PD-ABB-405

A.I.D. EVALUATION SUMMARY PART I

(BEFORE FILLING OUT THIS FORM, READ THE ATTACHED INSTRUCTIONS)

IDENTIFICATION DATA

A. REPORTING A.I.D. UNIT: USAID/Bangladesh (Mission or AID/W Office)

(ES #)

B. WAS EVALUATION SCHEDULED IN CURRENT FY ANNUAL EVALUATION PLAN? yes ☒ slipped ☐ ad hoc ☐

Eval. Plan Submission Date: FY ___ Q ___

C. EVALUATION TIMING interim ☒ final ☐ ex post ☐ other ☐

D. ACTIVITY OR ACTIVITIES EVALUATED (List the following information for project(s) or program(s) evaluated; if not applicable, list title and date of the evaluation report)

Project #	Project/Program Title (or title & date of evaluation report)	First PROAG or equivalent (FY)	Most recent PACD (mo/yr)	Planned LOP Cost ('000)	Amount Obligated to Date ('000)
388-0046	Agro-Climatic Environmental Monitoring				
	1986	81	11/88	7.4	7.4

ACTIONS

E. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR — Action(s) Required	Name of officer responsible for Action	Date Action to be Completed
1. BDG Approval of SPARRSO plan & schedule	SPARRSO	Completed
2. SPARRSO forms applications task groups	A.M. Choudhury	Completed
3. Contractor implementation plan approved	M. Chatman	Completed
4. Conduct applications and develop links to user agencies	SPARRSO & T. Wagner	On-going
* Prepare 1:50,000 scale upazila maps	SPARRSO	10/87
* Classify 1987 Landsat TM ag data	SPARRSO	8/87
* Measure cropping patterns, intensity, and area of principal crops for test areas	SPARRSO	9/87
* Monitor cyclones and severe storms	SPARRSO	On-going
* Monitor vegetation growth during dry season	SPARRSO	On-going
* Develop crop calendar information	SPARRSO	10/87
* Identify forest areas and changes for Bangladesh	SPARRSO	12/87
* Map changes in coastal accretion	SPARRSO	11/87
5. Develop local suppliers of spare parts and maintenance services.	T. Wagner	7/87
(see attached)		

(Attach extra sheet if necessary)

APPROVALS

F. DATE OF MISSION OR AID/W OFFICE REVIEW OF EVALUATION: mo___ day___ yr___

G. APPROVALS OF EVALUATION SUMMARY AND ACTION DECISIONS: Reviewed and approval updated 05/90

	Project/Program Officer	Representative of Borrower/Grantee	Evaluation Officer	Mission or AID/W Office Director
Signature				
Typed Name	P. Warren	N/A	Ann Schwartz	Malcolm J. Purvis
Date:	May /90		May /90	May /90

a'

ABSTRACT

H. EVALUATION ABSTRACT (do not exceed the space provided)

See attached

COSTS

I. EVALUATION COSTS

1. Evaluation Team Name	Affiliation	Contract Number OR TDY Person Days	Contract Cost OR TDY Cost (US$)	Source of Funds
Barry D. Mac Rae				
Thomas W. Wagner		N/A		

2. Mission/Office Professional Staff Person-Days (estimate) _____

3. Borrower/Grantee Professional Staff Person-Days (estimate) _____

E. ACTIONS REQUIRED CONTD...	OFFICER	DATE COMPLETED/ TO BE COMPLETED
6. Develop data management & archive system	T. Wagner	7/87
7. Guide and monitor applications and training	T. Wagner	On-going
8. Install new computer operating software, graphic, stat, & met packages and deliver appropriate hardware.	SSAI	7/87
9. Install & integrate GIS software and arrange required training.	SSAI	9/87
10. Approve, coordinate & monitor participant training	USAID	6/87
11. Conduct incountry training/workshops:	NASA	
* Agro-meteorology & remote sensing		9/87
* Oceanography		12/87
* Advanced TOVS (meteorology)		2/88
* Severe storms & cyclones		4/88
*Hydrology		7/88
12. USAID/SPARRSO/SSAI Quarterly reviews.	USAID/SSAI/ SPARRSO	4/87-done 7/87 10/87 1/88
13. Approve order for new Landsat data.	USAID	6/87
14. Install met/hydrologic models.	NASA/SSAI	12/87
15. Coordinate applications with UNDP/ FAO Project.	T. Wagner	10/87
16. Review training progress & results.	T. Wagner	After each training program
17. Conduct site visits to repair and calibrate DCP sensors.	SPARRSO	10/87
18. Conduct final project evaluation	USAID	10/88

C

H. EVALUATION ABSTRACT

The purpose of the Agro-Climatic/Environmental Monitoring Project (ACEMP)is to upgrade the capability of the Government of Bangladesh (GOB) to obtain, analyze, and use agro-climatic and other remote sensing data in the management of natural resources, particularly those related to agriculture and water development. To achieve this USAID is providing the GOB's Space Research and Remote Sensing Organization (SPARRSO) with the equipment, technical assistance, and training required to collect, process, and employ modern remote sensing data, especially satellite data. This interim evaluation was conducted to provide USAID and SPARRSO with a plan of action to achieve project objectives.

The project has two sets of outputs. The first focuses on providing modern remote sensing equipment, training SPARRSO personnel in maintaining and using that equipment, and developing the SPARRSO facilities to support that equipment. The second set of outputs concerns training and supporting SPARRSO in its efforts to apply this remote sensing technology on a continuing basis in ten application areas identified in the Project Paper.

ACEMP has made significant progress in providing the GOB with the technical capability to acquire and utilize satellite data for meteorological and land use studies. SPARRSO, however, was not sufficiently prepared to accept the responsibility for the daily operation and maintenance of the equipment, and has lacked the infrastructure to develop and institutionalize the applications.

Some important lessons have been learned. The total systems aspects of the project were inadequately assessed and addressed in the early planning stages. It is a common misconception that a receiving institution fully understands the implications of a sudden infusion of technology and has adequately prepared for the additional resources required. In the case of SPARRSO the institutional structure to support the facility and to provide the linkages necessary to promote and distribute the new products and information was inadequate.

In future projects of this nature, the full systems aspects should be examined and the recipient institution should be brought into the preparations for technology transfer much earlier in the project.

A.I.D. PROJECT EVALUATION SUMMARY - PART II

J. SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

USAID BANGLADESH September 1989

ASSESSMENT OF USAID PROJECT NO. 388-0046:
THE AGRO-CLIMATIC/ENVIRONMENTAL MONITORING PROJECT
- June 1986 -

1. PURPOSE OF ACTIVITIES EVALUATED

The purpose of the project is to upgrade the capability of the Government of Bangladesh (GOB) to obtain, analyze, disseminate, and use agro-climatic and other remote sensing data in the management of natural resources, particularly those related to agriculture and water development. To achieve this USAID is providing the GOB's Space Research and Remote Sensing Organization (SPARRSO) with the equipment, technical assistance, and training necessary to collect, process, and employ modern remote sensing data, especially satellite data. These data are to provide information for improving the management of local natural resources.

The project has two sets of outputs. The first focuses on providing modern remote sensing equipment, training SPARRSO personnel in maintaining and using that equipment, and developing the SPARRSO facilities to support that equipment. The second set of outputs concerns training and supporting SPARRSO in its efforts to apply this remote sensing technology on a continuing basis in ten application areas identified in the Project Paper.

2. EVALUATION PURPOSE AND METHODOLOGY

The purpose of the evaluation was to provide USAID and SPARRSO with a plan of action that would 1) keep the equipment obtained under the project agreement in good operating order and 2) specify implementation issues, including possible constraints, solutions and schedules, for institutionalizing the ten application activities. The evidence was gained through detailed on-site observations and through interviews with SPARRSO and donor agency project implementation personnel.

3. MAJOR FINDINGS AND CONCLUSIONS

The first set of direct outputs has been achieved. All major equipment components have been installed and are functioning. Delivered software is being tested, and with some notable exceptions, appears to be operational. All foreign training has been completed with moderate success.

The second set of outputs, institutionalizing the ten applications, is at an early stage of implementation, but can be achieved as on-going activities over the next two years. These applications are potentially very useful and important to Bangladesh's resource and early warning information requirements. However, institutionalizing the ability to effectively operate and maintain the equipment by SPARRSO is proving to be a bigger job than either SPARRSO or USAID anticipated.

Several critical assumptions concerning the implementation of this project either did not occur or proved much more difficult and time-consuming than was initially envisioned. Specifically, substantial delays in the procurement, shipment and installation of almost all major equipment conmponents put the project seriously behind its original schedule. Also, the technical support available form the commercial sector and SPARRSO's mechanisms for employing that support were greatly overestimated.

Also erroneous was the assumption that the cooperative linkages between the Bangladesh's Landsat Project (the predecessor to SPARRSO) and the various users would continue and expand. With several notable exceptions, these linkages have not been well maintained, and today the involvement of user agencies in SPARRSO activities is still at the development stage.

4. PRINCIPAL RECOMMENDATIONS

GENERAL

Over the next two years SPARRSO must make vigorous efforts to organize itself to maintain and operate its facilities effectively and to foster working linkages with user agencies if the overall purpose of the project is to be met. The ACEMP should turn its attention from facilities development to active research and to applications development programs. Early disaster warning (floods and cyclones) and agriculture should receive priority.

SPECIFIC

SPARRSO

* Consider fully staffing the Applications Wing with both permanent core staff and temporary user-agency staff, including a Director with strong applications-oriented experience.

* Establish administratiave procedures whereby SPARRSO technical and research facilities are easily accessible to the applications staff and user agencies.

* Assign single-person responsibility to prepare and coordinate annual workplans for each application as part of an overall 5-year strategy, and conduct quarterly reviews for each of the designated applications areas.

* Establish and maintain a data acquisition, reproduction, and archive facility within SPARRSO

* Reactivate discipline-oriented applications "task forces" comprised of SPARRSO and user agency personnel to provide guidance to and review of the applications activities.

* Continue an active program for the repair and maintenance of all acquired hardware, including an extensive spare parts inventory.

* Implement an organizational structure that clearly identifies assignments and individual responsibilities.

* Establish Standard Operating Procedures (SOPs) for operation and maintenance of all facilities and ACEMP equipment.

* Establish a parts and expendables procurement policy and contract with suppliers to assure timely procurement.

* Implement a computerized inventory control system.

* Establish on-going training program for refresher and advanced training in the operation and maintenance of the facility equipment.

* Establish remedial maintenance backup for major system components.

USAID

* Assist and guide SPARRSO in the above activities, primarily through the services of a resident project advisor.

* Conduct comprehensive applications-oriented training for SPARRSO and user agency staff which integrates tutorial and laboratory presentations with on-going applications tasks.

* Provide the short-term services of a computer systems engineer (2 person months), an applications software engineer (6 p/m), and a data reproduction and archival specialist (2 p/m).

* Provide 3-4 p/m of participant training in management at the Director level of SPARRSO.

* Ensure that delivered software be operational and obtain operational (tested and fully documented) GIS software as soon as possible to support data processing requirements for the ten applications.

5. LESSONS LEARNED

The transfer of high technology to developing countries is a complex and time-consuming task. The problems in projects of this type usually arise from not assessing and adequately addressing the total systems aspects of the project. The system does not stop with the equipment and associated personnel, but includes also the institutional structure which must support the facility and the linkages necessary to promote and distribute the new products and information. It is a common misconception that the institution fully realizes the implications of the sudden infusion of technology and has adequately prepared for the additional resources required.

Although this project was envisioned as institution-building, the facility management aspects of the project were neglected. No SPARRSO management personnel were exposed to training in facilities performing similar functions prior to or in the early stages of this project. In addition, SPARRSO has neither recognized the organizational structure required for the management of such a facility on a routine basis nor attempted to relate the facility to the objectives of the project, which is the development of ten application areas and the distribution of new data and information.

In future projects of this nature, the full systems aspects should be examined and the recipient institution should be brought into the preparations for technology transfer much earlier in the project.

K. ATTACHMENTS (List attachments submitted with this Evaluation Summary; always attach copy of full evaluation report, even if one was submitted earlier)

ATTACHMENTS

Assessment of USAID Project No.388-0046: The Agro-Climatic/Environmental Monitoring Project- June, 1986

L. COMMENTS BY MISSION, AID/W OFFICE AND BORROWER/GRANTEE

N/A

176508-1-F

Final Report

ASSESSMENT OF USAID PROJECT NO. 388-0046: THE AGRO-CLIMATIC/ ENVIRONMENTAL MONITORING PROJECT

BARRY D. MAC RAE
THOMAS W. WAGNER
Information and Processing Center

JUNE 1986

Prepared for:
U.S. Agency for International Development
Office of Contract Management
Washington, DC 20523

Contract No: PDC-1406-I-02-4116-01

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PREFACE

This report integrates the results and conclusions of a two part project evaluation which was conducted by the Environmental Research Institute of Michigan (ERIM) between March and December, 1985.

The first part was of the capability of Bangladesh's Space Research and Remote Sensing Organization (SPARRSO) to maintain the equipment and facilities provided through the Agro-Climatic-/Environmental Monitoring Project (PIO/T 388-00-4631-0441). This part of the evaluation was conducted by Barry Mac Rae in Dhaka in March and September, 1985, and was previously reported in ERIM Report 176500-1-F.

The second part of the evaluation looked at the current operation of the Agro-Climatic/Environmental Project and recommended procedures and schedules for the operational implementation of ten application tasks which were identified in the original Project Paper. This evaluation was conducted by Barry Mac Rae and Thomas Wagner in November-December 1985, and was submitted in draft to the USAID Mission at that time.

As part of the this evaluation, ERIM arranged for Dr. Syed M. Hashemi to evaluate a USAID-sponsored training course entitled "Satellite Imagery Interpretation and Application to Weather Forecasting" in progress at the time. This evaluation is summarized in Appendix E of this report.

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LIST OF TABLES

LIST OF SCHEDULES

1.0
EVALUATION SUMMARY

1.1 NAME OF MISSION AND TITLE OF EVALUATION REPORT

Mission: USAID/Bangladesh

Title: Assessment of Bangladesh Space Research and Remote Sensing Organization Agro-Climatic/Environmental Monitoring Project (PIO/t 3880046310441)

Date: June 1986

1.2 PURPOSE OF THE PROJECT

The purpose of the project is to upgrade the capability of the Government of the Peoples' Republic of Bangladesh (BDG) to obtain, analyze, disseminate, and use agro-climatic and other remote sensing data in the management of natural resources, particularly those related to agriculture and water development. To achieve this purpose USAID is providing BDG's Space Research and Remote Sensing Organization (SPARRSO) with the equipment, technical assistance, and training necessary to collect, process, and employ modern remote sensing data, especially satellite data. These data are to provide information for improving the management of Bangladesh's various natural resources.

The project has two sets of outputs. The first set of outputs are concerned with providing modern remote sensing equipment, training SPARRSO personnel in maintaining and using that equipment, and developing the SPARRSO facilities to support that equipment. The second set of outputs concerns training and supporting SPARRSO in its efforts to apply this remote sensing technology on a continuing basis in ten applications areas identified in the Project Paper.

1.3 PURPOSE OF THE EVALUATION

This evaluation is to provide USAID and SPARRSO with a report prescribing a plan of action which will:

(1) Keep the equipment obtained under the Agro-Climatic/Environmental Monitoring Project (ACEMP) in good operating order. This report includes the following:

- o A listing of and schedule for the organization and staffing of the equipment maintenance unit(s) within SPARRSO.
- o Recommendations for additional and/or enhanced training for maintenance personnel (including recommendations as to where the training could be best obtained).
- o Recommendations for provision by USAID for long and/or short term technical assistance to SPARRSO in the development of its equipment maintenance capability.
- o Recommendations for utilization of in-country (non-SPARRSO) equipment maintenance services.
- o Recommendations for utilization of repair and maintenance services outside of Bangladesh (i.e., from India, Singapore, U.S., etc.).
- o Recommendations for development of a spare parts (and expendable supplies) procurement system for parts and supplies needed both on a routine and emergency basis. (Use of both Bangladesh and U.S. private sector procurement services are discussed); and

(2) specify implementation issues, including possible constraints, solutions and schedules, for institutionalizing the ten application activities listed below.

- o Preparing categorized land-use maps and developing a resource management information system;
- o Conducting studies on cropping patterns and cropping intensity and developing identification keys for major crops;
- o Preparing estimates of the acreage and yields of principal crops, including the extent of damage by natural disasters;
- o Determining of crop calendars;
- o Development of planning strategies for flood prone areas and delineating areas prone to inundation, allowing a managed effort to increase land farmed;
- o Conducting follow-on studies of land accretion in the Bay of Bengal;
- o Conducting forest resource inventories;
- o Mapping and monitoring coastal afforestation;
- o Conducting studies of monsoon clouds over Bangladesh for a better understanding of rainfall, flood, and drought;
- o Determining the structure, dynamics, intensity, and movement of storms and storm surges.

1.4 SCOPE OF THE EVALUATION

1.4.1 KEY ISSUES AND QUESTIONS

Questions that were answered in order to meet the Evaluation's objectives include:

- What is the current status of the project implementation?
- What is the current status of routine and remedial maintenance procedures?
- What is the organization and staffing of SPARRSO's facility operational and maintenance unit(s)?
- What training has been provided to the maintenance staff and how well was this training assimilated?
- What are the capabilities of in-country (non-SPARRSO), regional, and U.S. repair and maintenance services for support of SPARRSO's maintenance requirements?
- What are the current practices with regard to spare parts and expendable supplies procurement?
- In each of these areas, what are the constraints which would prevent SPARRSO from adequately maintaining the facility equipment?
- What actions or resources are necessary to overcome the constraints identified above?
- How are the 10 application areas defined?
- What resources (equipment, supplies and software, personnel) must SPARRSO have to carry out each application on an operational basis?
- For each application,what should be the schedule of development and implementation?
- What constraints may limit or prevent SPARRSO from carrying out these applications?
- What actions or resources are necessary for SPARRSO to overcome the constraints identified above?

1.4.2 TYPES AND QUALITY OF THE EVIDENCE

The primary evidence used in this evaluation is detailed onsite observations and interviews with SPARRSO, donor agency, and U.S. project implementation personnel.

The nature, condition, and operation of the facility were observed during this period and the organization's professional and technical staff members were interviewed. Some staff members were requested to fill out specially prepared questionnaires and their responses were further discussed with them. Responses of SPARRSO to user agency requests and to supporting a 3-week applications-oriented training course (ongoing at the time of the assessment) also provided direct evidence. Secondary evidence in the various applications was obtained from a variety of SPARRSO reports, papers, and planning documents.

Dr. Syed Hashemi participated daily in the conduct of the three weeks applications training course, and received and compiled feedback from the trainees. His conclusions and recommendation concerning this training are included in Appendix E of this report.

Finally, valuable inputs were provided both by Fabian C. Polcyn (ERIM) and Mel Chatman (USAID) based on their long and constant association with SPARRSO in the implementation of the project to date.

1.5 FINDINGS

1.5.1 IMPLEMENTATION

In 1980, under a Participating Agency Service Agreement (PASA), USAID contracted with NOAA to implement the ACEMP in Bangladesh. The goals of the project were evaluated by NOAA and the contract was subcontracted to NASA and ultimately assigned to the Goddard Space Flight Center, Greenbelt, Maryland. Mr. Charles Vermillion has been NASA's Project Officer since the start of this project.

The primary responsibilities for the project resides in the Goddard Program Office and included:

- o Overall program coordination,
- o System design,
- o System specifications,
- o System integration, and
- o Shipment of system to Bangladesh.

Science Systems and Applications, Incorporated (SSAI) was awarded a major subcontract to provide the following goods and services:

- o Site preparation (UPS, A/C, etc.),
- o Procurement of all equipment,
- o Procurement and/or development of all software requirements, and
- o System installation in Bangladesh.

Louisiana State University (LSU) was contracted to provide specialized software and training to SPARRSO personnel for the use of NOAA AVHRR and Landsat MSS data in both meteorological and land use applications.

The University of Wisconsin (NOAA/CIMMS) was awarded a contract for the delivery of Tiros Operational Vertical Sounder (TOVS) software and training of SPARRSO personnel in its use.

1.5.2 OUTPUTS

First Set of Outputs:

The first set of direct outputs of the project have been obtained. These are:

(1) the installation of the advanced meteorological ground station,

(2) eleven Data Collection Platforms (DCPs) have been deployed to monitor environmental conditions in inaccessible locations,

(3) the SPARRSO facility has been constructed and staffed,

(4) nine Bangladeshi staff members have been trained -- six in maintaining and operating the new equipment and three in applications, and

(5) SPARRSO is actively providing BDG's Meteorology Department and Water Development Board with timely imagery and DCP data.

Second Set of Outputs:

The second set of outputs, "institutionalizing" the 10 selected applications activities, which directly relate to the project's purpose, have not been the focus of this project's activity and have not been attained to date. However, they provide the direct objectives of the proposed follow-on Project activity.

1.5.3 GOAL ACHIEVEMENT

As stated above, the project has made significant progress in providing the BDG with the technical capability to acquire and utilize satellite data for meteorological and land use studies. Due to delays in the procurement and installation of the equipment, several of the institutional-building goals of the project have yet to be realized. The SPARRSO organization was not sufficiently prepared to accept the responsibility for the daily operation and maintenance of this equipment before the expiration of the current project funds.

Progress in developing and institutionalizing applications within SPARRSO and the BDG user agencies has been slow and without strong positive direction from SPARRSO's management or significant involvement of user agency staff. As its technical capability develops and matures, SPARRSO needs to be more responsive to user information requirements.

1.5.4 COMMENTS ON ASSUMPTIONS

Several critical assumptions concerning the implementation of this project either did not occur or proved much more difficult and time-consuming than was envisioned. Specifically, substantial delays in the procurement, shipment and installation of almost all major equipment components put the project seriously behind its original schedule. Also, the technical support available from the commercial sector and SPARRSO's mechanisms for employing that support were greatly overestimated at the start.

Also erroneous was the assumption that the cooperative linkages between the Bangladesh's Landsat Project (the predecessor to SPARRSO) and the various users would continue and expand. With several notable exceptions, these linkages have not been well maintained, and today the involvement of user agencies in SPARRSO activities is still at the development stage.

1.5.5 CURRENT STATUS

The Agro-Climatic/Environmental Monitoring Project is successfully completing its equipment installing phase.

All major equipment components have been installed and most are functioning. Delivered software is just now being tested and, with some notable exceptions, appears to be operational.

All foreign training has been completed with moderate success. The 10 applications are still at an early stage of implementation, but can be institutionalized as ongoing activities over the next two years. These applications are potentially very useful and important to Bangladesh's resource and early warning information requirements. However, institutionalizing the ability to effectively operate and maintain the equipment by SPARRSO is proving to be a bigger job than either SPARRSO or USAID anticipated.

1.5.6 CONSTRAINTS

The 10 applications are likely to be hindered by: equipment failures, lack of appropriate operational software, lack of personnel training and motivation, lack of supplies, and limited user agency linkages and involvement. These constraints are serious and require the direct and continuous attention of project management personnel.

1.6 RECOMMENDATIONS

1.6.1 GENERAL

Over the next two years SPARRSO must make vigorous efforts to organize itself to maintain and operate its facilities effectively and to foster working linkages with user agencies if the overall purpose of the project is to be met. The ACEMP should turn its attention from facilities development to active research and applications development programs. We recommend that early disaster warning (floods and cyclones) and agriculture receive priority.

SPARRSO should begin immediately to plan and direct its attention toward the 10 ACEMP applications Implementation should consist of the assignment of qualified personnel and

appropriate resources. The schedule should include planning, data acquisitions, data processing, interpretation and field verification, reproduction and reporting.

SPARRSO needs continuing help and training in equipment maintenance, software acquisition, systems operation, and applications development. It is estimated that 50 pm of technical assistance in Dhaka is required over the next two years. Approximately $500,000 in new hardware and software is required.

