bulletin 92
3.7.1.6 Logistics 92
3.7.1.7 Training 92
3.7.1.8 Other Issues 93
3.7.2 Conclusions 93
3.7.3 Recommendations 94

3.8 **The Gambia** 95
3.8.1 **Observations** 95
3.8.1.1 AVHRR and Remote Sensing 95
3.8.1.2 GIS 95
3.8.1.3 Computer Knowledge 96
3.8.1.4 Natural Resource and Socio Economic Data 96
3.8.1.5 Bulletin 97
3.8.1.7 Training 97
3.8.1.8 Other Issues 98
3.8.2 **Conclusions** 99
3.8.3 **Recommendations** 100
3.9 **Guinea Bissau** 101
3.9.1 **Observations** 101
3.9.1.1 AVHRR and Teledetection 101
3.9.1.2 GIS 101
3.9.1.3 Computer Knowledge 101
3.9.1.4 Natural Resources and Socio-Economic Data 101
3.9.1.5 Bulletin 102
3.9.1.6 Logistics 102
3.9.1.7 Training 102
3.9.1.8 Other Topics 102
3.9.2 **Conclusions** 103
3.9.3 **Recommendations** 103

4.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 105
4.1 **Summary** 105
4.1.1 **Accomplishments** 105
4.1.1.1 Agrometeorology data collection 105
4.1.1.2 Technical Assistance 106
4.1.1.3 Software 108
4.1.1.4 Equipment 109
4.1.1.5 Geographic Information System 110
4.1.2 **Problems** 110
4.1.2.1 Management 111
4.1.2.1.1 USGS 111
4.1.2.1.2 USAID 111
4.1.2.2 Agrometeorological 112
4.1.2.3 Computer Hardware 112
4.1.2.4 Training 112
4.1.2.5 Remote Sensing/GIS 113
4.1.3. **Conclusions** 113

4.1.4 **Recommendations** 114
4.1.4.1 Management 114
4.1.4.2 Remote Sensing (see Section 2.2.8) 114
4.1.4.3 Geographic Information Systems 114
4.1.4.4 Computer Hardware/Software 115
4.1.4.5 Agrometeorological 115
4.1.4.6 Training 115
4.1.4.7 General Recommendations 116
4.1.4.7.1 Phase III 116
4.1.4.7.2 Phase IV 117
4.1.4.8 Geographic Information Systems 117
4.1.4.9 Computer Hardware/Software 118
4.1.4.10 Agrometeorological 118

ANNEXES

Annex 1. Plan Outline for Developing Agrometeorological Products
Annex 2. AGRHYMET Organization
Annex 3. Rainfall Data
Annex 4. Bulletin Example
Annex 5. Personnel Interviewed
Annex 6. Scope of Work Evaluation
Annex 7. Documents Consulted
Annex 8. AGRHYMET Interim Report

ACRONYMS

ACMAD	African Centre of Meteorological Applications for Development
ADAPS	AVHRR Data Acquisition and Processing System
AELGA	African Emergency Locust/Grasshopper Assistance Project
AFTN	Aeronautical Fixed Telecommunication Network
AGRHYMET	Agrometeorological/Hydrological/Meteorological
ARC	AGRHYMET Regional Center
ARGOS	Data Relay and Platform Location System (Sat.)
ASECNA	Agency for Air Safety in Africa and Madagascar
AVHRR	Advanced Very High Resolution Radiometer (Sat.)
BH	Hydrology Office
CAC	Coordination and Advisory Committee of AGRHYMET
CDB	Climatological Data Base
CILSS	Comité Inter-etats de Lutte contre la Secheresse du Sahel
CLICOM	Climate Computer Programme (Climate COMputing)
CNA(ACN)	AGRHYMET National Cell (National Component)
CRA(ACR)	AGRHYMET Regional Centre (AGRHYMET Centre, Niamey)
CRODT	Centre de Recherches Oceangraphics de Dakar-Thiaroye
CSE	Centre Suivi Ecologique
CTA	Chief Technical Officer
DAA	Agrometeorological Applications Department
DAF	Administration and Finance Department
DCP	Data Collection Platform, for transmission only (screen-keyboard-beacon-satellite antenna)
DFPV	Department of Plant Protection Training
DGCSFER	Department of Forestry, Soils and Rural Engineering
DIAPER	Permanent Diagnosis
DMN	National Meteorological Department
DPV	Plant Protection Department
DREM	Direction de Recherche des Eaux et Meteorologie
DRS	Data Retransmission System
EDC	Eros Data Center
ESPACE	Evaluation and Monitoring of Agricultural Protection with respect to Climate and the Environment
ETP	Evapotranspiration Potential
FAC	Fonds d'Aide et de Coopération, France
FAO	Food and Agriculture Organization
FEWS	Famine Early Warning System
FLUP	Niger Forestry and Land Use Project
GAC	Global Area Coverage

GDO	General Development Office, USAID
GIS	Geographic Information Systems
GTP	Groupement de Travail Pluridisciplinaire
HRPT	High Resolution Picture Transmission
INIA	National Agricultural Research Institute
INSAH	Institute du Sahel
ISRA	Institute Senegalais de Recherches Agricoles
ITCZ	Intertropical Convergence Zone
LAC	Local Area Coverage
LAN	Local Area Network
LAS	Land Area System
MWG	Multi-Disciplinary Working Group
NAC	National AGRHYMET Centers
NDVI	Normalized Difference Vegetation Index
NESDIS	National Environmental Satellite Data and Information Service
NOAA	National Oceanic Atmosphere Administration
NRC	Nationwide Regional Center
NRMS	Natural Resources Management System
OSU	Oregon State University
PAA	Project Assistance Approval
PASA	Participatory Agency Service Agreement
PSE/Dakar	Project Suivi Ecologique/Dakar
RNA	Requirement Needs Analysis
SAP	System d'Alerte Precoce
SMB	Soil Moisture Balance
SMI	Soil Moisture Index
SSB	Single Side Band (tranceivers)
SWDM	Sahel Water Data and Management Project
TDY	Temporary Duty
UNDP	United Nations Development Programme
UNSO	United Nations Sahel Office
USGS	United States Geological Survey
WMO	United Nations World Meteorological Organization

EXECUTIVE SUMMARY

AGRHYMET (Agrometeorological/Hydrological/Meteorological Program) was established in 1975 and is a multi-donor funded program linked to the nine member West African countries of CILSS (Comite Inter-états pour la lutte contre la Sècheresse an Sahel). The mandate of AGRHYMET is to support increased food production in the Sahel by providing national planners and researchers with timely weather and climatic data, and with better knowledge of cyclical events and their impact on water, soils, vegetation, and crops. This was to be accomplished by establishing a regional agrometeorological information networking system composed of interministerial working groups in each CILSS country comprised of representatives from meteorological, hydrological and agricultural services. Each working group was to compile country wide information to be communicated to the AGRHYMET Regional Center (ARC) in Niamey, Niger. The ARC has provide training for national staff. The executive agency for the AGRHYMET Program is the United Nations World Meteorological Organization (WMO) in Geneva, Switzerland. The program is multi-donor and multi-lateral in scope, with the United States (through USAID) providing data processing and telecommunications equipment, training, and services.

Phase I (1975-1981) and Phase II (1982-86) created the ARC in Niamey, strengthened the national capability through training, and installed the national computer systems. The first two phases of the USAID funded component of the program was managed through a Participating Agency Service Agreement (PASA) with the National Oceanic and Atmospheric Administration (NOAA). The United States Geological Survey (USGS) EROS Data Center (EDC) assumed the responsibility to provide computer hardware, software and technical assistance to operate and maintain the equipment, and technical training for Phase III (1987-91).

The evaluation of Phase III concluded that the AGRHYMET Project as a whole, has proceeded in a timely manner, and achieved most of the goals established by the Project Paper and subsequent PASA amendments.

1. The Project provided for the purchase of 35 microcomputers and their installation in the nine AGRHYMET countries. Difficulties in shipment caused serious delays, however, all requirements including the installation and training for each NAC was completed by the end of 1990.

2. Agrometeorological data collection, analysis and archiving at the national and regional levels have been enhanced through the production of the NDVI greenness maps that are distributed every ten days between May and September.

3. Climate and meteorological monitoring and archiving has been improved through the development of CLIMBASE, a software package developed by the USGS team. Despite its development, objectives and resistance to its use has been expressed by some NAC's and the French technical assistance team of AGRHYMET.

4. The recent installation of a Meteosat receiver at the ARC will produce better estimates of effective rainfall and improve AGRHYMET's ability to produce agricultural assessments.

Despite many positive accomplishments, the evaluation team identified several problems that need to be addressed.

1. Serious problems in management detracted from the smooth accomplishment of project goals and objectives.

2. Lack of USAID mission support for NAC's exist. AGRHYMET is perceived by most missions as a regional project with little or no relevance to the mission.

3. There has been resistance to the adoption of CLIMBASE, a software package developed by the USGS team for more efficient management of climate data.

4. Regular maintenance of computers is inadequate and many of the computer rooms are generally messy, in disarray, and dust laden.

5. The training component of the USGS has not measured up to expectations due to the frequent cancellation of planned courses at the NAC's.

6. The NAC's complained that although the NDVI maps were a valuable contribution, they were not delivered in a timely manner and that more training was needed in their use and application.

7. Accomplishments in the development of national and regional GIS data bases have not been achieved due to delays in the analysis of the GIS requirements and needs, and a lack of GIS expertise on the USGS team.

The overall conclusion of the evaluation of Phase III of the AGRHYMET Program is that it is one of the more successful projects in Africa. The long-term support of the various donor agencies has helped develop an important regional climatic, hydrologic and

agrometeorologic data base. The success of the training component to produce a cadre of well trained technicians has guaranteed the sustainability and Sahelianization of the Program. A recent survey of the graduates of the training center revealed that 82 percent of the technicians are still working for AGRHYMET in their respective NAC. This is indicative of the national support and recognition that AGRHYMET is performing a valuable service in providing data to assess early warning famine signs. The products produced by the USGS/USAID are used by a variety of government ministries, agencies, and donor and international organizations. The evaluation team recommends continuing USAID support of AGRHYMET for Phase IV.

RECOMMENDATIONS

Summary of Recommendations

Management

- A new Team Leader should be chosen. The Team Leader must be allowed to lead and manage without fear of constant harassment and must be sorneone in whom the USGS Project Director has confidence. He must be appointed as scientific/technical advisor to the Director of ARC to assure equal status with the French.

- The USGS Project Director must delegate responsibility to ensure success. It is impossible to completely control every detail from Sioux Falls. To continue to do so will result in continued delays and unnecessary travel expenditures.

- A NAC Client Advisor should be appointed as a liaison between USAID Missions, NAC, ARC and USAID/Niger.

Remote Sensing

- New products must be developed to improve the ability of the NAC's to assist decision makers and farmers.

- Produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important.

- Support is needed for agricultural/land use inventories to provide effective means to relate NDVI to yield and production.

Geographic Information Systems

- A much more careful and disciplined plan of action for the development of a GIS must be prepared.

- Data base collection should focus on one country initially (and not four as presently proposed).

- A discussion of methods and standards must take place in the Sahelian context to stop proliferation of costly, non responsive GIS systems and to promote an understanding of what an effective GIS can do.

- A rational approach to GIS must be implemented. It must consider Sahelian views, opinions, and advice, and not be imposed by USGS.

Computer Hardware/Software

- The ARC computers designated for training must remain in the training room.

- Greater effort needs to be made to keep computer rooms clean and dust free.

- All equipment purchased for the NAC's should be delivered immediately and not retained at the ARC.

- A system for tracking computer usage must be developed. This is essential to justify future computer acquisitions. Obsolete equipment must be disposed of.

Agrometeorological

- Develop a full software documentation of CLIMBASE and do extensive testing before distribution.

- A working plan for field data collection must be developed. (See Annex 1).

- An operational soil moisture balance (SMB) model should be in place as soon as possible after calibration and testing.

- Develop SMB derived indices and relate them to NDVI and observed crop yields.

- Compute and plot drought/crop moisture indices on a decadal basis and relate to NDVI.

- Develop regional rainfall maps using Meteosat and/or NOAA satellite based system.

Training

- Provide training to NAC's in agrometeorological applications as well as field data collection.

- Training must focus on the application and use of remote sensing products specific to local needs.

- Training in remote sensing should be in two phases: 1) Long term, U.S. training in remote sensing and GIS. 2) Short term, three weeks in country focusing on interpretation and use of software.

- Training in field testing methodologies for NDVI verification and relationship of NDVI to rainfall.

- Continued short courses in computer applications need to be promoted in order to keep the technicians' skills up to date.

- Consideration should be given to subcontracting the training component to a university for the development of two/three month short course in remote sensing and GIS.

General Recommendations

- FEWS and AGRHYMET should be more cooperative throughout their activities. In some instances their activities duplicate one another and are therefore not cost effective.

- A telecommunications needs assessment must be made of NAC/ARC needs.

- USAID missions that are funding projects requiring radios should cooperate with AGRHYMET field personnel in relaying data to the NAC.

- USGS has major hydrologic capability. A technical assistance component must be designed to focus on this aspect in Phase IV.

- Focus on data bank development (SRBD).

Phase III

For the remainder of Phase III the emphasis should be on:

- Cleaning up managerial and financial operations.
- In-country training in specific areas to support Sahelianization.
- NAC support by missions. (assistance in maintenance)
- Development of new products at ARC.
- Design of a long term Sahelianization training project.
- Development of basic GIS standards, data base, training component and in-country needs assessment by NAC and GTP.
- Conduct telecommunications needs assessment by country.
- Define relationship for ARC/FEWS/NAC future activities.
- Define areas where sustainability and feasibility issues will create problems in Phase IV.

Phase IV

Phase IV should focus on:

- Creating products that integrate dynamic ARC meteo data with existing (static) soil, population, etc. data to predict yield, production, degradation, rainfall, and the like. This can be done in an ARC/GIS framework.
- Define products, users and sales potential.
- The GIS put into the ARC and NACs must be an information system, not a toy for someone's pleasure. It must be a genuine tool to help manipulate existing and real time data received by the ARC to provide immediate and long term response to African farmers, decision makers, and donors.
- The ARC/GIS must develop standards and methods for quality control of data.

- The final (map) product must meet the standards of the USGS National Mapping Division. Maps must be geographically referenced, boundaries must match, and appropriate projections must be utilized.

Management Recommendations

- The team leadership crisis needs to be resolved immediately.

- The USGS Project Director should delegate responsibility. TGS must be allowed to manage the project without the constant, dominating influence of the USGS Project Director.

- The appointment of an NAC Client Advisor (cum scientific advisor to the Director), a position described in the Requirements Needs Analysis, should be made. This person would be a liaison between USAID missions, NAC's AGRHYMET and USAID/Niger. AGRHYMET needs someone to promote the program and products at both the mission and NAC level. This would relieve the USAID Project Assistant of this responsibility.

Recommendations for the Remote Sensing Component

New products derived from NOAA AVHRR Data must be developed to improve the ability of the AGRHYMET national components to assist decision makers and farmers in day to day agricultural management.

- A pilot study to produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important is recommended. It is also proposed that an agricultural inventory (land use) of the area be undertaken to provide effective means of relative NDVI to yield and production.

- Training must focus on the application and use of remote sensing products specific to the local needs.

- Training should be in two phases: 1) for a limited number of individuals long term training (2 years) in the USA is warranted if it also involves GIS and natural resources and environmental management. 2) short term, 3 weeks in-country, specific training should focus on interpretation of remote sensing products, and use of software for remote sensing applications.

- Training should also focus on field testing methodologies for NDVI verification and the relationship of NDVI to rainfall/greenness.

- Produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important, and support agricultural inventory (land use) of that area to provide effective means of relative NDVI to yield and production.

Recommendations GIS Component

It is difficult to offer a step-by-step rational series of recommendations for an effective GIS program because such recommendation will run counter to the current EDC implementation plan.

The following recommendations define some areas of possible change.

- A much more careful and disciplined plan of action for the development of a GIS must be prepared by EDC, particularly as it relates to its component parts and the obligation of the different actors. (see section 2.3.3.2 above)

- Once a plan of action is prepared, the data base collection should begin for one country (not four countries simultaneously as presently proposed). This will avoid the inclusion and preparation of poor data and their propagation in a GIS framework.

- During the first country data base collection and creation, visits should be made to other NAC's by one Sahelian and one project TA person to conduct the following activities:

  - Discuss and define GIS with NAC users,
  - Define user needs,
  - Locate and evaluate static data bases,
  - Collect data bases,
  - Train NAC in GIS data collection, collation, management, use, modeling and product preparation,
  - Define activities and obligations of NAC's and ARC and sign protocol for effective future activities,
  - Request NAC's to prepare a plan and schedule for GIS implementation,

- Request AID mission buy-in through FEWS/NRMS to help NAC develop GIS,

- A discussion on methods and standards must take place in the Sahelian context to stop the proliferation of costly non responsive GIS systems, and to promote an understanding of what an effective GIS can do.

- The use of poor statistical data (e.g. 1:3,000,000 FAO soil maps) must be stopped as relates to the ARC/NAC USAID supported GIS. Such data use will produce massive errors because the basic data is invalid or is irrelevant as it relates to available AGRHYMET rainfall and NDVI data which is of much higher quality.

- All GIS must be based on a participatory management approach. Sahelian views, opinions and advice have validity, as Sahelianization cannot take place without inclusion of these views. An EDC management structure (scientific or otherwise) which excludes these opinions and creates a GIS without the implicit and explicit cooperation (protocol) of the nations involved will have acceptance problems.

- National data base centers (or GIS libraries) should be considered as a means of providing good data to country research programs, donors, and potential investors.

Computer System Recommendations

- Current efforts to resolve the communications difficulties with the NAC's must be given the highest priority. Operational communications with the countries where modem tests have been successful should be established at once.

- A replacement for the Software Manager should be identified as soon as possible. This individual should be hired at least two months prior to the Software Manager's departure to ensure adequate training and a smooth transition.

- Regular maintenance procedures and documentation thereof must be established and enforced for the personal computers, both in the training

room and in the private offices. An individual must be identified to carry out this activity on a regular basis.

- The AST 286 machines that have been improperly removed to private offices should be returned to the training room immediately to optimize the computing resources available to the general user community.

- Unless specific justification is forthcoming, all equipment that has been purchased for the NAC's should be immediately delivered. If not, there is a grave danger of causing unnecessary dissention between the ARC and NAC's. If there is justification for retaining NAC equipment at the ARC, the NAC's should be informed.

- A system should be developed to keep track of the computer usage, both in the training room and in the private offices, and a person, probably the software manager, designated to oversee it. This is essential if future computer acquisitions are to be justified.

- A software inventory system should be developed to govern the maintenance of the hard disks, both in the training room and in the private offices. The possibility of installing the Lantastic LAN in the training room should be explored as a possible component of such a software management system. A diligent effort must be made to avoid copyright violations.

Agrometeorological Applications Recommendations

- Develop a full software documentation for CLIMBASE (in English, Portuguese and French) to firmly establish it as a data base management program. After extensive testing, provide wide distribution and training as a support software for CLICOM in CILSS countries.

- A working plan for field data collection of relevant variables should be developed. Agricultural/environmental variables such as: crop phenology, crop yield components and soil moisture content should be recorded according to known methodology. Some of the data collected from the Pilot Projects in different NACs may be useful for calibration of agrometeorological methods for crop yield monitoring. The observed field data can be used for testing and evaluation of agrometeorological/remote sensing products.

- An operational SMB should be in place as soon as possible after calibration and testing with field data. The process to obtain needed soil moisture observations for calibration and testing should be planned and coordinated with the National AGRHYMET Centers. The NACs may provide the required personnel for field observations and in some countries, there are available appropriate instruments (neutron probe, ovens and laboratory scales). In this way, crops and local conditions will be considered as input variables into the SMB.

- Develop SMB derived indices such as the RI (Yao, 1969), the SMI (Ravelo and Decker, 1979) or any other and relate them to NDVI and observed crop yields. RI and SMI can also be plotted to illustrate time and space variability these indices for specific crops. This may lead to a better interpretation of the greenness maps or any other remote sensing product in terms of crop productivity.

- Compute and plot drought/crop moisture indices (for example those developed by Palmer, 1965 and 1967) on a decadal bases and relate them to the NDVI. This will enhance the crop status information provided by the NDVI.

- As suggested in Requirement Needs Analysis report, regional rainfall maps should be developed using a Meteosat and/or NOAA satellite based system. There are several methods (ADMIT, PERMIT, BIAS, etc.) currently available for rainfall estimation. Snijders (1991) compared several estimation models for West Africa. The rainfall maps will provide spatial resolution for the raingauges data and it will enhance early warning of drought and accompanying low crop yields. A geostatistical technique (kriging) may be used to combine satellite and raingauge data (Creutin et al., 1986).

- Provide training to NACs in above agrometeorological applications as well as in field data collection.

Data Acquisition and Distribution Recommendations

- Improved telecommunications. Fax machines should be provided to the NAC's and ARC. Radios are also needed for transmission of data.

- Consideration should be given for the expansion of weather stations and the establishment of automatic stations.

- A user needs assessment should be carried out to establish the type of information, frequency, format, etc. of the bulletin.

- A number of tables (i.e. DHC estimates) may be represented by graphs considering only the most relevant variable in the bulletin.

- Research needs to be conducted to correlate the NDVI with the real world situation.
- The quality of the map production needs to be rigorously controlled to meet the USGS standards.

- More products need to be introduced at both a national and regional level. Products should be geared to the needs of the NAC's.

Burkina Faso Recommendations

- There needs to be a more concerted effort on the part of the USAID/USGS Team Leader to establish linkages with AID Missions, CILSS Headquarters and various NAC's.

- The Team Leader needs to establish linkages with other related projects in the region that can profit from the use of the data and products of the AGRHYMET Regional Center.

- Increase efforts to meet established objectives for workshops and seminars.

- Training and computer facilities are recommended to enable NAC personnel to establish a GIS Data base.

- Increased human resource to meet long-term needs to operate national facilities.

- Long-term (US) and short-term ARC and in-country seminars are suggested in which host country national participate.

Mali Recommendations

- Provide training in the use and interpretation of the NDVI maps. There is also a need for the maps to be delivered in a timely manner, i.e. in time for the GTP meetings.

- The USGS team needs to assess the feasibility of providing additional products requested by the NAC such as decadal maps that highlight water resources.

- Both the AGRHYMET Programme and Project representatives need to visit Bamako and discuss how the ARC can assist the NAC.

- The USAID/USGS team leadership must ensure that announcements for workshops, seminars and visits to the NAC are planned far enough in advance to allow for necessary preparations at the NAC. The information needs to be given to USAID/Niamey so that cables can be sent in a timely manner.

- The archives of the Meteorological Service needs to be computerized as soon as possible in order to preserve a historical data base that will otherwise be lost.

- The transfer of the ACT 386 computer from Niamey to the various NAC's needs to be done as soon as possible.

- Assistance in improving the internal and external telecommunications for the collecting and dissemination of data.

Mauritania Recommendations

- There is a need for the AGRHYMET leadership (both Program and Project) or representatives to visit the Mauritanian NAC. Considerable public relations work needs to be done to overcome the too frequent cancellation of visits and seminars.

- The Computer Center urgently needs a generator, cabinets and bookcases. With the closure of USAID mission, there is bound to be surplus material that can be donated.

- USGS should send a team for three weeks training to provide integrated course on NDVI Map Interpretation, yield modeling, hydrology research GIS and natural resource management. This should be one week of training, one week of exercises and one week of application, discussion and seminars.

Chad Recommendations

- Reestablish ARC credibility by meeting with NRC members to hear grievances. Honor commitments for visits.

- Provide funding to fix the air conditioner, publish the bulletin and other immediate support that is needed.

- Provided appropriate LAC data diskette for every decade so the NAC can break down the data and work with it.

- USAID/Chad mission should immediately provide funds FEWS to assist in publishing the bulletin.

- Coordinate AGRHYMET data collection with ongoing and upcoming USAID/Chad funded projects. One project will provide forty radios to relay cereal prices to N'Djamena. It would be a great service if meteorological and hydrological data collected by AGRHYMET field staff could also be sent at the same time.

- Ongoing training needs to be provided and supported.

Niger Recommendations

- More training will be required as the NAC moves toward developing a GIS data base.

- Assistance is recommended in providing more efficient telecommunications between the center and country wide data points.

- Assistance should be provided for establishing a larger network of meteorological stations to collect weather information.

Senegal Recommendations

- The hydrology personnel need more training in managing their computer resources. Special attention needs to be paid to data backup, proper record keeping and hard disk organization.

- The meteorological service needs to maintain better documentation of equipment management. A plan should be formulated that calculates and prioritizes the future demand for scarce computer resources.

- The optical disk drive units should be delivered as soon as possible, and consideration be given to installing a local area network.

- Unless the delivery of the NDVI maps can be made more in a more timely manner, consideration should be given to discontinuing their distribution and with efforts concentrated on developing other, more useful products.

Cape Verde Recommendations

- Production of the NDVI maps for Cape Verde should be discontinued, and efforts made to devise other, more appropriate products and methodologies.

- Steps should be taken to foster improved interagency cooperation and data exchange. The role of the GTP in this regard should be examined and strengthened.

- One of the major roles of the GTP, as designed by the AGRHYMET programme, is the analysis and formulation of the decadal bulletin. The Cape Verde GTP should become more active in this effort.

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The bulletin should be reformulated to include more specific information as requested by the user community. The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin, and additional information that should be included.

- A training needs assessment should be conducted to identify specific individuals for further training.

- More training is required for developing field data collection and analysis skills.

- More lead time needs to be built into the administrative communications infrastructure.

The Gambia Recommendations

- New products should be developed which are more appropriate to conditions in The Gambia to either supplement or replace the current NDVI maps. One possible avenue of experimentation is provided by a recent (1988) series of land use maps of The Gambia (agricultural lands, forest lands, rangelands and landscape and soils) These maps are available at the Banjul USAID office, provide an excellent source of ground truth data for the calibration of NDVI data. These maps should be digitized at an appropriate scale and be overlaid with Gambia LAC data to determine additional AVHRR products that could provide more useful information on Gambian natural resources. Also, field data collection from experimental trials should be done for developing crop yield models using agrometeorological data.

- An effort should be made to identify the decision makers who make up the potential GIS user community and educate these decision makers as to the usefulness of this tool in their particular spheres of interest through seminars, workshops, and demonstration projects. The manpower requirements of GIS must be carefully weighed against the competing uses of human resources and the benefits clearly demonstrated before any operational GIS effort is initiated. If not, there is a serious risk of failure because of local opposition.

- Current and future software should be designed produce output an all AGRHYMET languages (French, English, and Portuguese).

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin and additional information that should be included. More training is needed in data analysis to improve the content and format of the bulletin.

- The role of the MWG should be examined and efforts made in incorporate the group into the information interchange process.

Guinea Bissau Recommendations

- Production of the NDVI maps for Guinea Bissau should be discontinued, and efforts made to devise other, more appropriate products and methodologies.

- Steps should be taken to foster improved interagency cooperation and data exchange. The role of the GTP in this regard should be examined and strengthened.

- One of the major roles of the GTP, as designed by the AGRHYMET programme, is the analysis and formulation of the decadal bulletin contents. The Guinea Bissau GTP should be put in place as soon as possible.

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The bulletin should be reformulated to include more specific information as requested by the user community. The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin and additional information that should be included.

- A training needs assessment should be conducted to identify specific individuals for further training.

- More training is required for developing field data collection and analysis skills.

- More lead time needs to be built into the administrative communications infrastructure.

1.0 BACKGROUND

AGRHYMET (Agrometeorological/Hydrological/Meteorological) Program is a multi-donor funded regional project, linked to the nine member West African countries of CILSS (Comite Inter-etats de Lutte contre la Secheresse du Sahel). While it has been most active in support of national meteorology services, AGRHYMET as its name implies, also supports the hydrological and agricultural ministries of the member countries.

1.1 **AGRHYMET Program**

The AGRHYMET Program was established in 1975 by CILSS. Its mandate was to support increased food production in the Sahel by providing national planners and researchers with timely weather and climatic data, and with better knowledge of cyclical events and their impacts on water, soil, vegetation and crops. This was to be accomplished by establishing a regional agrometeorological information networking system composed of interministerial working groups (GTP - Groupement de Travail Pluridisciplinaire) in each CILSS country. Data gathered from the meteorological, hydrological and agricultural services are forwarded to the AGRHYMET Regional Center (ARC) in Niamey, Niger. The ARC in turn provides training for the national staff, and develops analytical capacities for transfer to the national GTP. The World Meteorological Organization (WMO) in Geneva, Switzerland is the organization through which funding from the various donor agents is channelled.

AGRHYMET has been in operation through three five years phases with a continuing Phase IV planned upon the completion of Phase III. The first three phases have focused on the following:

Phase I (1973-81): Created the ARC at Niamey and strengthened national agrometeorological and hydrological services through training.

Phase II (1982-86): Focused upon collecting classifying and analyzing national data. The publication of bulletins and the installation of computer systems at the National AGRHYMET Centers (NAC) with on-going training were the goals of Phase II.

Phase III (1987-1991): Focuses upon the provision of useful data to end-users; strengthening the national working groups (GTPs); on-going shift in technical responsibility from expatriate to Sahelian staff, and of financial responsibility from donor to CILSS governments.

1.2 AGRHYMET Project

The Sahel Water Data and Management (SWDM) Project, also known as the AGRHYMET Project, is the US funded portion of the AGRHYMET Program. The US, through USAID, has been providing data processing, equipment, training, and services through the Sahel Water Data and Management project. The US involvement began in 1977 with USAID providing funds through a Participating Agency Service Agreement (PASA) with the National Oceanic and Atmospheric Administration (NOAA) and through the U.N. World Meteorological Organization. The USAID contribution consisted of hardware and software, technical assistance to operate and maintain this equipment, and technical training. The United States Geological Survey (USGS) Eros Data Center (EDC) assumed the primary technical responsibilities for Phase III of the project in 1989, along with continued operational and logistical support through WMO.

1.3 Evaluation - Phase III

The purpose of the team was to conduct an evaluation of AID contributions in Phase III of the AGRHYMET Program.

1.3.1 Scope of work

The evaluation team was required to review relevant documentation, visit the National AGRHYMET Centers (NACs), interview people associated with and impacted by the project.

1.3.1.1 Objectives

The first objective of this evaluation was to determine if AID's Phase III and its implementation to date has met the twin criteria of feasibility and sustainability.

The second objective is to examine AID's Phase III inputs for continuity, completeness, effectiveness and appropriateness.

The third objective is to develop specific recommendations regarding AID's contribution to the remainder of Phase III and Phase IV.

1.3.1.2 Evaluation criteria

The following evaluation criteria were identified and were addressed in the evaluation.

1.3.1.2.1 Mandate - First Order

The mandate of the AGRHYMET project is to:

- Support increased food production by providing timely weather and climate data,
- Provide better knowledge of cyclical events and their impacts on soils, water, and vegetation and crops,
- Provide training to the ARC and NAC's,
- Develop agricultural capabilities to transfer to the National working groups (GTP).

1.3.1.2.2 Potential Contribution - Second Order

If successful, the AGRHYMET Program can offer the following four potential contributions to the Sahel.

- Early Warning - crop conditions assessment and identification of localized food deficits through rapid computerized information gathering,
- Crop Livestock Improvement - system management through collection and analysis of consistent and reliable meteorological and hydrological data,
- Statistics - source of agrometeorological statistics from which geographically specific rainfall estimates can be made,
- Improved Decision Making - tool for natural resources decision making.

1.3.1.2.3 Feasibility and Sustainability - Third Order

The inputs provided to the project include:

- Computer hardware and software,
- Technical assistance, both in the form of long-term resident specialists and short-term assistance,
- Training (short to medium term),

Management and operational support of the principal outputs of the project are:

- Data processing system: an efficient, fully operational system of hardware, software, peripherals and communication links,

- Remote sensing component: processed satellite images, statistical and graphical interpretation packages provided to the NAC's, and regularly produced NDVI maps and other crop condition assessment indicators,

- Trained staff in computer maintenance software development, electronics and other equipment maintenance; up to 75 Sahelian staff members trained in remote sensing methods and interpretation,

- Improved national communication links via provision of SSB radios in each country. The attainment of the above outputs were contingent upon:

    - Other donors' collaboration and funding,

    - Availability of trained Sahelians.

1.3.1.3 Evaluation Team

The evaluation team was comprised of four specialists in the following areas:

Agronomist/Team Leader - Derrick J. Thom
Remote Sensing/GIS/AVHRR Specialist - Andrew Stancioff
Computer Hardware Analyst - Douglas Brown
Agrometeorologist - Andres Ravelo

1.3.1.4 Work plan

The evaluation was scheduled to be undertaken in October 1990 but was delayed due to a challenge to the awarding of the contract to Tropical Research and Development, Inc. The evaluation was rescheduled for January 1991 but was again postponed due to the Gulf War. The team was finally able to undertake the evaluation once travel restrictions were lifted after the Gulf War in April 1991. The schedule followed by the team was as follows:

January 21 - June 29, 1991 - Sioux Falls, SD. AID/W

April 23 - April 29 - Niamey, Niger

April 30 - May 3 - Stancioff/Thom - Burkina Faso
April 30 - May 6 - Brown/Ravelo - Senegal

May 4 - May 8 - Stancioff/Thom - Mali
May 7 - May 10 - Brown/Ravelo - Cape Verde

May 9 - May 16 - Stancioff/Thom - Mauritania
May 11 - May 16 - Brown/Ravelo - The Gambia

May 17 - May 22 - Stancioff/Thom - Chad
May 17 - May 23 - Brown/Ravelo - Guinea-Bissau

May 23 - May 31 - Niamey, Niger

June 1 - June 4 - Team Leader, AID/W

2.0 AGRHYMET REGIONAL CENTER ACTIVITIES

The AGRHYMET Regional Center (ARC) is located in Niamey, Niger with the respective National AGRHYMET Centers (NAC) located in the capital city of the nine countries that comprise CILSS. The focus of this evaluation is on the USAID/USGS contribution to the AGRHYMET Program. The management, remote sensing, G.I.S., Computer Systems, Agrometeorological Applications, Data Acquisition and Training aspects of the USAID/USGS contributions to AGRHYMET will be evaluated.

2.1 Management Issues

2.1.1 AGRHYMET Program Management

An evaluation of the AGRHYMET Program management is beyond the scope of this evaluation. Nevertheless, an understanding of the AGRHYMET organization is necessary to appreciate where the USAID/USGS Project fits into the Program. The AGRHYMET Program is a complex multidonor project originally funded by UNSO that has expanded to include seven international donors (Belgium, France, Germany, Italy, Netherlands, Switzerland, and the USA) and two international organizations (CILSS and UNSO). Funds from the international donors are channelled in part through the World Meteorological Organization. The AGRHYMET Program is under the jurisdiction of CILSS and is advised by four committees that are responsible to the Coordination and Advisory Committee (CAC) (Annex 2).

Given the complexity of the organizational structure and the multiplicity of donors, management of the AGRHYMET Program is a difficult task. To coordinate the technical and financial aspects of the program and maintain contact with the NAC's is an extremely difficult task for one individual, the Director General. Recently CILSS approved the appointment of a technical and a financial director to assist the Director General in the management of the program.

The difficulties faced in the management of the Program were dramatically demonstrated shortly after the arrival of the evaluation team when staff paid by CILSS went on strike. CILSS had not paid its employees for four months. The problem took four weeks to resolve during which time all employees not paid by CILSS honored the picket line and worked at home. The strike delayed the production of the first decadal NDVI ("greenness") maps of the season by two weeks.

The USGS AGRHYMET team is part of the overall program, with the Team Leader responsible to the Director General. The Team Leader is required to keep the Director

General informed of the activities of the team and is to work in cooperation with other sections of the AGRHYMET Program.

2.1.2 USGS/TGS AGRHYMET Team Management

Through TGS, USGS is responsible for staffing long-term technical assistance personnel to carry out the mandate of the project paper. Three long-term positions were identified, a Team Leader, an Operations Production Supervisor, and an Agrometeorologist. An evaluation of the team management component quickly revealed that there were major problems. The Team Leader has been criticized by people at the ARC and the NACs as having difficulties coordinating the work of the USGS team with other staff. The scope of work for the Team Leader states that the "Team Leader should visit every NAC at least once per year to coordinate US technical inputs, advise/assist USAID mission involvement, encourage interaction of AGRHYMET, with other relevant host country projects." Feedback from the NACs and AID missions reveal that these visits have not been on a regular basis, that cancellations of planned visits caused embarrassment to NAC directors who had scheduled meetings with government officials. Furthermore, several AID missions were unsupportive of AGRHYMET viewing it as a regional project and of little concern to their mission. A major public relations effort needs to be made to re-establish the credibility of the AGRHYMET project at both the NAC and mission level.

Difficulties between the AGRHYMET Team Leader and the USGS Project Director remain unresolved and as a consequence, have affected team morale. The failure of the Team Leader to follow established protocol, such as informing the Directeur de Formation of scheduled courses, has caused resentment among Sahelian colleagues.

Another issue that has yet to be resolved is the deteriorating American/French relationship. The relationship and level of cooperation between the US team and the French team at the ARC is at an all time low. Except for a generally "workable" attitude of those in the map production unit, the lack of cooperation and bickering has resulted in accusatory memos and a decrease in morale of all involved. The resultant effect is that little or no useful work is being done by members in both groups and this is affecting Sahelian members of the ARC, CILSS and WMO.

Past evidence indicates that relations between the Americans and French were cordial and scientific work was profiting from this relationship. In the past year relations have deteriorated. Ostensibly the reason given for the disagreement between units is an argument over the use and availability of software capable of modeling water budgets from which crop yields are derived. The French refuse to provide their software (DHC) and modeling procedure to the US team and the US team developed its own model in defiance of the French, a model the French refuse to use. In view of the fact that the

validity of both models is questionable since neither has been adequately field tested, it would appear that this argument is merely masking the real and underlying problem, poor communication. This problem should never have developed if open communication and a good working relationship has existed between the Team Leader and the French.

Finally, the USGS intransigence and ill advised position regarding map projections has further compounded the ill-will and made a bad situation even worse. The American team needs strong leadership to repair the damage and to make certain such misunderstandings are resolved quickly.