1.6.2 SPECIFIC

It is specifically recommended that SPARRSO:

- consider fully staffing the Applications Wing with both permanent core staff and temporary user-agency staff -- including a Director with strong applications-oriented experience;
- establish administrative procedures whereby the technical and research facilities of SPARRSO are easily accessible to the applications staff and user agencies;
- assign single-person responsibility to prepare and coordinate annual workplans for each application as part of an overall 5-year strategy, and conduct quarterly reviews for each of the designated applications areas;
- establish and maintain a data acquisition, reproduction, and archive facility within SPARRSO;
- reactivate discipline-oriented applications "task forces" comprised of SPARRSO and user agency personnel to provide guidance, direction, and review to the applications activities.
- continue its active program for the repair and maintenance of all acquired hardware including an extensive spare parts inventory;

- o implement an organizational structure that clearly identifies assignments and individual responsibilities;
- o establish Standard Operating Procedures (SOPs) for operation and maintenance of all facilities and the ACEMP equipment;
- o establish a parts and expendables procurement policy and contract with suppliers in order to assure timely procurement;
- o implement a computerized inventory control system;
- o establish an on-going training program for refresher and advanced training in the operation and maintenance of the facility equipment;
- o establish remedial maintenance backup for major system components.

It is recommended that USAID should:

- o promote, assist, and guide SPARRSO in the above activities, primarily through the services of a resident Project Advisor (16 pm);
- o conduct comprehensive applications-oriented training at SPARRSO and user agency staff which integrates tutorial and laboratory presentations with on-going applications tasks. Five training/workshops averaging 1 month each with two instructors is suggested (12 pm of consultants).
- o provide the short-term services of a computer systems engineer (2 pm), an applications software engineer (6 pm), and a data reproduction and archival specialist (2 pm).
- o provide 3-4 pm of Participant Training in management at the Director level of SPARRSO.
- o arrange for delivered software to be made operational and obtain operational (tested and fully documented) GIS

software as soon as possible to support data processing requirements for the 10 applications. (If resident **software cannot be made operational early in the** program, alternative software should be obtained.)

1.7 LESSONS LEARNED

The transfer of high technology to developing countries is a very complex and time-consuming task. The problems in projects of this type usually arise from not assessing and adequately addressing the total systems aspects of the project. The system does not stop with the equipment and associated personnel but includes also the institutional structure which must support the facility and the linkages necessary to promote and distribute the new products and information. It is a common misconception that the institution fully realizes the implications of the sudden infusion of technology and has adequately prepared for the additional resources required.

Although this project was envisioned as institution-building, the facility management aspects of the project were neglected -- no SPARRSO management personnel were exposed to training in facilities performing similar functions. In addition, SPARRSO has neither recognized the organizational structure required for the management of such a facility on a routine basis nor attempted to relate the facility to the objectives of the project -- development of 10 applications areas and distribution of new data and information.

In future projects of this nature, the full systems aspects should be examined and the recipient institution should be brought into the preparations for technology transfer much earlier in the project.

2.0
CURRENT STATUS OF THE PROJECT

Due to the number of organizations and individuals involved in implementing this Project, we do not intend to identify responsibilities or individual contributions. A reconstruction of how this activity was carried out is outside of our Scope of Work (Appendix A). This section is concerned with the current status of the project. More details are included in Section 4.

2.1 FACILITIES

2.1.1 BUILDING AND ENVIRONMENT

The Applications Center at Sher-e-Bangla Nagar, Agargaon, has been completed. Additional facilities on the SPARRSO campus are currently under construction to house some of the administrative functions, which will free-up additional space in the Center for expansion of the technical facilities.

The ACEMP computers, Optronics film recorder-scanner, and ground station equipment is currently occupying approximately 1044 sq. feet of floor space. There are two interpretation/analysis areas, each with an IIS display system, occupying approximately 648 sq. feet. The X-Y coordinate digitizer table and Matrix film recorder are located in the larger of the two areas (432 sq. feet). The photographic darkroom for the Wing/Lynch processor occupies approximately 80 sq. feet. Additional space for the air conditioning, uninterruptable power supply (UPS), and office space for the facility support personnel occupy the remaining half of the second floor of the Center.

On the first floor are the Project stores, occupying approximately 540 sq. feet, and the office and work area of Project foreign personnel, including the office of the USAID Project Monitor (96 sq. feet).

The facility support equipment provided under this Project can be considered operational with a few exceptions. At the moment these exceptions do not materially hinder the current operation of the facility, but should be resolved if the Center is to achieve a capability to operate essentially on a 24 hour basis. These are further described below and in Section 5 of this report.

One outstanding facility construction task remains to be accomplished; the assembly of a "cold box" to store photographic materials and supplies. This "box" has been received but due to incountry delays, not assembled.

2.1.2 DATA RECEPTION AND PROCESSING

The advanced meteorological ground station has been installed and is operational with the exception of the capability to receive and process data from the restricted Indian satellite, INSAT. While INSAT was specified as a data source for this Project, to date India has treated INSAT data as an exclusive national resource and has not allowed its reception by other countries. (There are hopes that that position will change in the near future.)

The system is currently acquiring data from the Tiros-N series of satellites, the Japanese geostationary meteorological satellite (GMS), and occasionally, the Soviet Meteor satellite. In addition, the ground station receives daily data relayed by the Tiros-N satellites from the ground-based Data Collection Platforms (DCPs) furnished by this Project.

No Landsat data is currently being acquired by this or other reception facilities at SPARRSO. Some experimental Landsat scenes have been recorded in high density tape format

only under a French-sponsored project. It is expected that this project will provide Bangladesh with a Landsat/SPOT ground data reception capability.

2.1.2.1 Hardware

In December 1985 five of the eleven DCPs were in operation. There have been various problems associated with the DCPs, from minor miscalibration of individual sensors to the catastrophic destruction of an entire DCP by a major flood. Several of the DCPs were not operational from their installation, but this fact was not discovered until the DCP receiving capability was completed. Since that time SPARRSO has conducted an active program for the maintenance and repair of the DCPs. This program includes not only hardware repair, but in some cases, reprogramming to calibrate the devices to better suit Bangladesh's environmental conditions.

Of the DCP repairs, there seems to be an inordinate number of failures of the Master Control Modules (MCM) such that the spares have been exhausted. This lack of spares may cause delays in restoring some of the DCPs to operation. We are advised that the single sea buoy DCP, damaged during the May 1985 cyclone in the Bay of Bengal, will be recovered in January 1986. (The buoy had not been located in January 1986, it is presumed lost.)

Within the ACEMP computer facility, one of the two VAX 750 computers is operational. The other computer system has been non-operational for approximately 65% of the time since September of this year, and completely shut down since November 2nd. The major problem has been diagnosed by SPARRSO engineers, but cannot be repaired due to the lack of a spare for the faulty component. As a result practically all facility activities are

limited to new data ingest and processing of meteorological satellite pictures by the remaining computer.

The stand-alone Optronics film recorder/scanner has been intermittently operational for approximately 30% of the time during the last three months. The problem has been tentatively diagnosed as a "thermal problem" in the Automation computer which controls the operation of this device. A large fan has been temporarily placed directly in front of the Optronics to provide additional cooling. This measure has reduced but not eliminated the failures. (Subsequently, removal of the side panels to allow freer flow of cold air has apparently eliminated the problem.)

The Wing/Lynch film processor associated with the project should be considered non-operational for several reasons. There is a problem with the water pressure, apparently due to not providing an air relief in the waterline to the device. In addition, the water chiller operates intermittently and the water temperature controller is incapable of maintaining the proper temperature in the system. There is also some evidence that the filtration system is allowing contaminants, primarily silt, to enter the processor. (Repairs have been made to correct this problem.)

The X-Y coordinate digitizer appears to be working reliably but may require relocation to a temperature controlled environment. Infrequently, there have been some unreliable readings, possibly caused by temperature problems.

The Matrix display camera system appears to be working reliably, following a recalibration of the system by SPARRSO personnel.

The Tandy TRS80 Model 16B computer, delivered with the system, has been working very reliably since installation. While not currently being used for dissemination of DCP data to the Water Development Board, its intended use, it is being actively used for various data base and inventory control functions within SPARRSO. This is a valuable and cost effective use for overall information management within SPARRSO.

With a few exceptions, spare parts for the system have been sufficient for most remedial maintenance since the system installation. The notable exception has been the inability to repair the second computer due to the lack of a spare module. But this is a major module of the system and its absence from inventory is, perhaps, understandable.

A computerized inventory control system has been implemented at SPARRSO, and while still requiring some work, appears to be functioning.

2.1.2.2 Software

A complete assessment of the status of the ACEMP software is difficult since, at the moment, SPARRSO is using only a portion of the delivered software capability. However, since much of the software was developed around the IIS System 575 Image Processing software, a mature software package, we believe that basic processing functions exist and are probably reliable. (SPARRSO engineers are suspicious that the IIS software may have corrupted the system disk on three different occasions, but this has not been proven.)

A list of the major developed or purchased software modules and their status are shown in Table 1. In addition, we take this opportunity to comment on three other software capabilities which should be available to this Project.

TABLE 1. MAJOR SOFTWARE MODULES AT SPARRSO

Software Module	Status
*TIROS HRPT/AVHRR R/T & Tape Digest	Operational
*GMS Ingest	Operational
*TIROS TOVS	Not working for NOAA-6 Needs update for NOAA-9
*TIROS Data Collection System	Operational (but some confusion re presentation of DCP parameters)
*TIROS Archival Tape Creation	Operational
*ATP Archival Tape Creation	Operational
*GMS Archival Tape Creation	Operational
*GMS Archival Tape Read	Non-operational
*Output of AVHRR, GMS, or ATP disk file to Muirhead recorder	Non-operational
*TIROS/GMS Processing:	
World Map & Country Boundaries Overlay	Operational
TIROS Vegetation Index	Operational
Sea Surface Temperature	Operational calibration
Ocean Detail Enhancement	Operational
GMS Animation	Operational
Registration	Operational
Color Enhancement	Operational
Water Vapor Correction	Operational

*Landsat Analysis System (LAS): Non-operational

This important Landsat Analysis System (LAS) is intended to provide the capability to process high resolution Landsat TM and similar SPOT data -- a very important capability for future Bangladesh applications. It was developed for use on a different computer system and requires considerable modification and a different image display system (hardware) in order to be used by SPARRSO.

In addition, no documentation was delivered with this NASA Goddard Space Flight Center product. SPARRSO software personnel were evidently advised by NASA that it would make the necessary modifications for LAS to be operational on the ACEMP system. However, that has not happened to date, nor is it clear from comments by NASA officials, that NASA considers this software package to be a "deliverable" under the terms of its PASA. ACEMP personnel should investigate operational alternatives to the LAS package.

*AMS/MOSS: Partly-operational

This software package was delivered with limited documentation and no training. There is an interface problem between the Automated Mapping system (AMS) module and the Map Overlay and Statistical System (MOSS). The system does not allow digitized data acquired by AMS to be subsequently manipulated by MOSS. This is a critical deficiency for most of the ACEMP applications because it does not allow subsequent GIS file manipulations after data input.

There has been some exploratory use of AMS by SPARRSO personnel, but we consider this software to be non-operational for its intended GIS purposes.

*GEMPAK: Undelivered

There was mention of this software package as a possible deliverable under the ACEMP, but we cannot find it. We were advised by SPARRSO personnel that a software package from NASA/GSFC, AOIPS/2, is superior to GEMPAK and is currently being enhanced by GSFC. Presumably, NASA will provide this enhancement to SPARRSO, but at the moment no equivalent GEMPAK capabilities exist at SPARRSO. NASA officials have indicated their intention to include AOIPS/2 as part of a proposed training program.

2.1.3 INTERPRETATION AND GROUND TRUTH

Support of interpretation and ground truth tasks has not been covered by ACEMP activity to date, and the following discussion concerns facilities not directly developed by the ACEMP. However, as the 10 applications develop, attention and resources must be directed to these capabilities and augmenting them where necessary.

SPARRSO's on-going meteorological and agro-met research is being conducted by scientists in the Research Wing, while natural resources work (agriculture, forestry, hydrology) is largely conducted by the Cartographic Division of the Technology Wing.

Interpretation is the largely visual process of examining and recording information contained in raw or processed images, including aerial photography, and describing it in user understandable terms. This process is assisted by a number of optical devices which enhance or change the scale of the images and project it onto working surfaces. While SPARRSO has a basic supply of planimeters, stereoscopes, several transferscopes and projectors, considerable additional interpretation equipment will be supplied under the proposed UNDP Project.

Ground truth equipment includes 4-wheel drive field vehicles, a field spectral radiometer, and various measurement devices applicable for different disciplines. The implementation of the 10 ACEMP applications will be hampered if the UNDP Project is delayed or cancelled.

Aerial data collection is an important compliment to several agricultural and environmental monitoring tasks. These tasks are currently inhibited by the absence of an effective mechanism for obtaining aerial data routinely and quickly.

2.1.4 CARTOGRAPHY AND REPRODUCTION

Distinct from the requirement to interpret spatial data and imagery, is the need to render it into maplike form and to reproduce and/or publish it. SPARRSO's cartographic and reproduction capabilities are rudimentary -- which may hinder general dissemination of information. As far as could be determined, there is no coordinated or centralized facility or system for the reproduction, editing, printing, and distribution of SPARRSO reports and images or map products.

Of particular concern is the difficulty of determining precise locations in a cartographic sense for images, for existing maps, and for field reference. This limitation is of concern when attempting to exactly co-locate points or features on multisource geographic or geo-referenced data.

Photographic equipment delivered under this and other projects remains uninstalled, limiting some of the photographic reproduction tasks. Adequate supplies of film and chemicals are not well maintained and are degrading due to improper storage.

2.1.5 ARCHIVE, USER AND LIBRARY SERVICES

SPARRSO has a good library complete with a variety of technical books and journals. Unfortunately, many of the journals and technical documents appear to be out-of-date. SPARRSO lacks an organized, document data archive and user-services facility. There appears to be no standard or organized way of ordering or retrieving SPARRSO data and information (list of products or services, order forms, published price lists, list of published SPARRSO maps and documents).

SPARRSO has no digital data archive or reproduction facility. Digital data from various satellites and sensor systems are scattered in different locations, making retrieval of historical data problematical.

2.2 PERSONNEL

2.2.1 ACEMP PERSONNEL

Interviews with many of the SPARRSO people assigned to the ACEMP demonstrates a fairly high level of competence but an uncertain administrative and organizational structure. It is sometimes difficult to determine who works for whom and whether job performance is being adequately monitored and assessed. A common expression by applications people was uncertainty as to whether or not SPARRSO has a funded program to carry out applications development in their area of expertise.

Nine SPARRSO personnel have received participant training in the United States under the ACEMP. Six of these people were trained in various aspects of the operation and maintenance of the ACEMP system. In addition, certain hardware training has been conducted in Dhaka. A summary of the hardware and software training is shown in Table 2.

TABLE 2. ACEMP HARDWARE AND SOFTWARE TRAINING

Subject	Duration (person-days)
Hardware:	
VAX 11/750 hardware diagnostic user	15
VAX 11/750 processor internals	20
TU78 Magtape maintenance	10
RA80/81 disk maintenance	5
LA120 terminal maintenance	2
IIS image processor	5
Optronics C4500 film scanner/plotter	5
Wing/Lynch film processor	2
Matrix film recorder	2
Digitizer table	1
Printronix printer/plotter	2
Trilog color printer/plotter	2
EMR hardware interface	?
Uninterruptable power supply	5
Air conditioning	?
Gas generator	10
DCP	5
ACEMP system overview	?
Software:	
VAX/VMS utilities and commands	5
VAX/VMS operating system internals	5
VAX/VMS system management	5
VAX-11 Macro	5
VAX-11 Fortran	5
Utilizing VMS features from VAX-11 Macro/Fortran	5
VAX/VMS device drivers	5
IIS image processor software	5
AVHRR applications	8
TOVS applications	5
ACEMP systems overview	?

From this table, note that well over 12 person-months of hardware and 18 person-months of software training has been provided. Interviews with trainees and observation of their work indicates partial training success -- i.e., some trainees benefitted greatly from their training as evidenced by the quality of their work; others, less so.

2.2.2 INCOUNTRY TRAINING

Two formal training activities were conducted in Bangladesh -- one concerned with the use of TOVs data and one for satellite image interpretation for weather forecasting. Incountry training offers some significant advantages over foreign training in terms of the numbers of participants and the orientation toward local applications. Therefore, it is recommended that most of the future training for this project emphasize incountry training.

As a result of the participation of Dr. Syed M. Hashemi in the training on "Satellite Imagery Interpretation and Application to Weather Forecasting" a number of traditional problems associated with incountry training courses were addressed and solved. These include problems concerning participant selection, attendance, motivation, and monitoring of achievement. An abstract of Dr. Hashemi's report is included in Appendix E.

2.3 INSTITUTION

2.3.1 SPARRSO MANDATE

As identified in its organization chart of 17th January 1984, SPARRSO's official functions are listed in Table 3.

We are impressed with SPARRSO's mandate and find its official functions fully in keeping with and supportive of the goal

TABLE 3. SPARRSO'S MANDATE (KHAN, 1984)

(a) To apply space and remote sensing technology to resource survey in the country;
(b) to monitor natural hazards in the region;
(c) to collect data on renewable and non-renewable resources of the country;
(d) to evolve efficient methods for surveying, identifying, classifying, and monitoring natural resources of the country;
(e) to collect agro-hydro-meteorological data daily on a real-time basis through several Data Collection Platforms (DCPs) in the country via satellite;
(f) to set-up a data acquisition, processing and dissemination system for use by different organizations in the country;
(g) to set-up both resource and weather satellite ground stations;
(h) to develop instrumentation facilities for multidisciplinary applications of remote sensing data;
(i) to carry out research and development activities in the fields of agriculture, water resources, forestry, fisheries, meteorology, geology, oceanography, etc.;
(j) to establish regional and international cooperation and collaboration in the relevant fields;
(k) to provide relevant information to the Government of Bangladesh in formulating national and international policy issues concerning space science and remote sensing activities;
(l) any other duties as assigned by the Authority.

and objectives of the ACEMP. Indeed, the service and user-orientation are clearly mandated.

2.3.2 ORGANIZATIONAL STRUCTURE AND MANAGEMENT

In addition to its Administration and Finance divisions, SPARRSO is organized into three technical units or "wings": Applications, Technology, and Research. However, the Applications Sector is not staffed or functional. Effectively, all technical activities are carried out as "projects" within either the Technology or the Research Wing. Each wing has a Director who serves as "director" of all projects within his wing and reports to the Office of the Chairman. Technical resources available in one wing are shared, as required, by the staff and projects of the other wing.

Much of the agricultural and forestry user interaction to date has been by the Cartographic Unit of the Technology Wing. This unit has not interacted significantly with the facilities being developed under ACEMP and regards its role as limited to the "manual" interpretation of remote sensing images. This distinction of manual (human) versus digital (computer) analysis of remote sensing data is unfortunate and confuses output objectives with methodology. Most practical applications require both manual interpretation and digital processing procedures in their execution.

Our interviews with management level staff reveals an equipment and ad hoc project or study orientation that are not entirely in harmony with SPARRSO's overall mandate, or the goal of this Project. Currently, SPARRSO's orientation is to conduct inhouse research and studies. There is an important lack of mechanisms for facilitating information transfer to users or for users to express their requirements to SPARRSO.

2.3.3 LINKAGES TO USERS

In the planning stage of this Project it was envisioned that "temporary staff members from the various user agencies would be working along side of SPARRSO's core staff of administrators, researchers, equipment operators and maintenance technicians at the SPARRSO Applications Center". By this means it was thought that "the findings of the investigative staff would be immediately internalized in the decision making process of the user agencies and ministries since the identification of priority problems, their study and presentation of findings are conducted by employees of the user agencies and ministries themselves" [USAID].

Also, it was stated that "while the facilities and core staff of SPARRSO assist the investigators to conduct their studies, SPARRSO as an autonomous agency will not be conducting research for the subsequent external imposition on a development ministry or agency" [USAID].

"SPARRSO's core staff...will be supplemented by the temporary staff of investigators from the user ministries and agencies. This arrangement is a continuation of the organizational structure established for the Bangladesh Landsat Program (BLP) and over the past six years has resulted in the development of productive working relationships between the BLP staff and temporary investigators from the user ministries." [USAID].

These assumptions concerning linkages with user agencies have proven false. Currently there are no temporary staff from user agencies working at SPARRSO and any applications-oriented work is largely an internalized research effort.

Under UNDP sponsorship SPARRSO has proposed a three year project entitled "Service-oriented Application of Remote Sensing Technology in Agriculture, Water/Fisheries, and Forestry". The orientation of this project is to promote the technology transfer of remote sensing applications to users by "establishing a User Services Wing at SPARRSO" and conducting a series of user-and-SPARRSO personnel training programs (largely on-the-job) and pilot projects (11) at SPARRSO [UNDP].

The objectives and methodology of this proposed UNDP program is highly complimentary to and supportive of the objectives of the ACEMP. While one project does not depend directly on the other, together they provide a powerful double-pronged approach to the same goal; getting useful remote sensing-derived information into the hands of the users.

3.0
ACEMP APPLICATIONS

3.1 GENERAL APPLICATIONS FRAMEWORK

The primary product of remote sensing is information -- information which is needed and can be incorporated (applied) in a resource management/decision making process. Information serves no other functional purpose.

In describing the status of the following 10 applications, we make two kinds of assessments:

(1) where along the path from research to demonstration (feasibility testing) to operational practice is the technology, and
(2) what are the technical and institutional constraints to conducting the 10 specified applications today and in the future. What information is needed and can it be obtained cost effectively or timely with remote sensing.

In recommending a plan for continuing development within each application, we visualize and propose a specific information product (usually a report) which is to be available to one or more users at a specific time.

3.1.1 APPLICATIONS TECHNOLOGY

Within any area of application, there is a range of information products, from simple to complex. Where basic spatial (maplike) information is deficient or out-of-date, practical use can be made of basic picture-products as a primary input. Daily

use of low-resolution (APT) cloud pictures for weather forecasting is an example. However, because of the potential for processing and producing specialized information products, the utility of remote sensing data can be greatly extended. But the important role of simple or basic products should not be neglected or overlooked -- especially when the objective is operational results.

For each application task, we identify a single information product which we believe a BDG or donor agency can use. See Table 4. It may not be the most sophisticated product that the ACEMP theoretically can produce, but it is a useful product. Then we describe a technical plan for SPARRSO to create that product and hypothesize about how long it will take.

3.1.1.1 FUNCTIONAL ELEMENTS

All applications have certain functional elements in common: (1) data, (2) processing, (3) analysis and interpretation, (4) reproduction, and (5) information dissemination to identified users. Each of these elements (links in the chain) must be in place before an actual "application" of this technology occurs. If the application is to be "institutionalized" (conducted systematically and routinely), the functional elements must also be linked so that they operate more-or-less routinely.

To better insure continuing and efficient links from data collection to information dissemination, we strongly recommend the creation or reactivation of several institutional mechanisms -- such as a "data archive", a "training office", a "user services facility" within an Applications Wing, and disciplinary "task forces". These mechanisms are necessary, and we believe that without them, SPARRSO's institutionalizing of the 10 ACEMP applications and others, will remain sporadic, ad hoc, and most likely, incomplete.

TABLE 4. SUMMARY OF PROPOSED APPLICATIONS PRODUCTS AND USERS

Application	Product	User
1a. Categorized Land Use	Color-coded land cover photo-map Areal statistics for scene	All
1b. Management Information System	User-defined multi-source maps Areal statistics for selected area	All
2a. Cropping Patterns	Annual ag-land cover maps	Agriculture Statistics
2b. Interpretation Keys	Enhanced images	Agriculture
3. Area & Yield	Crop production estimates	Agriculture Food
4. Crop Calendars	GIS crop by location and season	Agriculture Food Transport
5. Flood Prone Areas	Daily flood pictures, DCP data	Water Development Board
6. Land Accretion	Coastal changes	Forestry Survey Fisheries
7. Forest Inventory	Annual forest cover	Forestry
8. Coastal Afforest	Forest condition, changes	Forestry
9. Monsoon Clouds	Clouds/precipitation DCP data	Meteorological Service Water Development Board
10. Storms & surges	Real-time pictures, alerts	Severe Storm Center Fisheries

In making recommendations for the next two years, we attempt to identify technical and administrative steps which are necessary and feasible. Given SPARRSO's current development -- both technical and administrative -- we are somewhat conservative in estimating what the results may be or, for that matter, the timescale over which they can be implemented.