2.1.3 USGS Management

The USGS - EDC is the premier institution in the world to provide the backstopping for the AGRHYMET Project. The production of the greenness map, the computer production facilities, and the staff with French capability and technical expertise provide AGRHYMET with training and first rate backstopping. There is also effective cooperation and coordination between the Project Director and USAID/Washington, the Sahel Desk, Africa Bureau, and the Club du Sahel. Good and effective communication has also been established by USGS, WMO, FAO, FAC and other donors.

Nevertheless, management related problems exist in the project and are undermining the efficacious progress of the work. The USGS management of the project has been criticized by some as being too centralized. In the view of the AGRHYMET Team Leader, the EDC Project Director has total control and decision making power. The AGRHYMET Team Leader maintains that neither he nor the USGS/TGS Project Coordinator, hired as a liaison between the project and the USGS Project Director, have the opportunity to manage and make decisions.

Tension exists between the USGS Project Director and Team Leader. There is a need to resolve the differences between the parties in order that progress be made toward achieving project goals, purposes, and outputs as described in the Project paper and PASA.

While there has been some progress toward obtaining the objectives, the existing project administrative and technical management structures failed to permit effective management, problem identification, and resolution.

2.1.4 USAID/Niger Management

The AGRHYMET Project is under the management of the General Development Officer. The direct link between the GDO and the AGRHYMET Project is the USAID Assistant

Project Manager. It is the responsibility of the USAID Assistant Project Manager to monitor project activities, to be a link between USAID/Niger and USAID/Washington, and to assist the contractor in complying with USAID regulations.

The Assistant Project Manager has carried out his responsibilities and has worked with the Director General of the AGRHYMET Program and the project Team Leader. Although aware of management problems in the project, the Assistant Project Manager is not in a position to resolve the issues or has not been able to do so.

Criticism of USAID/Niger surfaced in the evaluation team's visit to the NACs and USAID missions. Cables sent to missions announcing visits and seminars did not arrive in sufficient time to prepare for the visit or receive necessary clearances to attend training sessions. The tardiness of the cables may not be the fault of USAID/Niger but of the AGRHYMET Team Leader in not allowing sufficient lead time. Regardless of who is at fault, this problem has to be resolved with the Assistant Project Manager insisting on sufficient lead time to forward announcements to the missions.

Another problem that surfaced in the evaluation teams' visit to the USAID missions is the varied support for the AGRHYMET Program from mission to mission. In general, it was viewed as a regional project of little relevance to on-going projects within the various missions. Considerable public relations work with the missions is needed. The USAID Assistant Project Manager should visit each mission and NAC at least once a year. Mission buy-ins should be encouraged, and each Mission Director, Agricultural Development Office (ADO) and GDO needs to be made aware of the contributions of AGRHYMET.

2.1.5 Management Recommendations

- The team leadership crisis needs to be resolved immediately.

- The USGS Project Director should delegate responsibility. TGS must be allowed to manage the project without the constant, dominating influence of the USGS Project Director.

- The appointment of an NAC Client Advisor (cum scientific advisor to the Director), a position described in the Requirements Needs Analysis, should be made. This person would be a liaison between USAID missions, NAC's AGRHYMET and USAID/Niger. AGRHYMET needs someone to promote the program and products at both the USAID mission and NAC level. This would reduce the USAID Assistant Project Manager of this responsibility.

2.2 Remote Sensing

This section will describe the background requirements, goal and objectives of Phase III as they relate to remote sensing. The remote sensing data acquisition methods, the actual products of the project, and observations as to their applicability, use and distribution will be discussed. The kinds of products that could be produced with present equipment and recommendations for production of remote sensing materials for an extended Phase III and Phase IV will be identified. Finally an evaluation is made of the three objectives set forth in the scope of work of the evaluation team.

2.2.1 Background

During the first two phases of AGRHYMET no reference appears in the documentation concerning remote sensing products per se. During these two phases, meteorological data, albeit remotely sensed, was received and distributed along classical meteorological methods and consisted of statistical data.

2.2.1.1 Greenness Maps

In 1987 NOAA/NESDIS provided weekly NDVI data for 1/2 ° to 1° Latitude/Longitude grid cells to all CILSS countries except Cape Verde. These were produced in Missouri and telexed to the ARC. Typically these data were late in arriving. Production of the NDVI became the responsibility of the USGS in 1989 when the PASA was transferred from NOAA.

From 1986-1988 the USGS-EROS Data Center began to produce NDVI "greenness maps" in support of USAID projects. These maps were produced through USAID mission buy-ins. During this same time frame, the AID Famine Early Warning System (FEWS) project introduced the use of greenness maps into their efforts to establish areas of food security risk.

The USGS greenness mapping effort for specific USAID Sahel Missions was evaluated in 1988, and suggested improvements, particularly those related to timely delivery, were incorporated into the Project Paper Proposal for Phase III of AGRHYMET.

The PASA design was based on the joint AID EDC of June 1988. Requirement Needs Analysis (RNA) AGRHYMET Phase III, and the 1987 Sahel III Project Paper. This document spells out the need to produce 1 km vegetation index maps as the "key data contribution of the Regional Center".

2.2.1.2 Additional Products

Additional products derived from NOAA (A and B-Satellite) AVHRR were proposed in the RNA. These included intertropical convergence zone (ITCZ), biomass production, phenological development of principal crops, and locust infestation maps. The NRA further elaborates on remote sensing products, their potential, distribution, and use. These include:

- NDVI - Latitude/Longitude grid to NAC's,
- NDVI - Digital products, LAC raw data to NAC's,
- ITCZ position and monitoring to NAC's,
- Biomass development from higher resolution satellite data,
- Locust infestation location (combined data sets),
- Thermal fields for ground surface temperature from NOAA satellites,
- AVHRR raw data to NAC's in diskette form,
- NDVI analysis, display and mix, contour, base of monitoring units, etc.

It should be noted that although the RNA is an extraordinary compendium of information and a useful guide for AGRHYMET Phase III and IV, it fails to propose or discuss the potential of remote sensing products in hydrological or agrometeorological applications in spite of requests for specific products from NAC's.

2.2.1.3 Role of Remote Sensing

The importance of the remote sensing component cannot be underestimated in terms of the AGRHYMET early warning mandate. Clearly, that function can be demonstrated as viable, particularly in view of the use of NDVI-GAC data by FEWS and the SAP. These groups cannot depend on Washington FEWS-GAC derived data (seven km resolution) to define the level of detail needed to address food security problems. LAC data is essential for these detailed assessments.

The 1987 Project Paper calls for the Sahelianization (p. 26) of the Remote Sensing component, but does not provide any guidance as to products, methods, and

applications of remote sensing techniques. In fact, the PP gives very little guidance for Phase III.

The PASA agreement (AFR-0973-P-1C-9014-00) clearly defines the role, goals, objectives, inputs, and outputs of the remote sensing component. Unfortunately, the tasks outlined in the PASA are much more limited than those defined in the RNA. Nevertheless, item 1.3 page 2, of the PASA specifies that products should be developed in Phase III. Page 4, item 2.1 (General Duties), specifies that USGS will develop a sustainable AGRHYMET operation in areas of satellite data collection, data archiving, data interpretation and analysis (both satellite and field data).

Items 8 and 9, on page 7, and items 10 and 11, on page 8, specifically deal with the issue of production and analysis of remote sensing material. Page 10, paragraph six, defines the operations, production, supervisors duties, and describes production of remote sensing products including AVHRR and AVHRR derived products.

Section 2.3 on page 12 describes software transfer for AVHRR analysis including, ADAPS, LAS and other software necessary for image analysis. PASA amendment 2 dated December 27, 1989, further obligates USGS/EDC and its Niger field staff to provide software for processing of AVHRR imagery and the production of improved products and training related to AVHRR.

2.2.2 Remote Sensing Data Acquisition Generation Methods

A High Resolution Picture Transmission (HRPT) receiving station is located at the ARC and was built and paid for with French assistance. French operators preprocess the data and give the same to the USGS operator, who uses ADAPS and LAS software to produce NDVI maps. Processing is conducted on a VAX 11/780, but will soon be replaced by a VAX 4000. Other than the NDVI maps, few products are produced by either the American or French teams.

2.2.3 Remote Sensing Products

The production, quality control, and delivery of remote sensing products includes the following basic products:

- Gridded NDVI data by country at different scales 1:2,000,000 for Chad, 1:1,000,000, Senegal, The Gambia, Guinea-Bissau and 1:250,000 for Cape Verde,

- Country Vegetation Index Map,

- NDVI digital products on diskettes,
- Cumulative NDVI maps for countries for multiple years or certain number of decades,
- Regional NDVI maps at 1:10,000,000,
- Cumulative regional NDVI maps at various scales in color and black and white,
- Comparative national NDVI maps at various scales to show change in greenness from previous decade or from previous cumulative decades representing a number of years or high or low greenness,
- Vegetation condition maps in black and white for regional use,
- Composite maps showing national NDVI for a specific decade during a six month period,
- Regional change maps from one decade to next.

No other products have been seen nor have been discussed.

2.2.4 Applicability, Distribution and Use of Products

The distribution of the products has been a problem since the inception of the project. The national centers, with the exception of Niger, have complained of the delays in receiving the products. Typically the delays are 10-15 days, and often as much as 20 days. These delays are primarily due to a lack of rapid transport services between ARC and NACs.

The number of copies furnished has also been called into question, some countries receiving more than others. Typically the products have consisted of a regional NDVI map and three copies of a large scale national map. Sometimes countries receive diskettes of compressed NDVI data but this is not annotated or explained, and has no geographic reference or coordinate annotation. These products (diskettes) are provided by the French, and are usually not used. When used, time is wasted and little useful work is derived.

New products under production at the ARC, or recently sent to the NAC (May 1991), include black and white NDVI versions and a set of six separate, mostly cumulative, decadal data sets for the second decade.

The applicability of the NDVI maps has been called into question. No one in the field has doubts as to their use for locust infestation monitoring and warning, their use as a basic tool to establish "greenness", or as a means of locating dry pockets or to locate pastures in verdant state. In fact, these four applications continue to be the hallmark of the much praised maps. However a large number of users and potential users have commented on the limited application of these maps as a function of the potential of NOAA AGRHYMET data, for a number of reasons:

- The first complaint is that the maps are not interpretable (difficult to locate oneself on the map).

- There are complaints that the maps are qualitative and do not allow for comparison with other data (e.g. isohyets).

- Many users feel that either the raw NDVI data (uncompressed) or the raw NOAA-AVHRR data should be made available to them since they understand its potential and have ideas on how to use it.

- The users feel that conversely, the ARC should have developed other uses from the raw data.

- No improvements have been made to these maps in spite of suggestions made by the NAC's and specified in the RNA.

- The validity of the maps has been called into question in view of the need for rapid delivery of these particular kind of data. (i.e. decadal data should be delivered less than 10 days after the date of the last data capture).

2.2.5 Use of the Products and Their Potential

2.2.5.1 Potential Uses of These Products

The most obvious use for the present products is their potential for establishing relative levels of food security for population down to a level of detail of 1 km^2. Making use of these products would greatly assist in filling the mandate of AGRHYMET, in helping to avert famine, and secondarily, supporting the goal of increased food production.

While not included in the Scope of Work or PAA, improved NDVI products supplemented by land use (agricultural area under cultivation) maps can permit users to establish kilometer by square kilometer, the state of the crops. If this number is multiplied by a

yield figure established for each kilometer unit, production for each square kilometer on the map is determined. This can be done nationally or by arrondissement; an advantage provided by the computing capacity of the ARC and NAC.

2.2.5.2 The Limiting Factors of NDVI and Associated Products

The potential for utilizing NDVI data and the products such as the "greenness maps" has been seriously limited on three points:

- Poor use of NDVI,
- Untested yield models (see agrometeorology),
- Lack of information on total area under cultivation by country.

At present, estimates of crop production are off by as much as 50%, and in most cases by 30% (National Early Warning Units, FEWS and various other interviews). The use of the above three part system is well known, but its applications cannot take place in Africa without all three parts. The part now lacking completely is land use. If land use maps are not available to AGRHYMET, the NDVI/GIS plans and proposals lose a great deal of their value. On that basis the next evaluation may well call into question any proposal for future AGRHYMET phases.

2.2.5.3 Increasing Food Production

AGRHYMET's potential role in increasing food production has always seemed illusory if not totally unlikely. However, a careful campaign (work plan) based on available research results of rainfall prediction models and real time use of Meteosat data within the framework of the NDVI 1km country grid could provide real time prediction for rainfall probability with area specificity and a range of amounts. This information, relayed to the national centers, could be communicated to farmers, possibly resulting in increased production. The last step of this prediction modeling system may not be possible within the next five years, but the modeling procedures and supporting meteosat products could be prepared, tested, and evaluated within a Phase IV framework.

2.2.6 **Production of New Products**

A number of useful products not previously produced could be provided to the NACs. The conception of these products derives from the needs expressed in the countries, and are based on the explicit demand of national experts and some expatriates in organizations such as SAP and FEWS.

The following are product ideas requested by national (NAC) users or conceived of on the basis of problems stated by the NAC's.

2.2.6.1 Hydrologic Index

A hydrologic index map should be prepared. Such a map is needed to monitor the increase and decrease of water levels in lakes (Chad, Fitri, R'kiz, Aleg, Guyer, etc.), the Niger delta and temporary mares. The index could also help hydrologic services model and predict changes in superficial aquifers and develop aquifer recharge models or even predict dry down of aquifers or salination.

This hydrologic index map should be composited much in the same way an NDVI map is produced, by combining appropriate NOAA channels to produce the most effective product, and an index for water resource monitoring and management. The basic developmental elements of this product must be conducted at EDC, where such expertise exists. Once the system is developed, software must be sent to the ARC HRPT technician for use in production and distribution of the new product. Training should go hand in hand with the distribution of the new product to the NACs.

The products need not be produced as often as the NDVI, but a schedule should be established on the basis of need. For instance, a map should be prepared at the low water point for Lake Chad etc. or +/- April 15th for each year, then a 15 day interval map should be produced starting September 15 and lasting to December 31 or Jan 30, depending on the wetness/dryness of the season and the size of the lakes or mares.

Such a product was either requested or alluded to in Niger, Mali, Burkina Faso, Mauritania, Senegal and Chad.

2.2.6.2 Locust Location Map

A locust location map should be made on the basis of the 1988 field reports and the areas which are known to have been the last to maintain the level of greenness necessary for the fostering of egg laying by the last two generations of locusts during the 1988 outbreak. In other words, on the basis of 1988 field data and the late season NDVI 1988, maps should be prepared predicting areas of likely future outbreak.

2.2.6.3 NDVI Isoline Map

The creation of cumulative annual, or multi-annual NDVI isolines was recommended for the comparison to synchronous cumulative isohyets for establishing correlation analysis and deviations. Results would establish levels of skewness and attempt to explain change through interpretation of localized microclimatic factors.

2.2.6.4 Cumulative Third Decadel Map

The creation of isolines was also suggested on a three decade, cumulative basis in order to establish correlation to monthly cumulative rainfall data. (Request from Mauritania and Chad.)

2.2.6.5 Other Products

Assistance should be given to NACs to develop simple NDVI field verification methodology. NACs need to understand the relationship of NDVI to reality. This can only be done in large (10x10 km) vegetative homogeneous areas (i.e. pastureland). Types of recommended training are as follows:

- Prepare diskettes of raw NDVI data for distribution to NACs. These should have proper geographic referencing and be user friendly.

- Prepare base map with population density per unit area (i.e. to arrondissment level) in order to be able to make rapid population versus greenness comparison to assess populations and areas at risk and food security.

- Prepare country level NOAA images in photographic format biannually at vegetative and hydrologic minima and maxima to assist NDVI interpreters in evaluating NDVI maps and comparing them to reality. Provide diskettes of NOAA multi-channel data in raw form for each country.

- NDVI of region should be provided to NACs on a monthly or bi-monthly basis so that NACs can follow movement of ITCZ and conduct comparative analysis and research on changes, latitudinal as well localized, from which they might be able to develop predictive models.

- Create surface temperature map from Meteosat and conduct modeling to develop evapotranspiration model.

- LAC data should be provided to FEWS in diskette form.

- AVHRR raw data should be used to create Sahel wide (by country) bush fire maps two or three times a year (Jan, Feb, Mar).

- AVHRR and Meteosat data should be combined in various formats to develop improved soil moisture balance products.

- Create land use maps based on remote sensing data, so that yield models can be effectively used to provide production figures and pinpoint areas under stress.

2.2.7 Observations on Remote Sensing

- The project has been very effective in introducing a product (NDVI) and improving its quality.

- The project has been only partially successful in training people to use the product.

- The project has been deficient in responding to the needs of the NAC's and their requests for better products, as well as product use training.

- The project has been remiss and ineffective in establishing and maintaining contact with appropriate individuals in the NAC's in hydrology, agronomy, ag-statistics, and other AGRHYMET relevant disciplines.

- The project has not delivered products in a timely fashion due to telecommunications problems.

- The product itself has limited use because its interpretability is questioned by the NAC users, and the maps are unrelated to reality.

- AVHRR data has not been used effectively to support the goals and objectives of AGRHYMET.

- The relationship of the products to specific uses in agriculture is tenuous and difficult to establish without training or improved products.

2.2.8 Recommendations for the Remote Sensing Component

New products derived from NOAA AVHRR data must be developed to improve the ability of the AGRHYMET national components to assist decision makers and farmers in day to day agricultural management.

- A pilot study to produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important is recommended. It is also proposed that an agricultural inventory (land use) of the area be undertaken to provide effective means of relating NDVI to yield and production.

- Training must focus on the application and use of remote sensing products specific to the local needs.

- Training should be in two phases: 1) for a limited number of individuals long term training (2 years) in the USA is warranted if it also involves GIS and natural resources and environmental management. 2) short term, three week in-country, discipline specific training should focus on interpretation of remote sensing products, and use of software for remote sensing applications.

- Training should also focus on field testing methodologies for NDVI verification and relationship of NDVI to rainfall/greenness.

- Produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important, and support agricultural inventory (land use) of that area to provide effective means of relative NDVI to yield and production.

2.2.9 Feasibility and Sustainability of the Remote Sensing Component

A menu of products and recommendations have been made in previous sections which, if considered by the EDC and the technical assistance staff of the ARC, will improve project performances in the extension of Phase III of the project. These recommendations will also facilitate Phase IV decision making and planning.

The preparation of these products and the implementation of the recommendation will help the USGS Technical Assistance Team achieve Phase III objectives increase the cost efficiency of past Phase III activities. These changes should promote and provide for the deeper involvement and long term commitment of the Sahelian component of the project, thus taking direct aim at the issues of sustainability and Sahelianization. Additional comments specific to the sustainability/feasibility issues are addressed below.

2.2.9.1 Satellite Data Interpretation

As noted earlier, the satellite data interpretation methods could be improved by the development of new products, in-country training specifically to address interpretation, software use, and the development of ground truth methodology for satellite data verification.

2.2.9.2 Sahelianization

The transfer of satellite data interpretation methodology to Sahelian personnel has been successful beyond expectations. In every country Sahelian personnel exhibited knowledge, interest and enthusiasm of and for the product. However, they also showed frustration and exasperation at the insufficient response of the ARC personnel (both USGS and CILSS) in providing improved products, and additional training in-country in spite of requests.

2.2.9.3 Training

The efficiency of training programs will depend on a more timely, organized, and systematic approach to technology transfer. The ARC staff must review the needs and requests of the NAC, and prepare a syllabus in cooperation with the NAC on the basis of this evaluation. Once training begins in-country, it must focus on applications by disciplines, on ground truth methodology to support remote sensing data, on software applications, and interface training in each discipline.

2.2.9.4 Famine Early Warning

The coordination of the remote sensing/crop monitoring component with other food deficit/early warning systems actors is obviously of extreme importance as a measurable parameter indicative of the success or failure of the AID Phase III Project.

The interest of early warning actors (FEWS, SAP and GTP) was clearly demonstrated in all the interviews. However, certain AID missions or offices indicated a lack of interest based on what is interpreted as a lack of understanding of the project and its goals. Far more problematic is the fact that most AID and other donor representatives strongly oppose the effective collection of crop data. The word effective is underlined because present methods of crop monitoring are providing margins of error of up to 50 percent (in Niger) and errors of + 30 percent in Mali, Mauritania, Chad, Burkina and Senegal.

There are many reasons why these statistics are so far off the mark, both scientific and political, but most agree that the sampling methodology is in error and that it is inherent

especially to the process used and imposed on the countries by the CILSS DIAPER Project.

Several implications of such errors on the AGRHYMET Project and its relationship to other early warning/food deficit actors exist.

Dynamic 1km LAC NDVI data cannot provide effective early warning unless it is associated with land use data (areas under cultivation). Furthermore, we can have yield modeling procedures of requisite reliability but these will be of little value unless we know where crops are being grown, and how many hectares are under cultivation.

Without these data AGRHYMET data is simply providing the basis for intellectually titillating guess work. Thus, a good remote sensing component exists with a crop monitoring component that provides statistics that are from 30-50% off. This means that the food security - early warning community must go out and find other relevant indicators to assess the food security conditions. Information these individuals would like to have available to them at a first order level for early warning includes:

- land use area cultivated maps (the thing most wanted),
- land carrying capacity or soil capability.

Until such a time as these maps are produced, the AGRHYMET data is of limited relevance to the food security community. Once these maps are available, the usefulness of the NDVI becomes inestimable to the early warning community, and finally becomes useful to the farmers.

This statement cannot be underestimated and the USAID/AGRHYMET project will not be able to boast of anything but limited success until such maps are produced. They exist in Europe, the USA, and other countries and are used to support extension agents in providing farmers with decision making tools and rational for feasibility and sustainability.

USAID must address this problem before embarking in a Phase IV project. Land use maps are a prerequisite for good yield and good production statistics. Good statistics (less than 20% error) are a must for effective early warning.

From a cost effectiveness point of view, let us consider that $600,000 is spent over 3 years per country on FEWS. Yet FEWS can only make an educated guess at the people at risk and their location. If the equivalent money were spent on land use maps and on the collection of valid agricultural statistics and combined with AGRHYMET yield, rainfall and NDVI data, a much more accurate and therefore cost effective early warning system would be in place.

Finally, the early warning community in particular FEWS, has been extremely cooperative with AGRHYMET at the NAC local and has given the NAC's a great deal of assistance and seeks even closer ties because of the relevance of the AGRHYMET project data.

The existing effective relationship implies feasibility. The continued cooperation and recommended improvements to AGRHYMET strongly suggest a long-term mutuality and symbiosis, and by extension, sustainability.

2.2.9.5 Computer Obsolescence

The obsolescence of computer software and hardware in satellite data processing will continue to play a role in AGRHYMET activities for at least 10 years. Unfortunately this is the nature of computer technology and electronics. It is the opinion of the team that the project should not be terminated on the basis of cost of upgrading computer technology any more than one should consider closing down a company because its word processors are obsolete and need replacement.

2.2.9.6 The Telecommunications Problems

The refrain heard in every country in the Sahel relating to the late arrival of the remote sensing derived materials (NDVI) should produce an immediate reaction and involve seeking a rapid solution to this problem. One of the few attributes of, and perhaps the only rationale for producing decadal NDVI maps, is that they provide real time evaluation of the state of pasture land, locust habitation areas, and to a lesser extent with greenness information as it can be related in a very general way to agricultural development and monitoring. Given that the maps are 10-20 days late in every case and that the national SAP/FEWS/GTP teams have long since produced reports, it would seem that an immediate solution is critical or the project's main objective becomes a sham.

The quick and inexpensive solution to this problem is relatively simple and requires the purchase of high grade Fax machines through which system black and white versions of the NDVI must be sent within one day of their production at the ARC.

Such a system is presently in use and operated by the French project at AGRHYMET with maps going out to a selected audience of donors interested in the country's agricultural or meteorological services.

A careful analysis of other communication requirements should be undertaken during the last part of Phase III in preparation for Phase IV, and the expected emphasis during that Phase on the rapid combination of dynamic and static data for real time GIS product development and dissemination.

A second problem related to communications is that which is inherent to intra-national (internal) information transfer. In the normal sequence of events, rainfall is measured at a number of stations throughout each country with the information passed by radio links to the National AGRHYMET station for transfer to the ARC. Where there are too few field stations or lost radio contact because of equipment failure, the whole system breaks down and the long-term goals of the AGRHYMET program go by the boards.

The national centers require continuous transmissions of field meteorological and agronomic data. Such data can only be provided to the NACs and the ARC, and transmitted to the farmer if the SSB Radio System is maintained and improved.

The following is needed to maintain and/or improve the SSB Radio System:

- Maintain existing radios (repair or replacement).

- Supply of power sources for radio transmissions. Batteries and solar panels should both be considered.

- Supply NACs with generators so they have reliable and continuous radio reception from the field. In addition, (USAID supplied) computers can operate during power outages.

- Increase the number of reporting stations by providing additional radios, thereby improving quality of statistics.

The above can be implemented through the following:

- Conduct a needs assessment of each NAC communication requirements.

- Provide guidance and methodology to USAID missions for establishing buy-ins for communication linkages in the NACs in support of FEWS, AELGA and AGRHYMET activities. The buy-in can be implemented as a FEWS activity, for example, funds could be local counterpart currency.

2.2.9.7 Appropriate Systems and Tools

One of the objectives of the project identified in the PASA is the establishment of clear, simple, appropriate systems and tools to carry on project operations with a minimum reliance on costly, expatriate inputs after 1991.

Establishment of clear, simple, appropriate systems and tools to carry on project operations with a minimum reliance on costly expatriate inputs after 1991.

- A satellite receiving station with its complex hardware, software and concomitant systems and logistic support, as well as required education and training cannot be considered simple nor is it cheap. It is important therefore that USAID countries and donors disabuse themselves of this notion and not include this premise as a sine qua non of the sustainability of this project.

- Similar projects in Europe, the U.S. and the Far East require a high level of training, complex technology and an investment compatible with these two requirements. Any assumption to the contrary relegates Africa and the Sahel to the level of second class nations.

2.3 G.I.S. Component

2.3.1 Background and Introduction, Project Goals and the G.I.S. Component

As part of the goal to strengthen the capacity of the AGRHYMET System to perform agrometerological and hydrological data collection and analysis in the Sahel, the USGS Project was to provide the following technical assistance, training and materials during Phase III.

The project paper, RNA, PASA and project amendment #2 identify the need:

- To establish ARC and NAC capabilities which concentrate on data collection and archiving,

- To establish GIS capabilities in order to effectively utilize the data collected,

- To provide GIS training,

- To provide GIS technical assistance,

- To provide GIS equipment and software,

- To establish an effective GIS system.

2.3.2 Scope of Work

The original PASA provided two general categories of Work Statement (Section II, 1.3 Background):

(A) Technical Assistance and training for developing a sustainable ARGHYMET ARC and NAC Program as defined in PIO/T 625-0973-3-80904 and the RNA, and,

(B) Transfer of software capabilities to the ARC and training for AVHRR and GIS software use.

The PASA amendment will increase the level of effort in order to accelerate and enhance these work statements. The effort is divided into three primary categories:

1. Provide additional training in the application and operation of the systems,
2. Provide additional technical assistance to develop sustainable systems for critical problems of the ARC and NACs, and,
3. Administration and payment of per diem directly to AGRHYMET sponsored training participants.

2.3.2.1 System Definition

(A) Design and conduct pilot studies emphasizing local, national, and regional information system structure and applications. The initial step in this effort will be to define the objectives of the pilot tests and determine appropriate test sites. This will be accomplished through discussions with appropriate authorities within the AGRHYMET Program.

(B) Determine functional and technical specifications of GIS computer hardware and software appropriate for implementation in the ARC and the NACs. This will be accomplished by using the pilot studies in a prototype process. Specifications for an AGRHYMET GIS will be prepared, a detailed evaluation of available systems will be made, and a GIS configuration that best meets the needs of the NACs and ARC will be selected and tested. The recommendations will be presented to USAID/Niger AGRHYMET management for review. Concurrence from the USAID/Niger AGRHYMET Project Officer is required.

(C) Following concurrence from the USAID/Niger AGRHYMET Project Officer, several Geographic Information Systems will be purchased, tested at the EROS Data Center, and then transferred to AGRHYMET for use in operational programs and training (see section IV. (a)).

(D) A report summarizing the pilot studies, GIS equipment evaluation, and recommendations for AGRHYMET GIS implementation will be submitted to USAID/Niger and AGRHYMET management by December 31, 1991. This report will be prepared for review and concurrence prior to field implementation of the systems.

2.3.2.2 Additional Training

A GIS training and awareness program will be developed as part of the project. The costs for NAC participant travel to Niamey for these training programs are not included in this project agreement. Two levels of training will be developed:

(A) A formal training course will be offered at the ARC to train NAC and ARC technicians in the operation and use of the GIS.

(B) Country workshops for decision makers and cooperating technical ministries in the potential applications of the technology for their critical country problems. The workshops will be aimed at helping government officials define and prioritize implementation procedures, and in making internal resource commitments for sustaining the system in their respective countries.

Informal training of working technical staff at both the NACs and the ARC will occur through their co-participation in system implementation. Activities defined in System Definition above will identify one member country activity where one or more of their technicians will concentrate on early development and testing of the information systems. From their evaluation and example uses, training materials will be developed for the first training course.

2.3.2.3 Technical Assistance

Additional technical assistance will be required. However, no increase in long-term technical assistance for staff stationed at the ARC is envisioned. The technical assistance will be provided by TDY staff from the EROS Data Center in Sioux Falls, South Dakota and the existing USGS long-term technical assistance staff. (Note: no additional funds are required for the technical assistance staff salaries. However, additional travel and per diem funds are budgeted).

(A) Develop an ARC/NAC implementation plan. This includes defining and prioritizing resource issues and countries in a phased implementation plan. The plan will be developed and a report prepared in conjunction with the report identified in system Definition, paragraph (A) above, for concurrence by the USAID/Niger Project Officer.

(B) Provide guidance in structuring and implementing a system for taking maximum advantage of AGRHYMET data for country level planning and local data use.

2.3.3 Observations

2.3.3.1 G.I.S. Accomplishment within the Project

The EDC/USGS team has accomplished the following tasks.

- Two Sahelians have been trained at WMO Headquarters in Geneva on operating, programming, maintaining and updating a GIS. The software they are familiar with is called IDRISS I and ARC/INFO and is the UNITAR preferred system. These individuals are highly competent, well trained and ready to use and apply any hardware/software combinations which might be chosen as the basis of the ARC GIS.

- ARC personnel have acquired a limited amount of baseline resource data relevant to building a GIS. These data were acquired from the NAC's and digitized and aggregated within an unstandardized framework. The group doing this is referred to as the SBRD committee.

- The USGS field team has held numerous discussions within the project, within AGRHYMET, and with USAID Niamey project management to decide on the most appropriate system.

- The USGS team has conducted a workshop in Niamey, Niger on the applicability of certain GIS software and hardware to Sahelian countries. A number of other Niger based GIS users attended the seminar.

- The Project has available to it eight AST microcomputers (386), appropriate jet printers, digitizing table(s) and other equipment necessary for the establishment of a GIS and the development of baseline data archives, data management systems and data analysis systems, and the creation of hard copy maps and other graphic representations of data relevant to the Sahelian context.

- The project has produced a number of documents defining or describing GIS requirements, equipment and needs. These have been produced by members of the USGS PASA team. The most recent have been prepared by the Team Leader in April 1991 and by the USGS Project Coordinator in late May 1991. Although the documents were unofficial, they were submitted to AGRHYMET.

- The USGS team has sent short TDY staff to the Niamey Center to provide assistance in developing the required GIS.

- The USGS EDC has worked effectively at developing some of the requirements for a CILSS GIS at Sioux Falls.

- The USGS has provided funding to consultants to develop certain data bases for inclusion as baseline information layers in the AGRHYMET GIS system.

- The USGS has promoted the use of GIS in FEWS, AFR/TR, Sahel Desk, the World Bank, and the Club du Sahel as it relates to Sahelian/CILSS needs.

2.3.3.2 Problems in Reaching Project Goals of Creating a GIS

- A GIS "needs assessment" has only recently been completed and does not include input from GIS experts, Sahelian countries, other users in Africa (Sahel) other CILSS projects, NAC users, FEWS, NRMS, the AGRHYMET staff, and other donors within and outside the AGRHYMET structure. The perspective of the most recent GIS needs assessment is good but limited by many constraints.

- The present USGS (and the various needs assessments) view of an AGRHYMET GIS focuses on the data processing aspects of the system (raster vs. vector, software, hardware) or on some particular geographic aspect of the system (scale, projection). The current approach does not however focus on the most critical part of the system, i.e. information. The strategy appears to be to collect some data, digitize it and store it and produce an interpretation whose validity is highly suspect, but whose acceptance will be broad because of the attractive products that are generated. Little or no thought has been given to the validity of the products or their scientific merit. Responses to questions concerning the usefulness of this strategy has often been, "There are no better data out there", or "it costs too much to collect good data", or "we must not impose our requirements on national entities".

  Clearly the quality of the information is critical to producing useful results and thereby validating the role of AGRHYMET. Poor baseline data married to the extraordinary quality of the NDVI dynamic data will simply degrade the value of the latter and ultimately call into question its cost effectiveness and sustainability.

  The information component is critical. Good dynamic weather data is produced by AGRHYMET. Some good "static" baseline data exists for some areas in the Sahel. Good static information must be used in a GIS. Bad quality data is

presently being collected for use in the GIS which will devalue the project and AID investment.

- The needs assessment produced by the AGRHYMET Team Leader is simplistic and will not meet the GIS, ARC, or NAC requirements.

- The SRBD (Systeme Regional de Banque de Donnees) Committee (Regional Data Base System Committee) has defined seven discrete data banks (discipline areas) in which data collection is to take place. However the structure for this data collection has not been defined, no plan exists, no standards regulate data collection, display and reproduction, no standards have been defined relating to data validity, no process has been considered to identify data gaps and methods of responding to these gaps.

- The SRBD plan confuses GIS implementation plans with data products and discusses the data base and future data products interchangeably.

- The AGRHYMET Project (USGS) has made very little effort to collect useful, valid sources of information for the data bank. There exists extraordinarily detailed atlases of pasture resources of each of the CILSS countries produced by IEMNT of Paris. These documents show, grass types, biomass, population (cattle and human) non-pasture areas, forest areas, water resources, water table dates, etc. This atlas and similar atlases (USAID) Niger Forestry and Land Use Project (FLUP) which could be useful have not been collected.

- The ARC has not planned or budgeted for a data acquisition procedure for its GIS data base. No official requests or inquiries have been made to countries and donors for data other than for very basic geographic location and boundary data.

- There have been too many disparate views as to how a GIS should be built and operated in the ARC and NAC. The reason for this is that GIS has been personalized and defined from the bottom up. It has been defined by hardware (DEC), software (Atlas vs ARC/Info), or by a specific user need (human carrying capacity) instead of being <u>simply</u> a geographic information system, using the most up-to-date hardware available and the most appropriate software (data handling archiving and manipulating) with a relational data base manager defined by ARC/INFO with future VECTOR/RASTER integration capability and remote sensing image processing and integration.

- The ARC/NAC GIS has not been defined on the basis of its component parts by the project management.

The components in need of clarification include:

- Hardware @ ARC and NAC,
- Software @ ARC and NAC,
- Geographic standards and scales,
- Data standards and validity,
- Types of data, sources of data,
- Types of data manipulation and treatment, image classification, change detection, data conversion,
- Networking (ARC/NAC),
- Product definition for ARC/NAC (what will be limits of output and user of products?),
- The obligations of the donors, NAC's, ARC, CILSS, USAID in creating, maintaining and funding a functional GIS,
- GIS data flow,
- Static or Dynamic data collection, and monitoring role and obligations of actors,
- Services of ARC and NAC, client to be served, cost of service,
- Training component - in country and in the USA or other?
- Linkages to other CILSS and USAID projects and support requirements.

Whereas the AGRHYMET GIS Needs Assessment Document has only just been completed (June 1991) a GIS implementation plan has been prepared (May 1991) making very detailed recommendations as to country, data collection, individuals involved, and products to be delivered. Such an implementation approach is premature and likely to attract criticism. The approach will be considered sloppy and an imposition by the NAC's.

2.3.3.3 Feasibility and Sustainability of AGRYHMET GIS

2.3.3.3.1 Feasibility

GIS software and hardware is no different from other complex computer software and hardware in use in banks and offices throughout the world. The technology is no more complicated and requires the same level of computer literacy, programming capacity, and equipment maintenance as do other systems already in use throughout Africa.

The human resources exist in Africa to use GIS methods of dealing with masses of geographic and other relevant data that should be manageable by anyone who knows how to operate a computer keyboard. GIS is not a machine, but rather a method for archiving, accessing, formulating and analyzing data.

A GIS system is less dependent on computer literacy than it is dependent on the understanding of two and three dimensional representation of space and materials within a geographic context. GIS allows users to pass from the analysis of a single variable in a single and abstract dimension, namely the relation of a statistic to its analogue in space (reality) (e.g. people/km^2) which is represented in a two dimensional mode on a map by attribute code. Furthermore multi-variant analyses incorporating other measurable attributes, such as soil capacity or disease vectors or rainfall can be quickly and easily manipulated to increase the capacity to understand the implication of change in the framework of a particular problem.

GIS's capacity to very rapidly integrate and manipulate static data attributes, (such as soils) and dynamic ones such as rainfall does not render it's use improbable in the African context. Finally a GIS has the capacity inherent to all computers and clearly demonstrated in computer aided design (CAD) to work in three dimensions so that users can compute the interrelation between a variety of dynamic and static variables.

The preceding examples illustrate that it is not the understanding of the computers and software in a GIS which is the limiting factor for the development of an effective GIS, but rather it is the capacity to understand multivariant analysis in the context of natural and human resources within the framework of space (geography) and time (static and dynamic data) that is at the root of an effective GIS. Few people are trained to be a GIS product generator and manager. This requires training in a natural or social science with emphasis on geography and an understanding of geographic scales and scientific standards and methods, as well as a basic education in statistical analysis. However, many Sahelian Africans in the NAC's and the ARC are qualified and educated to work as GIS product creators and manipulators. Their greatest need is to have typing skills training.

Equally clear is the fact that most managers and economists can not be GIS product generators and managers, but should in fact be GIS users and directors.

GIS use and its effectiveness in the Sahel is based on a minimal amount of training of a technical nature (not scientific). A good GIS will exist when people are well trained in the natural and human sciences and understand the complex permutations involved in conducting multivariant analysis. The Sahelian is certainly capable of such analysis given training and applicable equipment which becomes both cheaper and easier to use and to maintain each year.