Ten applications activities may seem like a lot for the SPARRSO staff to pursue, considering its other activities and demands. However, we do not believe so for four reasons:

(1) In practice the output products are phased during the year. Generally, agricultural and forestry data collection and analysis occurs during the winter dry season when the skies are clear. Studies of monsoon clouds will utilize data from the May to September period, and cyclones and storm surges usually occur in May and from September to December.
(2) Many of SPARRSOs other activities are highly complimentary to the 10 ACEMP applications, such as the proposed UNDP program. In many cases these activities can and should be integrated.
(3) These activities are largely developmental activities which can and should proceed as fast as possible, regardless of inevitable delays in the schedule.
(4) The excellent SPARRSO staff is capable of far more than it is currently requested or organized to do.

3.1.1.2 ASSUMPTIONS AND CONSIDERATIONS

We make the following assumptions:

(1) There will be no delays or breaks between the end of the current ACEMP activities and the beginning of the follow-on activities proposed herein, i.e., project continuity will be maintained.

(2) The complimentary activities proposed under the UNDP/FAO will be implemented more-or-less as planned and on schedule.

(3) High-quality Landsat TM and/or SPOT computer compatible tape data of Bangladesh will be available on a continuing basis no later than December 1986.

(4) Aerial data collection in support of applications activities can be obtained and used on an ad hoc basis.

(5) The system problems identified in Sections 2 and 4 of this report will be solved or, at least, will not significantly impact the applications activities.

For each general application area, we suggest the following considerations:

(1) Single person responsibility for overall implementation. A single individual should be assigned to carry out the application on a full time basis. He should have a budget for new data, expendable supplies and materials, conducting field work, etc. and have reasonable access to the data processing and photo reproduction facilities. He would be expected to enlist the services of other SPARRSO personnel as required and to seek out and work with counterpart personnel in user agencies having an interest in the objectives of his application. This person would also be responsible for reporting the progress of his application.

(2) Annual workplans be prepared and reviewed twice during the project period: once in March 1986 and the other in January 1987. The annual workplan, which represents a single cycle of activity, describes the steps to be taken in implementing the activity during that year and a time-schedule for the projected milestones. Particular attention should be given to

critical factors which may be beyond the control of the individual or SPARRSO to implement. (It should be noted that there are some very convenient micro-computer programs available which make project planning and updating as painless as possible -- Microsoft Project is one such product.)

(3) The progress of all activities should be reviewed by the Project Director and the Project Advisor on at least a quarterly basis. This review should include a discussion of all achievements, and problems that have occurred during that period, and any update or change in the workplan or time-schedule that might be necessary. (These quarterly reviews could be staggered so that only two or three a month would be scheduled.)

(4) Each activity should have interim reports and a final report documenting the data, methodology, and results achieved. The final report should be reviewed by the SPARRSO Directors, the relevant task force, and any user agency involved. Subsequently, the results for the work should be published in quantity for general distribution and be made publicly available through the "user services" facility.

3.2 APPLICATIONS TASKS

Most of the applications identified in the ACEMP paper have been ongoing during this project and even prior to it under the Bangladesh Landsat Programme (BLP). For example, under this and other projects, a number of Bangladeshi scientists have received extensive applications training and experience. SPARRSO's "Five Year Research and Development Programme (1980-1985)" lists actions, dates of execution, and manpower commitments for ten applications sectors. While most of these activities have not been completed on schedule, the Programme provides an excellent

basis for further planning. These sectors and their tasks are listed in Appendix B of this report.

The ten ACEMP applications activities were listed but not actually described in the USAID Project Paper. Herein are what we believe to be useful and obtainable objectives for SPARRSO within each application area over the next two years. However, others may feel that these objectives and methodologies are not appropriate or are overly ambitious. Therefore, SPARRSO should review these recommendations as soon as possible and approve or modify them. Our objective here is not to cast these activities in concrete, but to propose a framework, a set of criteria, and methodology as a basis for discussion and development of these applications.

Please note that three of the applications (and 5 of the technical tasks) concerned agriculture -- reflecting both the importance of this sector to Bangladesh's economy and the probable applicability of the technology. While each task is worthwhile in itself, together they provide complimentary information as follows:

crop patterns:	general spatial information (ecological)
crop acreage:	area statistics for administrative units
crop yield:	within season temporal information
crop calendars:	multicrop seasonal temporal information
interp. keys:	crop identification from their tones and patterns on enhanced images.

We suggest that clear SPARRSO priority continue to be given to the early disaster warning and agriculture sectors.

While we think these are important applications activities, they should not be considered as the only project outputs. They are but indicators that the general goal of the project, to

provide a wide range of current resource information to user agencies, is taking place.

3.2.1 CATEGORIZED LAND USE MAPS AND INCOUNTRY RESOURCE INFORMATION SYSTEMS

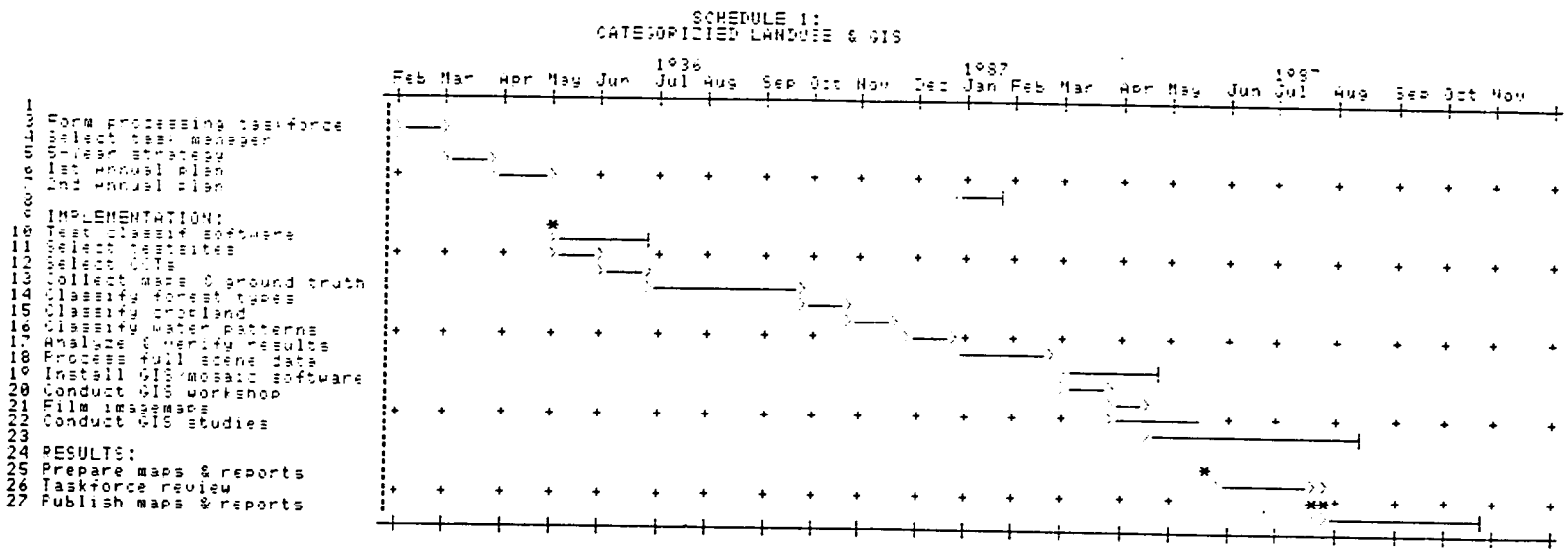
This application activity consists of two technical tasks: (1) multispectral image categorization, and (2) development of a "geographic information system" or GIS. This activity is a technical prerequisite for the applications described in sections 3.2.2 through 3.2.10 below. The two tasks are treated separately but are included in a single schedule.

The first task is concerned with computer image processing or "categorization" of satellite multispectral data. The second task is concerned with incorporating diverse geo-coded data into a system which allows it to be integrated, jointly processed, and easily retrieved for research or management purposes.

To avoid confusion, it should be noted that the term "geographic information system" or GIS is a new term for an old concept. The listing of this application in the Project Paper [USAID] as an "incountry resource management information system" leaves no doubt that an operational GIS was envisioned as effective mechanism for use of the multi-source remote sensing and other types of data provided by the ACEMP.

3.2.1.1 CATEGORIZED LAND USE MAPS

Status: For some years SPARRSO scientists have experimented with and produced categorized land use/land cover maps for a variety of applications -- using computer facilities outside of Bangladesh. The first categorized maps were produced in 1977 under a USAID grant and since that time many SPARRSO scientists have had the opportunity to develop them as products


SCHEDULE 1:
CATEGORICIED LANDUSE & GIS
1986
1987
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov
Form processing taskforce
Select task manager
5-year strategy
1st annual plan
2nd annual plan
IMPLEMENTATION:
Test classif software
Select testsites
Select SITE
Collect maps & ground truth
Classify forest types
Classify cropland
Classify water patterns
Analyze & verify results
Process full scene data
Install GIS/mosaic software
Conduct GIS workshop
Film imagemaps
Conduct GIS studies
RESULTS:
Prepare maps & reports
Taskforce review
Publish maps & reports

of their foreign training. A 1:500,000 scale categorized Landsat map of all of Bangladesh was prepared by Bangladesh scientists (SPARRSO and Survey Department) and published by the World Bank in 1979.

Of the 51 tasks described in SPARRSO's 5-year "Research and Development Programme" (1980-1985), 32 called for, but generally did not realize some form of categorized image processing. Field programs to obtain spectral reflectance ("signature") information and select "training-sets" or check classification results are aimed at this capability. The new ACEMP system provides SPARRSO with the capability to prepare categorized land use/land cover maps as part of its applications activities.

Resource Requirements: Data: Landsat MSS & TM, (SPOT when available). Processing: spectrum matching (variety of algorithms). Interpretation: spectral signatures, training set selection, field verification and accuracy check. Products: color-coded maps, area statistics. User(s): all.

Constraints: Currently SPARRSO has all hardware, software, and trained personnel to carry out this application with Landsat MSS data but generally lacks adequate Landsat data for user-selected historical and current season studies -- necessary for many of the applications. Also, the availability of film and large-size color photographic supplies is problematical.

Secondarily, it is our understanding that the resident ACEMP software cannot handle efficiently Landsat TM or future SPOT data -- a significant limitation given the importance of these high resolution data to Bangladesh's land use/land cover applications.

Solutions: SPARRSO must set-up a "data acquisition, duplication, and archive" facility that will automatically order CCTs of existing, good quality Landsat MSS data for all of Bangladesh (14 scenes) from the Indian and/or Thailand Landsat receiving stations. Two substantially cloud-free data sets for two times (October-January and February-May) for each of the past five years should be obtained and archived.

This facility should automatically receive new data listings from the foreign receiving stations for scenes covering Bangladesh and order these as appropriate.

USAID should provide the services of a U.S. data archive specialist as soon as possible for a period of 2 man-months to assist SPARRSO in this effort. The facility will also be concerned with computerized filing and proper storage of all satellite and other data tapes, daily meteorological pictures and other ACEMP data. (Landsat and other transparencies should be stored in a separate image archive.) The data facility should be provided with a two-year budget of $40,000 FE for data and storage facilities.

SPARRSO should either upgrade the existing non-operational LAS software and obtain additional display hardware for handling TM and SPOT data or obtain a new operational software package with efficient TM and SPOT processing capabilities. We cannot judge which procedure would be most cost-effective at this time, but recommend that a software systems engineer make that determination early in the program. In either case, the engineer would work with the SPARRSO software engineers in installing the capability to process TM and SPOT data such that it would be operational not later than December 1986.

Schedules and Milestones:

1st Q, 1986

(1) Technology task force meets to review current status of SPARRSO tasks in these areas and to recommend a 5 year strategy and review of one year workplan.

(2) SPARRSO appoints a Data Manager.

(3) USAID implements mechanism (contractor) for obtaining services of a data archive specialist and software systems engineer. Terms of Reference approved by USAID and SPARRSO.

(4) Project Advisor works with SPARRSO Data Manager to order new set of 1985/86 CCTs.

(5) SPARRSO building space for data archive identified.

(6) IIS categorization and hard-copy display programs tested, evaluated.

(7) SPARRSO Data Manager starts collecting existing data at SPARRSO.

2nd Q, 1986

(8) Quarterly review.

(9) Landsat MSS data categorization ongoing from this time in support of applications.

(10) Engineer determines requirements for processing TM and SPOT data.

(11) Racks and files arrive, set-up.

(12) Rapid-retrieval catalog system installed.

(13) System operation continues with testing and teaching of all operational software functions, other gaps identified.

3rd Q, 1986

(14) Conduct quarterly review.

(15) Data archive set-up and functioning, TM data and/or SPOT data received.

4th Q, 1986

(16) Conduct quarterly review.

(17) TM/SPOT data processing capability installed.

1st Q, 1987

(18) Conduct annual review and prepare annual workplan

(19) TM/SPOT data categorization ongoing from this time in support of applications.

(20) Technology task force meets.

2nd Q, 1987

(21) Conduct quarterly review

3rd Q, 1987

(22) Conduct quarterly review

4th Q, 1987

(23) Conduct quarterly review.

3.2.1.2 GEOGRAPHICAL INFORMATION SYSTEMS (GISs)

Description: Geographical information systems may be manually or computer-implemented, but because of the large quantities of data and nature of the spatial integration involved, are largely computer implemented.

Status: SPARRSO has the hardware, and some rudimentary software for implementing this activity, but has not done so to date. Since the effective utilization of a GIS capability requires extensive data base inputs from other data-gathering agencies, this application is a continuing "data base building" process. The data base and GIS capabilities become progressively more useful as the base increases in size and the GIS develops data manipulation processes (spatial models).

Resource Requirements: Data: Landsat MSS and TM, AVHRR, all maps, georeferenced data. Processing: software, spatial models. Interpretation: sensitivity and accuracy testing. Product(s): user-defined maps, predictions. Users: all.

Constraints: Constraints to the effective development of a general purpose GIS at SPARRSO are: lack of data (Landsat CCTs

and user-supplied georeferenced data), lack of operational GIS software, time-consuming data-input digitizing process, lack of spatially-oriented applications models.

Solutions: Three solutions are requisite to solving the above constraints.

Firstly, SPARRSO must obtain and archive current and recent-past Landsat MSS data in computer compatible tape (CCT) format. Landsat MSS data of Bangladesh is available from the U.S. (pre-1979) and India and Thailand (after 1979). Once its SPOT/Landsat receiving station is working, SPARRSO should also archive these data in CCT format for categorized land use mapping purposes.

Secondly, to develop an operational GIS capability, SPARRSO must develop linkages with one or more user agencies for defining a spatially-oriented user model that will accept and use both remote sensing derived and user data inputs. Where Landsat data provides a suitable base for comparing and overlaying other types of data, they should be geographically corrected using control point information.

Thirdly, SPARRSO must be supplied with existing, operational GIS software which allows the development of complex data editing and integration functions, and the display and reproduction of mosaicked image and map products.

Schedule and Milestones:

1st Q, 1986

(1) Cartography and Land use task force meets.
(2) SPARRSO person assigned for this task.
(3) Five-year strategy and annual work plan prepared.
(4) User-agency staff participate in task and install data bases.

(5) ERIM Landsat MSS mosaicked data file tested as base for nationwide GIS.

(6) Select resource maps (soils, political, etc.) and start ongoing task of digitizing boundaries.

(7) SPARRSO tests data file integration and display functions, software gaps identified.

2nd Q, 1986

(8) Quarterly review.

(9) Users and applications helped to define their GIS requirements.

3rd Q, 1986

(10) Quarterly review.

(11) New software ordered (as necessary).

(12) Develop crop yield GIS, other application models.

4th Q, 1986

(13) Quarterly review.

(14) Start to collect GCP data.

1st Q, 1987

(15) Annual review and preparation of work plan

(16) GIS/image mosaic software installed

(17) Input and geometrically correct TM or SPOT data

(18) GIS Cartography training/workshop held at SPARRSO.

(19) Land use/Cartography task force meets

2nd Q, 1987

(20) Quarterly review

(21) Mosaic map of Bangladesh prepared in support of various applications

3rd Q, 1987

(22) Quarterly review

(23) GISs being used by SPARRSO and users on continuing (operational) basis, new users attracted to system

4th Q, 1987

(24) Quarterly review

3.2.2 STUDY CROPPING PATTERNS AND INTENSITY, AND DEVELOP IDENTIFICATION KEYS FOR MAJOR CROPS

This activity consists of two tasks: (1) study and identification of crop pattern and intensity information, and (2) development of image interpretation procedures (keys) which will allow cropping patterns to be identified. The first task is concerned with a particular product, while the second provides a methodology.

3.2.2.1 CROPPING PATTERNS

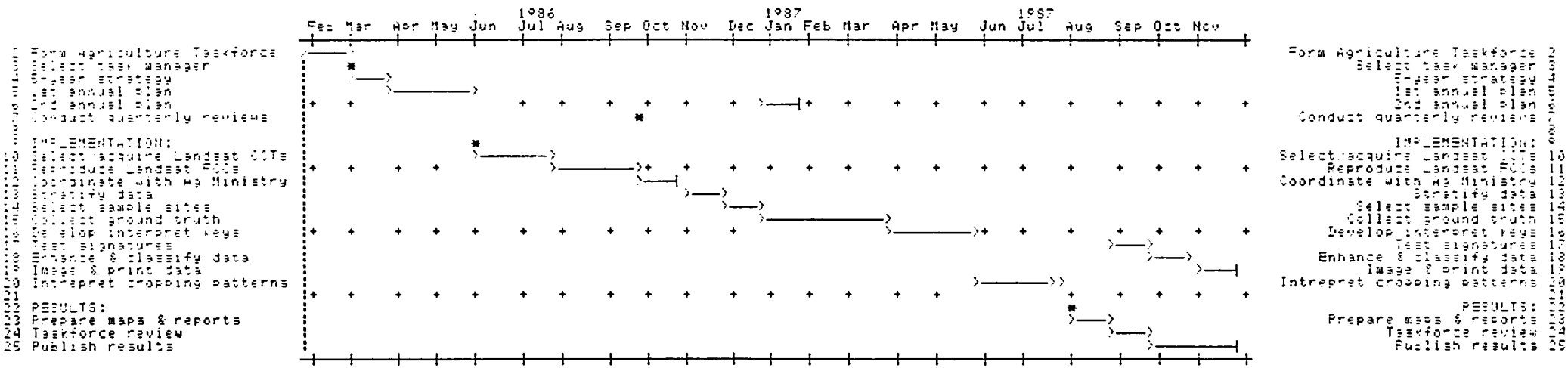
Description: Cropping patterns and farming systems are temporally and spatially complex in Bangladesh. However, efforts to improve farming practices and monitor crop production in different areas of Bangladesh depend on a knowledge of these local variations.

As one example, agricultural extension workers need detailed information concerning existing cropping practices and patterns before they can identify and recommend different crop varieties or improvements in farming systems. Agricultural planners should know the areas and locations of different cropping practices. (This application is also related to "crop calendars", described below.)

This application is primarily concerned with the use of single dry season satellite data to determine cropping patterns in Bangladesh. The approach is to have two cycles of procedures development and feasibility testing. The object is to produce reliable identifications of boro and aman crops with 1986 data. (Considerable work has already been done with these crops.) In 1987 the effort would add identifications of wheat and mustard crops.

Status: SPARRSO has conducted a number of studies during the last 10 years to better understand agricultural cropping

SCHEDULE 2:
STUDY OF CROPPING PATTERNS



Form Agriculture Taskforce 2
Select task manager 3
Prepare strategy 4
1st annual plan 5
2nd annual plan 6
Conduct quarterly reviews 7
IMPLEMENTATION: 8
Select/acquire Landsat CCTs 10
Reproduce Landsat FCCs 11
Coordinate with Ag Ministry 12
Stratify data 13
Select sample sites 14
Collect ground truth 15
Develop interpret keys 16
Test signatures 17
Enhance & classify data 18
Image & print data 19
Intrepret cropping patterns 20
RESULTS: 22
Prepare maps & reports 23
Taskforce review 24
Publish results 25

patterns in different parts of Bangladesh. The procedures make use of ground truth or aerial photography to select training sets and the categorization of Landsat data.

Resource requirements: Data: aerial photography, Landsat MSS and TM, SPOT. Processing: land use/land cover categorization. Interpretation: crop signatures, field verification. Distribution: color-coded Landsat pictures. Users: agriculture, statistics, Planning Department.

Constraints: Several constraints reduce SPARRSO's ability to implement this application. Studies thus far have relied on processing historical Landsat data -- 2 to 5 years after the date recorded. Also, aerial photography used for comparison is also out of date. This makes direct comparison with current season conditions and ground observations, somewhat doubtful.

Fields in Bangladesh are small -- often less than 1/4 acre -- and variable in crop and planting dates. Landsat MSS has a pixel size of 1.1 acre, making actual field and crop delineation impossible.

Collection and processing of aerial photography is likely to be a problem due to the lack of film and processing chemicals.

Solutions: SPARRSO should obtain current season Landsat for processing. While these data soon may be available, from the SPARRSO's French-installed Landsat/SPOT ground station, SPARRSO should order current season Landsat CCTs from the Thai or Indian stations. (Deliveries of one month or less are possible.)

Landsat TM and/or SPOT data soon will be available to SPARRSO -- either from the SPARRSO ground station, the Indian

station, or via NASA's TDRSS (Telecommunications and Data Relay Satellite System). The TM and SPOT data will provide spatial resolutions of 1/4 acre or better.

Aerial imagery for vegetation applications (agriculture and forestry) should be obtained using a special video camera system known as a Biovision. This camera records vegetation features in the same spectral range that Landsat MSS and the first three bands of TM. It records and reproduces a false-color display similar to standard false-color Landsat products without the requirement for film processing or delays in playback. We recommend that a Biovision be supplied for carrying out the aerial data collection in support of this and other applications.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO task leader selected and annual work plan prepared

(2) Agriculture task force meets to recommend 5-year strategy and discuss linkages

(3) Current season Landsat MSS CCTs ordered.

(4) Ground truth and/or aerial imagery obtained from selected boro and aman cropping areas.

2nd Q, 1986

(5) Landsat data processed for crop identification

(6) Quarterly review

(7) Processing results verified in field

(8) Information provided to Agriculture Department

3rd Q, 1986

(9) Quarterly review

4th Q, 1986

(10) Quarterly review

(11) New Landsat and AVHRR data recorded on CCTs for processing

1st Q, 1987

(12) Annual review and preparation of 1987 work plan

(13) Continuing collection and processing of current season data (Landsat and AVHRR)

(14) Training/workshop on using Landsat and AVHRR data for crop acreage and yield estimates (1985/86 data is used for applications demonstrations)

(15) Ground truth collection from selected sites using both ground observations and aerial VCR

2nd Q, 1987

(16) Quarterly review

(17) Results integrated with crop area and yield task

(18) Current season cropping pattern information reported and provided to Agriculture Department for evaluation

3rd Q, 1987

(19) Quarterly review

(20) Reported procedures and results discussed with users for possible routine implementation.

4th Q, 1987

(21) Quarterly review

(22) Administrative agreement for SPARRSO to obtain and supply current crop pattern and intensity data to Agriculture Department.

3.2.2.2 CROP IDENTIFICATION KEYS AND CROPPING INTENSITY

Description: Crop identification keys and studies of cropping intensity are concerned with evolving a methodology whereby agricultural investigations can make direct use of remote sensing images to identify particular crops or agricultural practices. Such "keys" refer to the determination of how different crops appear on different spectral bands of satellite data at different times. When consistent rules are established for crop identification, these can either be manually or machine (computer) implemented.

Status: This task will have SPARRSO scientists devise and test a number of enhancement algorithms for displaying conditions and contrasts related to agricultural crops. Previously, several Bangladeshi investigators have reported how agricultural crops appear in different types of images. From such information, keys may be evolved which aid the interpreter.

This task concerns the testing and selection of optimal image processing procedures, including interactive man/machine procedures, for labeling crops. It is expected that this activity and the published keys can be completed within the two year project period.

Resource requirements: Data: aerial photos, individual band, ratios and FCC images. Processing: single band comparisons, enhancements, etc. Interpretation: selected ground truth locations. Distribution: optimally enhanced images for interpretation. Users: agriculture, forestry.

Constraints: While SPARRSO has some of the basic image enhancement software capabilities, it lacks some of the more sophisticated image processing software which relates multispectral data to physical parameters: greenness index, brightness index, shadows, Kauth-Thomas transformation, etc.

The quality of SPARRSO's photographic reproduction is not satisfactory for recording and reproducing high-quality image products.

Solutions: Under its Large Area Crop Inventory Experiment (LACIE) and AgRISTARS program, NASA extensively tested and developed a number of sophisticated image enhancement techniques and procedures for their use. We recommend that this software be provided to SPARRSO for its testing and development.

SPARRSO's photographic laboratory will be upgraded by the installation of equipment and the proper storage of photographic

supplies. SPARRSO should introduce "quality control" procedures for reviewing, selecting, and distributing of photographic products.

Schedule and Milestones

1st Q, 1986

(1) Form agriculture task force
(2) Select task manager
(3) Develop first annual plan
(4) Review previous SPARRSO work

2nd Q, 1986

(5) Quarterly review
(6) Select test sites with known crops
(7) Assemble and label available images (MSS)

3rd Q, 1986

(8) Quarterly review
(9) Identify and interpret crop information

4th Q, 1986

(10) Quarterly review
(11) Devise keys for interpretation of standard images
(12) Develop new enhanced images from TM data

1st Q, 1987

(13) Annual review and second annual plan
(14) Continue development of enhanced images for crops using TM data

2nd Q, 1987

(15) Quarterly review
(16) Devise and document new identification procedures

3rd Q, 1987

(17) Quarterly review
(18) Prepare comprehensive report
(19) Task force review

4th Q, 1987

(20) Publish and distribute report

3.2.3 ESTIMATION OF ACREAGE AND YIELDS OF PRINCIPAL CROPS, INCLUDING EXTENT OF DAMAGE BY NATURAL DISASTERS

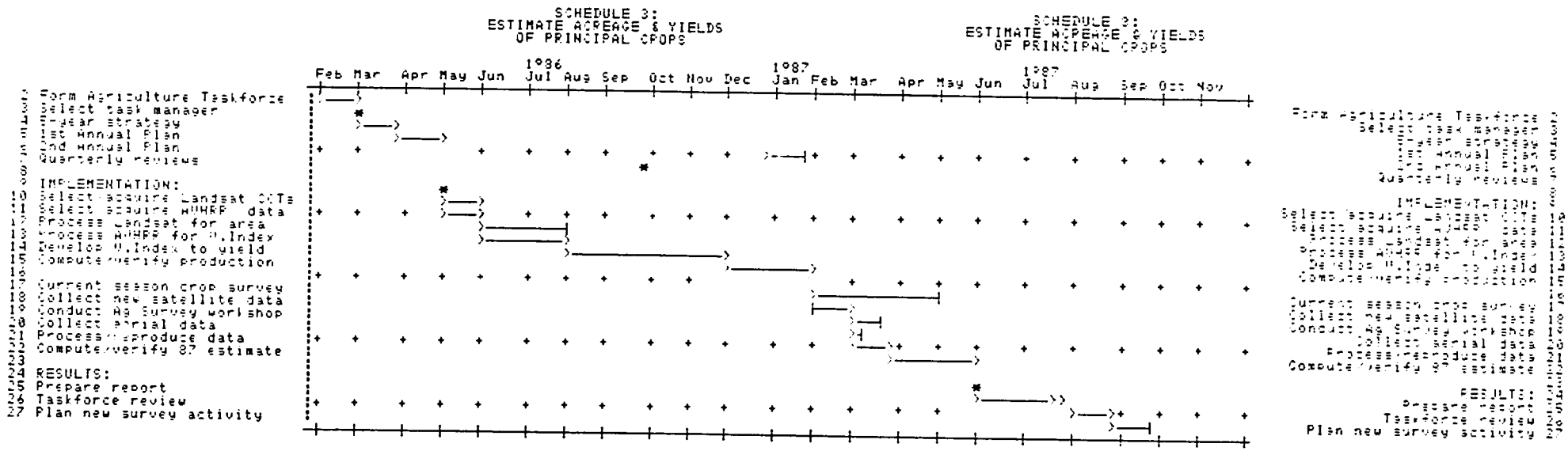
Description: Crop hectarage (area) and average yield determines production (what people eat). Landsat and other remote sensing data is being operationally used for crop acreage estimates where large-field monoculture predominates.

Annual yields of major crops are more difficult to obtain and are largely weather and soil determined. In Bangladesh temperature conditions for crop growth is usually not limiting, but moisture during the dry season is. A recent crop yield model for Bangladesh has focused on soil moisture as a key factor in yield determinations (Strand, 1985). Also catastrophic events (such as floods or hailstorms) can have severe effects on yields on a local basis.

Status: SPARRSO personnel have been trained concerning existing procedures to make use of Landsat data to estimate crop acreage and AVHRR data to study seasonal crop condition, as a precursor to average yield predictions. Part of their training has been directed at analyzing the effectiveness of various crop yield models in the United States [Nessa, May 1985; Nessa, September 1985]. Now under ACEMP, SPARRSO has the technical capability to implement these procedures.

Resource requirements: Data: Landsat CCTs, weekly AVHRR data, DCP, soil moisture, crop yield and production for test areas. Processing: categorization, vegetation index and other transformations. Interpretation: build and test yield and production models. Distribution: production estimates by crop and administrative unit. Users: agriculture, food, etc.

Constraints: This task involves solving a number of problems related to the spatial, spectral, and temporal aspects of remote sensing data.



SCHEDULE 3:
ESTIMATE ACREAGE & YIELDS
OF PRINCIPAL CROPS

Spatial limitations are related to the small field sizes and crop type and planting differences over small distances in relation to the Landsat and AVHRR pixel sizes.

Spectral limitations relate to the fact that the spectral reflectance from crops may be compounded by the influence by many factors, only some of which are directly related to yield.

Temporal limitations relate to the time and frequency of coverage in relation to final yield and/or production measurements. Generally the later the observations, the more accurate the estimates are expected to be. Weekly or monthly satellite observations provide a monitoring capability, but require a dedicated processing facility to obtain timely results.

Solutions: For attacking the spatial limitations, double sampling and other types of statistical sampling have been developed to reduce the bias in acreage estimates obtained from satellite data. These techniques make use of field observations and/or aerial images to obtain detailed crop information at the time the satellite data was collected.

While double sampling techniques show some promise for areas such as Bangladesh that have small field sizes, some investigators are waiting for the superior resolution of Landsat thematic mapper (TM) or SPOT to fully exploit this application.

Solutions to the spectral limitations are still being researched and developed. However, it appears that some combination of interactive human interpretation and computer data processing provides the most reliable crop identification and condition information. Such procedures, developed for AgRISTARS and other programs make use of a wide range of spectral, temporal and ground truth information.

The Metsats provide good temporal coverage (several times daily) but more work needs to be done in integrating such low-resolution data with the more detailed high resolution Landsat data.

Schedule and Milestones:

1st Q, 1986

(1) Form agriculture task force
(2) Select task manager
(3) Develop 5-year strategy

2nd Q, 1986

(4) Quarterly review
(5) 1st annual plan
(6) Select/acquire CCTs
(7) Select/acquire AVHRR data

3rd Q, 1986

(8) Quarterly review
(9) Process Landsat data for area
(10) Process AVHRR data for vegetative index
(11) Develop relation of vegetation index to yield model

4th Q, 1986

(12) Quarterly review
(13) Continue developing relation of vegetation index to yield model.

1st Q, 1987

(14) Quarterly Review
(15) Compute and verify production
(16) Collect new data

2nd Q, 1987

(17) Annual review and 2nd annual workplan
(18) Conduct Ag survey workshop
(19) Collect aerial data
(20) Process and reproduce crop data

3rd Q, 1987

(21) Quarterly Review
(22) Compute/verify 87 estimate
(23) Prepare report

4th Q, 1987

(24) Quarterly review

(25) Task force review

(26) Plan new survey activity

3.2.4 DETERMINATION OF CROP CALENDARS

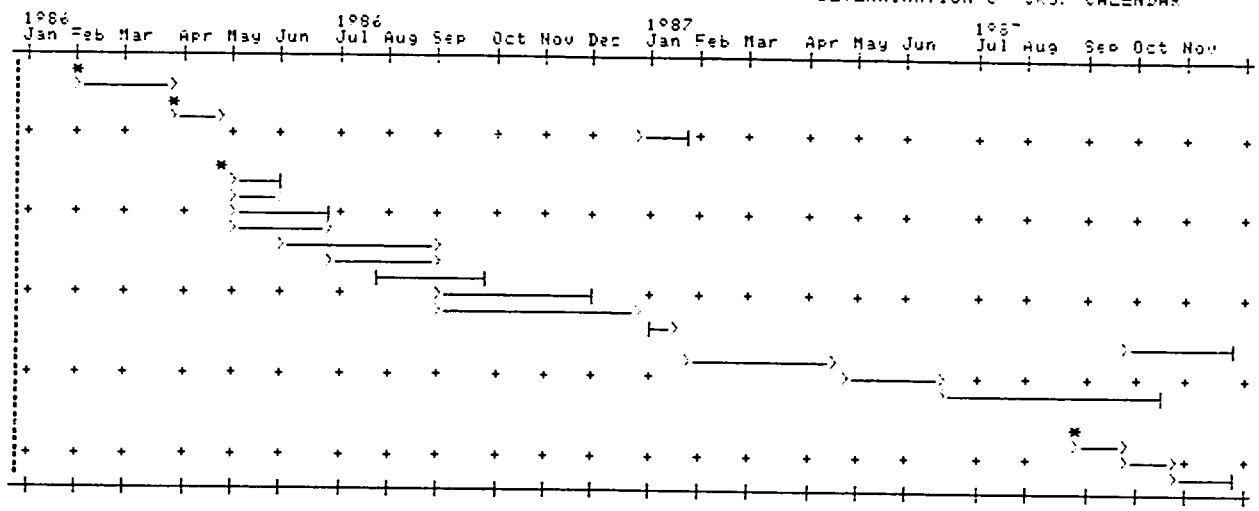
Description: As with cropping patterns (spatial variations), remote sensing data are equally important for studying and determining crop calendars (temporal variations). In Bangladesh, the type of crop and the time of planting and the time of harvesting within any locality determines local labor, transport, and crop storage requirements. Often the availability of food is determined by such harvest dates and the ease of transport.

Status: This task is complimentary to and relies on timely data from Task 2 and 3 above. Specifically, this agricultural task is concerned with using satellite data to help provide and improve detailed crop calendar information. Such information is needed for forecasting local food requirements and devising feasible or efficient mechanisms for the food distribution from surplus to deficit areas and for emergency relief.

Such information should be of use to the Ministries of Food, Agriculture, Transport, and various donor agencies.

Resource requirements: Data: Landsat MSS and TM, SPOT, AVHRR, population and transportation maps. Processing: Categorized images, GIS. Interpretation: crop production, food use and transport models. Distribution: crop calendar information for administrative or ecological units. Users: transportation, agriculture, food, external resources.

SCHEDULE 4:
DETERMINATION OF CROP CALENDAR



SCHEDULE 4:
DETERMINATION OF CROP CALENDAR

PLAN & MONITOR: 1
Form Agriculture Taskforce 2
Select Manager 3
1st annual plan 4
2nd annual plan 5
IMPLEMENTATION: 6
Collect images & JEDA data 8
Select rep. test sites 9
Reproduce multidate AVHRR data 10
Collect new Landsat SPOT data 11
Collect current ground truth 12
Produce Landsat/SPOT CCTs 13
Register & overlay images 14
Develop multidate models 15
Input multidate data to GIS 16
Conduct ag workshop 17
Develop calendar ID for crops 18
Collect current data 19
Process new data 20
Verify crop calendars 21
RESULTS: 23
Prepare report 24
Taskforce review 25
Publish report 26

Constraints: Constraints to this task are related to uncertainties in how much crop condition information can be obtained from AVHRR or other meteorological satellite data and how easily this information can be integrated with more detailed Landsat land use information.

While large-area low-resolution (1 km) AVHRR data can be processed quickly for vegetation enhancement, if new Landsat data were available on a 16 day update cycle, the current processing system may have difficulty keeping up.

Solutions: This must be considered a research and development task. A number of image enhancement algorithms should be tested with both the AVHRR and the Landsat data and correlations with crop condition and final yield, tested.

If the current software is inefficient at handling large quantities of Landsat MSS (and eventually TM and SPOT data), more efficient software systems should be obtained.

Schedule and Milestones:

1st Q, 1986

(1) Land use/Cartography task force meets to recommend 5-year strategy and annual work plan
(2) Task manager appointed
(3) CEDA crop calendar data base installed at SPARRSO
(4) Population and transport maps digitized

2nd Q, 1986

(5) Quarterly review
(6) Test sites with known cropping patterns selected
(7) Multidate, single season AVHRR images of test sites reproduced and examined
(8) Current season ground truth collected
(9) New Landsat/SPOT data obtained from station

3rd Q, 1986

(10) Quarterly review

(11) New Landsat data processed as CCTs and evaluated

(12) Single season, multidate Landsat/SPOT images produced and evaluated

(13) Multidate images registered and overlayed for comparison and analysis

4th Q, 1986

(14) Quarterly review

(15) Multidate Landsat/SPOT data digitally combined in GIS

(16) CEDA calendar criteria integrated into data base as model for crop identification of test sites

1st Q, 1987

(17) Annual review and second work plan

(18) Develop multitemporal categorization of crops

(19) Conduct agricultural crop workshop

2nd Q, 1987

(20) Quarterly review

(21) Collect ground truth and new Landsat/SPOT data

(22) Produce and evaluate CCTs

(23) Stratify crop production areas and apply crop calendar GIS for identification of selected crops

3rd Q, 1987

(24) Quarterly review

(25) Verify crop calendar information with selected field visits

(26) Prepare report

4th Q, 1987

(27) Quarterly review

(28) Task force evaluation

(29) Publish and distribute report

3.2.5 DELINEATION OF AREAS PRONE TO INUNDATION, ALLOWING A MANAGED EFFORT TO INCREASE LAND FARMED

Description: Some of the earliest terrestrial applications of satellite pictures were to identify and delineate water bodies and the extent of flooding. In particular, near-infrared pictures were found to separate surface water from most land very well. Indeed, Landsat infrared images (MSS Band 7) are often used as surrogate surface water maps.

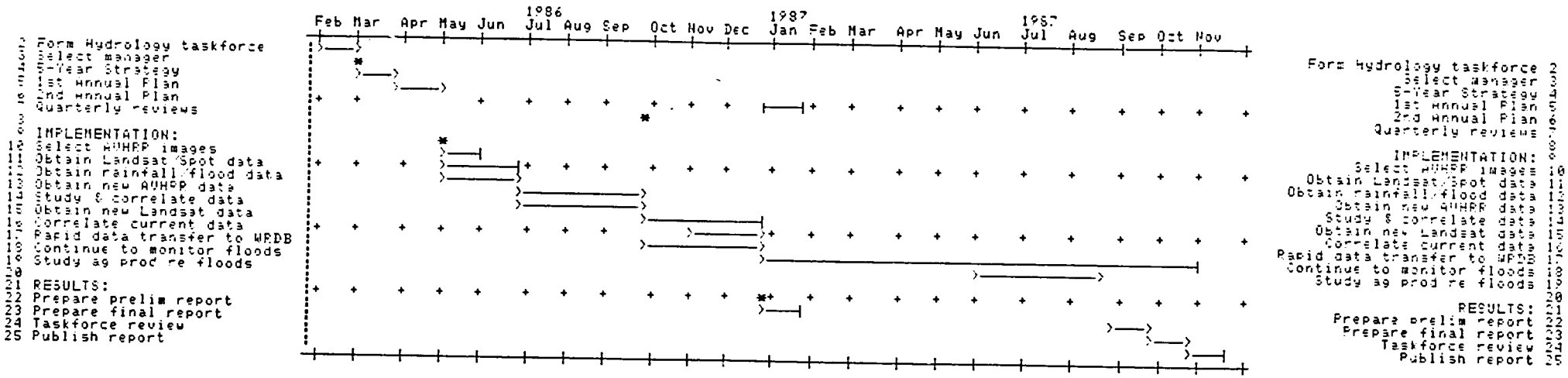
Status: Under separate donor funding, SPARRSO has completed a detailed surface water (pond) survey of all of Bangladesh for the Fisheries Department. This survey was based on the use of both aerial photography and satellite data. From time to time Landsat MSS Band 7 images have been used to show the extent of flooding in the depressions in Sylhet and elsewhere.

To date the Water Resources Development Board has expressed the greatest interest in these data and the establishment of real-time data links have been discussed.

Resource requirements: Data: Landsat MSS and TM, AVHRR, DCP. Processing: contrast enhancement, flood models. Interpretation: manual and/or digital delineation. Distribution: black and white images and interpreted maps. Users: Water Development Board, Department of Transport.

Constraints: Lack of a good data base and timely data are the chief limitations to this application. Landsat and Metsat pictures of flood areas are seldom available during the critical monsoon period (due to cloud cover) and the spatial dynamics of floodwater subsidence is not well recorded.

SCHEDULE 5:
DELINEATION OF FLOOD-PRONE
AREAS TO INCREASE LAND FARMED



Form Hydrology taskforce 2
Select manager 3
5-Year Strategy 4
1st Annual Plan 5
2nd Annual Plan 6
Quarterly reviews 7
8
IMPLEMENTATION: 9
Select AVHRR images 10
Obtain Landsat/Spot data 11
Obtain rainfall/flood data 12
Obtain new AVHRR data 13
Study & correlate data 14
Obtain new Landsat data 15
Correlate current data 16
Rapid data transfer to WRDB 17
Continue to monitor floods 18
Study ag prod re floods 19
20
RESULTS: 21
Prepare prelim report 22
Prepare final report 23
Taskforce review 24
Publish report 25

While current Landsat near-infrared pictures are fairly good as surface water maps, they have certain limitations: misclassification of small size (boundary) pixels and cloud cover. It is anticipated that AVHRR and the DCPs will provide real-time flood information, while Landsat/SPOT data will allow subsequent detailed analysis of the agricultural effects of flooding.

Solutions: With the daily availability of AVHRR data and the periodic availability of new Landsat data, SPARRSO should be able to build a good archive of flood pictures which may be related to precipitation events and subsidence. Even during the summer monsoon there will be opportunities to obtain some flood pictures. In the longer term, radar systems, which obtain surface pictures uneffected by clouds, will be available from space platforms to be launched by Canadian, European, and Japanese space organizations, however, these will require the development of new direct reception capabilities.

Schedules and Milestones

1st Q, 1986

(1) Form hydrology task force
(2) Prepare 5-year strategy
(3) Select task manager
(4) Prepare first annual work plan with Water Resources Development Board

2nd Q, 1986

(5) Quarterly review
(6) Assemble and select AVHRR near infrared images
(7) Assemble and select Landsat near infrared images
(8) Obtain flood stage and rainfall records from DCPs and other stations

3rd Q, 1986

(9) Quarterly review

(10) Study and correlate flood stage and rainfall records with surface water distribution

(11) Obtain current season AVHRR near IR surface water pictures

(12) Start to obtain Landsat TM/SPOT imagery

4th Q, 1986

(13) Quarterly review

(14) Process and compare Landsat MSS with TM images

(15) Correlate current season rainfall with flood conditions as shown by satellite data

(16) Design mechanism for rapid data relay to Water Resources Development Board

1st Q, 1987

(17) Annual review and second annual plan

(18) Continuing analysis of Landsat/SPOT data for flood area delineation

(19) Preparation of flood report for 1986

2nd Q, 1987

(20) Quarterly review

(21) Collect spatial precipitation, flooding, and river stage information in GIS

(22) Analyze spatial relationships between rainfall and flood distribution patterns

3rd Q, 1987

(23) Quarterly review

(24) Monitor current season rainfall and flood patterns

(25) Relate flooding to current agricultural production

(26) Prepare report

4th Q, 1987

(27) Task force review

(28) Continuing flood and rainfall monitoring

3.2.6 FOLLOW-ON ANALYSIS OF LAND ACCRETION IN THE BAY OF BENGAL

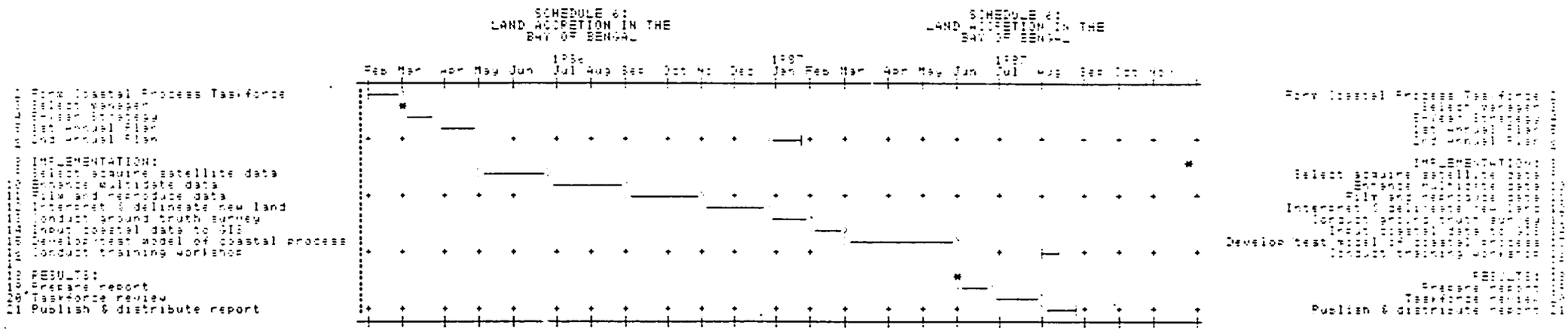
Description: Several reports and demonstrations have shown that remote sensing techniques have direct application to the location and measurement of new land accreted in the Bay of Bengal. Comparisons of Landsat or other types of relatively high-resolution data give quantitative measures of the change which has occurred over the span of time determined by the imagery.

Status: SPARRSO is currently using 1983 1:30,000 scale aerial photography to map coastal accretion and erosion as part of a World Bank sponsored coastal forestry project. Under a UNDP/FAO project, five 1972-1979 Landsat scenes were digitally registered for the two dates and a change detection map was prepared which clearly showed the coastal changes during that time.

SPARRSO should continue to carry out its coastal mapping from aerial photography, obtain new aerial data using a video camera system, and update this Landsat 1972-79 change detection map.

Resource requirements: Data: aerial photos, aerial video, Landsat data. Processing: photo overlays, digital mosaicking. Interpretation: aerial observations. Distribution: maps and images. Users: Inland Water Transportation Authority (IWTA), Water Development Board, Agriculture Department (Soil Survey), Forestry Department, SPARRSO Coastal Afforestation Project.

Constraints: SPARRSO currently lacks the software for digital mosaicking of large areas and Landsat CCTs for the 1972-79 map and the current 1985-86 period.



SCHEDULE 6:
LAND ACCRETION IN THE
BAY OF BENGAL

Solutions: SPARRSO should obtain the new Landsat CCTs of the coastal zone and a copy of the ERIM coastal change detection CCT.

The USAID contractor should provide SPARRSO with operational software for digitally mosaicking Landsat scenes.

While not intended primarily for this application, a video camera system for use in light aircraft should be obtained and used for this task.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO assigns task leader, annual plan prepared
(2) Coastal studies task force meets to recommend 5-year strategy
(3) Start assembling data including existing maps and photographs
(4) Order new Landsat MSS CCT data of Bangladesh coast
(5) Previous Landsat coastal accretion CCTs for 1972-79 ordered from U.S.