2.3.3.3.2 Sustainability

The financial sustainability of all African project depends on the ability and willingness of governments to collect revenue and to finance projects which promote the public good. Since Sahelian countries are primarily agricultural based and are far from self sufficient, projects such as AGRHYMET will not be sustainable in the near future. Until the governments in question have the wherewithal to support AGRHYMET, it is incumbent upon donors to sustain this and other projects which have provided a slight improvement to the standard of living both directly and indirectly. Such improvement can be expected to increase more rapidly as new seed varieties are developed and Africa becomes nearly self sufficient in food.

2.3.3.4 GIS Component Recommendations

It is difficult to offer a step-by-step rational series of recommendations for an effective GIS program because such recommendations will run counter to the current EDC implementation plan.

The following recommendations define some areas of possible change.

- A much more careful and disciplined plan of action for the development of a GIS must be prepared by EDC and field team, particularly as it relates to its component parts and the obligation of the different actors. (see section 2.3.3.2 above)

- Once a plan of action is prepared the data base collection should begin for one country (and not four countries simultaneously as presently proposed). This will avoid the inclusion and preparation of poor data and their propagation in a GIS framework.

- During the first country data base collection and creation, visits should be made to other NAC's by one Sahelian and one project TA person to conduct the following activities:

    - Discuss and define GIS with NAC users,
    - Define user needs,
    - Locate and evaluate static data bases,
    - Collect data bases,
    - Train NAC in GIS data collection, collation, management, use, modeling and product preparation,
    - Define activities and obligations of NAC's and ARC and sign protocol for effective future activities,
    - Request NAC's to prepare a plan and schedule for GIS implementation,

- Request AID mission buy-in through FEWS/NRMS to help NACs develop GIS.

- A discussion of methods and standards must take place in the Sahelian context to stop the proliferation of costly non responsive GIS systems and to promote an understanding of what an effective GIS can do.

- All GIS must be based on a participatory management approach. Sahelian views, opinions and advice have validity and Sahelianization cannot take place without inclusion of these views. An EDC management structure (scientific or otherwise) which excludes these opinions and creates a GIS without the implicit and explicit cooperation (protocol) of the nations involved will have acceptance problems.

- National data base centers (or GIS libraries) should be considered as a means of providing good data to country research programs, donors and potential investors.

2.4 Computer Systems

2.4.1 Hardware Issues

In general, there are very few problems with hardware at the ARC. Problems that do exist have been identified, and, with the sole exception of the communications difficulties between the ARC and NAC's, solutions have been formulated to resolve them.

2.4.1.1 VAX 11/780 Capacity

Since the inception of the Belgian climate data project the capacity of the VAX 11/780 has been exceeded. The problem has consisted of two parts: 1) inadequate hard disk space, 2) a slowdown of processing by excessive timesharing demands, which has delayed production of NDVI maps. All concerned are agreed that this problem will be resolved when the new MicroVAX 4000 is put into service. This new computer reportedly arrived in Niamey during the last week of the teams visit, and was awaiting customs clearance.

2.4.1.2 DECNET Communications

There has been a continuing problem with communications between the French MicroVax computer controlling the satellite reception station and the Vax 11/780. Data from the reception station had to be downloaded to tape and reloaded to the 11/780's disks--a

very time consuming process. This problem was supposed to be resolved by the installation of the DECNET LAN to directly connect the two computers, but, unfortunately, although communications was established, it is still slower than the tape interface. This problem has been diagnosed by M. Toure as an incompatibility in the operating systems of the two computers. The plan now is to install a new operating system (VMS-5) on the reception station computer.

2.4.1.3 VAX 11/780 to Personal Computer (PC) Communications

One of the major blockages in getting the digital NDVI data to the NAC's has been the lack of a communications channel between the VAX 11/780 and the PC's. This problem appears to have been resolved by the installation of the Ethernet LAN system, which was successfully tested during the last week of the team's visit.

2.4.1.4 LAN for the Training Room

Hardware and software for the Lantastic LAN have apparently already been received at the ARC and is not presently installed. This equipment could be profitably installed in the training room with the purpose of ameliorating some of the software management problems related to this equipment (see Personnel section below).

2.4.1.5 Obsolete Hardware

There is a great deal of obsolete hardware at the ARC, not the least of which is the PDP 11/60. This equipment is taking up a great deal of space in both the storerooms and the computer rooms. There has been no policy formulated for disposal of this equipment. This problem will soon become critical, probably with the arrival of the MicroVAX 4000.

2.4.1.6 ARC to NAC Communications Equipment

This is without a doubt the most critical, unresolved issue. Without adequate communications between the ARC and the NAC's there can be no regional program. This is not, strictly speaking, within the original scope of USGS responsibility, but it is a critical link in the system, upon which most of the rest of the USGS efforts depend, and therefore must be addressed and resolved.

Current attempts to resolve the issue depend on the use of the modems supplied to each of the NAC's by the project. M. Toure reports that tests have been performed on this equipment between all nine NAC's, with mixed results. The tests were successful in five countries: Niger, Senegal, Mauritania, and Burkina Faso. Chad had problems, but M.

Toure indicated that he thought they could be resolved. The tests failed to establish communications with Guinea Bissau and Cape Verde.

The evaluation team received contradictory information from two of the NACs: Mali and Mauritania. The team was told in these two countries that the communications tests had failed because line conditions were of inadequate quality. M. Toure indicated that operational communications were scheduled to start the first decade of the season with those countries where the tests had been successful. They had not done so because of the strike at the ARC. He indicated that arrangements were being made to start with the next decade.

Regardless of the success in some of the countries, there still remains an unresolved communications problem in others. The project is exploring a number of alternatives, including a variety of satellite links, but no adequate solution has yet been proposed.

2.4.1.7 Microcomputers

There were no problems identified relating to the microcomputer hardware. The system appears to be appropriate and are operating as planned.

2.4.2 **Software Issues**

This section deals with the software directly involved in the operation of the computer systems. Applications software is discussed in specific applications sections. As in the hardware section, software problems are minor, and well on their way to resolution.

2.4.2.1 LAS-5 and Automation of NDVI Map Production

A major component in the effort to transfer responsibility to the Sahelian staff is the production of the NDVI maps. This is currently the responsibility of the Production Supervisor. A number of steps are currently under way to achieve this goal. Experts at EDC are writing software that will automate the NDVI map production process to the extent that it can be routinely performed by a low level computer technician. These production routines are being written in the Land Analysis System, Version 5 (LAS-5). Production is currently being done using the previous version of this software, LAS-4, the decision having been made to not install LAS-5 until the new MicroVAX 4000 was in place. With the arrival of this new equipment (see section 5.1.1, above) the production supervisor expects the transfer of production responsibility to proceed rapidly, allowing him to shift emphasis to developing new methodologies and providing more training support to the NAC's.

2.4.2.2 Reception Station Operating System

As mentioned above, there is a continuing problem of communications between the satellite reception station MicroVAX and the PDP 11/780 that is blamed on the operating system of the MicroVAX. An upgrade to the VMS-5 operating system is expected to resolve this problem.

2.4.2.3 Microcomputer Software

No problems were detected involving the software for the microcomputers. Everything that is needed is available. The software is appropriate and well documented. The Software Manager is readily available, and completely capable of helping users with any problems they may encounter.

2.4.3 Personnel and System Management

2.4.3.1 ARC Maintenance Staff

The ARC maintenance personnel are well trained and completely capable of maintaining all of the computer equipment and peripherals installed at both the ARC and the NAC's

2.4.3.2 Software Manager

The ARC software manager is well trained and capable of assisting computer users with any software problems that may arise. Unfortunately, this person will leave sometime during the year, and there have, as yet, been no moves made to find or train a replacement.

2.4.3.3 Training Room Maintenance

The training room is filthy. There is a layer of dust on all of the furniture. Papers and books are scattered around the room. The open book shelves are disorganized and full of inappropriate materials. Obsolete and non-functional equipment is scattered about. A thick layer of dust was discovered covering the internal components of the microcomputers. No one was given responsibility for ensuring that the room and the equipment it contains is cleaned regularly.

2.4.3.4 Microcomputer Equipment Management

Major problems exist in the management of the microcomputer equipment. Four of the nine AST 286's that are supposed to be located in the training room were, in fact, located

in private offices. The team was told that the computers were brought back to the training room when they are needed for training courses. It was also indicated, however, that there were not enough microcomputer resources available in the training room to meet the needs of all users. Placing the communal microcomputer resources in private offices reduces their availability to the general user community.

The nine ACT 386 machines that were purchased for the NAC's have been distributed around the ARC. The NAC's are aware of this, and in the countries where existing microcomputer resources are strained, such as Senegal, Niger and Mali, a great deal of resentment exists.

The distribution of HP Paintjet color printers purchased for the NAC's, four of which have recently arrived at the ARC, could pose a similar problem. When asked where these machines were to be installed, M. Toure replied that two were to be installed in the GIS room, and the destination of the others had yet to be decided.

There was also quite a bit of comment about the lack of accessibility to the laser jet printer which is located in the Team Leader's office.

There did not appear to be a formally organized system of regular, preventative maintenance for the microcomputer systems located in private offices. Nor is there a system of recording microcomputer usage, either in the private offices or in the training room. Without such records it is impossible to evaluate the degree to which installed capacity meets requirements.

2.4.3.5 Microcomputer Hard Disk Management

The software manager is responsible for checking out software. She has established a system of checking out software which is supposed to be erased from hard disks before it is returned. Unfortunately, the system contains no means of insuring that this is actually done. Since an adequate list of installed software was not kept, it was impossible to verify copyright violations, however, it is the team's observation that such violations are common in the ARC. The amount of software installed on the hard disks in the training room alone suggest this to be the case (ie. ATLAS*GIS is on every machine). The team could not check every machine in every office, but the contents of the hard disks checked led to the same conclusion for these machines.

There is a program available at the ARC to record machine usage, but it has not been installed, either in the training room or in private offices.

The hard disks in the training room are very poorly managed. The software manager only maintains them when preparing for a course. Otherwise they are left to the mercies of a multitude of individual users. There is no responsibility assigned for maintenance of the hard disks located in private offices.

2.4.3.6 Minicomputer Management

There were no significant problems identified with the management of the minicomputer systems. The user community is much smaller, and any problems that have arisen have been worked out on an ad hoc basis.

2.4.4 Conclusions

- The hardware at the ARC is appropriate to the tasks that it is required to perform, and, for the most part, has no problems that are not solvable through the efforts under the current program of activities.

- The only exception to the above, is the problem of communicating with the NAC's. Although this is not a primary USGS responsibility, it is essential to the proper performance of the rest of the USGS project activities, and must be resolved.

- The systerns software at the ARC is completely appropriate. Where software is being developed, progress is on track.

- The Sahelian maintenance and software management staff at the ARC are well trained and qualified to perform their functions. The only cloud on the horizon is the impending departure of the Software Manager.

- Regular maintenance of the personal computers, both in the training room and in the private offices, is grossly inadequate.

- At least four of the computers which belong in the training room have been improperly removed to private offices. This unduly reduces the computer resources available to the general user community, which have been described as inadequate by the Software Manager.

- Equipment purchased for the NAC's has been retained by the ARC, which is causing discontent at the NAC's.

- The records of equipment use are inadequate. Without such records it is impossible to evaluate the degree to which installed capacity meets the requirements of the project.

- The management of the microcomputer hard disks is inadequate. There is no record keeping system for installed software so it is impossible to determine what software is supposed to be loaded on which machines. This has led to probable wide scale copyright violations throughout the ARC.

2.4.5 Recommendations

- Current efforts to resolve the communications difficulties with the NACs must be given the highest priority. Operational communications with the countries where modem tests have been successful should be established at once.

- A replacement for the Software Manager should be identified as soon as possible. This individual should be hired at least two months prior to the departure of the current software manager to ensure adequate training and a smooth transition.

- Regular maintenance procedures and documentation thereof must be established and enforced for the personal computers, both in the training room and in private offices. An individual must be identified to carry out this activity on a regular basis.

- The AST 286 machines that have been improperly removed to private offices should be returned to the training room immediately to optimize the computing resources available to the general user community.

- Unless specific justification is forthcoming, all equipment that has been purchased for the NAC's should be immediately delivered. If not, there is a grave danger of causing unnecessary dissention between the ARC and NAC's. If there is justification for retaining NAC equipment at the ARC, the NAC's should be informed.

- A system should be developed to keep track of the computer usage, both in the training room and in the private offices, and a person, probably the software manager, designated to oversee it. This is essential if future computer acquisitions are to be justified.

- A software inventory system should be developed to govern the maintenance of hard disks, both in the training room and in private offices. The possibility of installing the Lantastic LAN in the training room should be explored as a possible

component of such a software management system. A diligent effort must be made to avoid copyright violations.

2.5 Agrometeorological Applications

2.5.1 Climatological Monitoring

2.5.1.1 Climatological Data Base Development

The development of a regional CDB for the CILSS countries represents one of the major achievements of the AGRHYMET program. Several weather variables with emphasis on rainfall were collected, digitized and organized in computer files.

A detailed weather data inventory for each country is available. It specifies type of data, location, period of record, missing data, etc. The length and completeness of the historical weather data varies among countries and locations. An updated listing of countries and locations is attached in Annex VI. USAID contributions in terms of computer hardware, training and technical assistance made possible the development of a regional climatic data base.

The application of data base development programs such as CLICOM and CLIMBASE has considerably improved the data capture and archiving.

The large climate data base developed for all CILSS countries requires a considerable amount of disk space. A recent acquisition and operation of optical disks has allowed a more efficient archiving and retrieving of meteorological data.

2.5.1.2 Climatological Analysis

A significant effort in statistical rainfall analysis has been made. The availability of historical records of daily rainfall has allowed a statistical analysis to determine descriptive statistics: long term mean, standard deviation, coefficient of variation, etc.

Plots and histograms have been prepared to observe time and space variability of rainfall. The distribution of decadal and monthly rainfall on a regional or country basis has been accomplished by using isoline drawing programs (i.e. SURFER). Isoline maps of currently observed rainfall (decadal or monthly) in actual amounts or in deviation from long term mean are being prepared on a routine basis.

2.5.2 Agrometeorological Analysis

A valuable effort has been detected in the development of computer programs to derive agrometeorological variables such as potential evapotranspiration. The programs can manipulate recorded weather data or derived variables for export into application programs (soil moisture balances, etc).

2.5.3 Observations

CLICOM is a data base management software distributed by WMO to the weather services of member countries. CLIMBASE is also a data base management program developed by USGS technical assistance. Although there are some indications that CLICOM is being used successfully in some countries there are some problems in using CLICOM at several National AGRHYMET Centers. NACs personnel from Guinea Bissau, Cape Verde, Senegal, Mauritania, Chad, Burkina Faso and Mali indicated that the routine use of CLICOM for data base development and management has shown the following shortcomings:

- It is not very "user-friendly" and requires considerable training.
- Error trapping is inefficient and command errors are often fatal, causing frequent loss of already entered data.
- It has space limitations for a large data base (i.e. CILSS countries data base)
- Transfer of data on CLICOM format between computers is difficult.
- The development of data files for other programs (Surfer, Lotus, GIS) requiring special formats is not possible.

Therefore CLIMBASE can be used to support and complement CLICOM.

- There is not a widely tested soil moisture balance (SMB) method to estimate crop available soil moisture. Two SMB methods were established (CLIMBIL and DHC) at ARC. CLIMBIL is a computer software developed at ARC that implements a FAO soil moisture balance. DHC is also a computerized SMB method developed by IRAT (Montpelier, France). There is a need for establishing a reliable testing and evaluation procedure. The major components of a SMB method such as rainfall, evapotranspiration, crop coefficients, soil water holding capacity and crop calendar should be analyzed and determined for local conditions. Calibration and verification of any SMB methodology using observed soil moisture data are required before it can be used in an operational system. DHC estimates of soil moisture balance components are being published in NACs bulletins (i.e. The Gambia and Guinea Bissau) without verification with observed field data.

- The development of quantitative relationships between SMB derived indices and observed crop productivity variables (biomass accumulation, crop yield components, etc) has not reached a desired level for operational purposes. During the last two decades a considerable amount of research and development has been done in crop yield modeling using environmental variables. An adaptive work of selected crop yield models for the Sahelian environment can provide adequate tools for crop yield forecasting.

2.5.4 Agrometeorological Applications Recommendations

- Develop a full software documentation for CLIMBASE (in English, Portuguese and French) to firmly establish it as a data base management program. After extensive testing, provide wide distribution and training as a support software for CLICOM in CILSS countries.

- A working plan for field data collection of relevant variables should be developed. Agricultural/environmental variables such as crop phenology, crop yield components, and soil moisture content should be recorded according to known methodology. Some of the data collected from Pilot Projects in different NACs may be useful for calibration of agrometeorological methods for crop yield monitoring. The observed field data can be used for testing and evaluation of agrometeorological/remote sensing products.

- An operational SMB should be in place as soon as possible after calibration and testing with field data. The process to obtain needed soil moisture observations for calibration and testing should be planned and coordinated with the National AGRHYMET Centers. The NACs may provide the required personnel for field observations and in some countries there are available appropriate instruments (neutron probe, ovens and laboratory scales). In this way, crops and local conditions will be considered as input variables into the SMB.

- Develop SMB derived indices such as the RI (Yao, 1969), the SMI (Ravelo and Decker, 1979) or any other and relate them to NDVI and observed crop yields. RI and SMI can also be plotted to illustrate time and space variability of these indices for specific crops. This may lead to a better interpretation of the greenness maps or any other remote sensing product in terms of crop productivity.

- Compute and plot drought/crop moisture indices (for example those developed by Palmer, 1965 and 1967) on a decadal bases and relate them to the NDVI. This will enhance the crop status information provided by the NDVI.

- As suggested in the Requirement Needs Analysis report, regional rainfall maps should be developed using a Meteosat and/or NOAA satellite based system. There are several methods (ADMIT, PERMIT, BIAS, etc.) currently available for rainfall estimation. Snijders (1991) compared several estimation models for West Africa. The rainfall maps will provide spatial resolution for the raingauge data and will enhance the early warning of drought and accompanying low crop yields. A geostatistical technique (kriging) may be used to combine satellite and raingauge data (Creutin et al., 1986).

- Provide training to NACs in above agrometeorological applications as well as in field data collection.

2.6 Data Acquisition and Distribution

2.6.1 Meteorological Data

Meteorological data for the region are collected at the national level. These data are then transmitted via the Global Telecommunication System (GTS). The summarized decadal data for Mali, Mauritania, The Gambia, Guinea-Bissau, and Cape Verde are transmitted to Dakar and then relayed via satellite to Niamey. Burkina Faso and Chad transmit directly to Niamey.

Data collected from the Agrometeorological stations at the various NAC's includes precipitation, maximum and minimum air temperature, soil moisture, soil temperature (at different depths), wind speed and direction, evapotranspiration, humidity, day length and solar intensity. The data collected over the past 15 years has provided a valuable regional data bank and has been an important outcome of the AGRHYMET Program.

Despite the establishment of a regional data bank, there are too few agrometeorological, synoptic and rainfall data points. More stations for recording data need to be established to provide a more reliable climatological picture.

There is also a major problem in transmission of data both within the NAC countries and between the NAC's and the ARC. Assistance to improve telecommunications by the Italians has not been forthcoming and is urgently needed to improve the timeliness of data transmission. The ARC and each NAC should be provided with a fax machine, along with radios that are urgently needed to transmit data from the data collection stations to the NAC.

2.6.2 Bulletin

Two types of regional bulletins are being produced at AGRHYMET Center, decadal and monthly. Several aspects are addressed including meteorological conditions (mainly rainfall), crop and pasture monitoring, locust and pest infestation and river flows. Rainfall analysis in terms of cumulative amounts, departure from normal and deficit/excess situations are presented in tables and maps. A summarized discussion is included. Crop/pasture information in terms of weather impacts on planting, plant growth, and productivity is also included. Locust population and other pests are being monitored and commented on regarding potential outbreaks.

The bulletins are prepared immediately after the end of the period (10-day or month) and distributed to the regional audience (government and non government institutions of the CILSS countries) and international organizations.

The frequency of the bulletins appears to be appropriate for particular issues. From the agricultural point of view, 10 days is a reasonable period of time to notice any variation on crop or pasture responses to weather impacts. Plant pests and diseases have a shorter time response to environmental conditions. Therefore, the monitoring and assessment of pest/diseases outbreaks may require the issuing of special bulletins with different frequency.

2.6.3 NDVI "Greenness" Maps

The "greenness" maps are produced and distributed to the NAC's each decade of the growing season. As discussed previously, the degree of utilization of these maps varies. While some NAC's use the maps for identifying greening up of pasture areas or for the identification of potential locust infestation sites, most agree that the maps have only limited utility for agricultural applications. The scale of the maps is not appropriate for identifying and distinguishing farm land from pasture, and the maps generally arrive too late (10-20 days) to have real time applicability. Furthermore, the index is arbitrary and not linked to reality and what is actually happening on the ground. The numbers are meaningless - for example no one knows what an index of 0.4 or -0.2 really means except that one has considerably more green vegetation than the other. No attempt has been made to correlate the index with amount of rainfall, soil moisture or any other meaningful variable.

2.6.4 Recommendations

- Improved telecommunications. Fax machines should be provided to the NACs and ARC. Radios are also needed for transmission of data.

- Consideration should be given for the expansion of weather stations and the establishment of automatic stations.

- A user needs assessment should be carried out to establish the type of information, frequency, format, etc. of the bulletin.

- A number of tables (i.e. DHC estimates) may be represented by graphs considering only the most relevant variable in the bulletin.

- Research needs to be conducted to correlate the NDVI with the real world situation.

- The quality of the map production needs to be rigorously controlled to meet the USGS standards.

- More products need to be introduced at both a national and regional level. Products should be geared to the needs of the NAC's.

2.7 Training

The training component has been one of the more successful aspects of the AGRHYMET Program. A curriculum in agrometeorology, hydrology and computer technology has been established at the ARC and technicians from the NAC's have received both long term and short term training. Eighty-two percent of those trained in Niamey are still working for AGRHYMET. Long term and short term overseas training retention rates have not been as high, only about 45 percent.

2.7.1 Agrometeorological Applications

Training in Agrometeorological applications has been provided in the following areas:

- Data base management using Climbase software.
- Rainfall analysis using Suivi software.
- Computing agrometeorological variables using Suivi software.

The training provided to ARC and NAC technicians was effective. This was verified at the NACs during interviews with local technicians, particularly those responsible for the bulletin. NAC personnel trained at ARC and involved in the application areas mentioned above, showed a high level of expertise. There are some requests from non French speaking countries to provide training in English and Portuguese.

The following recommendations are proposed:

- Training in crop phenological/phenometric observations would be beneficial. This information can be used as "ground truth" for remote sensing data and agrometeorological applications. Crop responses variability in terms of biomass accumulation, growth stages, and yield are mainly due to weather and soil conditions during the growing season. The soil moisture balance, as well as other weather/soil indicators, are needed to identify the causes of such crop responses variability. In order to establish a relationship between crop productivity, environmental conditions, and remote sensed data, records of crop management (planting date, fertilizer applications, irrigation, etc), crop events (dates of emergence, flowering, maturing, etc), and crop productivity (biomass weight, grain weight and number, etc) are needed. Systematic observations of the above variables are recommended.

- Training in agrometeorological applications such as drought/crop moisture indices, crop yield and pasture production modeling is also needed.

2.7.2 Computer Training

AGRHYMET has a cadre of well trained computer technicians and computer maintenance personnel. Training should continue primarily in-country using ARC and local NAC personnel.

2.7.3 Remote Sensing/GIS Training (See Sections 2.2.8 and 2.3.3.4)

Training for remote sensing/GIS has been discussed in 2.2 and 2.3,

- Training must focus on the application and use of remote sensing products specific to local needs.

- Training should be two phased:

- For a limited number of individuals, long term training (2-4 years) in the U.S. is warranted if it also involves GIS, natural resource and environmental management.

- Short term, three week, in-country discipline specific training should focus on digitizing interpretation use of software and remote sensing applications.

- Training should also focus on field testing methodologies for NDVI verification and relationship of NDVI to rainfall/greenness.

3.0 NATIONAL AGRHYMET CENTERS

Following a week of interviewing and discussing the progress of the AGRHYMET Programme and AGRHYMET Project with USAID and AGRHYMET personnel in Niamey, Niger, the evaluation team separated to visit each of the National AGRHYMET Centers. Andres Ravelo and Douglas Brown visited Senegal, Cape Verde Islands, The Gambia and Guinea-Bissau. Andrew Stancioff and Derrick Thom visited Burkina Faso, Mali, Mauritania and Chad. The following is a report of each team's observations, conclusions and recommendations.

3.1 Burkina Faso

The arrival of the evaluation team in Burkina Faso was not expected by USAID/Burkina since a cable had been sent to AID/Niamey stating that key people to be interviewed in the Meteorological Service were in Geneva attending an international meteorological conference. This information was never passed on to the evaluation team. Insofar as the team's arrival had not been expected, interviews and contacts had to be arranged. The team was able to meet with individuals interested and involved with AGRHYMET. This included USAID/Ouagadougou personnel, the FEWS representative, CILSS personnel and the Meteorological Service personnel.

3.1.1 Observations

AGRHYMET in Burkina Faso is located in the Meteorological Service which occupies a relatively new building in Ouagadougou. The spacious building included a library, archives, maintenance facilities, computer center and conference room in addition to office space. There was room for expansion insofar as the building is presently under-utilized. Although relatively new, the facilities were observed to be in need of cleaning and general maintenance.

The Meteorological Service has established ten synoptic weather stations at Ouagadougou, Dori, Ouahigouya, Bobo-Diolasso, Fada N'Gourma, Boramo, Debougou, Po Goua Gozamo and Bougourde. Contact with the center in Ouagadougou is maintained through SSB transceivers for information pertaining to meteorological data on total rainfall, maximum/minimum and average temperature, humidity, total evapotranspiration, average solar intensity, soil temperature at the surface, 50 cm and one meter, wind speed and direction. Basic meteorological data are recorded every three hours and sent to the National AGRHYMET Center and ASECNA. Data are compiled and published in a bulletin every ten days during the growing season. These data are also sent to the AGRHYMET Center in Niamey which compiles the data into a regional bulletin. Although well organized for the collection of data, there is a need for reliable

communications between the various collecting data points, the National Center and the Regional Center.

The people interviewed in the Meteorological Service had been trained at the Regional Center in Niamey. All expressed satisfaction with their training. In addition to long term training, all had participated in a few seminars and workshops organized by the AGRHYMET project. While satisfied with their training, all expressed concern about keeping up in a rapidly changing field and endorsed the idea of continued workshops and seminars at both the ARC and NAC's.

The Computer Center was a relatively clean, dust free environment that was well air-conditioned and fully operational. The three AST-VGA computers donated by AID were observed to be operational, the fourth computer had been donated to Hydrology Service. The team also observed that the obsolete PDP11-34 was still in place although no longer operational. There was a library of software that included word processing, spreadsheet, and graphic programs. The staff was aware of the presence of the ACT 386 computer in Niamey that was to be shipped to the NAC's, and were anxious to receive it. They expressed a need to have additional memory capability to prepare for the development of a GIS data base.

Discussions of the NDVI "greenness" maps focused on how they were being used. Although they were viewed as a useful product, there was no consensus of how they should be used. None of the people interviewed had interpretive training and stated they would not only like to have a hard copy but also a diskette of the data. They also expressed a need for workshop training on the use of the "greenness" maps.

The Meteorological Service of Burkina Faso has links with the Ministry of Agriculture and the Hydrology Services of the Water Ministry. However, to date, the hydrology has not been integrated into AGRHYMET. As a consequence, AGRHYMET is viewed primarily as a meteorology program with limited agrometeorological applications.

Both USAID/Ouagadougou and CILSS expressed concerns over management of both the AGRHYMET Programme and Project. USAID/Ouagadougou viewed the Project with some skepticism and felt it was unrelated to reality. It was generally expressed that the AGRHYMET project provided good support to the National Centers in the provision of equipment and computer training. Concern was expressed that the AGRHYMET team had made little effort to establish contacts with AID, CILSS and related on-going projects in Burkina Faso and other CILSS countries. Only the FEWS representative had strong links with AGRHYMET received and used the bulletins, maps and data provided.

3.1.2 Conclusions

3.1.2.1 Accomplishments

- The AGRHYMET Programme and the AID funded components are generally viewed in a favorable light. The Programme is providing a valuable service and continued support should be forthcoming.

- The data and products provided by the US team are viewed positively although with regard to the "greenness maps", there is some uncertainty as to how they can be utilized.

- There is a well-trained cadre of computer literate individuals who are enthusiastic about their work and were anxious to improve their skills.

- The location of AGRHYMET in the Meteorological Service with a well maintained, functioning Computer Center is a credit to the training the people received at the AGRHYMET Regional Center.

- There is support in the NAC for the establishment of a GIS.

3.1.2.2 Problems

- There is a breakdown in communication between AID/Ouagadougou and the AID funded AGRHYMET Project.

- With the exception of the FEWS project, the USAID/USGS team in Niamey has made little effort to establish contact with projects that could use the data and products being produced by AGRHYMET.

- There have been too few workshops and seminars conducted by the AID/USGS AGRHYMET team.

- Computer maintenance is problematic because the person trained to perform this function is not at Meteorological Center but at Hydrology.

- AGRHYMET has removed a trained technician to the Regional Center and depleted local staff.

3.1.3 Recommendations

- There needs to be a more concerted effort on the part of the USAID/USGS Team Leader to establish linkages with AID Missions, CILSS Headquarters and various NAC's.

- The Team Leader needs to establish linkages with other related projects in the region that can profit from the use of the data and products of the AGRHYMET Regional Center.

- Increase efforts to meet established objectives for workshops and seminars.

- Training and computer facilities are recommended to enable NAC personnel to establish a GIS Data base.

- Increased human resources to meet long-term needs to operate national facilities.

- Long-term (US) and short-term ARC and in-country seminars are suggested in which host country nationals participate.

3.2 Mali

The team of Stancioff and Thom visited Mali from May 3-8 and held interviews and discussions with USAID/Mali, the National Meteorological Service, Ministry of Agriculture, the Hydrological Service, the Groupement de Travail Pluridisiplinaire (GTP), the FEWS representative and Systeme d'Alerte Precoce (SAP). Despite short notice of the team's arrival, USAID/Bamako had established all contacts and set up meetings prior to the team's arrival.

3.2.1 Observations

AGRHYMET in Mali is integrated into the National Meteorological Service and does not have a designated office. The Meteorological Service is located in the old airport facility in Bamako. Although the building is old, it is functional, but unfortunately has a rundown appearance and is in need of considerable maintenance. Administrative offices are located in a newer building close to the old airport. The old airport facility houses the NAC/Mali computer center and archives. A visit to the computer facility revealed that the computers donated by AID were well maintained and functioning. The three AST-VGA computers were identified and the fourth was located at the Hydrology Service where it had been assigned. The Computer Center was not as well maintained as other NAC

facilities. Although located in an air-conditioned environment, the room was not dust free. A window to the access entrance room was open and permitted a dust laden draft to sweep into the computer room whenever the door was opened.

A visit to the archives revealed a wealth of meteorological data dating back to the early 1900's. The data stored in files were gathering dust and rapidly deteriorating to the point that some files were almost illegible. These data need to be transferred and preserved on computer disk before they are lost.

The team was impressed with the quality and level of training of the people working with the Meteorological Service.

More than a dozen people have been trained at the AGRHYMET Regional Center in computer applications, agrometeorological methodologies, computer maintenance, CLICOM and remote sensing. Several Malians have received support to attend seminars and workshops in Europe. While expressing satisfaction with the training component, and recognizing the need for additional training, the Malians were critical of the shortness of the seminars and workshops. The general feeling was that there was insufficient time to effectively learn what needed to be learned. Also, many held the view that there have been fewer seminars and workshops in the past five years since USGS took over from NOAA.

There is evidence of a high degree of cooperation between the Meteorological Service and other government of Mali ministries and services. The Meteorological Service is cooperating with the Hydrological Service, the Ministry of Agriculture, Plant Preservation Service, Livestock Service, and the Ministry of Rural Development. Fourteen government agencies are represented on the Groupement de Travail Pluridisciplinaire (GTP) which functions under the aegis of the Meteorological Service. The GTP in Mali is responsible for monitoring agricultural and grazing lands, and disseminating agrometeorological information to the government and farmers. Since 1982, the GTP has operated a pilot project recognized as the most advanced in the AGRHYMET National network. Currently over 300 farmers in the region are receiving agrometeorological information and advice on when to plant, fertilize and weed. The result has been a 30% increase in yields.

The Meteorological Service produces monthly and decadal bulletins on agrometeorological data during the growing season. Over 150 decadal bulletins and 50 monthly bulletins are distributed to various interested agencies and projects. The data published in the bulletins are collected from 20 synoptic stations, 52 climatic stations and 226 rainfall stations. The Hydrology Service also operated 85 stations to collect hydrological data. A major weakness remains the efficient and timely collection of data. Communications, both internally and externally, remain a problem for data collection for

the Meteorological Service. By contrast, the Hydrological Service has an efficient real time monitoring system through ARGOS.

The distribution of the NDVI "greenness" maps are recognized as a valuable contribution of the USAID/USGS component of AGRHYMET. The GTP expressed appreciation for the maps, but questioned their worth on two fronts. First, the maps were received too late to be of "real time" value. The GTP meets four days after the ten day data accumulation cycle, yet maps are received 10-20 days after the end of the cycle. The GTP indicated that the maps would be of value if they were received in time for their meeting. Second, the GTP expressed concern that there was need for training in the use and interpretation of the maps. The consensus was that the maps provided a broad, generalized, country wide perspective, but was of little value for site specific decision making. Members of the GTP maintain that it is difficult to locate specific areas on the maps and that interpretation would be enhanced with availability of an image that showed geomorphological and other identifiable features.

Other projects and agencies that use AGRHYMET data includes the FEWS project, SAP and USAID/Mali. All use the bulletins and the published agrometeorological data to make country assessment reports. While each regard the maps as interesting, they are uncertain as to their value.

The Hydrological Service is an efficient, smooth running Service with a competent, well trained staff. The headquarters located in downtown Bamako were old but relatively clean. The computer center was well maintained, dust free, and well air-conditioned. The archival data has been computerized and print outs of all the data were neatly filed away in the computer room. The original files were stored in an adjacent room, were dust free and filed for easy access. With Belgian funding, the Hydrological computerized archives are a model for other services and agencies of Mali and AGRHYMET. The Hydrological Service sends data to AGRHYMET and, although not fully integrated into the programme, the degree of collaboration is greater than with any other NAC. Staff is familiar with the NDVI maps but state their value. It was suggested that the USAID/USGS team would provide a valuable contribution for Mali if decadal maps emphasizing water resources (illustrating increasing flooding of rivers, mares, bas fonds, etc.) could be developed. They also expressed an interest in seminars and workshops focusing on hydrological methodologies and applications.

The Mali/NAC has a strong Nationalist sentiment. Concern was expressed that AGRHYMET, in its attempt to standardize data collection, was imposing models and methods that were regarded as inferior to those already being used. The statement was made that they were not prepared to accept anything unless it served their national needs. The staff is well trained and capable of functioning independent of the ARC. The

Regional Center needs the National Centers, and has to respond to national needs and aspirations. Problems will definitely arise if the National Centers perceive that decisions are being imposed upon them. It may be that this will only be a problem in Mali where a separate office of AGRHYMET within the Meteorological Service does not exist. This may be a danger in totally integrating AGRHYMET and the Meteorological Service.

Finally, there was concern over the failure of USAID/Niamey and the USGS team to communicate with USAID/Bamako in an efficient and timely manner. Bamako requests more lead time in being advised of visitors to Bamako, seminars and workshops that are being held. Too often there is insufficient time to get necessary authorization to send Malians for training or to arrange meetings for visitors.

3.2.2 Conclusions

3.2.2.1 Accomplishments

- The Staff is well trained, enthusiastic and innovative. There is a strong sense of accomplishment and independence.

- The NDVI maps are viewed as having practical use.

- The Hydrological Service is functioning efficiently and providing hydrological data to AGRHYMET. Although not integrated into AGRHYMET, there is excellent collaboration.

- Power failures are no longer a problem now that the Meteorological Service has been provided generators by USAID.

- The GTP expressed a strong interest for the establishment of a GIS data base.

- FEWS works closely with AGRHYMET and uses data from both NAC/Mali and the Regional Center. FEWS in turn passes data to the NACs.

3.2.2.2 Problems

- The integration of AGRHYMET into the Meteorological Service does not give AGRHYMET a separate identity. However, the objectives of AGRHYMET are met in a timely and professional manner.

- There is a perception that the ARC is imposing its decisions on the NAC's without considering local concerns and needs.

- There was criticism about the shortness of seminars and workshops.

- AGRHYMET Regional Center is not providing data and maps on time.

- Telecommunications remains a major problem for reporting in a timely manner, both between the data collection points and the Meteorological Service and externally with the ARC.

- USAID/Mali is generally unaware of project objectives and goals although the Mission is supportive.

- The GTP, although organized, does not appear to be working and cooperating as efficiently as it should.

3.2.3 Recommendations

- Provide training in the use and interpretation of the NDVI maps. There is also a need for the maps to be delivered in a timely manner, i.e. in time for the GTP meetings.

- The USGS team needs to assess the feasibility of providing additional products requested by the NAC such as decadal maps that highlight water resources.

- Both the AGRHYMET Programme and Project representatives need to visit Bamako and discuss how the ARC can assist the NAC.

- The USAID/USGS team leadership must ensure that announcements for workshops, seminars and visits to the NAC are planned far enough in advance to allow for necessary preparations at the NAC. The information needs to be given to USAID/Niamey so that cables can be sent in a timely manner.

- The archives of the Meteorological Service needs to be computerized as soon as possible in order to preserve a historical data base that will otherwise be lost.

- The transfer of the ACT 386 computers from Niamey to the various NAC's needs to be done as soon as possible.

- Assistance in improving the internal and external telecommunications for the collecting and dissemination of data.

3.3 Mauritania

The evaluation team visited Mauritania May 9-15 and were hosted by M. Gandega Yelli, Coordinateur National du Project AGRHYMET. As the USAID/Mauritania mission was in the process of closing down, there was no USAID support for the team. The only remaining AID funded project in Mauritania is the FEWS Project. Because of a close working relationship between the FEWS representative and the AGRHYMET/Mauritania Coordinator had been informed of the team's arrival and a full schedule of interviews had been arranged. In addition to talking with staff at AGRHYMET Headquarters, the evaluation team talked with the GTP, representatives of the Ministry of Agriculture, Rural Development, Hydraulique, Elevage, Genie Rurale, FEWS and the US Ambassador.

3.3.1 Observations

The closing of the USAID/Mauritania mission has reinforced a feeling of isolation, neglect and abandonment on the part of AGRHYMET/Mauritania. Although a regional, multi-donor programme, all AGRHYMET NAC's have established links and a working relationship with the USAID missions. Although the linkage with AGRHYMET/Mauritania with the USAID/USGS team in Niamey will be through the US Embassy, the AGRHYMET staff is nevertheless concerned about their future with the closing of the USAID mission. The National AGRHYMET Center was quite critical of the lack of support from Niamey. Although appreciative of USAID/USGS support in providing computer technology, NDVI maps and other material support, they are extremely critical of the non-existent training program. Several seminars and visits by the USGS team leadership that had been planned were canceled. This lack of follow through on the part of USGS has created ill will and a feeling that Mauritania is being ignored.

The Mauritanian National AGRHYMET Center is, in effect, the Meteorological Service of Mauritania, collecting data from 13 Synoptic stations, 10 Agricultural stations and 60 Rainfall stations. Most of the data points are located in the southern part of the country, and neglects the collection of data from the predominately pastoral north. The center in Nouakchott has 14 staff members that have received training through the AGRHYMET Regional Center, with two having been trained overseas in the US and Tunisia. Although the center staff is well trained, the field staff has only minimal training in collecting, recording, and transmitting data. The result is that the data is suspect. For example, the 1990 meteorological statistics were in the process of being corrected. The data was being verified from the field notes collected by the field staff. The finalized 1990 annual report was to be published in May 1991.

The AGRHYMET Center published a decadal bulletin during the rainy season that summarizes rainfall, agricultural, grazing conditions and locust information. Approximately

50 copies of the bulletin are circulated to interested government agencies, services and other projects such as FEWS. The NDVI maps are used to identify grazing and potential locust infestation areas. The maps generally arrive 10-15 days late, but are still viewed as useful. However, the diskette provided was of no value since the information could not be accessed on the computer.

AGRHYMET/Mauritania has recently moved from the Service Hydraulique headquarters to their own building. The facilities are adequate for the present staff. Computer facilities are located in a separate, smaller building within the AGRHYMET compound. The building was built specifically to house the computer center. Unfortunately, it was constructed with windows which have been boarded up and sealed to minimize the dust and sand that constantly blows around Nouakchott. The facility was operating efficiently with all four USAID donated AST computers in functioning order. While the evaluation team was visiting Nouakchott, the AGRHYMET Center had a power failure. There was no alternate power source and work activities in the computer center were brought to a standstill for an entire work day. The computer room was completely devoid of storage space. Software and diskettes were scattered around the room in a disorganized manner.

AGRHYMET collaborates closely with government agencies and has an active GTP that meets weekly and reviews the data to be published in the bulletin. There is also an excellent working relationship with the FEWS project and an exchange of data.

3.3.2 Conclusions

3.3.2.1 Accomplishments

- AGRHYMET personnel are well trained and eager to upgrade their skills with continuing workshops and seminars.

- Effect of NOAA/USAID/USGS project on Mauritania National Meteorological Service should not be underestimated.

- Relationship of FEWS to NAC is excellent, though it may be strained due to the closing of the USAID Mission.

- Training has been effective for meteorologists and computer operations.

- NDVI maps are useful although they arrive 10-15 days late.

3.3.2.2 Problems

- Training is lacking in Hydrology, Agrometeorology, and Pasture lands.
- GIS is poorly understood.
- Distribution of data collection is concentrated in the South. Field staff is poorly trained, resulting in suspect data.
- The Computer Center is poorly equipped with respect to cabinets for storage and generator for power failures.
- Telecommunications are poor.

3.3.3 Recommendations

- There is a need for the AGRHYMET leadership (both Program and Project) or representatives to visit the Mauritanian NAC. Considerable public relations work needs to be done to overcome the too frequent cancellation of visits and seminars.
- The Computer Center urgently needs a generator, cabinets and bookcases. With the closure of USAID mission, there should be surplus material that can be donated.
- USGS should send a team for three weeks training to provide integrated courses on NDVI Map Interpretation, yield modeling, hydrology research, GIS and natural resource management. This should be one week of training, one week of exercises and one week of application, discussion and seminars.

3.4 Chad

The Republic of Chad was visited by Stanicoff and Thom, May 16 - 22 1991. The team was assisted by the USAID Mission in making contact with M. Bagdra Gag, Directeur, Direction de Recherche des Eaux et Meteorologie. M. Gag informed the evaluation team that no meetings had been set up because in the past visitors scheduled from the AGRHYMET Center too frequently canceled their visits at the last minute. These canceled visits had been an embarrassment in the past as he was forced to cancel meetings with government officials. Once M. Gag was assured that we were in-country, he immediately made appointments for us with the GTP, Hydrology Section, Agrometeorology Section

and Meteorology Section of DREM. The team also met with USAID officials, the FEWS representative and SAP.

3.4.1 **Observations**

Chad is a country that has had serious disruptions because of an unstable political situation in the past few years. The most recent disturbance was in December 1990 causing problems in budgeting government activities.

AGRHYMET is under the Direction de Recherche des Eaux et Meteorologie (DREM) in the Ministere des Mines, Resource d'eau et mines. The AGRHYMET office occupies a new building close to the entrance of N'djamena Airport. The building is adequate for the program. Within the compound there are additional older buildings that function as warehouses, offices for hydrology, and the old administrative building that has a conference room, a repair and maintenance room and the computer center.

The Computer Center is in a small room that has been divided into two. The four AST Computers contributed to AGRHYMET by AID were identified and all are in working order. Although small, the rooms were not adequately air-conditioned. One of the two air conditioners had broken down and the repair service had refused to fix it because of an outstanding bill that was owed for 200,000 CFA from a previous breakdown. AGRHYMET has no funds and requested payment by the AID mission who refused and referred them to the Regional Center. The payment has not yet been resolved and consequently thousands of dollars worth of equipment is running under less than ideal circumstances.

As a result of the recent coup, the DREM has virtually no operating budget. The funding situation is so critical that the recent issue of the decadal bulletin announced that there were sufficient funds to publish two more issues. There was also an appeal to donors to provide funding to continue publication.

The recent civil war has had an impact on the network of AGRHYMET data collection points. Under normal circumstances, 13 Synoptic stations, 9 Agrometeorology stations, 132 rainfall stations, and 41 Hydrological stations report to the National Center. Because of the lack of communications, these are no longer reporting, and there is a lack of transportation. AGRHYMET is having to rely on volunteer effort on the part of the military, non governmental groups, and others to report to the Center. Only about twenty stations are consistent in providing data. Historically, Chad has had an excellent reputation in being the first country to report to the Regional Center.

The NDVI maps are usually received ten days late, but are used and discussed in the GTP meetings to make crop and rangeland assessments. Chad has a very active and vocal GTP that uses the maps. One of the computer/remote sensing members of the committee complained that he would like to have a diskette of the data that he could manipulate and use. The diskette that he received is worthless since it is not georeferenced and there is no indication of what the map represents. He explained that he was trained two years ago and is losing what he learned since the ARC has not sent any imagery to be processed.

Despite the critical budgetary situation, the team was impressed with the enthusiasm of the AGRHYMET staff, most of whom received their training at the Regional Center. Two computer technicians had been trained in the US and one other had received training in computer maintenance. Unfortunately, after training in the US, the maintenance person went into business for himself. It was however, mentioned that in gratitude (or guilt) for his USAID sponsored training, he services AGRHYMET computers free of charge.

Among the staff at AGRHYMET/Chad there is a feeling of alienation. They generally feel they are ignored by the Regional Center. They complained of being excluded from visits and short courses sponsored by the ARC, and are convinced that they are by passed because they belong to Central Africa rather than West Africa. These perceptions may be more imagined than real, yet indicate some of the problems that develop when visits and courses are canceled. The ARC needs to maintain contact, provided support and follow through on scheduled visits.

3.4.2 Conclusions

3.4.2.1 Accomplishments

- A well trained cadre of Meteorologist, Hydrologists and computer literate staff that is enthusiastic and wants to work,
- Excellent cooperation between the FEWS representative and AGRHYMET,
- A very active, vocal and contributing GTP,
- A strong past record of providing data to the Regional Center on time.

3.4.2.2 Problems

- A feeling of neglect due to frequent cancellation of seminars and visits.

- Virtually no government funding due to recent political problems. Funds sufficient only to publish two more bulletins. No travel budget.

- No funds for repairing air conditioner for computer room, replacing radios and other material to accomplish the objectives of AGRHYMET.

- Very little support from the ARC/USGS.

- Virtually no telecommunications in the collection of field data. Field contact has decreased significantly due to political problems.

- Very little USAID/Chad mission support.

3.4.3 **Recommendations**

- Reestablish ARC credibility by meeting with NRC members to hear grievances. Honor commitments for visits.

- Provide funding to fix the air conditioner, publish the bulletin and other immediate support that is needed.

- Provided appropriate LAC data diskette for every decade so the NAC can break down the data and work with it.

- USAID/Chad mission should immediately provide funds to FEWS to assist in publishing the bulletin.

- Coordinate AGRHYMET data collection with ongoing and upcoming USAID/Chad funded projects. One project will provide forty radios to relay cereal prices to N'Djamena. It would be a great service if meteorological and hydrological data collected by AGRHYMET field staff could also be sent at the same time.

- Ongoing training needs to be provided and supported.

3.5 Niger

Because of disruption in the evaluation teams work schedule during the first week in Niamey, the team was unable to visit the Niger National AGRHYMET Center. Contact with the NAC was done following the team's return to Niamey and interviews were done during the week of report writing. The team interviewed members of the AGRHYMET staff, Meteorological Service, Hydrological Service, the FEWS Representative and USAID.

3.5.1 Observations

The Niger NAC has a definite advantage in being located in Niamey, close to the AGRHYMET Regional Center. This close contact results in the AGRHYMET staff being able to take advantage of Regional Center program activities. The AGRHYMET Center staff is well trained and enthusiastic about their work. The ANC office is located in the Meteorological Service Compound which operates 14 Synoptic stations, 4 Agrometeorological stations and more than 150 Rainfall stations. Just prior to the evaluation teams visit, AGRHYMET and Meteorological Service personnel had visited all data collection points throughout the country in preparation for the rainy season.

The data collection is well organized with dependence upon volunteers, local police stations, and the military to relay meteorological stations to Niamey. There is an active GTP which meets during the growing season and complies to the decadal bulletin. The bulletins produced by the Niger NAC are one of the more complete bulletins providing information on rainfall, hydrology, locust, and pests for each department. The bulletin is also well illustrated with graphs and country wide maps. Approximately 130 bulletins are distributed to interested ministries, agencies, and donors. The Meteorological Service tries to have the bulletin published within three to five days of the end of each decadal period. "Greenness" maps are usually in the hands of the GTP within five days and are eagerly pursued by representatives of elevage for pasture development. The maps are also used for identifying potential sites for locust identification. Because of the close proximity of the Niger NAC to the ARC, receipt of the "greenness" maps is the earliest of any of the NAC's and are usually available when the GTP meets.

The computer facility is well organized, clean and completely appropriate. The equipment is well managed with both hardware and software lists available for all machines. Documentation for both hardware and software is well organized and readily available. There are no dust covers for the equipment. The hard disks are well organized. There are no extraneous files in the root directory. Data backups, while they are not performed every day, are kept in two different locations. It is claimed that the equipment is fully used, but there are no operating records to support this contention.

Suivi B is the primary software used for rainfall data capture and production of the bulletin. CLICOM is used for data storage and capture of non-rainfall data. They do not use the data analysis capacities of CLICOM because they find it difficult to use. CLIMBASE is used for data analysis. SURFER is used to produce rainfall maps.

Maintenance is performed by technicians at the ARC. There is a system of regular preventative maintenance which is documented and followed.

The Hydrological Service collects data on the flow of nine hydrological stations and an ARGOS satellite link. There is a close working relationship between the Meteorologist Service and the Hydrological Service through the GTP.

3.5.2 Conclusions

- The Niger NAC is one of the better organized and efficiently functioning national centers.

- The personnel is well trained, and through the Meteorological Service, publish one of the more complete decadal bulletins.

- The computer center at Niamey is one of the best managed of any that were visited.

- There is a deficiency and lack of operating logs to identify computer utilization in the in the computer center.

- A major problem existing in the NAC is the inefficiently of telecommunications to relay data to the center.

- There are also too few data collection points for a country the size of Niger.

3.5.3 Recommendations

- More training will be required as the NAC moves toward developing a GIS data base.

- Assistance is recommended in providing more efficient telecommunications between the center and country wide data points.

- Assistance should be provided for establishing a larger network of meteorological stations to collect weather information.

3.6 Senegal

3.6.1 Observations

3.6.1.1 AVHRR and Teledetection

NDVI data comes on maps and diskettes, but is not used because it does not arrive in a timely manner, usually after the GTP meeting. The GTP use the NDVI data from CSE because it arrives on time for publication in the bulletin. CSE data comes from Las Palmas, Canary Islands reception station, and the tapes are flown in the first day after the end of the decade. CSE produces printed copies for inclusion in the decadal bulletin.

NDVI data is used solely for locust control efforts. The DPV uses PRIFAS software originating from the ARC. The DPV uses the manual vegetation index data to target the efforts of the anti-locust campaign field teams comparing the current data with the previous year and look for anomalies. They would like to use ARC NDVI maps because they believe the ARC methodology produces more useful data (more detail, easier to pick out potential problem areas) but it comes too late to be useful and does not come directly to DPV. They would like to be able to combine the two sets of data, believing that the combination would improve their targeting efforts. To do this, they need access to computer facilities, which they now lack. They would like to be able to automate their image interpretation program to improve timeliness and accuracy.

Elevage uses the CSE Vegetation index maps to qualitatively monitor the pasture development, but does not receive ARC NDVI maps. The Director lacks personnel who are trained to interpret the data.

The Director of Agriculture does not receive the ARC NDVI maps, and does not use the CSE NDVI maps. The Director lacks trained personnel and requires a computer.

The Director indicated that Meteorological Service, Landsat and Spot data would be useful in relating the NDVI data sets to the actual situation on the ground, but would require additional hardware, software and training for implementation.

The Hydrology Section does not use remote sensing data.

In addition to producing the NDVI maps for the AGRHYMET bulletin, the CSE is working on models to relate the NDVI data to both bio-mass production and crop yield prediction. Thirty-one bio-mass production test sites are scattered around the country where they are measuring ground samples to relate the NDVI values to production. In the crop yield

model effort they are working in the Groundnut Basin region trying to relate NDVI to groundnut and millet production.

The Institute Senegalese de Recherches Agricoles (ISRA) has remote sensing activity. ISRA has a French run research center called Centre de Recherches Oceanographiques de Dakar-Thiaroye (CRODT) which has a very advanced image processing facility and is using SPOT, Landsat, and Meteosat data in agricultural and oceanographic research. The Meteorological service is very anxious to have CRODT cooperate with AGRHYMET, but the CRODT people are not interested. Although they are nominally represented in the GTP, their representative(s) never show up for the meetings.

3.6.1.2 GIS

The NAC personnel did not participate in the December ARC GIS workshop because they were not informed in time to nominate a representative. As a result, they have no information about AGRHYMET plans in the GIS area. They are aware of GIS through the CSE program but have no practical experience, and no idea what role it will play in their program. A concern was expressed that GIS should be kept simple, that it be focused on national needs, and that these national needs be coordinated with the rest of the AGRHYMET countries. There is a very active GIS program under way at the CSE, which has been working with GIS for three years. Their primary tool is ARC-INFO which they find to be good, but has the disadvantages of fairly high costs and a cumbersome user interface. CSE personnel are also using IDRISSI, which they find to be very flexible, if supported by personnel with adequate computer programming skills. The main advantage is low cost.

The Canadian trained GIS technical advisor wants to purchase the SPANS system by TYDAC Technologies because of the storage space saving features of the Quad Tree data structures. He sees the major problems to be in personnel--especially training of high level personnel and potential end users of the data the system produces. The major problem being that personnel trained to a high level are very marketable and therefore hard to retain. He also expressed concern that the technology not be oversold and the question of limits of accuracy and propagation of error be adequately recognized and presented to users.

The data situation is very good. A large data base exists consisting of the Plan Nationale d'Admenagement de Territoire Maps produced by USAID and digitized by EROS Data Center, which includes:

Soils
Slopes
Digital Terrain Model
Natural soil degradation
Degradation of Vegetation
Natural Vegetation
Occupation and limitations of soils
Soil potentials
Classified forests
Hydrology
Wells
Administrative boundaries
Infrastructure (roads, RR's, communications, etc.)
Cities
Population
Agriculture production
Others

The projected organization of the GIS effort is designed to provide a resource for potential users. They are now engaged in doing some demonstration projects designed to interest potential users. Once users have been identified, the CSE will make a protocol of agreement to provide assistance in the development of the system. A person from the users organization will be attached to CSE to develop the system (training, data base development, analytical procedures, hardware, whatever) with the ultimate aim of the user organization becoming self supporting.

Examples of demonstration projects underway:

- Livestock, crop management, and cattle production deficits in one Dept.
- Fuelwood demand model
- Bush fire monitoring
- Reforestation management

3.6.1.3 Computer Knowledge

A common theme in discussion was the lack of computers. Personnel stated that most computer time is occupied by daily and historical data capture operations. Most analytical functions must be done after working hours. There is, however, no documentation to support these claims.

The second complaint is that there is not enough data storage space. Most data is stored on floppy disks in compressed format which makes data retrieval difficult and slow. Personnel suggested that a VAX or a LAN with a large capacity hard disk and/or optical disk capacity be installed so that all data can be kept on line.

NAC personnel are unhappy with the software from the ARC, especially DHC. It is not appropriate to local circumstances and comes in a "black box". They want source code and the ability to modify software to meet local circumstances. There should be more decentralization of responsibility for both hardware and software maintenance away from the ARC to the NAC's (especially the advanced NAC's like Senegal).

There are two well equipped workshops, an electronics workshop and a mechanical workshop. All required tools and equipment are available, however, a lack of space exists. The mechanical lab is doubling as a storeroom for consumable supplies and parts. It would help to get rid of the PDP 11/34, which is not being used.

The computer room is well set up, clean and appropriate.

The small UPS units supplied with the Micro-computers are not used because they have a large UPS supplying the entire building. One UPS is used at the Hydrology Department. The other two are in storage. The large UPS is new, purchased with Senegal national funds. It replaces the AGRHYMET (NOAA) supplied UPS, which is broken. No plans have been made for disposal of the old equipment. Electricity supplied by the Airport and is high quality and dependable.

The DEC Rainbows are both still functioning and being used as word processors. One is at DMN and one at Hydrology. DMN has a DOS operating system for its Rainbow, and is able to transfer ASCII text to the ASTs. Hydrology is using CP/M and cannot transfer data.

There were no maintenance records, written maintenance schedule, machine configuration logs or operating logs available. There have been no maintenance problems that the technicians could not handle, and the logistics system has never been tested.

Their main activity is data base development. They have three data bases:

A) daily weather data
B) synoptic weather data
C) upper air data

NAC is currently using CLICOM to capture all current and historical daily weather data. CLICOM was described as too limited for their uses. The size of the data base is too large, and it is slow and cumbersome in retrieving data. It is only being used for data query. It is not used in any other analysis capacity. The data base is too large for storage on the hard disk and is being stored in compressed format on floppies. This storage format makes data retrieval even slower and more cumbersome. There are two sets of data base backups, but both are stored in the computer room.

Development has not yet started on the other two data bases. The NAC estimates that, at current data entry rates, data capture for these three data bases would take six to seven years, although no documentation was available to show how this estimate was calculated.

Due to administrative problems, primarily funding, it is only possible to hire one shift of computer operators. The machines are used after hours by researchers to do their analyses, but there were no operating logs to track the amount of use. The team was told that the machines are in full time use during the day on the data base development (data capture) operations.

The major problem was identified as a lack of training for machine operators. They are only temporary employees. Operators have received only one month of training on basic data entry procedures. No data verification procedures were identified.

Another major problem was that the data analysis software for analyzing weather patterns developed for the PDP 11/34 is not transportable to the DOS environment. NAC personnel want a VAX to solve this problem.

The Hydrology Department is not nearly as well organized as at the Meteorological Service. The level of computer knowledge is quite low. Personnel use software called HYDROM version 2 which comes from ORSTOM, which they find not to be adequately flexible. Version 3 has been promised, but not yet received.

Hydrology makes no use of the data in the bulletins from either NAC or ARC. They publish a bulletin year-round which contains the same data as the NAC bulletin for use in the Hydrology department (NAC bulletin is only published during growing season).

Maintenance on the AST is performed by the DMN. DMN personnel have very little knowledge about the hardware, and seem to be afraid to touch it.

The operator is trained only to do data entry. The hard disk is a mess, with root directory cluttered with files of unknown origin. There is a need for disk management training.

Data is backed up only once a month. A primary reason for this is that no funds have been budgeted for consumable items (e.g. paper, diskettes, ribbons). The backup disk is kept in the HYDROM documentation booklet. No data analysis, other than the data query to produce the bulletin data, is being performed. All work is data base development. No estimate of the time this will require has been made. In addition, the Service cannot afford to buy more diskettes.

Hydrology lacks space for their computer in their office. They are sharing a facility which belongs to the Ground Water Section, but which is several kilometers from their own offices causing logistical problems. The service has developed a 3.2 million CFA proposal to build an adequate facility within their own offices to submit to USGS.

The computer is only operated during office hours due to a lack of funds needed to hire operators for extended use, and administrative problems with access to building at other times.

The Service has been promised another computer and wonder where it is. They also want a digitizing table (for SURFER) and a plotter (for HYDROM) but are not clear as to how these items would improve their analytic capabilities.

3.6.1.4 Natural Resource Data and Socio Economic Data

There is plenty of data, but lack data base development which GIS could provide. (See GIS, above). No specific use of the data has been identified.

3.6.1.5 Bulletin

One hundred copies of the bulletin are made available. The four classes of bulletin users are:

1) Government administrative and political figures (decisions on food imports)
2) Foreign aid donors (levels of support)
3) Regional development organizations (no use specified)
4) Technical services (no use specified)

Bulletin guidelines are set by ARC, but with local variations.

Incorrect use is made of contouring computer programs for isohyets drawing. Isolines are drawn on areas where there are no reference points (ocean and/or neighboring countries).

Soil moisture estimates using a SMB have not been verified against soil moisture observations.

There is a lack of training on phenological/phenometric observations for selected crops (groundnuts, millet, sorghum, beans and maize) and pasture.

The bulletin can be improved in several areas in terms of format and content.

A survey of bulletin users would be useful to determine what use is being made of the data, however this has not been done in years.

Training is needed for extension agents in the interpretation and use of the bulletin.

One NAC bulletin user, the Agricultural Program Assistant at USAID, uses the bulletin's data to prepare bi-monthly crop situation reports for circulation within the embassy and USAID mission, as well as a monthly situation report cabled to AID/Washington. He stated that the CSE NDVI maps and textual analysis are important in monitoring rainfall and crop development. The big advantages of the CSE NDVI maps is that they are free while AGRHYMET maps are expensive. In addition, CSE maps are on time while AGRHYMET maps suffer a great time delay. He indicated that the bulletin information is used by the Ambassador, the Mission economic office, and USAID personnel.

Another important consumer of bulletin information is the Committee Interministerial de Suivi del la Campagne Agricole--a technical level committee formed from various government departments. He feels the timeliness of the bulletin is a problem. He would like to see the data distributed sooner. The 5th day after the end of the decade is too late. He is happy with the responsiveness of AGRHYMET. He often calls for additional data and gets it with no problem.

3.6.1.6 Logistics

There have been no breakdowns that have tested the logistics system, but the feeling is that it is adequate. There is concern that an adequate supply of spare parts is not being maintained in the various countries, but no specifics were forthcoming.

3.6.1.7 Training

The following is a summation of the major points raised by NAC personnel on using training.

- Training of additional Computer hardware and software technicians is essential as there is only one of each.

- Remote sensing training would allow for the establishment of a research capacity.

- Some high level (M.S., Ph.D.) training of Agro-meteorologists is needed.

- AGRHYMET training courses have been too short, and not adequately comprehensive.

- There should be more of an emphasis on formal training relative to the informal training.

- More training is needed in Hydrology on computer system management, and for the operators. Meteorological Service computer training is adequate.

3.6.1.8 Other topics

There were many complaints about poor administrative communications between the ARC and the NAC. Specific examples included not being informed in time to send somebody to the GIS workshop, and USAID's complaints about generally having time to arrange travel for participants in ARC training sessions.

3.6.2 **Conclusions**

- The Senegal NAC is in a very advanced state of development, with excellent interdisciplinary cooperation achieved through an active GTP comprised of a well trained and well motivated members.

- The Meteorological Service appears to be making excellent use of the computer resources supplied by the project. Everyone interviewed requested more equipment, but this need is difficult to evaluate because there are no user logs available to document the claim that the current equipment is saturated. There is also no formal system of prioritizing equipment usage, or any documented estimation of the quantity of machine time required for current and future

projects. Nor are there maintenance logs, equipment inventories, or software inventories.

- The computer system in Hydrology is under-utilized, inappropriately located, and poorly managed. It suffers from the same lack of documentation as the systems in the Meteorological Service, and, in addition, has a hard disk that is cluttered and poorly organized.

- There are no problems with equipment maintenance.

- ARC NDVI maps are not used because they are not delivered on time. The Senegal NAC receives its NDVI data from another source (CSE).

- The NAC personnel are well qualified and trained. They are in a position to do most low level training for themselves. Their training needs are mostly at a high level (M.S. and Ph.D.).

- The bulletin is timely, contains appropriate information, and is presented in a clear, concise and well organized manner. In addition, AGRHYMET information is diffused by radio, and thought is being given to using television.

3.6.3 Recommendations

- The Hydrology personnel need more training in managing their computer resources. Special attention needs to be paid to data backup, proper record keeping and hard disk organization.

- The Meteorological Service needs to maintain better documentation of equipment management. A plan should be formulated that calculates and prioritizes the future demand for scarce computer resources.

- The optical disk drive units should be delivered as soon as possible, and consideration be given to installing a local area network.

- Unless the delivery of the NDVI maps can be made more in a more timely manner, consideration should be given to discontinuing their distribution and efforts concentrated on developing other, more useful products.

3.7 Cape Verde

3.7.1 Observations

3.7.1.1 AVHRR and Remote Sensing

No use of is made of NDVI. Personnel lack training to interpret it with a resolution of 1 sq. km. is being inappropriate for the local farming conditions where fields are all in narrow (200m wide) valley bottoms. The time lag in arrival of 10-20 days renders the data useless.

No work is being done on other satellite imagery (SPOT, Landsat) and there was no interest in doing so.

3.7.1.2 GIS

There is very little knowledge of GIS at the NAC. The NAC sent a staff member to the December meeting at the ARC and is therefore aware that the establishment of a GIS system is pending. NAC anticipated a GIS training course in January, but has heard nothing about it since then.

An IDRISSI based GIS has been installed at the Department of Forestry, Soils and Rural Engineering (DGCSFER) by the Geography Department at Oregon State University (OSU). OSU installed the system and trained a person to use it. Two demonstration projects in watershed management were performed and abandoned by the system. The local expert is not capable of utilizing the GIS, and without institutional support the system may cease to be operative.

3.7.1.3 Computer Knowledge

Basic computer knowledge seems to be adequate and sufficient machines exist to meet current needs. One person is assigned to each machine. There is, however, no supervisor for all the machines.

There are a number of software problems. The IDA software is not being used because of the problems with NDVI described above. CLICOM is found to be overly complicated. While NAC personnel need further computer training on existing software, the NAC has yet to receive Pagemaker, and has no list of the software currently installed on the machines.

System management is poor. The hard disks are loaded with unnecessary files. Backups are done only once per month. Backup disks are kept in a separate room. There is no users log, maintenance log, machine configuration list, or formal maintenance schedule.

The environment is suitable, clean, and well air conditioned. There are no dust covers for the equipment.

3.7.1.4 Natural Resource and Socio Economic Data

A wide variety of NR and S-E data exists within the rest of INIA, but the NAC has not found any need for it.

3.7.1.5 Bulletin

The bulletin is produced every 10 days and appears on the 5th day after the end of the decade. There are 21 recipients and software is adequate for the bulletins production. No survey of the users has been done.

There was interest expressed in receiving the 8½ X 11 inch NDVI maps for inclusion in the bulletin if the maps can be received in time.

The Bulletin contains little information on crop condition monitoring and can be improved in several areas in terms of format and content.

3.7.1.6 Logistics

The only hardware problem that has arisen is that one of the UPS units has not functioned since its arrival, and the NAC does not know how to repair it. The ARC has not responded to the cables which date back to November of last year. The technician who installed the hardware never tested this particular unit during installation.

3.7.1.7 Training

The staff perceives the major benefit received from association with AGRHYMET to be training. They are very satisfied with the training received so far and want more (NDVI, software, hardware). USAID training received so far includes:

- Dec. 1988--Management by Objective Seminar
- May 1989--Use of Micro-Computers
- Nov.-Dec.--Maintenance & Management of Micro-computers

- Feb. 1990--Applications in Agroclimatology
- Feb-March 1990--Applications in Hydrology
- March-April 1990--CLICOM
- March-April 1991-Applications in Agroclimatology

One major training issue relates to the training of the Hardware Maintenance person. He was one of the group originally trained to maintain the PDP 11/34. Due to an administrative mix up, he only received a two week seminar, while the technicians from the other countries all received several months training. In the ten years since, he has received no more training, and is quite bitter about it.

There is also an indication, particularly in the case of the Hardware Maintenance Seminar, that the wrong people were chosen due to inadequate specifications from the ARC. The course announcement called for one person from the Meteorology section and one from the Maintenance section attend. In Cape Verde there is almost no contact between AGRHYMET and the Meteorology Service (they are on different Islands). The Maintenance Section deals with maintaining the climate station equipment, not computers. As a result, the INIA administration sent two people who have no contact with the computers.

There is a lack of training on phenological/phenometric observations for selected crops (millet, sorghum, beans and maize) and pasture.

3.7.1.8 Other Issues

The GTP meets twice per month for "coordination of agricultural activities". The meetings are not related to the production of the bulletin.

3.7.2 **Conclusions**

- Given the size of the country and the nature of the agricultural system, there is little prospect that NDVI maps can ever be a useful tool, even if they can be delivered in a timely fashion.

- The effectiveness of the AGRHYMET programme could be greatly enhanced by improving the cooperation between the NAC and other agricultural and natural resource agencies (ie. Meteorology and DGSCFER). Such cooperation would be especially valuable in regard to the GIS initiative.

- Under its present structure the GTP does not contribute to the information contained in the decadal bulletin.

- The NAC personnel do not know who is using the information contained in the bulletin or for what purpose it is being used. Without a profile of the user community, it is difficult to determine what changes should be made in the bulletin contents. One area that is deficient, however, is the analysis of the impact of weather on crop conditions.

- There is inadequate management of the computer resources, as evidenced by the disorganization of the hard disks and lack of records (user logs, maintenance logs, software lists, and formalized maintenance procedures).

- The computer hardware configuration is adequate for the needs of the NAC. The software, while not ideal, is adequate. The physical environment is appropriate, despite problems with the air conditioning.

- Training and computer hardware are the most important USGS contributions to the NAC. Despite some problems with the selection of appropriate people for training, the training courses have been effective and well received.

- There is a lack of appropriate field data collection skills.

- There are severe problems with the administrative communications between the ARC and NAC.

3.7.3 Recommendations

- Production of the NDVI maps for Cape Verde should be discontinued, and efforts made to devise other, more appropriate products and methodologies.

- Steps should be taken to foster improved interagency cooperation and data exchange. The role of the GTP in this regard should be examined and strengthened.

- One of the major roles of the GTP, as designed by the AGRHYMET programme, is the analysis and formulation of the decadal bulletin. The Cape Verde GTP should become more active in this effort.

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The bulletin should be reformulated to include more specific information as requested by the user community. The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin, and additional information that should be included.

- A training needs assessment should be conducted to identify specific individuals for further training.

- More training is required for developing field data collection and analysis skills.

- More lead time needs to be built into the administrative communications infrastructure.

3.8 The Gambia

3.8.1 Observations

3.8.1.1 AVHRR and Remote Sensing

The NDVI maps are not used. Two problems cited: 1) they arrive late (average time-2 months), and 2) personnel lack training on how to use maps, the only person who has received training is on leave until September, ie. until near the end of the season). Given the size of the country (maximum 20 km. wide) they see no real prospect for future utility of this data.

NAC personnel advanced no ideas on how other remote sensing data would be useful.

3.8.1.2 GIS

There is quite a bit of interest in GIS but little real knowledge about what it is or how it could be used. There are currently no activities underway, but personnel at the Ministry of Natural Resources, UNDP, and the Planning Office of the Ministry of Agriculture are all interested. A document at USAID titled Natural Resource Information Available in the Gambia, produced by a consultant, recommends that a GIS be used in monitoring bush/stubble burning in the Gambia, and talks about the AGRHYMET GIS in general terms.

The major concern repeatedly expressed about GIS is that there are not enough human resources available to support it. Everybody is very concerned that if someone is trained to operate a GIS, he or she will have to be taken away from a current assignment that is

probably already understaffed. This was a concern that cropped up in practically every discussion we held.

3.8.1.3 Computer Knowledge

The physical facilities are adequate, clean and well air conditioned. All equipment has dust covers. Currently three of the machines are located at the Meteorological Service and one at the airport (the machine for communications). This machine will be moved to the Meteorlogical Service as soon as a phone line is installed. A major problem has been electricity. Power is off an average of 2/3 of the time. This will be solved by a USAID supplied generator which has been purchased and is awaiting installation.

There is excess machine capacity available. Plenty of hard disk space is available.

The major software problem is that much of the software is in French, with French language output, whereas few people in the Gambia speak French. Otherwise the software is considered adequate. No comprehensive list of the software is kept. There was no complaint expressed about CLICOM, which is perhaps an indication that it is not being used.

A major problem is equipment management. No user log or maintenance log is kept, there is no list of hardware configurations, and there is no formal maintenance schedule. Data backups are supposed to be done by the users on a daily basis, but had not been done for more than a month at the time of the team's visit. There is only one set of backups, and that is stored in the computer room.

No disk management system exists, the hard disks are cluttered, and the root directories are full of files that nobody recognized.

The major ongoing effort is data base development, but there is no timetable for this effort. There is no estimate as to how much historical and current data needs to be captured, how long it should take to capture it, and how much effort will be involved. The process appears to be moving very slowly, with only one year of meteorological data being captured using CLICOM.

3.8.1.4 Natural Resource and Socio Economic Data

The NAC is using neither NR nor S-E data, though personnel believe that it would be a valuable addition.

One of the goals of the Natural Resources Unit of the Ministry of Natural Resources is to create a Natural Resource Documentation Center. This is one of the major activities to be undertaken in the Environmental Action Plan which is now being formulated. The concept is to bring together under one roof, the wide variety of Natural Resource information which is now available. There is apparently a considerable amount of such information which is difficult to locate, leaving a considerable scope of cooperation for AGRHYMET in this effort.

3.8.1.5 Bulletin

The bulletin contains much data and very little analysis. The crop condition and yield outlook information as reported in the Bulletin need to be improved.

Also the format and content of the Bulletin requires further improvements. The soil moisture estimates using a SMB have not been verified against soil moisture observations.

The one recipient interviewed by the team questions the reliability of the analyses contained in this bulletin. His doubts were based due to a disparity between the bulletin information and his own observations.

The MWG (English version of GTP) has nothing to do with producing the bulletin. It meets once a month and uses the AGRHYMET bulletin as one input for the discussions on coordinating the agricultural effort.

One-hundred and two copies of the bulletin are distributed. It is currently printed in the offices of the UNDP (informal arrangement through the UN Volunteer) because the Meteorlogical Service copier is broken and they have no paper. It is only printed on one side of the page, despite the paper shortage. They would like to receive copies 8½ X 11 NDVI maps for inclusion in the bulletin, if they could be received in time.

3.8.1.6 Logistics

Although there have been no breakdowns in the equipment to test the logistics system, there has been a problem with the cabling of the ABC printer switch that is supposed to be used to connect one printer to two machines. Apparently the wrong cables were sent, and corrective measures have been unsuccessful.

3.8.1.7 Training

The major problem with ARC training is that they are conducted in French, thereby causing great frustration amongst the participants, who have little French language capacity.

Further training in phenological/phenometric observation is required.

The Meteorological Service requested more high level (degree program-overseas) training. They say that their research effort is hampered by lack of highly trained personnel and believe that in country training is too short a duration to be of much benefit. USAID expressed the opinion that training researchers for The Gambia is a waste since the funding and infrastructure is not available to support research, making it more attractive to depend on the international research centers.

There is a problem of high turnover amongst people who receive training. The Meteorological center has lost three such individuals in the last two years. The government has started a program of "bonding" to improve retention of trained personnel. The severity of the problem, which is particularly acute among computer trained personnel, is evidenced by the fact that almost all personnel referred to the bonding program.

Another major problem that was repeatedly mentioned is that the pool of potential trainees is small. Thus, if somebody is trained for a new role, it is very likely that he or she will be taken away from some important current task that will then remain undone. Careful consideration needs be given to prioritizing overall needs when selecting trainees.

There has also been some problem in sending trainees who were not appropriate to the training courses. An example is the micro computer hardware course where trainees were selected by administrative officials. The local AGRHYMET office was informed of the selection and had no input into it. As a result, an inappropriate trainer was selected. A comprehensive training needs assessment identifying specific individuals for specific training is therefore required.

3.8.1.8 Other Issues

Communications are a problem, both within the country and with the ARC. The major problem within the country is lack of power for the SSB radios at the weather stations. External communication links are too complicated (Meteorological Service to UNDP-Banjul to UNDP-Niamey to ARC) and subject to breakdown. Mail service takes up to two months. Efforts to establish a direct international telephone line installed at the Meteorological Service has been unsuccessful. GTS communications are also very unreliable.