2nd Q, 1986

(6) Quarterly report
(7) Coastal accretion data base designed and setup
(8) Processing procedures tested

3rd Q, 1986

(9) Quarterly review
(10) Data processing for production of new coastal accretion map based on 1984 Landsat data and map for change from 1972-1984
(11) Manual comparison of Landsat maps with airphoto maps

4th Q, 1986

(12) Quarterly review
(13) Order/receive TM and/or SPOT data of coastal zone

1st Q, 1987

(14) Annual review and prepare new annual work plan

(15) Conduct aerial/ground truth trip

(16) Presentation of results to users

2nd Q, 1987

(17) Quarterly review

(18) Training/workshop held

3rd Q, 1987

(19) Quarterly review

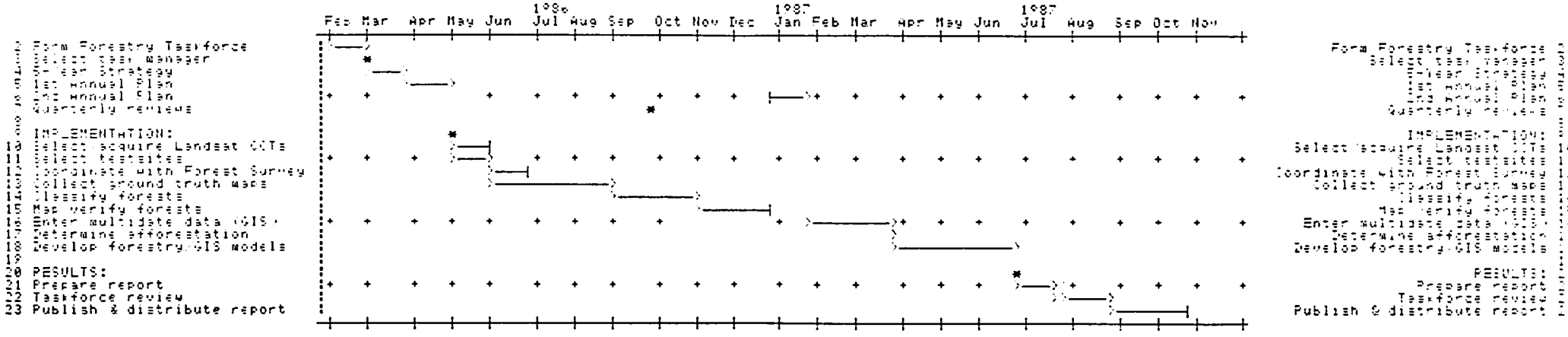
3.2.7 FOREST RESOURCES INVENTORIES

Description: Bangladesh's remaining forest resources are rapidly diminishing. The Working Plans Division of the Bangladesh Forestry Department needs a procedure for integrating ecological, new land cover, and climatological information for preparing and monitoring programs for the management of the forests. There activities are concerned with four working circles: Sal forests, hill forests (plantation and natural), mangrove forests, and coastal afforestation. This application, forest inventories, is concerned with providing information for the first three circles. The next application is concerned with afforestation in the coastal areas.

This application is intended to provide the Division Forest Office, Working Plans Division, with annual updates concerning the area and condition of the remaining forests and integrated spatial information concerning the ecological conditions which effect species selection for afforestation programs.

Status: Using 1983 1:50,000 scale color-infrared aerial photography, the Forest Department (with British assistance) has just completed a forest inventory of the entire country, with maps at a scale of 1:50,000. However, because the forest areas are rapidly disappearing, these will require updating on an annual basis.

SCHEDULE 7:
FOREST RESOURCES INVENTORIES



Form Forestry Taskforce
Select task manager
5-year Strategy
1st Annual Plan
2nd Annual Plan
Quarterly reviews
IMPLEMENTATION:
Select acquire Landsat CCTs
Select testsites
Coordinate with Forest Survey
Collect ground truth maps
Classify forests
Map verify forests
Enter multidate data (GIS)
Determine afforestation
Develop forestry GIS models
RESULTS:
Prepare report
Taskforce review
Publish & distribute report

Resource requirements: Data: Landsat, SPOT, soil maps, climatological data, forest reserve boundaries. Processing: vegetation index, GIS integration. Interpretation: forest condition, boundaries, changes. Users: Forest Department.

Constraints: As with the agricultural applications, spatial and spectral limitations place constraints on the level of detail and accuracy of forest information which can be obtained from satellite data. However, since the location of trees do not change greatly on an annual basis, seasonal limitations are not significant.

Generally, satellite data cannot provide tree species identification, height, or board feet of timber -- information commonly sought in forest inventories.

Solutions: SPARRSO should provide data and processing which aids the forester in conducting forest inventories. Specifically, SPARRSO can supply the Forestry Department with large-scale up-to-date pictures and maps of their reserves. From manual or digital interpretation, changes in forest area for reserves could easily be determined and delineated. through usage and understanding, Forest Department may develop interpretive keys and pursue an R&D program on utility of incorporating Landsat for species identification through multistage sampling.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO forester assigned to this task
(2) Forestry task force meets to recommend 5-year strategy
(3) Forestry Department data base and maps obtained
(4) Start design of data base

2nd Q, 1986

(5) Quarterly review

(6) New forest cover map obtained from 1984 Landsat mosaic data, forest boundaries overlayed

(7) Field trip to selected sites conducted with Forestry Department personnel.

3rd Q, 1986

(8) Quarterly review

(9) Agriculture training/workshop held, includes procedures for forestry

(10) Selection of reserve areas for detailed studies

4th Q, 1986

(11) Quarterly review

(12) Collection of new ground truth from selected reserves

(13) Order/obtain Landsat TM CCTs, add to data base

1st Q, 1987

(14) Annual review, prepare new work plan

(15) Process data for forest parameters: association, condition, crown closure, etc.

(16) Field check results with Forest Department personnel

2nd Q, 1987

(17) Quarterly review

(18) Develop operational plan with Forest Department for supplying annual forest cover/condition updates

3rd Q, 1987

(19) Quarterly review

4th Q, 1987

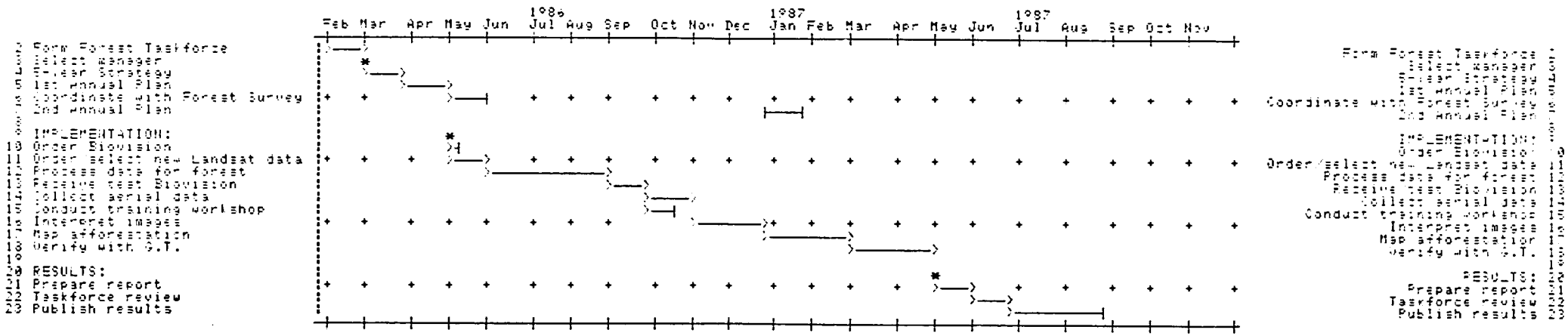
(20) Quarterly review

(21) Collection and processing of new data

3.2.8 COASTAL AFFORESTATION

Description: The annual targets of the Working Plans Division of the Forest Department is based on a knowledge of

SCHEDULE 8:
MONITOR COASTAL AFFORESTATION



Form Forest Taskforce 2
Select Manager 3
Prepar Strategy 4
1st Annual Plan 5
Coordinate with Forest Survey 6
2nd Annual Plan 7
IMPLEMENTATION: 9
Order Biovision 10
Order/select new Landsat data 11
Process data for forest 12
Receive test Biovision 13
Collect aerial data 14
Conduct training workshop 15
Interpret images 16
Map afforestation 17
Verify with G.T. 18
19
RESULTS: 20
Prepare report 21
Taskforce review 22
Publish results 23

coastal accretion and of the condition and harvest of the Sundarbans. The Forest Department is currently completing a 20-year cutting cycle and is preparing a new management plan for 1986-1990. Based, in part, on observations of 105 permanent plots, the plan needs to be updated continuously due to rapid and differential forest losses.

Status: SPARRSO is currently carrying out a coastal afforestation mapping project using aerial photography from 1983. The Forest Department desires that this work be updated every year due to the rapid rate of change within the coastal forests. While highly useful, already the 1983 photography is out-of-date.

Resource requirements: Data: new aerial data, Landsat MSS, and TM (SPOT). Processing: categorization and image enhancement. Interpretation: airphotos, VCR images, custom Landsat pictures. Distribution: annual forest condition and change. Users: Department of Forestry.

Constraints: This task is constrained by a lack of recent aerial and satellite data.

Solutions: SPARRSO needs to order and obtain new Landsat data from either the Thai or the Indian receiving station. For aerial monitoring of changing areas identified in the Landsat imagery, an aerial VCR should be purchased and provision made for annual flights.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO team leader selected, work plan prepared

(2) Forestry task force meets to recommend 5-year strategy

(3) AID contractor order VCR Biovision

(4) New Landsat data ordered

2nd Q, 1986

(5) Quarterly review

(6) Landsat data received, filmed, compared with WB photos and maps

(7) Field observations

3rd Q, 1986

(8) Quarterly review

(9) VCR Biovision arrives, arrangements made for aerial survey

(10) Forestry data base installed at SPARRSO

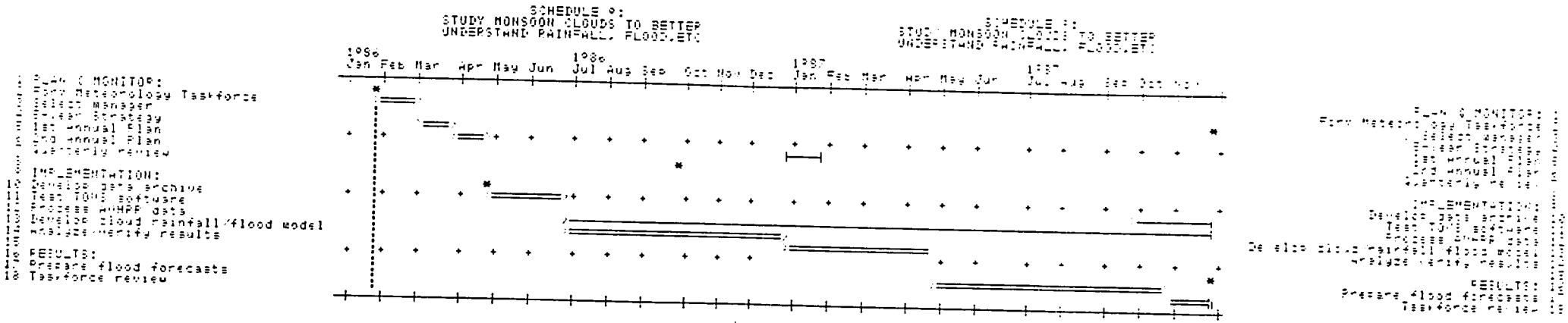
4th Q, 1986

(11) Quarterly review

3.2.9 STUDY OF MONSOON CLOUDS OVER BANGLADESH FOR BETTER UNDERSTANDING OF RAINFALL, FLOOD, AND DROUGHT

Description: Bangladesh's climate is largely determined by the annual pattern of monsoons. This task is concerned with developing better information concerning the relationship between annual summer monsoon cloud patterns and rainfall, floods, and/or droughts which occur. Most monsoon rainfall occurs in atmospheric depressions. Generally the testing and development of such relationships requires the availability of extensive historical data.

Status: The approach and onset of the annual southeast monsoon can be observed from satellite pictures, but it is not known whether satellite data can be used to help predict or monitor actual precipitation events, especially severe ones which lead to flooding. It has even been suggested that there is a relation between the intensity of summer monsoons and the extent of snow cover over the Himalayan Mountains and Tibetan


SCHEDULE 0:
STUDY MONSOON CLOUDS TO BETTER
UNDERSTAND RAINFALL FLOODLETS
1986
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1987
Jan Feb Mar Apr May Jun
PLAN & MONITOR:
Form Meteorology Taskforce
Select Manager
Develop Strategy
1st Annual Plan
2nd Annual Plan
Quarterly review
IMPLEMENTATION:
Develop data archive
Test TOM software
Process MAMAP data
Develop cloud rainfall/flood model
Analyze/verify results
RESULTS:
Prepare flood forecasts
Taskforce review

Plateau during the previous winter. Long-term studies should be conducted to better identify the relationships between monsoon clouds and rainfall.

Currently, SPARRSO is obtaining a variety of new types of Metsat data, including daily data from the Advanced Very High Resolution Radiometer (AVHRR) and the TIROS Operational Vertical Sounder (TOVS). From such data, it may be possible to develop processing and numerical modelling approaches which give better information on where and when destructive storms and excessive rainfall may occur. This task is concerned with the initiation of a long-term research and development activity.

Recently, several SPARRSO scientists have received limited training at the University of Wisconsin's Space Science and Engineering Center (SSEC) and the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Resource requirements: Data: AVHRR, GMS, TOVS, DCP, Met. Station reports. Processing: TOVS software, GIS. Interpretation: Coincidence of cloud features and precipitation. Distribution: Annual reports. Users: Meteorology, Agriculture, WDB.

Constraints: The development of long-range forecasting and predictive capabilities requires a good archive of data from which various hypothesis and models can be tested and calibrated. Currently, SPARRSO lacks the organized archival system and the archival materials (tapes and photographic materials) for establishing and maintaining this archive.

AVHRR and especially TOVS supply very sophisticated data which requires special software to use.

Solutions: If nothing else, AID should assist SPARRSO in assuring that a systematic and complete data archive is established and maintained. This will require the visit of an archival specialist for a period of two months and provision of enough tapes and photo materials to last for two years.

The University of Wisconsin is preparing a TOVS data analysis software package. This software with supporting training (August, 1987) should be made available to SPARRSO.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO scientist assigned to this task, annual workplan prepared

(2) Meteorology task force meets to define a 5-year strategy

(3) USAID contractor requested to provide a data archive specialist.

(4) SPARRSO starts permanently recording and storing all AVHRR, DCP, and TOVS data for later use; design data base.

2nd Q, 1986

(5) Quarterly review

(6) Other software packages obtained by contractor

(7) Start study of clouds and cloud patterns integrate rainfall (Meteorological Department) and flood (Water Development Board) information

3rd Q, 1986

(8) Quarterly review

(9) Primary data collection season begins

(10) Data processing ongoing, data base developed

4th Q, 1986

(11) Quarterly review

(12) Statistical analysis of results

1st Q, 1987

(13) Annual review and prepare annual workplan

(14) Develop, revise processing procedures

2nd Q, 1987

(15) Quarterly review

(16) Data collection, processing ongoing

3rd Q, 1987

(17) Quarterly review

4th Q, 1987

(18) Quarterly review

3.2.10 DETERMINING THE STRUCTURE AND DYNAMICS OF STORMS AND STORM SURGES

Description: Storm surges are invariably associated with tropical cyclones and cause the major destruction of cyclones. Thirty foot waves have been associated with surges and have submerged much of the low lying coastal areas of Bangladesh.

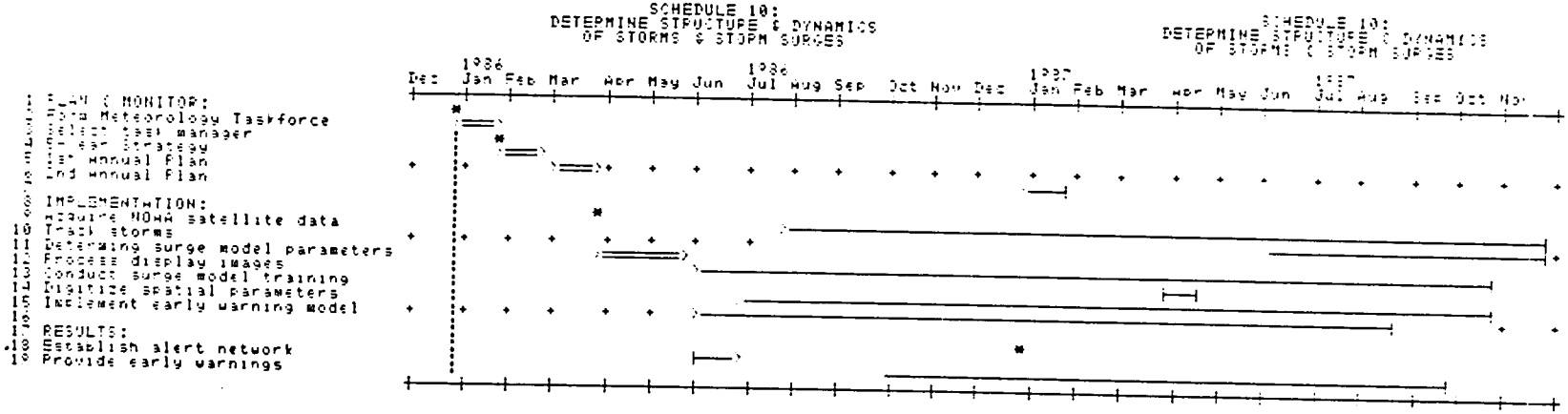
Status: SPARRSO's remote sensing capabilities can be applied in several ways to the study and understanding of storm surges.

Firstly, historical meteorological satellite pictures may be studied to improve the ability to predict the path of cyclones and where they are likely to make landfall.

Secondly, bathymetry, salinity, sea current and topographic data can be combined with the cyclone data in a data base to better correlate the influences of these and when given a predicted storm path, further predict the height and effects of the surge.

Thirdly, nearshore and coastal land use and topography can be studied to determine the likely extent of inundation (flooding) and destruction that would be caused by surges of different magnitudes. Given such information, the effects of managed activities to ameloriate destruction and loss of life could be tested. For an actual surge, the nature and extent of damage could be made known to rescue workers shortly after the surge has struck the Bangladesh coast.

Empirical models have been developed giving expected maximum storm surges associated with cyclones of given wind speeds.



However, the surge is determined by the track of the cyclone, which needs to be known, and the destructive effects depends on the coastal topography and the land use and land cover within the low lying areas. For example, a belt of Mangrove forest 100 m wide is sufficient to considerably reduce the destructive force of a surge. Destruction and loss will be much greater in heavily inhabited areas than in less densely settled areas.

Resource requirements: Data: AVHRR, Landsat MSS and TM, topography and bathymetry data, etc. Processing: storm path prediction model, storm surge model. Interpretation: model calibration with historical data. Products: better storm path predictions, surge predictions. Users: donor agencies.

Constraints: Constraints to this application are likely to be initially a lack of historical Metsat data, delays in model development, limited linkages with users, delays in near real-time processing.

Solutions SPARRSO should start at once to record and compile for easy retrieval all historical storm track information, daily metsat pictures, and coastal land use and bathymetric information.

We recommend SPARRSO assign one senior scientist to work with the BDG official who has responsibility for storm surge predictions on a full-time basis to help select and develop a prediction model.

In cooperation with USAID, SPARRSO should conduct a month-long training/demonstration program where both storm tracking procedures and storm surge models would be installed and tested.

A hardwired terminal should be installed in the Meteorological Department facility to provide near real-time display of enhanced cloud pictures. For this purpose, SPARRSO should store daily metsat pictures, enhanced for cloud information, on its system for retrieval by the Meteorology Department.

Schedule and Milestones:

1st Q, 1986

(1) SPARRSO assigns person for this application

(2) Meteorology and Hydrology task forces meet to determine status of existing work and to recommend strategy for 5 year program.

(3) SPARRSO Data Manager starts to locate and assemble historical data.

(4) USAID contractor determines availability of a instructor for conducting storm prediction and surge modeling training/demonstration course.

2nd Q, 1986

(5) Surge modeling parameters determined; start digitizing coastal topography, land use, and bathymetry

(6) Quarterly report

(7) Historical data reviewed

3rd Q, 1986

(8) Quarterly report

(9) All storms tracked, severe storms tracked on 24 hr basis

(10) Enhanced weather pictures stored daily and available on SPARRSO terminals

4th Q, 1986

(11) Quarterly report

(12) Terminal installed in Meteorological Department

(13) Test and calibrate surge model with historical data

1st Q, 1987

(14) Annual report

(15) SPARRSO prepares annual workplan

(16) Meteorology task force meets

(17) Meteorology Department receiving enhanced high resolution pictures on daily basis from terminal

2nd Q, 1987

(18) Quarterly report

(19) Training/workshop on storm prediction and storm surge modeling held at SPARRSO

3rd Q, 1987

(20) Quarterly report

(21) Severe storm tracking on 24 hr basis

(22) Issue surge prediction reports

4th Q, 1987

(23) Quarterly report

(24) Continuing model improvement

4.0
GENERAL CONCERNS FOR PHYSICAL FACILITIES

This section addresses a number of concerns we have about aspects of the Project which effect all of the applications, irrespective of individual requirements. We believe that if these general concerns are not adequately addressed, all previous recommendations concerning the individual applications are moot.

Here we are concerned with system problems which are recognized and which we believe are being addressed. Consequently, they may well be solved by the time this report is published -- we hope so. But we include them here for completeness of the record.

4.1 FACILITIES

4.1.1 GAS GENERATOR

The Greenland Tractor (GETCO), Bangladesh agent and distributor for this product, is responsible under contract for installation, maintenance, and operational training. The gas generator is currently not working properly (requires manual start) and, to the best of our knowledge, has never worked reliably inspite of several attempts to repair it. It is necessary that this generator work in the automatic mode, and we are advised that additional parts are required and have been ordered.

It should be pointed out that in the event of a commercial power failure, the entire ACEMP facility would be down without this back-up generator working. We believe that it is imperative that GETCO complete the proper installation of this equipment and initiate training of SPARRSO personnel in its operation and maintenance. The Project Director should give this problem his immediate attention and follow it up on a daily basis until the problem has been solved by GETCO.

Training in the operation and maintenance of this equipment should be given to at least three SPARRSO technicians so as to assure a capability for 24 hour operation. Senior SPARRSO staff should monitor this training and judge the subsequent competence of the technicians trained. If further training is deemed necessary to guarantee full operational status of this equipment, it must be arranged as soon as possible.

Under the Director, the senior SPARRSO staff member in charge of this equipment should make weekly inspections and generate reports concerning the equipment status, spare parts on hand, the fuel supply, and the availability of technicians to operate it. If there are any limitations to the operation, he must seek to correct them and report the limitations to the Director for his information and attention. (Since May 1986, the generator supplied power to the computers regularly since the UPS was in need of silicon rectifiers and fuses.)

4.1.2 AIR CONDITIONING

Although the air conditioning system installed at SPARRSO for the computer facility is operational, it has some problems associated with its original installation which should be addressed.

The major problem involves condensation on the cold water pipes. This results in condensation dripping inside of several areas of the building. SPARRSO should contact the local contractor responsible for the original installation of this air conditioner and request correction of this problem.

In addition, the main building air conditioner has some problems in its operation.

An appropriate operational goal is for the air conditioning system to maintain a continuous 24-hour environment of no more than 72 degrees Fahrenheit and 60% relative humidity for the computer facility. Reliable humidity and temperature gauges

should be installed in the computer room to monitor these conditions as soon as possible.

To help insure that the critical air conditioning system be properly maintained, we recommend that a full-time qualified air conditioning engineer and two technicians be hired. The air conditioning engineer and/or a technician should be on call (available if necessary) 24 hours a day and be alerted should the above conditions not be met. Also, the systems should have SOPs (Standard Operating Procedures) and several SPARRSO facilities staff should be familiar with these SOPs -- including how to contact the engineer or technicians if necessary.

4.1.3 UNINTERRUPTABLE POWER SUPPLY

The Uninterruptable Power Supply (UPS) is currently operating with one definable failure and one ad hoc solution to a problem which should be investigated.

The definable failure involves a circuit which bypasses the UPS in event of a UPS system failure and connects the facility directly to the commercial power source. This bypass mode in the event of UPS failure may be undesirable due to problems with the Dhaka power system, but the bypass should be disabled in a more appropriate way than tacit acceptance of the failure.

The UPS is also operating in a mode whereby system shutdowns due to deviations in the input frequency are disabled during operation, after start-up. We do not know whether this mode compromises the systems reliability, but this should be investigated as soon as possible.

Also, there is an alarm being sounded on the UPS control panel presumably due to deviations in the frequency of the incoming power. This alarm has become so routine that it is

currently ignored by the SPARRSO personnel. If a legitimate frequency error were to occur, the alarm would probably be ignored. This alarm problem should be corrected as soon as possible.

In terms of maintenance, there appears to be an insufficient level of spare parts in inventory and no parts locally available. There apparently exists a capability to run internal diagnostics on the UPS system with an appropriate terminal. This terminal should be identified (from documentation), obtained and installed.

4.1.4 MAIN PHOTOGRAPHIC LABORATORY

Although not actually part of this project, the main photographic laboratory is of concern. Photographic reproduction is a prime means of reproducing and distribution of remote sensing information. Most images will be produced as photographic enlargements from digital files produced on the system and transmitted to either the Matrix camera or the Optronics. The film products recorded by these devices must subsequently processed and reproduced by SPARRSO's photographic facilities. Consequently, high quality photographic facilities and procedures are necessary for producing and distributing quality products.