3.8.2 Conclusions

- The potential for NDVI in The Gambia is extremely limited because the resolution of the sensor is much too coarse for the size of the country, which at its widest point is 20 km. (20 pixels).

- There is widespread interest in GIS in The Gambia, accompanied by very little knowledge among the potential user community about its utility, limitations, or how to proceed with its development. There is great concern that activity in a new field of endeavor not drain already scarce human resources from current natural resource management efforts.

- Computer hardware is adequate and appropriate for the needs of the NAC. The electrical supply problem, which has greatly hindered NAC activities, should be solved by the generator supplied through local USAID funding.

- There is a major language problem with both the NAC and ARC bulletins. Much of the software used to produce the NAC bulletins use French language titles and labels. Also the ARC bulletins are in French. Since very few Gambians read French, this greatly limits the utility of these products.

- The management of the computer equipment is poor. Documentation, such as user logs, maintenance logs, software lists, hardware lists, and maintenance schedules are not kept. The data backup procedures which have been developed are not followed. There is no estimation of the level of effort required to perform current data capture operations and analyses, not to mention the capture of historical records.

- The bulletin is, for the most part, much data with little analysis of questionable accuracy. A very large number of copies are distributed, at significant cost, to a user community that has never been surveyed to determine its information needs.

- The training effort has been well received and perceived as very valuable, despite two problems:

    - ARC training has been conducted in French with little or no consideration given to the needs of the non-French speaking participants.

- Inadequate administrative communications have led to selection of some inappropriate trainees and logistical problems in arranging per diem and transportation.

- The MWG is not performing effectively in its information interchange role. It does not meet frequently enough, and does not provide input into the bulletin. Most of the shortcomings in the bulletin can be traced to this problem.

3.8.3 Recommendations

- New products should be developed which are more appropriate to conditions in The Gambia, to either supplement or replace the current NDVI maps. One possible avenue of experimentation is provided by a recent (1988) series of land use maps of The Gambia (agricultural lands, forest lands, rangelands and landscape and soils). These maps are available at the Banjul USAID office, and provide an excellent source of ground truth data for the calibration of NDVI data. These maps should be digitized at an appropriate scale and be overlaid with Gambia LAC data to determine additional AVHRR products that could provide more useful information on Gambian natural resources. Also, field data collection from experimental trials should be done for developing crop yield models using agrometeorological data.

- An effort should be made to identify the decision makers who make up the potential GIS user community and educate these decision makers as to the usefulness of this tool in their particular spheres of interest through seminars, workshops, and demonstration projects. The manpower requirements of GIS must be carefully weighed against competing uses of human resources and the benefits clearly demonstrated before any operational GIS effort is initiated. If not, there is a serious risk of failure because of local opposition.

- Current and future software should be designed to produce output in all AGRHYMET languages (French, English, and Portuguese).

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin and additional information that should be included. More training is needed in data analysis to improve the content and format of the bulletin.

- The role of the MWG should be examined and efforts made in incorporating the group into the information interchange process.

3.9 Guinea Bissau

3.9.1 Observations

3.9.1.1 AVHRR and Teledetection

NDVI data is received in diskettes and maps from ARC and they are used for qualitative vegetation assessment. The analysis of NDVI maps are included in a section of the Bulletins.

There are no plans for using other type of remote sensing data (LANDSAT, SPOT, etc).

3.9.1.2 GIS

NAC personnel are aware of GIS implementation plans at ARC but do not have any input on system selection, uses, etc. There is considerable interest at the Weather Services for a GIS and have requested training.

3.9.1.3 Computer Knowledge

The physical facilities are adequate, clean, and air conditioned. Three computers are located at the Weather Service and are protected with dust covers. An additional computer is located at the Hydrology Department which has a hard disk problem which they are unable to solve.

There is an excess of machine capacity available, and plenty of hard disk free space. Adequate software is also available.

The hard disk is not well organized at the Weather Service, with no listings of available software, hardware configuration, user log, maintenance log, or written maintenance procedures. Users have problems in executing CLICOM. The SUIVI software is used in the preparation of the bulletins.

3.9.1.4 Natural Resources and Socio-Economic Data

There are no plans for using Natural Resources and Socio-Economic data.

3.9.1.5 Bulletin

Two type of bulletins (decadal and monthly) are published during the growing season. They are prepared and printed immediately after the end of the decade or the month. There is no direct contribution of other institutions (Department of Agriculture, Plant Protection Department, etc). Only informal meetings are held with technicians from their institutions. The Weather Services is the major institution responsible for gathering and analyzing meteorological and agriculture data to be included in the bulletins. The bulletins contain summarized information on crop conditions, pastures and river flows. The isohiets drawings have to be adjusted and limited to regions with rainfall data. The bulletins are assembled in a "cut and paste" fashion instead of using desk-top publishing procedures. The bulletins are distributed to 50 recipients in the public sector and donor agencies. USAID is not using the bulletins and no other users were contacted.

3.9.1.6 Logistics

The main logistical problem is a lack of tools for computer maintenance. Also there is a shortage of printer paper and consumables. The ARC maintenance personnel traveled from Niamey to repair the hard disk of the Hydrology Department computer and to replace a fuse in the UPS. Recently, the hard disk failed again.

3.9.1.7 Training

Three technicians are being trained in Portugal and Niamey in Agrometeorology, with a list of trainees having been provided. There is a need for training in computer applications in Agrometeorology as well as in computer management and operations. Training appears to target a select few individuals.

3.9.1.8 Other Topics

Communications is a problem. Efforts to access a telephone line for the modem have been unsuccessful. The opinion was expressed at USAID that there is too little institutional capacity to support the AGRHYMET program. This opinion is supported by the underutilization of installed computer capacity (one of the computers has not been used at all). USAID/Bissau requires more lead time to make arrangements for trainees travel requiring 3-4 weeks advance notice.

3.9.2 Conclusions

- Given the considerable amount of rainfall, except at the beginning and end of the growing season, the NDVI maps are completely saturated and therefore the data they contain are of little value.

- The effectiveness of the AGRHYMET programme could be greatly enhanced by improving the cooperation between the NAC and other agricultural and natural resource agencies.

- The GTP is not functioning despite every effort made by the Weather Services.

- There is inadequate management of the computer resources, as evidenced by the disorganization of the hard disks and lack of records (user logs, maintenance logs, software lists, and formalized maintenance procedures).

- The NAC personnel do not have a grasp on who is using the information contained in the bulletin or for what purpose it is being used. Without a profile of the user community, it is difficult to determine what changes should be made in bulletin content. One area that is deficient, however, is the analysis of the impact of weather on crop conditions.

- The computer hardware configuration is adequate for the needs of the NAC. The software, while not ideal, is adequate. The physical environment is appropriate.

- Training and computer hardware are the most important USGS contributions to the NAC. There are some problems with the selection of appropriate trainees. A single person has attended most of the training courses while others have received almost no training.

- There is a lack of appropriate field data collection skills.

- There are severe problems with administrative communications between the ARC and NAC.

3.9.3 Recommendations

- Production of the NDVI maps for Guinea Bissau should be discontinued, and efforts made to devise other, more appropriate products and methodologies.

- Steps should be taken to foster improved interagency cooperation and data exchange. The role of the GTP in this regard should be examined and strengthened.

- One of the major roles of the GTP, as designed by the AGRHYMET programme, is the analysis and formulation of decadal bulletin content. The Guinea Bissau GTP should be put in place as soon as possible.

- More training is needed in computer resource management. On site training is especially appropriate in this area, as there is wide variation in local conditions.

- The bulletin should be reformulated to include more specific information as requested by the user community. The NAC should conduct a survey of all bulletin recipients to identify the uses to which the information is put, the appropriateness of the information in the bulletin and additional information that should be included.

- A training needs assessment should be conducted to identify specific individuals for further training.

- More training is required for developing field data collection and analysis skills.

- More lead time needs to be built into the administrative communications infrastructure.

4.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

4.1 Summary

AGRHYMET is a multi-donor funded, regional program, linked to the nine member West African countries of CILSS. While it has been most active in support of national meteorology services, AGRHYMET, as its name implies, also supports the hydrology and agricultural ministries of the member countries.

USAID support to the AGRHYMET program during the third phase includes funds administered directly by USAID/Niger, funds provided to WMO for use in the AGRHYMET program, and funds for technical assistance provided under contract. Technical assistance is channelled through the USGS program, based out of USGS's EROS Data Center in Sioux Falls, South Dakota. Because the US Agency for International Development (USAID) and the US Geological Survey (USGS) are both agencies of the US Federal Government, the contract between them takes the form of a Participating Agencies Services Agreement (PASA).

4.1.1 Accomplishments

Overall, the AGRHYMET Project has proceeded in a timely manner and achieved most of the goals established by the Project Paper, and subsequent PASA amendments.

4.1.1.1 Agrometeorology data collection

One of the primary objectives has been to improve agrometeorology data collection, analysis, and archiving at both the national and regional levels.

Comment: At the regional level USGS activity has improved the collection, processing and archiving of data from the NOAA satellites. Data gathered by the AVHRR sensor on these satellites are received at AGRHYMET Regional Center (ARC) and used in the routine production of Normalized Difference Vegetation Index (NDVI) greenness maps every 10 days. This continues throughout the growing season. The flow of data includes the production of national maps as well as maps of the whole of CILSS.

Climate data are now handled by the SUIVI program and archived using the program CLIMBASE. SUIVI is a meteorological monitoring program developed by FAO an Associate Expert (Hoefsloot). SUIVI, together with CLIMBASE, was recently recommended for adoption by the CILSS countries. (CLIMBASE is a software system developed by USGS (van Donk) to manage climate data.) Both programs improve AGRHYMET's ability to handle the collection, analysis and archiving of climate data.

The planned installation of a GIS system in AGRHYMET, although behind schedule will assist the analysis of spatial data and will be coupled with a data base management system for the seven data bases AGRHYMET is building. This will contribute to the improvement of data analysis and archiving. The planned extension of GIS to the National AGRHYMET Centers (NAC's) will improve the national component of this activity.

4.1.1.2 Technical Assistance

Technical assistance provided by USGS has been in several areas:

- The USGS is required to establish data systems analysis capabilities at the AGRHYMET center in Niamey, Niger which integrate satellite and ground data for agrometeorological assessments.

  Comment: Activity so far has concentrated upon the reception and processing of NOAA data and the management and analysis of climate data from the meteorology departments of the CILSS countries. Integration of these data sets is possible using GIS techniques. However, AGRHYMET will install a Meteosat receiver this season and produce data on cloud cover on an hourly basis. These data can be combined with the meteorological data to give estimates of rainfall and maps of its distribution.

  Linking the data from Meteosat with meteorological data from ground observations will produce better estimates of effective rainfall for crop production. Analyzing the links between these and the distribution of greenness during the growing season will add to the ability to produce agricultural assessments. Relating these results to variables such as soil type, agricultural land use and cropping practices should permit continuous assessment of each growing season.

  USGS input to this activity is proceeding on schedule and in collaboration with AGRHYMET's other major donor, French Cooperation. The introduction of GIS activities by USGS in the next several months will assist this work. Most of the required data systems and analysis capabilities are installed on the AGRHYMET computer system. These together with the systems to be installed this season constitute a major contribution to AGRHYMET's ability to conduct agrometeorological assessments.

  The USGS is responsible for training staff in acceptable operational procedures that can sustain the AGRHYMET Program. Training courses in Niamey for NAC staff and training in each NAC (given when equipment was installed) have

contributed to this objective. Training for the Technical Services staff at ARC has included specific training in the USA by the vendors of the equipment, and more of this is planned as new equipment is added. Although training courses have been provided by USGS, they have been too few, and too often courses have been canceled.

Coordination with donors, the scientific community, user organizations, and host countries will insure optimum technical visibility and acceptance of the AGRHYMET program and the use of AGRHYMET products and services. Coordination with donors is institutionalized through donor coordination meetings and through the day-to-day interaction between multinational staff at the ARC. Two user organizations have responded to the "greenness" map product by purchasing it under contract (FAO, USAID/Niger) for regional monitoring activity. Contact with government agencies continues through the NACs and the scientific community is aware of the activity by word of mouth.

The USGS is required to provide technical input for planning medium- and long-term AGRHYMET technical activities as required to meet AGRHYMET program objectives.

USGS has provided input to this planning process in the initial requirements needs analysis study for preparation of the Phase III AGRHYMET Project. Subsequently, a review of AGRHYMET computer operations produced by the EDC Computer Services Branch provided recommendations to USAID for procurement and delivery of a microvax. Delivery is scheduled for June. The study of medium- and long-term GIS requirements which will be done during 1991 will also contribute to these inputs. USGS is willing and able to contribute to these inputs.

The USGS is required to modernize software and provide training for data processing to improve the capacity of the AGRHYMET Regional Center in Niamey, Niger, to receive, process, and distribute data from the National Oceanic and Atmospheric Administration (NOAA) polar-orbiting satellites.

This has been done and software is being continuously reviewed and up-dated by the USGS staff. During 1990 the ARC produced greenness maps of the region (and of each country) every 10 days throughout the growing season. A total of 180 new maps were produced and multiple copies were produced to meet the requirements of contracts and support the NAC's. The software used for this work is being modified at EDC and the latest version (LAS 5.0) will be used in the production of greenness maps.

4.1.1.3 Software

In the original PASA agreement USGS was required to undertake the following tasks:

- Provide follow-up assistance in the use of ADAPS and LAS software. This will include informal training in new modules or capabilities needed to generate additional AVHRR products. Up to three visits to the AGRHYMET Regional Center for technical assistance will be authorized (Computer Training Specialist).

  This is in progress and the latest release of LAS software (LAS 5.0) is being installed for the start of the 1991 crop season. Informal training for staff at the ARC will be included in the installation process. The new release includes automatic image registration capability, a feature which should give a 40% reduction in the time staff have to be present during the processing cycle. A USGS scientist from the EDC was in Niamey to work on the software installation and support the AGRHYMET staff in the use of LAS 5.0.

  Following a visit to Sioux Falls, the Cooperation Francaïse scientist is modifying the NOAA data reception programs in use by AGRHYMET to include an orbit model recently developed by EDC. This will give a more efficient processing chain which will feed the data directly into LAS for "greenness" mapping. The arrival of the Meteosat station in April '92 will provide additional data which will be processed to give LAS compatible data. The NOAA data and the Meteosat data will thus be available for processing together in LAS. The result should be a remarkably efficient processing system providing AGRHYMET with a powerful tool for climate data analysis.

- Provide ADAPS and LAS software updates and enhancements that are necessary for the AGRHYMET Regional Center to meet member country needs and that are within the recommendations of the RNA.

  The question of software updates is addressed above. The member country needs will be more closely defined by the proposed GIS user needs assessments, otherwise the present activity is within the RNA recommendations.

- Provide software documentation up-dates (in English) covering applications, programming, and maintenance of the ADAPS and LAS systems.

  The initial documentation has been provided and up-dated versions will be supplied as newer versions of the software are installed on the system.

- Develop additional modular processes for AVHRR product generation that are needed to meet user requirements (as defined in the RNA). (Computer Training Specialist/EDC).

  This is a continuing process at EDC and the updates of LAS noted above are, in part, modules developed to meet user requirements. Additional modules will result from ongoing system development including installation of the meteosat data receiving system and the development of agrometeorological models. The use of these in official bulletins will require specific programs. The data handling for the timely production of bulletins and the operation of the crop production models (or other ag/met models) will be addressed as the project continues to develop. Pertinent modules will emerge from the ongoing work of the ARC and from work in collaboration with Sioux Falls.

- Provide technical assistance and training to implement GIS technology in National Centers (if determined to be necessary and feasible during the year 2 investigation). Provide training in installation, operation, and applications of systems. This training will be provided in French at the AGRHYMET Regional Center. Software and hardware procurement and NAC participant travel to Niamey are not included in costs for this PASA. (Senior Applications Scientist).

  The two year investigation of GIS requirements for the NAC's has been scheduled twice and twice postponed. Initially, the investigation of the requirements was scheduled for October 1990. It was postponed because of the concentration of activities at that time (CAC Meetings, NAC training, USAID mid-project evaluation, staff vacations). Rescheduled for January 1991, this activity was once again postponed by the Gulf War travel restrictions. Consequently GIS activity is behind schedule. However, systems configured for GIS use have been purchased and supplied to the ARC, and nine of these were intended for the NAC's.

4.1.1.4 Equipment

An amendment to the PASA provided for the purchase of 35 microcomputers and their installation in the nine AGRHYMET countries. Installation of the computers was supported by a week of training covering basic microcomputer operations for each NAC. All requirements for this amendment were satisfied by the end of 1990. Difficulties in shipment caused serious delays in the completion of this requirement.

4.1.1.5 Geographic Information System

An amendment to the PASA dated December 1989 added additional monies to accelerate and enhance technical maintenance and training, and to fully establish capabilities to effectively use modern Geographic Information Systems (GIS). In effect, the amendment did not change the technical objectives but required that a more intense effort be made to design and implement an AGRHYMET GIS before the end of 1990. This has not been done.

Much of this has not been achieved because, there have been delays in the analyses of GIS requirements and needs, and a lack of technical expertise in GIS on the USGS/TGS ARC Team.

- Design and conduct pilot studies emphasizing local, national, and regional information system structure and applications. The initial step in this effort will be to define the objectives of the pilot tests and determine appropriate test sites. This will be accomplished through discussions with appropriate authorities within the AGRHYMET Program.

  There is little documentation of any AGRHYMET GIS structure for regional, national or local applications. Pilot studies of chosen test sites are limited but there is activity on a Niger GIS prototype using ATLAS*GIS and a variety of digitized boundary files, place names and soils maps. At the regional level AGRHYMET's SRBD (Regional Data Base Committee) aspires to a data bank system which will maintain seven data bases. The proposal to utilize ATLAS GIS for a national and regional GIS is indicative of the lack of expertise.

  ARC/INFO has become the International Standard for GIS and to impose ATLAS*GIS is to relegate the Sahel countries to adopting an inferior system that does not have the capabilities to do everything that needs to be done. With training, Sahelian technicians will be capable of developing a GIS data base using ARC/INFO.

4.1.2 **Problems**

Despite significant accomplishments, problems have arisen that have detracted from the efficient accomplishment of project goals and objectives.

4.1.2.1 Management

The problem of the project is not the goal or purpose, but rather its poor management which has affected all aspects of the project and program. In the long run the success or failure of the project will depend on the inputs (or lack of) provided by USGS and USAID.

4.1.2.1.1 USGS

- Poor management at various levels by USGS/EDC because of lack of African experience,
- Insistence on maintaining total control at EDC,
- Inefficient technical leadership and project coordination by Team Leader,
- Inappropriate mix of technical skills (e.g. GIS) and insufficient communication skills arnong team members,
- Inefficient coordination on scientific topics, data exchange with other projects including DIAPER, PSE/Dakar, FEWS, INSAH, ESPACE, AELGA,
- Inefficient output response to NAC needs (products, training and methodology in remote sensing),

4.1.2.1.2 USAID

- Lack of understanding of AGRHYMET goals and purpose by USAID missions,
- Present administrative and technical management structure has not permitted effective problem identification and resolution. (It took two years to focus on the management problem),
- Little or no support of AGRHYMET National goals by USAID missions in spite of obvious relevance of ARC/NAC data to mission ADO, FEWS, or Food for Peace goals. This is particularly true as it related to support required for the maintenance of AID-supplied equipment in the NACs.

4.1.2.2 Agrometeorological

- There has been an on-going discussion over the value and use of CLICOM as a data base management software.

- The development of CLIMBASE to support and complement CLICOM has met with opposition.

- The American team failed to report the development of CLIMBASE to the Director General of AGRHYMET and this caused unnecessary difficulties with the French.

- Similarly, the development, and/or use of two soil moisture balance methods - CLIMBIL and DHC has presented difficulties in the working relationship between the American and French teams.

4.1.2.3 Computer Hardware

The provision of computer hardware and software to the ARC and NACs has been accomplished despite logistical difficulties in the initial stages.

- Regular maintenance of personal computers is grossly inadequate.

- Equipment purchased for the NACs has been retained by the ARC causing resentment in the NACs.

- Records of equipment use are inadequate.

- Computer rooms are generally messy, in disarray and dust laden.

4.1.2.4 Training

The training component of the AGRHYMET Program has certainly been successful. Unfortunately the training efforts of the USGS team has not measured up to expectations. Too often courses were canceled or postponed after the NACs had made preparations. The least that was expected was that the USGS follow through on planned courses

4.1.2.5 Remote Sensing/GIS

The remote sensing component and the production of the NDVI maps has been a positive contribution to the AGRHYMET Program, however problems have been identified.

- There has been a failure to promote the maps and develop training courses for interpretation at all the NACs.
- The maps are under-utilized.
- The maps are not delivered in a timely manner to the NACs.
- The USGS team has not responded to the growing need for products other than the NDVI maps.
- The GIS component is behind schedule and has not proceeded in a well planned manner.
- There is limited Niger team expertise in GIS.
- If the development of GIS continues in the present manner, the result will be an inferior product that will be an embarrassment to USGS.
- Too few seminars and workshops have been given.
- Courses and seminars have been canceled causing resentment in the NAC's.

4.1.3. Conclusions

The overall conclusion, despite on-going problems that need to be addressed, is that the AGRHYMET Program is one of the more successful projects in Africa. The long-term support of the various donor agencies has helped develop an important regional climatic, hydrologic and agrometeorologic data base. The success of the training component in producing a cadre of well trained technicians has guaranteed the sustainability and Sahelianization of the Program. A recent survey of the graduates of the training center revealed that 82 percent of the technicians are still working for AGRHYMET in their respective NAC. This is indicative of the national support and the recognition that AGRHYMET is performing a valuable service in providing data to assess famine early warning. The products are used by a variety of government ministries, agencies, donor and international organizations. The USGS/USAID contribution to the program has been important and has contributed to the overall success. However considerably more

effective team leadership and technical management is needed to resolve current problems.

4.1.4 **Recommendations**

4.1.4.1 Management

- A new Team Leader should be chosen. The Team Leader must be allowed to lead and manage without interference and must be someone in whom the USGS Project Director has confidence. It is recommended that he be appointed as scientific/technical advisor to the Director of ARC to assure equal status with the French.

- The USGS Project Director must delegate responsibility to ensure success. It is impossible to completely control every detail from Sioux Falls. To continue to do so will result in continued delays and unnecessary travel expenditures.

- A NAC Client Advisor should be appointed as a liaison between USAID Missions, NAC, ARC and USAID/Niger.

4.1.4.2 Remote Sensing (see Section 2.2.8)

- New products must be developed to improve the ability of the NACs to assist decision makers and farmers.

- Produce an enlarged NDVI map for a specific arrondissement where agricultural production is very important.

- Support is needed for agricultural/land use inventories to provide effective means to relate NDVI to yield and production.

4.1.4.3 Geographic Information Systems (see Section 2.3.3.4)

- A much more careful and disciplined plan of action for the development of a GIS must be prepared. It must consider Sahelian views, opinions, and advice and not be imposed by USGS.

- Data base collection should focus on one country initially (and not four as presently proposed).

- A discussion of methods and standards must take place in the Sahelian context to stop proliferation of costly, non responsive GIS systems, and to promote an understanding of what an effective GIS can do.

4.1.4.4 Computer Hardware/Software

- At the ARC computers designated for training must remain in the training room.

- Greater effort needs to be made to keep computer rooms clean and dust free.

- All equipment purchased for the NACs should be delivered immediately and not retained at the ARC.

- A system for tracking computer usage must be developed. This is essential to justify future computer acquisitions. Obsolete equipment must be disposed of.

4.1.4.5 Agrometeorological

- A full software documentation of CLIMBASE should be developed, and extensive testing should be done before distribution.

- A working plan for field data collection must be developed. (See Annex 1).

- An operational soil moisture balance (SMB) model should be in place as soon as possible after calibration and testing.

- SMB derived indices should be developed and related to NDVI and observed crop yields.

- Drought/crop moisture indices should be computed and plotted on a decadal basis and relate to NDVI.

- Regional rainfall maps using Meteosat and/or NOAA satellite based systems should be developed.

4.1.4.6 Training

- Provide training to NACs in agrometeorological applications as well as field data collection.

- Training must focus on the application and use of remote sensing products specific to local needs.

- Training in remote sensing should be in two phases: 1) Long term, U.S. training in remote sensing and GIS. 2) Short term, three week, in country focusing on interpretation and use of software.

- Training in field testing methodologies for NDVI verification and relationship of NDVI to rainfall should be implemented.

- Continued short courses in computer applications need to be promoted in order to keep the technicians skills up to date.

- Consideration should be given for the training component to be subcontracted for the development of two/three month short courses in remote sensing and GIS.

4.1.4.7 General Recommendations

- FEWS and AGRHYMET should be more cooperative throughout their activities. In some instances their activities duplicate one another and are therefore not cost effective.

- A telecommunications needs assessment must be made of NAC/ARC needs.

- USAID missions that are funding projects that require radios should cooperate with AGRHYMET field personnel in relaying data to the NAC.

- The USGS Project Director must delegate responsibility to ensure success. It is impossible to completely control every detail from Sioux Falls. To continue to do so will result in continued delays and unnecessary travel expenditures.

- A NAC Client Advisor should be appointed as a liaison between USAID Missions, NAC, ARC and USAID/Niger.

4.1.4.7.1 Phase III

For the remainder of Phase III the emphasis should be on:

- Cleaning up management and defining financial means to support NACs through missions,

- In-country training in specific areas to support Sahelianization,

- NAC support by missions (assistance in maintenance),

- Development of new products at ARC,

- Design of long-term Sahelianization training project,

- Development of basic GIS standards, data base, training component and in-country needs assessment by NAC and GTP,

- Conduct telecommunications needs assessment by country,

4.1.4.7.2 Phase IV

Phase IV should focus on:

- Creating products that integrate dynamic ARC meteo data with existing (static) data (such as soil, population, etc.) to predict yield, production, degradation, rainfall, and like information. This can be done in an ARC/GIS framework.

- Define products, users and sales potential.

- The GIS put into the ARC and NACs must be an information system, not a toy for someone's pleasure or from a particular vendor. It must be a genuine tool to help manipulate existing and real time data received by the ARC to provide immediate and long-term response to African farmers, decision makers and donors.

- The final (map) product must meet the standards of the USGS National Mapping Division. Maps must be geographically referenced, boundaries must match and appropriate projections must be utilized.

4.1.4.8 Geographic Information Systems (see Section 2.3.3.4)

- A much more careful and disciplined plan of action for the development of a GIS must be prepared. It must consider Sahelian views, opinions, and advice and not be viewed as imposed by the USGS.

- Data base collection should focus on one country initially (and not four as presently proposed).

- A discussion of methods and standards must take place in the Sahelian context to stop proliferation of costly, nonresponsive GIS systems, and to promote an understanding of what an effective GIS can do.

4.1.4.9 Computer Hardware/Software

- At the ARC computers designated for training must remain in the training room.

- Greater effort needs to be made to keep computer rooms clean and dust free.

- All equipment purchased for the NACs should be delivered immediately and not retained at the ARC.

- A system for tracking computer usage must be developed. This is essential to justify future computer acquisitions. Obsolete equipment must be disposed of.

4.1.4.10 Agrometeorological

- Use raw data from the five band NOAA satellite and to produce and distribute raw products.

- The USGS has not spent any time or effort verifying or assisting NACs in the verification of the NDVI data, or in setting up criteria for field verification.

- No effort has been made to correlate rainfall isohyets to isolines on the NOVI.

- Certain errors or misleading interpretations can be made in the drier end of the NDVI scale. No effort has been made to understand the reason for errors in the NDVI index in spite of field evidence.

- Very few secondary or derivative products have been produced by USGS.

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ANNEXES

ANNEX 1

Plan Outline for Developing
Agrometeorological Products

Plan Outline for Developing New Agrometeorological Products

1. Introduction

The productivity of agroecosystems depends on matching the variable requirements of crops, pastures, and practices to the variable characteristics of the farmers and their land. Mismatches result in diminished productivity and economic losses. Recent advances in computer technology and artificial intelligence present an opportunity to establish a system-based approach that simulates and therefore predicts the performance in a crop, pasture, or practice in any location during any season for a wide range of climatic conditions. These advances in information technology include personal computers, data base management systems, simulation models and new developments in the field of artificial intelligence.

The central concept of systems-based approach is that the whole system must be understood in order to evaluate changes in any single component. Until recently, this approach could not be applied to complex plant process consisting of large numbers of interdependent and now enable users to organize a minimum set of relevant data to simulate complex processes in crops and pastures. Existing simulation users in Sahelian countries should monitor plant growth and productivity and to integrate new crops, products and practices into existing farming systems. In addition, models can simulate process for 25, 50, or more years. These long-term simulations enable planners to evaluate the impacts of recurring droughts and to prescribe alternative crops, products, or practices to minimize losses.

The USAID contribution to the AGRHYMET program has allowed the development of a regional meteorological data base, the set up computer systems at both national and regional levels, and the training and technical support to Sahelian personnel. It can be pointed out that these achievements are the basic ingredient for the development of agrometeorological products within the framework of the AGRHYMET projects.

2. Agrometeorological Products

The following are suggested products for the remaining time of Phase III and the possibly implemented Phase IV.

A. A crop monitoring system. The operational system should be able to provide:

- Crop phenology simulation such as crop growth stages: emergence, flowering, maturity, etc.

- Crop yield forecast (4 to 6 weeks before harvest).

B. A pasture monitoring system. The system should provide quality/quantitative assessment of biomass production during the growing season.

C. Farmer advisories. Simulation models can be used as decision aides for the following management options:

- Crop selection
- Planting dates
- Planting density
- Fertilizer application (Cost/Benefit Analysis)
- Irrigation

3. Methodology

During the past two decades, several research groups have developed crop models to evaluate how the environment affects crop growth and productivity. Interdisciplinary teams have developed users-oriented models for grain (CERES), legumes (SOYGRO) and root (SUNGRO) crops. The models are designed to predict the yield of crops sown anywhere at any time and to be a useful tool for decision making by farmers, researchers, and governments.

The models use readily available weather and soil input, require minimal computation time and are adapted to run in personal computers. Most input data are available or can be estimated from routinely collected daily weather data, standard soil data, and other data provided in the model documentation. The model calculates the crop growth as affected by temperature, light, and degree of stress. The final growth stage is the economic yield.

Field experiments are required to verify that the models provide a realistic set of response data. The minimum data set includes: yield and yield components, biomass production at several times during the growing season, and dates of major phenological events. Additional information is needed on soil water holding capacity, pest damage, and other conditions that may influence crop growth.

Details about simulation models characteristics, input data requirements, data collection procedures, computer files format, model result interpretation and application can be found in the literature (Section 5).

Several training courses and seminars will be required for technical staff and decision makers at the Regional and National Centers. Training will cover the following areas:

Phenological observation techniques, crop/pasture condition assessment and report preparation. Also, seminars for users on product/service requests should be encouraged.

Technical assistance will be required to calibrate and verify crop/pasture simulation models and operational crop monitoring systems are needed to support current technical assistance provided by USGS.

4. Timeframe

A summarized timeframe is outlined.

Task Description		Year 1	Year 2	Year 3
1.	Field data collection	[----------]		
2.	Calibration of Simulation models	[------]		
3.	Verification of Models		[------]	
4.	Operational Monitoring system			[-------]
5.	Training	[----------]		

The experience obtained in implementing crop/pasture monitoring systems in developing countries should be taken into account to avoid implementation mistakes.

5. Resources Needed

Personnel:	Agrometeorologist, Field crop specialist, Field personnel
Equipment:	Weather station network providing real-time daily data (already in place). Personal Computers and printers (already required) Vehicles..
Materials:	Plastic bags and container. Tools for crop sampling and measurement.

6. Literature (Non-Comprehensive)

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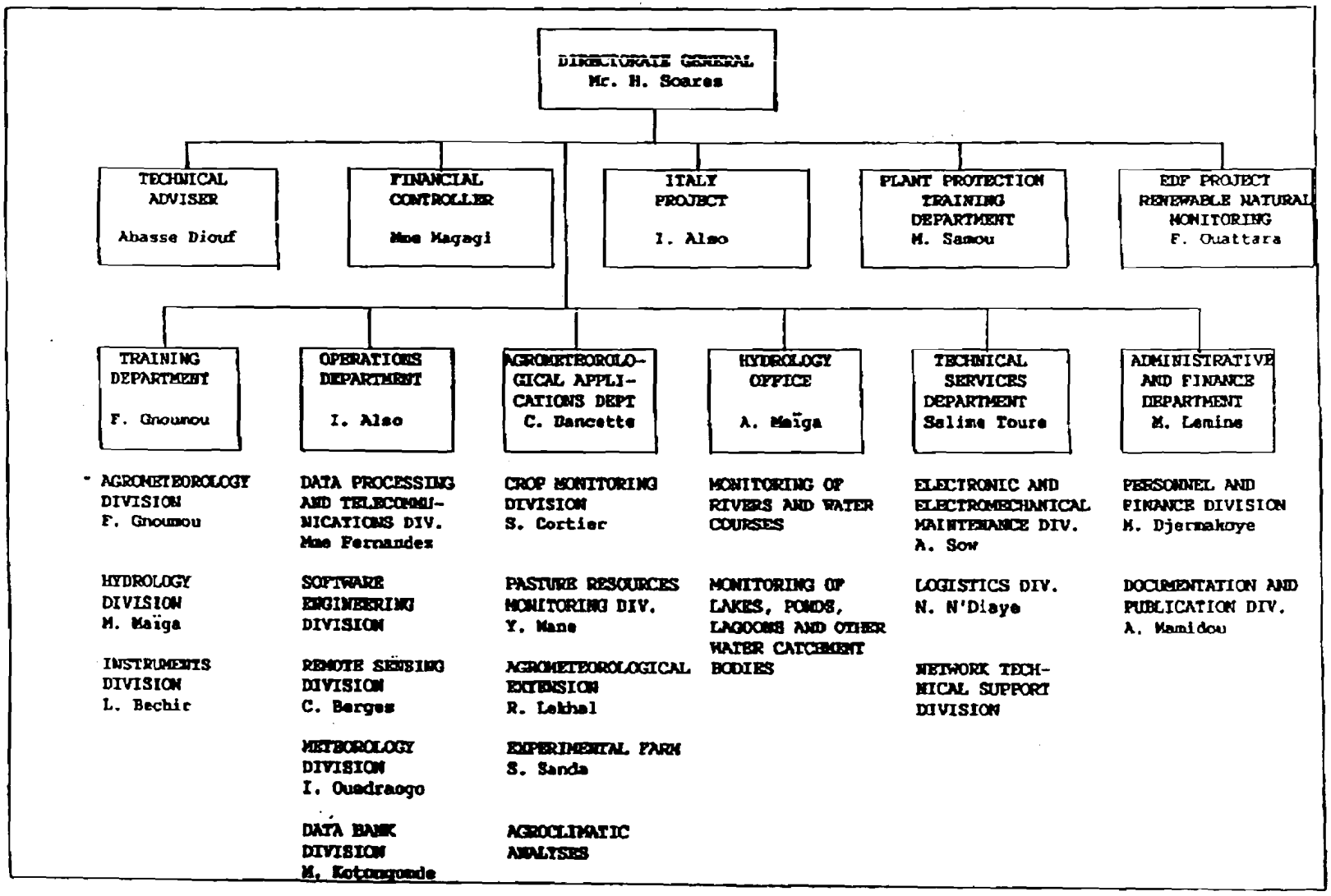
ANNEX 2
AGRHYMET Organization

AGRHYMET CENTRE ORGANIZATION CHART



ANNEX 3
Rainfall Data

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

DONNEES METEOROLOGIQUES DECADAIRES Deuxième décade de Aout 1990

Nom de Localité	T MIN °C		T MAX °C		T MOY °C		T-N-EXT °C		T-X-EXT °C		VEN2CAL m/s	
	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M
AGADEZ	25.2	1	39.2	1	32.2	1	24.0	1	41.4	1	2.4	1
BILMA	25.8	1	41.4	1	33.6	1	20.6	1	43.6	1	2.0	1
BIRNI N'KONNI	23.9	1	34.5	2	29.3	2	22.0	1	36.6	2	1.5	1
DIFFA	24.7	1	35.3	1	30.0	1	23.0	1	37.2	1	1.0	1
GAYA	21.8	1	31.1	1	26.5	1	19.4	1	33.5	1	0.5	1
GOURE		10		10		10		10		10		10
MAGARIA	23.1	1	33.2	1	28.2	1	20.2	1	35.3	1	1.8	1
MAINE SOROA	23.5	1	33.5	1	28.5	1	20.5	1	35.6	1	2.1	1
MARADI AERO	22.5	1	31.9	1	27.2	1	20.4	1	34.5	1	1.4	1
N'GUIGMI	24.5	1	37.6	1	31.0	1	21.5	1	41.2	1	0.8	1
NIAMEY AERO	24.1	1	35.6	1	29.9	1	22.3	1	38.0	1	2.1	1
TAHOUA	24.0	1	34.8	1	29.4	1	20.0	1	39.3	1	1.8	7
TILLABERY	25.5	1	36.3	1	30.9	1	23.2	1	39.4	1	1.3	1
ZINDER AERO	23.7	1	34.4	1	29.0	1	20.8	1	36.2	1	2.1	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
T MIN : Temperature minimale sous-abri
T MAX : Température maximale sous-abri
T MOY : Température moyenne sous-abri
T-N-EXT: Température minimale extrême pendant la décade
T-X-EXT: Température maximale extrême pendant la décade
VEN2CAL: Vent moyen à 2 mètre calculé avec vent moyen à 10 mètre