Currently, the photolab is not adequate due to its incomplete state. Major pieces of photolab equipment have been stored in SPARRSO's main hallway for two years or more, with the inevitable result of some damage due to moisture and disuse.

We strongly urge whatever facilities construction are necessary to complete installation and thorough repair and testing of this equipment. Full operation of the photolab is required as soon as possible but not later than 1 April 1986.

5.0
CONCLUSIONS AND RECOMMENDATIONS

The Bangladesh government and many donors have and are continuing to support the development of the Space Research and Remote Sensing Organization (SPARRSO). There is no disagreement between the BDG and/or the donors on the aim of that support. SPARRSO is expected to provide the space-age tools of satellite remote sensing to BDG's requirements for new and better environmental and resource information - information needed by line departments and agencies to better manage its resources and mitigate disasters.

5.1 FACILITIES

SPARRSO has an excellent facility for receiving meteorological satellite data, and for processing and displaying meteorological and earth resources satellite data. This capability compliments the user-oriented activities being proposed under a UNDP project. However, the continued operation of this facility is jeopardized by limited maintenance, inefficient spare-parts procurement, and limitations in applications software, expendables supplied, and data archiving.

Recommendations: We believe that it is imperative that SPARRSO, in working with NASA and its contractors, immediately implement the following:

1. A wide-ranging program to repair, maintain, and/or upgrade its physical facilities, including but not limited to data collection platforms (DCPs), computer peripherals, photographic laboratory, air conditioners and power supplied.

2. Develop and maintain an adequate spare parts inventory and provide for new replacement parts as others are removed from inventory and used.

3. Obtain additional fully tested and operational software for carrying out specific applications data-processing tasks, such as digital mosaicking, geometric correction to Lambert Conformal Conic Projection (Bangladesh standard), accurate merging of large data files, advanced image enhancements, GIS manipulations, etc.

4. Obtain as soon as possible, the services of a qualified computer systems engineer for a period of not less than two months in Dhaka to assist and further train SPARRSO technicians in operating and maintaining the equipment.

5. Obtain as soon as possible, the services of a qualified software systems engineer for a period of not less than six months in Dhaka to work with and help train SPARRSO technicians and scientists in employing the data processing capabilities of the computer system. This engineer should be fully experienced with the software resident on the computer and especially with GIS operations which are fundamental to a number of the applications.

6. Obtain as soon as possible, the services of a data archival specialist for a period of two months to help SPARRSO set-up and establish a "Data Acquisition & Archive Facility" to systematically obtain (order), catalogue and archive all satellite data tapes (including Landsat), DCP data, Metsat pictures, slides and maps, and ancillary information required for processing data in support of various applications.

5.2 ORGANIZATIONAL STRUCTURE

We recommend that SPARRSO immediately implement an organizational structure that clearly identifies assignments and individual responsibilities with respect to the IP application areas and equipment. SPARRSO should establish a management Standard Operating Procedure (SOP) for reviewing and grading individual performances based on their adherence to guidelines. This should include regular monitoring of task implementation. SPARRSO implement a reporting structure for all activities which guarantees rapid identification and review of progress and problems in program implementation. SPARRSO should immediately implement SOPs for operation and maintenance of all facilities and the ACEMP equipment. The initial source for these SOPs may be the manufacturers' Operations and Maintenance manuals. In addition, it should assign single responsibility for the implementation and utilization of each SOP and insure that all persons responsible for performance of the SOPs have a copy of the latest version. SPARRSO should develop a procedure for regular review, revision, and distribution of all SOPs.

5.3 PROCUREMENT AND INVENTORY

5.3.1 SPARES

DEC

We recommend that DEC spares, both under normal and rapid response procurement procedures, should be acquired directly from DEC's General International District facility located in the U.S. This would be one component of a multi-faceted contract with General International District (GID) to supply parts, including a rapid response capability; combination preventative maintenance/training trips; and remedial maintenance backup support. The maintenance activities will be discussed in later sections. A sample copy of such a contract is attached in Appendix C.

NON-DEC

SPARRSO should contract with a local Procurement Service Agent (PSA) to act as their agent in the procurement of goods and services up to a specified level of funding. This would allow SPARRSO to contract in local currency and let the PSA handle the currency conversion. A component of this contract would be the normal and rapid response procurement of spares. In cooperation with SPARRSO, the PSA would develop a list of potential suppliers and establish contact with these suppliers immediately. Upon notification by SPARRSO of the need for a particular part, the PSA would contact the supplier, handling all arrangements for shipping and currency conversion.

It is possible that SPARRSO could handle some small component of the spares procurement directly through the local market.

A copy of a typical U.S. PSA contract and a representative PSA terms of reference are attached in Appendix .

5.3.2 CONSUMMABLES AND ADDITIONAL MATERIALS

Wherever possible consummables and additional materials would be procured directly by SPARRSO through the local market. A number of potential suppliers for items such as magnetic media (CCTs and floppy diskettes) and paper have been identified and are attached as Appendix B.

Where local sources do not exist, these materials could be procured through the contracted PSA described above.

5.3.3 RESPONSIBILITY IN PARTS PROCUREMENT

- SPARRSO should petition the Bangladesh Government to modify S.R.O. 42(R)/69 of the customs regulations, only exempting duties on goods imported from countries signatories to the UNESCO Agreement. Since the United States, no longer a signatory country, will be the primary source for materials to be procured, imposition of import duties will constitute a major expense and delay. SPARRSO should also investigate the privileges and limitations caused by the organization now being under the Ministry of Defense. Failing a satisfactory resolution of the UNESCO country restriction, arrangements should be made with the local PSA to trans-ship all goods through a UNESCO signatory country. This may also impose additional delay and expanse, however.

- SPARRSO should make arrangements with the customs organizations at ZIA and perhaps Chittagong for priority clearance of SPARRSO shipments. The rapid response procedure breaks down completely if parts are delayed upon arrival in Bangladesh.

5.3.4 INVENTORY CONTROL SYSTEM

- SPARRSO should immediately implement a computerized inventory control system. An appropriate data base management system (Profile) is currently operational on the project's TRS80 and should be utilized. Suitable data bases should be established for the following items:

- Spare parts and consumables
- Test equipment and tools
- Manuals
- Data tapes - digital and analog
- Archival images

The implementation of the spare parts and consumables inventory is the first step in identifying potential sources for required materials. This will be a prime requirement for placing orders, either directly or through the local PSA.

These data bases should be regularly maintained through implementation of appropriate SOPs.

o SPARRSO should reorganize the current storage system to separate manuals and other materials.

  - Store Manuals in a more appropriate location.

  - Move photographic materials to a temperature controlled environment.

  - Purchase or construct magnetic tape storage units. Place them in a temperature controlled environment and store all magnetic tape in them in an appropriate manner. Location of individual tapes within the storage units should be identified in the computerized inventory system.

  - Devise appropriate storage for the archival images. Location of images within the storage should be identified in the computerized inventory system.

- SPARRSO should design and implement a materials transfer system to account for all dispersals from the parts and consumables inventory. Based on minimum stock levels, defined in the inventory control system, purchase requisitions could be initiated.

- If the inventory dispersal is for a major system component required due to system failure, initiate a repair request, either locally or through a foreign repair facility via an arrangement with the local PSA.

5.4 PERSONNEL

SPARRSO has approximately 70 scientific and technical officers assigned to two technical wings (or directorates) - Technology and Research. The ACEM Project is under the Director of Research but effectively uses some 42 people and the facilities from both wings.

We find SPARRSO's technical and administrative personnel to be of generally high calibre but, with notable exceptions, under motivated. The training conducted to date has been only partially successful due to differences in personnel motivation and applicability of the training subjects and materials.

5.4.1 TRAINING OFFICE

1. A "Training Office" should be established to help coordinate, conduct, and supply support services for SPARRSO's in house and user training programs, seminars, and workshops. This office should.

i) help select appropriate courses and trainees,
ii) assist in course logistics and motivating the trainees,

iii) help monitor the level of achievement, and
vi) conduct follow-up interviews to see if trainees are making use of their training.

5.4.2 APPLICATIONS TRAINING

With one exception, future training should be in-country and more broadly directed towards the 10 applications identified as the outputs of this product. The following five training themes and possible schedule are recommended:

i) GIS and production of cartographic products (March 1987),
ii) crop area and yield models with Landsat and AVHRR data (January, 1987),
iii) hydrologic models and flood forecasting with remote sensing data (August, 1987),
iv) coastal processes and storm surge modeling (April 1987), and
v) regional weather forecasting and monsoon cloud studies (August 1987).

This schedule is intended to coincide with the probable development of system capabilities and applications requirements. The latter three training programs will rely on a adequate archive of historical data, so they should come during the latter part of the follow-on Project.

We recommend that the Project Director receive 3-4 months of management training in the United States. (The USDA Graduate School offers excellent courses in management for essentially foreign project personnel.)

5.4.3 OPERATION AND MAINTENANCE TRAINING

In general, all operations and maintenance training in the near future occur on-site at the SPARRSO facility. SPARRSO now has a cadre of hardware and software personnel and they should be utilized to conduct in house training until such time as additional individuals can be identified who SPARRSO feels will improve the organization's capabilities through foreign training.

This recommendations does not include facility management training which should be accomplished by exposing management level SPARRSO personnel to operations of similar facilities in the United States and perhaps regional centers (India, Thailand, etc.).

DEC

- Directed Training

  Further training on the DEC hardware - the most effective method, both in terms of cost and current SPARRSO requirements would be to contract directly with DEC to provide a combination preventative maintenance/-remedial maintenance training through an on-site service arrangement. This is another component of the contract mentioned in the parts procurement section above. The agreement might provide up to four preventative maintenance trips per year with seminars on remedial maintenance of 3 - 5 days duration on two of the trips. This approach has four distinct advantages:

  - SPARRSO is in an operational mode at this time and remedial maintenance is of extreme importance.

- These seminars will be conducted by experienced DEC Field Service Engineers who can impart very practical knowledge to SPARRSO maintenance engineers.

- A much larger number of SPARRSO personnel can be exposed to this knowledge.

- The DEC engineer can review the current preventative maintenance procedures and perhaps make suggestions for their improvement.

o Self Paced Instruction (SPI)

SPARRSO should make maximum use of Self Paced Instruction courses available from DEC, in particular "Introduction to Minicomputers" and "Introduction to Digital Logic". These courses should be presented to all interested personnel but particularly to those hardware people who have had no formal training in digital computer equipment and who are being considered for foreign training. A Course Administrator should be used and technical support from previously trained personnel should be provided to assist students when necessary. These courses provide four valuable functions:

- They serve as excellent introductions to more structured training, perhaps abroad.

- They provide an equitable selection criteria for choosing candidates for further training based on their expressed interest and demonstrated capability at an introductory level.

- They improve the absorption of future training because the students will become familiar with the computer vocabulary and the presentation of technical concepts in English.

- They can be presented at a pace appropriate to the students' abilities and they can be reviewed at any time.

NON-DEC

o Directed Training

Again, we recommend that maximum use be made of on-site maintenance training. In at least two areas, the air conditioners and the ACEMP motor generator, local expertise exists and should be fully utilized. For other equipment, not supported through local expertise, I would recommend on-site seminars conducted by Field Service Engineers from the specific manufacturers, utilizing SPARRSO's equipment. This practical knowledge is much more value at this point at SPARRSO's development than additional "theory of operation" courses normally taught at manufacturers' facilities. Much of the theory of operation can be acquired by knowledgeable hardware personnel through use of the equipment manuals now at SPARRSO.

Another important advantage to on-site training is that SPARRSO can monitor the progress of the training and use the evaluation of individual aptitude as selection criteria for additional training.

- Self Paced Instruction

  All of the comments presented above are equally valid in this context. In addition, SPARRSO should consider the idea of purchasing courses which produce as a result of completion, valuable additional capital equipment (e.g., oscilloscope, digital voltmeter, microcomputer). These courses not only provide a tangible result for successful completion but also provide valuable instruction in the troubleshooting of electronic equipment.

5.5 REMEDIAL MAINTENANCE BACKUP

In general, remedial maintenance support should only be requested after SPARRSO personnel have made a concerted effort to resolve the problem. There should be an established procedure (SOP), however, that insures equipment is not out of service for extended periods of time because of the inability of SPARRSO personnel to perform the necessary repairs.

If the inability to resolve the problem is due to lack of proper training, an important component of any outside assistance should be providing instruction to SPARRSO personnel to allow them to independently prevent or resolve the problem if it occurs again.

The SPARRSO personnel should actively participate in any repair process. This implies that on-site repairs should be conducted whenever economically feasible.

5.5.1 DEC

We recommend that an additional component of the DEC contract mentioned above be an agreement by DEC to provide on-call remedial maintenance. This would provide a guaranteed response time and would also provide the best possible remedial maintenance backup and training of SPARRSO personnel on the SPARRSO hardware.

5.5.2 NON-DEC

As mentioned above, in the case of the air conditioners and the ACEMP motor generator, local expertise exists and should be utilized. This local support should also include the active SPARRSO participation and training described above.

In the case of failures in other equipment SPARRSO will have to decide on the proper approach based on the availability of funds and required timeliness of repair. In an extreme emergency it may be possible to utilize funds allocated to the local PSA to contract on-site maintenance services from foreign organizations.

5.6 INSTITUTIONAL DEVELOPMENT AND APPLICATIONS

SPARRSO'S mandate to promote and support user information requirements is clear and unequivocal. The goal and objectives of the ACEMP are entirely in concert with SPARRSO's mandate.

SPARRSO's management is deeply concerned about SPARRSO's ability to maintain and operate effectively its new and existing facilities in support of user agency requirements. Consequently, to date it is not highly supportive of user applications and tends to retreat to a "research-oriented"

position when addressing the secondary objectives and goal of this project.

5.6.1 INSTITUTIONAL DEVELOPMENT

To increase its user agency support and confidence, SPARRSO should:

1) Establish a "User Support & Services Facility" at SPARRSO to assist and support requests by user agencies FOR data, imagery, special map products, and resources data and reports generated by SPARRSO. The facility should have a computer terminal to allow applications personnel and user staff direct access to computer-enhanced procedures. (Such a facility has been proposed under the UNDP Project.)

2) Re-activate SPARRSO-user agency "Task Forces" in each of these major applications area: Agriculture (Crops & soils), Forestry and Wildlife, Water Resources (hydrology), Coastal and Marine (fishery) Resources, Cartography & Land use, Meteorology, Oceanography, and Technology. These Task Forces are intended to provide policy guidance and high-level administrative linkages between SPARRSO and the user agencies. Task force members should receive a small stipend for attending meetings to cover the incidental costs of their travel and refreshments.

3) Staff the separate Applications Wing which was previously created in SPARRSO. If initiated, recommendation 1 (above) should be placed under the Applications Wing.

4) Prepare a comprehensive 5-year research and applications strategy (1986-1990) and prepare and implement 1-year workplans based on that strategy. It should conduct quarterly (3 month) reviews of the progress in each application

sector. SPARRSO should review and consider the schedules and milestones identified in Section 3 of this report and, in cooperation with the resident Advicor, revise and implement them.

5) Coordinate and integrate the training and application tasks of this project as much as possible with those proposed under the UNDP Applications programme.

6) Provide 3-4 pm of management training for the SPARRSO Project Director (at USDA Graduate School).

5.6.2 APPLICATIONS

The ten applications which were identified as outputs of this project have not progressed materially during the past 2 years. This lack of progress is attributed to i) primary attention being given to equipment installation and maintenance, ii) extended foreign training for applications personnel, and iii) relatively little attention to applications by SPARRSO management.

Appropriate budgets be allocated for conducting each of these 10 applications, and equipment and supplies be procured as required, e.g., soil conductivity meter, aerial Biovision and video playback system, etc.

APPENDIX A: EVALUATION SCOPE OF WORK

A

TASK 1

SCOPE OF WORK

I. OBJECTIVE

In conjunction with the design of possible follow-on or extension to the Agro-Climatic/Env. Monitoring Project (388-0046) the contractor will provide a qualified technician who will assess SPARRSO's present capabilities to maintain the data reception and analysis system provided under that Project and, if and where appropriate, make recommendations for modification and enhancement of its equipment maintenance capability.

II. SCOPE OF WORK

Specific tasks to be accomplished are as follows:

1. Review and become familiar with operating practices and conditions, and equipment maintenance practices and conditions at SPARRSO, especially insofar as these related to existing and expected equipment used for meteorological and (Landsat) satellite data reception and processing.

2. Assess SPARRSO's capability adequately to maintain existing and expected equipment, taking into consideration number and qualification levels of in-house maintenance personnel, maintenance service available through the private sector in Dhaka, SPARRSO's organizational structure and personnel practices, SPARRSO and BDG procurement policies and practices, and the present and anticipated level of funding for maintenance which SPARRSO will have.

3. Based upon the above, prepare a report prescribing a plan of action which will result in SPARRSO's developing and maintaining a capability to keep its equipment in good operating order. The report/plan should include the following:

- A detailed listing of and schedule for necessary maintenance for all data reception and analysis equipment.
- Detailed listing of and schedule for the organization and staffing of the equipment maintenance unit(s) within SPARRSO.
- Recommendations for additional and/or enhanced training for maintenance personnel (including recommendations as to where the training could best be obtained).

- Recommendations for provisions by AID of long and/or short-term technical assistance to SPARRSO in the development of its equipment maintenance capability.

- Recommendations for utilization of in-country (non-SPARRSO) equipment maintenance services.

- Recommendations for utilization of repair and maintenance services outside of Bangladesh (i.e., from India, Singapore, U.S., etc.)

- Recommendations for development of a spare parts (and expendable supplies) procurement system - for parts and supplies needed both on routine and emergency basis. (Use of both Bangladeshi and U.S. private sector procurement services should be discussed).

III. METHOD OF APPROACH

The required scope of work will be accomplished in the following manner:

1. Conduct familiarization and information gathering visit to SPARRSO in Bangladesh, including addressing Tasks 1 and 2 of the scope of work above. Visit will include ascertaining of locations of vendor representatives and agents in locations such as Hong Kong and Singapore to be visited on the return trip to the United States. Time of performance: 2 weeks.

2. Visit U.S. manufacturers of major items of equipment to discuss sparing requirements and manufacturer's views on equipment maintenance and maintenance training. Write report covering Item 3 of Scope of Work. Time of performance: 5 weeks.

3. Visit Bangladesh to present draft of final report, review results of the scope of work, and incorporate comments into final report. Submit report and return to U.S. Time of performance: 2 weeks.

IV. REPORTS

A draft report covering all items discussed in #3 in scope of work, above will be submitted to USAID by the contractor at the end of 8 weeks. A final report, incorporating comments made by AID in response to the draft report, will be submitted to USAID and SPARRSO prior to the contractor's departure from Dhaka.

B
POTENTIAL SUPPLIERS CONTACTED

DHAKA

Beximco Computers, Ltd. - Moin Khan, Manager Systems Support, Computer Paper, Floppy Disks.

Ciproco Computers, Ltd. - M. Al-Amin, Chairman of the Board. Tandy representative - support for TRS80, possible DEC interface.

GETCO, Ltd. Local Catepillar Tractor representative - responsible for ACEMP motor generator installation and training.

IBM - Floppy Disks, Magnetic Tapes.

Kabir Brothers, Ltd. - Jahangir Kabir, Managing Director. Trading Company - potential agent for SPARRSO, Air Conditioning contractor.

Sakaimex, Ltd. - A.A. Kamruzzaman, Managing Director, Computer Paper.

UNITED STATES

Digital Equipment Corporation, General International District, Acton, Massachusetts - William Schaffer, District Field Service Marketing Manager. Parts supplier, Preventative Maintenance Training, Remedial Maintenance Backup. Provided representative service contract.

South-East Consortium for International Development (SECID), Chapel Hill, North Carolina - Harry Wheeler, Manager Procurement Department. Procurement agent with recent experience with USAID/Nepal. Provided representative PSA contract.

Wimvex Associates, Ltd., Hopewell Junction, New York - Paul Varinga, President. U.S., PSA with experience in the Middle and Far East. Provided PSA terms for reference.

TASK 2

E OF WORK

I. OBJECTIVE

In conjunction with the design of an extension to the current Agro-Climatic/Environmental Monitoring Project (ACEMP) at the Bangladesh Space Research and Remote Sensing Organization (SPARRSO), ERIM will provide qualified technicians to conduct a project evaluation of the first phase of the project to provide USAID with a better understanding of the progress to date in meeting project objectives and to identify possible constraints which will prevent all project objectives from being met by the proposed PACD (30 November 1987).

II. SCOPE OF WORK

Specific tasks to be accomplished are as follows:

1. Establish criteria and develop a plan for continuously monitoring and evaluating ACEMP implementation progress. Clearly define major implementation activities necessary to ensure that SPARRSO has the capability to, by the proposed PACD, effectively carry out the following ten key applications activities:

Preparing categorized land-use maps;

Conducting studies of cropping patterns;

Measuring cropping intensity and developing crop identification keys;

Preparing estimations of acreage and average yields of principal crops - including the extent of damage by natural disasters;

Determining crop calendars;

Analyzing land accretion in the Bay of Bengal;

Conducting forestry resource inventories;

Mapping and monitoring coastal afforestation activities;

Conducting studies of monsoon clouds over Bangladesh for a better understanding of rainfall, flood, and drought and;

Determining the structure, dynamics, intensity, and movement of storms and storm surges.

2. Identify the current status of project implementation. Using the plan developed for monitoring and evaluating the project developed above, a determination of the current status of the ACEMP with regard to the ten key applications areas will be made. This determination will include a detailed discussion of each criterion used and a concise justification for each rating.

3. Identify any constraints for each key application area that may prevent performance in that area by the proposed PACD.

4. Identify the activities and resources necessary to overcome the constraints identified in 3. above.

5. Establish a schedule for providing the activities and resources outlined in 4. above, in a manner that will insure that performance in all ten key applications areas is being effectively carried out by the proposed PACD.

III. WORK SCHEDULE

The required scope of work will be accomplished in the following manner:

1. Two (2) ERIM technicians will spend a total of seven (7) man-weeks of time in Bangladesh, primarily at SPARRSO, interviewing both operational and investigative personnel to determine the current status of the Project.

2. Within five (5) work days after initiating work in Bangladesh, a work plan will be submitted, for USAID/Dhaka approval, for accomplishing the scope of work. The plan will include specific details on how all the tasks mentioned in II. above will be accomplished and a time schedule for their accomplishment.

3. After the work plan is approved, the ERIM technicians will review contract progress every ten (10) working days with USAID/Dhaka during their stay in Bangladesh.

4. At the end of three (3) weeks after initiating work in Bangladesh, preliminary conclusions and recommendations will be presented to USAID/Dhaka and SPARRSO for their review and comments.

5. Based on this review, ERIM will submit a draft final report to USAID/Dhaka at the end of four (4) weeks, prior to the departure of the ERIM technicians from Dhaka.

6. Upon return to the U.S., the ERIM technicians will contact NASA, NOAA, and other experts to resolve any remaining questions as to background information regarding the Project. This activity will take approximately one (1) work week.

7. A final report will be generated and submitted to USAID/Dhaka. This activity will take approximately one (1) work week.

IV. REPORTS

1. A work plan will be submitted to USAID/Dhaka within five (5) days of initiating work in Dhaka.

2. A draft final report will be submitted to USAID/Dhaka at the end of four (4) weeks in Dhaka.

3. A final report will be submitted in ten (10) copies NLT fourteen (14) working days after completion of the contract.

APPENDIX B
SPARRSO RESEARCH AND DEVELOPMENT PROGRAMME
(1980 - 1985)

SECTOR		ACTIVITY
Agriculture:	1.	**Crop inventory of 20 thanas for 20 districts of Bangladesh.**
	2.	Potentially Potentiality studies of different islands in the Bay of Bengal.
	3.	Cropping pattern determination and soil characteristics studies of twenty thanas of twenty districts.
	4.	Development of model for crop estimation (sugar cane).
	5.	Study of central Barind Tracks and its development potentiality.
	6.	Studies of changes of cropping pattern and other ecological aspects due to construction of permanent embankment for controlled irrigation of the Meghna-Dhonagoda irrigation project under Matlab P.S. Comilla.
	7.	Crop inventor of Reed area of Sylhet.
Water Resources:		
	8.	Flood damage assessment and mapping of inundated area.
	9.	Updating the World Bank (hydrology) map showing water bodies, annual flood inundated zones and present river courses.
	10.	Study and assessment of flood damage in the north-west region bounded by the Ganges and the Brahmaputra.
	11.	Study for the temporal change in surface and ground water distribution of the western region of Bangladesh as a result of the withdrawal of water at Farakka Barage.

12. Water resources studies of test areas by computer techniques.
13. Studies of rive course monitoring of the following rivers by visual and computer techniques: Brahmaputra, Ganges, Teesta, Dharla.
14. Study of reservoir potentialities in respect to flood control drainage and irrigation of the following beels and haors: Hakaluki Haor, Dakan Haor, Chouldhuri Haor, Bara Haor, and Chalan Bill.
15. Study of the surface water resources in the Ganges Basin.
16. Preparation of dry season water inventory.
17. Study to delineate and quantify the irrigated and non-irrigated area in the following areas: Thakurgaon tube well project, Chandpur project, G.K. Project.

Forestry Sector:

18. Mangrove coastal afforestation monitoring project.
19. Inventory of forest resources.
20. Study of forest resources and promotion of village forest inventory.
21. Identification of potential afforestation areas along roads, railways, canals and other such areas.
22. Studies of wildlife habitat in Bangladesh.

Fisheries Sector:

23. Fishery resource survey of 20 thanas of 20 districts of Bangladesh.
24. Fishery resource survey of whole of Bangladesh.
25. Study of water pollution and its effect on fish habitat.

Oceanography Sector:

26. **Numerical modelling of salt water intrusion in major rivers of Bangladesh.**
27. Study of the fishing ground and marine resources of Bay of Bengal.

Meteorology Sector:

28. Analysis of tropical cyclone structure, intensity, movement, etc. with special reference to the use of metsat data.
29. Study of norwesters using metsat data.
30. Modelling of storm surges.
31. Study of monsoon depression in regard to precipitation/flood drought prediction.
32. Develop meteorological, hydrological, and oceanographic model using space and ground data.

Cartographic Sector:

33. Updating of political map of Bangladesh (1:500,000 scale).
34. Updating of transportation map of Bangladesh.
35. Updating population map of Bangladesh.
36. Updating of land use map of Bangladesh.
37. Interpretation of Landsat imageries of each district and area classification of land form types, water resources, and identification of development limiting factors.
38. Preparation of updated mosaic map of Bangladesh.

Instrumentation Sector:

39. Design antennas for reception of remote sensing data for pilot project applications.
40. Research and study on electrical/electronic instrumentation.
41. Applied research and studies on photographic processing of remote sensing data.
42. Identification of Landsat features by electronics/opto-electronics instruments.
43. Identification of spectral reflectances of vegetation.
44. Preparation of interpretation keys for their association with different sectors.
45. Development of software programmes for minicomputer.
46. Development of a resources data bank.
47. Statistical modelling and sample design for sectoral use.

Geology Sector:

48. Study of environmental geology in respect to salinity intrusion; bankline erosion, pollution in selected areas along the coastal belt.
49. Study of reflectance characteristics of soil, rock, and vegetation in selected areas.
50. Study of selected water reservoirs in Bangladesh.

Land use Sector:

51. Study of parameters of desertification process parts of Barind Tract.

APPENDIX C

SAMPLE CONTRACTS AND PRSA TERMS OF REFERENCE

DIGITAL EQUIPMENT CORPORATION

GENERAL INTERNATIONAL DISTRICT

DIGITAL EQUIPMENT CORPORATION ("Digital") agrees to provide, and _____. ("Customer") agrees to accept maintenance service on the equipment listed in Appendix A attached hereto, initialled by the parties and made part hereof, and such additional equipment as the parties may from time to time agree (collectively called the "Equipment") on the following terms and conditions:

1. DURATION

This agreement shall be effective when signed by both parties. The initial term is thirty-six (36) months from (here insert date) (Commencement Date). After the initial term has expired this agreement shall continue from year to year, and may be terminated by either party upon ninety (90) days written notice.

2. ELIGIBILITY FOR SERVICE AGREEMENT

A. The Equipment and other Digital-supplied equipment are eligible for inclusion under this Agreement immediately upon Digital installation or expiration of any on-site warranty or existing Digital On-Site Service Agreement.

B. Digital-supplied equipment not eligible for inclusion under 2.A. above will be subject to inspection by Digital to determine if it is in good operating condition. Any repairs, adjustments or field engineering changes then deemed necessary by Digital will be made at Digital's per call rates and terms then in effect prior to commencement of maintenance service.

C. Service under this Agreement is conditioned upon conformity with Digital's currently applicable minimum equipment configuration requirements.

D. The Customer's installation site ("the Site") must be in an area within a country in which the Customer or the end user has an established legal entity and where the living environment is suitable, with convenient access to the Site for Digital's Service Personnel.

3. SERVICE RESPONSIBILITIES OF DIGITAL

A. It is understood that the end-user, Bangladesh Space Agency ("Agency") has sent service personnel to the United States for training in maintenance on the Equipment, and that Agency wishes to assume responsibility for primary maintenance of the Equipment beginning one year from the Commencement Date. In order that Agency's service personnel may quickly become experienced in maintaining the Equipment, Digital's responsibilities under this Agreement shall include provision of on-the-job training to Agency's personnel for the first year of this contract. In addition, for the charges stated in Appendix A, Digital will provide preventive maintenance and will furnish On-Call remedial maintenance service. Digital may, at its option, send a VAX-qualified maintenance engineer from its General International District in Littleton, Mass., or from another Digital subsidiary or distributor field service office. In fulfillment of the above, Digital will:

1) Provide four scheduled preventive maintenance visits to the site during the first year of the Agreement, and while at the site, perform preventive maintenance, working with Agency's personnel and supervising such personnel to the extent deemed desirable by Digital's engineer.

(2) Provide unscheduled, on-call remedial maintenance as required during the term of the Agreement, following notification by the Customer that the equipment is inoperative, at 75% of Digital's Per Call charges then in effect, plus air fares and per diem charges.

(3) Provide on-the-job training on maintenance of various options at the site for the benefit of Agency's technical personnel. These seminars will be from one to two days in length, at Digital's choice.

(4) Provide unlimited telephone/telex support from Digital's GID Technical Assistance Center (TAC), during Digital's normal working hours.

(5) Maintain a customer configuration, application and operating system file at the TAC for use in assisting Customer.

(6) Furnish to Customer: Tech-Tips, Safety and Field Change Order notifications, and any additional information useful in maintaining the Equipment as such information becomes available.

(7) Provide an Emergency Parts Order Service (P-1).

(8) Provide additional support services such as environmental assistance, training recomendations, site management guide, and liaison to other Digital services.

B. Digital will install, at its option, field engineering changes on the Digital-installed equipment covered by this Agreement. The installation will be at no charge if done concurrently with preventive maintenance or at another time during the Call Window as mutually agreed upon.

4. SERVICE LIMITATIONS

A. Preventive maintenance service does not include (1) operating supplies or accessories, cleaning supplies necessary for preventive maintenance, paint, or refinishing the equipment or furnishing materials for this purpose, (2) electrical work external to the Equipment, or maintenance of accessories, attachments, alterations, or any device not furnished by Digital.

B. Unless specifically listed in Appendix A, Digital does not accept any responsibility to repair non-Digital equipment, or to connect or disconnect Digital equipment to or from non-Digital equipment. However, should Digital, as a convenience to Customer, disconnect, connect or repair such equipment, it does so only on the condition that it has no liability for any damange that may result.

C. Upon the expiration of twelve (12) months after the Commencement Date, or any time thereafter, if an item(s) of Equipment cannot, in Digital's opinion, be properly or economically repaired on-site because of excessive wear or deterioration, Digital may supply the Customer with a quote for reconditioning such item(s) at Digital's Product Repair Center or other factory repair location. If the Customer does not elect to have the item(s) reconditioned, or if reconditioning is impractical due to equipment age, unavailability of replacement parts, or inability due to government restrictions to ship the material from the Site to a Digital repair facility, Digital may withdraw such item(s) from the Agreement upon ninety (90) days prior written notice.

D. Any maintenance materials, tools, documentation, Site Management Guide, diagnostic software, test equipment and spare parts necessary for the maintenance services described herein and not expressly invoiced to the Customer, will remain at all times the exclusive property of Digital, and Digital shall have access to these during normal working hours.

4. RESPONSIBILITIES OF CUSTOMER

A. Customer will notify Digital immediately of Equipment failure and will allow Digital full and free access to the Equipment. Waiver of liability or other restrictions will not be imposed as a requirement for access to the Site. Customer will allow Digital to use necessary machines, communications facilities, features and other equipment (except as normally supplied by Digital) at no charge.

B. Customer will maintain site conditions including stability of power sources within the common environmental range of all system devices and media covered hereunder, as specified by Digital prior to the Commencement Date. Customer represents that it has effective control of the site environment and has the authority and technical capability to fulfill its responsibilities with respect to site conditions.

C. A representative of Customer will be present at the Site during Digital's performance of maintenance services.

D. To facilitate Digital's performance of maintenance services, Customer will provide reasonable facilities such as, but not limited to, secure storage space, designated work area with adequate heat and light, and access to a local telephone line; these facilities are to be provided on request and at no charge to Digital.

E. Customer will purchase from Digital an initial supply of spare parts as listed by Digital in Appendix C hereto, and will maintain these spare parts in a secure storage area near the Site. Customer represents that Digital has explained to Customer Digital's normal policy of requiring a 98% Level of Service in spare parts for remote sites, and that Customer has specifically elected to purchase a lower level of service, and that Customer is willing to assume all risks with respect to downtime. Customer will purchase from Digital and import into Bangladesh all necessary tools, test equipment and documentation set forth in Appendix C and required to support the system, and shall pay all taxes, air freight, insurance and duties in connection with delivery of such items as well as spares to the site.

F. Customer will provide Digital with access to international telex and telephone facilities at the Site. Digital will reimburse customer for the corresponding standard transmittal charges.

5. PERIOD OF SERVICE AVAILABILITY

A. Customer may notify Digital via telex or telephone

that its remedial maintenance services are required. An engineer will be dispatched to the site as soon as possible. The engineer will be available at a minimum of eight hours per day, and for six days per week.

7. CHARGES

A. Charges are payable and will be invoiced as follows: |

B. Charges for remedial maintenance for the first year of the contract will be invoiced upon completion of the work at $ per day, portal to portal, plus $ per day living expenses for each day actually spent in Bangla Desh. Charges for remedial maintenance for the second and third years of the contract will be invoiced at 75% of Digital's then applicable per call rates, plus per diem expenses and air fare.

C. Charges are payable in U.S,. dollars in cash or by check drawn on a major U.S. Bank. All amounts due Digital under this Agreement are to be received by Digital in full net of any bank or government remittance, conversion, service or other fees. Customer will also pay any added value, withholding, sales, service or other taxes, official fees or charges payable in the country where services are rendered under this Agreement (except for taxes payable by Digital based on and calculated with respect to net income of Digital) in connection with this Agreement. This includes any taxes imposed in respect of the payment of any of the above taxes or other charges.

8. MOVEMENT OF EQUIPMENT

A. To permit continuity of service under this Agreement, Customer will give Digital at least sixty (60) days prior written notice of its intent to move the Equipment. Equipment moved outside the country where services are to be provided under this Agreement may be eligible for continued service under Digital's local terms and conditions then in effect for like equipment in the territory or country of re-installation.

B. Digital personnel will supervise the dismantling and packing/unpacking of the Equipment, will inspect and re-install the Equipment at the new location, and will charge the customer for all such labor and materials provided at its then current rates and terms.

C. Digital will be under no obligation to furnish continued service (preventive or remedial) under this Agreement

if the Equipment is moved from the Site and/or reinstalled without the prior written approval of Digital.

9. LIMITATION OF LIABILITY AND WARRANTY

A. Except in the case of personal injury, Digital's liability to Customer (whether in contract or tort, including negligence) for damages of any nature, will not exceed the sum of $60,000.

B. No action (whether in contract or in tort, including negligence) arising out of the performance of services under this Agreement, may be brought by either party more than eighteen (18) months of the date of the last payment.

C. In no event will Digital be liable for any loss of data, lost profits or any special, indirect or consequential damages.

D. Except as otherwise provided by this Agreement, DIGITAL DISCLAIMS ALL WARRANTIES, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

10. GENERAL

A. Digital's obligations under this agreement are conditioned upon its ability to obtain through official channels the necessary visas and permits for its personnel. Customer will assist Digital in securing such visas and permits, and DIGITAL WILL ASSUME NO OBLIGATION FOR THEIR TIMELY ISSUANCE.

B. If either party neglects or fails to perform any of its obligations under this Agreement, and such failure continues for a period of twenty (20) days after written notice thereof, the other party will have the right to terminate this Agreement forthwith.

C. The terms and conditions of this Agreement will prevail over the terms and conditions of any order submitted by the Customer for maintenance services under this Agreement.

D. This Agreement supersedes all prior service agreements and understandings between the parties with respect to the Equipment and may not be changed or terminated orally.

E. Any failure of a party to enforce strict compliance with a term or condition of this Agreement, will not constitute a waiver thereof, nor will it affect that party's right to enforce the same at any other time.

F. Neither party will assign this agreement without the prior written consent of the other party.

G. This Agreement will be governed by the laws of the Commonwealth of Massachusetts.

H. Digital reserves the right to suspend performance of its obligations under this Agreement if continued performance would, in its reasonable opinion, jeopardize the health or safety of its personnel. If an extended suspension is foreseen in such a case, Digital will refund an appropriate portion of any charges paid in advance.

IN WITNESS WHEREOF the parties have signed this Agreement on the dates indicated below.

	DIGITAL EQUIPMENT CORPORATION
By: _____	By: _____
Typed Name: _____	Typed Name: _____
Title: _____	Title _____
Date: _____	Date: _____

APPENDIX A
DIGITAL EQUIPMENT CORPORATION
SYSTEM CONFIGURATION

MODEL #	DESCRIPTION	QUANTITY
F50XA-AJ	11/750 SYSTEM KERNEL	1
RUA81-CD	RA81 DISK DRIVE AND CONTROLLER	2
RA81-AD	DISK DRIVE	2
TGU78-FD	SINGLE ACCESS TAPE SYSTEM	1
DZ11-DP	8 LINE ASYNCH MULTIPLEXER	2
LA120-DA	HARD COPY TERMINAL	2
DR11-W	DIRECT MEMEORY ACCESSS CONTROLLER	2
CMF32-LP	ASYNCH/SYNCH MULTIPLEXER	2
VT220-B	VIDEO TERMINAL	3
CM78-C	TU78 DUAL ACCESS KIT	1
CT07-BS	8 PORT ISOLATED LOOP PACKAGE	1
LN03-RB	PERSONAL PRINTER	1
BDA11-DK	8-SLOT EXPANSION BACKPLANE	1
BDA11-CK	4 SLOT EXPANSION BACKPLANE	1
MS750-CD	4 MB MOS MEMORY	1
FP750	FLOATING POINT	1
UW750	UNIBUS OPTION	1
BA11-KV	EXPANDER BOX	1
BA42-FE	EXPANDER CABINET	3
AFA11-AA	ANALOG/DIGITAL CONVERSION KIT	1
AA11-KT	ANALOG/DIGITAL CONVERTER BOARD	1

CONTRACT FOR PROCUREMENT SERVICES AGENT

This Contract is entered into as of _____ by the University of Arkansas Acting on Behalf of the U.S. Agency for International Development and the South-East Consortium for Int'l Development having its principal place of business in Chapel Hill, North Carolina. Services to be provided under this contract shall be performed between _____ 19__ and _____ 19__.

WHEREAS, the University of Arkansas has entered into an Agreement No. 696-0110 with the United States Agency for International Development;

WHEREAS, the University of Arkansas on behalf of U.S. Agency for International Development desires to obtain the services required for the procurement and delivery of certain of the commodities to be purchased under Agreement No. 696-0110 to Kigali, Rwanda as specified; and

WHEREAS, the Agent has stated that it is fully qualified and willing to provide such services;

NOW THEREFORE, the parties to this Contract agree to the following:

Definitions:

1. "AID" means the Agency for International Development.
2. "Buyer" means the University of Arkansas Farming Systems Improvement Project.
3. "Agent" means the South-East Consortium for International Development.
4. "Supplier" means the firm or individual from which the commodity is procured by the Agent.
5. "Host Country" means the Government of the Republic of Rwanda.
6. "Handbook 11" means AID Handbook 11, Country Contracting.

ARTICLE I - SCOPE OF WORK

A. The Buyer has undertaken a project, supported jointly by the Government of the Republic of Rwanda and AID for the improvement of farming systems. The Project is identified as the Farming Systems Improvement Project (696-0110). The services of the Agent are hereby contracted for to procure for the Project commodities as described in attachment A.

The Agent is required to handle all procurement transactions as requested regardless of the size of transaction or the value of individual items.

B. Required Services:

The Agent's services will include, but not be limited to:

1. Reviewing and refining all commodity specifications, developing, modifying, or adding to specifications as necessary in order to better describe commodities in terms of technical and performance requirements, thereby assuring that each item is sufficiently identified so as not to unduly restrict competition from prospective suppliers;

2. Issuing and advertising commodity solicitations;

3. Preparing Invitations for Bids and Requests for Quotations;

4. Evaluating bids and recommending/making awards;

5. Issuing Contracts or Purchase Orders (obtaining AID and Buyer approval when required);

6. Expediting suppliers'/manufacturers' performance;

7. Inspecting and Consolidating shipments;

8. Handling and Forwarding documents;

9. Arranging freight forwarding and ocean/air transportation;

10. Providing complete and accurate monthly reports to the Buyer indicating status of each procurement actions.

11. Handling management and communication responsibilities required in implementing the procurement;

12. Handling any and all claims which might arise from subject procurement;

13. Pursuing economies in the procurement process that may be obtained through improving specifications, soliciting from sources involving the least mark-ups, obtaining project freight rates and utilizing other sound, prudent purchasing practices.

The Agent shall follow the procurement rules and refer to the guidelines set forth in Chapter 3 of Handbook 11. In case of a conflict between Chapter 3 and this Contract, the provisions of this Contract shall govern.

The official designated in the Legal Relationships clause of this Contract will send requisition documents (PIO/C, 11-94 forms, etc) to the Agent. The requisition(s) will contain data as to the quantity and descriptions of the commodities that the Buyer wants the Agent to purchase on behalf of the Buyer and will also specify other conditions such as source requirements, shipping instructions, insurance needs, and required delivery date. Upon

receipt of each requisition the Agent shall carry out the procurement of such commodities in accordance with the terms and conditions of this contract.

E. The Agent shall seek offers/bids from a reasonable number of the most appropriate suppliers, i.e. manufacturer, distributor, wholesaler, retailer, etc., in order to obtain the lowest available competitive price. The Agent shall, where appropriate, solicit on behalf of the Buyer, discounts, rebates or other credits from the Supplier or manufacturer of a commodity, the carrier or the insurer and shall assure that all such credits are reflected in the supplier's invoice to the Buyer.

F. All procurement transactions shall be conducted in a manner to provide, to the maximum extent practical, open competition in order to assure the most reasonable prices. Although the Agent may seek information from suppliers in carrying out its contractual responsibilities, the Agent shall assure that no supplier receives an undue advantage.

G. Solicitations for commodities and related services shall be based upon a clear and accurate description of the technical requirements for the material, product or services to be procured.

H. Solicitations shall clearly set forth all requirements which bidders/offerors must fulfill and all factors to be used in evaluating bids or proposals.

I. 1. The Agent is expected to communicate expeditiously with the Buyer concerning procurements under this Contract.

2. The Agent shall submit to the Buyer a status report each month that indicates, at a minimum, what commodities have been ordered, expected shipping dates, and actual shipping dates and names of vessels as available.

J. The Agent shall maintain procurement records and files for all purchases, which shall include the following:

1. Evidence of solicitation of offers:

2. Basis for supplier selection;

3. Justification for lack of competition when competitive bids or offers are not obtained and a copy of waiver from AID; and

4. Price or cost analysis (reference to price comparisons and reasonableness of cost elements).

K. The Agent shall maintain a system of contract administration to ensure supplier conformance with terms, conditions and specifications of the contract or purchase order to assure adequate and prompt deliveries.

In all contracts and purchase orders with suppliers, the Agent shall include the clauses required by Section 2.13 of Handbook 11, Chapter 3. In addition to those clauses and other provisions necessary to define a sound and complete agreement, the Agent shall include the following provisions:

1. A provision specifying that the commodities (including raw material, components, intermediate assemblies and end products) shall be subject to inspection and test by or on behalf of the Buyer and at the expense of the Buyer prior to shipment.

2. When appropriate for the type of commodity being purchased, a clause requiring the supplier to provide a warranty which shall, at a minimum, protect the Buyer from any loss due to defective workmanship, material and parts for twelve months after initial delivery to the port of entry, provided that removal from the port of entry will take place not later than two months after discharge from the vessel. The Buyer shall give the supplier prompt notice of any claims under such warranty and, if the supplier fails to remedy defects within a reasonable time, shall have the right to take such remedial action as may be necessary and to claim the reasonable cost thereof from the supplier.

Should any insurance claim arise as a result of the shipment of commodities purchased pursuant to this contract the Buyer shall forward to the Agent with the claim a copy of the Bill of Lading, the original insurance certificate and surveyor's report detailing the damage. The Agent shall take such steps as may be necessary to collect the claim. All claims honored by the insurance company shall be payable to the Buyer and proceeds realized shall be utilized for repair or replacement of the lost, destroyed or damaged commodities in accordance with AID requirements. The Agent shall submit to the Buyer a statement of claims honored by the insurance company and received by the Agent.

ARTICLE II - PAYMENTS

Payment for Agent's Services

1. Amount

The Buyer will pay the Agent the total fixed amount of $_____ (_____). This amount is the entire payment called for in the Scope of Work and no additional payments will be made to the Agent for purchasing or arranging for commodity-related services as may be required.

2. Schedule and Documentation

The Agent will be paid on a monthly basis. Requests for payment will be supported by the following documentation:

1. Voucher SF 1034 in original and three copies.

2. One copy of the Agent's invoice.

3. One copy of each relevant bill of lading or airway bill for the commodities shipped.

The Agent shall submit the request for payment and the appropriate documentation to the Buyer. The Buyer shall provide a "Certification of Performance" or "Certification of Nonperformance of Specific Items' within 30 days after receipt of the request. If neither certification is provided within 30 days, the Agent shall be paid according to the request.

B. Payment for Commodities and Commodity-Related Services

1. Amount

The Buyer will reimburse the Agent for commodities and commodity related services purchased in accordance with this contract at the price agreed to in the purchase order or contract between the Agent and supplier of the commodity or related service.

2. Schedule

a. Suppliers of commodities and freight will be paid on the basis of shipment of the commodities; except that when the Agent consolidates commodities for shipment, the commodity supplier may be paid on the basis of delivery into custody of the Agent. Suppliers of other commodity-related services will be paid on the basis of delivery of services.

3. Documentation

a. Requests for payment for commodities and freight will be supported by the appropriate documentation required under Chapter 3 of Handbook 11.

b. Requests for payment of other commodity-related services which are not covered by the commodity supplier's request for payment will be supported by the following:

(i) One copy of the invoice for the services

(ii) One copy of the following as appropriate:
(a) the inspection certificate; or
(b) the marine insurance policy
(c) the warehouse receipt.

ARTICLE III - SPECIAL PROVISIONS

A. Legal Relationships

1. Relationship of Parties

a. The Agent shall perform the services under this contract for the benefit of the Buyer

b. The official of the Buyer who has authority to issue purchase requests, PIO/C's, change orders, etc. is _____ (Name and Title).

2. Legal Effect of AID Approvals and Decisions

a. The parties hereto understand that the Contract has reserved to AID certain rights such as, but not limited to, the right to approve the terms of this Contract, the supplier, and any or all plans, reports, specifications, subcontracts/purchase orders, bid documents, drawings, or other documents related to this Contract and the project of which it is a part. The parties hereto further understand and agree that AID, in reserving any or all of the foregoing approval rights, has acted solely as a financing entity to assure the proper use of United States Government funds, and that any decision by AID to exercise or refrain from exercising these approval rights shall be made as a financing entity in the course of financing this project and shall not be construed as making AID a party to the contract. The parties hereto understand and agree that AID may, from time to time, exercise the foregoing approval rights, or discuss the matters related to these rights and the foregoing approval rights, or discuss the matters related to these rights and the project of which this Contract is a part, with the parties jointly or separately, without thereby incurring any responsibility or liability to the parties jointy or to any of them.

b. Any approval (or failure to disapprove) by AID shall not bar the Buyer or AID from asserting any right, or relieve the Agent of any liability which the Agency may otherwise have to the Buyer or AID.