130

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

DONNEES METEOROLOGIQUES DECADAIRES — Deuxième décade de Aout 1990

Nom de Localité	INSOL heures		INSOL% %		RAD CAL J/cm², j		HUM MIN %		HUM MAX %		TV mbar		DS mbar		EVA BAC mm/jour		EVA PIC mm/dec	
	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M
AGADEZ	10.1	1	80	1	1876	1	21	1	71	1	18.9	1		10	138	1	80	1
BILMA	10.1	2	79	2	1876	2	17	1	51	1	14.6	1		10		10	118	1
BIRNI N'KONNI	8.6	1	68	1	1756	1	49	1	92	1	27.0	1		10	63	1	35	1
DIFFA		10		10		10	45	1	83	1	25.7	1		10		10	41	1
GAYA	9.6	1	77	1	1840	1	62	1	96	1	27.5	1		10		10	20	1
GOURE		10		10		10		10		10		10		10		10		10
MAGARIA	8.1	1	64	1	1716	1	45	1	89	1	25.8	1		10	87	1	44	1
MAINE SOROA	7.1	1	56	1	1638	1	47	1	89	1	25.8	1		10	78	1	42	1
MARADI AERO	8.8	1	71	1	1779	1	54	1	93	1	26.1	1		10	61	1	30	1
N'GUIGMI	8.2	1	65	1	1731	1	37	1	85	1	25.2	1		10	89	1	49	1
NIAMEY AERO	9.4	1	75	1	1826	1	46	1	87	1	26.3	1		10	67	1	37	1
TAHOUA	8.3	1	66	1	1738	1	38	1	80	1	23.4	1		10	99	1	65	1
TILLABERY	8.9	1	71	1	1784	1	38	1	83	1	25.5	1		10	80	1	42	1
ZINDER AERO	8.9	1	71	1	1785	1	43	1	83	1	23.9	1		10	91	1	55	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
INSOL : Durée d'insolation moyenne
INSOL% : Pourcentage moyen d'insolation
RAD CAL: Radiation globale moyenne calculé avec la durée d'insolation
HUM MIN: Humidité minimale
HUM MAX: Humidité maximale
TV : Tension vapeur moyenne
DS : Déficit de saturation moyen
EVA BAC: Evaporation moyenne du bac
EVA PIC: Evaporation moyenne du piche

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE NATIONALE

Pluviometrie journaliere et Decadaire

PAGE : 1
ANNEE : 1990
MOIS DE : AOUT
DECADE : 2

LOCALITES	11	12	13	14	15	16	17	18	19	20	21	SOMD	MD	SOMS	ESAP	MC	EC
TERA			18.0				7.3					25.3	31.6	284.7	-54	259.3	25.4
AYERCU			15.0				23.2	0.9	1.7			40.8	32.1	176.3	-88	188.0	-11.7
TILLABERY			12.1				4.8		TR			16.9	46.9	299.0	-23	248.3	50.7
TOROCI			3.0									3.0	45.9	385.6	53	363.6	22.0
OUALLAM							12.0					12.0	44.2	401.4	128	233.7	167.7
NIAMEY AERO			TR				5.4	TR				5.4	52.6	345.5	-97	359.4	-13.9
NIAMEY VILLE			TR				5.0					5.0	50.5	355.9	-106	356.5	-0.6
SAY			TR	9.4				2.5				11.9	57.0	271.5	-77	392.1	-120.6
B. N'GAOURE				5.5			3.2					8.7	60.9	301.5	-1	367.8	-66.3
FILINGUE							7.6					7.6	48.4	231.8	-7	251.5	-19.7
DOSSO				9.0			46.2					55.2	68.9	447.9	50	366.7	81.2
GAYA			20.9	28.5	1.0	0.3	11.4					62.1	64.4	554.5	31	545.1	9.4
DOUTCHI				2.5		11.4	2.4					16.3	44.8	276.2	8	312.7	-36.5
TAHOUA							5.3		30.4			35.7	38.6	239.2	-27	244.0	-4.8
BIRNI N'KONNI				4.5		1.1	0.7			0.4		6.7	52.4	373.4	-20	329.3	44.1
ILLELA			0.1				28.0		13.2			41.3	35.7	297.6	-123	272.6	25.0
LOGA *							2.2					2.2	65.9	221.1	-38	354.8	-133.7
KEITA									15.2			15.2	50.5	221.3	-17	290.1	-68.8
BOUZA						11.9	2.7					14.6	49.4	183.2	-156	292.1	-108.9
MADACUA						2.4	7.0					9.4	47.9	182.6	-256	250.8	-68.2
IN-GALL	1.4		11.0	6.0		1.2		44.0				63.6	33.3	146.0	17	118.1	27.9
T. TABARADEN			9.6	4.2					24.0			37.8	34.1	101.1	-93	153.9	-52.8
DAKORO						7.0						7.0	36.5	159.4	-14	228.4	-69.0
ADERBISSINAT *			0.2	2.2		0.9						3.3	11.7	70.8	-46	99.6	-28.8
MARADI AERO		6.8	0.8	7.9			5.0	TR				20.5	47.5	348.6	-80	329.1	19.5
AGADEZ	1.3		2.2		TR			0.1	9.8			13.4	15.9	84.1	-14	80.1	4.0
ABALA *	7.0											7.0	43.2	142.2	5	219.7	-77.5
MAYAHI							3.1					3.1	46.2	207.1	-120	279.7	-72.6
TESSAOUA		2.3					28.8					31.1	50.2	289.0	-60	289.5	-0.5
GAZAOUA		23.7		31.8			34.5					90.0	45.6	419.4	87	302.2	117.2
IFEROUANE												0.0	4.7	11.9	-42	35.8	-23.9
ABALAK *				4.8			21.7					26.5	19.8	109.6	-159	192.6	-83.0
TANOUT								1.3	10.1			11.4	36.7	138.3	-62	154.5	-16.2
ZINDER		3.4			0.1		10.6		0.5			14.6	57.8	245.4	-1	292.8	-47.4
MAGARIA		TR	2.7			TR	TR					2.7	57.4	328.7	29	350.8	-22.1
MIRRIAH		1.0					23.0					24.0	46.6	228.1	-16	252.6	-24.5
N'GOURTI		0.5										0.5	5.8	46.9	-14	31.0	15.9
GOUDOUMARIA					TR							0.0	39.9	154.8	-68	210.7	-55.9
MAINE SOROA		18.8				10.1						28.9	44.8	203.7	-27	211.1	-7.4
DIFFA		0.4				14.4						14.8	34.2	82.0	-97	178.7	-96.7

* : Postes recents avec moyenne decadaire etablie sur moins de 10 ans
SOMD : Somme pluviometrique decadaire (TR = Traces)
MD : Moyenne pluviometrique decadaire etablie sur la periode de 1968 - 1986
SOMS : Cumul pluviometrique (Somme de SOMD) depuis le debut de la saison

132

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE

Pluviometrie journaliere
et Decadaire

PAGE : 2
ANNEE : 1990
MOIS DE : AOUT
DECADE : 2

LOCALITES	11	12	13	14	15	16	17	18	19	20	21	SOMD	MD	SOMS	ESAP	MC	EC
BILMA												0.0	1.4	0.2	-9	6.3	-6.1
N'GUIGMI		14.3	25.2						TR			39.5	24.0	119.9	41	132.0	-12.1
DIOUNDIOU *				27.0			5.0					32.0	55.7	500.6	20	411.8	88.8
TABELOT												•	12.9	•	•	40.6	•
BANKILARE *			2.5				41.2		2.5			46.2	41.1	184.3	-121	197.8	-13.5
BANIBANGOU *								2.4				2.4	39.6	190.7	-37	159.4	31.3
CHIKAL												•	42.9	•	•	196.9	•
TASSARA *			40.4			31.0						71.4	22.2	142.6	15	97.0	45.6
TILLIA *				9.0								9.0	23.2	136.0	-11	94.6	41.4
ARLIT *				0.6								0.6	8.4	5.3	-44	26.7	-21.4
G. ROUMDJI *				22.0		TR	31.5					53.5	30.3	427.7	123	255.3	172.4
MADAROUNFA *		9.2		31.0			11.2					51.4	32.6	324.2	-52	295.3	28.9
DAN-ISSA *				36.0								36.0	43.5	267.7	-248	308.2	-40.5
AGUIE *		16.5		24.0			18.5					59.0	36.2	343.1	-27	269.8	73.3
MATAMEYE *		0.6	13.5									14.1	61.4	382.0	-27	290.1	91.9
TESKER *		3.5										3.5	11.0	53.9	-54	69.1	-15.2
MARADI VILLE		0.8		14.0			4.3					19.1	47.5	406.0	-21	329.1	76.9
ZINDER VILLE		3.4					8.4		1.1			12.9	57.8	194.8	[illegible]	292.8	-98.0
GOURE		18.9										18.9	36.7	211.5	-81	183.3	28.2
DARGOL *							19.0	11.0	0.5			30.5	40.0	221.5	-125	248.0	-26.5
MARGOU *				7.0			TR					7.0	62.9	280.2	-34	356.6	-76.4
ANOU-ARAREN			3.8	4.2								8.0	14.3	171.0	93	75.0	96.0
AKOKAN								0.6				0.6	5.4	19.1	-8	21.6	-2.5
SADORE-ICRISAT												•	57.0	•	•	392.1	•

* : Postes recents avec moyenne decadaire etablie sur moins de 10 ans
SOMD : Somme pluviometrique decadaire (TR = Traces)
MD : Moyenne pluviometrique decadaire etablie sur la periode de 1968 - 1986
SOMS : Cumul pluviometrique (Somme de SOMD) depuis le debut de la saison
ESAP : Ecart de SOMS par rapport a l'annee precedente
MC : Moyenne pluviometrique cumulee etablie sur la periode de 1968 - 1986
EC : Ecart cumule : ecart de SOMS par rapport a la moyenne cumulee (MC)

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

Nom de Localité	ETP-TV mm/dec	
	VAL	M
AGADEZ	75	1
BILMA	77	2
BIRNI N'KONNI	57	2
DIFFA		10
GAYA	48	1
GOURE		10
MAGARIA	55	1
MAINE SOROA	56	1
MARADI AERO	52	1
N'GUIGMI	57	1
NIAMEY AERO	61	1
TAHOUA	54	7
TILLABERY	59	1
ZINDER AERO	61	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
ETP-TV : ETP cumulé calculé avec la tension de vapeur

ANNEX 4
Bulletin Example

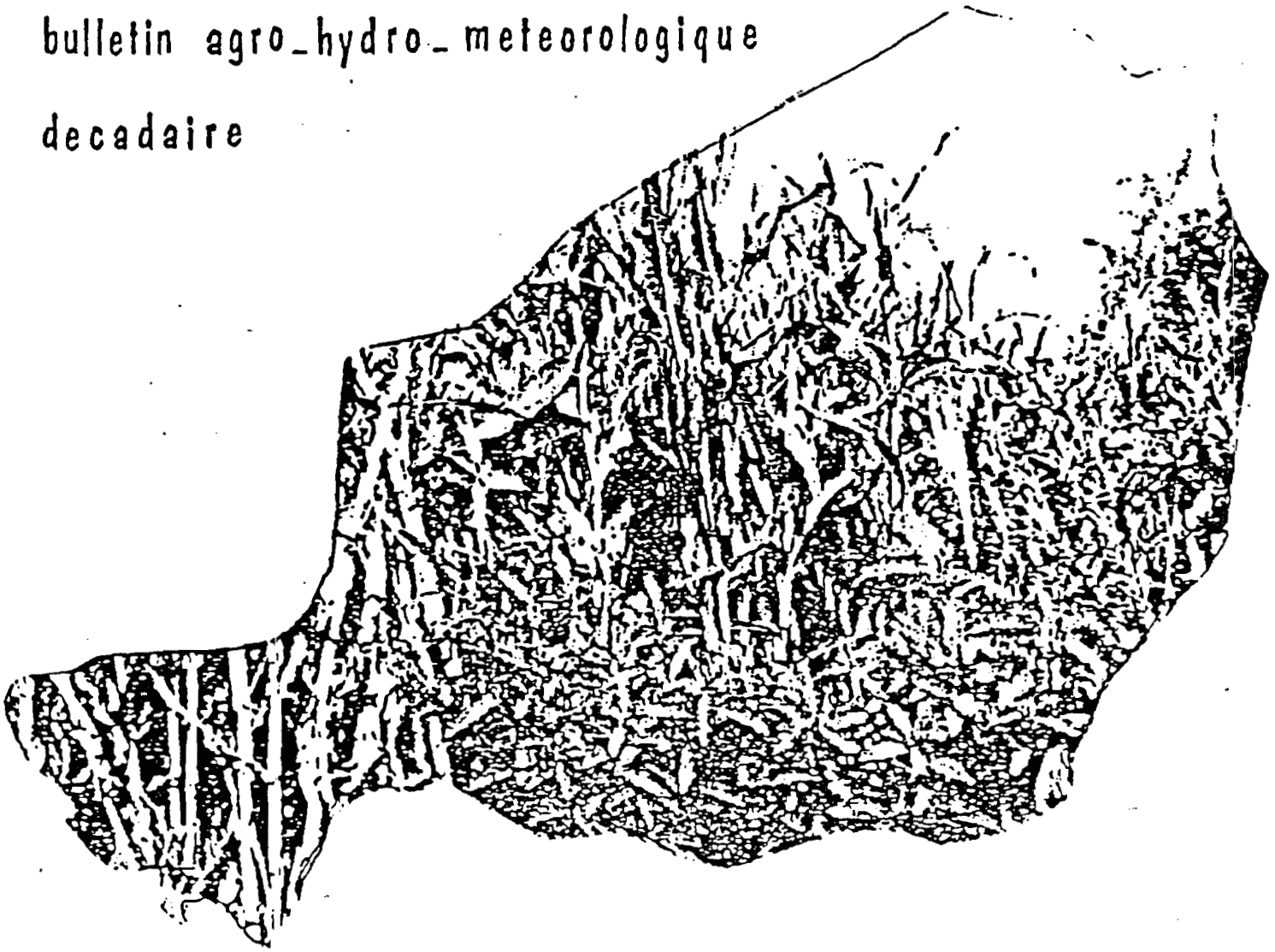
SUIVI DE LA CAMPAGNE AGRO_PASTORALE

AU NIGER

NIAMEY , le 27 AOUT 1990

bulletin agro_hydro_ meteorologique

decadaire



periode: 11 au 20 Août 90

GROUPE DE TRAVAIL PLURIDISCIPLINAIRE

CHEF DE FILE

126

A/ SITUATION METEOROLOGIQUE

La saison pluvieuse en Afrique de l'Ouest et particulièrement dans le Sahel connaît généralement sinon de tout temps un mois d'Août stable dans le comportement des champs dynamiques de pressions et de vent et, pratiquement de tout autre paramètre lié au phénomène de pluie. Cette stabilité se traduit non seulement par de nombreuses formations orageuses d'évolution diurne locale, mais surtout par la traverseé d'amas nuageux organisés en zones orageuses ou lignes de grains venant d'autres horizons (Soudan-Tchad ou même de la Mer Rouge).

Ce mois d'Août, précisement dans sa deuxième décade, a été particulièrement sec sur le Niger et la majeure partie Nord du Tchad. Le changement ainsi observé est dû à la pénétration de mousson par composante Ouest à d'ailleurs Ouest-Nord-Ouest au lieu de Sud/Sud-Ouest sur presque toute la bande sahélienne dépassant rarement une épaisseur de 1000 m. Cette forme de pénétration de mousson a véhiculé sur le Niger un air sans grande teneur en eau.

Le Front Inter-tropical (FIT), malgré ses fluctuations assez remarquables à l'Est sur Niger/Tchad a eu des mouvements à tendance de retraits manifestes. Il était axé en fin de décade sur Tessalit au Mali, Assamaka/Fachi au Niger et Fada au Tchad.

L'activité orageuse a été par conséquent faible et très ponctuelle.

B/ SITUATION PLUVIOMETRIQUE

Comme conséquence de la situation météorologique decrite précédemment, cette décade a été caractérisée par de très faibles quantités de précipitations dans la majeure partie du pays; Seules quelques localités ont enregistré des quantités de pluie appréciables (plus de 25 mm): l'extrême Ouest du département de Dosso, le Centre et le Nord du département de Tahoua, l'Ouest du département d'Agadez, l'extrême Sud des départements de Maradi et Diffa.

Comparativement à l'année dernière, la décade a été déficitaire dans la majeure partie du pays.

S'agissant de la pluviométrie cumulée au 20 Août comparativement à celle de l'année dernière, elle est déficitaire dans la plus grande partie du pays à l'exception de quelques zones localisées (les alentours d'Ouallam, Abala, Torodi, le Sud du département de Dosso, les alentours de Tassara, In-gall, Guidan-Roumdji, Gazaoua, Magaria et N'Guigmi).

Aussi, par rapport à la moyenne des 20 dernières années, cette pluviométrie cumulée demeure déficitaire dans la majeure partie du pays.

C/ SITUATION HYDROLOGIQUE : Fleuve Niger et affluents

Quelques données de la décade :

a) Débit maximum du fleuve Niger à Niamey = 477 m^3/s
b) Débit maximum de la Sirba = 110 m^3/s

Déjà observée la décade dernière, la diminution des débits du fleuve Niger à Niamey s'est accentuée sensiblement (45 % en moyenne par rapport à l'an dernier); cela se traduit par un hydrogramme situé nettement aux dessous des courbes saisonnières, hormis celle du mois d'Août 1984 où la moyenne de la deuxième décade était de 300 m^3/s.

D/ SITUATION AGROMETEOROLOGIQUE

Les précipitations enregistrées au cours de cette décade n'ont pas permis la satisfaction des besoins en eau des cultures sur l'ensemble de la zone agricole à l'exception de la frange Sud des départements de Dosso et Maradi. Néanmoins, dans les alentours immédiats de certaines localités, le recours aux réserves en eau réalisées au cours des décades précédentes a permis d'approcher la satisfaction de ces besoins; c'est le cas notamment de Ouallam, Filingué et Tillabéry.

Dans les zones de premiers semis où les cultures sont en général aux stades de floraison-grenaison voire début mûturation, la sécheresse constatée çà et là, conjuguée au faible taux de l'humidité atmosphérique et aux fortes températures observées au cours de cette décade, risque d'occasionner le sèchage des fleurs et le non remplissage des grains.

Pour les cultures semées tardivement et qui sont aux stades de levée avancée-tallage, les besoins en eau pour la prochaine décade sont estimés à 50 mm en moyenne. De ce fait il faut que la décade prochaine couvre ces besoins. Dans le cas échéant, des flétrissements légers à permanents (irréversibles) compromettront le développement normal de ces cultures.

Dans la zone pastorale, il est à noter également la rareté des précipitations. Seul le triangle Tassara (71 mm)/In-Gall(64 mm)/Tchintabaraden (38 mm) offre des conditions agrométéorologiques favorables au développement du pâturage et à la recharge des nappes et points d'eau.

E/ SITUATION PHYTOSANITAIRE

Les infestations acridiennes prévues dans les zones névralgiques se confirment à Bouza (TAHOUA), Dakoro (MARADI), Doutchi (DOSSO), et Filingué (TILLABERY). Les densités moyennes de sautériaux sont de l'ordre de 30/m^2 variant entre 5 et 50/m^2. La situation est très préoccupante vu l'évolution du temps. Les

périodes de sècheresse seraient à l'origine des concentrations et fortes pressions acridiennes sur les cultures dont les stades tallages du reste vulnérables, prédominent encore dans les parties marginales de la zone des cultures.

Les oiseaux granivores sont présents dans DIFFA, TILLABERY et TAHOUA, mais les moyens de prospection et d'intervention sont insuffisants pour donner une situation assez précise des niveaux de populations et effectuer les traitements qui s'imposent.

Des ravageurs multiples, en majorité des pucerons sur légumineuses, des punaises dont Dysdercus volkéri, des coléoptères et des chenilles de lépidoptères défoliatrices sur les céréales, sévissent dans les zones au Sud des départements de DIFFA, DOSSO, MARADI, et ZINDER. Des traitements terrestres sont en cours d'exécution par les brigades villageoises.

La situation par département est la suivante :

ACRIDIENS :

Département de DIFFA

La situation est calme dans l'ensemble. Des prospections ont été effectuées dans le Sud et le NOrd-Est de Mainé-Soroa. Des éclosions sont rapportées.

Département de DOSSO

Le Nord de l'arrondissement de Doutchi est infesté de sautériaux, larves et adultes sur près de 40000 ha dont 19920 ha ont été traités. Les densités étaient de 15 à 30/m^2.

Département de MARADI

Dakoro présente 25000 ha infestés sur sa partie Ouest. Les espèces en question sont le criquet sénégalais et Ornithacris turbida aux stades larves et adultes à raidon de 10 à 30/m^2. La défoliation du mil en tallage est notée. Les traitements ont porté sur 480 ha.

Des signalisations de sautériaux au Nord de Tessaoua méritent plus de précision. Les traitements ont été effectués sur 575 ha au cours de la décade dans cette zone.

La forêt classée de Aguié présente des densités de sautériaux de 10 à 30/m^2.

Mayahi signale des Acrotulus et Catantops de 10 à 15/m^2 et Madarounfa fait état de 365 ha infestés de larves et traités au cours de la décade écoulée.

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Département de TAHOUA

Bouza a déclaré 54000 ha infestés avec des densités de 10 à 15/m^2 dans les champs de cultures et 50 à 70/m^2 dans les friches. L'intervention aérienne est préconisée. Par ailleurs un total de 10000 ha attaqués par les sautériaux dont 2467 ha traités, est signalé intéresser les arrondissements de Madaoua, Konni, Tahoua, Illéla, Keita et Bouza avec des densité de 10 à 15/m^2.

Département de TILLABERY

Filingué a rapporté 30800 ha infestés de larves et adultes de criquet sénégalais, dans le Nord-Est avec des densités de 40 à 100/m^2 à une moyenne de 50/m^2.

L'intervention aérienne est en cours.

Des traitements aériens ont été effectués sur 4000 ha dans l'arrondissement de Tillabéry.

Département de ZINDER

Des sautériaux des genres Acrotylus et Diabolocatantops sont signalés à Tanout, entre 5 et 10/m^2 dans les cultures et 10 à 15/m^2 dans les friches, sur une superficie 9587 ha dont 3113 ha traités.

Matameye et Magaria présentent des poches d'infestation de 45 ha à 500 ha avec des densités acridiennes de 9 à 40/m^2. Les traitements terrestres sont en cours.

OISEAUX GRANIVORES

Les signalisations aviaires ont intéressé DIFFA avec 6 dortoirs de Moineau doré déclarés, TILLABERY avec 20 ha traités et TAHOUA où un dortoir de Quéléa et de Gendarme du village est observé dans l'arrondissement de Konni.

AUTRES RAVAGEURS

Le département de DIFFA est infesté surtout des Pucerons sur le niébé (50 ha attaqués - 20 ha traités). MARADI présente des Pucerons surtout à Mayahi où 2545 ha ont été traités, ainsi que dans Aguié, Guidan-Roumdji, Tessaoua et Madarounfa. Dans ces mêmes arrondissements, Dysdercus volkéri sévit sur des superficies de 14 à 4630 ha (Guidan-Roumdji où 816 ha sont traités). MARADI Commune déclare, en plus, des Coléoptères et des Cicadelles. ZINDER fait état d'infestations par des Pucerons, Dysdercus, mouches blanches, des Coléoptères et des termites sur de petites superficies de 5 à 75 ha reçevant des traitements.

F/ SITUATION PHENOLOGIQUE ET OPERATIONS CULTURALES

F.1 Généralités

En cette fin de 2ème décade du mois d'Août on assiste par endroit au niveau de tous les départements exceptés Diffa (sauf le poste administratif de Goudoumaria) et Maradi à un léger flétrissement voir souvent avancé des cultures. Ceci est dû à la faiblesse et ou au manque de précipitations observés depuis le début de ce mois. Cette situation est localement préoccupante car elle intervient au moment où les cultures sont aux stades de leurs besoins en eau maximum (épiaison, floraison).

Les premiers semis de mil réalisés dans la 1ère et 2ème décade de Mai sont en grenaison. Des cas de maturation sont signalés çà et là. Ces cultures se rencontrent de façon éparse au niveau de tous les départements. Les semis de la dernière décade de Mai et ceux de la 1ère et deuxième décade de Juin sont en montaison-début épiaison. Ils dominent dans le département de Maradi. Dans les zones de derniers semis, le mil est en tallage, le sorgho au stade de levée avancée à début tallage, les légumineuses de la levée à la ramification.

Dans les zones de premiers semis, le sorgho est en grenaison, les légumineuses en formation de gousses.

Les opérations aratoires se poursuivent localement.

F.2 Situation par département

F.2.1 Département de DIFFA

Les premiers semis de mil réalisés dans ce département sont en floraison-grenaison, les cultures semées pour l'essentiel au mois Mai se rencontrent dans le District Agricole de Chétimari et celui de Goudoumaria.

Pour le mil, le stade dominant est l'épiaison-floraison au niveau de l'arrondissement de Mainé-Soroa, la montaison à Diffa et N'Guigmi.

Dans les zones de derniers semis principalement dans le Nord N'Guigmi, le lit du lac Tchad, l'Ouest Mainé, La zone de Chéri et le canton de la Komadougou, le Mil est en début tallage, le Niébé en levée avancée-début ramification. Il s'agit là des semis réalisés dans la 2ème et 3ème décade de Juillet.

Dans la zone de premiers semis le sorgho est en épiaison-début floraison, le niébé à un début formation de gousses. Excepté le Poste Administratif de Goudoumaria où on assiste à un flétrissement des cultures, aucune poche de sécheresse n'a été signalée.

F.2.2 Département de DOSSO

Dans la majeure partie de l'arrondissement de Gaya le mil est au stade de grenaison-mâturation. Dans le district agricole de Gaya est la mâturité généralisée. Un début de récolte a été signalé dans le Poste Administratif de Dioundiou. Dans ce dernier cas il s'agit là des semis réalisés pour l'essentiel au mois d'Avril.

Dans les arrondissements de Doutchi, Boboye et Dosso, le stade dominant pour le mil est l'épiaison-floraison. Des cas de grenaison-mâturation sont signalés localement. A Loga par contre c'est la montaison.

Dans les zones de premiers semis, le sorgho est en épiaison-début floraison, les légumineuses en formation de gousses.

Dans les zones de derniers semis qu'on rencontre par endroit au niveau de tous les arrondissements, le mil est en fin tallage-début montaison, le sorgho en levée avancée-début tallage, les légumineuses en levée avancée-début ramification. Des cas de sécheresse avancée sur le mil en épiaison-grenaison et les légumineuses en floraison-début formation de gousses ont été signalés à Doutchi (Districts Agricoles de Matankari et de Tibiri). Dans les arrondissement de Dosso et Loga par contre, il s'agit surtout de flétrissements légers.

F.2.3 Département de MARADI

Les premiers semis de mil réalisés dans ce département au mois de Mai et rencontrés par endroit au niveau de tous les arrondissements sont en épiaison-floraison. Des cas de grenaison s'observent localement.

Concernant le mil, le stade dominant au niveau de tous les arrondissements est la montaison.

Dans les zones de derniers semis qu'on rencontre principalement dans les arrondissements de Tessaoua, Mayahi et Dakoro, le mil et le sorgho sont au stade de levée avancée-tallage, les légumineuses en levée avancée-début ramification. Le sorgho en épiaison début floraison dans les zones de premiers semis, les légumineuses en formation de gousses.

F.2.4 Département de TAHOUA

La situation des cultures dans ce département est caractérisée au cours de la décade par un flétrissement des plants observé çà et là au niveau de tous les arrondissements. La situation est préoccupante surtout dans l'arrondissement de Keita où le flétrissement est très avancé.

Dans les zones de premiers semis le mil est au stade de grenaison. Ces cultures sont rencontrées localement au niveau de tous les arrondissements. Des cas de mâturité sont signalés çà et là. Maggia-Konni, Sud-Est Illéla etc... Concernant le mil le stade dominant est la grenaison-montaison dans l'arrondissement de Konni, épiaison-floraison à Illéla, montaison au niveau de Tahoua, Bouza, Madaoua et Tchintabaraden, à Keita c'est le tallage.

Dans les zones de premiers semis, le sorgho est en épiaison-floraison début grenaison, les légumineuses en floraison-début formation de gousses. Ailleurs les stades varient de la levée avancée à un début tallage pour le sorgho et la ramification pour les légumineuses.

F.2.5 Département de TILLABERY

Dans les zones de derniers semis (fin Juillet début-Août) qu'on rencontre principalement dans les arrondissements de Tillabéry, Téra, Filingué, Ouallam et Kollo, le mil et sorgho sont au stade de levée avancée - début tallage, les légumineuses en levée avancée.

Les premiers semis réalisés au mois de Mai sont en floraison-début grenaison.

Pour le mil le stade dominant est la montaison dans les arrondissements de Say, Kollo et Ouallam, le tallage à Téra, Tillabéry et Filingué.

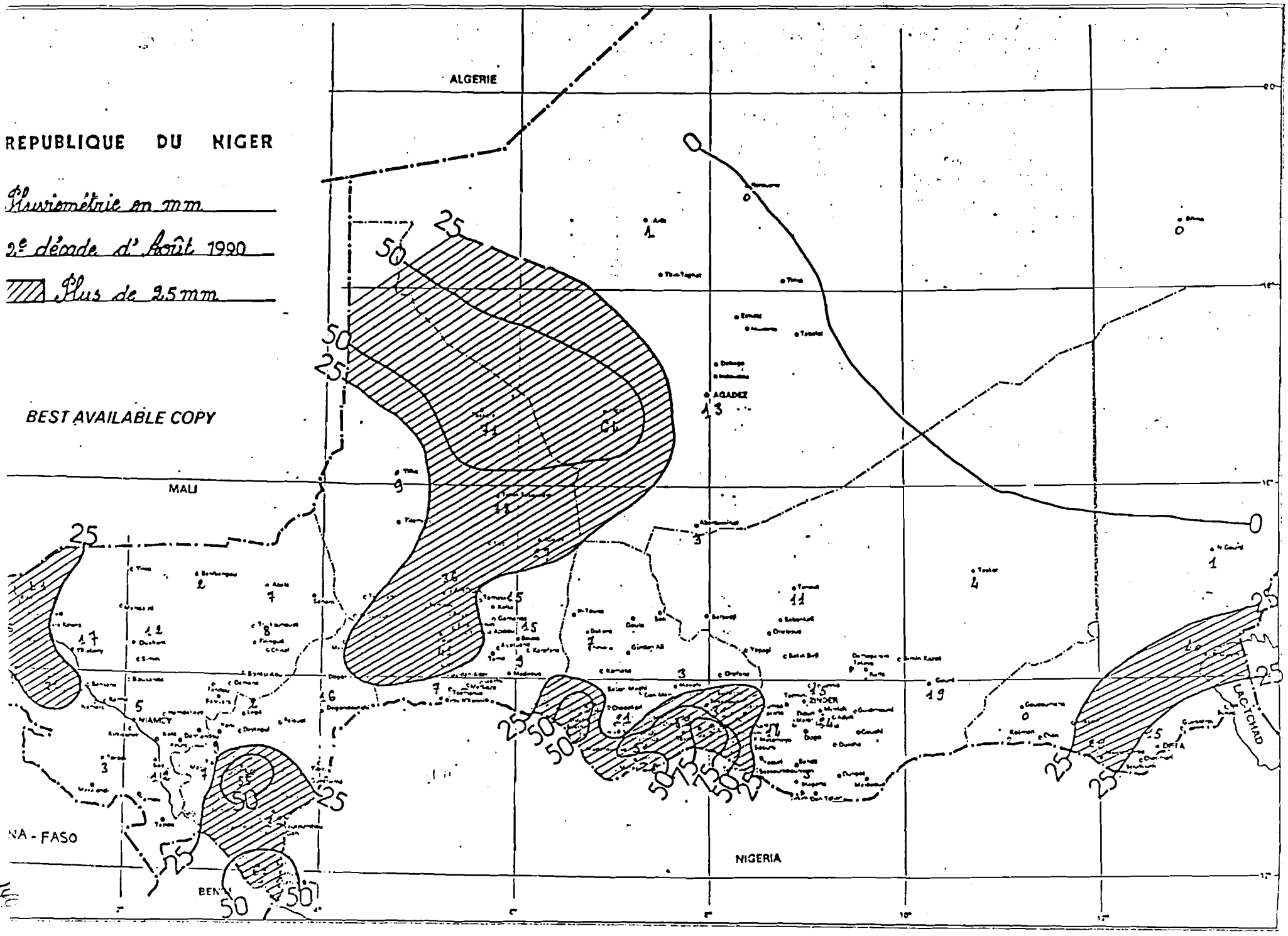
Dans les zones de premiers semis, le sorgho est en épiaison - début floraison, les légumineuses en formation de gousses.

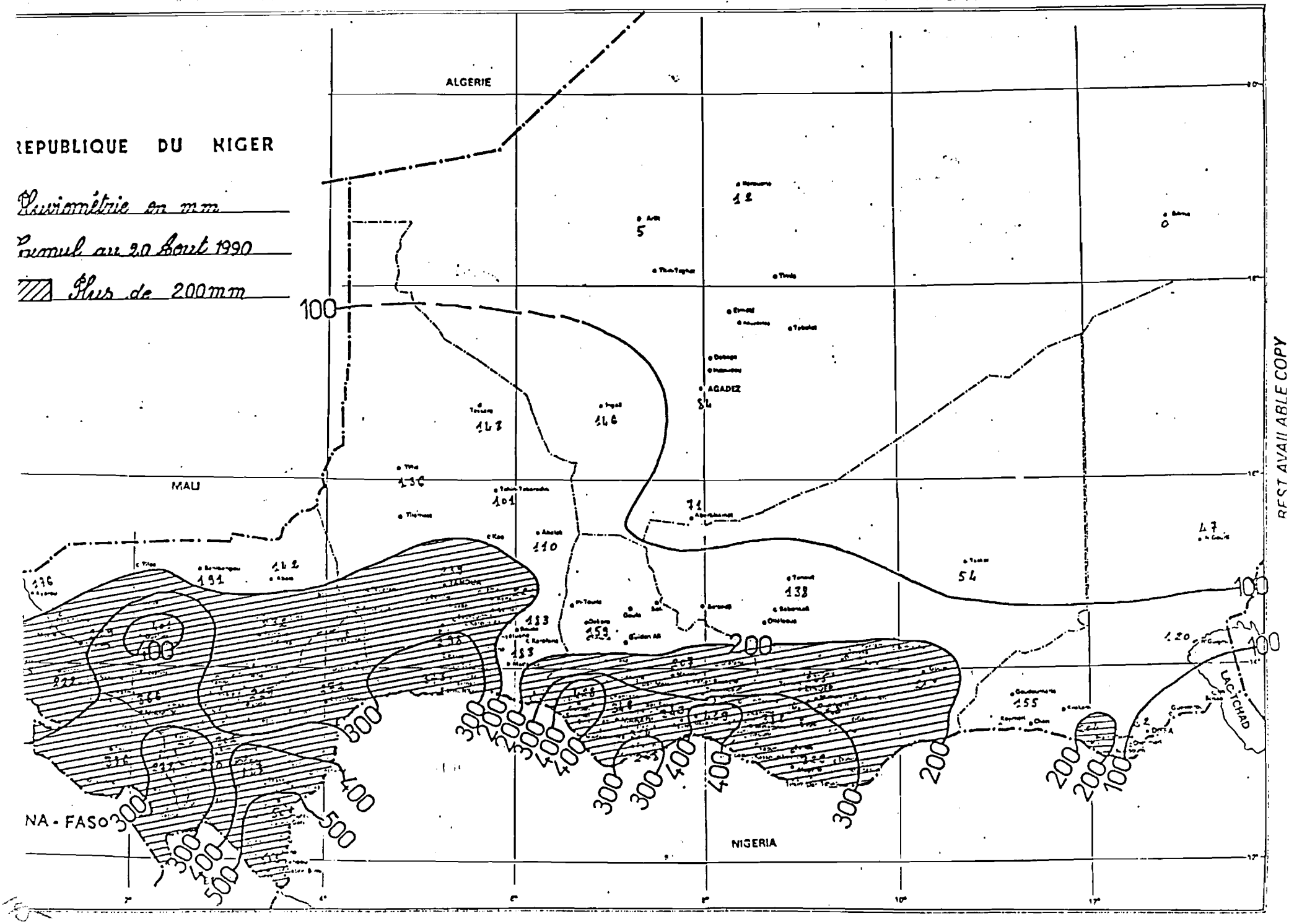
F.2.6 Département de ZINDER

Les derniers semis de mil réalisés dans le département (3ème décade de Juillet) sont en levée avancée début-tallage. Ces cultures se rencontrent principalement dans les arrondissements de Mirriah et Tanout.

Dans les zones de premiers semis, le mil est en grenaison. Il s'agit des semis de Mai qu'on rencontre localement au niveau de tous les arrondissements. Pour le mil, le stade dominant est l'épiaison-floraison au niveau de tous les arrondissements sauf Tanout où c'est la montaison. Le sorgho est en épiaison début floraison dans les zones de premiers semis, les légumineuses en formation de gousses. Ailleurs les stades varient de la levée avancée début tallage pour le sorgho et la ramification pour les légumineuses.

Des cas de sécheresse ont été signalés un peu partout dans ce département.