B. Source and Nationality

1. Commodities

Each purchase request or PIO/C issued to the Agent shall specify the eligible source countries either by name or by AID Geographic Code. If not specified, the eligible source is the U.S. only. Commodities must meet the course, origin, and componentry requirements in Handbook 11, Chapter 3, Section 2.6.1 and 2.6.2. Suppliers of commodities must meet the nationality requirements in Handbook 11, Chapter 3, Section 2.6.3.

2. Delivery Services

Each purchase request or PIO/C issued to the Agent shall specify the eligible source for delivery services either by name or by AID Geographic Code. If not specified, the eligible source is the U.S. only. Delivery services must meet the eligibility requirements in Handbook 11, Chapter 3, Section 2.6.4 and, in addition, ocean transportation must meet the cargo preference requirements in Section 2.7 of the same chapter. When Code 941 is the authorized source for delivery services, the cooperating country is

also eligible to provide delivery services. Under AID grants, the eligible source for international air transportation is always the United States.

C. Documents furnished by the Buyer

The Buyer shall furnish to the Agent lists and description of the commodities to be purchased, and other related documents which pertain to the technical requirements for the AID-financed project of which the Contract is a part.

ARTICLE IV - GENERAL PROVISIONS

A. Marking

All commodies and their shipping containers, except materials shipped in bulk and semi-finished products which are not packed in any way, shall be marked with the official AID (clasped hands) emblem in accordance with AID marking requirements. The Agent is responsible for making sure that the Supplier is informed of the AID marking requirements and that the supplier correctly marks commodities and shipping containers as per Handbook 11, Chapter 3, Section 2.12.5.

B. Inspection

The Agent agees to permit authorized representatives of the Buyer and AID, at all reasonable times, to inspect its facilities, activities, and work pertinent to the contract in the USA or abroad, and to interview personnel engaged in the performance of the contract to the extent deemed necesary by the Buyer and AID.

C. Taxes

All commodities and services shall be exempt from all taxes, fees, levies, customs or impositions imposed under laws in effect in the host country or the Buyer shall make payment for or reimbursement for such taxes, fees, levies, customs or impositions to the extent specified in the Agreement signed between the government of the host country and AID.

D. Nondiscrimination

During the performance of this contract, the Agent agrees not to discriminate in the recruitment or employment conditions of personnel hired in the United States because of race, color, religion, sex, or national origin.

E. Conflict of Interest

No employees, officers or representatives of the Agent shall participate in the selection, award or administration of a contract where, to their knowledge, they or any immediate family member or partner have a financial or future employment interest. The Agent's officers, employees, and representatives shall neither solicit nor accept gratuities, favors or

anything of monetary value from suppliers or potential suppliers, carriers or insurers, nor shall they engage in any activity which is or gives the appearance of being a conflict of interest.

F. Books and Records

The Agent shall maintain books, records, documents and accounts with respect to all transactions under or connected with this contract adequate to show whether all requirements of this contract have been complied with. The system of accounts employed by the Agent shall follow generally accepted accounting principles. All such books, records, documents and accounts shall be subject to inspection and audit by the Buyer or any of its duly authorized representatives, at all reasonable time, and the Agent shall afford such official personnel proper facilities at the place where such books and records are normally maintained for such inspection and audit The Agent agrees to maintain such books and records, to make them available for inspection for a period of three years after final payment under this contract. However, records which relate to appeals under the "Disputes" clause of this contract, or litigation or the settlement of claims arising out of the out of the performance of this contract shall be retained until such appeals, litigation or claims have been finally settled.

G. Assignments

The Agent may not assign the right to receive payments nor delegate any of its duties under this contract without the prior written approval of the Buyer.

H. Changes, Amendments, and Modifications

1. The Buyer may at any time, by written order, make changes within the scope of work of this contract. Changes in the number, type, specifications, etc. of the commodities to be procured shall be governed by the provisions of Article II - Payments. If any change not covered by Article II causes an increase or decrease in the cost of, or the time required for, performance of any part of the work under the contract, an equitable adjustment shall be settled in accordance with the provisions of the "Disputes" clause of this contract.

2. No amendments of modifications of this contract may be made except in writing signed by the authorized representative of the Buyer and the Agent.

Suspension of Work

1. The Buyer may, in writing, order the Agent to stop all or any part of the work under this contract for a period of up to 90 days from the specified a effective date. Upon receipt of such an order, the Agent shall comply with its terms and take all reasonable steps to minimize the incurrence of costs allocable to the work covered by the order.

2. Within the period of the Suspension of Work Order, the Buyer, may either cancel the Suspension Work Order or terminate the work covered by such Order as provided in the "Termination by the Buyer for Convenience" clause of this contract.

3. If the Suspension of Work Order is cancelled or the Order expires, the Agent shall resume work. An equitable adjustment shall be made as necessary in the time schedule, the price, or a combination thereof, or any other provisions of the contract that may be affected, and the contract shall be amended accordingly, if the Agent asserts a claim for such adjustment within 30 days after the end of the period of work suspension. Failure to agree to any adjustment shall be a dispute under the "Disputes" clause of this contract.

J. Termination by the Buyer for Convenience

1. This contract may be terminated by the Buyer in whole, or from time to time in part, in accordance with this clause whenever the Buyer shall determine that such termination is in the best interest of the Buyer.

2. Termination shall be affected by Notice of Termination to the Agent, specifying that termination is for the convenience of the Buyer, the extent to which performance of work under the contract the contract is terminated, and the date upon which such termination becomes effective.

3. After receipt of a Notice of Termination and except as otherwise directed by the Buyer, the Agent shall:

   1. Stop work under the contract on the date and to the extent specified in the Notice of Termination, and place no further orders or subcontracts except as may be necessary for completion of the portion of the work under the contract which is not teminated;

   2. Terminate all orders and subcontracts to the extent that they relate to the performance of work terminated by the Notice of Termination;

   3. Assign to the Buyer as it may direct, all of the right, title, and interest of the Agent under the orders and subcontracts so terminated, in which case the Buyer, shall have the right to settle or pay any claims arising out of the termination of such orders and subcontracts;

   4. With the approval of raftification of the Buyer, to the extent the Buyer may require, which approval or ratification shall be final and conclusive for all purposes of this clause, settle all outstanding liabilities and all claims arising out such termination of orders and subcontracts;

   5. Complete performance of the part of the work which has not been terminated by the Notice of Termination; and

6. Take such action as may be necessary for the protection of the property related to this contract which is in the possesssion of the agent and to which the Buyer has title.

4. The Agent shall submit to the Buyer its written claim promptly but not later than three months from the effective date of termination, except as the Buyer may agree in writing.

5. The Agent and the Buyer shall consult within 30 days of the submission of the claim concerning the sole or any part of the amount to be paid to the Agent by reason of the termination of work. The contract shall be amended accordingly, and the Agent shall be paid the agreed amount.

6. In deciding the amount due the Agent, all settled claims which the Buyer, may have against the Agent in connection with this contract; and the agreed price for, or the proceeds of sale of property acquired by the Agent or sold and not otherwise recovered by or credited to the Buyer, shall be deducted.

7. Any disagreement regarding termination amounts or procedures shall be settled under the clause of this contract entitled "Disputes".

K. Termination by the Buyer for Default

1. The Buyer, subject to the provisions of this contract, by written notice of default to the Agent sent by registered mail, may terminate the whole or any part of this contract in any one of the following circumstances:

   (a) If the Agent fails to perform the work called for by this contract within the period specified, or

   (b) If the Agent fails to perform any of the order provisions of this contract, or so fails to prosecute the work as to endanger performance of this contract in accordance with its terms, and in either of these two circumstances, does not cure such failure within a period of ten (10) days (or such other period as the Buyer may authorize in writing) after receipt of notice from the Buyer specifying such failure.

2. In the event the Buyer terminates this contract in whole or in part as provided in paragraph 1 of this clause, the Buyer may procure upon such terms and in such manner as the buyer may deem appropriate, work similar to the work so terminated and the Agent shall be liable to the Buyer for any excess costs for similar work. However, the Ageny shall continue performance to the extent not terminated under the provisions of this clause.

L. Force Majeure

1. Except with respect to default of subcontractors or suppliers, the Agent shall not be liable for any excess costs if the failure to perform the contract arises out of causes beyond the control and without the fault or negligence of the Agent (Force Majeure) and if the Agent, within 15 days from the beginning of any such Force Majeure notifies

the Buyer of such prevention of performance and the cause thereof. Such causes may include, but are not restricted to, acts of the Borrower/Grantee in either its sovereign or contractual capacity, war, revolution, riot, earthquake, fires, floods, epidemics, quarantine restrictions, strikes, freight, embargoes, and unusually severe weather, but in every case the failure to perform must be beyond the control and without the fault or negligence of the Agent. If the failure to peform is caused by the fault of a subcontractor or Supplier and if such default arises out of causes beyond the control of the Agent and the subcontractor or supplier and without the fault or negligence of them (Force Majeure) and the Agent, within 15 days from the beginning of any such Force Majeure notifies the Buyer of such prevention of performance and the cause thereof, the Agent shall not be liable for any excess costs due to the failure to peform, unless the supplies or services to be furnished by the subcontractor or supplier were obtainable from other sources in sufficient time to permit the Agent to meet the required delivery schedule.

2. In the event of a Force Majeure, the Agent, unless otherwise directed by the Buyer in writing, shall continue to undertake and perform the duties set forth in this contract as far as is reasonably practical.

3. In the event of a Force Majeure resulting in a suspension of work, this contract shall be extended by a period equal to that for which the Agent was prevented from performing.

4. The Agent shall be entitled to reasonable costs incurred as a consequence of a Force Majeure.

5. If the Agent's inability to perform by reason of the Force Majeure lasts for more than 45 days after notice has been given to the Buyer, either party may terminate this contract and the Agent shall be entitled to any sums which would be payable in case of termination of this contract by the Contracting Agency for convenience.

M. Report of Delays

The Agent agrees to keep the Buyer fully informed about any delays in the procurement of shipment of commodities under this contract and the corrective action being taken.

N. Disputes

1. In the event of a disagreement under this contract, the Agent shall submit a written statement to the Buyer briefly describing the nature of the problem, the position of the Agent regarding the issue and a narrative of facts in support of the Agent's position.

2. Within 10 days after receipt of the Agent's statement, the Buyer shall decide the issue and deliver a written statement of the decision to the Agent, including the reasons supporting the decision, if adverse to the Agent.

3. Within 30 days after receipt of the Buyer's decision or the date such decision was due, the Agent may submit to the Buyer a written Notice of Appeal including a detailed description of the facts of the dispute with the dates of events, names of persons involved, references to documentation bearing on the matter (with copies attached), the relevant contract provision(s), the Agent's contentions and conclusions, and a statement of why the Buyer's decison is being questioned.

4. If within 30 days after delivery of a Notice of Appeal, the parties cannot agree to a satisfactory settlement, the matter shall be presented for arbitration following the rules of the International Chamber of Commerce.

). Worker's Compensation Insurance

1. The Agent, before commencing perrformance under this contract shall maintain coverage through worker's compensation insurance of security covering each employee to the extent required by the Defense Base Act of the United States, if applicable, but in any event equivalent to coverage required by law or custom in the location where the employee is performing services.

2. The Agent agrees to insert this clause in all subcontracts hereunder except those exclusively for furnishing commodities.

Governing Law and Language

1. This contract shall be interperted in accordance with the laws of the United States of America.

2. The English language version of this contract shall govern.

Notices

1. All notices or other communications between the contracting parties shall be in English and shall be directed to the following addresses:

_____ _____

(Agent)

_____

_____

_____

(Address)

_____ _____

(Buyer)

_____

_____

_____

(Address)

WORK-DESCRIPTION OF A PROCUREMENT SERVICE AGENT (PSA)

1.a. The Agent is responsible for preparing and/or refining non-restrictive specifications for equipment listed in paragraph C. herebelow based on detailed requirements and/or catalogue descriptions furnished by the Principal.

b. Specifications for vehicles and communication equipment will be provided by the Principal; the Agent is responsible for reviewin these vehicle specifications to assure their adequacy.

c. Specification prepared/refined on items having a unit FOB value of $25,000.- or more shall be sent to the Principal for review and approval before purchase action is initiated.

2. The Agent is responsible for purchasing all items requested by the Principal in accordance with AID's Handbook 11 CH-3 to include advertising, document preparation, solicitation, evaluating bids, recommending /granting awards, issuing purchase orders, and for obtaining all necessary approvals.

3. The Agent is responsible for following-up on orders placed, to expedite supplier's performance, and if the supplier can not deliver, to take necessary actions to re-procure.

4. The Agent is responsible to consolidate shipment to the extent possible, packinging for export when necessary, and arranging freight when required.

5. The Agent is responsible for arranging independent inspection of commodities as requested by the Principal: also for having visual inspection arranged on material being consolidated for shipment t assure that all items are accounted for and that there are no obvious discrepancies between commodities contracted and shipped.

6. The Agent is responsible for obtaining marine insurance in the nam of the Principal and for Principal's account on all cargoes on a warehouse-to-warehouse basis at 120% of the CIF value and for handling any insurance claims arising thereunder.

7. Any re-ordering necessary, other than when the original supplier cannot deliver (see par 3. above), shall be considered to be additional Line-Item(s) and shall be handled in accordance with th provisions in the clause "Change Orders" in the Contract.

8. The Agent is responsible for arranging the issuance of letters of credit to suppliers of commodities and commodity related services under the terms of the Bank Letter(s) of Commitment that shall be issued by AID to finance the procurement.

9. In all the work undertaken by the Agent, the Agent shall follow appropriate AID's Regulations as specified, including the policies on restricted and prohibited commodities and the eligibility criteria and special provisions for certain commodities set forth in the AID's Commodity Eligibility Listing (AID's HB-15 Appendix B.) as from time to time amended.

APPENDIX D

DATA ACQUISITION AND ANALYSIS CENTER (DAAC) PROVISIONAL ORGANIZATION

D
DATA ACQUISITION AND ANALYSIS CENTER (DAAC)
PROVISIONAL ORGANIZATION

I. HEAD OF CENTER

A. RESPONSIBILITIES

- Administrate DAAC facility.
- Direct Operations, Maintenance, Software, and Facility Utilization groups.
- Prepare budget and initiate requests for equipment procurement.
- Write proposals and solicit potential facility users.

B. REQUIRED CAPABILITIES

- Have overall view of SPARRSO's objectives to be able to determine long-term priorities for facility use.
- Sufficient engineering background to understand facility's capabilities and limitations.
- Able to interact well with SPARRSO personnel and outside contacts to promote use of facility.
- Able to project future needs and make budget recommendations for necessary expansion.

II. OPERATIONS GROUP

A. RESPONSIBILITIES

- Provide day-to-day operation of the facility.
- Set up system authorization and accounting files and procedures to allocate system resources.
- Monitor system activities and adjust system parameters if necessary for optimum facility utilization.
- Interact with Maintenance Group in detection and correction of equipment failures.

- Establish and maintain a handbook of Standard Operating Procedures (SOP) for system operation.
- Establish a policy and schedule for regularly backing-up files on public disk file volumes.
- Maintain an information retrieval data base for magnetic tape library.

B. REQUIRED CAPABILITIES

- Sufficient understanding of the overall system operation, hardware and software, to provide day-to-day operational support to the facility.
- Sufficient vendor training and/or equivalent experience to be able to adjust system parameters for optimum efficiency.
- Sufficient vendor training and/or equivalent experience to establish and maintain a user accounting system.

III. MAINTENANCE GROUP

A. RESPONSIBILITIES

- Responsible for reliable operations of the facility hardware, including environmental control.
- Responsible for both preventative and corrective maintenance procedures.
- Establish and maintain a handbook of Standard Operating Procedures (SOP) for hardware maintenance.
- Interact with the Operations Group to detect impending equipment failures based on system error messages and scheduled preventative maintenance.
- Maintain spares and consumables inventory for facility operation.
- Maintain an information retrieval data base for the spares and consumables.

B. REQUIRED CAPABILITIES

- Be able to analyze logical, electrical, and mechanical operations using diagrams and functional schematics.

- Be able to perform preventative maintenance and, where applicable, run diagnostic programs for fault isolation.
- Be able to make necessary adjustments to equipment.
- Be able to interpret system error messages and diagnostic printouts.

IV. SOFTWARE GROUP

A. RESPONSIBILITIES

- Maintain system software and software libraries.
- Implement and/or direct applications software modifications and upgrades.
- Develop software documentation and standardization procedures.
- Support implementation and maintenance of an information management system.
- Develop and maintain a user's manual for the operational software in the facility.

B. REQUIRED CAPABILITIES

- Vendor level training in system software operation.
- Vendor level training or equivalent experience in assembly level and higher programming languages.
- Familiarity with the theory and operation of data base management systems (DBMS).

V. FACILITY UTILIZATION GROUP

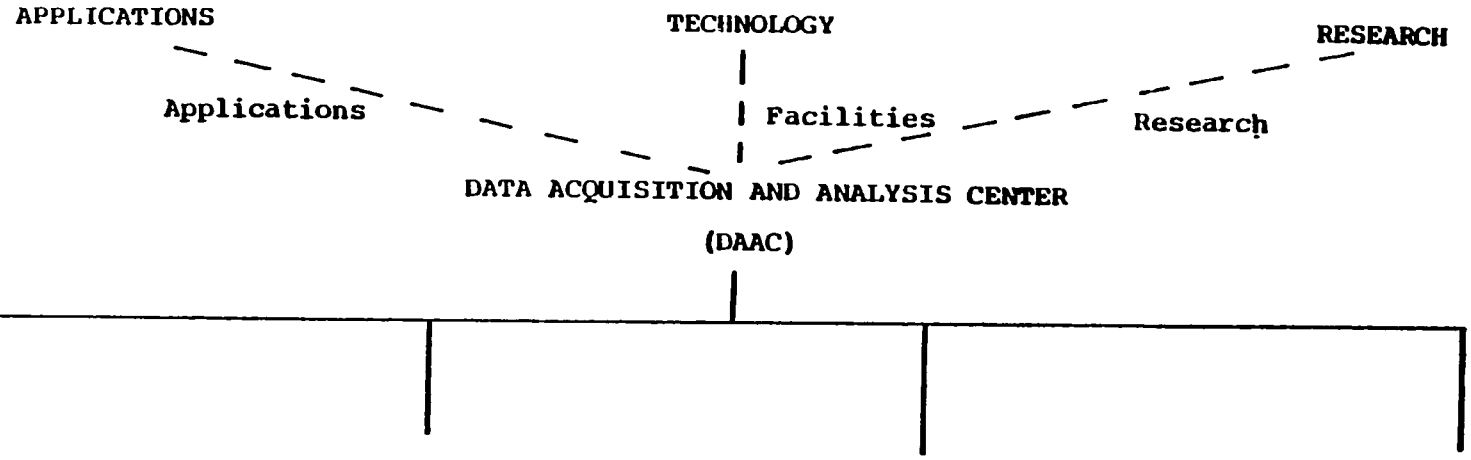
A. RESPONSIBILITIES

- Interact with individual users to determine facili requirements.
- Determine and provide user support and training for effective facility utilization.

- Interact with the Operations and Software Group to provide necessary support to users.

B. REQUIRED CAPABILITIES

- Sufficient understanding of overall system operation, hardware and software, to adequately advise potential users on the feasibility of proposed projects.
- Able to interact well with SPARRSO personnel in providing system support and promoting facility useage.
- Able to assist potential users in problem definition to the point of determining if software development is required and, if so, to act as the interface between the Software Group and the user.



OPERATIONS

- APT
- HRPT
- GMS
- DCS
- Computer
- Optronics, Matrix Wing/Lynch
- Digitizer Table
- Magnetic Tape Library

MAINTENANCE

- APT
- HRPT
- GMS
- DCS
- Computer
- Optronics, Matrix
- I^2S Display
- Spares Inventory

SOFTWARE

- System software and software libraries
- Implementation and maintenance of DBMS
- Software documentation and standardization procedures
- Users' manual
- Software development and/or direction

FACILITY UTILIZATION

- User interface to facility
- Provide support and training to potential users
- Operate on users' behalf with Operations and Software Groups to provide facility resources

APPENDIX E: ABSTRACT OF EVALUATION OF THE USAID/SPARRSO TRAINING ON "SATELLITE IMAGERY INTERPRETATION AND APPLICATION TO WEATHER FORECASTING"

APPENDIX E:
ABSTRACT
EVALUATION OF THE USAID/SPARRSO TRAINING ON
"SATELLITE IMAGERY INTERPRETATION AND
APPLICATION TO WEATHER FORECASTING"

by

Dr. Syed M. Hashemi

December, 1985

BACKGROUND

Twenty eight (28) participants, including seven women, from different government ministries, universities, and agencies received training in "satellite imagery interpretation and application to weather forecasting". the three week course was organized by NASA and SPARRSO and was supported through USAID's Agro-climatic and Environmental Monitoring Project (ACEMP). It was conducted at SPARRSO's facilities from 23 November to 12 December 1985. The instructor was Mr. Vincent Oliver.

PROCEDURE

This training course implemented a number of procedures in an effort to stimulate the interest of the participants and evaluate the success of the training. These procedures included:

(1) Review with the instructor of course outlines and lesson plans prior to class to help ensure the appropriateness of the materials.

(2) Screen candidates for participation in the course in order to select participants with appropriate previous training and current professional requirements.

(3) Provide a continuing review and feedback of participant progress through daily quizzes -- 13 in all.

(4) Provide recognition and special incentive for high level achievement (trip to Bangkok).

(5) Provide local course facilitator to interact with participants and identify problems throughout the course.

The daily quizzes were designed to be equivalent to U.S university standard and were conducted after each training session. In addition to the 13 quizzes, Dr. Hashemi maintained

a various training strategies and issues. As a direct result of his participation, the following recommendations were implemented during the course:

(1) Daily handing of lecture notes to all participants.

(2) Providing of supplementary reference materials.

(3) Coaching the instructor in using simple, non-ideomatic speech and written instructions.

(4) Reinforcing learning through repetition of important material, especially material imperfectly learned as indicated by the quizzes.

(5) Designating daily "study periods" for the participants to discuss the materials and interact with each other.

(6) Associate course participation and achievement with the National Aeronautics and Space Administration by use of the NASA logo on the course completion certificates.

(7) Revise quiz question ambiguities to promote comprehension and conceptual understanding.

(8) Organize informal interaction between trainees and participants through a social gathering.

RESULTS

The training program was considered to be successful by both the participants and the trainer. The participants maintained a nearly 100% level of attendance and an average of 83% on the U.S. university-level quizzes.

CONCLUSIONS

The clear success of this training program was largely due to careful implementation of several SPARRSO/USAID initiatives which were designed to solve certain problems identified with previous training courses. In particular, the course provided immediate feedback to both the instructor and the participants as to how well the subject matter was being understood. It also set in place a mechanism for tracking attendance and recognition for achievement.

As a result of this experience, a number of recommendations were made by Dr. Hashemi for future training projects of this type. Future training courses should:

(1) Conduct a pre-course orientation to provide basic information to those participants with a weak background in the subject matter.

(2) Provide a course outline and lecture notes in advance to allow outside preparation for the daily lectures.

(3) Provide participant access to a variety of texts and other reference materials which cover all aspects of the course material.

(4) Support participant interaction and self-help by appointing a couple of the better participants as "teaching assistants" to help weaker participants.

(5) Insure implementation of appropriate incentives. (The lottery for the Bangkok trip was cancelled at the last minute.)

(6) Provide recognition of levels of course achievement on the course completion certificates, e.g., "Highest Distinction", etc.

(7) Provide continuous access to tea or coffee and appropriate refreshment during the day.

(8) Encourage and support participant interaction and identification with achievement early in the training project.

(9) Develop and improve testing methodologies to assure accurate understanding of the practical applications of the conceptual materials.

APPENDIX F: BIBLIOGRAPHY

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