REPUBLIQUE DU NIGER
Pluviométrie en mm
2e décade d'Août 1990
Plus de 25 mm
BEST AVAILABLE COPY
ALGERIE
MALI
NIAMEY
AGADEZ
ZINDER
NIGERIA
LAC TCHAD
DIFFA
NA - FASO
BENIN



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REPUBLIQUE DU NIGER

entre pluviométrie 2e décade

Aout 1990 et 1989

Excédentaire

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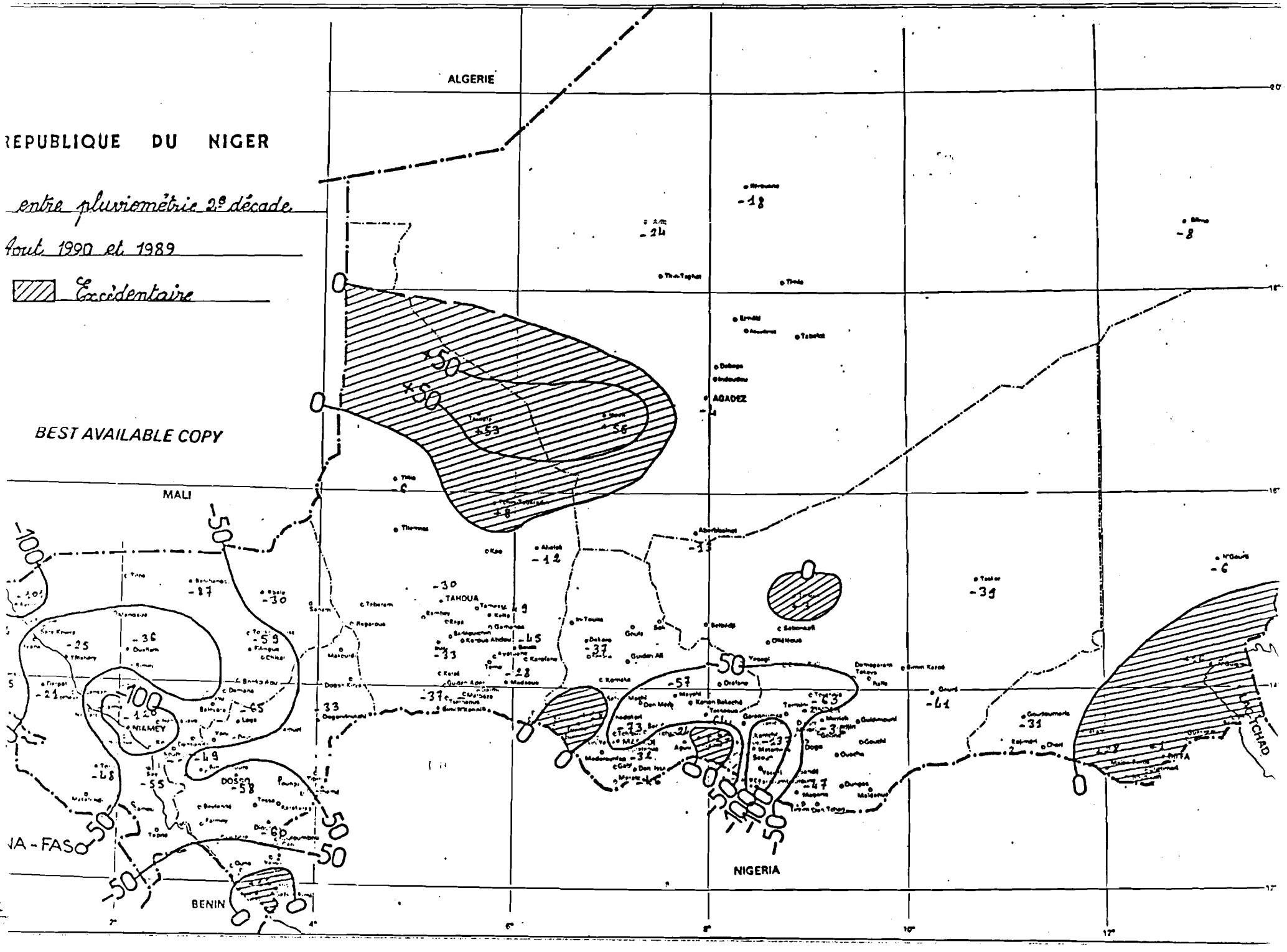

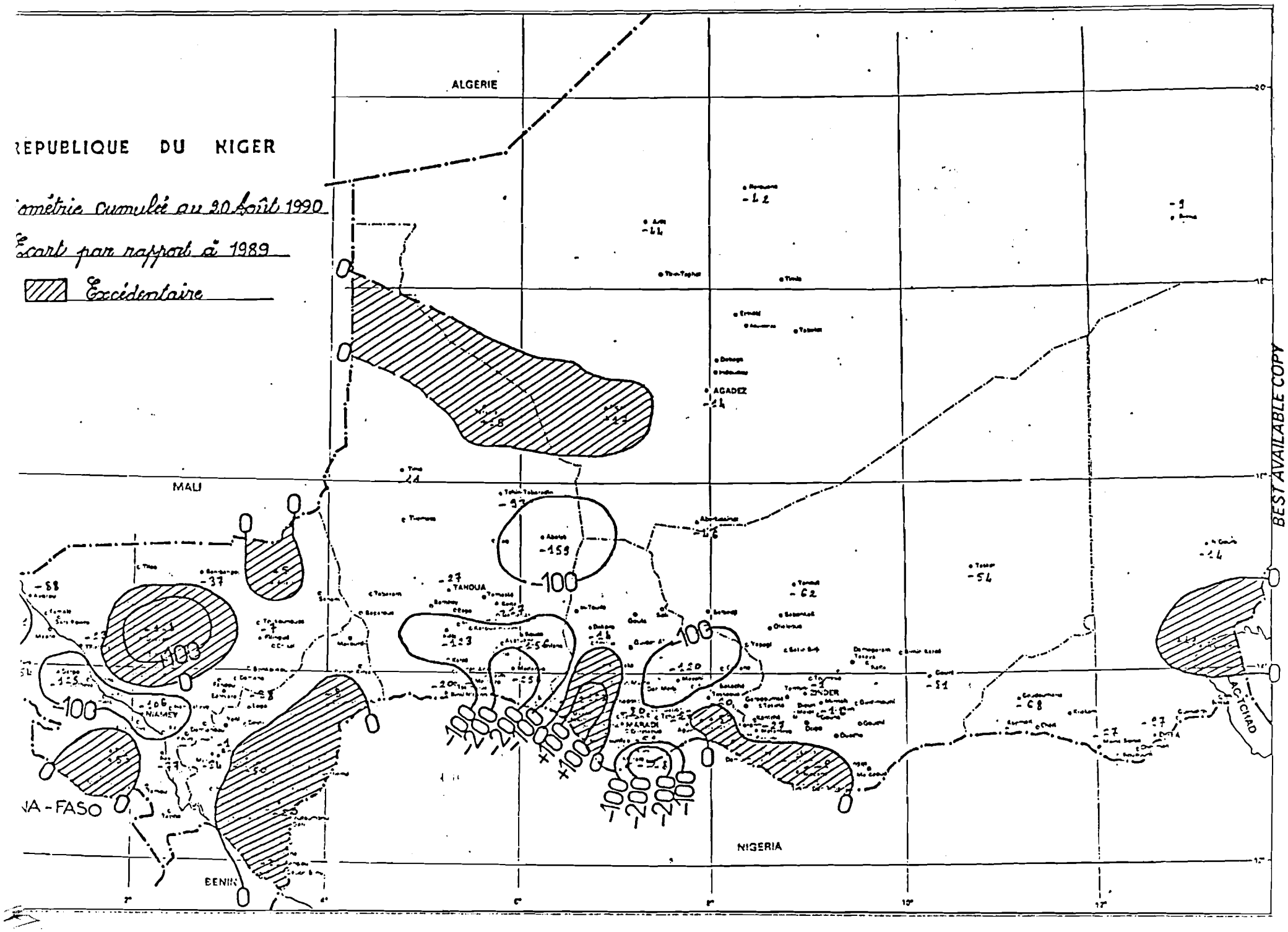
REPUBLIQUE DU NIGER
ométrie cumulée au 20 Août 1990
Ecart par rapport à 1989
Excédentaire
ALGERIE
MALI
NIGERIA
BENIN
AGADEZ
TANOUA
NIAMEY
TCHAD
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EPUBLIQUE DU NIGER

ctrie cumulée au 20 Août 1990

rt par rapport à la moyenne

Excédentaire

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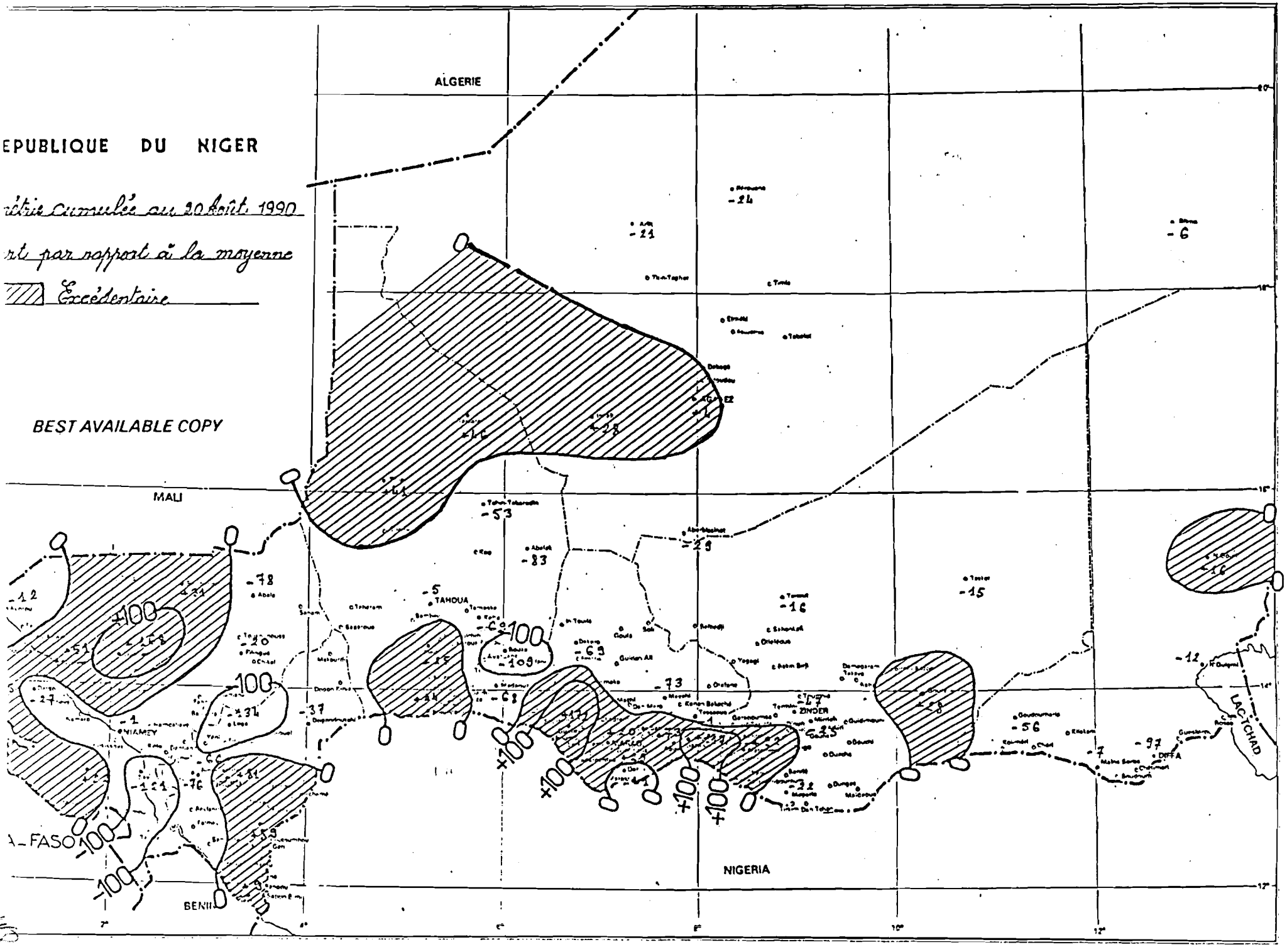


SITUATION PHENOLOGIQUE DES CULTURES

(Stade dominant)

e : Mil

(2ème décade d'Août 1990)

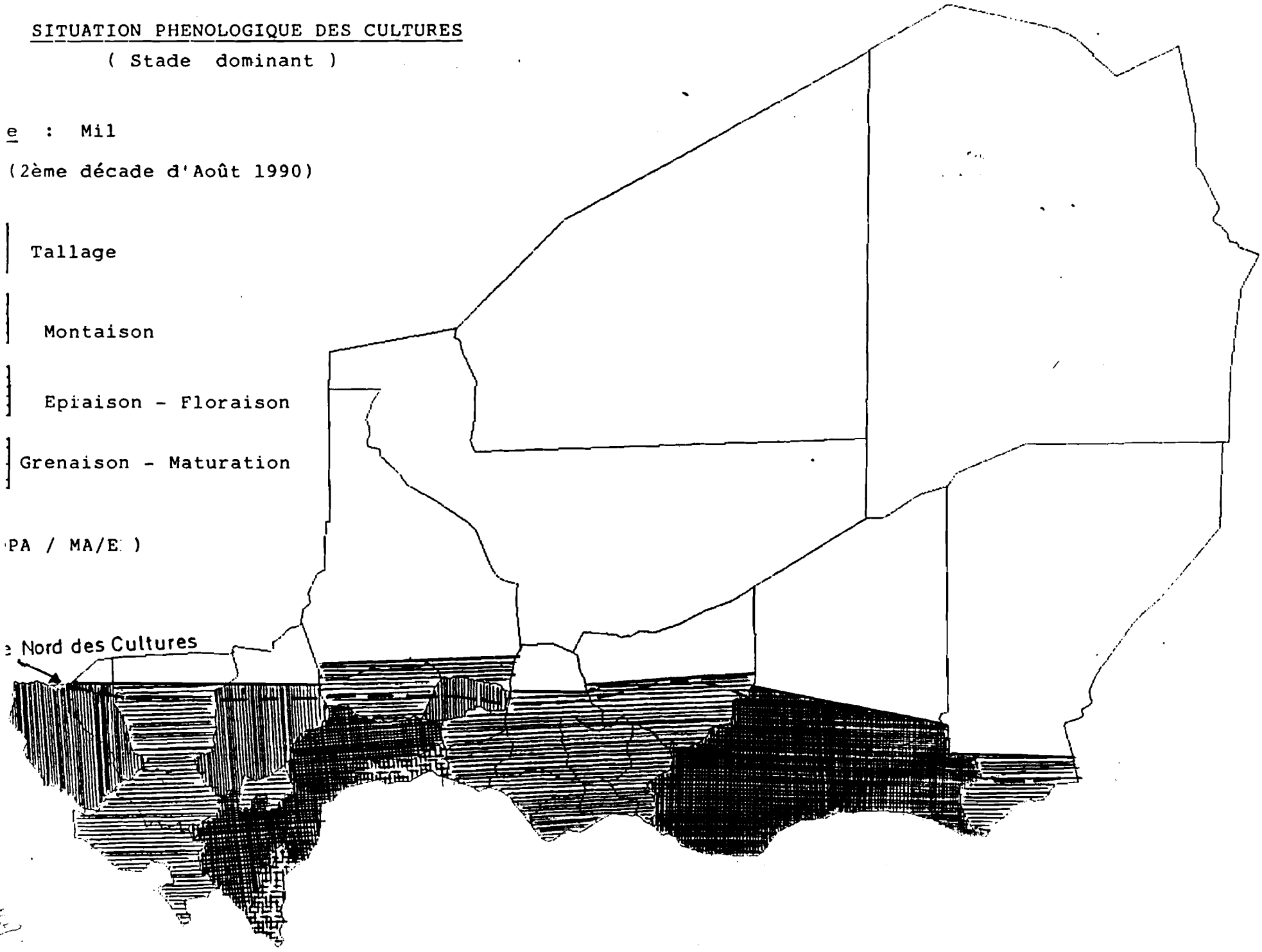
Tallage

Montaison

Epiaison - Floraison

Grenaison - Maturation

PA / MA/E)

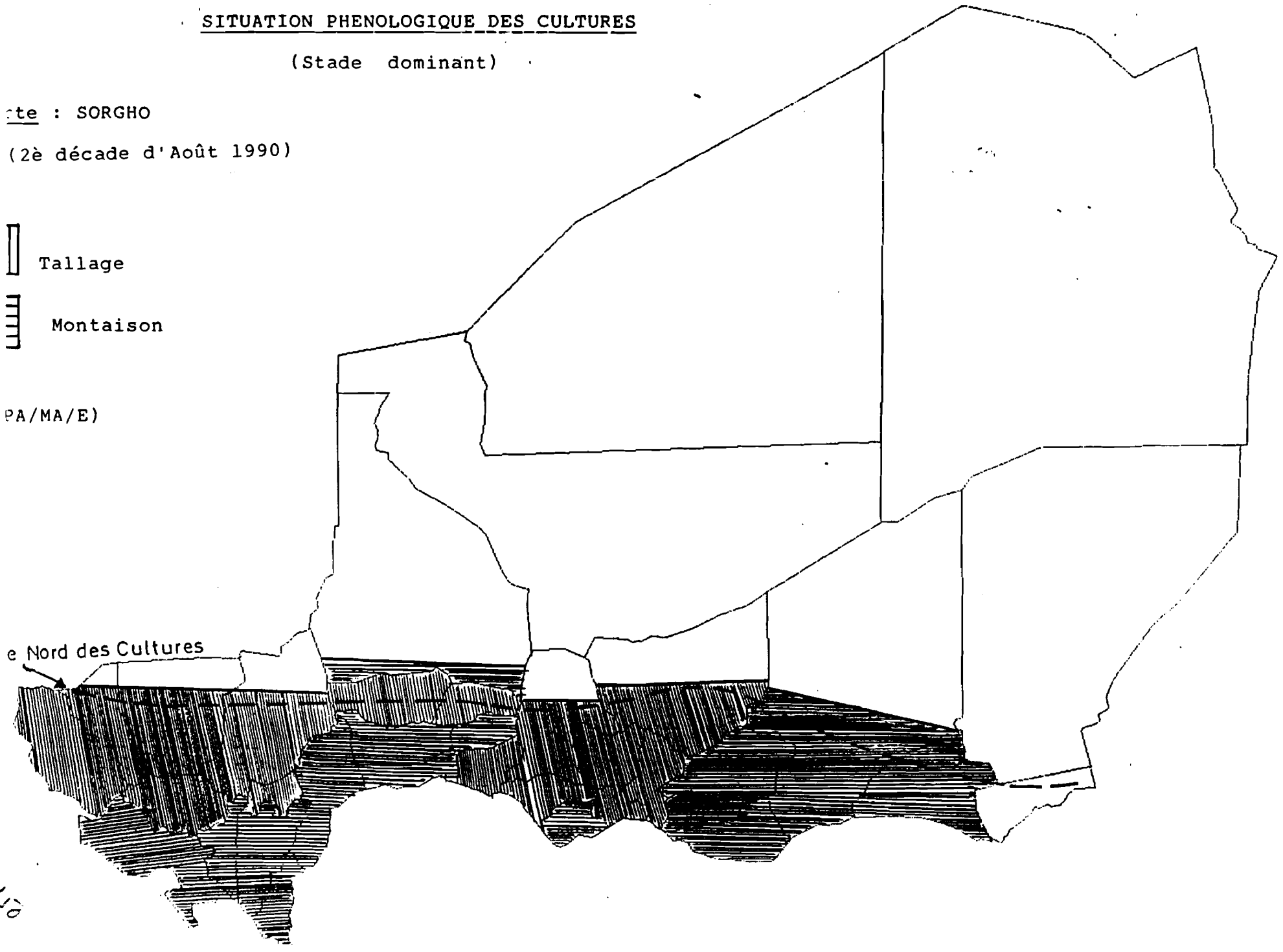


SITUATION PHENOLOGIQUE DES CULTURES

(Stade dominant)

:te : SORGHO

(2è décade d'Août 1990)



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SITUATION PHENOLOGIQUE DES CULTURES

(Stade dominant)

te : NIEBE

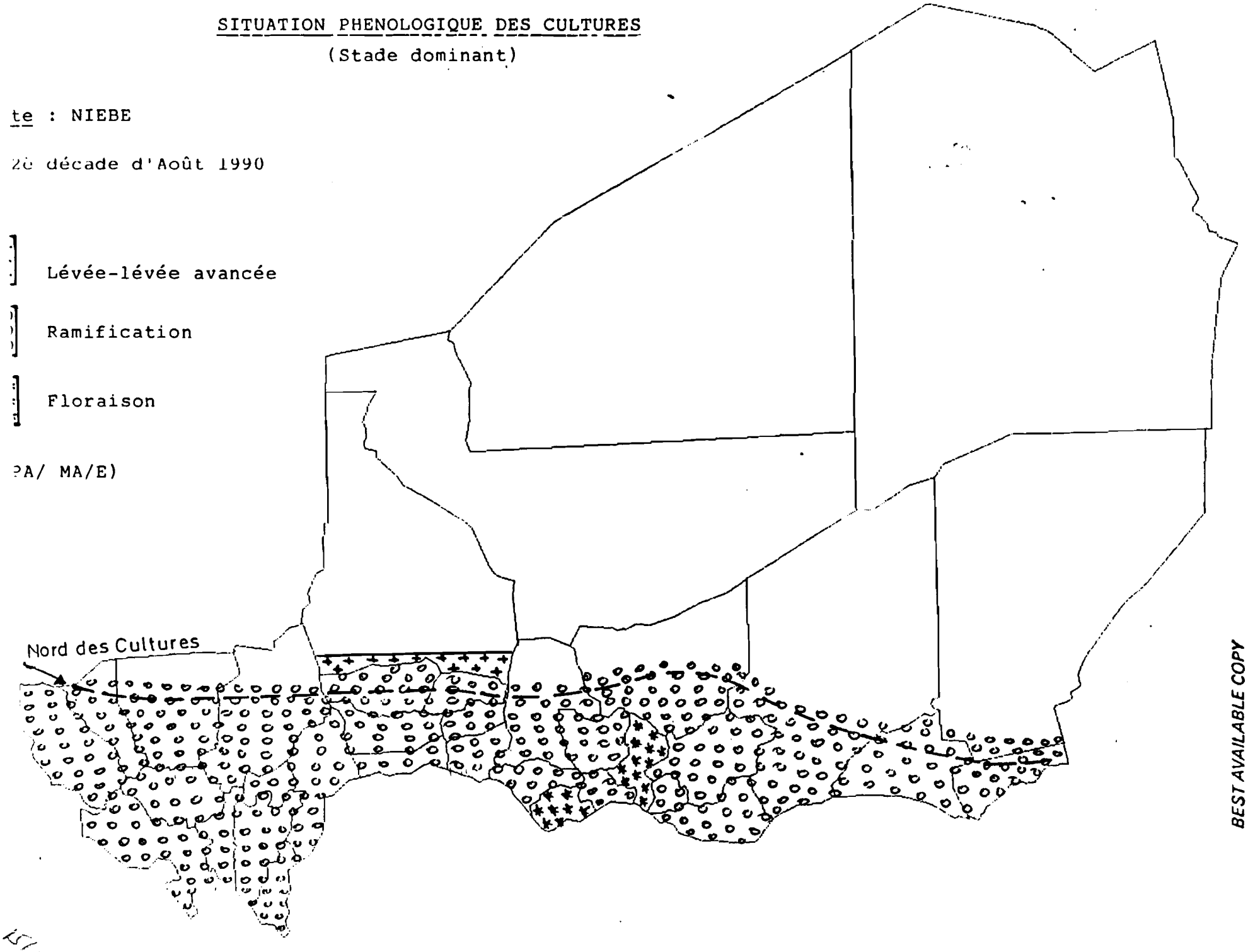
2e décade d'Août 1990

Lévée-lévée avancée

Ramification

Floraison

PA/ MA/E)



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SITUATION PHENOLOGIQUE DES CULTURES

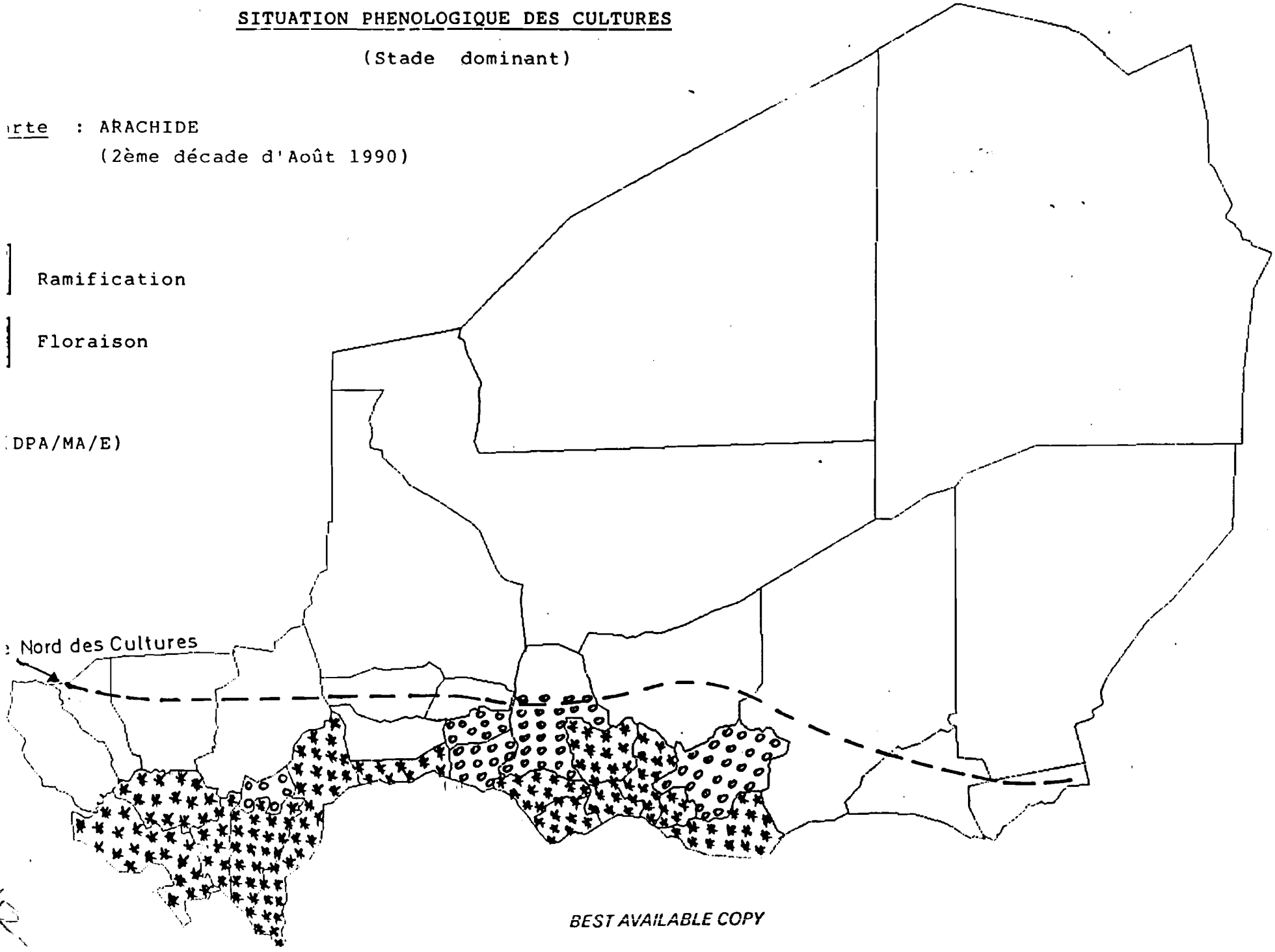
(Stade dominant)

rte : ARACHIDE
(2ème décade d'Août 1990)

Ramification

Floraison

DPA/MA/E)



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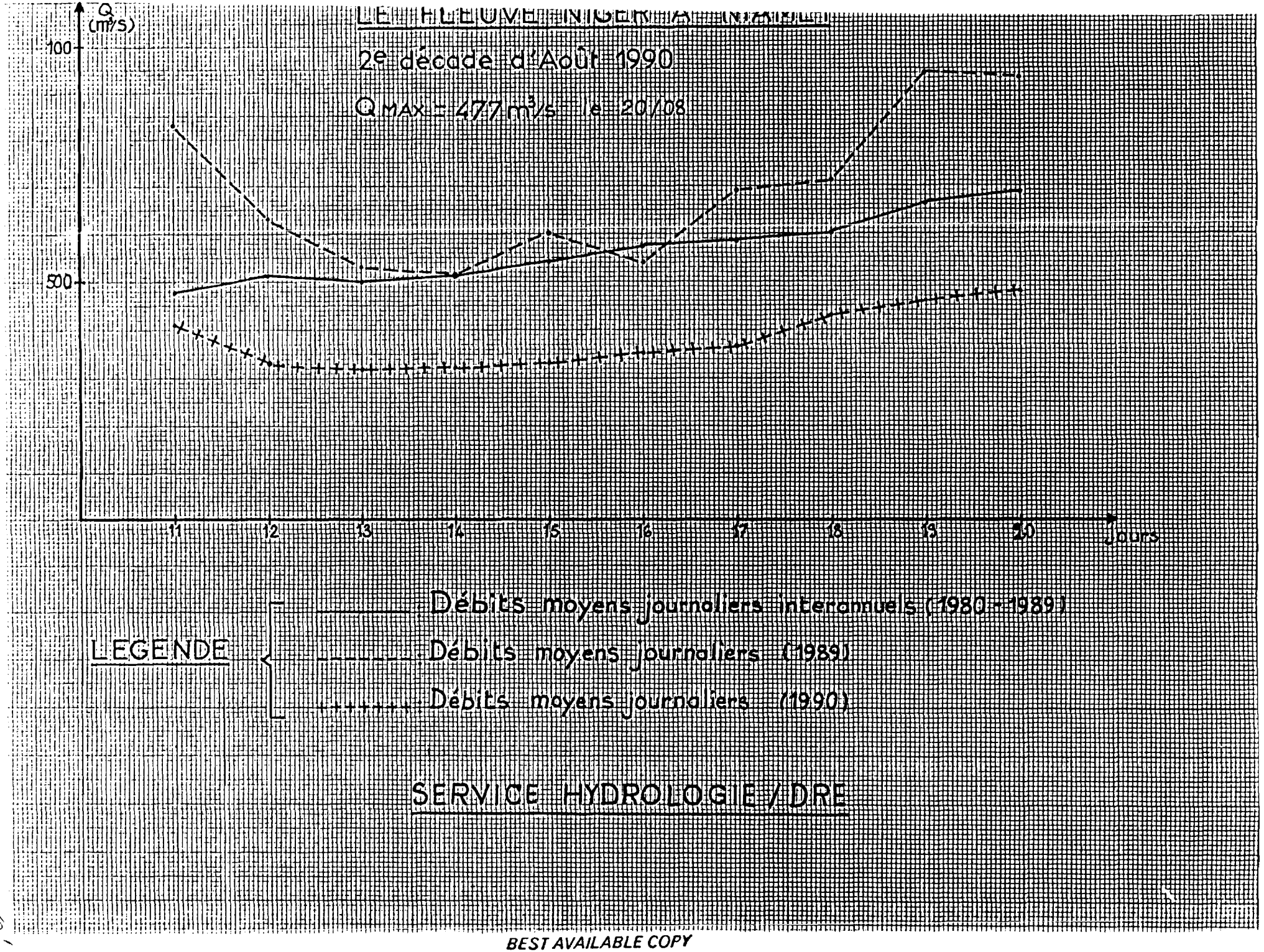

153

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REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

DONNEES METEOROLOGIQUES DECADAIRES Deuxième décade de Aout 1990

Nom de Localité	T MIN °C		T MAX °C		T MOY °C		T-N-EXT °C		T-X-EXT °C		VEN2CAL m/s	
	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M
AGADEZ	25.2	1	39.2	1	32.2	1	24.0	1	41.4	1	2.4	1
BILMA	25.8	1	41.4	1	33.6	1	20.6	1	43.6	1	2.0	1
BIRNI N'KONNI	23.9	1	34.5	2	29.3	2	22.0	1	36.6	2	1.5	1
DIFFA	24.7	1	35.3	1	30.0	1	23.0	1	37.2	1	1.0	1
GAYA	21.8	1	31.1	1	26.5	1	19.4	1	33.5	1	0.5	1
GOURE		10		10		10		10		10		10
MAGARIA	23.1	1	33.2	1	28.2	1	20.2	1	35.3	1	1.8	1
MAINE SOROA	23.5	1	33.5	1	28.5	1	20.5	1	35.6	1	2.1	1
MARADI AERO	22.5	1	31.9	1	27.2	1	20.4	1	34.5	1	1.4	1
N'GUIGMI	24.5	1	37.6	1	31.0	1	21.5	1	41.2	1	0.8	1
NIAMEY AERO	24.1	1	35.6	1	29.9	1	22.3	1	38.0	1	2.1	1
TAHOUA	24.0	1	34.8	1	29.4	1	20.0	1	39.3	1	1.8	7
TILLABERY	25.5	1	36.3	1	30.9	1	23.2	1	39.4	1	1.3	1
ZINDER AERO	23.7	1	34.4	1	29.0	1	20.8	1	36.2	1	2.1	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
T MIN : Temperature minimale sous-abri
T MAX : Température maximale sous-abri
T MOY : Température moyenne sous-abri
T-N-EXT: Température minimale extrême pendant la décade
T-X-EXT: Température maximale extrême pendant la décade
VEN2CAL: Vent moyen à 2 mètre calculé avec vent moyen à 10 mètre

154

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

DONNEES METEOROLOGIQUES DECADAIRES — Deuxième décade de Aout 1990

Nom de Localité	INSOL heures		INSOL% %		RAD CAL J/cm², j		HUM MIN %		HUM MAX %		TV mbar		DS mbar		EVA BAC mm/jour		EVA PIC mm/dec	
	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M	VAL	M
AGADEZ	10.1	1	80	1	1876	1	21	1	71	1	18.9	1		10	138	1	80	1
BILMA	10.1	2	79	2	1876	2	17	1	51	1	14.6	1		10		10	118	1
BIRNI N'KONNI	8.6	1	68	1	1756	1	49	1	92	1	27.0	1		10	63	1	35	1
DIFFA		10		10		10	45	1	83	1	25.7	1		10		10	41	1
GAYA	9.6	1	77	1	1840	1	62	1	96	1	27.5	1		10		10	20	1
GOURE		10		10		10		10		10		10		10		10		10
MAGARIA	8.1	1	64	1	1716	1	45	1	89	1	25.8	1		10	87	1	44	1
MAINE SOROA	7.1	1	56	1	1638	1	47	1	89	1	25.8	1		10	78	1	42	1
MARADI AERO	8.8	1	71	1	1779	1	54	1	93	1	26.1	1		10	61	1	30	1
N'GUIGMI	8.2	1	65	1	1731	1	37	1	85	1	25.2	1		10	89	1	49	1
NIAMEY AERO	9.4	1	75	1	1826	1	46	1	87	1	26.3	1		10	67	1	37	1
TAHOUA	8.3	1	66	1	1738	1	38	1	80	1	23.4	1		10	99	1	65	1
TILLABERY	8.9	1	71	1	1784	1	38	1	83	1	25.5	1		10	80	1	42	1
ZINDER AERO	8.9	1	71	1	1785	1	43	1	83	1	23.9	1		10	91	1	55	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
INSOL : Durée d'insolation moyenne
INSOL% : Pourcentage moyen d'insolation
RAD CAL: Radiation globale moyenne calculé avec la durée d'insolation
HUM MIN: Humidité minimale
HUM MAX: Humidité maximale
TV : Tension vapeur moyenne
DS : Déficit de saturation moyen
EVA BAC: Evaporation moyenne du bac
EVA PIC: Evaporation moyenne du piche

REPUBLIQUE DU NIGER
DIRECTION DE LA METEOROLOGIE
NATIONALE
B.P. 12246 NIAMEY

BULLETIN DECADAIRE

Nom de Localité	ETP-TV mm/dec	
	VAL	M
AGADEZ	75	1
BILMA	77	2
BIRNI N'KONNI	57	2
DIFFA		10
GAYA	48	1
GOURE		10
MAGARIA	55	1
MAINE SOROA	56	1
MARADI AERO	52	1
N'GUIGMI	57	1
NIAMEY AERO	61	1
TAHOUA	54	7
TILLABERY	59	1
ZINDER AERO	61	1

EXPLICATION DES ABREVIATIONS:

M : Nombre des valeurs manquantes
ETP-TV : ETP cumulé calculé avec la tension de vapeur

MH/E - DRA
rvice Hydrologie

LE FLEUVE NIGER A NIAMEY

HAUTEURS ET DEBITS

2ème DECADE DU MOIS D'AOUT 1990

TE	$\bar{Q}$ (m^3/s)	$\bar{H}$ (cm)	H (cm)	1989 Q (m^3/s)	1990 H (cm)	1990 Q (m^3/s)	$\frac{Q\ 90}{Q\ 89}$	TENDANCE (%)
	479	220		825	244	409	0.50	EN BAISSE DE 50
2	507	226		632	227	339	0.54	" " " 46
3	501	224		517	221	316	0.61	" " " 39
4	513	229		512	222	319	0.62	" " " 38
5	543	235		603	225	331	0.55	" " " 45
6	570	240		543	228	343	0.63	" " " 37
7	584	241		686	232	359	0.52	" " " 48
8	597	242		705	250	435	0.62	" " " 38
9	659	256		944	255	456	0.48	" " " 52
0	684	261		932	260	477	0.52	" " " 48

$\bar{Q}$ = Débits moyens journaliers interannuels (1980-1989)

$\bar{H}$ = Hauteurs moyennes correspondant à $\bar{Q}$

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151

ANNEX 5
Personnel Interviewed

Personnel Interviewed

GAMBIA

Meteorological Service

N.D. ALIMI	U.N. Volunteer
M.P. GAH	Deputy Head of AGRHYMET
Bubu DIALLO	Chief, Meteorological Section
Abu DEMBRA	Computer Maintenance
Seedy JOBE	Meteorological Officer
Boboucar MANNEH	Chief Hydrology Section

Ministry of Natural Resources

Bolong SONKO	Permenent Secretary
Robert ROBERTS	Techncial Advisory
Sigismond JOHNSON	Assistant Director--Rural Water Supply

Ministry of Agriculture

Phillip DECOSSE	Technical Advisor--Planning Department

USAID

Donald DURGA	ADO
Somar JALLOW	GARD Project Manager

UNPD

Helga SELROD	Junior Program Officer

SENEGAL

Direction Meteorologie Nationale

Assane SENE	GTP Representative
Mama KONATE	WMO NAC Representative
Mbaye DIOUF	Responsable du Centre de Calcul

Moctar DIOP	Chef Bureau Maintenance
Mamadou NDIAYE	?
Ndene NDIAYE	Chief of NAC
Sanran NDIAYE	GTP Representative
Sory DIEJLLO	Deputy Director Meterologie National
Wassila THIAO	Chef de Bureau Recherches

Direction Protection Vegetaux

Abdoulaye BALDE	GTP Representative

Direction Elevate

Daniel NDECKY

USAID

David DELGADO	ADO
Lamine THIAM	AGRHYMET Project Manager

Direction du Genie Rural et de l'Hydraulique

Diegane DIONE	Chef Section Hydrologie
Masse NIANG	AGRHYMET Responsable

ASECNA

Mbida SOW	GTP Representative
Madiagne THIAW	GTP Representative

Centre de Suivi Ecologique

Ibrhima DIA	GTP Representative
Hubert GEORGE	Technical Advisor in Geography
Malcolm MARKS	Technical Advisor in Ecology
Michael Schultz RASMUSSEN	Technical Advisor in Agriculture

Direction Agriculture

Simon DIATTA	Responsable AGRHYMET
Amadou Moustapha KAMARA	Directeur de l'Agriculture

Yatma NDIAYE	GTP Representative

NIGER

AGRHYMET Regional Center

Also IDRISSA	Directeur de l'Exploitation
Claude DANCETE	Chef des Applications
Gilles LECHAPT	Conseiller Technique (FAC)
Horacio SOARES	Director General
Idalina FERNANDEZ	?
Mark MCGUIRE	Operations Production Supervisor
Ndiapaly NDIAYE	Chef Division Logistique
Richard SWANSON AGRHYMET	USGS Technical Assistance Team Leader
Salime TOURE	? (Maintenance)
Simon VAN DONK	Agro-Climatologist
_____ BURGESS	?
_____ CUNIN	?

USAID

John SLATTERY	GDO-AGRHYMET Project Officer
George TAYLOR	ADO

Service Meteorologie Nationale

_____ NDUKWE	Chef de Service Meteorologie

CABO VERDE

National Agricultural Research Institute (INIA)

Carlos COUTINHO	Computer Hardware Maintenance
Evelyn MONTERIO	AGRHYMET Representative

Direction of Soil Conservation, Forestry and Rural Engineering (DGCSFER)

Joao Mendez DE CARVALHO	GIS Technician-DGCSFER

16

USAID

John JONES	Forester
Paul THEISEN	Head of Mission
Thomas LUCHE	

SIOUX FALLS

USGS EROS Data Center

Alan FALCONER	Principal Scientist
Don MOORE	
A. WATKINS	
D. LAUER	
Tom LOVELAND	
Grey TAPPAN	
Steve HOWARD	
D. OCHNER	
John LAVERGNE	
Tom BODOH	
John MERCHANT	
Andrew NADEAU	
Mike WEHDE	

BURKINA FASO

Usaid

Wilbur THOMAS	USAID Mission Director
Dennis MCCARTHY	Agricultural Development Officer
Sally SHARP	Programs Director
Boua ZLENSO	Agricultural Economist/ADO

CILLS

Michael KOUTABA	Directeur des Projets et Programmes, President Commite de Pilotage de l'AGRHYMET
Dramene COULIBALY	Agro-Economiste
Stephen REID	Conseiller in Planification

FEWS

Jeffery WRIGHT	FEWS Representative, Ouagadougou

Meteorological Service

Denis OUEDRAGO	Chef Projet Pilote Suivi Agrometeorologigues
Ernest OUEDRAGO	Agrometeorologist
Enoch KABORE	Chef-Creation de Fishier de Systeme de bases
Jean-Pierre QUEDRAOGO	Direction de la Meteorologie

MALI

USAID

ATWOOD	Agricultural Development Officer
Dennis BRENNAN	USAID Mission Director

GTP

Aliou TEKETE	Direction Mete
Salif SOW	FEWS/USAID
Paul BARTEL	FEWS/USAID
Abdoulaye SIBIDE	ONHE
Mamadou MAIGA	Direction Meteo
Fanta TRAORE	Direction Meteo
Bouboucar N'JALLE	ODIPAC
Abdoulaye LIBIDE	CMDT
Mahaman COULIBALY	DNM
Modibo KONI	DNM
Mamadou Augustin DEMBELE	USAID/Bamako
Nommoutre DIAKTE	OHV

Meteorological Society

Kalibou TRAORE	Directeur Ajoint
Biraima DIARREA	Agrometeorologist
Mamadou DIALLO	Climatologist
Ibrahim KONE	Computer Software

System d'Alerte Prococe

Mary DIALLO	Conseiller Technique
Bah Ali TAMBOUA	Superviseur del Enqutes

Ministry of Agriculture

M. KONATE	Statistique Agricole

Hydrological Service

Amadou BA	Division Chief

Institut du Sahel (INSAH)

Amadou Tijan JALLON	Director

MAURITANIA

FEWS/USAID

Denise DALY	Field Representative
Sy HAMADY	Assistant

AGRHYMET/Mauritania

Gandega YELLI	AGRHYMET Coordinator
Djibirl SARR	Chief Division Hydrology
Hanoud Ould Lechlim	Chief Division Meteo
M. ZEIN	Chief Statistique Agricole
Sidi Ould DIOBUAYE	Chief Services Protection Vegetaux
Mamadou Yaro BESS	Chief Extension
Ibragim MBASS	Computer Maintenance

GTP

Gandega YELLI	AGRHYMET
Mohamed EL MOCTAR	Hydraulique
Youssouf MALLE	Statistiques Agricoles
Djibril SARR	AGRHYMET/Hydrologie
Salim Ould SYDINA	CP/HDR

Sy HAMADY	FEWS/Mauritania
Denis DALY	FEWS/Mauritania

Elevage

Amadou TALL	Chef Bureau Pastorale

Ministry of Agriculture

Anai KPONTON	Chef Statistiques Agricoles
Torre ALBA	Extension

Hydraulique

M. BOUCOUN	Conseiller Technique
Saadou Ebih Ould Mohamed EL HACEN	Planification

UND

Demba DIOP	Director UNDP Program

Genie Rurale

Mohamed DALY	Directeur

ANNEX 6

Scope of Work Evaluation

ARTICLE I - TITLE

Sahel Water Data Network and Management III

(PROJECT NUMBER: 625-0973)

ARTICLE II - OBJECTIVE

Conduct a mid-term evaluation of the Phase III Contribution to the Agrhyment Program.

ARTICLE III - STATEMENT OF WORK

A. Summary

The first objective of this evaluation is to determine if A.I.D.'s Phase III project and its implementation to date met the twin criteria of feasibility and sustainability. While A.I.D. is obviously interested in how successful the project has been, A.I.D. wants to be sure that this evaluation provides specific recommendations to improve project performance to be undertaken in time to affect the course of Phase III implementation. Therefore, factors to be examined in this regard are those which affect achievement of Phase III objectives and which will increase the cost efficiency and sustainability of post-Phase III Sahelization of the project. Items to be examined in this regard during the course of the evaluation are presented below in paragraph 1.

The second objective is to examine A.I.D.'s Phase III inputs for continuity, completeness, effectiveness and appropriateness. Progress made by the implementing agency, USGS, towards meeting the project objectives under its PASA will be specifically focussed on, as well as a review of USAID/Niger and A.I.D./Washington management of the project. Items to be evaluated in the connection are presented below in paragraph 2.

The third objective of this evaluation is to develop specific recommendations regarding A.I.D.'s contribution to the remainder of Phase III in terms of: (1) scientific/technical direction, (2) nature and type of inputs, (3) funding level and (4) length of time and level of effort that would be needed to meet Phase III project objectives.

1. Feasibility and Sustainability Issues

- A review of progress towards implementation of the recommendations of the Management-By-Objectives Study.

- Rate at which regional and national maintenance responsibility is being successfully transferred to sahelian personnel.

- Level of up-time of sufficient system capacity (ARC and NAC computers) to perform all critical functions.

- Success at transferring satellite data interpretation methodology to Sahelian personnel.

- Efficiency of training programs.

- Coordination of remote sensing/crop monitoring component with other food deficit/early warning systems actors.

- Degree to which technological advances in computer hardware and software and/or in satellite data processing technology render existing or planned project activities obsolete.

- Extent to which solutions to the telecommunications bottlenecks have proven viable and progress towards their implementation.

- Finally, relative success or failure of the project in establishing clear, simple and appropriate systems and tools to carry on project operations with a minimum reliance upon costly expatriate inputs, particularly in the post-1991 period and beyond.

2. Issues Relating to A.I.D. and USGS Inputs

- The progress made toward achieving project goal, purpose, and outputs as described in the Project Paper and PASA. The continuing relevance of the goal, purpose and project outputs given the implementation experience to date and the multi-donor nature of the project.

- The extent to which the existing project administrative and technical management structure and procedures permit effective problem identification and resolution.

- The appropriateness of A.I.D./USGS program inputs taking into consideration: (1) A.I.D.'s long-term commitment to the AGRHYMET Program, (2) A.I.D.'s overall development strategy in the Sahel, and (3) the inputs of other donors.

- The effectiveness of support by other USAID missions in AGRHYMET countries for project activities being carried at the national level.

- A.I.D./USGS actions required to improve project implementation through the end of the current phase in terms of: (1) funding levels, (2) project management decisions, (3) length of project, and (4) special actions required.

- The progress made in strengthening the National AGRHYMET Centers (meteorological and hydrological) taking into account the objectives of the AGRHYMET Regional Center and the AGRHYMET program as a whole.

ARTICLE IV - REPORTS

The results of the evaluation will be incorporated into a detailed final report (typed in English and French) that will include, but not be limited to, the points discussed above in Paragraph IIIA. The draft report (typed in English) will be presented to USAID/Niger before the team departs Niamey. The final report (Typed in English and French, USAID/Niger requires 15 English copies and 5 French copies) will be sent to USAID/Niger within one month of the completion of the evaluation. The Team Leader will be fully and directly responsible for assigning specific work to team members and coordinating the work of all the team members into one, comprehensive, draft report (typed in English). The 4-member team also meet with WMO officials in Geneva and A.I.D./W Sahel West Africa Bureau personnel in order to present their findings/recommendations.

ANNEX 7
Documents Consulted

DOCUMENTS CONSULTED

1. Requirements Needs Analysis AGRHYMET Phase III
2. Participating Agency Service Agreement (PASA) Dated Jan. 31 1989
3. PASA Amendment 1 Dated Aug 25 1989
4. PASA Amendment 2 Dated Dec 27 1989
5. PASA Amendment 3 Dated Sep 20 1990
6. USGS AGRHYMET Report for 1989
7. USGS AGRHYMET Report for 1990 (draft)
8. Financial Management Report by Rejean Labonte, May 1990
9. Rapport de Mission au Centre AGRHYMET du 24 au 28 Septembre Cherif Elvalide Seye
10. Report of the Visit to the AGRHYMET Center by Cherif Elvalide Seye (english translation)
11. 1991 Draft Workplan
12. GIS Development within the AGRHYMET: 1991 Program Activities
13. Sahel Water Data and Management II - Project Paper
14. AGRHYMET Hardware Activities 1989/91
15. Report on the Second Meeting of the AGRHYMET Scientific Advisory Council, NIAMEY, Sep 17-21 1990 by Sharon Nicholson
16. "Atelier sur l'Utilisation des Images d'Indice de Vegetation pour le Suivi des Conditions Vegetal et pour la Protection des Vegetaux." Centre AGRHYMET, NIAMEY, Niger, Julliet 1990
17. USGS AGRHYMET Work Plan 1991

18. World Meteorological Organization, Third Session of the Coordinating and Advisory Committee and of the Executive Committee of the AGRHYMET Programme, NIAMEY, Niger, 10-14 December 1990

Doc. 1	Provisional Agenda
Doc. 2	Review of the Activity Report of the Director General of the AGRHYMET Center for the Period October 1989 to September 1990
Doc. 4	Review of the Reports of the Meetings of the AGRHYMET Scientific Advisory Council
Doc. 6	Review of the Programmes of Activities of the AGRHYMET Center and National Components for the Year 1991
Doc. 7.1	Review of the Funding of the End of AGRHYMET Programme Phase III
Doc. 8	Preparation of the AGRHYMET Programme Phase VI
Doc. 10	Progress made in the Implementation of the RDBS

19. CILLS/UNDP/WMO/FAO, AGRHYMET Programme, "First Meeting of the AGRHYMET Programme Management by Objective (MBO) Steering Group." NIAMEY, Niger, 26-27 July 1990

20. Plan de Travail (Jan-Dec 1991)

21. WMO, Third Joint Session of the Coordinating and Advisory Committee and Executive Committee of the AGRHYMET Programme, "Preparatory Meeting of the Coordinating and Advisory Committee of the AGRHYMET Programme." NIAMEY, Niger, 11 Dec 1990

22. CILLS/PNUD/OMM Programme AGRHYMET, Intercalibration de Satellites NOAA 10 et NOAA 11, NIAMEY, Niger, Aout 1990

23. WMO, Third Joint Session of the Coordinating and Advisory Committee and Executive Committee of the AGRHYMET Programme, "Review of the Activity Report of the Director-General of the AGRHYMET Center for the Period October 1989 - September 1990.", NIAMEY, Niger 10-14 December, 1990

24. USAID/Gambia, "Natural Resource Information Available in the Gambia", undated

25. Forest, F.,"Simulation du Bilan Hydrique des Cultures Pluviales", Division Recherche-Development Economie-Valorisation de l'Eau:IRAT-CIRAD, February 1984

26. Points sur l'Etat d'Advancement des Projects Pilotes du Senegal, Revue Tripartite, Project AGRHYMET (SEN/86/009-Phase III) 27 December 1990

27. Copies of Decadal Bulletins from GAMBIA, SENEGAL, CABO VERDE, and GUINEA BISSAU

28. Distribution list of Bulletin for GAMBIA, SENEGAL, CABO VERDE, and GUINEA BISSAU

29. Software DHC, Version Montpellier, March 1991

30. Bulletin Pluviometrique de Conjoncture. Evolution de la Saison Pluviometrique 1990. Point de la situation au 31 Aout. Direction Nationale de la Meteorologie, Bamako, Mali

31. Bulletin Pluviometrique Mensual, October 1990. Direction Nationale de la Meteorologie, Bamako, Mali

32. Bulletin d'Information Agro-Hydro-Meteorologique Decadaire. 11-20 Octobre, 1990. Direction Nationale de la Meteorologie, Bamako, Mali

33. Bulletin Agrometeorologique Decadaire. 21-30 Sept. 1990. Direction Nationale de la Meteorologie, Bamako, Mali

34. European Association for Development of Health. Brochure.

35. African Center of Meteorological Applications for Development (ACMAD). Preparatory Assistance Project (PAP). 1987

36. Bulletin Systeme d'Alerte Precose (SAP) No. 58. Situation Fin Mars 1991. Bamako, Mali

37. Sahel Water Data and Management III. Project Paper. AID/Washington. 1987. Volume 1.

38. Sahel Water Data and Management III. Project Paper. AID/Washington. 1987. Volume 2.

39. Strategie et Programmation Quinquinnale:1990-1994. Institute du Sahel. Bamako, Mali. August, 1990.

ANNEX 8

AGRHYMET Interim Report

AGRHYMET EVALUATION
INTERIM REPORT

TEAM: Derrick J. Thom - Team Leader
Andrew Stancioff - Remote Sensing/GIS/AVHRR Specialist
Douglas Brown - Computer Hardware Systems Analyst
Andres Ravelo - Agrometeorologist

I. Introduction

A. Schedule

Jan 21 - Monday - Meet in Sioux Falls

Jan 22 - Tuesday - Eros Data Center, Sioux Falls

Jan 23 - Wednesday - Meetings with the following:
A. Watkins, D. Lauer, D. Moore
T. Loveland, G. Tappan, S. Howard
A. Falconer, D. Ochner,
J. LaVergne, T. Bodoh, J. Merchant,
A. Nadeau, M. Wehde

Jan 24 - Thursday - USAID, Washington, D.C.
AID Sahel - Roger Simmons, Ron Daniels, Danna Fischer

Jan 25 - Friday - AID AFR/TR - Tony Pryor, M. Magahey

Jan 26 - Saturday - Returned home

Jan 29 - One day preparation of Interim Report

B. Objective of Interim Report

1. The AGRHYMET Evaluation Team met in Sioux Fall, South Dakota on January 21, 1991 and began interviewing EROS Data Center personnel on January 22. Because of the Gulf War Crisis, all non-essential AID funded travel was terminated worldwide. In so far as the Evaluation Team had begun its activities, the team proceeded to Washington, D.C., to be briefed by AID officials familiar with the AGRHYMET project. It was deemed appropriate by AID-Washington and AID-Niger that the team summarize its findings in an interim

report. This report will permit the Evaluation Team to proceed directly to West Africa once the travel ban is lifted.

2. The objective of this Interim Report is thus to summarize the activities and information gleaned from interviews with individuals involved with the USAID component of the AGRHYMET project at the USGS-EROS Data Center and AID-Washington.

3. Because this document is an Interim Report it should not be viewed as a final document but rather a document of background information to prepare the Evaluation Team for continuing the evaluation process in West Africa. The team was well received at EROS Data Center and the people interviewed provided the team members with valuable information. The interview process raised many questions that can only be answered by an on-site visit. This report thus raises many questions that need to be asked before recommendations can be made.

II. Report of Activities

A. Administration and Management

The AGRHYMET Project is a complex multi-donor funded project for which USGS-EDC under a PASA agreement with USAID is responsible for only a portion of the overall project.

From initial indications, it appears that there is very little integration of the whole project which presumably has an impact on the smooth running of the project.

Initial observations of a tentative nature suggest that:

1. <u>USGS - EROS Management</u>
EROS has only been involved with AGRHYMET for the past two years and has run into problems and difficulties in management and administration-many not of EDC making.

There is an apparent lack of international experience on the part of the EROS Management. Perhaps the exception of one or two individuals international experience has been limited. The hiring within the past year of one individual with broad international experience has addressed this problem.

Problems arose the first year over shipping computers and hardware to the Regional Center and the National Center. Much of the delay

in the shipping process was not of EDC's making. However, the responsibility for this task was an EROS technician whose talents would have best been used in his profession.

Once the logistics of transferring the hardware from the U.S. to West Africa had been achieved the Administration and Management by EROS appears to have been improved in that EROS was involved in the actual development and production.

2. USGS - AGRHYMET Management

It became apparent that there is a lack of donor coordination between the USGS on-site team and other donor agencies.

This lack of coordination may be due to lack of program definition, planning, scheduling and general lack of strong overall high level management in the African context.

3. AGRHYMET Management (Sahelian)

There is an apparent need of a management structure and delegation of duties to second level management the Director has too many duties.

It appears that other donor functions at the Regional Center are placing an undue burden on the management structure.

B. Remote Sensing Component

At present the use of Remote Sensing is restricted to the development of NDVI Vegetative index maps of the Sahel on a decadal basis. These maps are called Greenness Maps and are used regionally by a number of organizations and by the National AGRHYMET Centers (NACS).

1. Products

The products are at first sight extremely effective and legible. That is, they appear to be easily interpretable. Improvements have been made in defining the upper and lower ends of the greenness/dryness scale (NDVI Ratio). Interpretation is however dependent on education and training and although straightforward interpretations can be made, people in the field, we are told, quickly run out of things to do with these maps in an application framework. Gray Tappan and others felt strongly that more training was necessary at the NAC level.

The products have some visible problems which are in fact evident only because of the effectiveness and impact of the maps.

a. The scale is too small for individuals working at most levels in agricultural development, or with hydrological problems.

b. People working at these levels wish to see geographic boundaries related to their needs. (local administrative units.)

c. The diskette with AVHRR should be compatible with other software packages allowing them to super impose the decadal data onto administrative boundary layers and other compatible needs.

d. The interpretability of AVRHH/NDVI is limited as long as there is no equivalent scale land use map, soils map, groundwater map, degradation map, phenologic calendric maps, etc.

e. Few if any other remote sensing products are being used at AGRHYMET, (eg-Spot Landsat) in a project defined framework and in support of AGRHYMET objectives.

2. <u>G.I.S. Requirements</u>

The G.I.S. component of AGRHYMET is very limited in Phase III. Based on the demonstration provided at EROS as well as the equipment available to AGRHYMET both in Niamey and at the NAC a multi-level data base G.I.S. could well be implemented throughout the Sahel.

The question arises as to who should develop the framework for this system. (i.e. set the standards, define its limits, develop the software, define training and other requirements) and who should implement this phase or task. Clearly apparent to this team is the fact that EROS is in a position to conduct the necessary research and development in this field whereas the USGS/ARC project is best placed to implement such a project in the field, provide training, and helping the NAC develop the expertise in GIS which would later be used in a national interface program with other agencies.

Of paramount importance as regards G.I.S. is the role the USGS EROS Data Center can and should play in establishing the

guidelines and standards of any regional G.I.S. in Africa. This function is very important in view of the proliferation of partial, poorly constructed, inapplicable or nonpertinent data bases or so called G.I.S. systems in Africa. The USGS EROS Center has long term experience in developing data bases and G.I.S. for Forest Services and BIA and internally. It is one of the few organizations capable of integrating the worldwide knowledge accumulated on G.I.S.

The G.I.S. system implemented in Phase IV must show many purposes and not be restrictive. It must be LANDSAT or SPOT compatible but should be based on a grid system related to AVHRR LAC Data. All other data layers must be acquired and integrated at the 1km level or larger scale. Any information of lesser quality, (1:250,000 or 1:1,000,000) will be of little value. The system must be capable of accepting video camera digitized data and formatting it to its needs. Most important the operational G.I.S. must serve the NACS and must therefore be exportable or importance and must provide the framework for the monitoring and translation of agricultural and other natural resource data into predictions modeling and economic modeling framework.

3. Other AGRHYMET Requirements

Most of the comments in this section are drawn from meetings held in Washington by the team with personnel from USAID Sahel and USAID AFR/TR.

Based on the various project papers, evaluations and statements of objectives as well as comments of AID staff it is evident that AGRHYMET has not yet fulfilled its mandate (see Scope of Work of the Evaluation Team; Attachment I; Page 7; Section II; Project Summary). Although much has been done and other donors are producing material not originally planned or foreseen important lacunae exist in the project implementation. These may or may not be related to the USAID program, nevertheless the gaps that exist in the production of agricultural and hydrological statistics are unquestionably the missing links in providing useful standardized agrometeorological statistics that can provide or improve farming practices, contribute to food self sufficiency and specifically strengthen the capacity to perform agrometeorological and hydrological data collection and analysis in the Sahel.

If AGRHYMET is to be considered as having been useful, somebody has to collect verifiable agricultural statistics, someone needs to know land use patterns on a km^2 basis. If these data are not collected then all the greenness maps will have had little or no

impact. They will be documents unrelated to the reality of where crops exist and therefore what production is, what yields are and what people are affected and how. This part of Phase III and the next phase must focus on a completely useful product and not a partially useful product.

This objective can only be met if AID management and project management clearly understands the goals and limitation of the systems in place. More important, AID and project management must define the objectives to be met and either plan for them or request other donors do so.

Such a plan cannot be piece meal and it cannot be dependent on the Sahelian Observatory or a non-operative CILSS structure.

It is clear from discussions at AFR/TR that NRMS/FEWS and other regional projects are in need of the basic data that AGRHYMET is collecting or perhaps should collect. In fact the question becomes who should collect the data? and not should it be collected? Perhaps these USAID regional projects should be reviewed as to goals and objectives and critical data collection functions be assigned to avoid redundancy. Most important these activities should be integrated so that data are entered into one G.I.S. to avoid redundancy of data and cost.

C. Computer System at EROS Data Center

When analyzing a computer system it is convenient to think of it as consisting of three highly interdependent elements: 1) hardware, 2) software, and 3) personnel.

1) Hardware

For the most part, the AGRHYMET hardware is in place and functioning as expected. There have been some delays in the hardware installation program due to shipping problems and the failure of vendors to meet specifications. Although these delays have caused considerable frustration to all concerned, their causes now appear to have been resolved. These problems have, however, consumed a disproportionately large amount of a highly paid technician's time. It would be more cost effective to transfer these types of administrative/logistical problems from the technical staff to a more administratively oriented individual.

The only major unresolved hardware issue expressed is in the area of communications: both internal communications within the ARC and communications between the ARC and NACs.

Internal ARC communications--There currently is no direct communications links between the various computer systems in the ARC (the satellite receiving station, the VAX 11/780, and the numerous PC Systems). The major problem caused by lack of direct communication is major time delays in the production of greenness maps due to the need to first download the AVHRR imagery onto tape from the satellite receiving station and reload it on the VAX 11/780. This is not a difficult technical problem to resolve as a fairly wide variety of hardware networking systems are available on the market (e.g.-The Director of Technical Services at EROS have proposed a possible solution using Decnet). The principal difficulty appears to be the inability of the mangers of the different systems to reach agreement.

Communications between the ARC and NACs--There is general agreement that communications between the ARC and NACs is inadequate. Attempts have been made to use modem connections over the telephone system, but the poor quality of the telephone lines has made this solution impractical. The difficulty is compounded by the fact that communications were supposed to be paid for by funds from the Italian government which have not been forthcoming. Again, there are a variety of technical solutions to this problem, and the barriers to employing them are administrative/political.

No significant down time was reported due to hardware maintenance problems.

2) Software

A large amount of software has been installed at the ARC and in the NACs. No complaints were expressed about the appropriateness or completeness of the installed software. The three software issues that were discussed were:

a) The IDA software for image display and analysis is not available in French, but a French version is now being developed. This is not a major task and no difficulty was foreseen.

b) The CLICOM meteorological software has proved cumbersome and ill suited, especially in regards to the data entry function. Mr. Simon van Donk has developed some front end software in dBase

that alleviates some of this problem, and is actively working with the developers of the CLICOM software to resolve some of the problems that have been encountered.

c) There is active discussion about the nature of the most appropriate GIS software to be installed. A review was to be conducted by the end of 1990 but has not yet been accomplished.

3) Personnel

Typically, the personnel element of a computer system is the source of the most intractable problems, and, despite the current paucity of information, preliminary indications are that the AGRHYMET system is no exception. In examining this element it is useful to divide it into three interrelated sub-components: a) system operation, b) system administration, and c) system maintenance.

a) system operation (data capture and analysis)-- To date discussions on data capture and analysis have revolved around the activities of the expatriate staff at the ARC. The purpose of these activities is to develop operational procedures which can then be made the responsibility of the Sahelien counterparts. Available information on the progress of these efforts was scanty at EDC and must await the visit to the ARC.

b) system administration (work priorities and scheduling, record keeping, finance, "external" contacts)--This sub-component has been almost universally identified as the principal problem area. Given the multi-national, multi-linguistic character of both donor and recipient agencies, this fact is not surprising. It has been identified as a major concern in all previous evaluations, and will be a primary focus of our field investigations. The relationship between the various nationalities involved in the administration of the system will be of particular concern.

c) system maintenance (hardware, software, personnel training)-- Considerable activity has taken place in this area. High praise was expressed for the abilities of the hardware maintenance staff at the ARC, and there is no indication that hardware problems have caused any significant downtime. Technicians from each of the NACs have been trained to maintain the PCs, although there was some concern expressed that some of the individuals who were given the training were not the most appropriate ones to receive it.

--The major software maintenance issues expressed are the problems with CLICOM and the fact that IDA not yet available in French, both of which were discussed above.

--Personnel training is one of the major objectives of the AGRHYMET project and is discussed in detail elsewhere in this report.

4. Computer System at USAID

The only significant computer issue that arose in our discussion at USAID was in connection with the FEWS project. In discussion concerning the use of the information obtained from the AVHRR imagery by FEWS, Jonathan Olesen said that it was not possible because the FEWS computer systems are not adequately equipped to use the greenness maps produced by AGRHYMET. This is probably a misunderstanding on the part of FEWS because use of the digital greenness maps requires only a standard PC configuration with the IDA software. There is every indication that a linkage with FEWS is not only possible, but could be extremely cost effective and valuable for both FEWS and AGRHYMET.

5. Training at EDC

All training during Phase III is to be either short or medium term. No long term academic training is envisioned.

In 1989 three formal training courses were held at the ARC: 1) Micro-computer applications, 2) Remote Sensing Methods for Agroclimate Applications, and 3) Micro-computer Hardware Maintenance. Each of these courses was attended by two participants from each of the AGRHYMET countries. Courses were taught by a mixture of expatriate and Sahelien staff members, and was generally well received.

In addition to the formal training, there was an informal training mission for all USGS staff, including the field team. All TDY personnel were expected to make this informal training a component of their daily activities by working directly with the individuals they encountered on a daily basis.

Several problems arose in the training programs. There were initial administrative problems with the payment of per diem that were resolved after the first training program. There was also a problem with the selection of training participants. Often the person chosen to participate in the training was not appropriate for the training,

based on background or position in the organization. As a result there was a wide variation in the skills and interests of the trainees, making it difficult to keep everyone interested.

The experience with training in 1989 resulted in a change in emphasis. It was determined that a relatively large pool of skill exists within the Sahelien AGRHYMET staff as a result of the training efforts undertaken in Phase II. The decision was made to use these individuals as trainers wherever possible, thereby promoting the goal of turning over functions to Sahelien staff and minimizing cost. It was also felt that the emphasis should be transferred to training at the national centers where the unique problems of each site could be more readily addressed.

In 1990, two training courses were held at the ARC: 1) Micro-computer Applications for Agrometeorology, and 2) Applications of Micro-computers in Hydrology. In addition, courses were given at the NACs in greenness mapping, CLICOM and IDA. The use of the Sahelien staff as trainers has been deemed to be successful. Even though the training is moving at a slower pace than would be the case if expatriate staff were employed, the long term advantage of developing the in-house training capacity should be significant.

In addition to the in-country training, two individuals are currently in Geneva attending a three month training course in GIS operation.

D. Agrometerological Component

1. It appears that major efforts have been dedicated to gather and analyze meteorological data from the network stations. As a result of these activities, monthly and decadal bulletins are being published. There is not a standardization in format and contents. At present each National AGRHYMET Center (NAC) collects and publishes there own data. A bulletin prepared according to AGRHYMET goals and distributed in a timely manner to users in the private sectors will provide good visibility of project activities.

2. The EROS Data Center (EDC) is providing agrometeorological methodology for weather analysis (rainfall). A powerful software, called Rainman has been developed at EDC. It will be very useful at the National AGRHYMET Centers (NAC) and the AGRHYMET Regional Center (ARC) for data analysis as well as for report/bulletin preparation. Another weather analysis carried out by EDC includes plotting isohyets during the growing season. Isohyets provides additional information to interpret the green wave reflected in the greenness maps. EDC field personnel have been stationed at

Niamey, headquarters for the AGRHYMET Regional Center since April 1990. One individual is providing technical support to both the Regional Center and the National Centers (two visits per year).

3. Research and application facilities at EDC are mainly related to Remote Sensing/AVHRR/GIS for the AGRHYMET project. To date no GIS has been developed although as mentioned above, a software package has been developed and is operational for rainfall analysis.

4. Major efforts have been made to establish computer facilities at the ARC and NAC's. Data communication between ARC and NAC's are not adequate. This is a major constraint for both remote sensing and meteorological data transfer between centers. At NAC's the meteorological analysis is done on real time using the national weather network. Weather data from the NAC's is not transmitted to the ARC on real time therefore it cannot be matched to AVHRR data.

E. Agronomy and Hydrology Components

1. With the exception of the locust eradication program there appears to have been very little application to specific agronomic and hydrologic problems. The main focus has been upon the collection of meteorological data and the development of Natural Vegetation Distribution Index Maps (greenness maps).

F. Other Issues

1. Bulletin - It is clear that the preparation of the Bulletin is a major problem area. The subject was brought up a number of times and the conclusion seems to be that the Bulletin is not effective.

   The biggest problem seems to be that no one has defined the objectives of the Bulletin(s). There are two bulletins one at the ARC and those produced at the NAC.

   The goals and objectives of the ARC bulletin seems to be relatively simple compared to those at the NAC. Clearly this bulletin must disseminate information to regional and donor organization as well

   as the national centers on the subject of operational procedures, plans and programs conducted by the donors at the center and activities, costs and schedules.

   The NAC have a greater problem in disseminating information. To whom, in what form, how often?

Typically the NAC address their Bulletins to an audience which is undefined. Much work needs to be done to understand who the audience should be and why. Once this is established the framework for the content and periodicity can be established.

2. Training - Training is a component that is definitely a problem area. Specific training activities to be revised relate to AVHRR interpretation. Other areas include microcomputer training, agrometeorological data evaluation as it relates to rainfall and AGRHYMET goals. Training needs also include G.I.S. and natural resources training, as well as early warning data needs and use. Training needs of computer maintenance backups in ARC and NACS must also be considered.

III. Questions

From the discussions with EDC and USAID personnel, the team has generated the following questions that need to be asked and discussed with personnel in the ARC and NAC's.

- Remote Sensing (AVHRR, Landsat, Spot, aerial photos)
- Geographic Information Systems
- Computer Knowledge
- Natural Resources and Socio-Economic Data
- Bulletin
- Inventory Tracking

A. AVHRR and Other Remote Sensing Questions

* Do you use the AVHRR maps provided by AGRHYMET?
* In what form, paper? diskette?
* How would you improve the maps?
* What scale? What additional data do you need?
* How would you disseminate the information to other users? Who might these be?
* Do you see anyway of passing this information to the farmer? If so why or how? Why not?
* Do you or others need more training? What would you seek in a training program?
* Do you create your own data from the diskette?
* Would you like to see additional data formatted into the diskette? Soils?
* What other data?
* Would you like to have other digitized information from remote sensing sources such as Landsat, Spot?

* What data should appear in the Bulletin as relates to Remote Sensing?
* Do you believe you could or should lecture on AVHRR to other potential national users? (i.e. provide training)
* Do you believe AVHRR is used effectively in your country? Who is using it?
* Do you have a national remote sensing center?
* Do they use AVHRR? Do you pass copies of the diskettes to them or to others?
* Do the AGRHYMET projects at the ARC work together? Share information? Integrate data? Distribute data?

B. Geographic Information Systems

* Do you know or feel you know enough about their use, possibilities and direct applications in the NAC framework?
* What do you think is needed in the NAC to bring G.I.S.? into use? Do you think you need G.I.S?
* At what scale should a national G.I.S. be constructed?
* Who should develop, maintain, operate, a G.I.S. in the framework of your national policy and ministerial structure?
* What are the primary data sets you would like to see in a national G.I.S.?
* In a NAC G.I.S.?
* Would you be interested in constructing a NAC G.I.S.?
* How would you interface with AGRHYMET and a national G.I.S.? Other regional G.I.S.?
* What standards would you set for a national, regional, Pan African, and Global G.I.S.?
* What do you know about the computer requirements of a G.I.S. system?
* Would you be interested in a Landsat interactive G.I.S. system?
* How do you view resource monitoring in the G.I.S. framework?
* Do you think AVHRR and G.I.S. can help in meeting the goals of AGRHYMET?
* How is AVHRR/GIS going to improve decision making in your country?
* Are you providing statistics to other Africans on the basis of the AVHRR data?
* Do you believe AVHRR provides you with an early warning tool?
* Can you identify areas of food deficit using AVHRR? How?
* Do you believe AVHRR can provide you with the input to create improved agriculture and livestock production and systems management?

C. Computer Knowledge

* Where are the machines located? Is the environment appropriate? Dust? Temperature? Lighting?
* Who operates the machines, and how are they trained? Operating schedules? Who has access? What security precautions are taken?
* Who maintains the machines? Regular preventative maintenance schedules?
* What records are kept? Hardware configurations? Operating log Maintenance Log?
* How is the hard disk organized? Is it full? Are all files in the root directory? Do the operators understand and use directory structures?
* How is data stored and backed up? Is there a regular procedure?
* Is there documentation available on software and hardware? In what language? Is it readily available to users? Do users understand it?
* Who administers the computers? Schedules use? Develops work priorities? Resolves conflicts?
* Are machines fully used or do they sit unused part or most of the time?
* Which software is used? For what? Which not?
* What data is collected? How is it captured? By whom? How is it verified?
* What are data analysis procedures? What products emerge? Are the procedures appropriate?
* Who uses the analysis products? How?
* Are there procedures for making special requests for information from the system? What are they? Formal or informal?
* What data and information is passed from NACs to ARC? ARC to NACs? How? Is it timely and appropriate?
* Is there additional hardware or software that could be useful?
* Is there hardware or software that remains unused? Why?

D. Natural Resources Data and Socio Economic Data

* Do you believe you have enough natural resources information available to you to enable you to integrate the same into a model to provide the answers for early warning, improved ag production etc.?
* What kind of natural resource data do you need?
* In what format?
* From whom would you acquire it?
* Is it available in your country?
* Do you believe the FAO data sets (soils etc) are adequate?
* At what scales do you wish the natural resource data to be formatted?

* What level of importance do you give to good natural resources data in establishing effective economic development in your country?
* Do you believe your country has good data? What is its relative age?
* What natural resources monitoring framework would you construct to support your activities? At what intervals? for what resource?
* Do you use census data in your AVHRR resources?
* Do you use economic data?
* Do you believe your national data collection network has been improved in the last 5 years? Ditto Sahelian data collection?
* How have you been involved in assistance to regional or national networks to increase agricultural production?

E. Bulletin

* Are you involved in the preparation of the Bulletin?
* How?
* How many copies are produced?
* Who prints them? How often?
* What is the main purpose of the Bulletin?
* Who is the audience?
* How did your organization decide on the format for your Bulletin?
* Was there any input from other national groups?
* What would you like to see in the Bulletin?
* Should the Bulletin be directed to another audience?
* Should there be a semiannual administrative Bulletin? as well as a scientific weather resume Bulletin?
* Should the Bulletin be a place to publish conclusion on research?
* Should the Bulletin be attached to (or enhanced by participation of) other agencies?
* Should it be more widely disseminated?
* Do you believe that your Bulletin can affect response farming in this region or your country?
* Are the Bulletins timely prepared and distributed?
* Are the number of copies printed sufficient?
* Is there any feedback from the users?
* Shouldn't the end-users be classified according to their needs and be addressed with special bulletins? Can this be achieved given the current level of technical support?
* Has there been any analysis on impacts caused by the information provided by Bulletins?
* Shouldn't be crop/pasture phenological information included and emphasized in the Bulletins.

F. Logistics Tracking

* Does the system work?
* Do you know where every machine, part or manual is to be found?
* Can you demonstrate the effectiveness of the system?
* Do you track through to the NAC?
* Do you follow up on exported materials?
* How often do you send out inventory review sheets? Who has what? Where?
* Is there anything missing?
* How long has it been gone?
* What has been done to locate it?
* Who is in charge of inventory? of tracking?
* How do you transfer this data back to EROS?

G. Training

* Who has received training? What kind? How much? Where?
* Who needs more training? What kind? How much? Where?
* What has been the cost of training?
* What is the turnover amongst trained individuals? Has training promoted turnover?
* How are training participants selected? Are they the appropriate people in the organization for the type of training they have received?
* Is the level of training appropriate? Higher level? Lower level?
* Is the ratio of formal to informal training appropriate?
* Is the amount of training appropriate? More? Less?
* What training topics need more emphasis? Less emphasis?
* Should more emphasis be given to training at the ARC or at the NACs?
* Are the weather observers properly trained to insure the gathering, recording and transmission of reliable and timely meteorological information?
* Is the NAC personnel properly trained for data analysis and agrometeorological applications?
* Is the AGRHYMET personnel properly trained in gathering and analysis of crop/pasture phenological observations?